SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

Chapter 21

Matters of National Environmental Significance

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21.0 Matters of National Environmental Significance

21.1 Introduction

BM Alliance Coal Operations Pty Ltd (BMA) is seeking approval to develop the Saraji East Mining Lease Project (the Project) involving a single-seam underground mine and supporting infrastructure on Mining Lease Application (MLA) 70383 and MLA 70459 adjacent to, and accessed through, the existing open cut mine void within Mining Lease (ML) 1775.

This chapter of the Environmental Impact Statement (EIS) (BMA, 2024a) assesses Matters of National Environmental Significance (MNES) defined under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Project's Terms of Reference (ToR) for the EIS (DEHP, 2017) require the preparation of a stand-alone chapter addressing the Project's potential impacts on MNES and the principles of ecologically sustainable development set out in the EPBC Act (refer Section 21.1.3). This chapter has been updated in response to submissions on the draft EIS received in July 2021.

On 18 October 2016, the Project (EPBC Act Referral No. 2016/7791) was determined to be a controlled action under the EPBC Act requiring assessment of potential significant impacts on MNES. A summary of the MNES and relevance to the Project is presented in Table 21-1. The relevant controlling provisions under the EPBC Act with potential to be impacted by the Project include:

- Nationally listed threatened species and communities (Section 18 and 18A of the EPBC Act)
- a water resource, in relation to coal seam gas development and a large coal mining development (Section 24D and 24E of the EPBC Act).

This chapter addresses the issues relevant to the controlling provisions under the EPBC Act. No further assessment is presented for matters that are not controlling provisions.

Table 21-1 Matters of national environmental significance relevance to Project

MNES	Relevance to Project
Declared World Heritage properties	No declared World Heritage properties are located within or in the vicinity of the Project Site. The Great Barrier Reef received world heritage status in 1981 and is the nearest property. The Project Site is located approximately 490 kilometres (km) upstream from the mouth of the Fitzroy River and the Great Barrier Reef World Heritage Area (GBRWHA). Watercourses that traverse the Project Site combine with more than 20,000 km of waterways including six major river systems of the Fitzroy Basin catchment that drain into the Fitzroy River and Great Barrier Reef lagoon. Declared World Heritage properties are not a controlling provision for this Project under the EPBC Act.
National Heritage places	There are no National Heritage Areas located within or in the vicinity of the Project Site. The Great Barrier Reef is a listed place on the National Heritage List (Place ID: 105709). The Project Site is located approximately 490 km upstream from the GBRWHA. Watercourses that traverse the Project Site combine with more than 20,000 km of waterways including six major river systems of the Fitzroy Basin catchment that drain into the Fitzroy River and Great Barrier Reef lagoon. National Heritage places are not a controlling provision for this Project under the EPBC Act.
Declared Ramsar wetland	There are no Wetlands of International Importance (declared Ramsar wetlands) located within or adjacent to the Project Site. The closest Wetlands of International Importance are the Shoalwater and Corio Bays Area (Shoalwater Bay Training Area, in part – Corio Bay) located approximately 190 km east of the Project Site by direct line. Declared Ramsar wetlands are not a controlling provision for this Project under the EPBC Act.

MNES	Relevance to Project
Listed threatened species and ecological communities	Nationally listed threatened species and communities are a controlling provision for this Project under the EPBC Act. The EPBC Act Protected Matters Search indicates listed threatened species and threatened ecological communities (TEC) have potential to occur within or in the vicinity of the Project Site, including: • Four (4) EPBC listed TEC with description, status under Commonwealth legislation and likelihood of occurrence discussed in Section 21.5.2 • Six (6) EPBC Act listed flora species with description of preferred habitat, status under Commonwealth legislation and likelihood of occurrence discussed in Section 21.5.2.2 • 20 EPBC Act listed fauna species with description of preferred habitat, status under Commonwealth legislation and likelihood of occurrence discussed in Section 21.5.2.3. Significant impact assessment for species and communities known or potentially occurring within the Project Site are in Section 21.8.
Listed migratory species	The EPBC Act Protected Matters Search indicates 12 migratory bird species with potential to occur are within in the vicinity of the Project Site (AECOM, 2024d). Historical ecological assessments for the SRM confirmed presence of four migratory species on or near the Project site: Fork-tailed Swift (*Apus pacificus*); Latham's Snipe (*Gallinago hardwickii*); White-throated Needletail (*Hirundapus caudacutus*); and Caspian Tern (*Hydroprogne caspia*). Migratory species known or having potential to occur on site are aerial or non-breeding migrant species that use the Project Site for foraging only. Listed migratory species is not a controlling provision for this Project under the EPBC Act.
Commonwealth marine areas	The Project is not located in a Commonwealth marine area. Commonwealth marine areas are not a controlling provision for this Project under the EPBC Act.
The Great Barrier Reef Marine Park	The Great Barrier Reef Marine Park occurs approximately 490 km downstream from the Project. Watercourses that traverse the Project Site combine with more than 20,000 km of waterways including six major river systems of the Fitzroy Basin catchment that drain into the Fitzroy River and Great Barrier Reef lagoon. The Great Barrier Reef Marine Park is not a controlling provision for this Project under the EPBC Act.
Nuclear actions	The Project is not and does not involve a nuclear action.
A water resource, in relation to coal seam gas development or large coal mining development	A water resource is a controlling provision for this Project under the EPBC Act as the Project involves a large coal mining development. This chapter presents significant impact assessment for these matters in Section 21.8.

21.1.1 Project justification

The Project will allow BMA to expand its production capacity in the Bowen Basin to meet current and future market demands for its coal products. The Project will produce metallurgical coal for export, generate jobs and result in increased investment and royalties for Queensland. Increased demand for coal products in India, China and other international markets, particularly for steel manufacturing has created additional export opportunities for the development of this new mine.

Coal is Queensland's largest export commodity with the Queensland Government benefiting significantly from royalties paid by the mining industry each year. In the 2022 financial year (FY2022), the total royalties and taxes paid to the Queensland Government by BMA was AU$3.6 billion (BHP, 2022). The Project will add to royalties derived from mining activities during each year of operation. In addition to these economic benefits, BMA through its existing operations, provides employment and training opportunities through direct and indirect employment and secondary support industries. BMA also provides extensive support to community development, education, health, social and recreational programs in the region.

The Project will benefit Isaac Regional Council (IRC) and State of Queensland. Key benefits include:

- direct economic benefits, including employment, payment of taxes and royalties
- creation of up to 1,000 jobs during the peak construction phase, and up to 500 jobs during the peak operational phase
- indirect economic benefits to industries in the Mackay region
- indirect employment benefits in Project-related services both locally in IRC and state-wide
- expansion of the BMA Community Partnership Program for increased community initiatives
- support for appropriate skills and training programs to further develop industry skills.

21.1.2 Project alternatives

The following key objectives were considered when planning the Project:

- commence high productivity longwall underground mining of the Dysart Lower Seam down dip of the existing Saraji open cut mining operation
- provide continued production of high-quality hard coking coal to the export market
- design, construct and operate the Project to:
  - minimise adverse impacts on the surrounding bio-physical and social environments
- comply with relevant statutory obligations and employ processes to enhance sound environmental management

Project alternatives considered as part of the Project include do nothing and alternative locations, layout and methods for mining and key project elements. The principles of ecologically sustainable development were considered during development of the Project and are described in Section 21.1.3.

Table 21-2 Project alternatives

Alternative	Discussion
Do nothing	• remains grazing and land tenure • avoids ecological habitat, land and water impacts and greenhouse gas (GHG) emissions • demand for metallurgical coal sourced from another mine • loss of economic benefit, primary and secondary employment opportunities • loss of State royalty payments and Commonwealth tax revenue.
Location	• existing exploration tenure contiguous with existing operational BMA mine lease • suitable siting within existing mining precinct in the Bowen Basin • surrounded by operational coal mines and supporting infrastructure • access to highest quality coals in the down dip coal seam via open cut-highwall • reduced capital expenditure, minimal disturbance and increased operational efficiency through shared infrastructure, water and waste management systems • mining intersects Hughes Creek and Boomerang Creek already subject to diversions and impacts of mining upstream, avoiding mining impacts to Phillips Creek, Spring Creek and One Mile Creek to the south
Target resource	• targets Dysart Lower Seam (generally a thicker seam with maximum opportunity to extract high quality coals) in comparison to the Harrow Creek Upper Seam • consistently higher coal quality and production output from the target resource • optimal seam thickness for longwall mining • maximises economic viability of the Project

Alternative	Discussion
Underground mine plan	• maximised underground mining footprint results in greater surface disturbance, particularly subsidence impacts on overlying waterways and surface water flow • underground mine plan optimised access to dipping coal seams and minimised environmental impacts • integrates with existing SRM open cut mine and supporting infrastructure • accessed via the existing open cut high wall, the Project ensures mining commences in a low gas environment. • access point structurally benign, avoiding faults and suitably separated from productive mining operations in SRM's open cut 'pits' to the south
Mining methods	• target deep dipping coal seams at depths greater than 150 metres (m) and seam thickness between 4.9 m and 7 m conducive to underground mining methods (Minserve, 2022) • modern longwall mining techniques and equipment have made significant improvements in production efficiency as well as safety (IESC, 2014) • open-cut mining can be safer and achieve higher cost recovery but generates more dust, light, noise and spoil to be managed, as well as greater surface disturbance • average extracted seam thickness of 3.6 m reduces surface subsidence; increased panel heights and extraction volumes of longwall top coal caving (LTCC) generally have greater impacts at the surface; bord and pillar techniques sterilise significant proportion of coal resource and result in pothole subsidence over decades (MSEC, 2007).

21.1.3 Integration of ecologically sustainable development

The goals of ecologically sustainable development are to develop and improve the quality of life, both now and in the future, in a manner that maintains the integrity of ecological processes on which life depends.

The principles of ecologically sustainable development have been an integral consideration throughout the development of the Project. The Project's compatibility was reviewed against the objectives and principles defined in the National Strategy for Ecologically Sustainable Development (Ecologically Sustainable Development Steering Committee, 1992). The Project addresses the principles of ecologically sustainable development (ESD) as outlined in Table 21-3.

Table 21-3 Integration of EPBC Act principles of ecologically sustainable development

Principles of ESD	Integration into Project development
If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	BMA has undertaken an assessment of the risk of unacceptable environmental harm consistent with the precautionary principle and used the findings to determine appropriate environmental control strategies, which have been detailed in this chapter and described further in the Project's summary of commitments (refer to EIS, **Appendix O-1 Summary of Commitments**). A conservative impact assessment methodology has been adopted for the Project and is described in Section 21.3.
The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations	Through appropriate management strategies and monitoring of impacts, the Project will not significantly reduce, or fail to maintain the health, diversity and productivity of the Queensland environment or negatively affect future generations. The EIS demonstrates appropriate level of assessment is undertaken to properly identify and manage potential impacts to the environment to: • Achieve compliance with quality objectives such as Queensland Environmental Protection Policy (EPP) (Air Quality), EPP (Noise) Policy and EPP (Water and Wetland Biodiversity). • Achieve compliance with Basin-specific surface water and groundwater quality objectives defined by the Queensland Water Act.

Principles of ESD	Integration into Project development
	• Align with planning goals as expressed in the Isaac Regional Council (IRC) Community Strategic Plan 2035 and Mackay, Isaac and Whitsunday Regional Plan 2012 ensuring BMA contributes to infrastructure provision (e.g. water supply and road infrastructure) by agreement with the IRC to support the liveability of local towns. • BMA will maintain and/or increase its community investment in local towns, commensurate with increases in BMA employment. • BMA has demonstrated that its community investment expenditure exceeds IRC benchmarks. • Progressively rehabilitate land disturbed by the Project to a safe and stable landform able to sustain an approved post-mining land use.
The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making	Environmental assessments have been undertaken to assess the impact to terrestrial and aquatic ecology values in the vicinity of the Project site to determine appropriate environment control strategies. The Project infrastructure has been located to minimise impacts on terrestrial and aquatic systems. Offsets are proposed for residual impacts as presented in Section 21.10.
Improved valuation, pricing and incentive mechanisms should be promoted	The Project has the technical and financial support and resources to establish and maintain the proposed environmental protection controls.

21.1.4 Project overview

The Project is located approximately 170 km southwest of Mackay and 30 km north of Dysart in the Isaac Region of central Queensland. This location is immediately east of the approved existing open-cut SRM, which means that the extent and nature of the resource is well understood to be of high quality and will meet current and expected future market requirements and demands.

The Project will involve development of a greenfield single-seam underground mine on MLA 70383 and MLA 70459 commencing from within ML 1775. The Project Site comprises Exploration Permit for Coal (EPC) 837, EPC 2103, MLA 70383, MLA 70459, ML 1775, ML 70142 and ML 1782, except the southern extent of the powerline connection that is within Lot 10 on CNS83 and Lot 11 on CNS373.

The Project Site encompasses approximately 11,427 hectares (ha) of predominantly grazing land. Mining and the infrastructure required to support the Project will be constrained to 3,348 ha; this is referred to as the Project Footprint. This area is a conservative estimate, meaning it likely overestimates the actual area. The Project Site and Project Footprint are presented in Figure 21-1.

The Project is expected to produce approximately 110 million tonnes of product coal for the export market over a 20-year mine life, supporting economic prosperity and employment in the region.

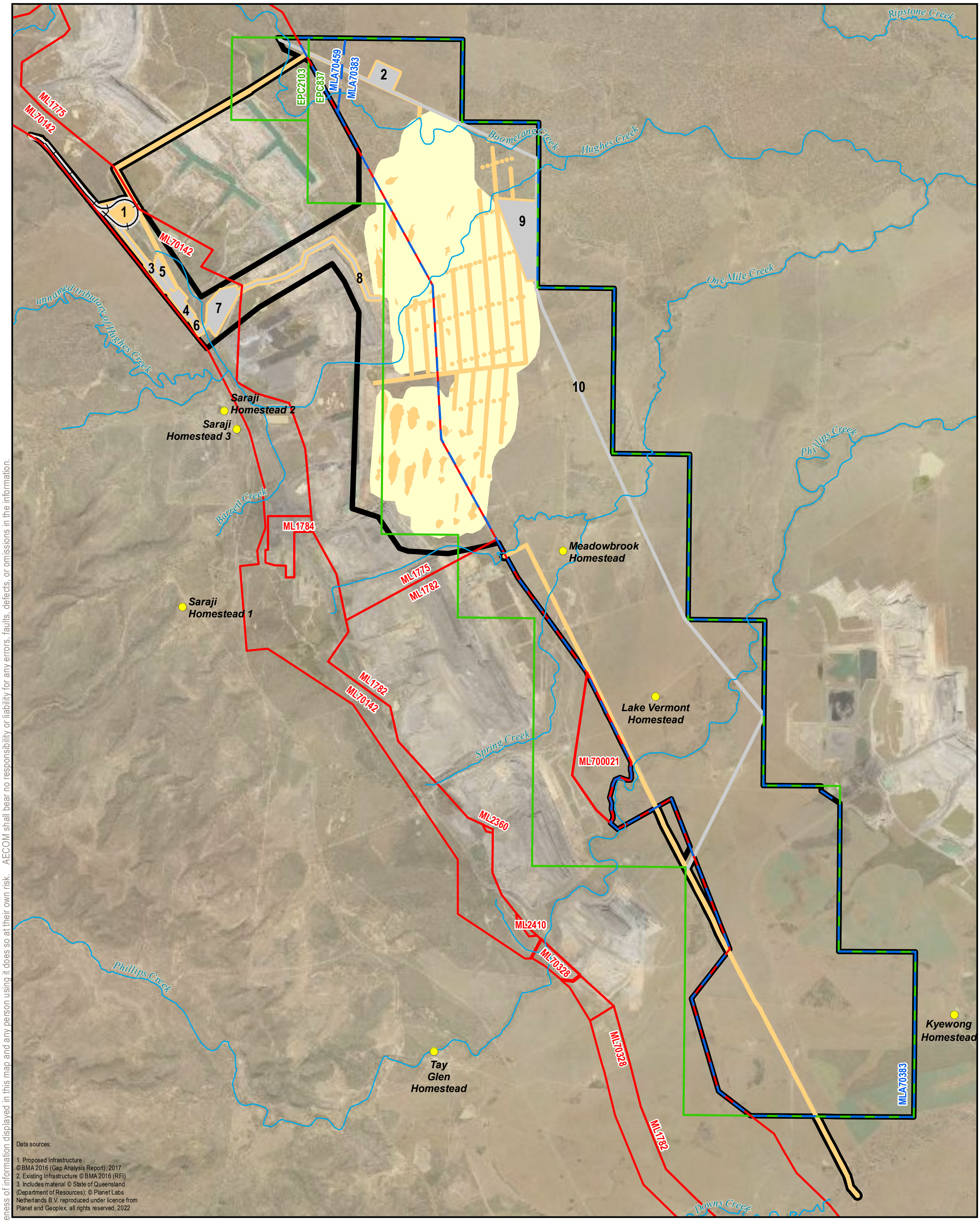
The Project Site is located adjacent to, and in some cases overlaps, areas which are currently approved as the existing BMA SRM. The existing SRM is an active, open cut mine owned by the Central Queensland Coal Associate (CQCA) Joint Venture, namely BHP Coal Pty Ltd, BHP Queensland Coal Investments Pty Ltd, Umal Consolidated Pty Ltd, QCT Resources Pty Limited, QCT Mining Pty Ltd, QCT Investments Pty Ltd and Mitsubishi Development Pty Ltd. The CQCA is an unincorporated joint venture between BHP (50 per cent) and Mitsubishi Corporation (50 per cent). The mine is operated by BMA under a management agreement. Resource projects surrounding the Project Site are presented in Figure 21-2.

The Project is immediately east of the existing SRM where BMA is approved to undertake open cut mining on ML 1775, ML 70142, ML 1784, ML 1782, ML 2360, ML 2410, ML 70294, ML 70298, ML 70328 and ML 700021 under Environmental Authority (EA) Permit No. EPML00862313. The existing SRM is not within the scope of this Project and BMA will continue to undertake open cut mining operations, and related activities (for example rehabilitation), at the existing SRM in accordance with the terms of its existing approvals.

Siting of Project infrastructure will prioritise locations to minimise the overall impact on MNES through an iterative process of identifying environmental and operational constraints and opportunities. The Project configuration was developed based on proximity to practical siting and sizing of Coal Handling and Preparation Plant (CHPP), proximity to rail loading infrastructure, future mining and minimising disturbance of environmentally sensitive areas.

The Project will utilise the existing approved SRM infrastructure such as powerlines, water supply pipelines, CHPP, haul roads, workshops and warehouses, where practical. Additional mine infrastructure will include a new CHPP, associated mine industrial area (MIA) and a new rail spur and balloon loop to be located on the Project Site where it overlaps the existing adjacent SRM. A new infrastructure and transport corridor will be constructed on MLA 70383 and MLA 70459 to accommodate the reconfiguration of existing power and water networks and internal access roads. No additional water supply is planned. Surface infrastructure layout is shown in Figure 21-1.

The key features of the Project are summarised in Table 21-4.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Surface Infrastructure
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Watercourse
- Homestead
- Rail loop

Surface Infrastructure

1 Rail Loading Balloon Loop
2 Process Water Dam
3 Product Stockpiles
4 CHPP
5 Raw Water Dam
6 ROM Pad
7 Future MIA
8 Conveyor
9 Construction Village
10 Transport and Infrastructure Corridor

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Figure 21-1
Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

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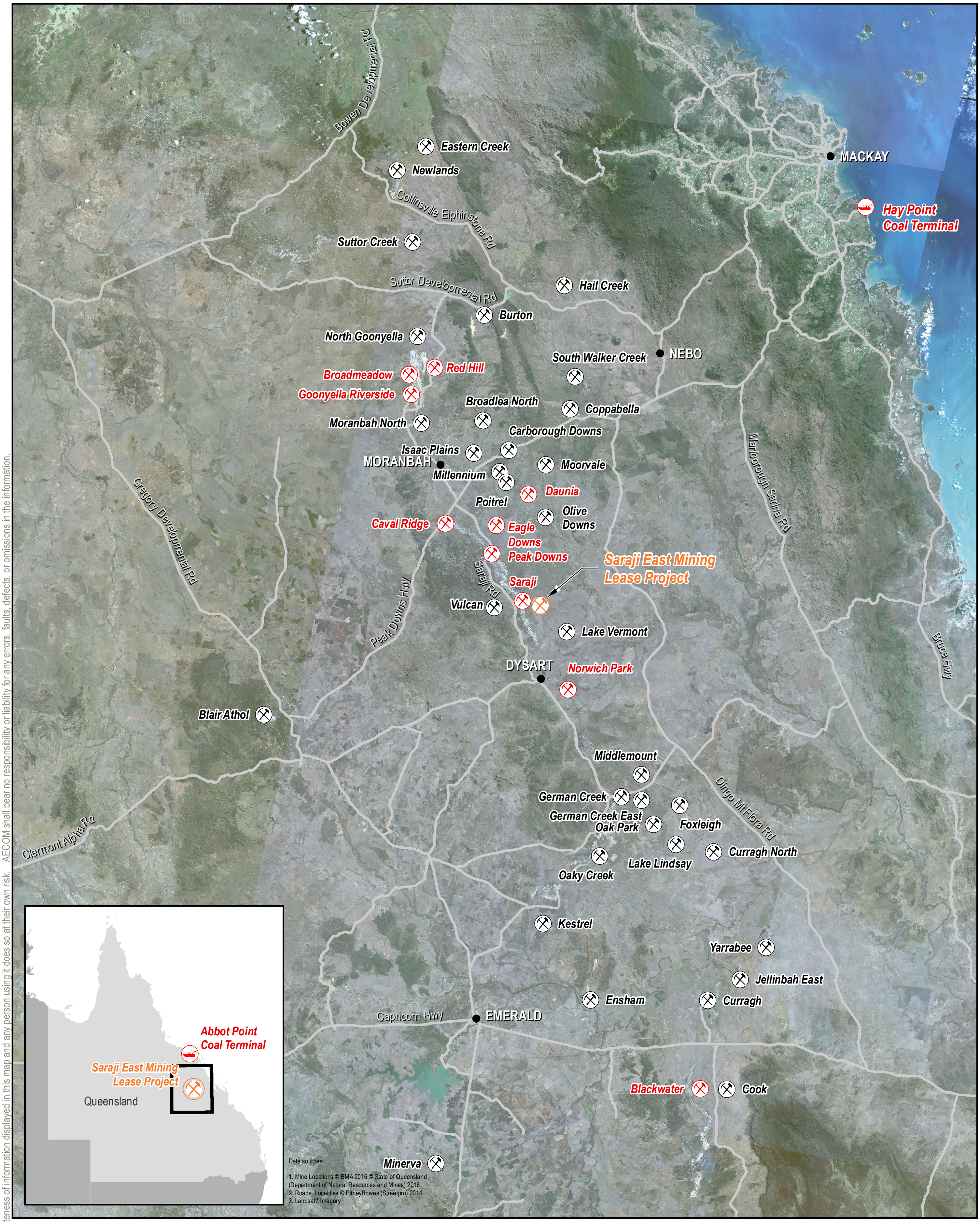

LEGEND

- Saraji East Mining Lease Project
- BMA Coal Terminal
- BMA Mine
- Other Mine
- Locality
- Major Road

N

0 5 10 20

Kilometres

Scale: 1:1,500,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

Figure 21-2
Regional Context

Environmental Impact Statement
Saraji East Mining Lease Project

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Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\21 MNES Ecology\60507031_G073_v6_A4P_RegionalContext.mxd

Table 21-4 Key features of the Project

Project feature	Description
Total production	Approximately 150 million tonnes (Mt) run-of-mine (ROM) coal based on a 20-year mine life i.e. approximately 110 Mt of product coal.
Average annual production (excluding ramp up/down and potential extensions)	8.2 million tonnes per annum (Mtpa) ROM coal annual average up to 11 Mtpa 6.2 Mtpa product coal annual average with a maximum of 8 Mtpa.
Capital expenditure	Estimated to be approximately $1.3 billion.
Mine life	Approximately 20 years with potential for extensions (production), with nominal 10-year period of decommissioning and rehabilitation.
Operating hours	24 hours per day, 7 days a week.
Workforce	Up to 1,000 (construction). Up to 500 (operation).
Accommodation Construction	Temporary construction village with capacity for 1,000 mine workers (refer Surface Infrastructure area 9 of Figure 21-1).
Mining method	Underground longwall mining.
Existing ML	ML 70142, ML 1782 and ML 1775.
Proposed MLA	MLA 70383 and MLA 70459.
Mine infrastructure and tailings/rejects management	The Project will largely utilise existing infrastructure as part of the current SRM operations. The Project assumes the following additional components: • new MIA located on ML 70142 (refer Surface Infrastructure area 7 of Figure 21-1) • new CHPP on ML 70142 (refer Surface Infrastructure area 4 of Figure 21-1) • a conveyor system and haul road to deliver coal from the underground portals to the CHPP and product coal to the rail loading facilities located over both ML 1775 and ML 70142 (refer Surface Infrastructure area 8 of Figure 21-1) • ROM stockpile and product stockpile pads located on ML 70142 (refer Surface Infrastructure area 3 and 6 of Figure 21-1) • a new rail spur, balloon loop and signalling system on ML 70142 (refer Surface Infrastructure area 1 of Figure 21-1) • network of incidental mine gas (IMG) drainage bores and associated surface infrastructure consisting of gas and water collection networks and access tracks across the underground mine footprint across ML 1775 and MLA 70383 (refer Surface Infrastructure area 2 of Figure 21-1).
Mine Water Management System (WMS)	Dams, catchment diversions and drains will be required to support mining operations, manage mine affected water (MAW) and protect downstream environmental values by minimising uncontrolled releases. Project water infrastructure will consist of: • process water dam (PWD): Runoff from disturbed areas of the Project, including the MIA, CHPP, stockpiles (ROM and product coal), train load out, and portal entry sump will be collected at source and transferred to the PWD. The PWD will be constructed as a turkey's nest (no external catchment) and located on MLA 70383 • temporary gas dewatering storage: The pre-drainage of IMG will result in the production of water. This water will be collected in local facilities near the well head. These facilities will act as a balancing storage to allow transfer at a constant rate to the PWD • raw water dam (RWD): The RWD will be a turkey's nest design and will receive clean water inflows from BMA's 10,000 mega litres per year (ML/yr) allocation from the Northern Network Pipeline. Water from the RWD will be used to satisfy the Project's potable water and underground mining equipment demands, as well as makeup supply for dust suppression and CHPP process demand when supplies of MAW are unavailable for reuse. The RWD will be located on ML 70142 • additional highwall pumps:

Project feature	Description
	The access portal to the underground workings will be via the existing open cut highwall. Water collected in the highwall portal pit sumps will be pumped to the PWD to maintain the flood immunity of the underground workings • pipelines: Relocation and re-connection of the existing Eungella Water Pipeline Company (EWPC) Southern Extension Water Pipeline into a new infrastructure and transport corridor to the eastern boundary of MLA 70383 and northern boundary of MLA 70459. A water pipeline will be constructed connecting the Project's surface infrastructure located on ML 70142 to the PWD located on MLA 70383. Water transport associated with the Project will be achieved via the utilisation (and enhancement where necessary) of BMA's existing water pipeline network connecting SRM to BMA mines to the north and south of SRM. • mine-affected stormwater drainage infrastructure: Mine affected runoff dams, bunds and drains to capture and treat run-off from disturbed areas, including ROM and product stockpile pads, CHPP and MIA. Under normal operating conditions, the Project mine water system will operate independently; however, as authorised by SRM EA, water may be transferred between the Project and the broader BMA network of mines via the existing water pipeline network to enhance available water supply and storage capacity. Site transfers will be subject to operational demand and water quality testing and control.
Electricity infrastructure	Existing 132 kilovolt (kV) powerline will be relocated and re-connected into a new infrastructure and transport corridor to the eastern boundary of MLA 70383 and northern boundary of MLA 70459. Bulk electricity demand will be supplied by the existing Ergon Supply (Dysart 66 kV supply to SRM). Two new powerlines will be constructed to support the provision of power to the Project: • a co-aligned 66 kV powerline and connection extending off lease and connecting to the Dysart Substation • a northern extension connecting the Project to the transport and infrastructure corridor. To the extent that the powerline extends beyond lease boundaries, subsequent discussion with relevant authorities and legislative approvals will be undertaken to confirm approval requirements for off-lease infrastructure. As the off-lease transmission line will not be authorised by the Project EA on mining tenure, development approval will likely be required. Required approvals will be confirmed following detailed design. The existing SRM currently has an authorised maximum allowance of 43 megawatts (MW). The current maximum demand of the SRM is between 26 MW and 30 MW. The anticipated demand for the Project (underground and surface infrastructure) is estimated to be between 11 MW and 14 MW.
Public and private roads	Construction of an access road within the new infrastructure and transport corridor near the eastern boundary of MLA 70383 and the northern boundary of MLA 70459. Intersection development will occur: • between the proposed internal access road and the Lake Vermont Road • Saraji Road and existing SRM identified access point for the CHPP and MIA.
Communications	Communications will be provided by extending the services from the SRM via the existing service corridor. Telecommunications will be controlled and monitored through a new Project control room located on site or from a centrally located facility in Brisbane.
Rehabilitation	Rehabilitation and decommissioning strategies to be implemented for the Project: • mine roads will be rehabilitated unless otherwise agreed with the subsequent landowner and in accordance with the EA • water dams not required for long term water management will be decommissioned and removed, unless otherwise agreed with the subsequent landowner and in accordance with the EA • major infrastructure, including the CHPP, will be decommissioned, dismantled and removed from site

Project feature	Description
	• concrete pads will be covered with benign waste rock or ripped and removed, then topsoiled and re-vegetated in accordance with the EA • other facilities, including workshops and warehouses, will be decommissioned and removed, unless otherwise agreed with the subsequent landowner and in accordance with the EA. BMA will comply with the legislative amendments associated with the *Mineral and Energy Resources (Financial Provisioning) Bill 2018*. The EA will require a transitional Progressive Rehabilitation and Closure Plan (PRCP) to be developed prior to construction commencing and will demonstrate that the proposed Project will: • be rehabilitated to a safe and stable landform • not cause environmental harm • sustain post mining land uses. Progressive rehabilitation will be carried out as described within **Chapter 5 Land Resources** and **Appendix K-1 Rehabilitation Management Plan.**

The easements for linear components are summarised in Table 21-5. As linear infrastructure siting and alignment will be subject to further detailed design, the extent of direct disturbance/impacts are modelled and assessed based on a maximum 100 metre (m) corridor for roads, powerlines and gas drainage to allow for future variation in alignment and micro-siting.

Table 21-5 Easement width

Project feature	Easement width
Transmission line	20-50 m
Access tracks	20-50 m
Pipeline crossing	10-20 m
Incidental mine gas drainage pipeline	10-20 m (plus cleared pads for gas wells)

21.1.4.1 Construction

Construction will commence following the granting of relevant approvals and BMA's decision to proceed with the Project. For EIS-related impact assessment purposes, the two-year construction stage (Stage 1) was assumed to commence FY 2023 (Year 1). The actual timing for Project commencement will be determined based on progress of mining at the neighbouring SRM and commercial market drivers.

Initial construction workforce of 500 people will be required in Year 1, increasing to 1,000 people by Year 2. Mine construction hours during this peak period will be in two 12-hour shifts, seven days a week, 365 days per year. Anticipated activities during construction years are summarised in Table 21-6.

Table 21-6 Construction activities

Construction year	Construction activities
Year 1	• construction accommodation village • mine portal • gas drainage infrastructure (western-most gas wells, pipelines) • raw water dam and process water dam.
Year 2	• powerlines • MIA • CHPP • rail loop and load out facility • vent shafts • remaining gas drainage infrastructure • water pipelines • construction area rehabilitation

Of the Project Footprint (3,348 ha) with potential to be impacted by Project activities, direct impacts of construction (Stage 1) comprise 1,294.5 ha associated with:

- surface infrastructure (799.6 ha)
- indicative IMG drainage network layout (376.3 ha).

Due to the overlap between infrastructure components such as surface infrastructure and IMG drainage network, the sum of the direct impact disturbance areas does not equal the total direct disturbance area of 1,294 ha. Areas disturbed during construction that are not proposed to be utilised during operational activities will be progressively rehabilitated.

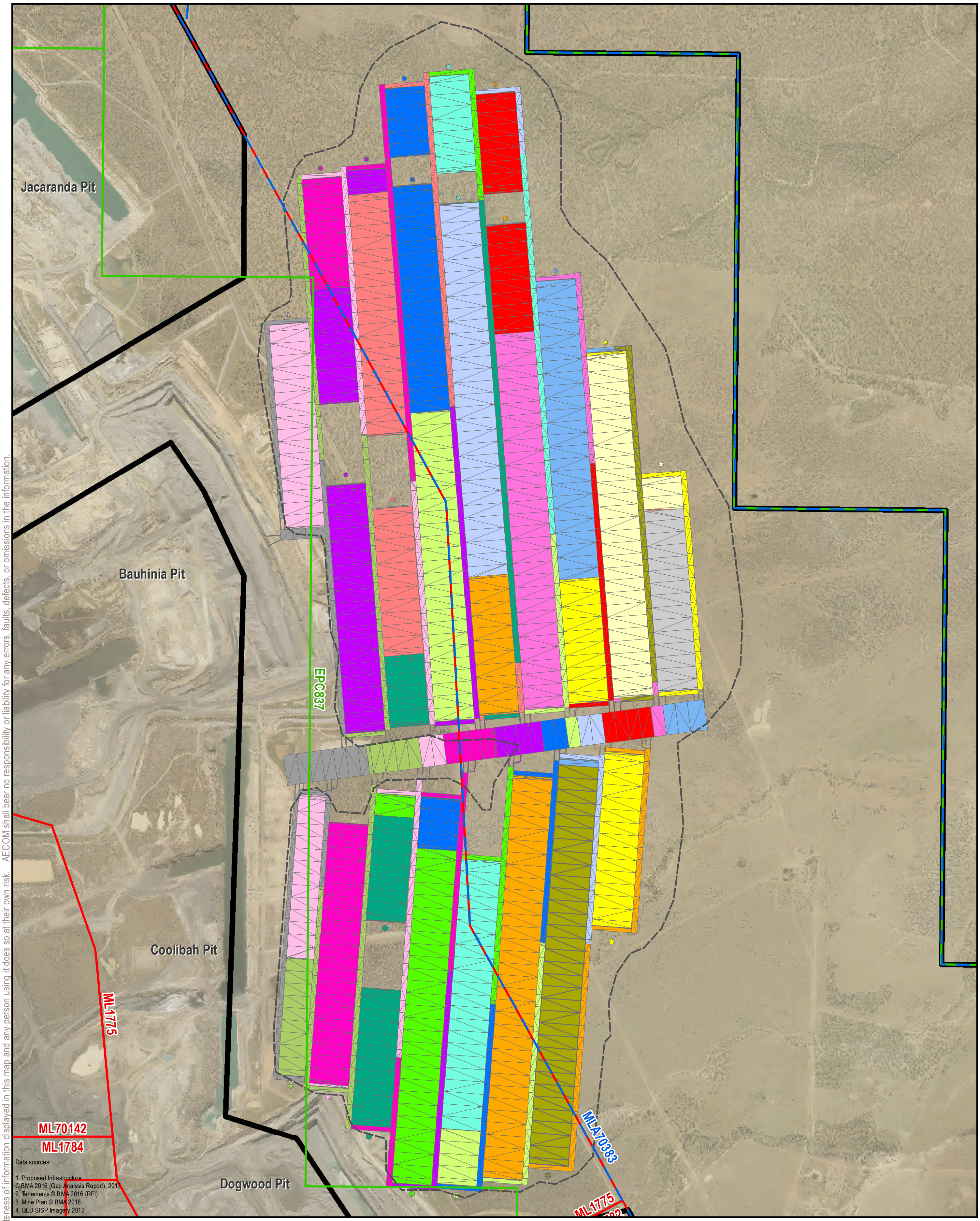
21.1.4.2 Operation

The proposed underground extraction sequence is to commence longwall extraction with the shallowest longwall panel in the southern mining domain of the Dysart Lower (D24) seam. The Project will be developed according to an optimised underground mine plan to minimise resource waste and sterilisation. Sequencing will be designed to maximise safe and efficient resource extraction.

Timing for production will depend on commercial arrangements and infrastructure constraints. For EIS-related impact assessment purposes, production / operations begin FY2025 with a total mine life of 20 years. The operational phase (Year 3-20) forms Stage 2 of the Project.

The underground mine plan and mining sequence over 20 year mine life is shown in Figure 21-3.

Of the Project Footprint (3,348 ha) with potential to be impacted by Project activities, direct impacts of operation (Stage 2) comprise 145.7 ha associated with maximum extent of temporary ponding areas. Indirect impacts (2,054.3 ha) are represented by the balance of the Project's predicted subsidence areas.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Limit Of Subsidence

Underground Mine Layout

Year 1	Year 8	Year 15
Year 2	Year 9	Year 16
Year 3	Year 10	Year 17
Year 4	Year 11	Year 18
Year 5	Year 12	Year 19
Year 6	Year 13	Year 20
Year 7	Year 14	

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Figure 21-3
Proposed underground mine plan

Groundwater Technical Report
Saraji East Mining Lease Project

0 0.25 0.5 1
Kilometres

Scale: 1:40,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Gas drainage and management

Incidental Mine Gas (IMG) occurs in the two major coal bearing geological units of the Project Site. These units are the Fort Cooper Coal Measures (FCCM) and Moranbah Coal Measures (MCM). The Project will require construction of a gas drainage network to drain and manage IMG to enable the safe and efficient mining of coal. An example of the IMG pre-drainage process is illustrated in Figure 21-4.

An IMG hazard management strategy will be developed prior to construction to reduce the associated risks during operation. This will include:

- pre-drainage of coal measures prior to underground mining (pre-drainage methane)
- dilution of methane through mine ventilation during underground mining, known as ventilation air methane
- post-drainage of goaf after longwall underground mining (goaf methane)
- co-development agreements are being discussed with relevant tenement holders to enable gas drainage activities which are expected to be resolved prior to granting of the mining leases.

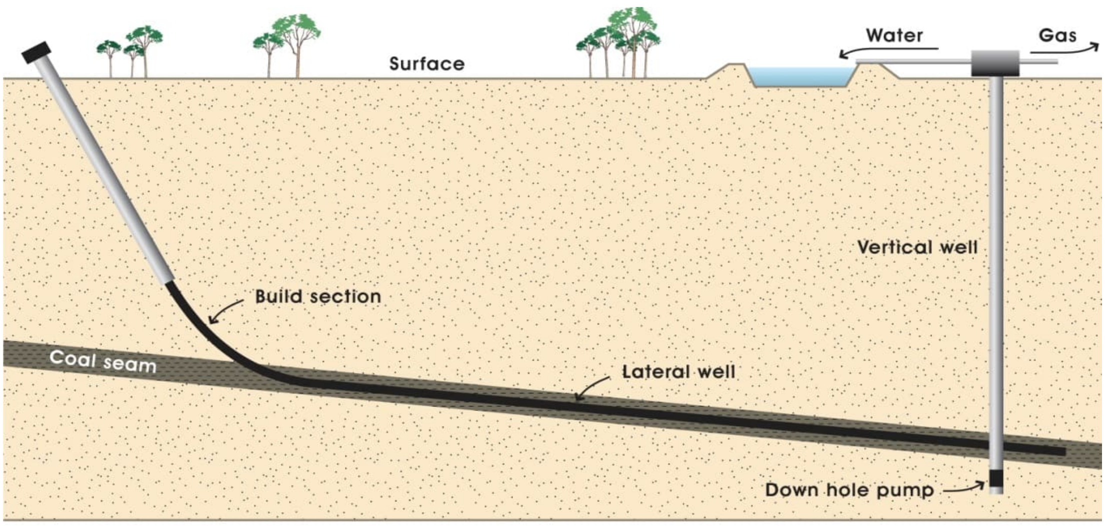


Figure 21-4 Incidental mine gas pre-drainage process

As described in Table 21-5, as linear infrastructure siting and alignment associated with IMG drainage network will be subject to further detailed design, extent of direct disturbance/impacts are modelled and assessed on a maximum 100 metre (m) corridor for roads, powerlines and gas drainage to allow for future variation in alignment. The impact calculated would be considered an over-estimation.

Water supply

BMA holds allocations to source water from the Fitzroy and Burdekin water catchments and licences to take water across BMA's mine sites via an existing BMA-operated water pipeline network servicing its mines, landholders, and towns.

BMA holds contractual rights to approximately 10,000 mega litres (ML) of water per annum from the Burdekin Pipeline (owned by SunWater) as a supply source for BMA operations in the vicinity of Moranbah. BMA also has a water allocation of 6,200 ML per annum from the Eungella Dam for use in BMA operations in the Moranbah vicinity. In securing its water rights, BMA has allowed for the current and potential future use of water from these sources at the SRM and for growth options associated with MLA 70383.

The Project's raw water dam does not have a local catchment and will only receive clean water inflows from BMA's existing water allocations and delivered via BMA's existing pipeline network. Raw water from the BMA's surface water allocations will be piped to the Project Site and used to satisfy the Project's potable water and longwall mining equipment demands. Raw water will be used to supplement CHPP make-up water as required.

No additional water allocation will be sourced for this Project.

21.1.4.3 Decommissioning and rehabilitation

Decommissioning of the Project Site will occur on a staged basis over several years prior to closure in accordance with landholder agreements and the Project EA. The following strategies will be implemented for decommissioning the Project:

- mine roads will be rehabilitated, unless otherwise agreed with the subsequent landowner and in accordance with the EA
- water dams not required for long term water management will be decommissioned and removed, unless otherwise agreed with the subsequent landowner and in accordance with the EA
- major infrastructure, including the CHPP, will be decommissioned and removed offsite
- decommissioning of built infrastructure (with no beneficial use to the post mining land use (PMLU)) will include removing concrete to a depth of 0.5 m below the surface or covering to a minimum depth of 0.5m to enable establishment of the PMLU
- other facilities, including workshops and warehouses, will be decommissioned and removed, unless otherwise agreed with the subsequent landowner and in accordance with the EA.

An assessment of the roads and infrastructure onsite will be undertaken in consultation with the landholders as well as relevant parties to determine the extent of removal and the correct retention, recycling, rehabilitation or disposal methodology. Transport requirements will support removal of infrastructure for re-purposing, re-sale or recycling (if considered cost effective) and the removal of waste material by a suitably licensed contractor.

Rehabilitation will be progressively completed in accordance with the Rehabilitation Management Plan (RMP) (BMA, 2024b) and is discussed further in Section 21.7. The PMLU proposed is an undulating landscape that could be used as grazing land or dryland cropping, consistent with the existing land use. PMLUs for the Project will be confirmed prior to construction. An indicative summary of the rehabilitation program to be implemented throughout the life of the Project is detailed in Table 21-7. As the life expectancy of the Project is expected to align with the existing SRM, no changes are anticipated to the existing RMP timing.

Table 21-7 Indicative mine rehabilitation schedule

Phase	Year progressive rehabilitation phase starts	Year progressive rehabilitation phase ends
Phase 1	Year 1	Year 19
Phase 2	Year 19	Year 21
Phase 3	Year 21	Year 22
Phase 4	Year 22	Year 24
Phase 5	Year 24	Year 28
Phase 6	Year 28	Year 28

21.1.4.4 Environmental management systems and compliance

On 24 May 2013, BMA applied to the former Department of Environment and Resource Management (DERM), now DES, for a new Project-specific EA for underground coal mining. On 25 June 2013, DERM issued a Notice of Information Request for the EA application requiring an assessment by EIS in accordance with the ToR.

The Project EA will authorise mining activities and ancillary activities that are environmentally relevant activities (ERA) under Schedule 2A and Schedule 2 of the Environmental Protection Regulation 2008. The ERAs proposed to be undertaken as part of the Project include:

- resource activity ERA 13 – mining black coal
- ERA 8 – Chemical storage
- ERA 31 – Mineral processing
- ERA 63 – Sewage treatment.

The Project EA will impose environmental management conditions on the proposed mining activities on the relevant ML and outline the environmental management requirements BMA will comply with related to regulated structures, water and waste management, monitoring and reporting.

The existing adjacent SRM currently operates under EA Permit No. EPML00862313. This EA permits interactions between the SRM tenure and the Project, as well as other BMA mining operations. Potential Project interactions with SRM EA Permit No. EPML00862313 includes:

- Specific waste types to be transferred from the Project to SRM waste management systems
  - SRM EA currently includes a condition (Condition D3) to accept certain waste types (including rejects) from other BMA mines, there will be no wording amendment required to the SRM EA. Where waste is transferred to SRM, it will be managed in accordance with existing SRM EA conditions.
- Option to transport MAW between the Project and SRM
  - Will only occur under exceptional circumstances. The Project CHPP mine water system has been designed to operate independently. SRM EA currently includes a condition (Condition F23) in support of MAW transfer from other BMA mines.
- Option for the use of SRM CHPP when Project CHPP reaches maximum capacity
  - SRM will only accept ROM up to the current authorised capacity of the CHPP under the SRM EA. There is no requirement to increase the throughput of SRM CHPP as volumes will be managed within existing limits.

Due to the existing SRM EA Permit allowing for such interactions between SRM and the Project, no change in annual product tonnage output or new ERAs are anticipated on SRM tenure.

Operation of the existing SRM is anticipated to extend beyond 2040 under approved and proposed ML boundaries. An amendment was made to the SRM EA in 2017 to permit the extension of the Grevillea Pit to access further coal resources in ML 700021. Future operations may include development within MLA 7083.

The SRM operates an Environmental Management System (EMS) consisting of systems, programs and procedures to manage water, biodiversity, dust and noise nuisance, waste, cultural heritage and rehabilitation. While the SRM and the Project are two independently operated operations, relevant environmental management plans will be updated as required to address operational overlap.

BMA has an excellent record of responsible environmental management and a strong commitment to continual improvement of environmental performance. BMA has not been subject to any environmental related proceedings in any of the following Courts - High Court, Federal Court, Supreme Court, District Court, and Planning and Environment Court. BMA has been the subject of environmental related proceedings in the Queensland Magistrates Court, for matters related to State legislation. A fine was imposed and paid by BMA. No conviction was recorded.

BHP’s approach to environmental management is incorporated in the Health, Safety and Environment Charter, which outlines ‘an overriding commitment to health, safety, environmental responsibility and sustainable development’. BHP strives to achieve the efficient use of resources, including reducing and preventing pollution, and enhancing biodiversity protection by assessing ecological values and land use in our activities. Our stewardship approach is designed to ensure that the lifecycle health, safety, environment and community impacts associated with resources, materials, processes and products related to our businesses are minimised and managed. BHP’s environmental policy describes these values and is available on the company’s website (https://www.bhp.com/our-approach/our-purpose/).

Further information can be found in the annual BHP sustainability report available on the company’s website (https://www.bhp.com/investor-centre/sustainability-reporting-2020/). During the 2020 period BHP reported zero work-related fatalities, zero significant environment incidents and zero significant community incidents. Social investment spending for the 2021 financial year reached (US) $174.84 million (BHP, 2021).

21.2 Regulatory framework

21.2.1 Commonwealth

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Amongst other matters, the EPBC Act provides the legal framework to protect and manage nine MNES currently prescribed that include:

- declared World Heritage properties
- National Heritage places
- declared Ramsar wetland
- listed threatened species and ecological communities
- listed migratory species
- commonwealth marine areas
- The Great Barrier Reef Marine Park (GBRMP)
- nuclear actions
- a water resource, in relation to coal seam gas development or large coal mining development.

Under the EPBC Act, a project or activity that may have an impact on MNES is deemed to be an 'action'. Actions that have or are likely to have a significant impact on MNES are controlled actions that require assessment and approval under the EPBC Act.

Whether or not an action is likely to have a significant impact depends on the sensitivity, value, and quality of the environment that is impacted, and the intensity, duration, magnitude and geographic extent of the impact, including the combined (cumulative) impacts of the activities proposed.

On 5 October 2016, BMA referred the Project to the DCCEEW (Referral No. 2016/7791) and on 18 October 2016, the Project was determined to be a controlled action that requires assessment and approval under the EPBC Act. The relevant controlling provisions under the EPBC Act with potential to be impacted include:

- Nationally listed threatened species and communities (Section 18 and 18A)
- a water resource, in relation to coal seam gas development and a large coal mining development (Section 24D and 24E).

The assessment was conducted in accordance with the bilateral agreement between Australian and Queensland Governments to accredit the EIS assessment process under the *Environmental Protection Act 1994* (EP Act), as acknowledged by the ToR issued by the Queensland Department of Environment and Heritage Protection (DEHP) (now the Department of Environment and Science (DES)) on 2 June 2017. This assessment considers the nationally threatened species and communities listed at the time the Project was determined to be a controlled action by decision under Section 75 of the EPBC Act.

The precautionary principle is applied in accordance with the relevant Significant Impact Guidelines when deciding whether a proposed action is likely to have a significant impact on MNES. A lack of scientific evidence as to whether an impact will occur, or to what extent, cannot be used to support or approve an application under the EPBC Act; similarly, beneficial impacts cannot used to justify other adverse impacts or an approval under the EPBC Act. Environmental offsets are required where significant residual impacts on MNES occur from the proposed Project activities.

Commonwealth Offsets Policy

Applicable to the Project, the EPBC Act Environmental Offsets Policy 2012 has five key aims:

1. ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act

2. provide proponents, the community and other stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act
3. deliver improved environmental outcomes by consistently applying the policy
4. outline the appropriate nature and scale of offsets and how they are determined
5. provide guidance on acceptable delivery mechanisms for offsets.

An Offsets Strategy has been developed for the Project (BMA, 2024c) and is also discussed further in Section 21.10. Final offset requirements are subject to the final clearing footprint and assessment and approval from the DCCEEW.

21.2.2 State

Potential impacts of the from the proposed Project activities will also be managed through management measures, including offsets, prescribed under State legislation.

Environmental Protection Act 1994

The Queensland *Environmental Protection Act 1994* regulates prescribed environmentally relevant activities (ERAs) and resource activities (which includes a mining activity) through the issuing of Environmental Authorities (EAs) and the enforcement of the conditions of granted authorities.

An EA for a resource activity is required to authorise the proposed mining activities within the lease area. BMA will be seeking an EA for the ERA 13 (mining black coal), with ancillary activities being ERA 8 (chemical storage), ERA 31 (mineral processing), ERA 63 (sewage treatment) and ancillary activities over the lease area. Through the EA, BMA will have obligations to implement management, monitoring and offset requirements to protect environmental values.

Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The EPP (Water) seeks to protect and enhance the suitability of Queensland waters for various beneficial uses. The Queensland Department of Environment and Science (DES) (formerly the Department of Environment and Heritage Protection (DEHP)) hold responsibility for administering the EPP (Water).

The policy identifies environmental values for waters in Queensland and guides the setting of Water Quality Objectives (WQOs) to protect the environmental values of any water resource. Water quality guidelines or objectives are the minimum levels required to protect all of the beneficial uses of a waterway (DERM, 2009). In accordance with the EPP (Water), environmental values, water quality guidelines and WQOs for the Fitzroy Basin were established (DEHP, 2011).

The document that is of relevance to the Project Site's receiving environment is the *EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives* (DEHP, 2011).

To derive site specific (sub-regional) WQOs, the methods outlined in the *Queensland Water Quality Guidelines 2009* (DEHP, 2009), the *Qld Deciding aquatic ecosystem indicators and local water quality guideline values 2022* (DES, 2022*)* and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG, 2018) were applied.

Environmental Offsets Act 2014 and Environmental Offsets Regulation 2014

The Queensland *Environmental Offsets Act 2014* (EO Act) coordinates the delivery of environmental offsets across jurisdictions and provides a single point-of-truth for offsets in Queensland. The Environmental Offsets Regulation 2014 (EO Reg) provides details of the prescribed activities regulated under existing legislation and prescribed environmental matters to which the EO Act applies. These matters are MNES, Matters of State Environmental Significance (MSES) and Matters of Local Environmental Significance (MLES).

Potential synergies exist between the EPBC Act EO Policy and offset policies administered by the Queensland Government. The EPBC Act, EO Policy and EO Act support the development of complementary offset packages. The overlapping MNES and MSES will be considered when developing offset packages for the Project and offset delivery will preferentially secure offset areas which satisfy both MNES and MSES. However, in accordance with the Queensland EO Policy offset liabilities will not be unnecessarily duplicated and where interactions between commonwealth and state offsets apply:

- the State cannot impose an offset condition for the same or substantially the same impact if the Commonwealth has assessed an activity as a controlled action and decided that an offset is, or is not, required
- State agencies cannot impose an offset condition for the same or substantially the same impact if another State agency has already imposed an offset condition.

For land-based offsets, the suitability of the offset site relative to the impact site and the prescribed environmental matters is measured through undertaking a habitat quality analysis. The Guide to Determining Terrestrial Habitat Quality (Department of Environment and Heritage Protection, 2017) must be used for Regional Ecosystems (REs) and species offsets (including advanced offsets) to undertake this analysis, unless an alternative approach is approved by DES as being able to measure a conservation outcome.

Water Act 2000

The use of water for activities such as irrigation, stock water, drinking water and industrial use are regulated under the *Water Act 2000* (Water Act). The Water Act provides a basis for the planning and allocation of Queensland water resources, which in turn must make allowances for the provision of water purely for the support of the natural processes that underpin the ecological health of natural river systems, that is, environmental flows. The watercourses potentially affected by the Project are subject to protection under the Water Act, which regulates the extraction of water from these watercourses and works that might disturb bed and banks of each watercourse.

Watercourses identified under the Water Act flow through the Project Site, including Boomerang Creek, One Mile Creek, Hughes Creek, Plumtree Creek, Spring Creek and Phillips Creek. Of these streams, only Boomerang Creek, Plumtree Creek and Hughes Creek intersect the underground mining panels and the predicted area of subsidence.

The Water Act prescribes the process for preparing Water Resource Plans (WRP) and Resource Operation Plans (ROP) which are specific for catchments within Queensland. Under this process, the WRP identifies a balance between waterway health and community needs and are applied on a catchment scale. The WRP establishes Environmental Flow Objectives of importance for waterway health and sets Water Allocation Security Objectives important to maintain water availability for community needs. The ROP provides the operational details on how this balance can be achieved. The WRP and ROP determine conditions for granting water allocation licences, permits and other authorities, as well as rules for water trading and sharing. The WRP and ROP applicable to the Project are detailed below.

Fitzroy Basin Water Resource Plan

The Project is located within the Fitzroy Basin. The Water Resource (Fitzroy Basin) Plan was finalised in 1999 and amended in 2005 to address overland flow water management and again updated in 2011 (Queensland Government, 2011).

Fitzroy Basin Resource Operations Plan

The Fitzroy Basin ROP came into force in January 2004 and was amended in October 2011 (Revision 3) (DNRM, 2015). It details how the objectives of the Water Resource (Fitzroy Basin) Plan will be met on an operational level and defines strategies to support the WRP's overall goals for water entitlement security and ecological health.

In general, it provides the basis and rules for trading of water allocations, allows for unallocated water to be identified and allocated and also details operating rules for the use of water management infrastructure such as weirs and dams. The Nogoa Mackenzie, Lower Fitzroy, and Fitzroy Barrage Supplemented Water Supply Schemes operate within the wider Fitzroy Basin catchment.

21.3 Methodology

21.3.1 Water resources

The water resource methodology specifically relates to the controlling provisions identified in the 2016 EPBC Referral (2016/7791), namely a water resource, in relation to coal seam gas development and a large coal mining development.

The ToR states that where the proposal is a coal seam gas development or large coal mining development and likely to significantly impact on a water resource, reference must be made to:

- The Independent Expert Scientific Committee's (IESC) Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines
- The Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (DoEE, 2013b).

The significant impact assessment of water resources was undertaken in line with the Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources (DoEE, 2013b). Reconciliation of each of the IESC information requirements are presented in Table 21-8. Further detail is provided in **Appendix B-1 Subsidence Modelling Report** (Minserve, 2022), **Appendix F-1 Groundwater Modelling Report** (SLR, 2023), **Appendix F-3 Groundwater Resources Technical Report** (AECOM, 2024a), **Appendix D-2 Groundwater Dependent Ecosystems Assessment** (3D Environmental, 2023), **Appendix E-1 Surface Water Resources Technical Report** (AECOM, 2024b), **Appendix E-2 Mine Water Balance Technical Report** (AECOM, 2024c), **Appendix E-3 Hydraulics, Hydrology and Geomorphology Technical Report** (Alluvium, 2023) and **Appendix E-4 Conceptual Ponding Assessment** (Engeny, 2023).

Table 21-8 IESC information requirements checklist

IESC information requirements checklist		Section
Description the proposal		
✓	A regional overview of the proposed project area including a description of the geological basin, coal resource, surface water catchments, groundwater systems, water-dependent assets, and past, current, and reasonably foreseeable coal mining and CSG developments.	21.4.1
✓	A description of the statutory context, including information on the proposal's status within the regulatory assessment process and on any water management policies or regulations applicable to the proposal.	21.2
✓	A description of the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	21.1.4
✓	A description of how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	21.1.4.4
Groundwater – context and conceptualisation		
✓	Descriptions and mapping of geology at an appropriate level of horizontal and vertical resolution including: • definition of the geological sequence/s in the area, with names and descriptions of the formations with accompanying surface geology and cross-sections • definitions of any significant geological structures (e.g. faults) in the area and their influence on groundwater, in particular, groundwater flow, discharge or recharge.	21.4.4
✓	Data to demonstrate the varying depths to the hydrogeological units and associated standing water levels or potentiometric heads, including direction of groundwater flow, contour maps, hydrographs and hydro chemical characteristics (e.g. acidity/alkalinity, electrical conductivity, metals, major ions). Time series data representative of seasonal and climatic cycles.	21.4.5.2

	IESC information requirements checklist	Section
✓	Description of the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	21.4.5.2 21.5.1.2
✓	Values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and storage characteristics) for each hydrogeological unit.	21.4.5.2 21.5.1.2
✓	Assessment of the frequency, location, volume and direction of interactions between water resources, including surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water.	21.6.1.2
Groundwater – analytical and numerical modelling		
✓	A detailed description of all analytical and/or numerical models used, and any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	21.3.1.2.3
✓	Undertaken in accordance with the Australian Groundwater Modelling Guidelines, 2009, including peer review.	21.3.1.2.3
✓	Calibration with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets when predicting changes to baseflow).	21.3.1.2.3
✓	Representations of each hydrogeological unit, the thickness, storage and hydraulic characteristics of each unit, and linkages between units, if any.	21.4.5.2
✓	Representation of the existing recharge/discharge pathways of the units and the changes that are predicted to occur upon commencement, throughout, and after completion of the development activities.	21.4.5.2
✓	Incorporation of the various stages of the proposed development (construction, operation and rehabilitation) with predictions of water level and/or pressure declines and recovery in each hydrogeological unit for the life of the project and beyond, including surface contour maps.	21.6.1.2
✓	Identification of the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	21.6.1.2
✓	An explanation of the model conceptualisation of the hydrogeological system or systems, including key assumptions and model limitations, with any consequences described.	21.3.1.2.3
✓	Consideration of a variety of boundary conditions across the model domain, including constant head or general head boundaries, river cells and drains, to enable a comparison of groundwater model outputs to seasonal field observations.	21.3.1.2.3
✓	Sensitivity analysis of boundary conditions and hydraulic and storage parameters, and justification for the conditions applied in the final groundwater model.	21.3.1.2.3
✓	An assessment of the quality of, and risks and uncertainty inherent in, the data used to establish baseline conditions and in modelling, particularly with respect to predicted potential impact scenarios.	21.3.1.2.3
✓	A program for review and update of the models as more data and information become available, including reporting requirements.	21.3.1.2
✓	Information on the time for maximum drawdown and post-development drawdown equilibrium to be reached.	21.6.1.2
Groundwater – Impacts to water resources and water-dependent assets		
✓	An assessment of the potential impacts of the proposal, including how impacts are predicted to change over time and any residual long-term impacts: • description of any hydrogeological units that will be directly or indirectly dewatered or depressurised, including the extent of impact on hydrological interactions between	21.6.1.2

IESC information requirements checklist		Section
	water resources, surface water/groundwater connectivity, inter-aquifer connectivity and connectivity with sea water • the effects of dewatering and depressurisation (including lateral effects) on water resources, water-dependent assets, groundwater, flow direction and surface topography, including resultant impacts on the groundwater balance • description of potential impacts on hydraulic and storage properties of hydrogeological units, including changes in storage, potential for physical transmission of water within and between units, and estimates of likelihood of leakage of contaminants through hydrogeological units • consideration of possible fracturing of and other damage to confining layers • for each relevant hydrogeological unit, the proportional increase in groundwater use and impacts as a consequence of the development proposal, including an assessment of any consequential increase in demand for groundwater from towns or other industries resulting from associated population or economic growth due to the proposal.	
✓	Description of the water resources and water-dependent assets that will be directly impacted by mining or CSG operations, including hydrogeological units that will be exposed/partially removed by open cut mining and/or underground mining.	21.4.5.2 21.4.5.3
✓	For each potentially impacted water resource, a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact.	21.8.1.2
✓	Description of existing water quality guidelines and targets, environmental flow objectives and other requirements (e.g. water planning rules) for the groundwater basin(s) within which the development proposal is based.	21.4.5
✓	An assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	21.6.1.2
✓	Proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	21.7
✓	Description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	21.7 21.9.1
Groundwater – data and monitoring		
✓	Sufficient physical aquifer parameters and hydrogeochemical data to establish pre-development conditions, including fluctuations in groundwater levels at time intervals relevant to aquifer processes.	21.4.5.2
✓	A robust groundwater monitoring programme, utilising dedicated groundwater monitoring wells and targeting specific aquifers, providing an understanding of the groundwater regime, recharge and discharge processes and identifying changes over time.	21.7.2.6
✓	Long-term groundwater monitoring, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	21.7.2.6
✓	Water quality monitoring complying with relevant National Water Quality Management Strategy (NWQMS) guidelines and relevant legislated state protocols.	21.7.2.6
Surface water – context and conceptualisation		
✓	A description of the hydrological regime of all watercourses, standing waters and springs across the site including: • geomorphology, including drainage patterns, sediment regime and floodplain features. • spatial, temporal and seasonal trends in streamflow and/or standing water levels. • spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals and metalloids and radionuclides).	21.4.5.1

IESC information requirements checklist		Section
	• current stressors on watercourses, including impacts from any currently approved projects.	
✓	A description of the existing flood regime, including flood volume, depth, duration, extent and velocity for a range of annual exceedance probabilities, and flood hydrographs and maps identifying peak flood extent, depth and velocity.	21.4.5.1
✓	Assessments of the frequency, volume and direction of interactions between water resources, including surface water/groundwater connectivity and connectivity with sea water.	21.4.5
Surface water – analytical and numerical modelling		
✓	Conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	21.4.5.1
✓	Methods in accordance with the most recent publication of Australian Rainfall and Runoff13.	21.4.5.1
✓	A programme for review and update of the models as more data and information becomes available.	21.3.1.1
✓	Description and justification of model assumptions and limitations, and calibration with appropriate surface water monitoring data.	21.4.5.1
✓	An assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	21.4.5.1
✓	A detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	21.3.1.1
Surface water – Impacts to water resources and water dependent assets		
✓	Description of all potential impacts of the proposed project on surface waters, including a clear description of the impact to the resource, the resultant impact to any water-dependent assets dependent on the resource, and the consequence or significance of the impact, including: • impacts on streamflow under different flow conditions. • impacts associated with surface water diversions. • impacts to water quality, including consideration of mixing zones. • estimates of the quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets • identification and consideration of landscape modifications, for example, subsidence, voids, onsite earthworks including disturbance of acid-forming or sodic soils, roadway and pipeline networks through effects on surface water flow, surface water quality, erosion and habitat fragmentation of water-dependent species and communities.	21.4.5.1
✓	Existing water quality guidelines and targets, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	21.4.5.1
✓	Identified processes to determine surface water quality and quantity triggers which incorporate seasonal variation but provide early indication of potential impacts to assets.	21.3.1.1
✓	Proposed mitigation actions for each trigger and identified significant impact.	21.7.2.6
✓	Description and adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	21.7.2.6
✓	Description of the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and/or reasonably foreseeable) are considered in combination.	21.11

	IESC information requirements checklist	Section
✓	An assessment of the risks of flooding, including channel form and stability, water level, depth, extent, velocity, shear stress and stream power, and impacts to ecosystems, project infrastructure and the final project landform.	21.9.1
Water-dependent assets – context and conceptualisation		
✓	Identification of water-dependent assets, including: • water-dependent fauna and flora supported by habitat, flora and fauna (including stygofauna) surveys • public health, recreation, amenity, Indigenous, tourism or agricultural values for each water resource.	21.4.5.3 21.4.6
✓	Identification of GDEs in accordance with the method outlined by Eamus et al. (2006)14. Information from the GDE Toolbox15 and GDE Atlas16 may assist in identification of GDEs.	21.3.1.3
✓	Conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	21.3.1.3
✓	An estimation of the ecological water requirements of identified GDEs and other water-dependent assets.	21.4.5.3
✓	Identification of the hydrogeological units on which any identified GDEs are dependent.	21.3.1.3
✓	An outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	21.3.1.3
✓	A description of the process employed to determine water quality and quantity triggers and impact thresholds for water-dependent assets (e.g. threshold at which a significant impact on an asset may occur).	21.3.1.2.3
✓	Conceptualisation and rationale for likely water-dependence, impact pathways, tolerance and resilience of water-dependent assets. Examples of ecological conceptual models can be found in Commonwealth of Australia (2015).	21.3.1.3
Water-dependent assets – impacts, risk assessment and management of risks		
✓	An assessment of direct and indirect impacts on water-dependent assets, including ecological assets such as flora and fauna dependent on surface water and groundwater, springs and other GDEs.	21.8.1.2
✓	A description of the potential range of drawdown at each affected bore, and a clear articulation of the scale of impacts to other water users.	21.8.1.2
✓	Indication of the vulnerability to contamination (for example, from salt production and salinity) and the likely impacts of contamination on the identified water-dependent assets and ecological processes.	21.8.1.2
✓	Identification and consideration of landscape modifications (for example, voids, onsite earthworks, roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	21.8.1.1
✓	Estimates of the impact of operational discharges of water (particularly saline water), including potential emergency discharges due to unusual events, on water-dependent assets and ecological processes.	21.8.1.1
✓	An assessment of the overall level of risk to water-dependent assets that combines probability of occurrence with severity of impact.	21.8.1.2
✓	The proposed acceptable level of impact for each water-dependent asset based on the best available science and site-specific data, and ideally developed in conjunction with stakeholders.	21.8.1.2

IESC information requirements checklist		Section
✓	Proposed mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	21.7.2.6
Water-dependent assets – data and monitoring		
✓	Sampling sites at an appropriate frequency and spatial coverage to establish pre-development (baseline) conditions, and test hypothesised responses to impacts of the proposal.	21.3.1.1
✓	Concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design).	21.7.2.6
✓	Monitoring that identifies impacts, evaluates the effectiveness of impact prevention or mitigation strategies, measures trends in ecological responses and detects whether ecological responses are within identified thresholds of acceptable change.	21.7.2.6
✓	Regular reporting, review and revisions to the monitoring programme.	21.7.2.6
✓	Ecological monitoring complying with relevant state or national monitoring guidelines.	21.7.2.6
Water and salt balance and water management strategy		
✓	Quantitative site water balance model describing the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc), including all sources and uses.	21.6.1.1
✓	Description of water requirements and onsite water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	21.6.1.1
✓	Estimates of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets.	21.6.1.1, 21.3.1.1
✓	Salt balance modelling, including stores and the movement of salt between stores taking into account seasonal and long-term variation.	21.6.1.1
Cumulative impacts – context and conceptualisation		
✓	Cumulative impact analysis with sufficient geographic and time boundaries to include all potentially significant water-related impacts.	21.11.1
✓	Cumulative impact analysis identifies all past, present, and reasonably foreseeable actions, including development proposals, programs and policies that are likely to impact on the water resources of concern.	21.11.1
Cumulative Impacts – impacts		
✓	An assessment of the condition of affected water resources which includes: • Identification of all water resources likely to be cumulatively impacted by the proposed development. • A description of the current condition and quality of water resources and information on condition trends. • Identification of ecological characteristics, processes, conditions, trends and values of water resources. • Adequate water and salt balances. • Identification of potential thresholds for each water resource and its likely response to change and capacity to withstand adverse impacts (e.g. altered water quality, drawdown).	21.11.1
✓	An assessment of cumulative impacts to water resources which considers: • The full extent of potential impacts from the proposed development, including alternatives, and encompassing all linkages, including both direct and indirect links, operating upstream, downstream, vertically and laterally. An assessment of impacts	21.11.1

IESC information requirements checklist		Section
	considered at all stages of the development, including exploration, operations and post closure / decommissioning. • An assessment of impacts, utilising appropriately robust, repeatable and transparent methods. • Identification of the likely spatial magnitude and timeframe over which impacts will occur, and significance of cumulative impacts. • Identification of opportunities to work with others to avoid, minimise or mitigate potential cumulative impacts.	
Cumulative Impacts – mitigation, monitoring and management		
✓	Identification of modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts	21.11
✓	Identification of measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies	21.11
✓	Identification of cumulative impact environmental objectives.	21.11
✓	Appropriate reporting mechanisms.	21.11
✓	Proposed adaptive management measures and management responses.	21.11
Subsidence – underground coal mines and coal seam gas		
✓	Predictions of subsidence impact on surface topography, water-dependent assets, groundwater (including enhanced connectivity between aquifers) and movement of water across the landscape.	21.6.2.2
✓	Description of subsidence monitoring methods, including use of remote or on-ground techniques and explanation of predicted accuracy of such techniques.	21.7.2.5
✓	Consideration of geological layers and their properties (strength/hardness/fracture propagation) in subsidence modelling.	21.4.4
Final landforms and voids – coal mines		
✓	Identification and consideration of landscape modifications (for example, voids, onsite earthworks, roadway and pipeline networks) and their potential effects on surface water flow, erosion and habitat fragmentation of water-dependent species and communities.	21.6.1
✓	An assessment of the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	21.3.1.2.3
✓	An assessment of the long-term impacts to water resources posed by various options for the final landform design, including complete or partial backfilling of mining voids, which considers: • groundwater behaviour – sink or lateral flow from void • water level recovery – rate, depth, and stabilisation point (e.g. timeframe and level in relation to existing groundwater level, surface elevation) • seepage – geochemistry and potential impacts • long-term water quality, including salinity, pH, metals and toxicity • measures to prevent migration of void water off-site.	21.6.1
Acid-forming materials and other contaminants of concern		
✓	Identification of the presence and potential exposure of acid-sulphate soils (including oxidation from groundwater drawdown).	21.7.1.1
✓	Identification of the presence and volume of potentially acid-forming waste rock and coal reject/tailings material and exposure pathways.	21.7.1.1
✓	Handling and storage plans for acid-forming material (co-disposal, tailings dam, encapsulation).	21.7.1.1

	IESC information requirements checklist	Section
✓	Assessment of the potential impact to water dependent assets, taking into account dilution factors, and including solute transport modelling where relevant, representative and statistically valid sampling, and appropriate analytical techniques.	21.6.1
✓	Identification of other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	21.3.1 21.7.1
✓	Description of proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	21.6.1

21.3.1.1 Surface water

Surface water resources assessment for this Project comprised:

- **Appendix E-1 Surface Water Quality Technical Report** (AECOM, 2024b) to identify environmental values of surface waters within the Project Site and immediately downstream of the Project and define relevant water quality objectives (WQOs) applicable to the environmental values (Section 21.3.1.1.1)
- **Appendix E-2 Mine Water Balance Technical Report** (AECOM, 2024c) to identify the quantity, quality, location and timing of potential and/or proposed release of contaminants (such as controlled water releases to surface water streams) from water and wastewater from the Project (Section 21.3.1.1.2)
- **Appendix E-3 Hydrology, Hydraulics and Geomorphology Technical Report** to evaluate risks associated with predicted changes to land surface, surface water and geomorphic characteristics of watercourses affected by the Project (Alluvium, 2023) (Section 21.3.1.1.3)
- **Appendix B-2 Subsidence Modelling**, predictions of surface subsidence and cracking following successive stages of longwall panel excavation by the longwall top caving (Minserve, 2022) (Section 21.3.1.1.4).

Relevant details are presented in this chapter, with further details of the assessment of surface water resources provided in **Appendix E-1 Surface Water Resources Technical Report** (AECOM, 2024b), **Appendix E-2 Mine Water Balance** (AECOM, 2024c), **Appendix E-3 Hydraulics, Hydrology and Geomorphology Technical Report** and **Appendix E-4 Conceptual Ponding Assessment** (Engeny, 2023).

21.3.1.1.1 Water quality assessment

To identify potential impacts from the Project on the environmental values and preventative and mitigation measures to demonstrate that the Project will not result in degradation of water quality related values, the assessment involved the following steps:

1. identification of the environmental values of surface waters within the Project Site and immediately downstream of the Project
2. definition of relevant WQOs applicable to the environmental values
3. characterisation of the quality of surface waters within the area
4. identification of the quantity, quality, location and timing of all potential and/or proposed release of contaminants (such as controlled water releases to surface water streams) from water and wastewater from the Project
5. assessment of the likely impact of any releases on all relevant environmental values of the surface water receiving environment
6. assessment of how the WQO and performance outcomes will be achieved, monitored and audited, and how corrective actions will be managed.

Water quality data management, interpretation and quality

Watercourses identified under the Water Act flow through the Project Site, including Boomerang Creek, One Mile Creek, Hughes Creek, Plumtree Creek, Spring Creek and Phillips Creek.

Water quality datasets used in this assessment comprise monitoring data from locations monitored as part of Receiving Environment Monitoring Programs (REMP) for SRM and Peak Downs Mine (PDM) or water quality trend assessments between July 2012 and July 2022, dependent on location. Data showed a high variability of physico-chemical WQ parameters within and between streams traversing the Project Site. These ephemeral watercourses represent moderately disturbed aquatic habitats as defined by the Queensland Government (2022). These are discussed in greater detail in **Appendix E-1 Surface Water Resources Technical Report** (AECOM, 2024b)

Water quality data was analysed for the following purposes**:**

- Environmental background values
- From upstream of mining activity to develop sub-regional WQOs
- From downstream of the existing SRM to assess the existing baseline conditions of the Project Site.

Sampling locations upstream of the proposed release point used to develop sub-regional WQOs for the upper reaches were located on Boomerang Creek, Hughes Creek, One Mile Creek and Spring Creek as shown in Figure 21-29. Plumtree Creek was not assessed as this stream has no catchment upstream of the Project, the headwaters having been developed by the existing Saraji mine, and no water quality data was available. Environmental background values were derived from downstream sampling points at Phillips Creek, Isaac River and Spring Creek.

Interpretation and assessment of water quality

The method for deriving site-specific WQOs were designed by the Queensland Government for purposes of setting targets to allow catchment managers to make improvements to the water quality of the catchment over the long-term. Because of this intent, they are a very conservative measure.

Due to high variability of WQ parameters and deviations from the WQ guideline values as outlined in EPP 2019 (Water Isaac River 1301) and ANZG (2018), site specific, or sub-regional WQOs were developed for the Hughes/Boomerang Creek sub-catchment with potential to be impacted by mining.

To derive WQOs for this sub-regional catchment, parameters and monitoring locations were chosen in accordance with *Deriving site-specific guideline values for physico-chemical parameters and toxicants* (Huynh & Hobbs 2019), Section 4 in the *Queensland Water Quality Guidelines 2009 (DEHP* 2009*)* and the combined guidelines of *Qld Deciding aquatic ecosystem indicators and local water quality guideline values 2022* and *Environmental Protection Policy 2019* (DES, 2022). Applying the 40th percentile rule for best available moderately disturbed reference sites means the designed subregional WQO will be exceeded 60 per cent of the time without influence of the proposed project.

Additionally, the QWQG (DES 2022) requires wherever the 40th percentile value of a developed site-specific parameter falls within 1 standard error (SE) of the ANZG 2018 or EPP2019 WQO (2 SE if high variability between sites), the default WQO is to be applied. Hence site-specific data must vary significantly from the default WQOs for a different background value to be defensible. Therefore, it is unlikely a data set of local water quality data will comply with these sub-regional WQOs in the short term and these should be regarded as a guideline and not as trigger or threshold values.

For the purposes of understanding if water quality data from local samples is likely within the variability representative of the sub-regional catchment, the data was also compared to the 80th percentile of the WQO data set. The 80th percentile is used for application to undisturbed reference sites for which the selected WQO sites meet the criteria: within 20 km upstream there is no intensive agriculture, major extractive industry, major urban area, significant point source wastewater and seasonal flow regime not greatly altered by regulation or abstraction, and the sites used to develop sub-regional WQOs do meet these criteria.

For the purposes of detecting if the Project has unexpected impacts on the receiving environment, a REMP will be developed as discussed in Section 21.7.1.1.

Monitoring site justification

Sampling locations for the upper reaches of Boomerang Creek, Hughes Creek, One Mile Creek and Spring Creek (Upstream sites, Figure 21-29) were used to develop sub-regional WQOs. Environmental background values were derived from downstream sampling points at Phillips Creek, Isaac River and Spring Creek (Background sites, Figure 21-29).

The IESC guidelines outline the need for sufficient data to quantify and characterise impacts to water resources from coal seam mining activities either direct, indirect or cumulative. Accordingly, selection of monitoring sites for the Project was based on the following:

- Monitoring locations upstream of mining to characterise the condition of the receiving environment unimpacted by mining (Upstream sites).
- Establishment of test monitoring sites downstream of the proposed mine to adequately identify and quantify water quality impacts from mining/subsidence. Water courses potentially impacted by the Project include Boomerang Creek, Hughes Creek, One Mile Creek, and the Isaac River. Phillips Creek, and Spring Creek will not have any mining activity within their catchments and are not likely to be impacted.
- Monitoring of watercourses occurring within the mining lease but not subject to impacts from subsidence or mining have to understand the existing environment only (Background sites).
- Proximity of monitoring sites to access infrastructure such as gazetted roads and road reserves to facilitate access to monitoring sites for sampling procedures
- Other considerations such as whether the site is within a groundwater drawdown location or mining tenement have been accounted for.

21.3.1.1.2 Mine water balance

To assess potential impacts from the Project on the environmental values and preventative and mitigation measures to demonstrate that the Project will not result in degradation of water quality related values, the assessment involved:

- identification and description the existing environment relevant to the conceptual Project WMS
- identification of key objectives and considerations for the WMS
- development of the proposed Project WMS required to meet the key objectives and considerations
- validation of proposed Project WMS through water balance assessment
    - development of schematic for mine WMS
    - development of a water balance model to analyse the potential hydraulic performance of the WMS, subject to a range of climatic conditions, including historical climate data, climate change sequences and sensitivity analyses
    - validation of proposed Project WMS against key objectives and regulatory requirements such as containment requirements as outlined in DES (ESR/2016/1933)
    - consideration of net WMS balance including estimated water balance within WMS elements, estimated required external make up water supply, estimated salt balance, estimated transfer and dewatering volumes and potential spills via emergency spillway structures.

The initial water balance modelling was conservatively assessed; as such, seepage losses from the proposed dam features were not modelled.

Conceptual mine WMS

The conceptual mine WMS has been progressed to a level of detail commensurate with the current Project design and data availability. Preliminary capacity estimates for all mine WMS dams and the water transfer network were determined through water balance assessment using 128 years of historical climate data and conceptual operational rules (AECOM, 2024c).

The WMS is assumed to be in line with best management practice for mine water management by:

- minimising generation of mine affected water (MAW) by passively diverting clean runoff around the mine WMS wherever practical
- minimising the volumes of MAW stored onsite by preferencing the use of MAW (e.g. for CHPP process and dust suppression)
- minimising the consumption of raw water by preferencing the use of MAW.

The conceptual mine WMS consists of the following key components:

- a process water dam
- mine affected runoff collection dams located at each Project process area (MIA, CHPP, ROM and product coal stockpile pads)
- a raw water dam (RWD)
- a sump located in the existing open cut pit where the underground mine portal will be located
- a water transfer network of pumps and pipes.

Concept mine WMS schematic is outlined in Figure 21-5. Mine affected runoff is proposed to be collected from each process area dam and transported to the process water dam. In addition, the process water dam also receives MAW from the underground mine portal sump located in the existing SRM open cut pit. MAW enters the sump either as runoff, or as a by-product of dewatering of the underground mine. MAW stored in the process water dam is the preferred source of water for the CHPP and dust suppression activities.

Raw water is stored in the RWD, which has been sized to meet Project water demands for approximately one month. Raw water is used to satisfy potable, underground mine, CHPP and dust suppression water demands when MAW is unavailable.

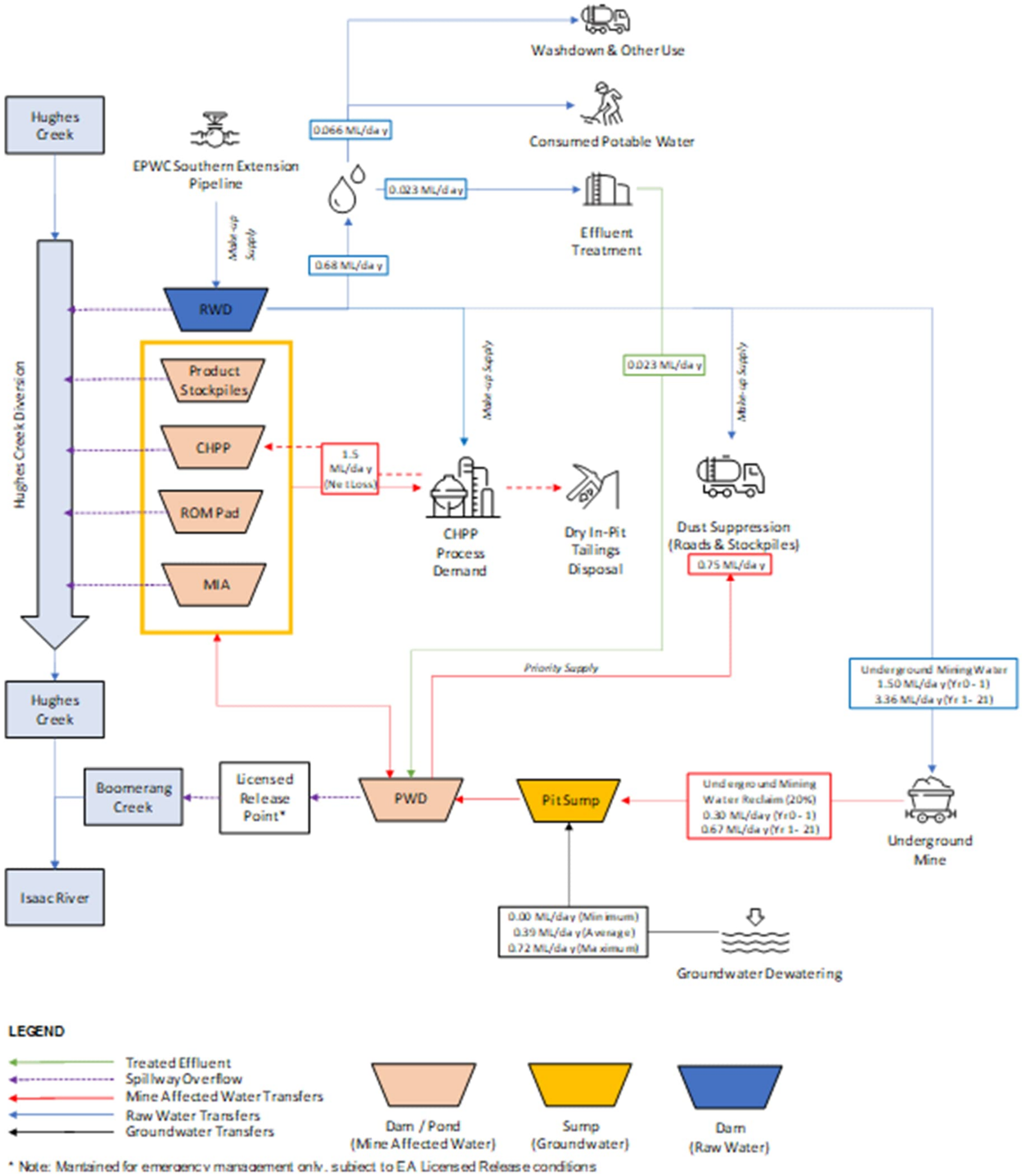


Figure 21-5 Conceptual mine WMS schematic

Water Balance Model development

A dynamic water balance model (WBM) was developed for the Project using GoldSim probabilistic modelling software. GoldSim is a Monte Carlo simulation software package that is commonly used in the mining industry for water balance modelling. The purpose of the water balance assessment was to validate the proposed mine WMS under a range of climatic conditions and potential future climate change projections, with the aim of:

- estimating the potential quantity and quality of MAW that may be generated by the Project throughout the operation of the mine
- estimating the storage capacity required for each of the WMS dams to meet the stated MAW containment objectives
- confirming that the proposed operational rules are supportive of the proposed MAW containment reuse objectives
- identifying the required transfer capacities to move MAW around the mine WMS so that containment, productivity (CHPP operations) and reuse objectives are met
- estimating the potential volumes of raw water required to satisfy Project consumptive demands considering:
    - process demands that cannot be satisfied through use of MAW due to water quality requirements, or
    - when stored volumes of MAW are unavailable following periods of prolonged drought.
- developing an understanding of the potential risk and impacts of controlled and uncontrolled releases to the receiving environment.

The WMS has been designed with adequate capacity to avoid releases. However, any open system has the potential for uncontrolled discharge of MAW as a result of extreme rainfall events. As such, BMA is seeking authority and licence conditions to conduct the controlled release of MAW from the PWD to allow responsible flexibility and contingency management of MAW inventories. In the rare event the site experiences extreme rainfall conditions exceeding the containment volume developed for each storage, BMA has identified a licensed release as a potential water management strategy in preference to allowing spills from MAW dam emergency spillway structures.

Because the WMS was not modelled to spill via emergency spillway structures in the initial WMS validation, a stress test scenario was established that specifically creates an elevated water condition, such that licensed release(s) are required to prevent spills. This stress test scenario is not an expected water inventory scenario.

As a licensed release from the PWD into Boomerang Creek has the potential to interact with the downstream receiving environment, submissions on the draft EIS requested additional analysis of managed releases. Sensitivity testing of potential release volumes and MAW water quality from the PWD has been assessed to demonstrate when and how much water could be released to the receiving environment while meeting minimum conditions as per neighbouring mines. Notwithstanding, the modelling of water quality within the WBM was simply developed, and due to available data limitations, does not model all water quality contaminants applicable to the Project.

21.3.1.1.3 Hydrology, hydraulics and geomorphology

Data was collected through on-ground inspections, sediment sampling, previous relevant studies, aerial imagery and hydrological records. A hydrologic model was developed to estimate hydrographs and peak flows through the streams of the Project Site. Flow estimates were used in 1D and 2D modelling to establish instream hydraulic and sediment transport characteristics and characterise flooding behaviour. The potential physical effects of subsidence through the Project Site were identified in the predicted subsidence report (Minserve, 2022). The likely geomorphic response to subsidence was informed through 1D and 2D hydraulic modelling of the post-subsidence conditions. The potential changes to flooding behaviour were determined through 2D hydraulic modelling of the post-subsidence conditions. The potential changes in channel hydraulics, sediment transport and flooding behaviour were used to identify risks to environmental values and develop mitigation measures to minimise impacts to the Project and the environment.

21.3.1.1.4 Subsidence

Background information provided by BMA, including detailed geological logs and in situ stress measurements, informed an assessment of potential surface subsidence and cracking that may be incurred over the longwall panels. Analysis using the longwall coal mining method presents results using three-dimensional deformation models to account for overburden lithology, topography and mining extent. Geotechnical rock strength data, stratigraphy and insitu stress conditions used to conduct the subsidence analyses are based on previously reported data and experience. The potential physical effects of subsidence at 1, 2, 5, 10 and 20 years of mining through the Project Site were identified in the predicted subsidence report (Minserve, 2022).

21.3.1.2 Groundwater

Assessment of groundwater resources comprises a description of the existing hydrogeological environment and an assessment of the potential impacts of mining on the hydrogeological environment. The groundwater assessment for this Project comprised:

- Data review (Section 21.3.1.2.1) to utilise available historical groundwater studies, groundwater management reports for the existing SRM operations, and publicly available data from bores on the surrounding agricultural land to characterise the hydrogeological system.
- Mine plan assessment and conceptualisation (Section 21.3.1.1) to update geological and groundwater baseline conditions and conceptualisation of current groundwater resources.
- Impact assessment (Section 21.3.1.2.3) included the use of the Bowen Basin regional groundwater flow numerical model to assess and predict groundwater ingress rates to the underground mine and evaluate the potential impact of the Project.

Relevant information for assessment of groundwater resources is presented in this chapter with further details of the groundwater resources assessment provided in **Appendix F-1 Groundwater Modelling Report** (SLR, 2023) and **Appendix F-3 Groundwater Resources Technical Report** (AECOM, 2024a).

21.3.1.2.1 Data review

A groundwater impact assessment for underground longwall mining for the Project was previously undertaken by AGE (2011) using a now outdated mine plan and schedule. Predicted inflows to the underground mine workings and drawdown extents were further reported by AGE (2012). The groundwater modelling technical report (EIS **Appendix F-2**), compiled by SLR (SLR, 2023) to assess the potential impacts of the Project on groundwater resources, included more regional geological and hydrogeological data. These data aided in describing and evaluation the hydrostratigraphic units within and adjacent to the Project Area.

Previous studies for existing SRM

A groundwater impact assessment for underground longwall mining for the Project was previously undertaken by AGE (2011) using a now outdated mine plan and schedule. Predicted inflows to the underground mine workings and drawdown extents were further reported by AGE (2012b). Several previous groundwater studies have been undertaken at the adjacent SRM, including a groundwater technical report to support an amendment to the SRM EA to include an extension of the existing open-cut Grevillea Pit AECOM (2016). Other investigations at the SRM have largely focussed on addressing groundwater issues related to geotechnical and dewatering feasibility studies, characterisation of the hydrogeological regime, and review of groundwater monitoring and water quality data.

Key reports reviewed for the groundwater impact assessment included the following:

- AECOM (2016). Saraji Open-Cut Extension Project – Groundwater Technical Report.
- AGE (2013). Annual Review of Groundwater Data and Monitoring Network – 2031 - SRM.
- AGE (2012a). Review of Groundwater Monitoring Data – SRM, dated December 2012.
- AGE (2012b). Australian Groundwater & Environmental Consultants Memorandum – Predicted Inflows and Drawdown Extents – Saraji East Underground Mine, dated 24 February 2012.
- AGE (2011). Report on Saraji East Project Groundwater Impact Assessment.

- AGE (2007). Report on Hydrogeological Regime and Impact Assessment - SRM.
- BMA Monitoring data spreadsheets.
- Gauge (2015). Annual Groundwater Monitoring Report - Saraji Coal Mine - June 2015.
- Gauge (2016). Annual Groundwater Monitoring Report - Saraji Coal Mine - September 2016.
- Gauge (2019). Annual Groundwater Monitoring Report - Saraji Coal Mine – May 2020.
- Gauge (2020). Annual Groundwater Monitoring Report - Saraji Coal Mine - April 2021.
- Gauge (2021). Annual Groundwater Monitoring Report - Saraji Coal Mine – March 2022.
- GEOGas (2011). Gas Reservoir Assessment – May 2011.
- GEONET (2022). Subsidence over longwall panels – February 2022.
- IESA Annual groundwater monitoring reports 2006 to 2011
- IESA (2011a). Saraji East Mine Stygofauna Survey Report – September 2011.
- IESA (2011b). Saraji East Mine Stygofauna Survey Report – December 2011.
- Mining One (2011). BMA Saraji East Extension: Packer Test Program.
- Minserve, 2017. Subsidence over Longwall Panels – Saraji East Underground Mine, February 2017.
- SKM (2011). Saraji East Coal Mine Project – Baseline Environmental Studies – February 2011.
- BMA (2023). Saraji Mine Progressive Rehabilitation and Closure Plan.

The above reports and associated data were reviewed to refine understanding of the hydrogeological system within and surrounding the Project.

Other groundwater studies in the region

Numerous reports have also been undertaken for nearby mining projects. The following additional publicly available reports from nearby projects were also reviewed to gain an appreciation of the regional groundwater system within the Project Area:

- Arrow (2012). Arrow Bowen Gas Project EIS - Chapter 14 – Groundwater.
- JBT (2014). Lake Vermont Northern Extension Groundwater Impact Assessment.
- URS (2014). Groundwater Chapter for the Dysart Coal Mine Project prepared for Bengal Coal Pty Ltd, ref. 42627233/GW dated 10 February 2014.
- URS (2012). Report Groundwater Impact Assessment Bowen Gas Project.
- URS (2009). Caval Ridge Groundwater Impact Assessment.

The groundwater modelling technical report compiled by SLR (SLR, 2023) to assess the potential impacts of the Project on groundwater resources, included more regional geological and hydrogeological data. These data aided in describing and evaluation the hydrostratigraphic units within and adjacent to the Project Area.

21.3.1.2.2 Mine plan assessment

Coal will be mined by longwall methods consisting of a northern region of panels and a southern region of panels separated by a portal which will be progressively mined out and developed as mining progresses. Panels within the northern region will be oriented northwest-southeast whilst panels in the southern section will be oriented northeast-southwest. This assessment considers the potential for structural alteration resulting from longwall mining, as estimated in the most recent subsidence modelling provided in **Appendix B-2 Subsidence Modelling** (Minserve, 2022).

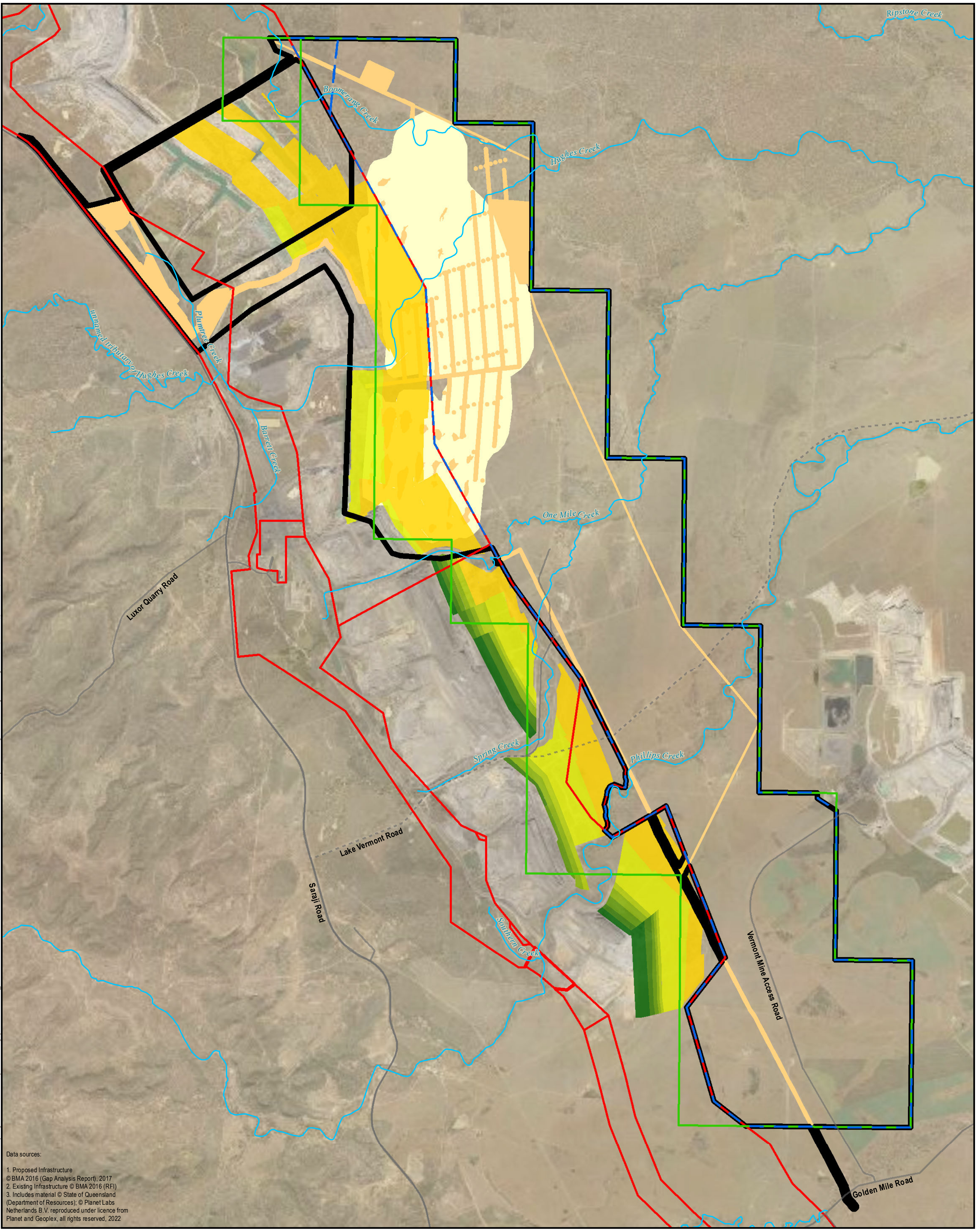
The approved Saraji open-cut mine plan in Figure 21-6, shows that open-cut operations are planned to continue until 2031 (when several pits reach the ML boundary). This means that the proposed underground mining and approved open-cut mining may occur concurrently between 2023 and 2031 i.e. an eight-year overlap.

For simulation of the areas where both the approved open-cut mining and maximised underground mine layout overlap (presented in Figure 21-7), the sections of open cut were modified (removed and replaced by underground mining only). The justification being these areas cannot be mined by open-cut mining methods if they are being mined using the underground mining methods. The overlap and alteration from open cut to underground is illustrated in Figure 21-8.

Previous modelling (AECOM, 2016) of groundwater impacts from the approved open-cut operations (including the Grevillea Pit extension) results in groundwater drawdown contours extending into the footprint of the proposed underground workings.

Intrinsically, the underground mine and open-cut mine are linked through drawdown contour overlap, operational scheduling overlap and proximity; impacts from underground mining were assessed by simulating continuous operation of the revised open-cut mine plan to facilitate the underground mining on the MLs in Figure 21-7 and underground mining operations. This approach meant that drawdown contours and impacts from underground mining were considered as cumulative impacts with the SRM open-cut mining.

In addition, the predictive groundwater modelling included a no mining within the region model scenario. This scenario, to assist in addressing IESC requirements, aided in the evaluation of predicted cumulative drawdown impacts.



LEGEND

- Project Site
- Watercourse
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse

Conceptual Mine Plan

- FY2017
- FY2018
- FY2019
- FY2020
- FY2021
- FY2022 - FY2026
- FY2027 - FY2031

N

Figure 21-6
Approved Saraji Open-cut Mine Plan

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

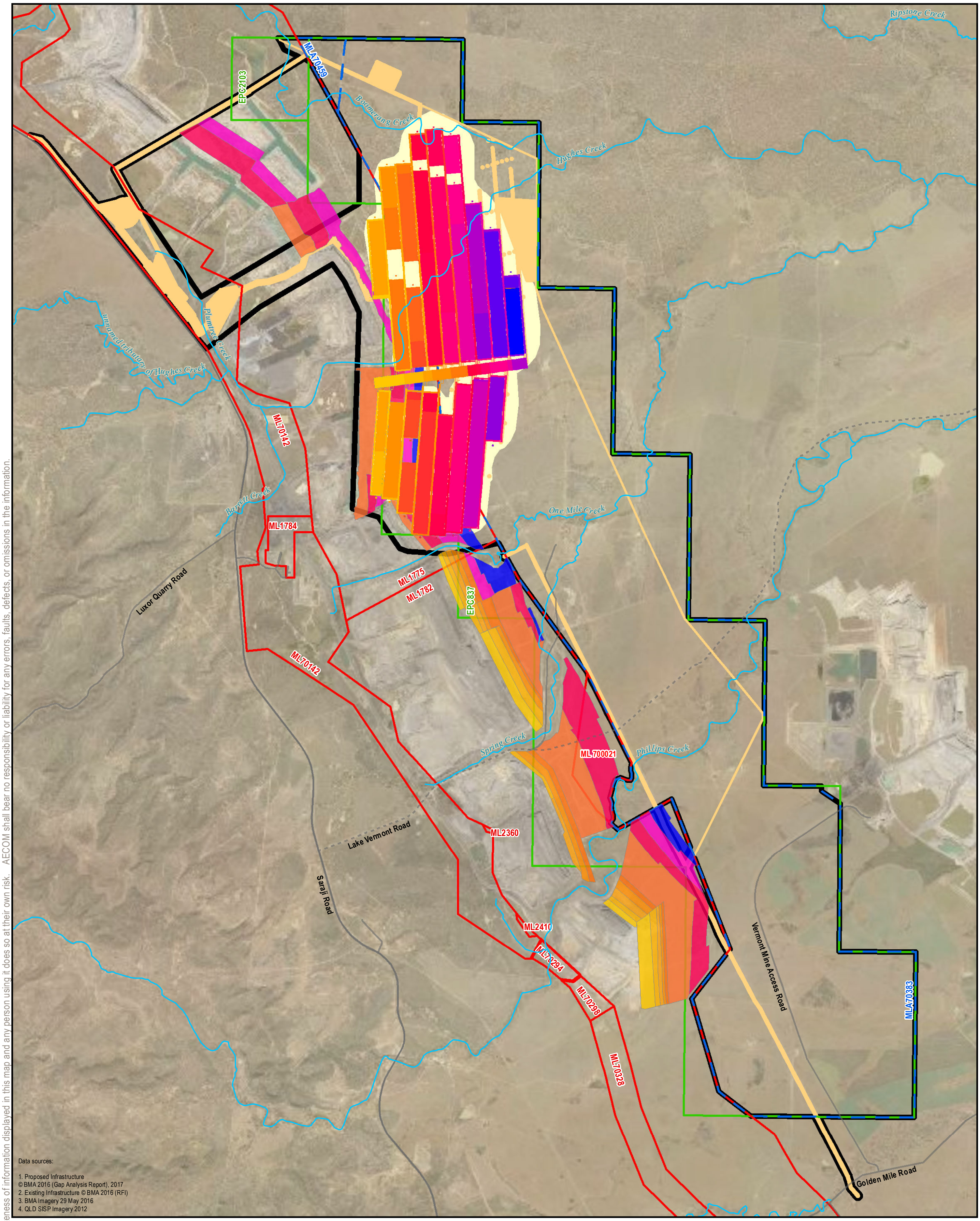
Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 4/06/2024 VERSION: 2

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\21 MNES Ecology\60507031_G353_v2_A4P_ApprovedSarajiOpenCutMinePlan.mxd



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse

SRM/SELMP Progression

Year 1	Year 8	Year 15
Year 2	Year 9	Year 16
Year 3	Year 10	Year 17
Year 4	Year 11	Year 18
Year 5	Year 12	Year 19
Year 6	Year 13	Year 20
Year 7	Year 14	

N

Figure 21-7
Saraji Mine Open-cut Mine Plan and Project Underground Mine Plan

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 1

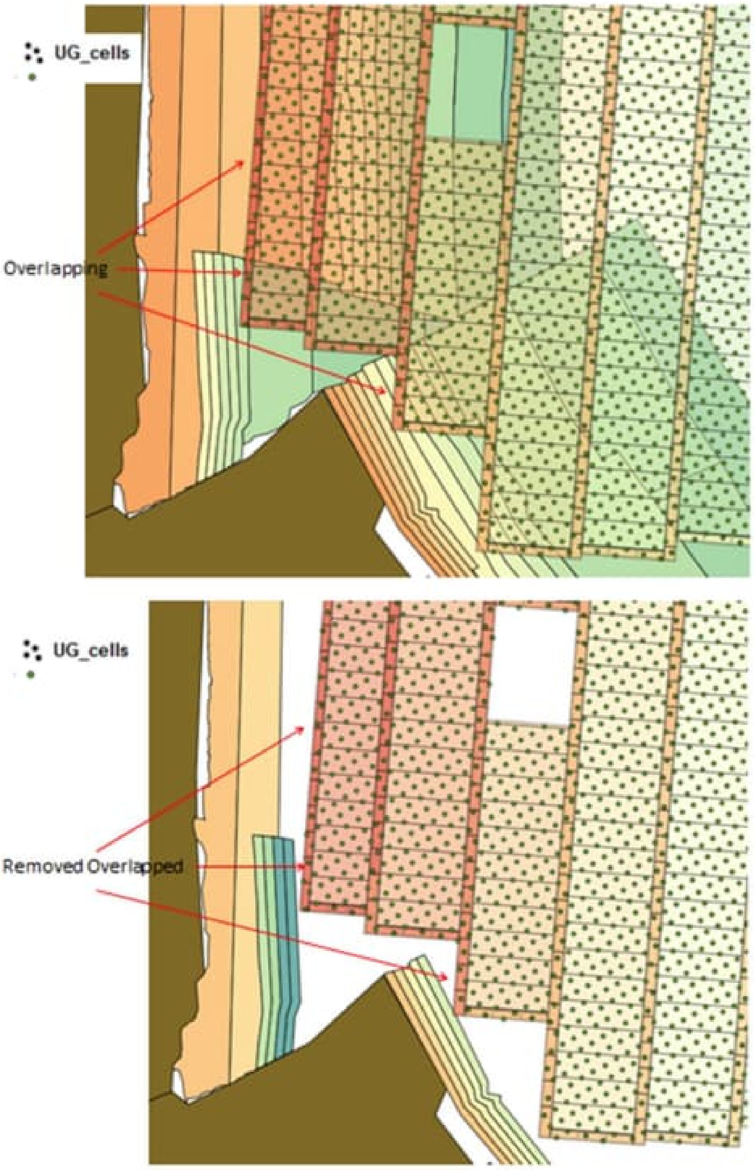


Figure 21-8 Overlap of mining techniques

Conceptual groundwater model

A conceptualised west to east cross-section showing the underlying geology and the three hydrostratigraphic systems at and adjacent to the existing approved SRM open-cut pits as shown in Figure 21-9. The data used to develop the conceptualisation indicates three hydrostratigraphic separate systems occur within the Project Area; these groundwater systems are associated with the following geological units:

- seasonal or sporadic alluvium groundwater
- localised basal sand and gravel at the base of the Tertiary sediments
- deeper Permian coal seams.

The hydrogeological conceptualisation of the more regional model area, which is included in the predictive modelling, is illustrated in 21-10.

The numerical groundwater modelling included the conceptual understanding of the groundwater systems in the Project Area, including key understandings from the conceptualisation:

- Differences in groundwater levels measured in the Tertiary and deeper Permian aquifers indicating there is limited hydraulic connection between these groundwater systems.
- Recharge occurs from infiltration from the rainfall and creek flow into the Tertiary and Permian aquifer sub-crop areas. Minor leakage from overlying aquifers may occur but is not evident based on groundwater level data.
- The regional groundwater levels are a subdued reflection of the surface topography except immediately adjacent to the open-cut mine area where localised discharge / seepage into the pits results in the steeper gradients around the pits.
- Regionally groundwater discharge within the deeper aquifers is complex based on the horst and graben structures within the Bowen Basin. Groundwater flow is considered to flow down dip from sub-crop to the east. Groundwater level data indicates lower groundwater levels to the east even though the permeability decreases with depth. It is considered that faulting facilitates more complex groundwater movement to the east of the Project Area.
- Groundwater associated with the alluvium occurs as discontinuous and sporadic resource, which is recognised under the EP Act and Environmental Protection Regulation 2008. As such this limited resource is recognised to have intrinsic environmental values.

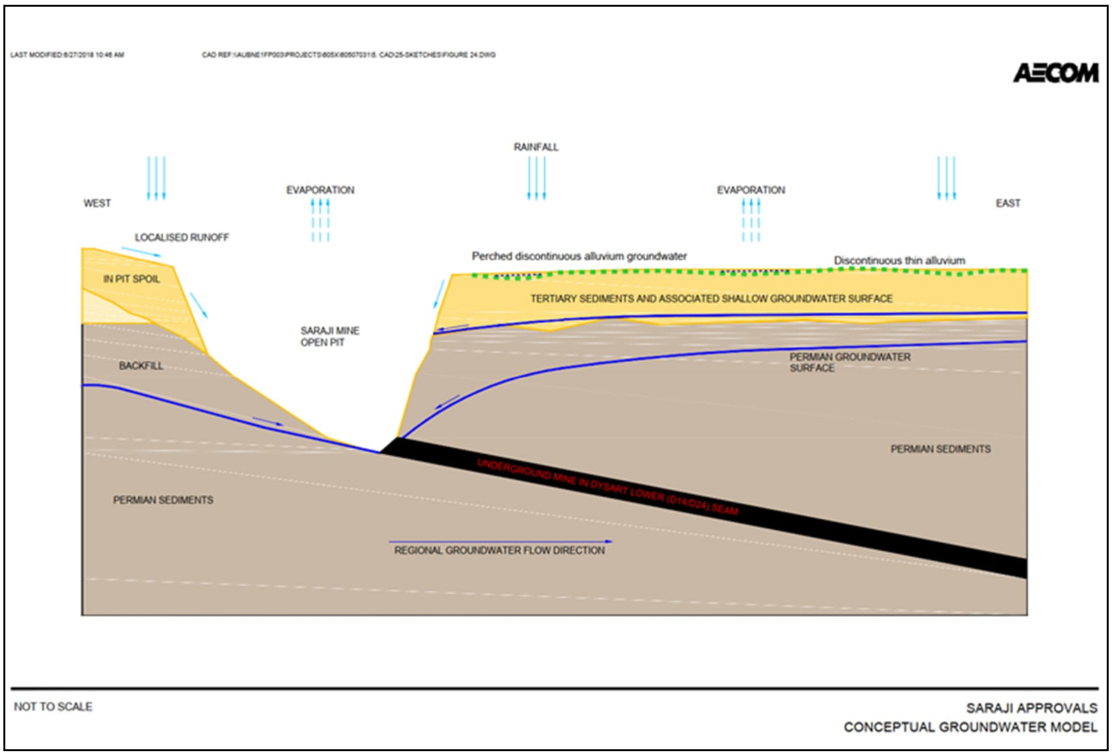


Figure 21-9 Conceptual west to east regional cross section of the approved SRM open cut mining

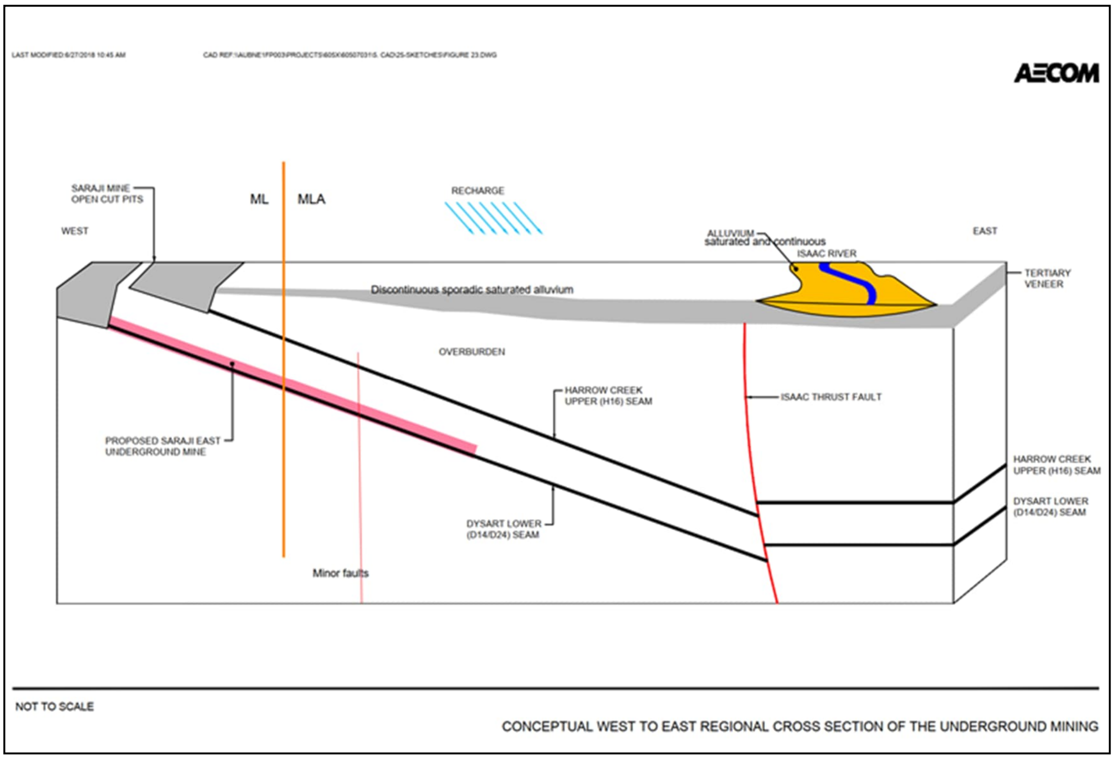


Figure 21-10 Regional geological and groundwater components included in the groundwater modelling

21.3.1.2.3 Impact assessment on water resources

Predictive groundwater modelling was conducted to assess the potential impacts of the proposed longwall mining. The modelling looked at mine dewatering impacts (groundwater ingress and groundwater level drawdown) considering approved and foreseeable mining in the region, including the approved SRM open-cut workings, with and without the Project. Predictive simulations, including an evaluation of groundwater level drawdown, the prediction of groundwater ingress and an evaluation of groundwater level recovery was conducted with sensitivity and uncertainty analysis presented in detail in **Appendix F-1 Groundwater Modelling** (SLR, 2023).

The objective of groundwater modelling was to use a constructed and calibrated regional model, which has been reviewed and assessed by an independent reviewer, to suitably represent the current conceptual understanding of the groundwater systems within and beyond the Project Area and allows for the prediction of changes in groundwater conditions and water resources due to the Project. The predictive groundwater modelling aims to:

- Estimate the groundwater inflow to the Project underground mine workings as a function of mine position and timing
- Simulate and predict the extent of groundwater level drawdown due to the Project
- Identify areas of potential environmental risk, where groundwater impact management measures may be necessary.

The numerical groundwater model, refined and calibrated for the Project, was subject to a Peer Review. **Appendix F-2 Groundwater Modelling Peer Review** (Hydroalgorithmics, 2023) presents the findings of the peer review, as required by the Commonwealth significant impact guidelines for assessment of water resources. There are two accepted guides to the review of groundwater models: the Murray-Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2000), and guidelines issued by the National Water Commission in June 2012 (Barnett et al., 2012). The National Water Commission Compliance Checklist concludes that the groundwater model is “fit for purpose”, where the purpose is defined by the model objectives.

Regional numerical groundwater model

A numerical groundwater model for the Project was developed using BMA’s regional numerical groundwater model as the foundation. The updated BMA regional groundwater model, referred to as the Project numerical groundwater model, builds on the regional scale Olive Downs Project model (i.e. the foundational model constructed and calibrated in 2018. The foundational model was subsequently updated for the following Bowen Basin mine projects:

- Moorvale South Project in 2019
- Winchester South Project in 2020
- Caval Ridge Mine and Horse Pit Extension Project in 2021
- Lake Vermont North Extension Project in 2021
- Millennium Mine Mavis Extension in 2021
- Daunia Mine Water Licence Review in 2021.

It is noted that this regional scale model has already been reviewed and accepted twice by State agencies and once by the Commonwealth for other project approval applications, as well as used by BMA to support various State mining compliance reporting requirements. Data sharing agreements have been established by these project proponents that allow the sharing of groundwater information and modelling. Under these agreements, the groundwater models developed as part of each project’s groundwater assessment were adopted as a base for the Project model, where relevant.

MODFLOW-USG Transport was used as the model code (Panday et al. 2013). MODFLOW-USG is the recent version of industry standard MODFLOW code and was determined to be the most suitable modelling code for accomplishing the model objectives. MODFLOW-USG optimises the model grid and increases numerical stability by using unstructured, variably sized cells. These cells take any polygonal shape, with variable size constraints allowing for refinement in areas of interest (i.e., geological or mining features).

MODFLOW-USG is also able to simulate unsaturated conditions, allowing progressive mine dewatering and post mining rewetting to be represented by the model. For the SEMLP model, vadose zone properties have been excluded, and the unsaturated zone was simulated using the upstream-weighting method.

Predictive simulations

The calibrated groundwater model was utilised to assess potential impacts of the Project on groundwater resources. Groundwater level drawdown was evaluated in the following geological layers:

- Quaternary age alluvium, colluvium and Tertiary basalt
- Regolith (weathered Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt)
- Moranbah Coal Measures Q seam, P seam, and H seam
- The target Dysart Lower coal seam (D seam).

All model predictions of underground mining impacts also included simulation of the approved SRM open-cut operations (including the Grevillea Pit extension) as previously undertaken by AECOM (2016) and shown in the open-cut mine plan (Figure 21-6).

As there was overlap between the approved open-cut mine plan and the proposed underground mine plan, the open-cut mine plan was modified for simulation of underground mining activities by removing those open-pit mining areas which overlapped with the proposed underground workings (Section 21.3.1.1); the justification being that these areas cannot be mined by open cut mining methods if they are being mined using the underground mining methods. The modifications to the open-cut mine plan are shown in Figure 21-8.

The predictive model simulations included:

- Predictions of groundwater levels from the end of the transient calibration model from January 2022 to January 2044
- Predictions of groundwater level recovery from January 2044 to January 4044 for 2000 years
- The prediction of groundwater ingress into the proposed Project, allowing for the estimate of groundwater ingress into the underground mine over time.

Groundwater level drawdown

A combined steady sate, transient warm-up and transient calibration model was developed, as follows:

- A steady state model with one stress period to simulate the water levels pre-mining
- A transient warm-up model with one 20-year stress period from January 1988 to December 2007
- A transient calibration model with 56 quarterly stress periods from December 2007 to December 2021.

The first stress period of the model was steady-state and did not include any mining. The transient warm-up model was built to incorporate pre-2008 mining activities and their impacts on groundwater levels around the SEMLP. The warm-up model provided appropriate starting conditions for the calibration model (i.e., starting heads and hydraulic properties).

The groundwater model was then used to simulate changes to pre-mining conditions within the model domain in response to the approved open-cut and proposed underground mining plans. As per the AECOM (2016) model, backfilling of the open-cut pits with spoil was simulated to occur.

The combination of backfill of open-cut pits (recharge), open-cut workings (dewatering), and underground workings (goaf alteration and dewatering) were simulated to allow for the evaluation of groundwater levels in response to complex mining operations.

Bore trigger thresholds

Sections 376(b)(iv) and 376(b)(v) of the Water Act refer to bore trigger thresholds. As defined in the Water Act, a bore trigger threshold for an aquifer means a decline in the water level that is:

- 5 m for consolidated aquifers (e.g. sandstones)
- 2 m for unconsolidated aquifers (e.g. sand/alluvial aquifers).

The area within which water levels are predicted to be lowered in an aquifer by more than the bore trigger threshold within three years, due to water extraction, is referred to as the Immediately Affected Area (IAA). The area within which water levels are predicted to be lowered by more than the bore trigger threshold in the long term, due to water extraction, is referred to as the Long-term Affected Area (LTAA).

To align with the requirements of the Water Act, groundwater drawdown contours were produced to be consistent with the bore trigger thresholds as follows:

- The surficial Quaternary/Tertiary sediments (including alluvium) are unconsolidated and thus 2 m drawdown contours were produced which is consistent with the bore trigger threshold for unconsolidated sediments.
- The deeper Tertiary and Permian sediments are consolidated and thus 5 m drawdown contours were produced which is consistent with the bore trigger threshold for consolidated sediments.

The 2 m and 5 m triggers relate to change in groundwater levels from the initial groundwater levels at the start of model predictions (i.e. pre-activities).

Model method

The BMA regional scale groundwater model was adopted as a base for the Project model. A range of updates to the BMA regional groundwater model were required for the model to be considered representative for the Project. The updates to the model design include:

- Updated fracture zone depth and hydraulic property changes above the proposed Project longwall panels based on the Project subsidence modelling report (Minserve, 2022).
- Updated model layer geometry based on the Peak Downs Mine, SRM, the Project, and Saraji South[1] latest BMA geological models.
- Implemented historic and approved future mining operations at SRM and Peak Downs Mine and the proposed project underground operations.
- Refined surface elevations and hydrologic features.

Model extent

The model is a regional scale model with the domain extent designed to meet environmental approvals application requirements for cumulative impact assessment, (i.e., the domain is large enough to appropriately consider all potential overlapping groundwater impacts from resource operations in the Bowen Basin). The regional groundwater model extent is shown in Figure 21-11.

Model boundaries

The model domain is intended to place boundary conditions sufficiently distant from the Project and surrounding mines to allow the extent of potential impacts from mining activities on the groundwater system to be assessed. At its widest extents, the model is approximately 62 km west-east by 95 km north-south. The model boundaries, deemed appropriate for the Project model, includes:

- The western boundary is represented by the outcrop boundary of the Back Creek Group, which dips below the coal bearing units and forms the low permeability basement layer of the model.

[1] Formerly known as Norwich Park Mine

- The northern model boundary contains the primary geological unit being targeted by the Project and is 50 km away from the proposed longwall panels.
- The southern boundary is set along the Stephens Creek 30 km south of the Project and is expected to be far outside the range of predicted Project related drawdown.
- The eastern boundary is set along the Delvin Creek 40 km east of the Project and is expected to be far outside the range of predicted Project related drawdown.

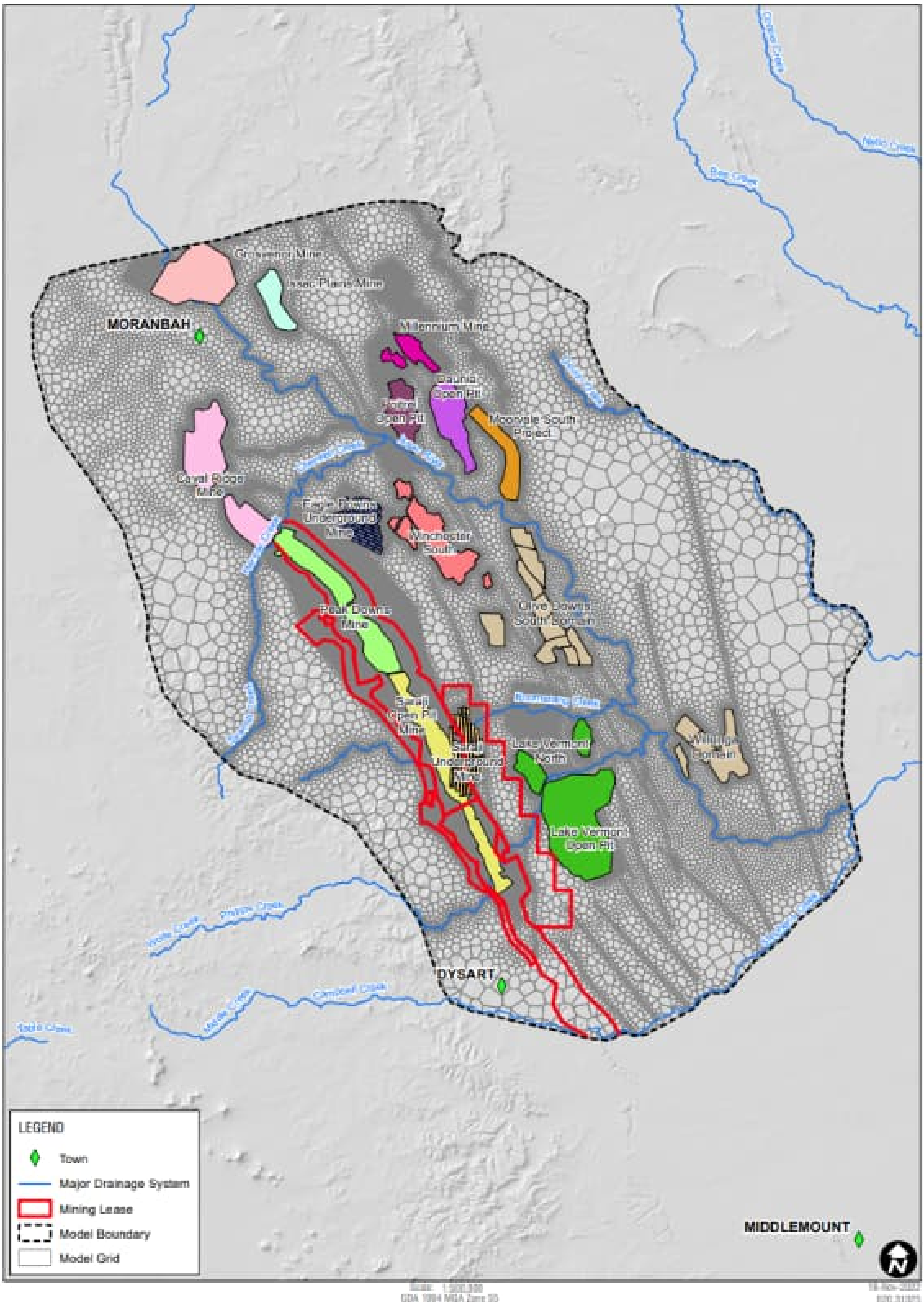


Figure 21-11 Model domain

To allow stable numerical modelling of the large spatial area of the model domain, an unstructured grid with varying Voronoi cell sizes was designed, as evident in Figure 21-11, to allow refinement around areas of interest (such as a longwall panel or fault).

The model domain was vertically discretised into 19 model layers, each layer comprising up to 121,225 cells. The total number of cells in the model is 1,362,485.

Model stresses and boundary conditions

Regional groundwater flow

General Head Boundary (GHB) was specified along the eastern, southern, and part of the northern model boundaries. The GHB boundary condition is used to represent the regional flow into and out of the model area and was assigned using GHB cells in all layers using the pre-mining head elevations.

Groundwater enters the model where the head set in the GHB is higher than the modelled head in the adjacent cell and will leave the model when the water level is lower in the GHB. GHB conductance was calculated using the hydraulic conductivity and the dimensions of each GHB cells and is therefore variable in this model due to variable cell-size.

No flow boundary was applied to the western boundary of the model that represents the outcrop of the Back Creek Group.

A drain boundary condition was used in the northern model boundary to simulate the mining at the Grosvenor Mine.

Watercourses

Major rivers (including Isaac River) as well as minor creeks were built into the model using the MODFLOW-USG RIV package.

River and creek widths, thickness and conductance values were adopted from the base BMA regional scale groundwater model. The rivers are set with the riverbed 1 to 10 m below the surrounding topography to represent the steep-banked incised channels. The river widths were assumed to be fixed for each river in the model. The river widths were estimated using aerial photography.

The river conductance was calculated using river width, river length, riverbed thickness, and the vertical hydraulic conductivity of river bed material. Therefore, the river conductance is variable due to the non-constant spatial discretisation in each of the model river cells. The vertical hydraulic conductivity of river beds for different rivers in the model were adopted from the base model.

The river stage height in the minor tributaries or drainage lines was set to 0 m (i.e., river stage elevation was equal to river bottom elevation). Therefore, the minor tributaries or drainage lines act as drains to the groundwater system and do not result in any recharge from the watercourse to the groundwater system.

Rainfall recharge

The dominant mechanism for recharge to the groundwater system is through diffuse infiltration of rainfall through the soil profile and subsequent deep drainage to underlying groundwater systems. Diffuse rainfall recharge to the model was represented using the MODFLOW-USG Recharge package (RCH).

The recharge rates were established through the calibration process, with bounds based on the conceptual understanding of the system and comparing them with other groundwater models prepared for the region. The starting values adopted in the calibration process were from the base BMA regional scale groundwater model. Rainfall recharge was imposed as a percentage of actual rainfall from the SILO Grid Point observations. Long-term average rainfall was used for the steady-state model. For the transient calibration model, quarterly averages of the historical rainfall data were used (2008 to 2020). For the prediction model, annual averages of 1990-2020 rainfall data were used.

Evapotranspiration

The MODFLOW Evapotranspiration (EVT) package was used to simulate evapotranspiration from the groundwater system. Extinction depths (the depth below land surface below which EVT does not occur) were set to 2 m below ground across the model domain. Maximum potential rates were set using actual evapotranspiration values (from the Bureau of Meteorology), with the average value (600 mm/year) used as the transient calibration evapotranspiration rate. An EVT rate of 0 was assigned to the model cells representing the rivers.

<u>Groundwater use</u>

Private groundwater pumping bores have not been included in the model due to lack of information regarding abstraction rates across the model domain. Due to generally low groundwater abstraction across the Project Area and model domain, it is likely that the bores have limited and localised drawdowns, which will not significantly impact model results.

<u>Mining</u>

The MODFLOW Drain (DRN) package was used to simulate mine dewatering in the model for the Project and surrounding mines. Boundary conditions for drain cells allow one-way flow of water out of the model. When the computed head drops below the stage elevation of the drain, the drain cells become inactive. This is an effective way of representing removal of water seeping into a mine over time, with the actual removal of water being via pumping and evaporation.

Project longwall mining groundwater extraction was represented as drain cells in the target D Seam and predicted fracture zone, extending above the Moranbah Coal Measures H seam. The depth of overburden over the target D seam coal varies between 110 m and 470 m. The panel width and extraction height are 320 m and 3.6 m, respectively.

The drain cells representing the surrounding mines are consistent with the base model. To simulate open cut mines in the model, drain cells are applied to all active layers from the surface to the base of the lowermost mined seam. Longwall extraction at Grosvenor Mine and Eagle Downs Mine are represented as drain cells in the target D Seam and the fracture zone, consistent with the base model.

Model layers

The structure of the coal seams within the Project comprises a Permian sequence overlain by a surficial covering of Tertiary and alluvium (in places) sediments. The Permian rocks form a regular layered sedimentary sequence which was simplified for the numerical model by merging several formations / strata into model layers. This is most evident when considering the overlying Permian coal measures, where coal seam aquifers and interburden aquitards are considered as one hydrogeological model layer. This is a conservative approach allowing for higher vertical hydraulic conductivity than can be expected associated with the interburden aquitards.

Topography within the model domain has been defined using numerous sources of varying accuracy, including high resolution (1 m) Digital Elevation Model (DEM) data, which was used to define local surface elevation within the Project Area. Outside the extents of the DEM dataset, LiDAR data and public domain 25 m DEM data sourced from Geoscience Australia was used to define topography in the remainder of the model domain.

The model domain includes 19 model layers, listed in Table 21-9, which includes the average thicknesses across the model domain for each layer. Model layer extents (lateral and vertical) where based on the following sources:

- The BMA SRM site geological model
- The BMA Saraji South site geological model
- The BMA Daunia Mine site geological model
- The BMA Caval Ridge Mine site geological model and borehole logs
- The BMA Poitrel Mine site geological model
- The Jellinbah Mining Pty Ltd, Lake Vermont, Lake Vermont North and Lake Vermont Meadowbrook site geological models and borehole logs
- The Whitehaven WS Pty Ltd Winchester South Project site geological model and borehole logs
- The MetRes Pty Ltd, Millennium site geological model

- The Peabody Energy Limited, Moorvale South Project site geological model and borehole logs
- The Pembroke Resources Limited, Olive Downs Project site geological model and borehole logs
- The CSIRO Regolith depth survey
- Queensland Globe borehole logs
- Queensland surface geology and basement geological map.

Model Layer 1 is extensive across the entire model domain with an average thickness of 8.3 m. It is noted that alluvium is not laterally or vertically extensive across the model domain; as such it was included within Layer 1 as a separate zone but not as a separate layer. With respect to Boomerang Creek (at the Project), the alluvium associated with the creek was set a uniform thickness of 3.75 m consistent with deepest alluvium recorded within the drill hole logs along the creek.

Model Layer 2 is also fully present across the model domain with a minimum thickness of 1 m. The available site geology models were used to define the base of model Layer 2. Outside these site geology models the base of Layer 2 was interpreted from CSIRO regolith survey depths and Queensland Globe bore log lithology data.

The underlying Triassic and Permian layers are present only to their outcrop extents, with some inference made for the presence of older units beneath the surface outcrop due to folding and (horst and graben) faulting. The Rangal Coal Measures and Fort Cooper Coal Measures are consistent with the base BMA regional scale groundwater model.

The Moranbah Coal Measures model layers, include for all the coal seam targets, consistent with the site geological models. As noted, it was not possible to represent every individual coal seam or ply in the model layers representing the Moranbah Coal Measures, therefore a ‘combined thickness’ totalling the approximate thickness of coal for the main seams was used. The major coal seams represented in the model are the Q, P, H and D seams. In doing so, the thicknesses of each individual coal seam (typically < 1m thickness) were combined separately for the major coal seams and the combined thicknesses were used in the model.

The basement layer has the thickness of 100 m and considered to replicate the Back Creek Group. The Back Creek Group, the footwall sediments for the target Moranbah Coal Measures, in general has low permeability and will act as regional aquitard, suppressing downward vertical flow. Site-specific long-term groundwater level monitoring in the Back Creek Group, adjacent to the SRM at MB37, does not indicate any dewatering of this aquitard unit below and adjacent to the SRM.

Table 21-9 Model layers

Model layer	Hydrostratigraphic units	Description	Average thickness (m)
1	Alluvium, colluvium, Tertiary basalt	Surface cover – alluvium, colluvium and Tertiary basalt	8.3
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt	19.2
3	Rewan Group	Triassic mudstone and sandstone	117.7
4	Rangal Coal Measures	Leichhardt overburden	36.6
5		Leichhardt seam	4.6
6		Interburden	35.6
7		Vermont seam	3.8
8		Vermont underburden	34.1
9	Fort Cooper Coal Measures	Fort Cooper overburden	206.6
10		Fort Cooper seams (combined)	55.9
11		Fort Cooper underburden	56.1

Model layer	Hydrostratigraphic units	Description	Average thickness (m)
12	Moranbah Coal Measures	Q seam	3.3
13		Interburden	38
14		P seam	2.9
15		Interburden	56.4
16		H seam	5.5
17		Interburden	67.1
18		D seam (target coal seam)	8.4
19		Base of model – aquitard Back Creek Group	100

Hydraulic parameters

The groundwater modelling approach included a staged approach, which included:

- A steady state model with one stress period to simulate the water levels pre-mining
- A transient warm-up model with one 20-year stress period from January 1988 to December 2007
- A transient calibration model with 56 quarterly stress periods from December 2007 to December 2021.

The first stress period of the model was steady-state and did not include any mining. The transient warm-up model was built to incorporate pre-2008 mining activities and their impacts on groundwater levels around the Project. The warm-up model provided appropriate starting hydraulic properties (i.e., horizontal, vertical conductivity, specific yield, specific storage, and recharge rates) for the calibration model.

A transient predictive model was then developed from the end of the transient calibration model from January 2022 to January 2044. The recovery model will then start from January 2044 to January 4044 for 2000 years.

The hydraulic conductivity of the Permian interburden material in the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures reduces with depth as recognised in the field observations. As the decrease of hydraulic conductivity within hydraulic conductivity the interburden rock units is driven by an increase in overburden pressure, the relationship between hydraulic conductivity and depth is different from that of coal seams. These relationships were determined using hydraulic conductivity versus depth data for the Rangal Coal Measures, Fort Cooper Coal Measures, and Moranbah Coal Measures interburden and coal seams.

The reducing hydraulic conductivity (exponential and power equations) of the coal seams and interburden with depth (detailed in Section 21.4.5.2) included:

- Coal: $HC = HC_0 \times e(-0.015 \times depth)$ (*Eq. 1*)
- Interburden (RCM and FCCM): $HC = HC_0 \times e(-0.018 \times depth)$ (*Eq. 2*)
- Interburden (MCM): $HC = HC_0 \times -2.1^{depth}$ (*Eq. 3*)

Where:

- HC is horizontal hydraulic conductivity at specific depth
- HC_0 is horizontal hydraulic conductivity at depth of 0 m (intercept of the curve)
- depth is depth of the floor of the layer (thickness of the cover material)
- slope is a term representing slope of the formula (steepness of the curve).

Recharge and discharge

The recharge rate was varied across the model, where seven recharge zones were included for the model calibration. The seven recharge zones include:

- Isaac River Flood Plain Alluvium
- Isaac River Channel Alluvium
- Alluvium – rest of the model
- Regolith
- Basalt
- Duaringa Formation
- Weathered Permian units.

The rainfall recharge was refined during the calibration, the recharge rates and per cent Mean Annual Precipitation (MAP), using 565 mm/year, is included in Table 21-10.

Table 21-10 Recharge rates

Recharge zone	Rate (mm/year)	% MAP
Isaac River Flood Plain Alluvium	1.3	0.24
Isaac River Channel Alluvium	0.3	0.05
Alluvium – rest of the model	0.7	0.13
Regolith	0.1	0.01
Basalt	2.3	0.40
Duaringa Formation	0.2	0.03
Weathered Permian units	0.5	0.10

An enhanced recharge of 100 per cent is applied to residual mine pit voids in the prediction model, where void lakes are not represented. No recharge is applied to constant head cells representing void lakes during recovery predictions. Recharge to mine spoil is set to 1 per cent of average annual rainfall.

Surface discharge of groundwater was included in the model using the MODFLOW river (RIV) package in model Layer 1. The RIV package compares the water level in the aquifer against a reference river depth level, whereby if the aquifer water level is above the reference level then water is removed at a rate specified by the river bed conductance.

Groundwater inflow to the mine workings was modelled using the MODFLOW Drain (DRN) package. Using drains involved the setting of a reference (drain target) elevation at the base of the target D seam and a conductance (leakage) term.

Impacts of longwall mining - goaf

To estimate mine impacts and estimates of groundwater ingress from underground longwall mining activities, aquifer alteration due to mining (longwall goaf) was taken into consideration.

Longwall mining results in collapse of the overlying rock strata into the void left by coal extraction. The collapsed or disturbed overburden material is referred to as goaf. The collapse propagates upwards from the extracted seam until bulking of the goaf limits vertical movement and the tensile strength of the rock is sufficient to hold up the overburden without failure. Where propagation extends to the land surface, subsidence of the land surface occurs.

Kendorski (1993) defines five zones in the goaf shown in Figure 21-12 and described as:

- Caved Zone: This is the zone of complete disruption of broken and rubble-sized strata extending from 2 to 10 times the seam thickness, in height above the caving roof.

- Fractured Zone: This zone occurs above the caved zone to a height of 24 to 30 times the seam thickness. The strata do not fall and detach but cracks and settles, resulting in fractures extending through individual beds, opening of bedding planes and shearing and dislocation of beds. The caved and fractured zones have increased vertical and horizontal transmissivity and storativity and both attributes decrease exponentially with height above the seam roof.
- Dilated Zone: This zone is often referred to as the "Aquiclude Zone". In this zone the strata sag allows bed separations, but not connecting fracturing and drainage into the mine. It occurs at a height of 30 to 60 times the seam thickness. The water level of aquifers located in this zone may be lowered in response to the relatively rapid increases in void space laterally, but the water level generally recovers given sufficient time, as the voids are filled.
- Constrained Zone: This zone occurs where the extracted seam is deeper than 60 times the seam thickness plus about 15 m and is characterized by overall tensile strains of less than 1 mm/m, a stress level at which rock masses are not disrupted sufficiently to increase their permeability. Hence there is no significant change in transmissivity or storativity, and therefore aquifers which occur in this zone, are largely unaffected.
- Surface Fracture Zone: The surface fractures generally relate to panel and trough edges and extend to a depth of about 15 m. If transmitted into soils, the soil properties may allow little or no crack development due to the plastic and non-brittle nature of many soils. If in rock, the natural pre-existing fracturing will be dilated, having little effect on continuity. The cracks are transmissive zones and the increased void space may result in a temporary lowering of shallow groundwater levels as the voids fill. The cracks will not provide pathways for deeper migration of groundwater unless extending into the "fracture zone". This may happen where the "dilated zone" is absent due to shallow mining, that is, shallow overburden thickness. Surface cracks also generally fill quickly with sediment or close due to spalling.

The subsidence zones described by Kendorski (1993) above are generic; the depth of cover, overlying stratigraphy and panel widths vary between mines and each of these factors have to be taken into account when assessing subsidence effects.

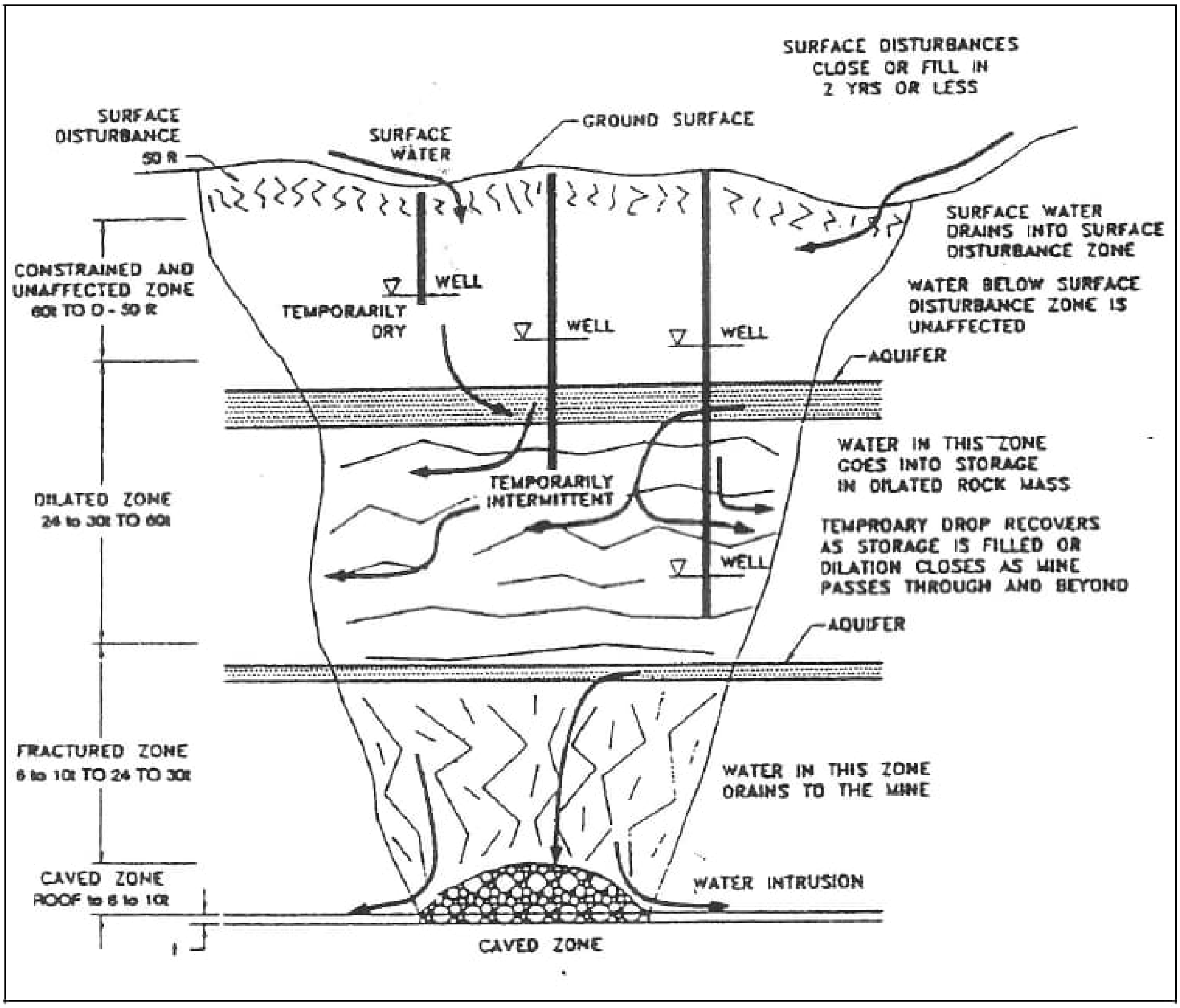


Figure 21-12 Subsidence Zones (Kendorski, 1993)

<u>Simulation of subsidence effects due to goaf alteration</u>

Modelling of subsidence predictions specific to the proposed underground mine workings were undertaken (Minserve, 2022). **Appendix B-2 Subsidence Modelling** (Minserve, 2022) allowed for an estimate of the vertical extents of alteration above the longwall mining panels. In addition, the GEONET subsidence assessment provided estimates of possible changes to aquifer hydraulic properties, dependent on the hydrostratigraphic unit, because of goaf.

The subsidence model was set up to include the major geological strata with properties which reflected pre-mining conditions. The subsidence model simulated the effect of bed separation, opening of joints and the formation of new cracks in the originally intact overburden rock mass. Changes in stress and the induced deformation in the surrounding rock mass associated with rock fracture and bedding plane separation were calculated. Main findings of the subsidence modelling are summarised below:

- When overburden thickness is less than 300 m above the target D coal seam, the subsidence modelling results show continual volumetric strain and rock mass damage in the overburden strata extending from longwall edge to the surface. Shear cracks at the surface are predicted to form to a depth of 30 m to 70 m below the ground level.
- When the overburden thickness is more than 300 m, the results indicate that the fractured zone extends to above 30 m to 50 m above the Harrow Creek seam (H Seam, layer 16 in the groundwater model). The overlying units will be undamaged rock mass. Longwall mining also induces shallow tension cracks which are predicted to extend to a maximum depth of 15 m below ground level.

Changes in hydraulic properties due to longwall mining

As longwall mining progresses through the coal seam, the void left behind collapses (goaf) and fills with collapsed rock from the formations directly above the coal seam (i.e., the caved zone). There is a sag in the bedded formations above the goaf zone and the deformation causes generally vertical fractures to occur. These fractures can provide new flow paths for groundwater and alter the permeability of the strata overlying longwall mining areas.

Based on the subsidence model findings, two different fracture zones were predicted and included in the model. These include:

- Fracturing where the longwall panels have an overburden thickness > 300 m
- Fracturing where the longwall panels have an overburden thickness < 300 m.

With respect to deeper longwalls (overburden thickness > 300 m), it was assumed that the fracture zone generally extends to 50 m above the Harrow Creek seam (H Seam) and the surface cracking occurs up the depth of 15 m.

Over shallower longwalls (i.e., overburden thickness < 300 m), the surface cracking extend to a depth of 50 m. It was assumed here that the fracturing occurs above the longwall up to the surface cracking zone. These fracture zones, as included in the groundwater model using the time-variant materials (TVM) package of MODFLOW-USG Transport, are included in Figure 21-13.

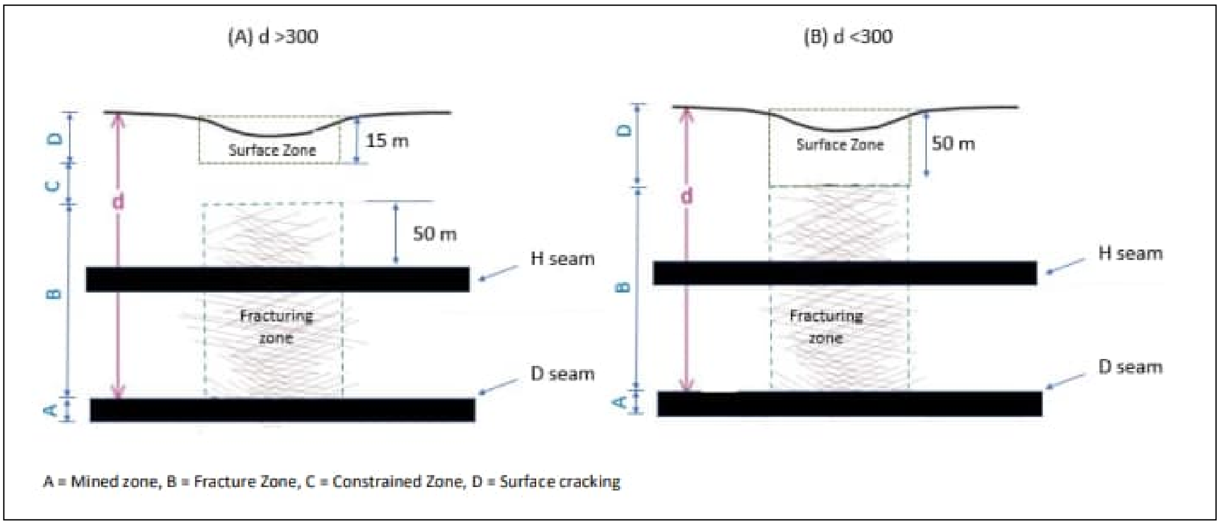


Figure 21-13 Fracture zones (SLR, 2023)

Note: In this study, it was assumed that any change to hydraulic and storage properties remained until the end of model predictive run, (i.e., there is no ‘self-sealing of subsidence fracturing over time). This approach is considered to be conservative given that the overlying Tertiary sediments, particularly those at the surface zone, swell and self-seal over time, and therefore any surface cracks fill with sediments reducing their hydrological effect over time. This phenomena is recognised in the Bowen Basin, as evident at the Goonyella Broadmeadow Riverside Mine complex, where water ponding occurs in subsided areas and does not drain vertically (Plate 1).

Plate 1 Flooded subsided longwall panels at the Bowen Basin Goonyella Broadmeadow Riverside Mine complex

These changes were included in the predictive modelling to simulate longwall mining alteration.

Table 21-11 Hydraulic parameter changes due to longwall mining

Fracture zone components	Zone (Figure 21-13)	Changes
Surface cracking	D	No change to horizontal hydraulic conductivity 10 x increase in vertical hydraulic conductivity
Constrained zone	C	No change
Fracture zone	B	3 x increase in horizontal hydraulic conductivity 100 x increase in vertical hydraulic conductivity
Mined zone (extracted coal)	A	Horizontal hydraulic conductivity of 100 m/day Vertical hydraulic conductivity of 100 m/day Specific yield of 0.16

<u>Open cut mining alteration</u>

For open cut mining, the spoil and waste rock are more permeable than the undisturbed strata. Completed open cut mining areas, as identified within the SRM, have and will be backfilled with waste overburden as the extraction proceeds.

The model includes for the variation in hydraulic properties in the open-cut pits, using the MODFLOW TVM package, based on the operational mine plans. Horizontal hydraulic conductivity of 0.3 m/day and vertical hydraulic conductivity of 0.1 m/day is applied to the spoil. The storage parameters used for the spoil were a specific yield (S_y) of 0.1 and a storage coefficient (S) of 1.0 x 10^{-5}.

<u>Simulation of incidental mine gas extraction</u>

Removal of gas from the Permian sediments is required to ensure that the underground mine workings are unhindered by seam gas emissions during extraction of the coal.

Conceptual gas extraction modelling was undertaken by GEOGas (2016). GEOGas identified five regions with differing gas characteristics (Figure 21-14). Modelled gas and associated water extractions were simulated from pre-drainage wells to achieve pre-determined gas contents within three years, five years, and eight years following gas and water extraction.

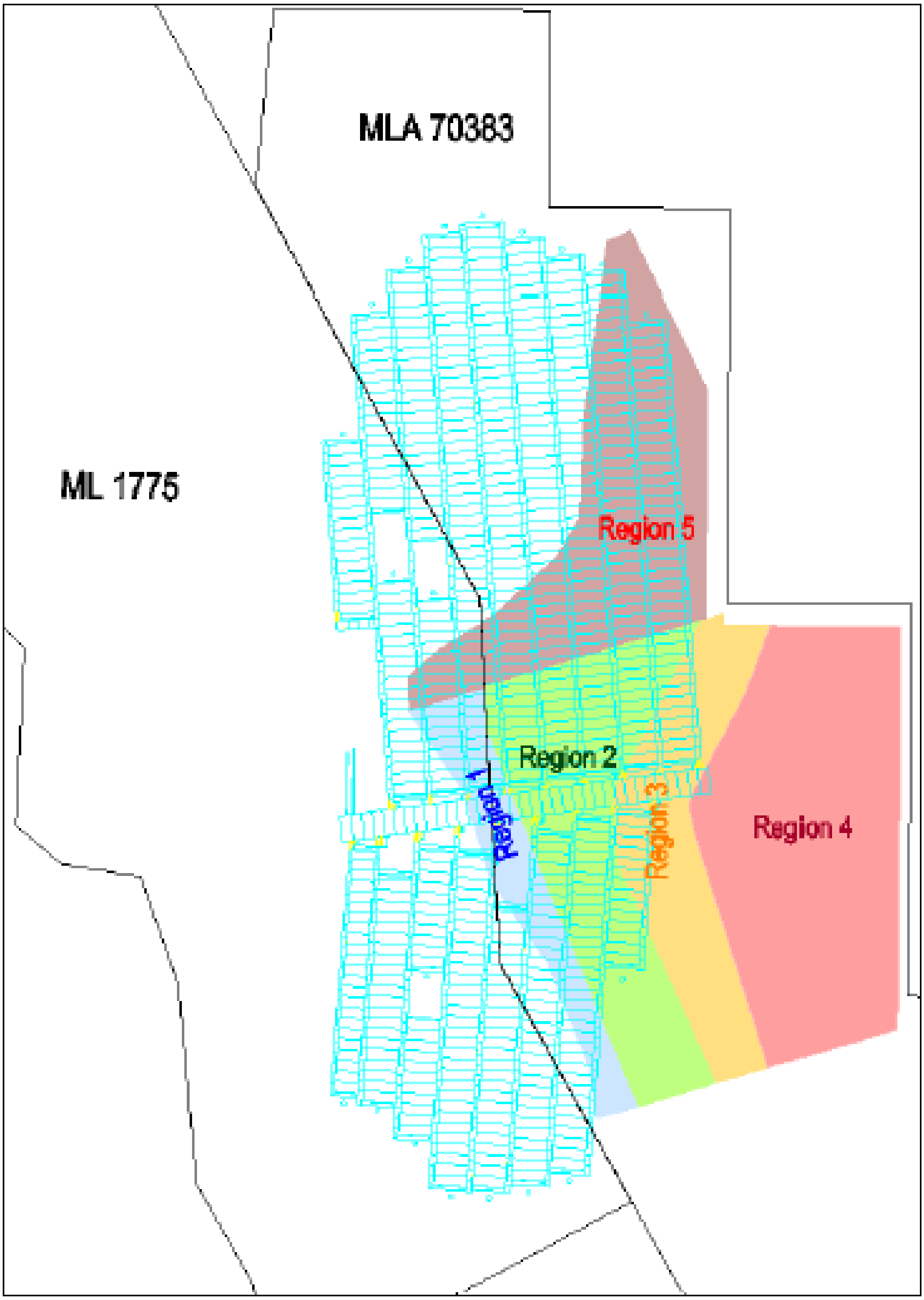


Figure 21-14 Incidental Mine Gas Regions (from GEOGas, 2016)

The eight-year gas and water extraction predictions, assessed by GEOGas, were adopted for the inclusion in the groundwater modelling. This allowed for the realistic simulation of groundwater extraction before and across longwall panels, as well as the dewatering associated with the actual underground mine panel mining.

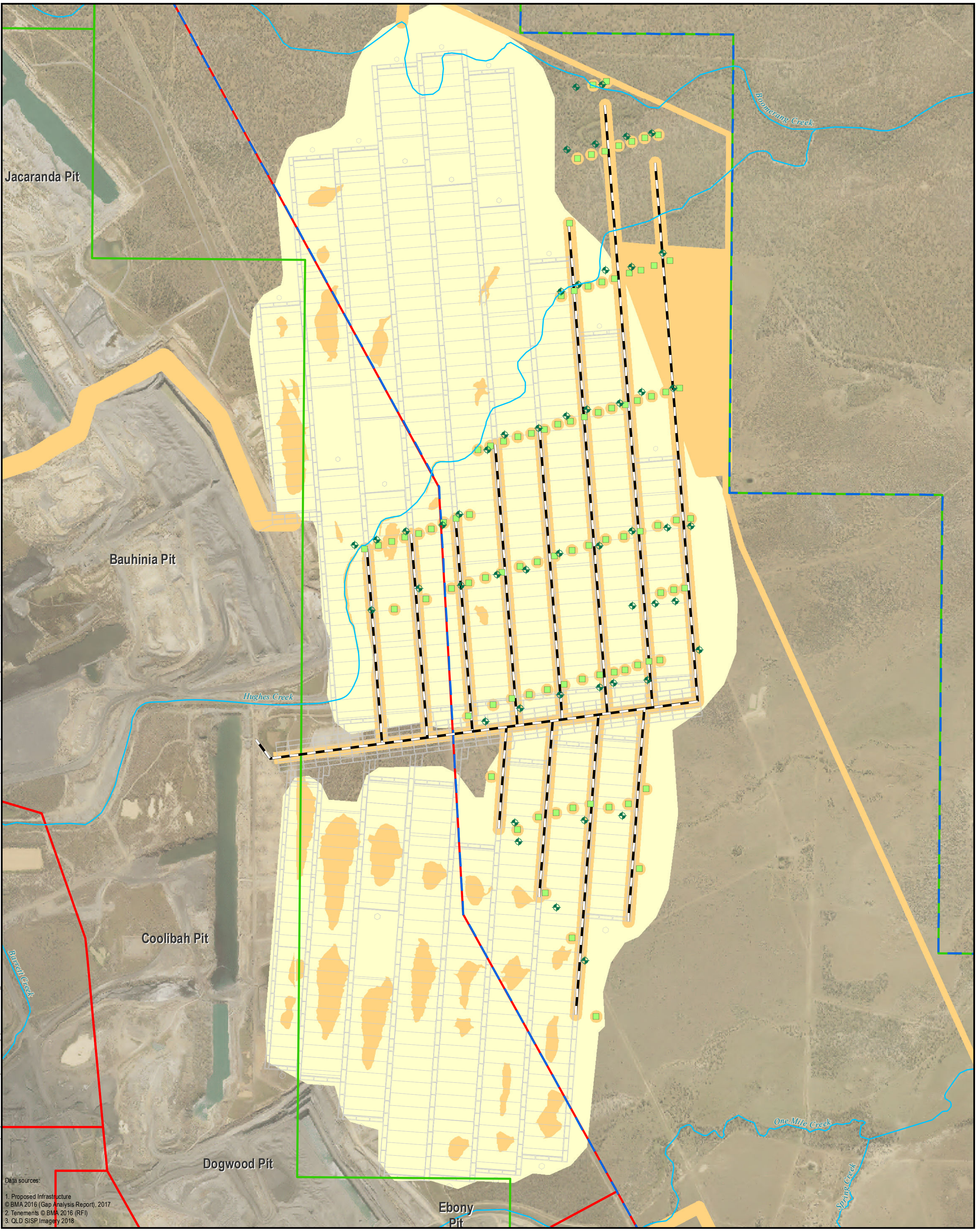
A summary of the drainage bores and water extraction volumes is provided in Table 21-12. The location of the water extraction bores is shown in Figure 21-15.

Table 21-12 Gas drainage simulation

	Region 1	Region 2	Region 3	Region 5
ML 1775				
Number of bores	2	-	-	4
Bore spacing (m)	250	-	-	110
Total pumped volume / 8 years (ML)	13,800,000	-	-	7,700,000
Total pumped volume per year (L)	1,725,000	-	-	962,500
Continuous Extraction over 8 years (L/s)	0.05	-	-	0.03
MLA 70783				
Number of bores	4	13	7	20
Bore spacing (m)	250	140	90	110
Total pumped volume / 8 years (L)	23,000,000	57,700,000	18,800,000	70,800,000
Total pumped volume per year (L)	2,875,000	7,212,500	2,350,000	8,850,000
Continuous Extraction over 8 years (L/s)	0.09	0.23	0.07	0.28

Gas extraction ahead of mining also removed groundwater as associated water during the gas extraction process. For the groundwater model, the mine gas extraction from the 50 gas and water extraction wells, was assumed to be starting one year prior to underground mining and continued for a period of 8 years.

The layout of the bores is presented in Figure 21-15. It is considered that these bores will be located to allow for the longevity of the gas wells (i.e. along longwall pillars); however, these wells will be lost / become dry over time as mining continues down dip.



LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Underground Mine Layout
- Watercourse
- Modelled Gas Extraction Bore
- Gas Drainage Location
- Gas Collection Line (to be collected at Centrally Located Location)

N

Figure 21-15
Location of Modelled Gas Drainage Bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.25 0.5 1
Kilometres

Scale: 1:40,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 4/06/2024 VERSION: 4

Model calibration

The calibration methodology adopted for the Project model involved running the model a number of times using different parameter sets and investigating which model produce the best calibration statistics. In doing so, the previously calibrated parameter set from the base model was used as a starting point to establish 550 realisations of the Project model, and the model was run using those 550 realisations. A full description of the parameter distribution across the 550 realisations is provided in EIS **Appendix F-1 Groundwater Modelling Technical Report**.

After running the 550 calibration realisations, the calibration statistics for each realisation were assessed and the lowest Scaled Root Mean Square error (SRMS) was considered to be the best calibrated model for the purposes of the Project. The model with the parameter distribution, which produced the lowest SRMS error, was considered the base case model. The remaining 549 realisations were used to quantify the model uncertainty.

The groundwater model was calibrated to groundwater level measurements determined to be representative of water levels prior to mining (i.e. pre-1974). The model calibration considered the relatively low rainfall and high evaporation and tried to obtain a representative simulation of observed versus simulated (modelled) steady-state groundwater levels.

Groundwater levels

The groundwater levels recorded between January 2008 to December 2021 were used for the calculation of SRMS statistics. A total of 3,449 target heads were used from 281 bores across the model domain. The model calibration bores included:

- 34 groundwater level observation sites and VWPs[2] at SRM and the Project
- 30 groundwater level observations sites and VWPs at Lake Vermont
- 16 bores and two VWPs at Winchester South
- 38 groundwater level observations sites and VWPs at Olive Downs Project
- 6 monitoring bores at Peak Downs Mine
- 33 bores including VWPs at Caval Ridge Mine
- 124 other bores at Moorvale South Mine, Millennium Mine, Lake Vermont Meadowbrook Mine, Eagle Downs Mine, Poitrel Mine, Daunia Mine, Moranbah South Mine and several Queensland Department of Regional Development, Manufacturing and Water (DRDMW) monitoring bores.

Groundwater targets were selected where:

- Valid information on bore construction or geology information was available for the site
- Targets were manually reviewed to ensure the measurements were accurate.

The hydraulic properties (i.e., horizontal, vertical conductivity, specific yield, and specific storage) and recharge rates were adjusted during the calibration to provide best match between the groundwater level measurements and model simulated heads.

Calibration statistics

The calibration statistics for the best calibrated model (lowest SRMS error) is included in Table 21-13. One of the industry standard methods to evaluate the calibration of the model is to examine the statistical parameters associated with the calibration. This is done by assessing the error between the modelled and observed (measured) water levels in terms of the root mean square (RMS). RMS is considered to be the best measure of error if errors are normally distributed. The RMS error calculated for the calibrated model is 10.4 m.

[2] Vibrating wire piezometers (VWPs) a vibrating wire pressure transducer to accurately measure the pore water pressure of the ground by responding to changes in water pressure.

Table 21-13 Calibration statistics for the base case model

Statistics	Value
Sum of squares (m^2)	275,362.7
Mean of squares (m)	79.8
Square Root of Mean of Squares (RMS) (m)	8.9
Scaled Root Mean Square (SRMS) (%)	5.9
Sum of Residuals (m)	23,035.2
Mean Residuals (m)	6.7
Scaled Mean Residual (%)	4.4
Coefficient of Determination (tend to unity)	1.2
Targets within ±2 m (% of total)	740 (21%)
Targets within ±5 m (% of total)	1,728 (50%)
Targets within ±20 m (% of total)	3,327 (96%)

The acceptable value for the calibration criterion depends on the magnitude of the change in heads over the model domain. The total measured head change across the model domain is 156 m; therefore, the ratio of RMS to the total head change (i.e., scaled root mean square, SRMS) is 5.9 per cent. While there is no recommended universal SRMS error, the Australian Groundwater Modelling Guidelines suggests that setting SRMS targets such as 5 or 10 per cent may be appropriate in some circumstances (Barnett et al, 2012).

The difference between the measured and the modelled water level at each bore, referred to as the residual, was assessed across the model domain. A negative residual represents an over estimation of water levels, while a positive residual represents an underestimate. The average residual data for each model layer is included in Table 21-14.

Table 21-14 Residual data for each model layer

Model layer	Hydrostratigraphic units	Description	Average residual (m)	Number of targets	Number of bores
1	Alluvium, colluvium, Tertiary basalt	Surface cover – alluvium, colluvium and Tertiary basalt	-5.3	212	18
2	Tertiary sediments, Tertiary basalt	Tertiary and minor Triassic Clematis Group, weathered Permian, Tertiary basalt	2.3	910	93
3	Rewan Group	Triassic mudstone and sandstone	-6.0	153	15
4	Rangal Coal Measures	Leichhardt overburden	-4.6	251	10
5		Leichhardt seam	-2.3	358	28
6		Interburden	-7.2	123	6
7		Vermont seam	-7.4	259	23
8		Vermont underburden	-7.2	175	5
9	Fort Cooper Coal Measures	Fort Cooper overburden	1.3	338	23
10		Fort Cooper seams (combined)	2.9	90	10

Model layer	Hydrostratigraphic units	Description	Average residual (m)	Number of targets	Number of bores
11		Fort Cooper underburden	6.8	29	4
12	Moranbah Coal Measures	Q seam	0	117	3
13		Interburden	-2.1	39	2
14		P seam	-2.5	99	6
15		Interburden	-10.4	66	5
16		H seam	-3.7	85	14
17		Interburden	-5.6	7	3
18		D seam	-4.7	138	14
19		Base of model	-	-	-

No observations in layer 19

The table also show overall the simulated groundwater levels are closer to the observed groundwater levels in the model layers representing the Moranbah Coal Measures (layers 12 to 18), excluding layer 15 which has a small number of observation bores (5).

Model water budget

The assumed water volumes, storages and movement rates relevant to the model (known as the model water budget), was assessed to:

- Ensure the converged solution was adequately conserving mass during the simulation
- Assess water movements in and out of the model domain.

Steady-State calibration

The water balance for the steady-state model indicates that recharge was the largest net inflow contributor to the steady state model (4.2 ML/day). Regional groundwater inflow and outflow are 2.2 and 0.2 ML/day, respectively, indicating that groundwater enters the model domain through this boundary.

A net outflow of 2.3 ML/day from the steady-state model occurs due to baseflow seepage to the Isaac River (i.e. surface water and groundwater interaction in the Isaac River). Other factors that contribute to outflow from the groundwater system are evapotranspiration (3.1 ML/day outflow) and baseflow seepage to minor drainage systems (0.8 ML/day outflow).

The difference between the calculated model inflows and outflows at the completion of the calibration (known as the mass balance error), was 0 per cent. This indicates the model is stable and achieves an accurate numerical solution (Barnett et al, 2012). Table 21-15 presents the model water balance for the steady state simulation.

Table 21-15 Steady-state model water budget

Component	Flow (ML/day)
IN	
Recharge	4.20
ET / EVT	0.0
SW-GW interaction – Isaac River	7.63
SW-GW interaction – other rivers	0.00
Regional groundwater flow	2.21
Mines	0.0

Component	Flow (ML/day)
Storage	0.0
TOTAL IN	**14.03**
OUT	
Recharge	0.0
ET / EVT	3.09
SW-GW interaction – Isaac River	9.97
SW-GW interaction – other rivers	0.76
Regional groundwater flow	0.21
Mines	0.00
Storage	0.0
TOTAL OUT	**14.03**
IN - OUT	0
Percent Discrepancy	0.0%

<u>Transient calibration</u>

The model water balance for the transient simulation averaged over the duration of the calibration period is presented in Table 21-17. The mass balance error, that is the difference between calculated model inflows and outflows at the completion of the transient calibration, was 0.00 per cent, which indicates the model is stable and achieves an accurate numerical solution.

Table 21-17 shows 3.1 ML/day is lost to evapotranspiration in areas where the water table is within 2 m of the land surface. In total 11.4 ML/day is discharged via surface drainages, with the vast majority of that attributed to the Isaac River. A net flow loss of approximately 2.5 ML/day occurs to the Isaac River (reach within the model domain) indicates a net gaining condition in the river in the calibration period.

Table 21-16 Transient model water budget

Component	Flow (ML/day)
IN	
Recharge	4.68
ET / EVT	0.0
SW-GW interaction – Isaac River	8.18
SW-GW interaction – other rivers	0.00
Regional groundwater flow	2.26
Mines	0.0
Storage	10.65
TOTAL IN	**25.76**
OUT	
Recharge	0.0
ET / EVT	3.11
SW-GW interaction – Isaac River	10.71
SW-GW interaction – other rivers	0.74
Regional groundwater flow	0.22

Component	Flow (ML/day)
Mines	6.32
Storage	4.66
TOTAL OUT	**25.76**
IN - OUT	0
Percent Discrepancy	0.0%

Other rivers contribute to a loss of approximately 0.7 ML/day from the groundwater system over the transient calibration with no inflow component. The regional groundwater flow fluxes (inflow and outflow) are 2.3 and 0.2 ML/day, respectively. This indicates that a small volume of water enters the model domain through this boundary and, therefore, this boundary condition does not have a significant influence on the model predictions.

6.3 ML/day is removed from the model by the Drain boundary condition that represents historical mining (1988 - 2022) in the model. The average simulated historical ingress for major active mines active during the calibration period include:

- SRM – 1.3 ML/day
- Peak Downs Mine – 1.6 ML/day
- Caval Ridge Mine – 0.6 ML/day
- Daunia Mine – 0.3 ML/day
- Poitrel Mine – 0.3 ML/day
- Millennium Mine – 0.6 ML/day
- Lake Vermont – 0.6 ML/day.

Calibrated model parameters

Table 21-17 presents a summary of the model layer parameter values for horizontal and vertical hydraulic conductivity for the base case groundwater model.

Table 21-17 Model parameters

Model Layer	Formation	Unit	Horizontal hydraulic conductivity (m/day)	Anisotropy (Kv / Kx)
1	Alluvium	Surface cover	54	0.28
1	Regolith	Surface cover	4.6	0.04
1	Weathered Permian	Surface cover	0.35	0.40
1	Duaringa Formation	Surface cover	1.8	0.40
1 and 2	Tertiary Basalt	Basalt	2.7	0.10
2	Regolith	Surface cover	0.35	0.20
3	Rewan Group	Aquitard	4.8×10^{-3}	0.50
4	Rangal Coal Measures	Leichhardt overburden	5.0×10^{-5} to 8.5×10^{-3}	0.10
5		Leichhardt seam	1.0×10^{-4} to 1.0×10^{-1}	0.15
6		Interburden	5.0×10^{-5} to 8.9×10^{-4}	0.002
7		Vermont seam	1.0×10^{-4} to 1.9×10^{-2}	0.50
8		Underburden	5.0×10^{-5} to 7.6×10^{-3}	0.03
9		Overburden	5.0×10^{-5} to 6.3×10^{-3}	0.001

Model Layer	Formation	Unit	Horizontal hydraulic conductivity (m/day)	Anisotropy (Kv / Kx)
10	Fort Cooper Coal Measures	Fort Cooper seam	1.0×10^{-4} to 3.5×10^{-3}	0.50
11		Underburden	5.0×10^{-5} to 3.5×10^{-3}	0.20
12	Moranbah Coal Measures	Q seam	1.0×10^{-4} to 5.9×10^{-2}	0.003
13		Interburden	5.0×10^{-5} to 1.0×10^{-2}	0.06
14		P seam	1.0×10^{-4} to 1.0×10^{-1}	1
15		Interburden	5.0×10^{-5} to 1.0×10^{-2}	0.50
16		H seam	1.0×10^{-4} to 7.4×10^{-2}	0.01
17		Interburden	25.0×10^{-5} to 1.0×10^{-3}	0.20
18		D seam	1.0×10^{-4} to 4.9×10^{-2}	0.20
19		Interburden	5.0×10^{-5} to 6.6×10^{-5}	0.001

Where: K_x = Horizontal hydraulic conductivity and Kv is the vertical hydraulic conductivity

The prediction modelling storage values for specific yield (S_y) and specific storage (S_s) were included in the model, as presented in Table 21-18.Note that these base case parameters were used to provide an assessment of groundwater impacts, related to ingress and drawdown cone extent.

Table 21-18 Storage coefficients

Model Layer	Formation	Unit	Specific yield (%)	Specific storage (m^{-1})
1	Alluvium	Surface cover	4.2	1.0×10^{-5}
1	Regolith	Surface cover	3.6	5.5×10^{-6}
1	Weathered Permian	Surface cover	1.0	1.0×10^{-6}
1	Duaringa Formation	Surface cover	2.1	1.0×10^{-6}
1 and 2	Tertiary Basalt	Basalt	3.4	1.2×10^{-6}
2	Regolith	Surface cover	2.8	1.0×10^{-6}
3	Rewan Group	Aquitard	4.2	7.0×10^{-7}
4	Rangal Coal Measures	Leichhardt overburden	2.8	4.7×10^{-6}
5		Leichhardt seam	0.8	9.0×10^{-7}
6		Interburden	0.1	7.0×10^{-7}
7		Vermont seam	0.2	3.1×10^{-6}
8		Underburden	0.2	1.6×10^{-6}
9	Fort Cooper Coal Measures	Overburden	0.1	7.0×10^{-7}
10		Fort Cooper seam	0.5	3.2×10^{-6}
11		Underburden	0.6	1.9×10^{-6}
12	Moranbah Coal Measures	Q seam	0.1	4.8×10^{-6}
13		Interburden	0.4	1.7×10^{-6}
14		P seam	0.1	9.0×10^{-6}
15		Interburden	0.13	1.4×10^{-6}
16		H seam	0.1	9.0×10^{-6}

Model Layer	Formation	Unit	Specific yield (%)	Specific storage (m^{-1})
17		Interburden	0.32	3.4×10^{-6}
18		D seam	0.1	9.7×10^{-6}
19		Interburden	0.39	3.5×10^{-6}

Faults

The modelling of faults are included within the groundwater model domain. Mesh refinement has been used along fault lines to allow for isolated changes of hydraulic properties along fault zones during calibration.

With regards to the faults, an exponential equation was used to replicate changes in hydraulic conductivities of fault at depth similar to the approach adopted for coal and interburden. The equation for faults used was:

- $HC = HC_0 \times e(-0.018 \times depth)$

To show how the hydraulic conductivities changes at depth within the faults, the hydraulic parameters within faults were calculated for each layer and shown in Table 21-19.

Table 21-19 Hydraulic conductivity of faults (base case model)

Model Layer	Formation	Unit	Horizontal hydraulic conductivity (m/day)	Anisotropy (Kv / Kx)
3	Rewan Group		9.8×10^{-3}	0.35
4	Rangal Coal Measures	Leichhardt overburden	9.1×10^{-3}	0.34
5		Leichhardt seam	9.0×10^{-3}	0.32
6		Interburden	8.5×10^{-3}	0.30
7		Vermont seam	8.0×10^{-3}	0.29
8		Vermont underburden	7.7×10^{-3}	0.27
9	Fort Cooper Coal Measures	Fort Cooper overburden	7.3×10^{-3}	0.35
10		Fort Cooper seam	6.3×10^{-3}	0.18
11		Fort Cooper underburden	4.9×10^{-3}	0.12
12	Moranbah Coal Measures	Q Seam	4.3×10^{-3}	0.17
13		Interburden	4.1×10^{-3}	0.19
14		P seam	3.8×10^{-3}	0.19
15		Interburden	3.7×10^{-3}	0.23
16		H seam	3.3×10^{-3}	0.21
17		Interburden	3.0×10^{-3}	0.22
18		D seam	2.6×10^{-3}	0.21
19		Interburden	1.9×10^{-3}	0.18

The calibrated values for specific storage and specific yield for the faults in the base case model were:

- Specific yield ranged 0.2 to 3.9 per cent
- Specific storage ranged from 7.0×10^{-7} to 6.3×10^{-6}.

Cumulative impacts

The use of a regional scale model with the domain extent was designed to meet environmental approvals application requirements for cumulative impact assessment, (i.e., the domain is large enough to appropriately consider all potential overlapping groundwater impacts from resource operations in the Bowen Basin).

The predictive modelling allowed for the simulation of cumulative drawdown to assess whether the zone of impact from the neighbouring operations is predicted to interact with the zone of impact predicted for the Project in different aquifers, including the alluvium, regolith, and Moranbah Coal Measures.

The transient predictive modelling, to aid with assessing cumulative impacts, involved three model scenarios, which included:

- Project – all approved and foreseeable mining in the region including SRM open-cut pits and the Project (proposed underground mining)
- Approved – all approved and foreseeable mining in the region including SRM open-cut pits (no Project)
- Null run – no mining within the region.

Maximum cumulative drawdown predictions were determined, which represent the total impact to modelled groundwater levels resulting from all mining within the model domain. These drawdowns were determined by comparing the maximum difference in aquifer groundwater levels for the Project model scenario with those in the theoretical “no mining” Null Run scenario, for all times during the predictive model period.

Model classification

The groundwater modelling was conducted in accordance with the Australian Groundwater Modelling Guidelines (Barnett et al. 2012), the Murray Darling Basin Commission (MDBC) Groundwater Flow Modelling Guideline (MDBC, 2000), and the released IESC Explanatory Note for Uncertainty Analysis (IESC, 2018). These are mostly generic guides and do not include specific guidelines on special applications, such as underground coal mine modelling.

The 2012 Australian Groundwater Modelling Guidelines has replaced the model complexity classification of the previous MDBC guideline by a "model confidence level" (Class 1, Class 2, or Class 3 in order of increasing confidence) depending on:

- Available data (and the accuracy of that data) for the conceptualisation, design, and construction.
- Calibration procedures that are undertaken during model development.
- Consistency between the calibration and predictive analysis.
- Level of stresses applied in predictive models.

In general, a model confidence level of Class 2 is required for mining environmental impact assessment; the 2012 Australian Groundwater Modelling Guidelines state a Class 2 model is appropriate to be used for assessing impacts associated with mine dewatering (Barnett et al. 2012). As outlined in Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines includes the subjective qualitative criteria allowing model classification.

Assessment presented in Table 21-20 indicates the Project groundwater model overall can be classified as primarily Class 3 using the 2012 Australian Groundwater Modelling Guidelines classification system (effectively “high confidence”), with some aspects meeting the Class 2 (“medium confidence”) criteria. This is considered an appropriate level for the Project groundwater assessment.

Table 21-20 Groundwater model classification table[1,2]

Class	Model characteristics		
	Data	Calibration	Prediction
1	Few or poorly distributed data points	Not possible	Predictive timeframe >> calibration timeframe
	Unavailable or sparse data in areas of greatest interest	Unacceptable levels of error	Temporal discretisation is different to calibration

Class		Model characteristics				
		Data		Calibration		Prediction
	X	No metered groundwater extraction data		Inadequate distribution of data		Transient prediction but steady state calibration
		Remote climate data		Targets incompatible with model purpose		Unacceptable validation
		Little or no useful data on land- use, soils, or river flows and stage elevations				
2		Some data but may not be adequate throughout domain	X	Reasonable calibration statistics with errors in parts of the model	X	Predictive timeframe > calibration timeframe
		Some metered groundwater extraction data		Long-term trends not replicated in all parts of domain		Long stress periods compared to calibration
	X	Streamflow and stage measurements are available at some points		Transient calibration not extending to present day		New stresses not in calibration
		Reliable irrigation application data available in part	X	Weak seasonal replication		Poor validation
				No use of calibration targets compatible with model purpose		
			X	Validation not undertaken		
3	X	Spatial and temporal distribution of data adequate	X	Scaled RMS error or other calibration statistics are acceptable		Predictive timeframe ~ calibration timeframe
		Clearly defined aquifer geometry	X	Long-term trends adequately replicated where important	X	Temporal discretisation in predictive model consistent with transient calibration
		Reliable metered groundwater extraction data		Seasonal fluctuations adequately replicated	X	Similar stresses to those in calibration
	X	Rainfall and evaporation data is available	X	Transient calibration is current		Steady state prediction consistent with steady state calibration
	X	Aquifer testing data to define key parameters	X	Model is calibrated to heads and fluxes		Model validation suggests calibration is appropriate
	X	Good quality and adequate spatial coverage of DEM	X	Key modelling outcomes dataset used in calibration		Steady-state predictions when the model is calibrated in steady-state
		Streamflow and stage measurements are available at many points				
		Reliable land-use and soil-mapping data available				
		Reliable irrigation application data available				

[1]Refer Table 2.1 of the 2012 Australian Groundwater Modelling Guidelines (Barnett et al. 2012)

[2]Green highlighted cells = model has been subjectively assessed to meet the classification criteria for that class

Model limitations

The groundwater flow model is a simplification of a real system, so it is subject to limitations. Limitations result from the simplification of the conceptual model upon which the numerical model is based, the model cell scale, the inaccuracies of measurement data, and the incomplete knowledge of the spatial variability of input parameters. Verification of reliability of the model was conducted by undertaking uncertainty analysis for the predictive model.

The IESC Uncertainty analysis – Guidance for groundwater modelling within a risk management framework (2018) identifies four key sources of scientific uncertainty affecting groundwater model simulations:

- Structural/conceptual.
- Parameterisation.
- Measurement error.
- Scenario uncertainties.

These four sources of scientific uncertainty have been qualitatively assessed with regards key aspects of the Project groundwater model.

The Project model captures depressurisation due to active mining. The model is numerically stable with no mass balance error. The model shows a good fit between observed and modelled groundwater levels.

A depth dependence function was used for hydraulic conductivity, with the calibrated values showing a good fit to observed data. Overall, the model is considered fit for purpose to achieve the objectives based on the data provided and the Project time frame (i.e. the Project model is deemed fit for purpose for the Project impact assessment).

21.3.1.3 Groundwater dependent ecosystems

The definition of a groundwater dependant ecosystem applied to this assessment is consistent with the definition provided in the guidance document Modelling water-related ecological responses to coal seam gas extraction and coal mining prepared by Commonwealth of Australia (2015) on the advice from the IESC on Coal Seam Gas and Large Coal Mining Development and IESC 2018a. This definition is described below:

> Groundwater dependent ecosystems (GDEs): Natural ecosystems which require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes and ecosystem services (Richardson et al. 2011). The broad types of GDE are (from Eamus et al. 2006a and 2006b):
>
> - Ecosystems dependent on surface expression of groundwater (springs, and spring fed streams and rivers, otherwise defined as Aquatic GDE’s).
> - Ecosystems dependent on subsurface presence of groundwater (terrestrial GDEs).
> - Subterranean ecosystems (caves as well as sub-terranean species including stygofauna).

Eamus (2006a) defines groundwater (when related to GDEs) as:

> ‘all water in the saturated sub-surface; water that flows or seeps downwards and saturates soil or rock, supplying springs and wells, water stored underground in rock crevices and in the pores of material’.

For this assessment of GDEs, the term groundwater refers to those areas in the sub-surface where soil or rock interstitial porosity is saturated with water including the associated capillary fringe. In the overlying unsaturated zone, water may be present in varying amounts over time although saturation is rarely reached during infiltration or percolation of rainfall, stream water or other surface sources of groundwater recharge moving under gravity (excluding wetting fronts).

Appendix D-2 Groundwater Dependent Ecosystem Assessment details the assessment undertaken for the Project. The field assessment was completed over a six-day period from 7 to 12 August 2020. Field conditions were hot and humid with a daily temperature range from 23°C to 39°C with some heavy showers reported at the end of the survey window. Climatic conditions preceding the assessment were dry and hot, although significant rainfall was received in the early summer months of 2021 and is likely to have recharged the shallow perched water tables associated alluvial drainage features. Where ambiguity from biophysical measurements is apparent (e.g. Leaf Water Potential (LWP) and Soil Moisture Potential (SMP)), stable isotope signatures were relied upon to differentiate groundwater from other moisture sources utilised by trees.

As an indication of the likely degree and nature of groundwater dependence or interaction, areas in the soil profile with a SMP less negative than measured pre-dawn LWP will be accessible as a source of moisture. In ecohydrology and plant physiology fields, large, mature trees are unable to extract moisture from regions in the soil profile where the total SMP is significantly below LWP measured in pre-dawn leaf material (Feikema et al. 2010, Lamontagne et al. 2005, Thorburn et al. 1994, Mensforth et al. 1994, Holland et al 2009 and Doody et al. 2015). Wilting point is considered relatively consistent between all plant species (Mackenzie et al, 2004), although many Australian plants have adapted to conditions of low water availability and can persist strongly in soil conditions where soils moisture potential is below standard wilting point (Eamus 2006a). As a general measure however, where measured LWP is below standard wilting point, it indicates plant water deficit, and the tree is unlikely to be supported by a saturated water source regardless of groundwater salinity.

Aquatic and terrestrial GDE assessment

Field survey for GDE assessment (**Appendix D-2 Groundwater Dependent Ecosystem Assessment)** focused on areas mapped as high potential aquatic and terrestrial GDE in the GDE Atlas (BOM, 2020) associated with woody vegetation occupying creek channels, floodplain vegetation and vegetation associated with residual surfaces. In total, 13 sites were chosen for targeted GDE assessment as presented in Figure 21-16.

Methods used to assess groundwater dependence of vegetation within the Project Site included:

- Site selection to provide representative coverage of the major vegetation types and landform elements that are most likely to be groundwater dependent
- Assessment of LWP pre-dawn as a function of soil water availability, evaporative demand, and soil conductivity
- Use of soil auger holes to assess SMP as a measure of the energy required to extract moisture from soil
- Analysis of stable isotope composition in a manner that is consistent with Jones et al (2020) and supplemented with methodology from Richardson et al (2011), IESC (2018b), Doody (2019) and Eamus (2009).

The GDE assessment provides a snapshot of eco-hydrological process at each of the GDE assessment localities identified during pre-survey desktop assessment and sampled during field survey and does not assume tree moisture sources are uniform across a broader range of climatic variations. Considerable information has been drawn from the recently completed GDE assessment for the Lake Vermont - Meadowbrook Project (3D Environmental 2022) which forms a contiguous boundary with the Saraji Project to the east. Ecological processes and hydrogeological conditions encountered within the Project Site are complex and transient; conceptualisations based on interpretations of multiple lines of evidence can continue to be refined from further data collection on a seasonal basis.

Full details of the GDE assessment methodology and findings are presented in **Appendix D-2 Groundwater Dependent Ecosystems** (3D Environmental, 2023).

Stygofauna

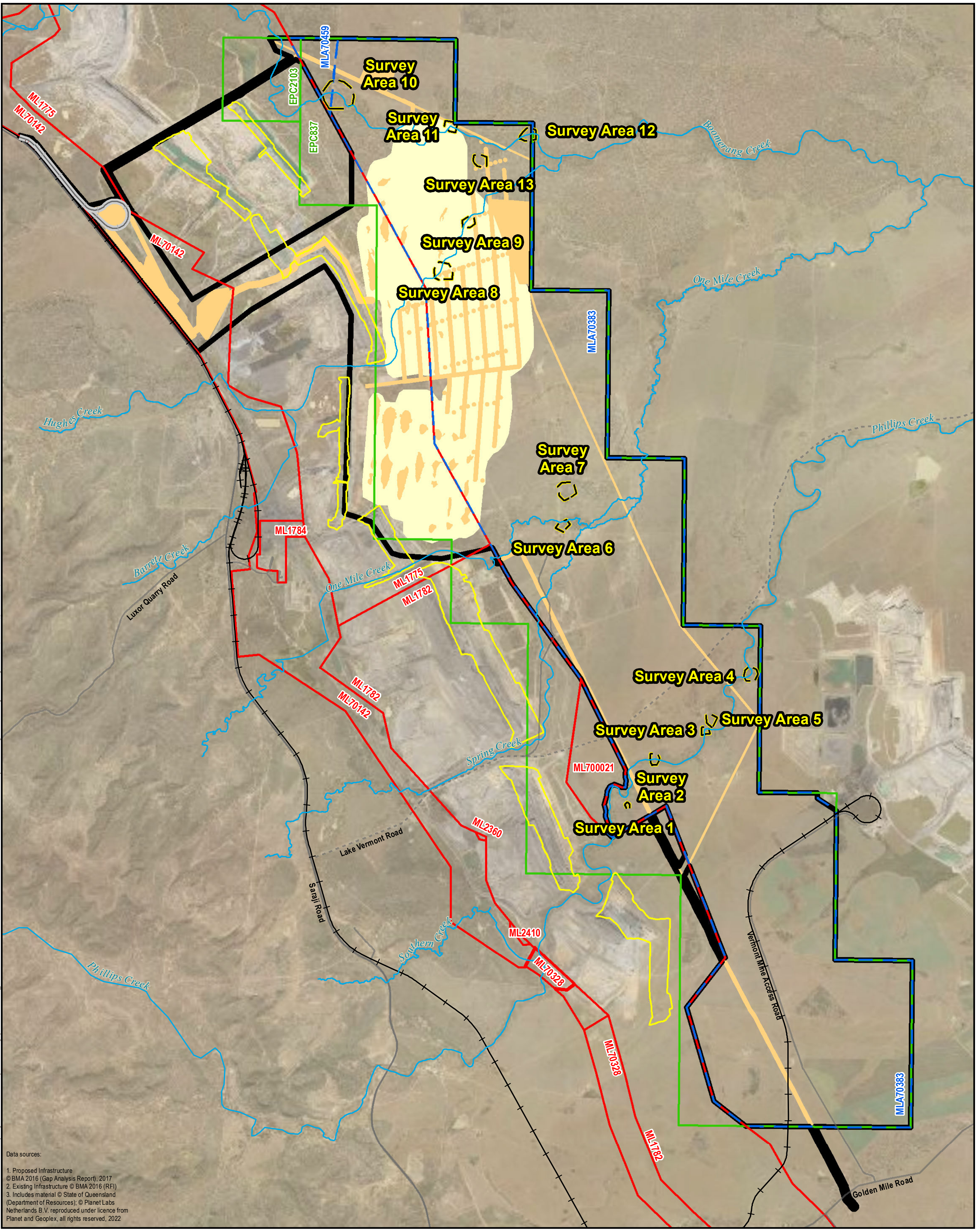
Several previous investigations have been undertaken to assess the suitability of sediments within the Bowen Basin for stygofauna. Desktop review of assessments undertaken across Bowen Basin by 4T Consultants in 2011 identified the conditions where stygofauna were likely to be found. During the September 2011 and December 2011 sampling events undertaken by IESA in seven groundwater monitoring bores on the Project Site screened across Tertiary and Permian sediments, no stygofauna species were detected. Sampling was undertaken in accordance with Draft Guidance No. 54A -

Sampling methods and survey considerations for subterranean fauna in Western Australia (WA EPA, 2007).

Table 21-21 Monitoring bores sampled for stygofauna

Hole ID	Sediments Sampled	Latitude	Longitude	Total Depth (mbGL)	Water Level (mbGL)
SEGT02	Triassic and Permian	-22.3872	148.3002	149.62	28.61
SEGT04	Triassic and Permian	-22.4004	148.3001	138.01	22.40
SEGT10	Triassic and Permian	-22.4062	148.3053	162.30	45.77
PZ002-1	Tertiary	-22.3229	148.2828	26.00	17.44
PZ002-2	Triassic and Permian	-22.3229	148.2828	170.00	34.29
PZ009-1	Tertiary	-22.3492	148.2917	20.00	16.98
PZ00902	Triassic and Permian	-22.34927	148.2917	170.00	33.60

Note: Bores SEGT02, SEGT04, and SEGT10 were temporary bores, constructed for the stygofauna assessments. mbGL: metres below ground level.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Active Pits
- Saraji Survey Areas
- Private Access Road
- Public Road
- Existing Railway
- Rail Loop
- Watercourse

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Figure 21-16
GDE assessment sites

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.3.2 Threatened species and ecological communities

This methodology specifically relates to the controlling provisions identified in the 2016 EPBC Referral (2016/7791), namely nationally listed threatened species and TEC. Full details of the terrestrial ecology investigations are provided in **Appendix C-1 Terrestrial Ecology** (AECOM, 2024d) and **Appendix D-1 Aquatic Ecology** (Hydrobiology, 2023).

Desktop and field-based terrestrial ecological assessments of the Project Site undertaken by AECOM and SKM, document existing environmental values and identify ecological values of conservation significance, including MNES values. Robust assessment of MNES values and potential impacts on these values within the Project Site comprised the following assessment approach:

- detailed desktop review of literature (i.e. past and/or relevant studies) and databases to highlight known or potential sensitive values (e.g. vegetation communities and/or flora and fauna species) – described in Section 21.3.2.1
- field verification and habitat assessment to document condition, extent and value of vegetation and habitats with focus on those values identified in the above stage – described in Section 21.3.2.2
- based on results of field verification and habitat assessment, likelihood of occurrence assessment for TEC and threatened species identified during the desktop review – refer Section 21.3.2.3
- mapping of habitat associated with the MNES values known or having the potential to occur within the Project Site – refer Section 21.3.2.4
- significant impact assessment in accordance with the Significant Impact Guidelines 1.1: Matters of National Environmental Significance (Department of the Environment, 2015) – described in Section 21.3.2.4.1.

21.3.2.1 Desktop assessment

A desktop assessment was completed to identify MNES with potential to occur across the Project Site. The data sources used included:

- EPBC Act Protected Matters Search Tool (PMST) (Department of Agriculture Water and the Environment, 2020a)
- Queensland Wildlife Online search results for flora and fauna species records (DES, 2020b)
- DoR Vegetation Management Regional Ecosystem (RE) Map (DoR, 2022a)
- DoR Regulated Vegetation Management Map to determine the extent of Category A, Category B, Category C and Category R vegetation (DoR, 2022b)
- DoR Vegetation management watercourse and drainage feature map (DoR, 2022c)
- Brigalow Belt Bioregion Biodiversity Planning Assessment (BPA) Version 1.3 (DES, 2020a)
- Environmentally Sensitive Areas Mapping (DEHP, 2017)
- Atlas of Living Australia (ALA) (Australian Government, 2020)
- aerial photography
- current distribution texts for vascular flora and fauna taxa
- relevant publications, including scientific papers and literature
- Results of previous flora and fauna surveys undertaken within and adjacent the Project Site
  - EcoServe (2005). A review of Habitat Values for Biodiversity and Species of Conservation Significance. Final Report Submission for BMA SRM
  - EcoServe (2007). Biodiversity and Threatened Species Action Plan for SRM. Final Report Submission 27th June 2007. An unpublished report prepared for BMA SRM
  - EcoServe (2006). 2006 Winter Vertebrate Fauna Surveys of Remnant Habitats on SRM. Draft Submission. An unpublished report prepared for BMA SRM

- EcoServe (2008). Baseline Fauna Surveys of Rehabilitated Lands on Saraji Coal Mine. An unpublished report prepared for BMA SRM
- EcoServe (2009). Baseline Fauna Surveys of Rehabilitated Lands on Saraji Coal Mine. An unpublished report prepared for BMA SRM
- SKM (2007 and 2010). Results from Comprehensive Fauna and Flora Surveys of MLA 70383 for BMA
- SKM (2008). Results from Brigalow Mapping within MLA 70383 for BMA
- SKM (2009). Results from Targeted Survey for Ornamental Snake on MLA 70383 for BMA
- SKM (2010). Results from Flora Survey for Regional Ecosystem (RE) Mapping on MLA 70383 for BMA
- SKM (2011). Results from Winter Fauna Surveys conducted on MLA 70383 for BMA
- AECOM (2018b) Saraji East Mining Lease Project Terrestrial Ecology Technical Report.

To identify the range of MNES values potentially present within the Project Site and the broader region, reviews of the above data sources were conducted for the search area bound by the coordinates presented below in Table 21-22.

Table 21-22 Data source search parameters

Data Source	Search area	Search buffer
EPBC Act Protected Matters Search	Bounds: -22.2247, 148.17096; -22.2247, 148.518; -22.6227, 148.518; -22.6227, 148.17096; -22.2247 148.17096	10 km (built into these search coordinates)
Wildlife Online	Latitude: -22.6227 to -22.2247 Longitude: 148.1710 to 148.5180	10 km (built into search coordinates)
Biodiversity Planning Assessment and Environmentally Sensitive Areas	Latitude: -22.6227 to -22.2247 Longitude: 148.1710 to 148.5180	100 km
State mapping, including REs	Restricted to bounds of the Project Site	0 km

Reliability of information

The reliability of the DES (previously DEHP) Wildlife Online records is regarded as moderately high, since these records have been vetted by recognised experts, even if some are observations only. The information used to produce the Wildlife Online species lists is based on collated species lists and wildlife records (located within +/- 2 km).

The relative reliability of the EPBC Protected Matters search tool for flora/fauna and ecological communities must be borne in mind as values highlighted by this search do not necessarily correlate to an actual observation. Species are highlighted by the database if the currently known distribution overlaps with the search area by one degree of latitude or longitude (approximately 100 km). Corresponding indication of potential presence does not consider actual presence of suitable vegetation, habitats, geology, soil or climate to support the type of presence reported in the Protected Matters search.

21.3.2.2 Field assessment

Several field surveys have been conducted on, or in the vicinity of, the Project Site over the past 15 years. EcoServe studies between 2005 and 2009 and SKM studies for ML70383 between 2007 and 2011 provide background information on the flora and fauna present in the locality of the Project Site (AECOM, 2024b). To supplement previous field surveys, four additional biodiversity surveys have been conducted across the Project Site by AECOM between 2016 and 2020 (AECOM, 2024b) including:

- winter season survey between 27 and 29 August 2016
- spring season survey between 6 and 10 October 2016

- summer season survey between 30 January and 3 February 2017
- autumn season survey between 23 and 20 March 2020.

The MNES surveys and methodologies undertaken across the Project Site (AECOM, 2024b) provide valid and contemporary data to ground-truth vegetation and habitat types and inform identification and assessment of threatened flora and fauna and ecological communities throughout the Project Site.

21.3.2.2.1 Flora survey

Flora surveys assessed floral taxa and vegetation communities in keeping with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner, 2012). Flora surveys involved a botanical assessment at representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches outlined in Section 21.3.2.1. The surveys employed standard methods including secondary survey sites, tertiary survey sites, quaternary survey sites and random meander search areas (AECOM, 2024b). RE classification (Sattler, P., & William, R., 1999) was determined based on estimated structural and floristic analysis.

Secondary survey sites followed the Queensland Herbarium standards as identified in Neldner et al. (2005) using formalised secondary-level sampling procedures. Data recorded included location, environmental and overall structural information as well as a comprehensive list of woody species and percentage cover. Tertiary transects recorded descriptive site information such as location, aspect, slope, soil type, landform, disturbance, fire history and general notes on ecological integrity. Quaternary-level sites were utilised to verify vegetation units and confirm dominant characteristic species. Structural analysis included recording the height class and life form of the dominant species within the mid and canopy strata as per Neldner et al. (2005).

To assess threats, evidence of previous disturbance, fire history, incidence of exotic species and general notes on soil type and ecological integrity were compiled for each quaternary survey site. Several time encoded digital photographs were taken at each plot as a reference. The combined flora survey effort undertaken since 2007 comprises a total of 185 sites, including 14 secondary, 41 tertiary transects and 130 quaternary sites. Flora survey sites are shown in Figure 21-17.

21.3.2.2.2 Threatened ecological community assessment

TEC assessments were undertaken to confirm the presence of TEC identified as potentially occurring on or near the Project Site during the desktop assessment. Specifically, analogous vegetation was identified within the Project site, and further assessment was undertaken for two TEC:

- brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (Brigalow TEC)
- natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC (Grasslands TEC).

The following sections provide a detailed description of this assessment.

Brigalow TEC

The Commonwealth Conservation advice on Brigalow (*Acacia harpophylla* dominant or co-dominant) (Threatened Species Scientific Committee, 2013b) provides the following diagnostic criteria and condition thresholds, which is utilised in field assessments to determine the TEC status of vegetation:

- dominance or co-dominance of brigalow
- age of community – at least 15 years since last comprehensively cleared
- exotic perennial cover – less than 50 per cent total vegetation cover of the patch
- patch size – greater than 0.5 ha.

For Brigalow TEC, the methods for survey and mapping of RE in Queensland (Neldner, 2012) are suitable for defining vegetation that may be analogous to the TEC. The RE analogous to the TEC and observed within the Project Site include:

- RE 11.3.1

- RE 11.4.8
- RE 11.4.9.

Brigalow TEC was surveyed by SKM in 2007. To supplement this, during the 2020 field survey 19 brigalow TEC assessments were completed at sites containing brigalow vegetation.

Grasslands TEC

Commonwealth Listing advice on Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (Threatened Species Scientific Committee, 2009) provides key diagnostic characteristics for recognising the TEC. The methodology employed for targeted assessment of grassland communities within the Project Site is consistent with the Listing Advice.

The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC was sampled in the optimal seasonal conditions with surveys completed in October 2016 within two months of significant rainfall. The RE analogous to the TEC and observed within the Project Site was sampled in an area with the most apparent native perennial grass species to refine mapping (sampling effort shown for each RE): RE 11.4.4. The following data was collected in grassland communities to determine if characteristics and thresholds were met:

- patch size – at least 1 ha (best quality) or 5 ha (good quality)
- grasses – at least 4 native perennial grass species (best quality) or 3 native perennial grass species (good quality) from list of perennial native grass indicator species
- tussock cover – at least 200 native grass tussocks
- woody shrub cover – total projected canopy cover of shrubs is less than 30 per cent (best quality) or less than 50 per cent (good quality)
- introduced species – of total perennial plant cover, perennial non-woody introduced species are less than 5 per cent (best quality) or less than 30 per cent (good quality).

21.3.2.2.3 Threatened flora species searches

There are no EPBC survey guidelines for threatened flora species. Flora survey methods (AECOM, 2024b) involved establishment of tertiary and quaternary-level assessment sites (based on desktop site selection and on-ground assessment) to assess vegetation communities and record flora species. Following the assessment at the tertiary and quaternary sites, a further area of approximately one hectare surrounding each plot was also searched for 20 minutes utilising meander searches (Cropper, 1993). Where a vegetation community presented potential critical habitat for EPBC Act listed flora species, the search area was broadened to capture flora species from an extended search area.

Botanical voucher specimens were collected throughout the field survey to verify site floristics and enable laboratory identification of those species that were problematic. All specimens were able to be confirmed during this process and hence no vouchers were required to be sent to the Queensland Herbarium for identification. Searches for *Dichanthium setosum* (Bluegrass), *Dichanthium queenslandicum* (King Bluegrass) and *Aristida annua* were also undertaken during the targeted surveys of natural grasslands in suitable habitat for these species.

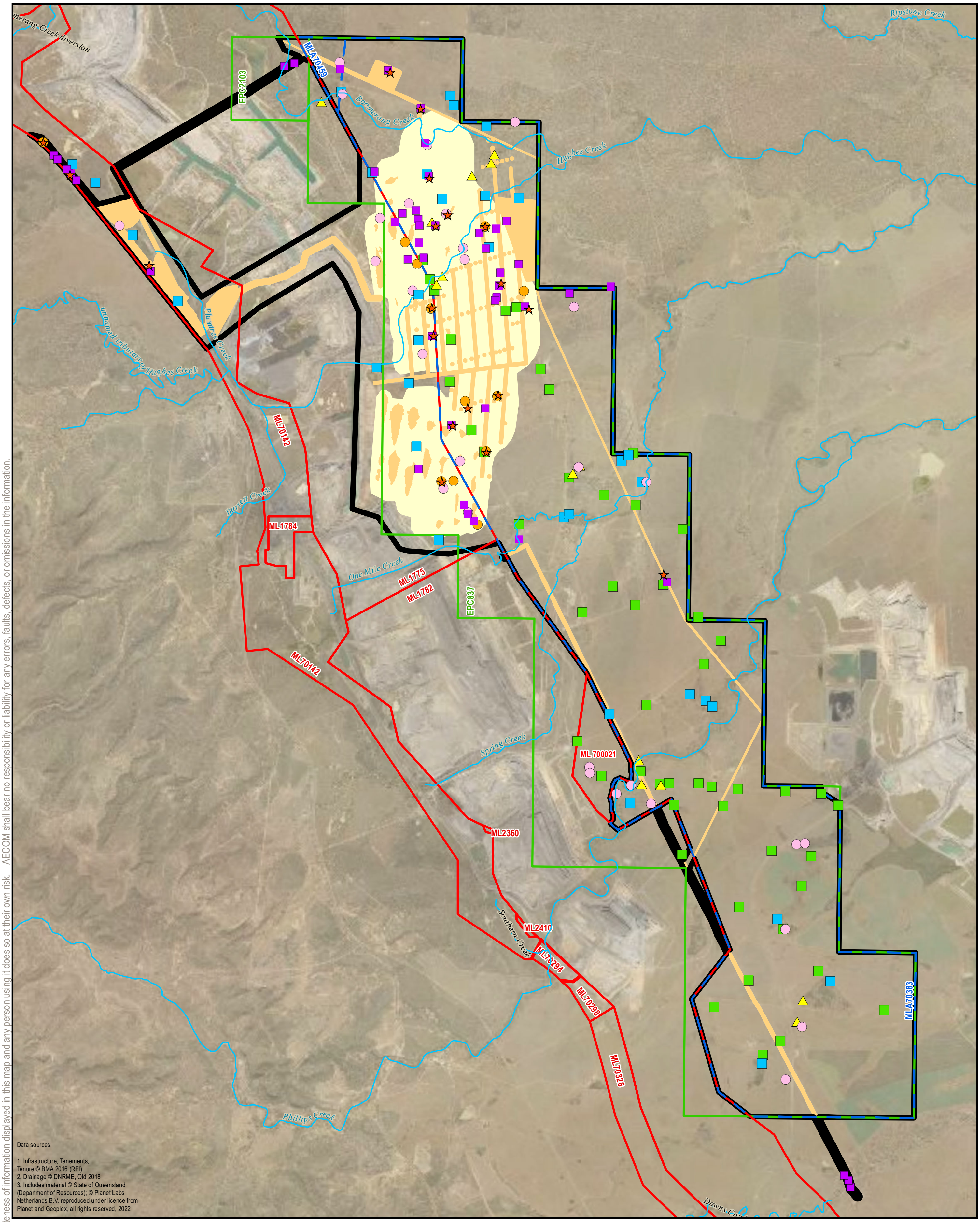
21.3.2.2.4 Fauna survey

The sampling of vertebrate fauna species including threatened species was undertaken using standard methodologies for the systematic survey of terrestrial fauna in eastern Australia (Eyre et al., 2018) and relevant Commonwealth and species-specific survey guidelines including:

- Survey guidelines for Australia's threatened reptiles (Department of Sustainability, Environment, Water, Population and Communities 2011)
- Survey guidelines for Australia's threatened birds (Department of the Environment, Water Heritage and the Arts, 2010)
- Draft referral guidelines for the nationally listed Brigalow Belt reptiles (Department of Sustainability Environment Water Population and Communities, 2011a)

- Survey guidelines for Australia's threatened mammals (Department of Sustainability, Environment, Water, Population and Communities, 2011b)
- Survey guidelines for Australia's threatened bats (Department of the Environment, Water, Heritage and the Arts, 2010a)
- Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (Department of the Environment and Energy, 2017)
- Species-specific survey guidelines, such as the survey guidelines for the Koala (*Phascolarctos cinereus*) (Department of the Environment, 2014), Painted Honeyeater (*Grantiella picta*) (Rowland, 2012b), Ghost Bat (*Macroderma gigas*) (Hourigan, 2011), and Yakka Skink (*Egernia rugosa*) (Ferguson and Mathieson, 2014).

Fauna survey sites are shown in Figure 21-18. Fauna survey methods (AECOM, 2024b) employed to accommodate targeted species are described below and attributed to the various surveys undertaken in Table 21-23.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Flora survey sites

- TEC assessment - Brigalow (AECOM 2020)
- Quaternary RE assessment (AECOM 2020)
- Tertiary RE assessment (AECOM 2020)
- Quaternary RE assessment (AECOM 2017)
- Tertiary RE assessment (AECOM 2017)
- Quaternary RE assessment (SKM 2007)
- Secondary RE assessment (SKM 2007)

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Figure 21-17
Flora survey sites

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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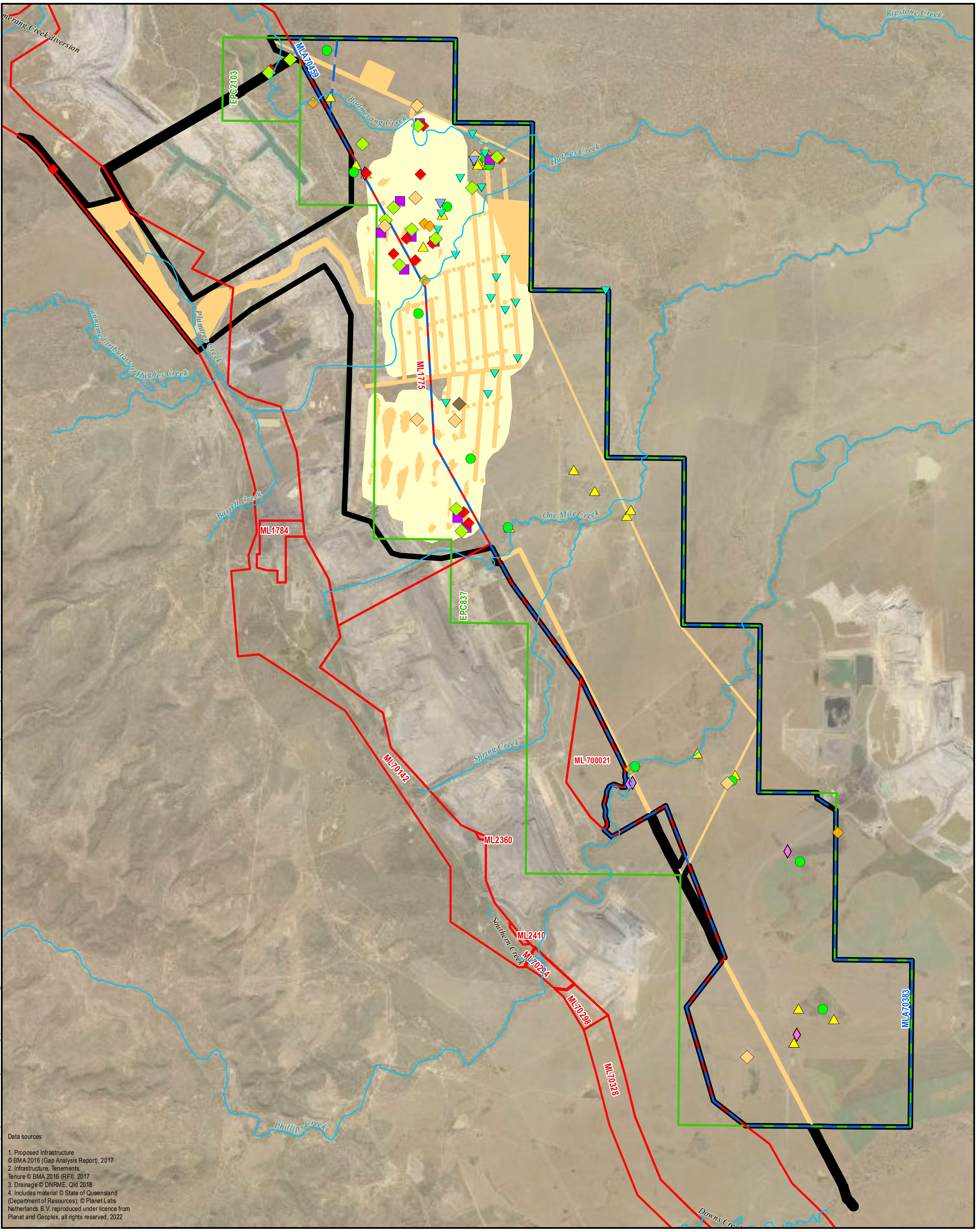

Legend

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Fauna survey sites

- General habitat assessment (AECOM 2017)
- Yakka Skink habitat assessment (AECOM 2020)
- Squatter Pigeon habitat assessment (AECOM 2020)
- Greater Glider habitat assessment (AECOM 2020)
- Active fauna search (AECOM 2020)
- Spotlighting site (AECOM 2020)
- Spotlighting Site (AECOM 2017)
- Anabat location (AECOM 2017)
- Winter site (SKM)
- Primary site (SKM)
- Secondary site (SKM)

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Figure 21-18
Fauna survey sites

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Table 21-23 Fauna survey methods employed during respective survey periods

Survey Method	Survey							
	Nov-2007	Jan-2010	Apr-2010	Jul-2011	Aug-2016	Oct-2016	Jan-2017	Mar-2020
	SKM	SKM	SKM	SKM	AECOM	AECOM	AECOM	AECOM
Live trapping								
Elliot trapping	✓		✓					
Cage trapping	✓		✓					
Harp trapping	✓		✓					
Pitfall trapping	✓		✓					
Habitat assessments	✓	✓	✓	✓	✓	✓	✓	✓
Bird surveys	✓		✓	✓	✓	✓	✓	✓
Spotlighting	✓		✓		✓	✓	✓	✓
Anabat call detection	✓		✓	✓	✓	✓		
Call playback	✓		✓					
Active searches	✓		✓	✓	✓	✓	✓	✓
Transect searches		✓						

Live trapping

Ground-dwelling terrestrial fauna and microchiropteran bats were targeted using live trapping methods by SKM in November 2007 and April 2010. Live trapping methods describe included Elliot traps, cage traps, pitfall traps and harp traps. Each method is described in further detail below.

Elliot traps

Large and small Elliott traps were used to capture ground-dwelling mammals. At four sites, twenty small traps were placed in a single transect line at intervals of approximately 5-10 m. Two large traps were placed along the transect line, at the first and tenth trap. At an additional three sites, twenty small traps were placed in a single transect line at intervals of approximately 5–10 m, with no large traps. Traps were left open for four consecutive nights and checked early each morning within two hours of sunrise. Traps were baited with a mixture of rolled oats, peanut butter, honey and vanilla essence.

Cage traps

Cage traps were used to target arboreal and terrestrial mammals. At the four Elliot trap sites where large traps were also used, a single cage trap was placed at the beginning of the Elliot transect line. Traps were left open for four consecutive nights and checked early each morning within two hours of sunrise. Traps were baited with fruit scraps.

Pitfall traps

Pitfall traps were also installed to capture reptiles, amphibians and small mammals. At six of the Elliot trap-sites, a single pitfall line was installed comprising five pitfalls linked by a drift fence. Pitfalls were left open for four consecutive nights and were checked each morning and afternoon.

Harp traps

Due to the difficulties associated with identifying fast flying, small microbats, the use of harp traps is recommended. Trapping was conducted within the vicinity of potential roosts and forest flyways, rocky outcrops, scarps and riparian zones. Traps were checked periodically throughout the night and were packed down after midnight, to reduce stress on heavily pregnant females and to allow lactating females to return to their young. Trapped microbats were identified to species level in the field. Appropriate measurements were recorded (such as forearm length, weight, outer canine width (OCW)), where necessary for determination to species level.

Habitat assessments

Habitat assessments were undertaken to characterise the fauna habitat values within the Project Site. These assessments provide an indication of likely fauna utilisation, and suitability for fauna species, including conservation significant fauna. Habitat attributes recorded during the assessment include:

- vegetation structure and dominant species, including a description of canopy, shrub and ground layer structure and composition
- presence and abundance of tree hollows and stags
- presence and abundance of woody debris such as habitat logs and ground timber
- presence and abundance of Koala (*Phascolarctos cinereus*) food trees
- presence and abundance of soil cracks and gilgai
- rocky habitat such as surface rocks, boulders, crevices, overhangs and caves
- proximity to water (both permanent and ephemeral)
- disturbance from invasive weeds/pests
- other disturbances such as grazing pressure, clearing, thinning or fire
- any other significant habitat features, or values present e.g. large nesting trees.

Habitat assessments included searches for signs of animal activity, including tracks, scats, scratches, bones, fur, feathers, nests, foraging holes and diggings. At fauna habitat assessment locations, active searches, incidental observations and visual and auditory survey of birds (including for migratory birds where suitable conditions existed) were conducted.

Spotlighting

Roaming/meandering nocturnal searches in suitable habitat using headtorches and hand-held spotlights. Spotlighting from the passenger window of a slow-moving vehicle was also undertaken along farm tracks, targeting larger ground and arboreal mammals and nocturnal birds.

Microchiropteran bat call detection

Unattended bat recorders (Anabat Swift and Songmeter SM2) were placed in the vicinity of foraging sites such as vegetation corridors, flyways, over watercourses and adjacent to artificial waterbodies (dams) in representative potential, likely and known habitat. Data recorded on the bat recorders were analysed by a qualified specialist, Greg Ford of Balance! Environmental. The format and content of the analysis summary reports comply with nationally accepted standards for the interpretation and reporting of Anabat data (Reardon, 2003).

Call playback

Playback sessions targeting nocturnal mammals, birds and owls were conducted at selected sites. The activity involved broadcasting pre-recorded calls, and then listening and spotlighting the area immediately afterwards.

Active searches and incidental observations

Active diurnal and nocturnal searches were undertaken for reptiles, amphibians and small mammals included scanning of trees and ground, searching beneath microhabitat such as rocks, fallen timber and peeling bark, and digging through leaf litter and soil at tree bases. Searches also focussed on locating and identifying tracks and traces such as nests, scats, diggings and tree scratchings. In suitable habitat, searches for signs of activity specific to threatened fauna were also conducted (i.e. searches for communal latrine sites for Yakka Skink (*Egernia rugosa*) and searches for Koala (*Phascolarctos cinereus*) scratches and scats).

Active searches were undertaken within suitable microhabitat at each habitat assessment site (i.e. across the broad range of habitat types throughout the Project Site). All fauna observed incidentally within or in near to the Project Site were recorded, including those seen while travelling along roads and tracks.

21.3.2.2.5 Threatened fauna species

Fauna survey effort undertaken for potentially occurring threatened species listed under the EPBC Act is outlined in Table 21-24. This includes a comparison of survey effort with the recommended Commonwealth survey guidelines.

Commonwealth survey guidelines provide a recommended standardised method of collecting ecological data, generally across smaller sized project sites (i.e. < 50 ha). They are broad guidelines and do not factor in quality of habitat and other site-specific information that may influence presence and the suitable level of survey effort that is practical to implement. For example, undertaking four separate surveys across the migratory period for a highly disturbed inland environment that is likely to support occasional individual visitors of migratory species.

A review of aerial imagery prior to surveying highlighted that the Project Site includes large sections of land historically disturbed by agricultural practices, which is likely to have reduced ecological value. Where practical, the survey guidelines above have been met as detailed below in Table 21-24. Where survey guidelines have only partially been met due to their impracticality at this scale, effort is still considered sufficient due to the nature of the Project Site and the adoption of other techniques such as habitat assessments where presence of suitable habitat resources has been used as a surrogate for presence. This information has been extrapolated in accordance with species-specific habitat definitions to map potential habitat for threatened species across the Project Site. Potential Project impacts have been based on this habitat mapping, providing a conservative approach that further addresses any limitations associated with not meeting survey guideline requirements.

Table 21-24 Target MNES fauna species, survey guidelines and effort undertaken to date

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
Birds						
Squatter Pigeon (Southern) (*Geophaps scripta scripta*)	Survey guidelines for Australia's threatened birds (Department of the Environment, Water, Heritage and the Arts, 2010)	**Survey Techniques** • road driving during day (driving transects) • active searches: 15 hours over 3 days in areas <50 ha • flushing surveys: 10 hours over 3 days in areas <50 ha • waterhole searches: Survey effort not specified. **Seasonal Considerations** No evidence of long-distance seasonal movements or seasonal considerations required.	• active searches and flushing surveys conducted concurrently: 364-person hours over 33.5 days • driving transects: 182 hours over 33.5 days • waterholes and dams were visually surveyed throughout the surveys, and one dam was targeted with a camera trap • targeted habitat assessments conducted for the species throughout the duration of the field surveys.	• active searches and flushing surveys conducted: 62-person hours over 6 days • driving transects: 12 hours over 6 days • targeted habitat assessments conducted for the species throughout the duration of the field surveys.	• total active searches and flushing surveys conducted: 426-person hours over 39.5 days • driving transects total of 194 hours over 39.5 days.	**Yes** Survey effort conducted exceeds minimum survey requirements for the species. Survey involved all recommended survey techniques (active searches, flushing surveys, road driving and waterhole searches). Targeted habitat assessments were conducted across a range of suitable habitat types to supplement the search effort.
Red Goshawk (*Erythrotriorchis radiatus*)	Survey guidelines for Australia's threatened birds (Department of the Environment, Water, Heritage and the Arts, 2010)	**Survey Techniques** • area searches: 80 hours over 10 days • search in groups of tall trees and in trees along riverbanks for nests. Red goshawks are very secretive, so scanning for	• active searches conducted: 24-person hours of bird surveys over 9 days • incidental bird surveys: 622-person hours of over 33.5 days	• active searches conducted: 12-person hours over 3 days • incidental bird surveys: 86-person hours over 6 days.	• total active searches conducted: 36-person hours over 12 days • total incidental bird surveys: 708-person hours over 39.5 days.	**Yes** Potential nests for the species were searched throughout the surveys. Audio and visual surveys for birds were conducted throughout

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		nests is the most effective way to detect the species presence. **Seasonal Considerations** No evidence of long-distance seasonal movements or seasonal considerations required.	• targeted habitat assessments were conducted for the species throughout the duration of the field surveys.			the field surveys, including those seen while travelling along roads and tracks. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement the search effort.
Painted Honeyeater (*Grantiella picta*)	Targeted species survey guidelines – painted honeyeater (Rowland, 2012b)	**Survey Techniques** • area searches (during breeding season) involving systematically searching/listening for birds and signs of their presence (e.g. nesting habitat) • surveys to be during daylight hours and preferably in the early morning (<2 hours after sunrise) and late afternoon (<2 hours before sunset); avoid inclement weather (i.e. rain, wind) • at least 1 hour of surveying per day for a minimum of 4 days. **Seasonal Considerations** Exhibits seasonal north-south movements following mistletoe fruiting matching	• active searches conducted: 8.5-person hours over 3 days during the November survey • incidental bird surveys: 330-person hours over 15.5 days during October and November • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• active searches conducted: 8-person hours over 3 days • incidental bird surveys: 56-person hours of over 6 days.	• total active searches conducted: 16.5-person hours over 6 days • total incidental bird surveys: 386-person hours completed for the duration of all field surveys.	**Yes** The survey effort exceeds the recommended survey effort for the species. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement the search effort.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		its breeding season (October to March).				
Australian Painted Snipe (*Rostratula australis*)	Survey guidelines for Australia's threatened birds (Department of the Environment, Water, Heritage and the Arts, 2010)	**Survey Techniques** • area searches or transects through suitable wetlands (for sites of less than 50 ha when wetland holds water but is not flooded) - 10 hours over 3 days. • targeted stationary observations at dawn and dusk within suitable wetlands - 10 hours over 5 days. • spotlight shortly after dusk - Survey effort not specified. Difficult to detect even when present. **Seasonal Considerations** Movements are poorly known. No seasonal considerations for targeted surveys for this species.	• active searches: 364-person hours over 33.5 days • waterholes and dams were visually surveyed throughout the surveys, and one dam was targeted with a camera trap for 5 days/4nights • spotlighting at dusk adjacent to water for 5 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• active searches conducted: 8-person hours over 3 days • incidental bird surveys: 56-person hours of over 6 days.	• total active searches: 372-person hours over 36.5 days • total incidental bird surveys: 56-person hours over 6 days.	**Yes** Active searches and spotlighting effort exceed the recommended survey effort for the species. Stationary observations were not undertaken; however, the habitat within the Project area is considered marginal and this species is difficult to detect even when present. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement the search effort.
Curlew Sandpiper (*Calidris ferruginea*)	Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species: Latham's snipe	**Survey Techniques** • bird surveys in suitable habitat: - 1 x survey in December - 2 x surveys in January	• active searches conducted: 15-person hours during October and 8.5-person hours over 3 days during November	• active searches conducted: 8-person hours over 3 days • incidental bird surveys: 56-person hours over 6 days.	• total active searches conducted: 31.5-person hours completed for the duration of the field surveys	**Requirements partially met** Only a total of two surveys rather than the required 4 surveys has been undertaken.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
	(Department of the Environment and Energy, 2017)	- 1 x survey in February. Surveys to be conducted during the day and consist of area searches or line transects in suitable habitat (i.e. wetland or other waterbodies and their surrounding vegetation (Department of Agriculture Water and the Environment, 2020b). **Seasonal Considerations** Surveys to be conducted between October and February when the species arrive and depart in Australia.	• incidental bird surveys: 330-person hours of over 15.5 days during October and November • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.		• total incidental bird surveys: 386-person hours of incidental bird surveys over 21.5 days.	Targeted habitat assessments were conducted across a range of suitable habitat types to supplement the search effort.
Mammals						
Ghost Bat (*Macroderma gigas*)	Targeted species survey guidelines – ghost bat (Hourigan, 2011)	**Survey Techniques** • attended bat recorders: Walking transects with a hand-held bat detector and spotlight. 8 detector hours over 4 nights • harp traps and mist nets (optional): A minimum of 8 trap nights over 4 nights, plus 8 mist net hours over 4 nights (optional) • roost searches: 2 hours per survey day. **Seasonal Considerations**	• unattended bat recorder: 40 detector nights over 12 nights • attended bat recorder: 15 detector hours (3 hours per night for 5 nights) • spotlighting: 70-person hours over 14 nights • roost searches: while conducting habitat assessments	N/A	• unattended bat recorder: 40 detector nights over 12 nights • attended bat recorder: 15 detector hours (3 hours per night for 5 nights) • spotlighting: 70-person hours over 14 nights • roost searches: while conducting habitat assessments	**Yes** Survey effort undertaken exceeds the minimum survey requirements for the species and was undertaken during the suitable season for detection (October). The May 2019 survey was just outside the window for the winter survey (June). The survey consisted of all recommended

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		Ghost bats vary seasonally in the use of roosts; individuals congregate in maternity roosts from September to April and disperse in small groups over winter. Surveys targeting this species to be carried out between September and April (when congregated) and, particularly if maternity roosts are not present within the Project area, may need to be repeated between June and August (when individuals are dispersed).	identified no roosts or caves • harp traps: 20 trap nights (4 harp traps used over 5 nights) • mist nets: 10 trap nights over/ adjacent to water (2 mist nets over 5 nights) • targeted habitat assessments conducted for the duration of the field surveys.		identified no roosts or caves • harp traps: 20 trap nights (4 harp traps used over 5 nights) • mist nets: 10 trap nights over/ adjacent to water (2 mist nets over 5 nights) • targeted habitat assessments conducted for the duration of the field surveys.	survey techniques (attended bat recorders, roost searches, harp traps and mist nets). Targeted habitat assessments were conducted across a range of suitable habitat types to supplement trap effort.
Corben's Long-eared Bat *(Nyctophilus corbeni*)	Survey guidelines for Australia's threatened bats (Department of the Environment, Water, Heritage and the Arts, 2010a)	**Survey Techniques** • unattended bat recorder: - Calls not reliably distinguishable from other *Nyctophilus* species using bat recorders. Bat detectors can be used to identify areas used by long-eared bats, then followed up with appropriate level of trapping • harp traps and/or mist nets:	• unattended bat recorder: 40 detector nights over 12 nights • attended bat recorder: 15 detector hours (3 hours per night for 5 nights) • harp traps: 20 trap nights (4 harp traps used over 5 nights) • mist nets: 10 trap nights over/adjacent to water (two mist	N/A	• unattended bat recorder: 40 detector nights over 12 nights • attended bat recorder: 15 detector hours (3 hours per night for 5 nights) • harp traps: 20 trap nights (4 harp traps used over 5 nights) • mist nets: 10 trap nights over/adjacent to water (two mist	**Yes** Survey effort undertaken exceeds the minimum survey requirements for the species and was undertaken during the optimal season for detection (October). The survey consisted of all recommended survey techniques (unattended bat recorders, harp traps and mist nets).

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		- 20 trap nights over a minimum of 5 nights Harp traps and/or mist nets to be placed both within open flyways and within cluttered vegetation such as woodland, mallee or forest as the species forages below the tree canopy, often at ground level. Significant effort to be conducted over water (artificial or naturally occurring). **Seasonal Considerations** Surveys are best conducted on warm nights from October through to April.	nets used over 5 nights) • targeted habitat assessments conducted for the duration of the field surveys.		nets used over 5 nights) • targeted habitat assessments conducted for the duration of the field surveys.	Targeted habitat assessments were conducted across a range of suitable habitat types to supplement trap effort.
Greater Glider (*Petauroides volans*)	Species-specific guidelines for survey for the greater glider are not currently available. However the species is readily detectable by spotlighting (Lindenmayer et al., 2001) Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al., 2018) were utilised in the	**Survey Techniques** In the absence of species-specific survey guidelines, Eyre *et al.* (2018) was used to determine suitable survey techniques. • spotlighting transects (100 m x 100 m) per 30-person minutes. Survey effort not specified. **Seasonal Considerations** The greater glider is known to have high site fidelity with relatively small home ranges. There are no	• spotlighting: 70-person hours over 14 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• spotlighting: 12-person hours over 3 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• spotlighting: 84-person hours over 17 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	**Yes** Spotlighting survey effort was concentrated in eucalypt woodlands along or adjacent to watercourses with a high abundance of hollow-bearing trees. The survey effort for greater glider is not specified, however effort conducted is considered suitable for detecting the species. Targeted habitat assessments were

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
	absence of species-specific guidelines	seasonal considerations for this species.				conducted across a range of suitable habitat types to supplement search effort.
Koala (*Phascolarctos cinereus*)	Survey guidelines for Australia's threatened mammals (Department of Sustainability, Environment, Water, Population and Communities, 2011b) EPBC Act referral guidelines for the Vulnerable Koala (*Phascolarctos cinereus*) (Department of the Environment, 2014)	**Survey Techniques** The EPBC Act referral guidelines for the Vulnerable Koala (*Phascolarctos cinereus*) do not prescribe specific survey effort requirements due to the high level of variation of this species across its distribution. Both this document and the survey guidelines for Australia's threatened mammals recommend the following survey techniques: • spotlighting with call playback: - survey effort determined on a case-by-case basis • remote camera: - survey effort determined on a case-by-case basis • SATs (Phillips and Callaghan, 2011): - sampling of a minimum of 30 Koala (Phascolarctos	• spotlighting: 70-person hours over 14 nights • call playback was conducted concurrently with spotlighting for Koala (Phascolarctos cinereus) during the November survey • remote cameras: 64 camera trap nights over 12 nights • three SATs were conducted in suitable habitat • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• spotlighting: 12-person hours over 3 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• spotlighting: 82-person hours over 17 nights • call playback was conducted concurrently with spotlighting for Koala (Phascolarctos cinereus) during field surveys prior to March 2020. • remote cameras: 64 camera trap nights over 12 nights • three SATs were conducted in suitable habitat • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	**Yes** A combination of key survey techniques, as recommended by the survey guidelines were utilised to determine utilisation and areas of potential habitat for Koala (*Phascolarctos cinereus*). As such, spotlighting with call playback, remote cameras and SATs were conducted in suitable habitat (i.e. Nogoa River, creek lines, alluvial floodplains, upland woodlands and higher slope areas), as determined by targeted habitat assessments, to adequately sample differing habitats. Targeted habitat assessments were conducted across a range of suitable

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		cinereus) food trees within suitable habitat - survey effort determined on a case-by-case basis. **Seasonal Considerations** Optimal time period for direct observation surveys is between August and January, as this is when Koala (*Phascolarctos cinereus*) activity is generally at its peak and resident breeding females with back-young are most easily observed. Direct observation surveys conducted outside of this period must take into account the potential for lower Koala (*Phascolarctos cinereus*) activity (reduced detectability) and other relevant seasonal considerations. Presence/absence surveys in the inland context, conducted during dry periods, to be centred on riparian areas, upper/mid-slope areas and other dry period refugia in order to maximise detectability.				habitat types to supplement search effort.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
Reptiles						
Adorned Delma (*Delma torquata*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability, Environment, Water, Population and Communities, 2011a) Survey guidelines for Australia's threatened reptiles (Department of Sustainability, Environment, Water, Population and Communities 2011)	**Survey Techniques** The EPBC Act draft referral guidelines for nationally listed Brigalow Belt reptiles prescribes one-off diurnal searches as the most effective method for detecting this species. This includes active searches of microhabitat for 1.5 hours in each hectare of suitable habitat. A minimum of 3 days with 1 repeat (6 days). The survey guidelines for Australia's threatened reptiles state that pitfall trapping proved to be less effective than rock turning. However, recommends: • one-off hand searches (including raking through leaf litter) in suitable habitat • pitfall trapping (during late spring to summer) and funnel trapping, using six 20 litre (L) buckets and funnel traps along a 15m drift fence. **Seasonal Considerations** Previous studies suggest the optimal period for survey is between October	• pitfall and funnel trapping during May and November, along a 45 m T fence • diurnal active searches: 11-person hours over 17.5 days • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• diurnal active searches: 34-person hours over 5 days.	• pitfall and funnel trapping during May and November, along a 45 m T fence • total diurnal active searches: 45-person hours over 22.5 days • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	**Requirements partially met** Hand searches / active searches were conducted in suitable habitat; however not to the required effort detailed in the guideline (1.5 hours / ha). Pitfall and funnel trapping were conducted during both seasonal surveys. Four pitfall buckets were used at each survey site. Additional funnel traps were used to supplement the pitfall traps. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement active search effort.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		and February (warmer conditions), particularly after rain when soil moisture is increased. Additionally, referral guidelines recommend surveys to be undertaken late September to late March.				
Ornamental Snake (*Denisonia maculata*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability, Environment, Water, Population and Communities, 2011a) Survey guidelines for Australia's threatened reptiles (Department of Sustainability, Environment, Water, Population and Communities 2011)	**Survey Techniques** The EPBC Act draft referral guidelines for nationally listed Brigalow Belt reptiles prescribes the following survey methods and effort for the Ornamental Snake (*Denisonia maculata*): • one-off diurnal search: - active searches of microhabitat for 1.5 hours in each hectare of suitable habitat - a minimum of 3 days with 1 repeat (6 days) • spotlighting: - 1.5 hours in each hectare of suitable habitat - a minimum of 3 nights - pitfall and funnel trapping: • 6 x 20L buckets along a 30m drift fence	• diurnal active searches: 11-person hours over 17.5 days • pitfall and funnel trapping during May and November, along a 45m T fence • spotlighting: 70-person hours over 14 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• diurnal active searches: 34-person hours of over 5 days • spotlighting: 13-person hours over 4 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• total diurnal active searches: 45-person hours over 22.5 days • pitfall and funnel trapping during May and November, along a 45m T fence • total spotlighting: 87-person hours over 18 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	**Requirements partially met** The species is likely to be active between sheltering sites at night. As such, spotlighting was undertaken; however not to the required effort detailed in the guideline (1.5 hours / ha). Spring surveys were conducted during presumably the peak activity season. Pitfall and funnel trapping were conducted during both seasonal surveys. Four pitfall buckets were used at each survey site. Additional funnel traps were used

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		• 2 replicates per habitat type, morning and evening checks over 4 days. - opportunistic surveys of roads. **Seasonal Considerations** The Ornamental Snake (*Denisonia maculata*) is most likely to be encountered by searching in and around suitable gilgai habitats during the evening when frogs are most active, approximately 1–3 days following heavy rainfall (greater than 5 mm), especially thunderstorms (Department of Agriculture Water and the Environment, 2020b). Additionally, referral guidelines recommended surveys to be undertaken late September to late March.				to supplement the pitfall traps. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement active search effort.
Yakka Skink (*Egernia rugosa*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability, Environment, Water, Population and Communities, 2011a)	**Survey Techniques** The EPBC Act draft referral guidelines for nationally listed Brigalow Belt reptiles prescribes the following survey methods and effort for the yakka skink (*Egernia rugosa*): • one-off diurnal search:	• diurnal active searches: 11-person hours over 17.5 days • targeted habitat assessments were conducted for the species throughout the	• diurnal active searches: 19.5-person hours over 5 days • targeted habitat assessments were conducted for the species throughout the	• total diurnal active searches: 30.5-person hours over 22.5 days • targeted habitat assessments were conducted for the species throughout the	**Requirements partially met** Surveys were conducted during the period of maximum activity (post dawn, pre dusk) for the reptile and during the

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
	Targeted species survey guidelines – yakka skink (Ferguson and Mathieson, 2014) Survey guidelines for Australia's threatened reptiles (Department of Sustainability, Environment, Water, Population and Communities 2011)	- active searches of microhabitat for 1.5 hours in each hectare of suitable habitat - a minimum of 3 days with 1 repeat (6 days). • transects: - survey effort not specified - visual searches using binoculars - survey effort not specified. • Elliot traps: - used for confirmation only around burrows or colony sites - cat food used as bait • camera traps (only around colonies): - 12 camera trap nights per colony over 4 nights • funnel traps (only around colonies): - 60 trap nights per colony over 4 nights. **Seasonal Considerations** Seasonal activity patterns are not well known, however previous surveys/ observations of the species suggest that peak activity	duration of the field surveys • no potential burrows or colonies were identified.	duration of the field surveys • no potential burrows or colonies were identified.	duration of the field surveys • no potential burrows or colonies were identified.	recommended season (spring). Hand searches / active searches were conducted in suitable habitat; however not to the required effort detailed in the guideline (1.5 hours / ha). Targeted habitat assessments were conducted across a range of suitable habitat types to supplement active search effort.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		times are late spring and summer. Additionally, referral guidelines recommended surveys to be undertaken late September to late March.				
Dunmall's Snake (*Furina dunmalli*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability Environment Water Population and Communities, 2011a) Survey guidelines for Australia's threatened reptiles (Department of Sustainability, Environment, Water, Population and Communities 2011)	**Survey Techniques** The EPBC Act draft referral guidelines for nationally listed Brigalow Belt reptiles prescribes the following survey methods and effort for the Dunmall's snake: • one-off diurnal search: - active searches of microhabitat for 1.5 hours in each hectare of suitable habitat - a minimum of 3 days with 1 repeat (6 days) • transects: Survey effort not specified • spotlighting: 1.5 hours in each hectare of suitable habitat. A minimum of 3 nights • pitfall and funnel trapping: 6 x 20L buckets along a 30m drift fence. 2 replicates per habitat type, morning and evening checks over 4 days	• 11-person hours over 17.5 days of diurnal active searches • pitfall and funnel trapping during May and November, along a 45m T fence • 70-person hours of spotlighting over 14 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	• 34-person hours of active diurnal searches over 5 days • 13-person hours of spotlighting over 4 nights.	• a total of 45-person hours over 22.5 days of diurnal active searches • pitfall and funnel trapping during May and November, along a 45m T fence • a total of 83-person hours of spotlighting over 18 nights • targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	**Requirements partially met** The species is likely to be active between sheltering sites at night. As such, spotlighting was undertaken; however not to the required effort detailed in the guideline (1.5 hours / ha). Spring surveys were conducted during presumably the peak activity season for the species. Although, very little is known about the species peak activity and habitat preferences, consequently active day and night searches were conducted across a wide range of habitat types.

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		• opportunistic surveys of roads. The survey guidelines for Australia's threatened reptiles state that all survey methods are likely to yield low returns as reliable survey methods for the species are not known; however, the guidelines recommend: • active searching of sheltering sites • pitfall trapping • road driving at night (particularly after wet weather). **Seasonal Considerations** Seasonal activity patterns are not well known; however, the species appears to be more active from late spring to early autumn and is more likely to be observed moving between sheltering sites on warm nights. Referral guidelines recommend surveys to be undertaken late September to late March.				Pitfall and funnel trapping were conducted during both seasonal surveys. Four pitfall buckets were used at each survey site. Additional funnel traps were used to supplement the pitfall traps. Targeted habitat assessments were conducted across a range of suitable habitat types to supplement active search effort.

21.3.2.3 Likelihood of occurrence assessment

A likelihood of occurrence assessment for TEC and threatened species identified during the desktop review was undertaken. Targeted searches were undertaken in the field for species identified as either being likely to occur, or having potential to occur, within the Project Site, based on the desktop sources. The methodology was applied again after field surveys to determine the likelihood of occurrence once site-based information became available.

Each species was assessed against the categories defined below.

- **known**: species was positively identified and recorded in the Project Site during the field surveys; or previous, reliable records occur within the Project Site
- **likely**: species was not recorded during the field surveys or previously, however there are known records within the nearby surrounding area (i.e. 15 km) and suitable habitat exists in the Project Site
- **potential**: species was not recorded during the field surveys or previously, however known records occur in the surrounding area (i.e. 15 km) and habitat in the Project Site is marginal or degraded
- **unlikely**: habitat in the Project Site might be suitable or marginal; however, species was not recorded during the field surveys, and no known records of the species exist within the surrounding area (i.e. 15 km)
- **none**: this is usually applied to marine species or seabirds for terrestrial sites.

21.3.2.4 Potential habitat mapping

Following the completion of field surveys and the likelihood of occurrence assessment, habitat mapping for the MNES values known or considered likely to occur within the Project Site was undertaken. MNES potential habitat mapping of the Project Site was undertaken to:

- estimate the extent of potential habitat present within the Project Site
- determine the potential impact to MNES values
- aid the development of specific mitigation measures.

MNES potential habitat mapping was undertaken in accordance with the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). This covers some of the key threatened fauna species of the Central Queensland region and defines habitat based on three categories – preferred, suitable and marginal habitat. The definitions of each category are provided in Table 21-25 below. These different habitat types are likely to be of differing importance to threatened species, with preferred and in some instances, suitable habitat making a meaningful contribution to the maintenance of local populations of these species.

The habitat descriptions were developed as a result of an agreed outcome of lessons learned with the DCCEEW on previous projects regarding issues relating to variability and inconsistencies in understanding threatened species habitats in the region. The definitions were developed to:

- reflect the unique environment of the region (for threatened species)
- use the best available regional information to refine Species Profile and Threats (SPRAT) Database definitions
- ensure assessment information is standard, consistent and scientifically robust.

The process of development of the definitions included:

1. collation of available information – including SPRAT, conservation advices, scientific literature, approvals documentation and spatial analysis
2. iterative drafting of habitat definitions with input from a variety of experts
3. two rounds of peer review from consulting ecologists and academic reviewers (15 reviewers in total)

4. periodic update to the definitions to reflect species listing changes, additional species and new information available

Appendix C-3 Central Queensland Threatened Species Habitat Descriptions contains the Central Queensland Threatened Species Habitat Descriptions report which includes detailed information regarding the process of development including expert elicitation and review.

Preferred habitat definitions have been provided for all species but not all species have been allocated both a suitable and marginal habitat category. Allocation of these categories was based on the known ecological requirements of the species and the most applicable category that best describes the species habitat. The specific definitions of preferred, suitable and marginal habitat for threatened species relevant to this assessment are provided in Section 21.8.

For threatened flora species not covered by the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020), habitat definitions were developed from information sourced from publicly available databases, including relevant species recovery plans (where available), referral guidelines, approved conservation advice, the Species Profile and Threats database (SPRAT), management plans and peer-reviewed journal articles.

Habitat assessment information collected during the field surveys, species records (previous and survey records), and Project vegetation mapping was used to map the potential habitat according to the habitat definitions.

Table 21-25 Habitat category definitions

Habitat category	Definition
Preferred	Habitats that are most important to the species and contain the features that are crucial for the species' persistence in an area. It includes habitats in which key activities are undertaken e.g. breeding, roosting and/or where high quality/species limiting foraging resources are found. If the species is present in a region, individuals will usually be found in preferred habitat.
Suitable	Habitats that provide resources for the species but is not crucial for its persistence in an area. Individuals may be found in suitable habitat but are not likely to be undertaking key activities such as breeding or roosting. Foraging resources may be lower quality or used opportunistically (rather than being depended upon). If the species is present in a region, individuals may be found in suitable habitat, but this habitat type may also remain unoccupied.
Marginal	Habitats that provide limited resources for the species and is not crucial for its persistence in an area. Individuals may be occasionally found in marginal habitat but will not be undertaking key activities such as breeding, roosting or extensive foraging. If the species present in a region, individuals would be found in marginal habitat only rarely and this habitat type is likely to be unoccupied most of the time.

21.3.2.4.1 Habitat critical to the survival of the species or ecological community

The EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance (Department of the Environment, 2013b) defines Habitat critical for the survival of the species (HCSS) or ecological community (HCSEC) as areas that are necessary for:

- activities such as foraging, breeding, roosting, or dispersal
- the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- the reintroduction of populations or recovery of the species or ecological community.

For the purposes of undertaking an impact assessment for MNES threatened species and ecological communities, habitat mapping for each species, as detailed within Section 21.3.2.4 and **Appendix C-1 Terrestrial Ecology Technical Report,** were reassessed and re-defined based on the HCSS definition under the Guidelines.

In summary, HCSS mapping for threatened species (for the purposes of significant impact assessment) comprised:

- All areas of preferred habitat: Habitats that are most important to the species and contain the features that are crucial for the species' persistence in an area, including activities such as foraging, breeding and/or roosting; and
- Most areas containing suitable habitat: Specifically, habitat areas connected to areas of Preferred habitat within the Project Site and/or contiguous areas of potential habitat (DoR mapped Regulated Vegetation) within the greater landscape context. While these areas may not be crucial to the species persistence in the Project Site, these are likely to be readily utilised by individuals/populations present, providing supplementary foraging resources and dispersal opportunities (i.e. contributing to 'long-term maintenance of the species') to adjacent areas of preferred habitat within the Project Site and surrounds.

HCCS did not include:

- Some minor areas of suitable habitat: This comprises smaller areas that are isolated and disconnected from preferred habitat or larger areas of suitable habitat within the Project Site and/or potential habitat within the greater landscape context. These areas are not considered to comprise breeding/roosting habitat and unlikely to be necessary foraging resources or dispersal areas for the species ongoing persistence in the area; and
- Marginal habitat: As defined under the Central Queensland Threatened Species Habitat Descriptions (Kerswell et al., 2020), marginal habitat comprises limited resources for the species and is not crucial for its persistence in an area. Individuals may be occasionally found in marginal habitat but will not be undertaking key activities such as breeding, roosting or extensive foraging. If the species present in a region, individuals would be found in marginal habitat only rarely and this habitat type is likely to be unoccupied most of the time. Based on this description, marginal habitat is not considered to comprise HCSS.

Further species-specific details of habitat areas considered to comprise HCSS and those areas excluded are detailed within Sections 21.8.2 to 21.8.4. Areas containing HCSEC were considered to comprise as all patches that meet the key diagnostic characteristics and condition thresholds for the TEC. As such, all areas identified as Brigalow TEC or Grasslands TEC were considered HCSEC.

21.3.2.5 Impact assessment on ecology

The EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance (Department of the Environment, 2013b) provides the framework for the assessment of potential impacts upon MNES as well as a process for determining the level of significance of impacts.

In accordance with the guideline, impacts on MNES are to be assessed utilising the broadest scope of proposed action, with consideration to both direct and indirect impacts and proposed measures to avoid and reduce impacts. Significance is tested through a set criterion stipulated in the guideline, which is tailored to each MNES and for some values, the conservation status of the MNES.

As per the guideline a 'significant impact' is an impact which 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, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DoTE 2013). The Guidelines direct proponents to consider these factors when determining whether an action is likely to have a significant impact on MNES.

In the context of this Project, the presence and configuration of habitat types (preferred, suitable, marginal), allows for a robust consideration of the *sensitivity, value, and quality of the environment which is impacted* (and as discussed for each relevant species below). A conservative approach to considering *the intensity, duration, magnitude and geographic extent of the impacts* has been taken by assuming a worst-case scenario upfront and as discussed for each of the stages.

A generic assessment of potential impacts on ecological values within the Project Site has been undertaken (refer to Section 21.6). Mitigation measures have also been developed to address identified potential impacts (refer to Section 21.7). In addition to this, a specific impact assessment in accordance with the guidelines has been undertaken for each MNES considered likely or known to occur within the Project Site. The significant impact criteria utilised in the assessment is outlined in Table 21-26.

Other Commonwealth guidelines used to support the assessment of MNES impacts include:

- EPBC Act Draft Referral guidelines for the nationally listed Brigalow Belt reptiles (Department of Sustainability Environment Water Population and Communities, 2011a)

Additional Commonwealth resources such as threat abatement plans, and approved conservation advice statements have been referred to in the impact assessments. These include:

- Threat abatement plan for predation by feral cats (The Commonwealth of Australia, 2015)
- Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (Department of Sustainability Environment Water Population and Communities, 2011b)
- Threat abatement plan for predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) (Department of the Environment and Energy, 2015)
- Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (Department of the Environment Water Heritage and the Arts, 2009)
- Threat abatement plan for predation by the European Red Fox (Department of the Environment Water Heritage and the Arts, 2008)
- Conservation Advice *Geophaps scripta scripta* (Squatter Pigeon (Southern)) (Threatened Species Scientific Committee, 2015).
- Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (Department of Sustainability, Environment, Water, 2013)
- Conservation Advice for *Petauroides volans* (greater glider (southern and central)) (Department of Climate Change, Energy, the Environment and Water, 2022).
- Conservation Advice for *Phascolarctos cinereus* (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory (Department of Agriculture, Water and the Environment, 2022).
- National Recovery Plan for the Koala *Phascolarctos cinereus* (combined populations of Queensland, New South Wales and the Australian Capital Territory) (Department of Agriculture, Water and the Environment, 2022).
- Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake) (Threatened Species Scientific Committee, 2014a).
- Approved Consevation Advice for the Brigalow (*Acacia harpopylla* dominant and co-dominant) ecological community (Department of the Environment, 2013).
- Approved Conservation Advice for the Natural grassland of the Queensland Central Highlands and the northern Fitzroy Basin (Department of the Environment, Water, Heritage and the Arts, 2008).
- Approved Conservation Advice for *Dichanthium setosum* (Department of the Environment, Water, Heritage and the Arts, 2008).
- Approved Conservation Advice for *Dichanthium queenslandicum* (king blue-grass) (Department of the Sustainability, Environment, Water, Population and Communities, 2013).

Table 21-26 Significant impact criteria

MNES	Criteria	Key definitions
Critically endangered and endangered species and ecological communities	An action is likely to have a significant impact on a Critically Endangered or Endangered species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a Critically Endangered or Endangered species becoming established in the Endangered or Critically Endangered species' habitat • introduce disease that may cause the species to decline, or • interfere with the recovery of the species.	• 'habitat critical to the survival of a species' refers to areas that are necessary: • for activities such as foraging, breeding, roosting, or dispersal • for the long-term maintenance of the species (including the maintenance of species essential to the survival of the species, such as pollinators) • to maintain genetic diversity and long-term evolutionary development, or • for the reintroduction of populations or recovery of the species. To interpret the above definition the following factors were considered for habitat within the Project Site in the context of the overall MNES being assessed: • habitat quality and condition • abundance of habitat resources • level of habitat connectivity to maintain processes of dispersal and to maintain exchange of genetic material and recruitment • ability to provide refuge from a changing climate or climatic extremes • limitations in habitat extent • uniqueness and rarity of habitat, important habitat features or habitat locality • patch viability and carrying capacity • level of existing threats • extent of core habitat.
Vulnerable species and ecological communities	An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of an important population of a species • reduce the area of occupancy of an important population • fragment an existing important population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of an important population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat • introduce disease that may cause the species to decline, or • interfere substantially with the recovery of the species.	**'Habitat critical to the survival of a species'** as defined above. An **'important population'** is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are: • key source populations either for breeding or dispersal • populations that are necessary for maintaining genetic diversity, and/or • populations that are near the limit of the species range.

21.4 Environmental values

21.4.1 Physical setting

The Project is located within the IRC Local Government Area (LGA), approximately 30 km north of Dysart and 170 km southwest of Mackay in Queensland. The Project area is predominantly grazing land including both freehold land, and utility and access easements. Surrounding mining activities have markedly altered the surface profile west of the Project area.

The Project is adjacent to, and in some cases overlaps, areas of the existing approved and operational open cut BMA SRM. The target Dysart coal seam plies vary in thickness between 4.9 m and 7 m. The depth below ground surface of the seams across the site varies between 120 m and about 450 m. Overlying these coal strata is a thick cover of Tertiary sediments varying between 35 m and 65 m.

Contour data (Department of Natural Resources, Mines and Energy (DNRME)[3], 2016) indicates that most of the Project Site is flat, with elevations ranging from 180 m Australian Height Datum (AHD) to 200 m AHD. This changes at the eastern side of the Project Site, where existing open-cut mining operations have created artificial elevations ranging from 90 m AHD to 270 m AHD. The generally flat terrain continues to the north, south and east of the Project Site; however, some 3 km to the west of the Project Site are the Harrow, Denham and Peak Ranges, with peaks reaching over 680 m AHD.

Intermittent watercourses and drainage lines cross the Project Site, making their way from the ranges in the west to the downs in the east (DNRME, 2015) ultimately draining into Isaac River, which is 20 km east of the Project Site, and the major watercourse in the catchment area. These ephemeral creeks are considered to have limited flow, typically only after high intensity rainfall events.

Tenure is mostly leasehold, with cattle grazing being the major land use. Clay soil areas have been extensively cleared for introduced pastures and cropping in higher rainfall areas due to relatively high soil moisture availability and high fertility. Across the Brigalow Belt North region, consistent loss of landscape function and woody cover (largely due to clearing) has increased degraded areas, loss of biodiversity, weed spread (e.g. Parthenium and rubbervine) and reduced opportunities for woodland thickening of previously cleared woody vegetation in regrowth and non-remnant areas.

21.4.2 Bioregion

Biogeographic regionalisation for Australia (Commonwealth of Australia, 2012) represents a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna.

The Brigalow Belt Bioregion (Bioregion: 11) extends from Townsville south to the New South Wales border and covers more than 365,000 square kilometres (km^2) or more than a fifth of the State. The Brigalow Belt Bioregion is divided north-south by the Great Dividing Range and is fringed by other ranges that enclose the Burdekin and Fitzroy River basins in the north and Warrego-Condamine in the south.

The Brigalow Belt is a wide band of acacia-wooded grassland that runs between tropical rainforest of the coast and the semi-arid interior of Queensland. The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Brigalow Belt into two IBRA regions, or bioregions, Brigalow Belt North (BBN) and Brigalow Belt South (BBS) representing 2 of the 15 bioregions in Queensland.

The Project occurs within the Brigalow Belt North region, and more specifically the Isaac-Comet Downs sub-region (BBN11). The Isaac-Comet Downs sub-region is characterised by semi-arid subtropical climate with predominantly summer rainfall (approximately 600 millimetres (mm) average annual rainfall).

The sub-region comprises Cainozoic (Tertiary to Quaternary) unconsolidated sediments derived from alluvial processes, including land zone 3 (recent alluvial systems on river and creek flats) and land zone 4 (old alluvial clay plains, mainly vertosols with potential for gilgai microrelief).

Land zone 4 environments are typically gently undulating plains with clay soils and texture-contrast sediments that support brigalow (*Acacia harpophylla*), belah (*Casuarina cristata*), some box (e.g. *Eucalyptus populnea*, *Eucalyptus moluccana*) communities, grasslands (*Astrebla pectinata*, various

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[3] Formerly known as Department of Natural Resources and Mines

bluegrasses), herblands, and semi-evergreen vine thicket in more favourable areas. Wildlife records for the Brigalow Belt North region indicate the region may provide habitat for 10 EPBC Act-listed threatened flora species and 22 EPBC Act-listed threatened fauna species.

21.4.3 Climate

The nearest operating climate weather station is the Bureau of Meteorology (BoM) Station 034035 at Moranbah Airport, approximately 48 km north of the Project, has only been operational since 2012; too short of a timeframe to comprehensively assess climate trends within the area. Data from BoM Station 035019 at the Clermont Post Office, approximately 85 km south-west of the Project, has been operational since 1870 and was used to assess long term rainfall (1870 to 2018), temperature (1910 to 2011) and evaporation (1979 to 2011). The climate data is assumed to be representative of the Project Site.

Overall, the climate is sub-tropical characterised by high variability in rainfall, temperature and evaporation, typical of Central Queensland. Climate data in Table 21-27 shows mean annual rainfall is approximately 660 millimetres per year (mm/year) and the average annual evaporation is approximately 2,070 mm/year. Evaporation is recognised to exceed rainfall every month indicating a negative climate budget. This indicates a strongly negative mean annual water balance.

Table 21-27 Climate summary

Month	Average Temperature (°C)	Average Rainfall (mm)	Average Daily Pan Evaporation (mm)	Average Monthly Pan Evaporation (mm)
January	34.3	117.8	7.5	232.5
February	33.0	114.4	6.8	190.4
March	32.0	74.6	6.4	198.4
April	29.5	38.2	5.1	153.0
May	26.1	33.9	3.7	114.7
June	23.1	33.2	3.0	90.0
July	23.1	25.1	3.2	99.2
August	25.3	18.6	4.2	130.2
September	28.8	20.0	5.7	171.0
October	31.9	35.2	7.0	217.0
November	33.9	57.0	7.4	222.0
December	34.8	91.5	8.1	251.1
Annual Total	**29.7**	**659.5**	**5.7**	**2,069.5**

Source: BoM Station 035019

The Cumulative Rainfall Departure (CRD) method (Weber and Stewart, 2014) depicts monthly rainfall trends compared against long-term average monthly rainfall. A rising trend in the CRD indicates periods of above average rainfall (and possibly increased groundwater recharge to unconfined aquifers), whilst a falling slope indicates periods of below average rainfall. The CRD for the period 1900 to 2018 indicates:

- the area has experienced several climatic fluctuations of above average and below average rainfall since 1900
- the area experienced a period of below average rainfall between 2001 and 2007 followed by a period of above average rainfall between 2010 and 2013
- more recently, the Project Area has experienced below average rainfall from 2013 to 2018 (Clermont Post office weather station closed in 2018).
- from Moranbah airport, the period of below average rainfall continued through to 2022.

The CRD for both Clermont Post Office (1900 – 2018) and Moranbah Airport (2012 – 2024) are shown in Figure 21-19 . Groundwater levels in unconfined aquifers receiving direct rainfall recharge could be expected to show a trend which mirrors the CRD.

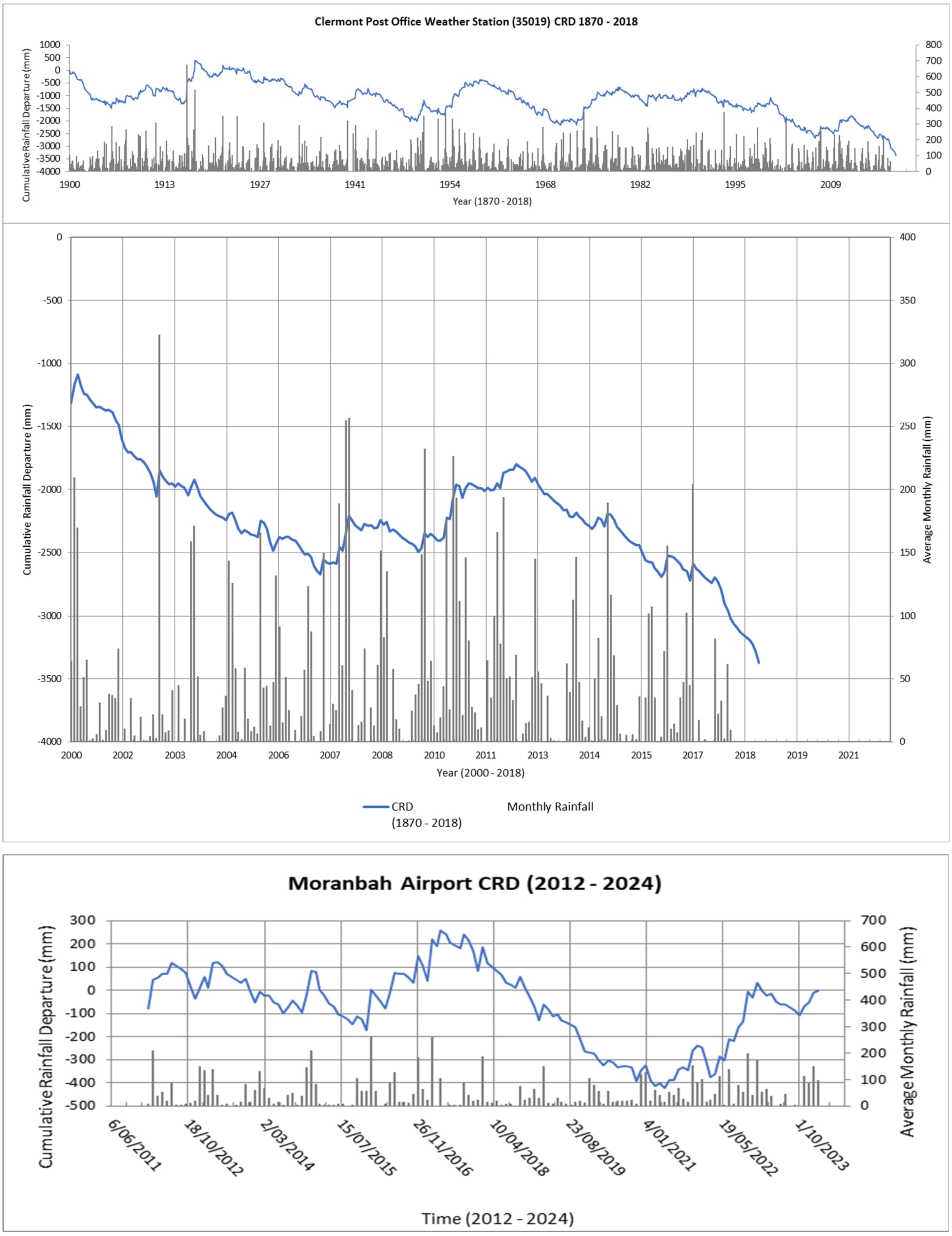


Figure 21-19 Cumulative Rainfall Departure plots

21.4.4 Geology

The Project is located on the western limb of the northern Bowen Basin; a north-south trending Early Permian to Middle Triassic geological basin. The Bowen Basin is divided into tectonic structures that comprise north north-west to south south-west trending platforms or shelves, separated by sedimentary troughs. The major regional structural feature is the Collinsville Shelf. The Nebo Synclinorium, a major axis of deposition, occurs to the east of the Project (Dickins et al, 1973).

Folds within the basin are generally gentle and mostly related to drag on thrust faults at the eastern margin of the basin. The boundary between the Collinsville Shelf and adjoining Nebo Synclinorium is marked by a major thrust fault, the Jellinbah Thrust Fault (URS, 2012). The regional stratigraphic sequence in the Project Area comprises:

- Middle Permian Back Creek Group (basement)
- Late Permian Blackwater Group sediments (and coal measures)
- Tertiary sediments
- Unconsolidated Quaternary alluvium sediments.

The surface geology for the Project Area based on the 1:100,000 scale Grosvenor Downs (Sheet 8553) geological map sheet is shown in Figure 21-20 and the detailed basement geology based on the 1:500,000 scale Bowen Basin basement geology map is presented in Figure 21-21. The mapped geology indicates that the stratigraphy typically comprises Permian coal measures overlain by a variable thickness of unconsolidated to poorly consolidated Tertiary and Quaternary age sediments.

The surface geology (Figure 21-20) shows Tertiary sediments outcrop throughout the Project Area whilst mapped Quaternary sediments are associated with the present day channels of the Isaac River and Phillips Creek. It is noted that no alluvium is mapped within or adjacent to Boomerang Creek, Plumtree Creek, and the former Hughes Creek on the 1:100,000 scale maps, which drains across the underground mining footprint.

Bore logs, CSIRO mapping, plus site-specific auguring within the mine footprint were used to delineate the alluvium, which was included in the predictive groundwater modelling. This allowed for the potential impacts of longwall mining on groundwater resources associated with the alluvium across the Project to be determined. The presence of alluvium is included in Figure 21-23.

21.4.4.1 Structural geology

The location of mapped faults and structures within and surrounding the Project are shown in Figure 21-22. The faults in the Project Area comprise both normal and thrust faults with mapped trends which describe two dominant structural domains: one trends north north-west, the second trends north-south. The Isaac Fault, which is located to the east of the Project, separates relatively undisturbed sediments towards the west from a complex zone of folded and faulted sediments to the east.

Inferred and mapped faults (within the SRM) within the footprint of the proposed underground mine workings are shown in Figure 21-22. The Project mine plan takes these faults into consideration (i.e. longwall panels avoid faults).

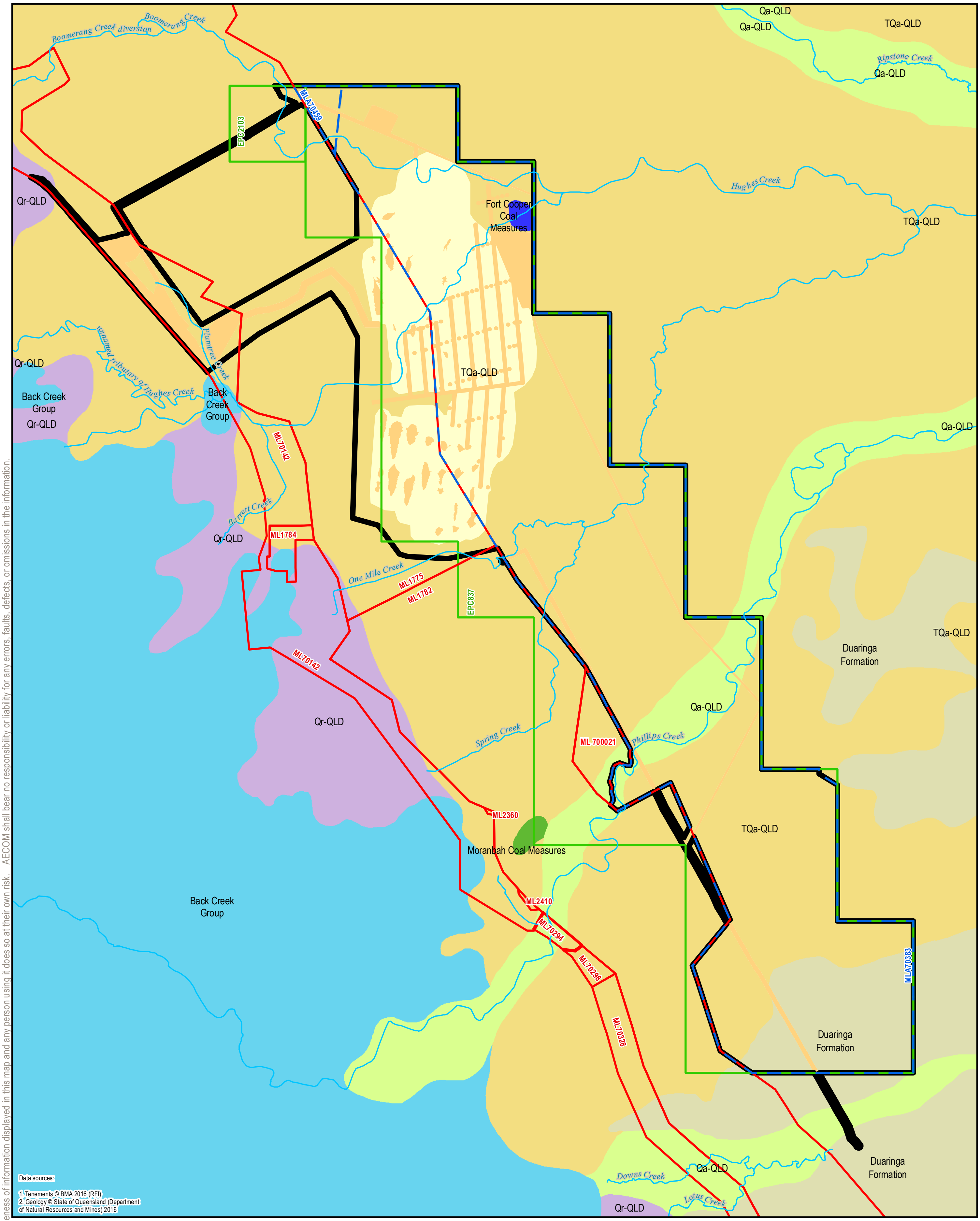
The modelling of faults within the groundwater model domain is from the base BMA regional scale groundwater model using the fault mapping and site-specific geology models where available. Local faults displacements derived from the site geological models have also been captured in the model layer elevations at these sites. There are three key regional northwest-southeast trending fault zones included in the model (as included in Figure 21-22):

- Extending 50 km, 500 m to the east of the Project footprint[4]
- Extending 70 km, 12 km to the east of the Project
- Numerous shorter faults extending 25 km total, 15 km to the east of the Project.

[4] This fault is conservatively included as a continuous fault in the model. The fault is discontinuous in Figure 21-22.

As faults can act as barriers or conduits to groundwater flow, which can influence ingress and groundwater drawdown, the nature of the faulting was assessed through model calibration and uncertainty analysis. As per industry best practice, if the nature of a fault, or other hydraulic feature, is unknown, then the parameterisation of the fault should be sufficiently large to capture all plausible conceptualisations. This is the practice employed within the SLR (2023) modelling, and development of the calibrated ensemble; in particular, the allowed parameter ranges during calibration allowed representation of the fault as a full barrier, full conduit, and all possibilities in between.

The Project's Groundwater Modelling Technical Report (Appendix F-1 SLR, 2023) provides the ranges in conductivities for the different fault zones within the model (lines 25 to 28 of Table 57). The range in values within the ensemble varies by orders of magnitude and as such the predictive uncertainty captures the uncertainty in the conceptualisation on the nature of the faults. In this sense, the predictive results incorporate the possibility of faults being barriers, conduits, and/or both. The modelling approach is recognised to assess the fault/s influence on groundwater ingress and drawdown.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

Figure 21-20
Surface Geology
(1:100,000)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:120,148 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 4/06/2024 VERSION: 2

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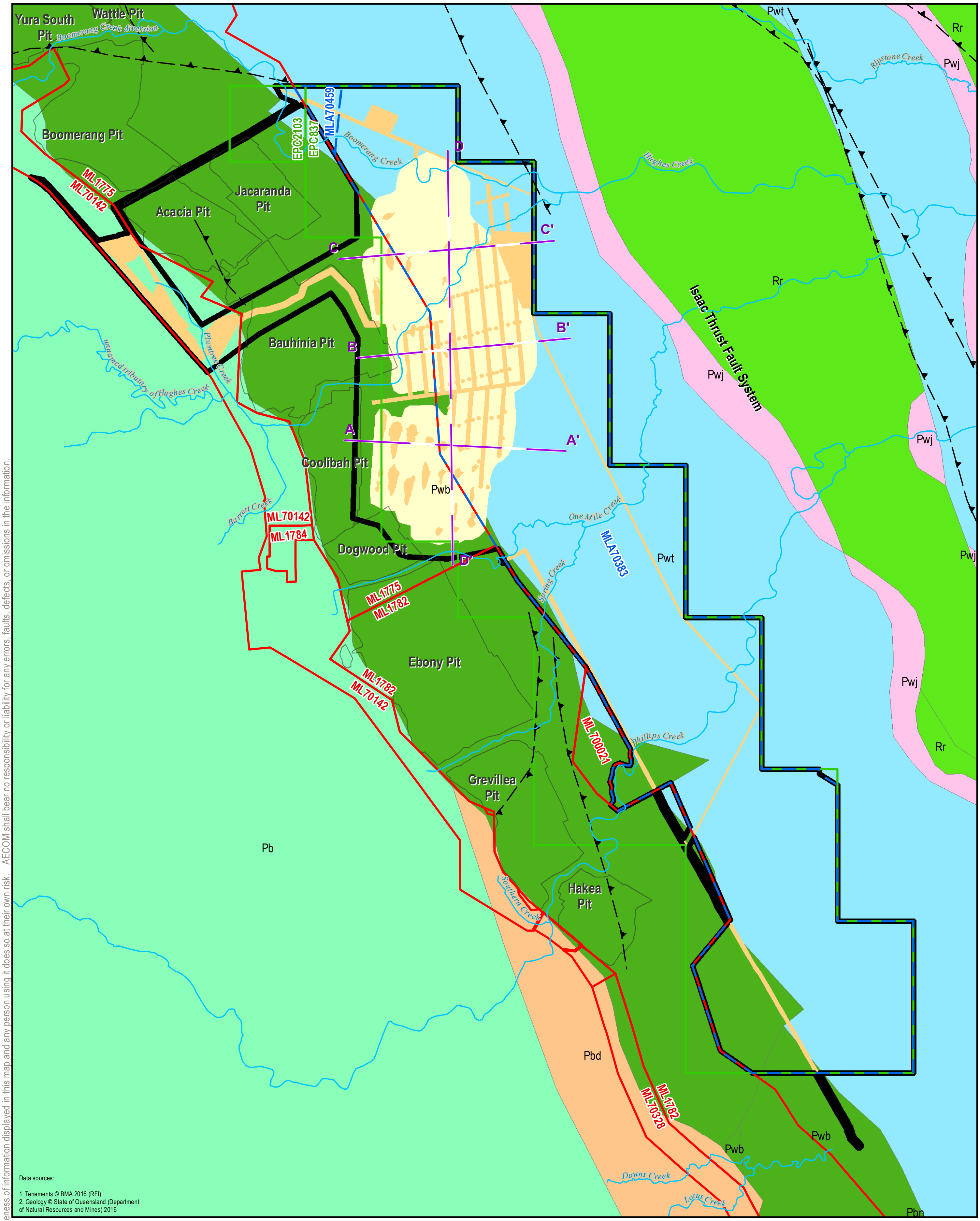

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Existing Open-Cut Extent
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Cross Section
- Fault

Bowen Basin Basement Geology

- Pb - Permian Back Creek Group
- Pbd - Permian German Creek Formation
- Pbn - Permian MacMillan Formation
- Pwb - Permian Moranbah Coal Measures
- Pwj - Permian Rangal Coal Measures
- Pwt - Permian Fort Cooper Coal Measures
- Rr - Triassic Rewan Group

N

Figure 21-21
Basement Geology
(1:500,000)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:120,148 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 4/06/2024 VERSION: 3

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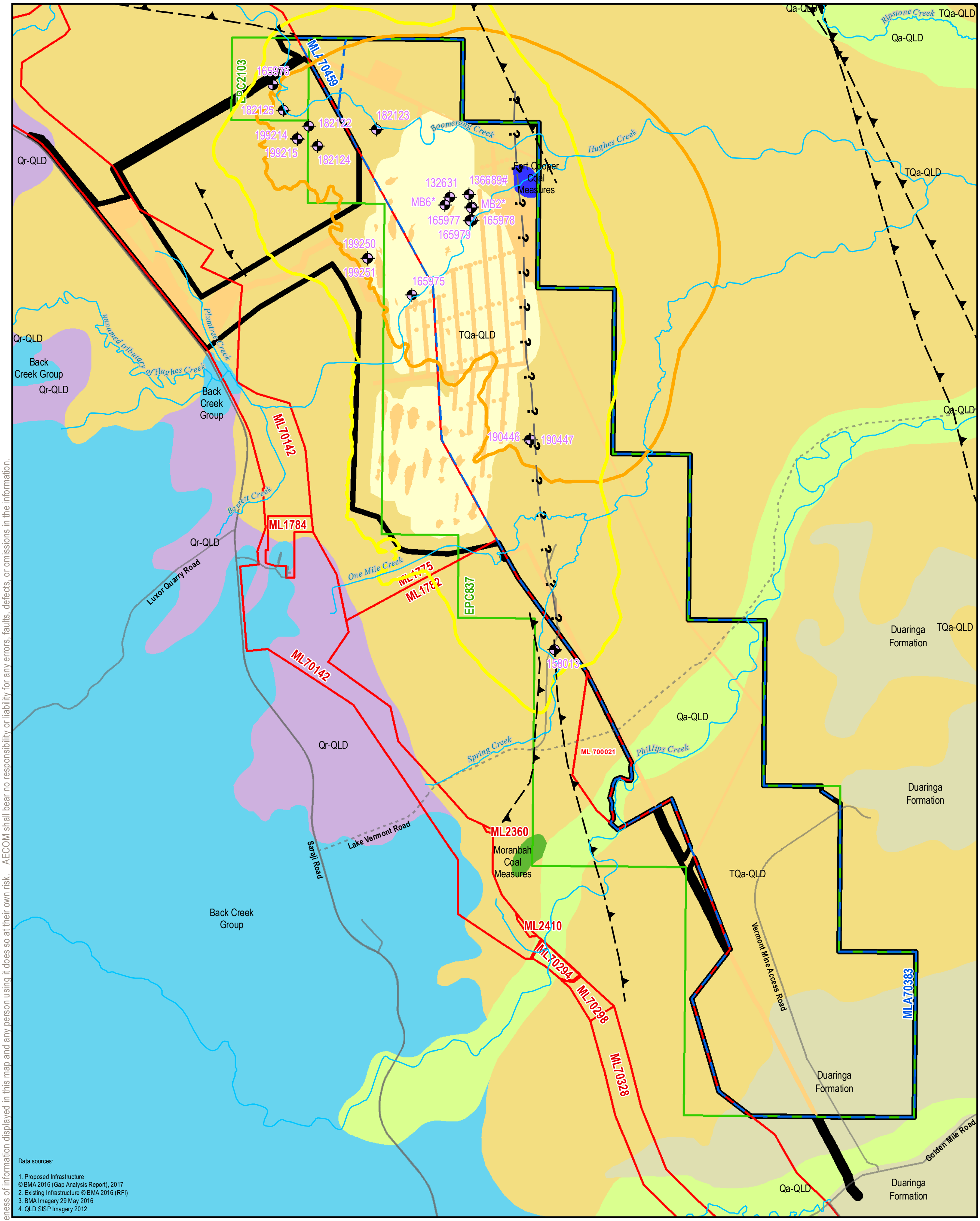

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Potentially impacted bores
- Maximum drawdown in the D-Seam
- Maximum drawdown in the Tertiary Layer
- Fault
- Inferred Fault

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

Figure 21-22

Bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam

Environmental Impact Statement

Saraji East Mining Lease Project

0 0.5 1 2

Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA

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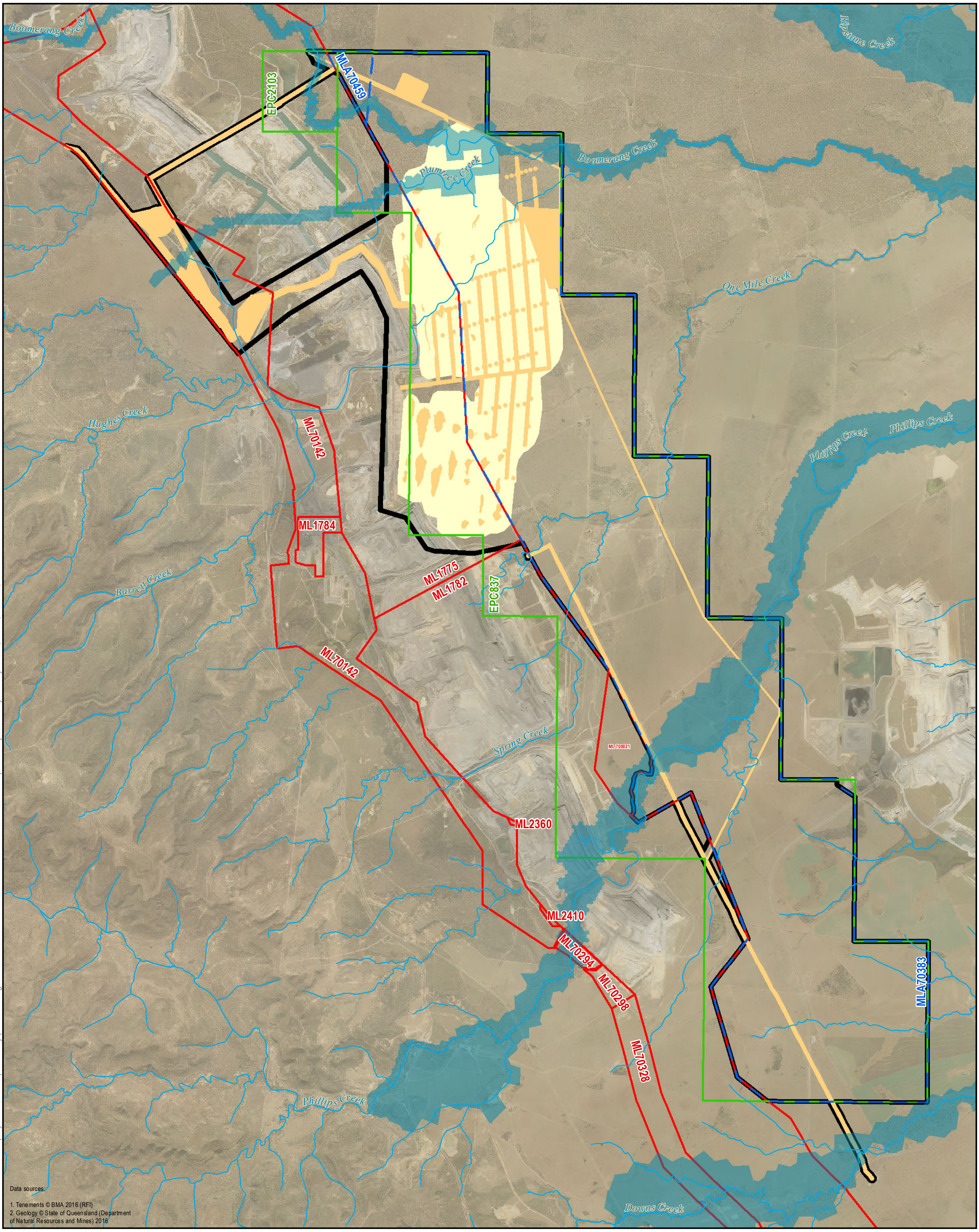
DATE: 4/06/2024 VERSION: 3



LEGEND

- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse
- Alluvium extent

N

Figure 27
Modelled Alluvium Extent

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:114,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 7/06/2024 VERSION: 0

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21.4.4.2 Stratigraphy

The mapped geology indicates that the stratigraphy typically comprises Permian coal measures overlain by a variable thickness of unconsolidated to poorly consolidated Tertiary and Quaternary age sediments. As shown conceptually in Figure 21-9, Permian sediments form a regular layered dipping sedimentary sequence while the overlying Tertiary materials are more complex and irregular with a maximum thickness of approximately 45 m across the underground mine footprint. Figure 21-20 shows Tertiary sediments outcrop throughout the Project Area whilst mapped Quaternary sediments are associated with the present-day channels of the Isaac River and Phillips Creek. Modelled alluvium including site-specific data is shown in Figure 21-23. Stratigraphy of the Project and surrounds (including geology outside the Project but within the BMA regional scale model) is summarised in Table 21-28.

Table 21-28 Stratigraphy

<table>
<tr><th>Age</th><th colspan="2">Stratigraphic Unit</th><th>Description</th><th>Average Thickness (m)</th><th>Occurrence</th></tr>
<tr><td>Quaternary</td><td colspan="2">Alluvial sediments</td><td>Clay, silts, sand, gravel, floodplain alluvium.</td><td>0 - 25</td><td>Continuous alluvium confined to present day stream and creek channels of the Phillips Creek and Isaac River.</td></tr>
<tr><td rowspan="3">Tertiary</td><td colspan="2">Clay</td><td>Clay, clayey sand, sandy clay, sand.</td><td>4 - 45</td><td>Covers Project area with regular distribution; individual lenses are discontinuous and lensoidal.</td></tr>
<tr><td colspan="2">Basal Sand/Gravel</td><td>Sand.</td><td>0 - 3</td><td>Irregular distribution generally observed where Tertiary sediments are thickest. Not reported within underground mining footprint.</td></tr>
<tr><td colspan="2">Duaringa Formation</td><td>Mudstone, sandstone, conglomerate, siltstone.</td><td>~ 20</td><td>Extensive outside of the underground mining footprint to the southeast.</td></tr>
<tr><td rowspan="4">Permian</td><td rowspan="2">Fort Cooper Coal Measures (FCCM)</td><td>Burngrove Formation</td><td rowspan="2">Sandstone, siltstone, mudstone, carbonaceous shale and coal.</td><td rowspan="2">Up to 400</td><td rowspan="2">Present beneath eastern portion of underground mining footprint.</td></tr>
<tr><td>Fairhill Formation</td></tr>
<tr><td rowspan="2">Moranbah Coal Measures (MCM)</td><td>MacMillan Formation</td><td rowspan="2">Sandstone, conglomerate, claystone, siltstone, coal. Contains target coal seam – D14/24.</td><td rowspan="2">250 – 350</td><td rowspan="2">Present beneath entire underground mining footprint.</td></tr>
<tr><td>German Creek Formation</td></tr>
<tr><td>Early to Middle Permian</td><td>Back Creek Group</td><td></td><td>Sandstone, siltstone, carbonaceous shale, minor coal.</td><td>-</td><td>Underlies entire Project area. Outcrops west of SRM and extends under mined areas to the east.</td></tr>
</table>

Quaternary sediments

The 1:100,000 surface geology map (Figure 21-20) indicates that Quaternary sediments are confined to the present day channels of Phillips Creek and the Isaac River. The Quaternary sediments comprise irregular sequences of unconsolidated clay, silt, sand, and gravel which are variable in thickness.

Quaternary sediments surrounding the Project Area have been reported to have a maximum thickness of 25 m at Phillips Creek (AGE, 2007).

An assessment of the alluvium (3D Environmental, 2022) identified in the field at Boomerang Creek, Plumtree Creek, and the former Hughes Creek, and along Phillips Creek was conducted. The hand auger holes and logged sediments are summarised in Table 21-29. The location of these augur holes is included in Figure 21-24.

Table 21-29 Non-perennial creek alluvium and Philips Creek alluvium

Site	Creek	Depth interval	Description	Comment
2_AU1	Phillips	0 – 0.75 m	Coarse river sand	Moist to wet
		0.75 – 1.15 m	Coarse river sand mixed with silty clay and clay loam	Water table in clayey sand at 1.15 mbGL[5]
3_AU1	Phillips	0 – 1 m	Coarse river sand	Moist at 1 mbGL
		1 – 1.1 m	Coarse gravel	Base of river sand
		1.1 – 1.6 m	Fine to medium clayey sand	Moist
		1.6 – 2.1 m	Orange brown fine sandy clay with some mottling	Moist clay
		2.1 – 2.3 m	Light brown / grey plastic clay	Moist
		2.3 – 2.7 m	Orange brown clayey sand	Wet to moist
		2.7 – 2.8 m	Coarse gravel bed	
4_AU1	Phillips	0 – 0.3 m	Coarse river sand	
		0.3 – 0.5 m	Coarse gravel bed at base of river sand	Dense tree roots at 0.5 m
		0.5 – 0.95 m	Fine sandy clay with orange grey mottling	Moist
		0.95 – 1.6 m	Strongly mottled grey brown sandy clay	Moist to very moist
		1.6 – 1.7 m	Grey to orange decomposed sandstone	Base of alluvium
6_AU1	One Mile	0 – 0.3 m	Dark brown clayey sand with orange mottling	
		0.3 – 0.75 m	Grey brown clayey sand	Moist to wet
		0.75 – 1. 75 m	Grey brown sandy clay with mottling	Moist to wet
		1.75 – 2 m	Grey to brown clayey sand with minor gravel and orange mottling	Tree roots at 2 mbGL
		2 – 2.5 m	Grey brown clay with mottling and gravel fragments	
		2.5 – 2.6 m	Grey to brown gravelly / clayey sand with mottling	
9_AU1	Plumtree	0 – 0.5 m	Medium to coarse grained river sand	

[5] mbGL – metres below ground level

Site	Creek	Depth interval	Description	Comment
		0.5 – 1 m	Grey to brown sandy clay transitioning to fine sand at 1 m	
		1 – 1.6 m	Grey to orange fine clayey sand with iron staining and mottling	
		1.6 – 2 m	Sand and gravel in grey clay matrix with mottling	Top of decomposed bedrock Moist
		2 – 2.25 m	Dense clay with some gravel and iron mottling	Coarse tree roots at 2 mbGL
		2.25 – 2.5 m	Dense grey clay	
10_AU1	Boomerang	0 – 1 m	Medium to coarse river sand	Gravel horizon at 1 mbGL
		1 – 1.25 m	Grey brown gravelly clay with mottling	Dense roots at 1.2 mbGL
		1.25 – 1.5 m	Fine grey clayey sand and gravel	Moist to very moist
		1.5 – 1.6 m	Yellow fine river sand with clay nodules	Dry Hole terminated on weathered sandstone bedrock
11_AU1	Boomerang	0 – 0.5 m	Coarse river sand	Minor tree roots
		0.5 – 1.6 m	Grey to brown medium to coarse clayey sand	Moist Medium to coarse tree roots
		1.6 – 2.25 m	Brown to yellow, fine river sand	Dry
		2.25 – 2.6 m	Brown medium to coarse clayey sand Decomposed sandstone bedrock with clay nodules and ironstone mottling	Medium to coarse tree roots in bedrock
12_AU1	Boomerang	0 – 0.4 m	Free draining dry river sand	Fine tree roots at 0.4 mbGL
		0.4 – 0.5 m	Grey brown cemented sand	
		0.5 – 2.5 m	Dry river sand	Dry
13_AU1	Boomerang	0 – 1 m	Grey brown clay loam with minor orange mottling	
		1 – 1.5 m	Orange to brown silty loam with minor mottling	
		1.5 – 2.9 m	Orange to brown iron stained fine river sand	Dry
		2.9 – 3.0 m	Grey to brown clayey sand	Medium to coarse tree roots at 3 mbGL
		3 – 3.75 m	Grey to brown clayey sand with mottling	Contains weathered sandstone fragments
		3.75 – 3.8 m	Weathered sandstone	

The shallow augur hole program identified:

- thin heterogenous alluvium within the creeks with varying moisture content
- shallow bedrock below the non-perennial creeks
- perched water on the clay-rich sediments
- limited effective storage in the river sand (i.e. dry due to drainage from the sand)
- the deepest alluvium within the Project footprint was recorded in Augur 13_AU1 hole, some 3.75 m deep; this depth was adopted for the modelling.

Project Alluvium data

SRM installed a five new monitoring bores during 2019 (GHD, 2023). A summary of these alluvium bores is included in Table 21-30.

Table 21-30 SRM alluvium monitoring bores

Bore ID	Depth (m)	Screen (mbGL)	Lithology	Comment
MB38 / MB19SRM01A	8.5	5.5 – 8.5	Sand, gravel, and clay	Water level at 7.39 mbTOC[6] Drilled on 28/07/2019
MB20SRM01A / MB20SRM01A_HY	10.5	7.2 – 10.2	Sand, gravel, and clay	Dry Drilled on 16/10/2019
MB20SRM04A	12	6.5 – 9.5	Silty gravel	Bore was developed using a bailer because of the low water volume within the bore and slow recharge Water level was 9.12 mbTOC Saline groundwater Drilled 05/10/2019
MB20SRM05A / MB20SRM05A_PZ	24	6.5 – 9.5	Sand and gravel	Dry Drilled 02/10/2019
MB20SRM06A / MB20SRM06A_PZ	9.75	2 - 6	Sand, gravel, and clay	MB20SRM06A was not completed due to detected contamination at the start of the development process – to be replaced Water level was 6.10 mbTOC Drilled 02/10/2019

The location of these alluvium monitoring bores is included in Figure 21-25. The drilling results for these five alluvium bores indicated:

- Bedrock was not intersected within MB19SRM01A, adjacent to Phillips Creek. Bore collapsed at 8.5 mbGL within sandy clay with gravel, the end of hole.
- MB20SRM01A (MB20SRM01_PZ), adjacent to Plumtree Creek, intersected dry coarse grained alluvial sand.
- MB20SRM04A, adjacent to Boomerang Creek, was screened across silty gravel above clay and weathered sandstone at 9 mbGL. The bore was drilled dry but seepage was measured after development.
- MB20SRM05A (MB20SRM05A_PZ) on Hughes Creek intersected thick clay with dry alluvium sands 6 to 9 mbGL.
- Shallow alluvium sand above clay was intersected adjacent to One Mile Creek within MB20SRM06A.

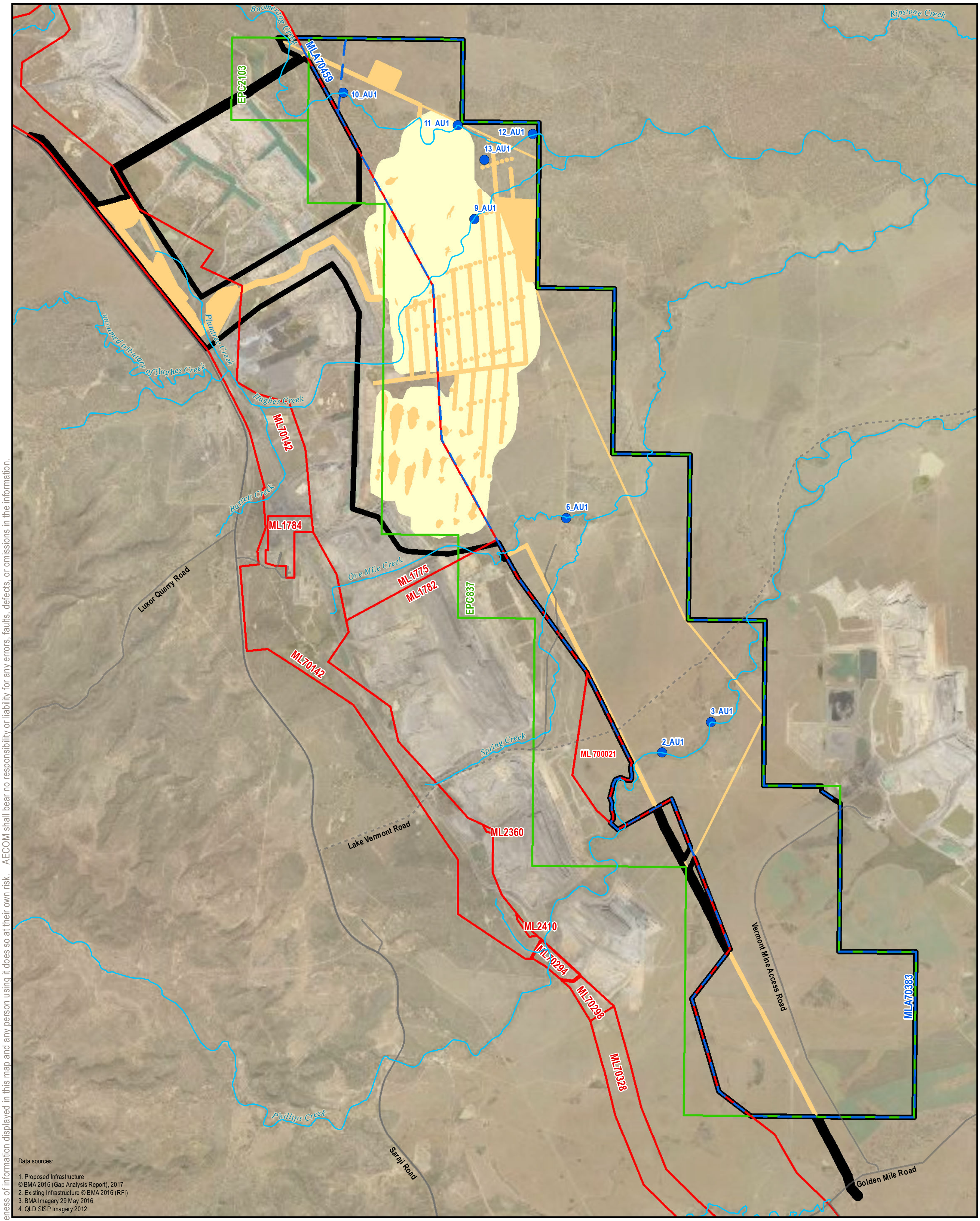
The site-specific drilling data confirmed that the alluvium comprise irregular sequences of unconsolidated clay, silt, sand, and gravel which are variable in thickness.

NOTE: Due to BMA data management systems, bores have multiple names, this has led to misinterpretation of available monitoring and sampling data for the respective location. The data associated with the various bore identifications are combined to form a complete monitoring record at the respective location. Tables have been updated to reflect the multiple monitoring bore names, and include the following:

- MB38 / MB19SRM01A / MB19SRM01A_HY
- MB39 / MB19SRM03P / MB19SRM03P_HY
- MB40 / MB19SRM02T / MB19SRM02T_HY
- MB19SRM04P / MB19SRM04P_HY

[6] mbTOC – meters below top of casing

- MB20SRM01A / MB20SRM01 / MB20SRM01_PZ
- MB20SRM05A / MB20SRM05A_PZ
- MB20SRM06A / MB20SRM06A_PZ.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Auger Sites

N

Figure 21-24
Auger Hole Locations

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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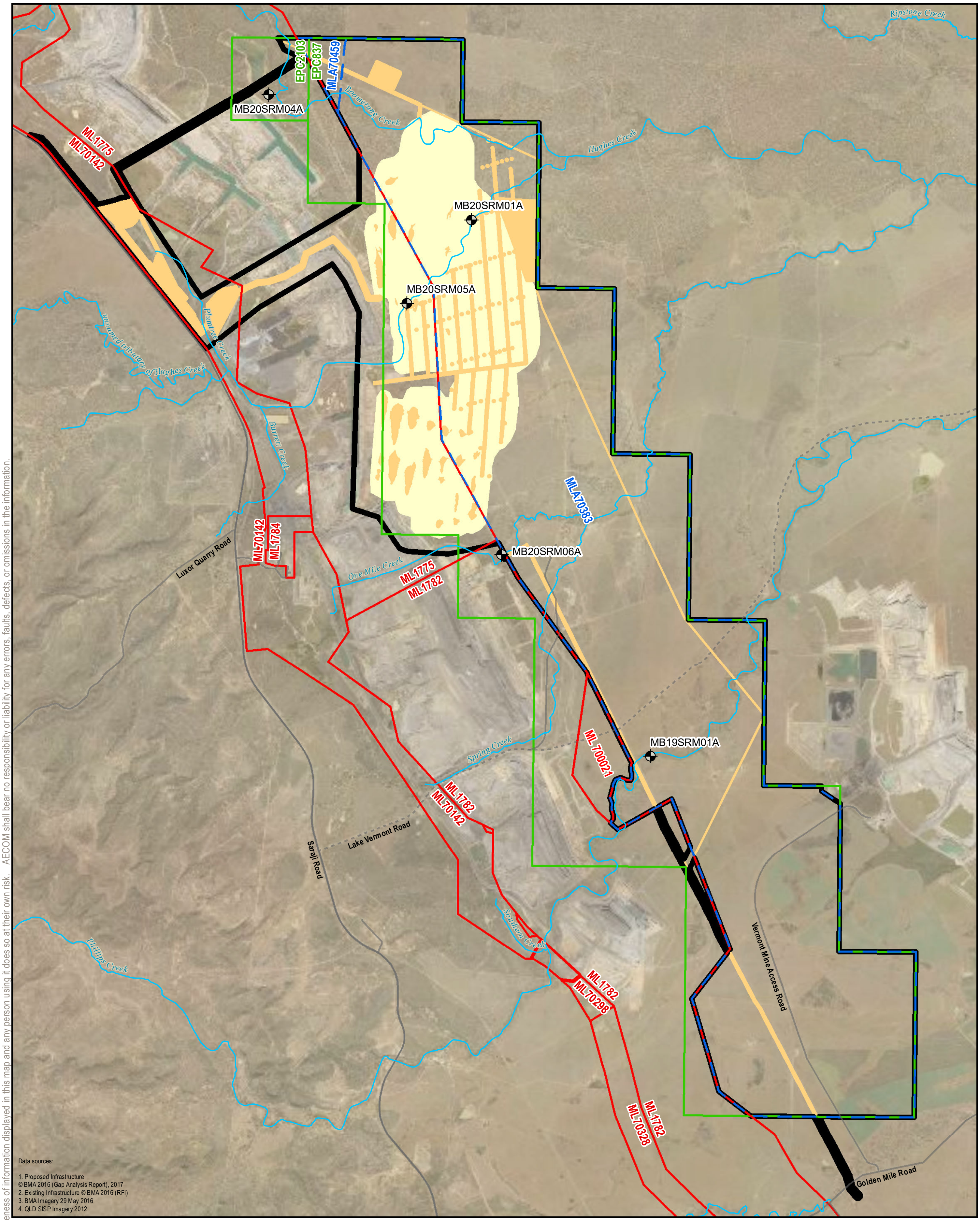

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Alluvium Bores

N

Figure 21-25
Saraji Mine new alluvium monitoring bores

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Tertiary sediments

Tertiary sediments within the Project Area comprise dominantly of ‘tight’ clay overlying an irregular / discontinuous basal unit comprising sand and gravel. Tertiary sediments reach a maximum thickness of approximately 45 m across the underground mine footprint whilst AGE (2011) indicates that the Tertiary sediments are up to 57 m thick in the western portion of the SRM. The Tertiary sequence is defined by an unconformable boundary with the underlying Permian sequence which characterises the Permian topography prior to deposition of the Tertiary sediments.

- Tertiary clay unit comprises a predominantly clay matrix with intercalation of clay and sand lithologies and is the dominant Tertiary lithology present across the Project Area. At least seven depositional phases are evident in the Tertiary sediments in the Bowen Basin, generally as truncating, fining upward, sequences. Weathering of the sediments is evident in at least three periods of laterisation with associated mottling and concretionary structure (AGE, 2011).
- Basal sand/gravel sequence is associated with the base of the Tertiary sediments. Comprising medium to coarse grained sands and fine gravels, the sequence has a maximum thickness of approximately three metres where present and can be locally continuous. JBT (2014) suggests that the basal sand and gravels represent the presence of a laterally discontinuous paleo-channel system assumed to be related to a proto-Phillips Creek system.
- Duaringa Formation, which is mapped towards the south and north of the underground mining footprint (Figure 21-20), contains mudstone and siltstone (i.e. low permeability argillaceous strata). The Duaringa Formation has not been logged within the underground mining footprint.

<u>Project Tertiary data</u>

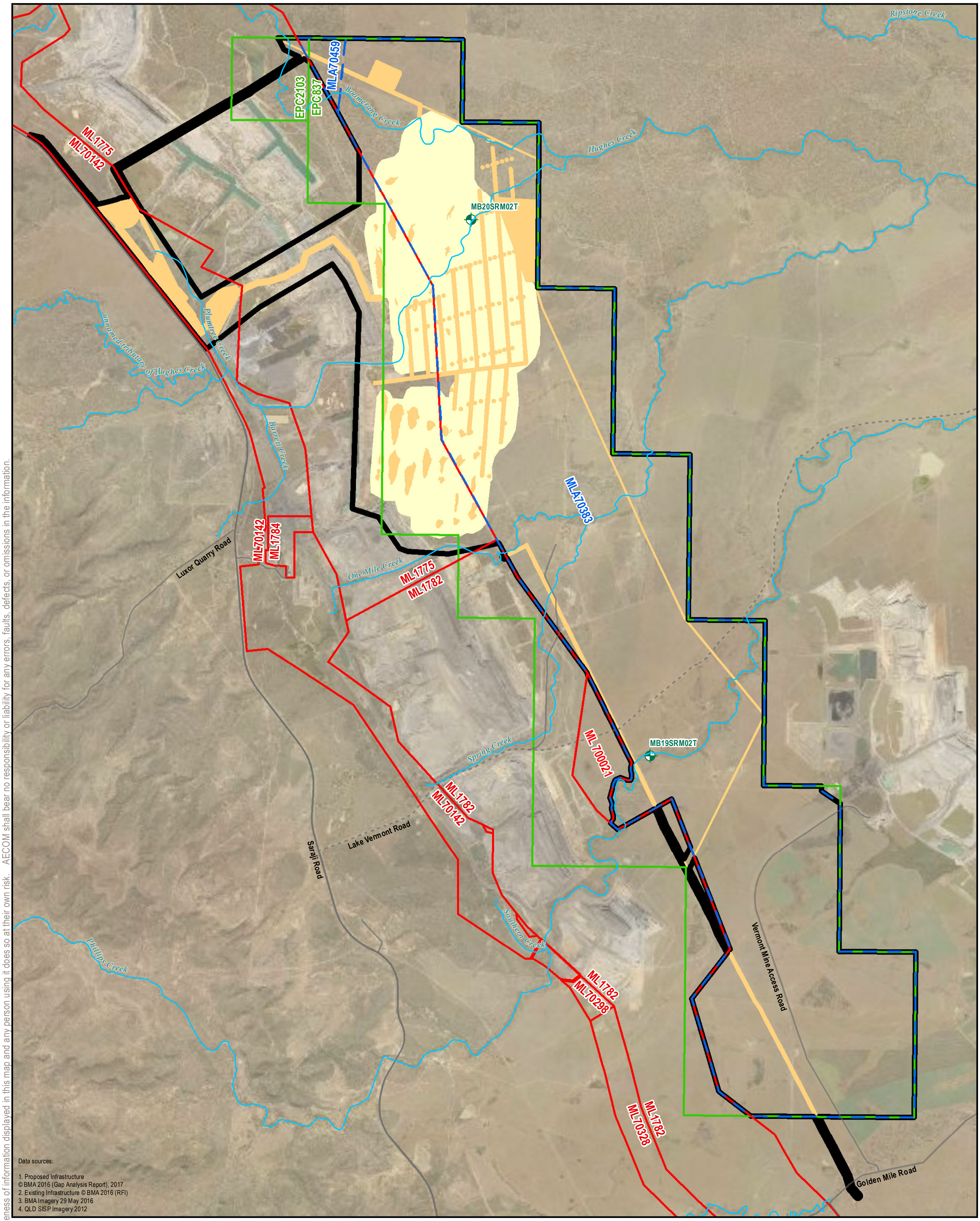
SRM installed a series of monitoring bores during 2019 (GHD, 2023), including two Tertiary bores. A summary of these Tertiary bores is included in Table 21-31. The location of these Tertiary monitoring bores is included in Figure 21-26.

Table 21-31 SRM Tertiary monitoring bores

Bore ID	Depth (m)	Screen (mbGL)	Lithology	Comment
MB40 / MB19SRM02T	27	14 - 20	Clay and gravel	Water level at 17.36 mbTOC Drilled 27/07/2019
MB20SRM02T	36.5	27.5 – 36.5	Sandstone	Water level at 23.56 mbTOC Permian sediments and Tertiary age sediments intersected Drilled 18/10/2019

MB40 / MB19SRM02T, constructed adjacent to alluvium monitoring bore MB38 / MB19SRM01A on Phillips Creek, intersected clay and sandy clay below the alluvium. A zone of basal gravels and clay were intersected above sandstone. The Tertiary sediments were screened between 14 and 20 mbGL, with water measured within the screen (unconfined) at 17.36 mbTOC. The saturated Tertiary sediments are separated from the perched discontinuous alluvium water, some 10 m difference in water levels. This is consistent with the conceptual model derived during the EIS.

Monitoring bore MB20SRM02T was drilled on Plumtree Creek, adjacent to MB20SRM01A (MB20SRM01_PZ). Clayey sand and clay was intersected below the alluvium logged within MB20SRM01A (MB20SRM01_PZ). No basal gravels were intersected as this bore intersected Permian coal and sandstone below 24.5 mbGL.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Tertiary Bores

N

Figure 21-26
Saraji Mine new Tertiary monitoring bores

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Permian strata

The Permian coal bearing strata within the Project Area comprise the Fort Cooper Coal Measures (FCCM) and the underlying Moranbah Coal Measures (MCM).

The coal measures comprise sandstone, siltstone, claystone, mudstone and coal. Coal seams of interest within the MCM include the P seam, Harrow Creek Upper (H16) seam, Harrow Creek Lower (H15 and H19) seams, Dysart Upper (D52) seam and Dysart Lower (D14, D24) seam. Other seams are present but are generally too thin or discontinuous to be of economic value within the Project area. The target coal seam of the underground workings is the Dysart Lower (D14 / D24) seam.

The Dysart Lower seam (D24 and D14) is located 17 m to 35 m below the Dysart Upper seam (D52). The D24 seam depth of cover ranges from 120 m at western to maximum of 780 m at eastern limit of MLA 70838 and the seam is typically seven metres thick where coalesced towards the northern end of the MLA 70383. The seam thins to the north and progressively splits to the south into the D14/D142/D291 plys with thicknesses ranging from 2 m to 5.8 m. Figure 21-27 outlines the Saraji seam correlation present across the Project Area.

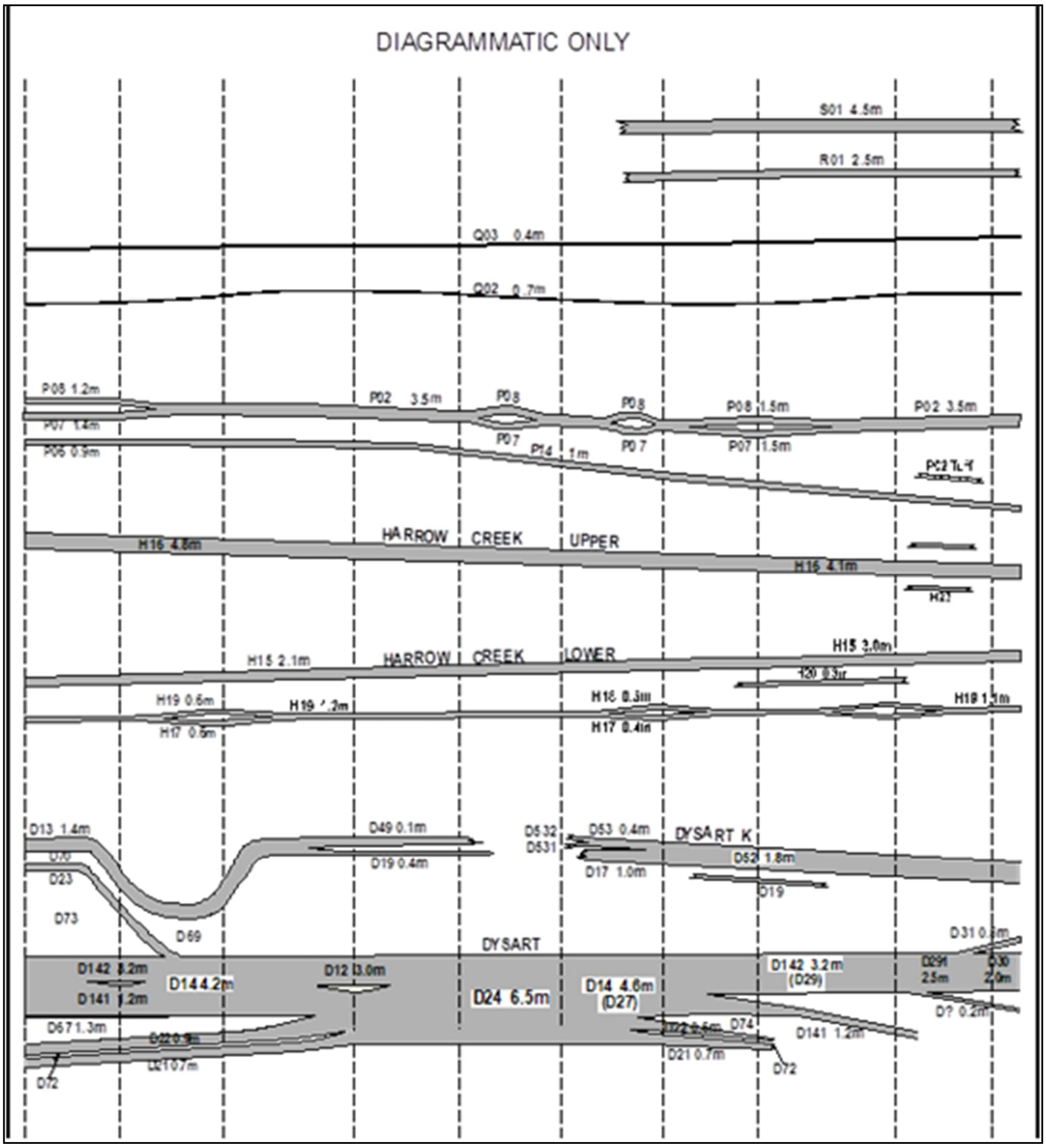


Figure 21-27 Saraji seam correlation

21.4.5 Water resources

21.4.5.1 Surface water

Regional catchment

The Project Site sits within the Isaac River catchment, a sub-catchment of the broader Fitzroy Basin. The Fitzroy Basin covers an area of approximately 142,660 km^2, comprising rivers, streams, waterholes and modified impoundments (DES, 2018c). It is the largest river catchment flowing to the eastern coast of Australia (Fitzroy Basin Association, 2018). The Fitzroy River discharges to the ocean in Keppel Bay, near Rockhampton, approximately 260 km from the Project Site. Its major tributaries are the Nogoa, Comet, Mackenzie, Isaac, Connors and Dawson Rivers and Callide Creek. Regional catchment context relevant to the Project is shown in Figure 21-28.

Watercourses

Waterways defined as a watercourse under the *Water Act 2000* flow through the Project Site, including Boomerang Creek, Plumtree Creek, Hughes Creek, One Mile Creek, Spring Creek and Phillips Creek. Of these streams, only Boomerang Creek, Plumtree Creek and Hughes Creek intersect the underground mining operations and potential extent of subsidence; however, One Mile Creek and Spring Creek join the catchment before the confluence with Isaac River. Phillips Creek passes south of mining activities; only proposed construction of access roads and powerlines will intersect this watercourse. Watercourses are identified in Figure 21-30.

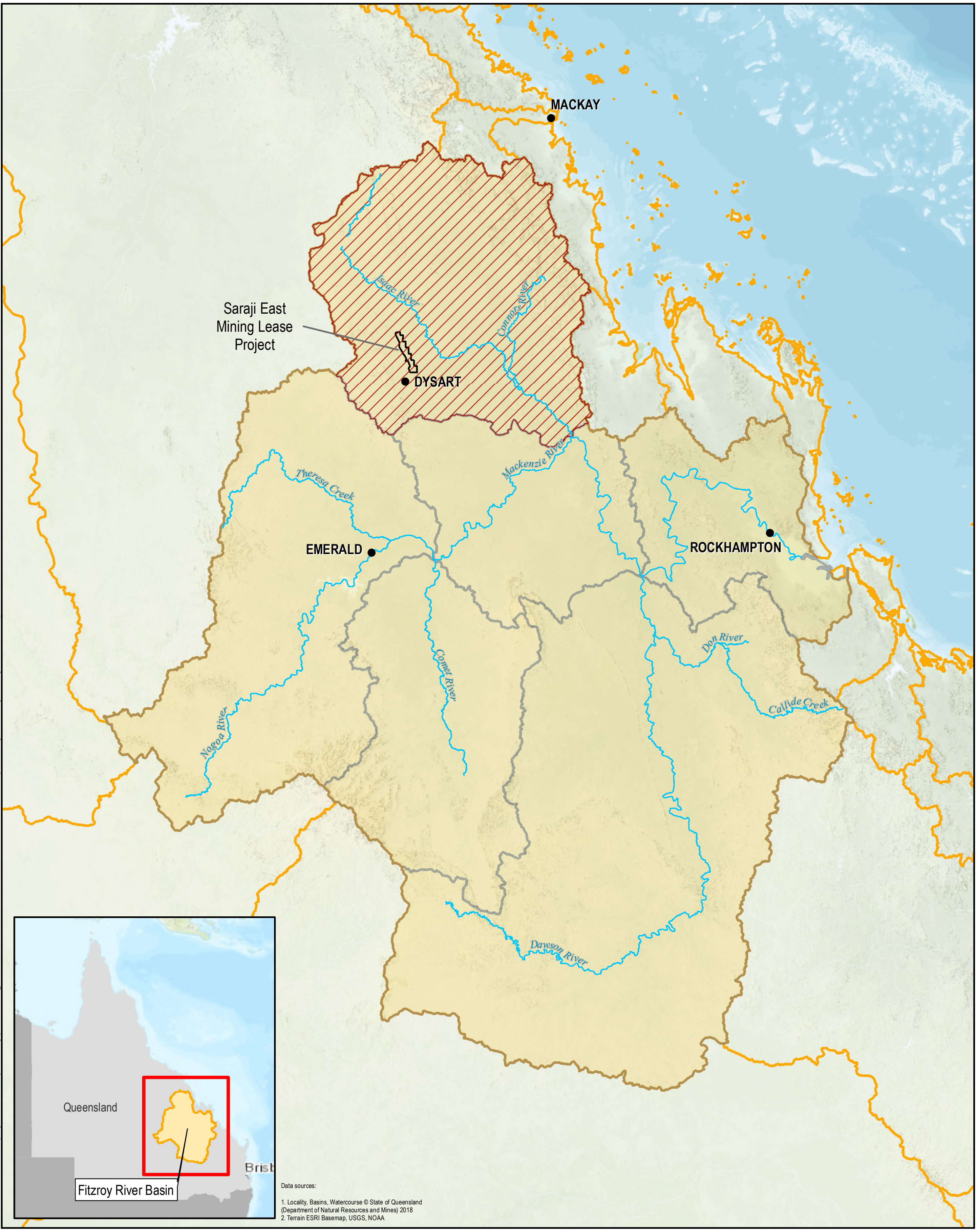
Boomerang Creek, Hughes Creek and Plumtree Creek are previously modified by open cut mining operations west of the Project Site. Both Boomerang Creek and Hughes Creek flow through open cut Mining Leases (MLs) and contain diversion reaches. Boomerang Creek and Hughes Creek converge approximately 1 km downstream (east) of the Project Site. Plumtree Creek has no catchment upstream of the Project as the headwaters have previously been developed by the existing Saraji mine, and was not assessed further.

The watercourses within the Project Site are ephemeral in nature and provide seasonal habitat for aquatic fauna and flora. The aquatic ecosystems are moderately disturbed from current mining and grazing activities and are classified accordingly in the EPP (Water) and mapped by the Queensland Government (2022). Stream substrates are dominated by coarse sand in all creeks across the site (Gauge Industrial and Environmental, 2014).

Surface water values

Within the broader Fitzroy Basin (basin 130), fresh surface water and groundwater draining the Isaac River Sub-basin are described by the DEHP 2011 document entitled ‘Environmental Protection (Water) Policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)’. Environmental values identified for the Isaac River western upland tributaries (including Phillips, Boomerang, Hughes creeks) include:

- aquatic ecosystems
- stock watering (high) (e.g. cattle)
- human consumer (e.g. of wild or stocked fish)
- primary recreation (e.g. swimming)
- secondary recreation (e.g. sailing, fishing)
- visual appreciation (e.g. picnic, bushwalking)
- drinking water (e.g. raw water supplies taken from river)
- cultural and spiritual values (e.g. traditional customs).



LEGEND

- Locality
- Watercourse
- Isaac River Catchment
- Tenement
- Fitzroy River Basin
- Drainage Basin

N

Figure 21-28
Fitzroy River Basin

Environmental Impact Statement
Saraji East Mining Lease Project

0 25 50 100
Kilometres

Scale: 1:3,000,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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Surface water quality

As monitoring data showed a high variability of physico-chemical water quality parameters within and between the watercourses traversing the Project Site, and deviations from the guideline values outlined in EPP 2019 (Water Isaac River 1301) and ANZG (2018), site specific, or sub-regional WQOs were developed for the Hughes/Boomerang Creek sub-catchment, being the catchment with potential to be impacted by mining.

Site specific sub-regional WQOs were developed in accordance with the QWQG 2009 & 2022 and ANZG 2018 due to high variability of water quality parameters and deviations from the water quality guideline values outlined in EPP 2019 (Water Isaac River 1301) and ANZG (2018). Sub-regional WQOs are a conservative measure used to set targets for long-term water quality improvement across the catchment – refer to Section 21.7.2.6.

Sub-regional WQOs were derived from sampling data collected between July 2012 to March 2021 from monitoring locations within the upper reaches of Boomerang Creek, Hughes Creek, One Mile Creek and Spring Creek (Upstream sites, Figure 21-29) based on contribution to Boomerang/Hughes Creek sub-catchment.

Environmental background values for comparison of water quality before the Project commences were derived from downstream sampling data collected between July 2012 to July 2021 from sites unlikely to be impacted by proposed mining at Phillips Creek, Isaac River and Spring Creek (Environmental Background sites, Figure 21-29).

Plumtree Creek was not assessed as this stream has no catchment upstream of the Project, the headwaters having been developed by the existing Saraji mine, and no water quality data was available.

A comparison of site specific sub-regional WQOs for the Boomerang/Hughes Creek sub-catchment and guideline values are provided in Table 21-32.

Table 21-32 Developed sub-regional WQOs for the Boomerang-Hughes Creek catchment

Parameter	Unit	Developed WQO	Existing Guideline Value (GLV)	Guideline Source
Water quality objectives to protect aquatic ecosystem environmental values				
Total suspended solids	mg/L	Existing GLV retained	55	EPP (Water) (2019)
Turbidity	NTU	Existing GLV retained	50	EPP (Water) (2019)
Electrical conductivity	µS/cm	Existing GLV retained	720	EPP (Water) (2019)
Sulfate	mg/L	Existing GLV retained	25	EPP (Water) (2019)
pH	-	6.5-8.0	6.5-8.5	EPP (Water) (2019)
Ammonia	µg/L	40	20	EPP (Water) 2019
Nitrate	µg/L	288 (High flow)	60 (low flow)	EPP (Water) (2019)
Kjeldahl nitrogen	µg/L	916 (Low flow) 1440 (High flow)	420	EPP (Water) (2019)
Total nitrogen	µg/L	1174 (Low flow) 2420 (High flow)	420	EPP (Water) (2019)
Filterable reactive phosphorus	µg/L	Existing GLV retained	20	EPP (Water) (2019)
Total phosphorus	µg/L	Existing GLV retained	50	EPP (Water) (2019)
Dissolved oxygen	%	37-86	85-110	Developed Objective EPP (Water) (2019)
Metals (Dissolved)				
Aluminium	µg/L	NA	5,000	EPP Water (2011) Stock watering**

Parameter	Unit	Developed WQO	Existing Guideline Value (GLV)	Guideline Source
Water quality objectives to protect aquatic ecosystem environmental values				
	µg/L	Existing GLV retained	55	ANZG (2018)*
Arsenic	µg/L	NA	500	EPP Water (2011) Stock watering**
		Existing GLV retained	13	ANZG (2018)*
Chromium	µg/L	NA	1,000	EPP Water (2011) Stock watering**
	µg/L	Existing GLV retained	1	ANZG (2018)*
Copper	µg/L	NA	400	EPP Water (2011) Stock watering**
	µg/L	1	1.4	(ANZG 2018)*
Iron	µg/L	214	Not provided	
Molybdenum	µg/L	NA	150	EPP (Water) (2011) Stock watering**
	µg/L	Existing GLV retained	34	ANZG (2018)*
Nickel	µg/L	NA	1,000	EPP (Water) (2011) Stock watering**
	µg/L	1.2	11	Developed Objective (ANZG 2018)
Selenium	µg/L	NA	20	EPP (Water) (2019) Stock watering
	µg/L	Existing GLV retained	5	ANZG (2018)*
Uranium	µg/L	NA	200	EPP (Water) (2019) Stock watering
	µg/L	Existing GLV retained	0.5	ANZG (2018)*
Zinc	µg/L	NA	20,000	EPP (Water) (2019) Stock watering
	µg/L	Existing GLV retained	8	ANZG (2018)*

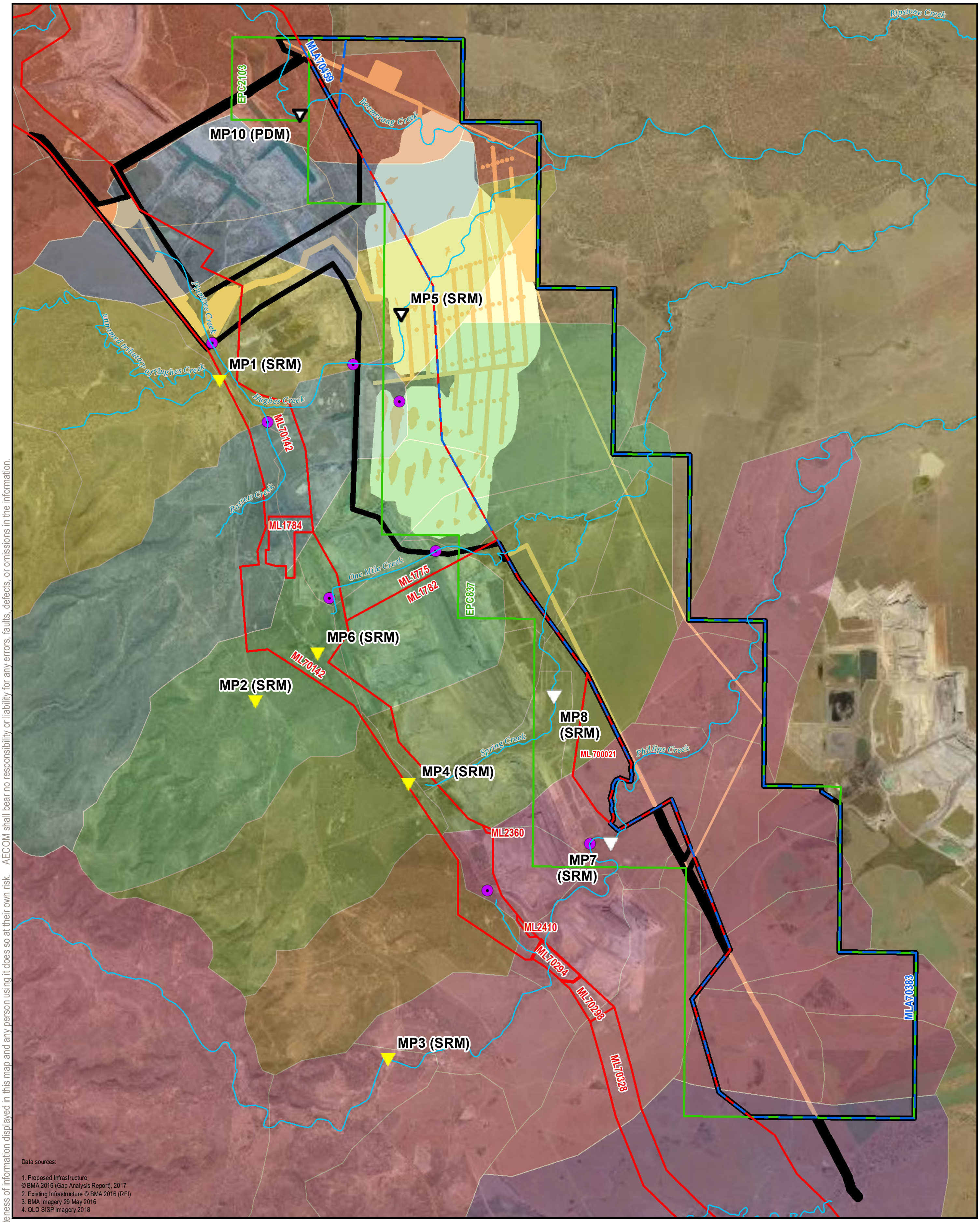
*ANZG trigger values for toxicants applied to slightly-moderately disturbed systems

**ANZECC guideline still applicable as ANZG has not been updated for stock watering.

Comparison between developed sub-regional WQOs and Environmental Background values from unimpacted sites surrounding the proposed Project is presented in Table 21-33; red shading indicates exceedance of developed sub-regional adopted WQOs. Most of the median values of recorded parameters at the environmental background sites were within or below the developed sub-regional WQOs. However, median values for Turbidity, TSS, Sulfur, Ammonia, Copper and Nickel exceeded the developed sub-regional WQOs (Table 21-32). This could be due to the different geology, lithology and soil characteristics of Isaac River and Phillips creek compared to the rest of the streams. Other possible factors could be varying discharge rates and dissimilar land use upstream. Statistical analysis reinforces this difference as there was a statistically significant difference for these parameters between upstream and background sites (Table 21-33). Fewer exceedances of WQOs were present for sites within the actual mining extent (Turbidity, Sulfur, and Nickel, Table 21-33). This possibly represents more accurately the conditions in the Boomerang Hughes Creek sub-catchment. Deviations from site specific WQOs could be due to the availability of only one stream (Hughes Creek) compared to the combined data of four water courses within the sub-regional catchment utilised for WQO development.

Table 21-33 Comparison between developed sub-regional WQOs and Environmental Background values

Analyte	Developed Sub-Regional WQO	Environment Background	WQ within footprint of the extent of underground mining	Guideline adopted for Sub-Regional WQOs
pH	6.5-8.0	7.8	7.6	Developed (Sub-Catchment Specific)
EC (µS/cm)	720	490	686	EPP (Water) (2019)
Turbidity (NTU)	50	319	183	EPP (Water) (2019)
DO%	37-86	77.7	27	Developed (Sub-Catchment Specific)
TSS (mg/L)	55	271	41	EPP (Water) (2019)
SO_4 (mg/L)	25	42	84	EPP (Water) (2019)
Ammonia (µg/L)	40	50	10	Developed (Sub-Catchment Specific)
Nitrate (µg/L)	60 low flow 288 high flow	170	132	Developed (Sub-Catchment Specific)
Total Organic (Kjeldahl) Nitrogen as N (µg/L)	916 low flow 1440 high flow	600	800	Developed (Sub-Catchment Specific)
Total Nitrogen as N (µg/L)	1174 low flow 2420 high flow	1,350	1,300	Developed (Sub-Catchment Specific)
Total Phosphorus as P (µg/L)	50	50	45	EPP (Water) (2019)
Reactive Phosphorus as P (µg/L)	20	ND	ND	EPP (Water) (2019)
Al (µg/L)	55	35	16	ANZG (2018)
As (µg/L)	13	ND	ND	ANZG (2018)
Cr (µg/L)	1	ND	ND	ANZG (2018)
Cu (µg/L)	1	2	1	Developed (Sub-Catchment Specific)
Fe (µg/L)	214	80	60	Developed (Sub-Catchment Specific)
Mo (µg/L)	34	1	1	ANZG (2018)
Ni (µg/L)	1.2	2	2	Developed (Sub-Catchment Specific)
Se (µg/L)	5	ND	ND	ANZG (2018)
U (µg/L)	0.5	ND	ND	ANZG (2018)
Zn (µg/L)	8	ND	ND	ANZG (2018)



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Watercourse
- Data for WQO
- Proposed monitoring location
- Background water quality location
- Existing mine water release point

Catchments

- Barretts Creek Catchment
- Boomerang Creek Catchment
- Downs Creek Catchment
- Hughes Creek Catchment
- One Mile Creek Catchment
- Phillips Creek Catchment
- Plumtree Creek Catchment
- South Creek Catchment
- Spring Creek Catchment
- Unnamed Creek Catchment

N

Figure 21-29
Catchment Delineation with release and monitoring locations

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Existing water users

The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River. They have 28,621 mega litres (ML) and 62,335 ML of allocated water, respectively. The total catchment area of these tributaries upstream and within the Project Site is about 590 km^2, this equates to less than 0.4 per cent of the total catchment area for these water supply schemes (142,665 km^2).

The ROP explanatory notes state the western tributaries of the Isaac River are significantly drier than those to the north, with annual rainfall less than 600 millimetres (mm) in the west and less than 1,600 mm in the north. This suggests creeks in the vicinity of the mine (Boomerang, Hughes, One Mile and Phillips Creek) provide a relatively small contribution to water allocations in the Fitzroy River Basin.

The dominant land use upstream of the proposed mine site is beef cattle grazing and native bushland. Tree clearing has occurred over time to improve pastures. There is also mining activity upstream of the Project Site and the Isaac River has been dammed upstream through the construction of Burton Gorge Dam. As a result, the catchments are not in pristine condition and are susceptible to the impacts of existing land use activities. Existing land uses downstream of the Project Site include mining, grazing (modified pastures) and dryland cropping (Alluvium, 2023).

Land use within a range of 100 km downstream of the Isaac River-Boomerang Creek confluence mainly consists of grazing and cropping with minor areas being utilised for irrigated perennial horticulture. Department of Natural Resources, Mines and Energy (DNRME) database records of surface water extraction licences downstream of the Project Site (prior to the confluence with the Isaac River) consist of two licences for stock watering purposes, with three licences held by BMA to divert a watercourse and site water management at the existing SRM.

Also prior to the confluence with the Isaac River (9 km south of the Project), Lake Vermont Meadowbrook Project owned by Bowen Basin Coal Pty Ltd (BBC) on ML 70331, ML 70477 and ML 70528 is seeking to extend the mining activity authorised under the approval of the EA Permit No. EPML00659513; the EIS is currently under assessment. Terms of Reference for this Project submitted to DNRME in April 2020 outline the need for identification of any approval or allocation for water that would be needed under the Water Act 2000, hence any likely water extraction permits from the site cannot be confirmed at the time of this EIS.

Three unnamed gullies traverse Lake Vermont mine site and generally drain in a north-easterly direction to the floodplain of the Isaac River. The northern section of Lake Vermont Mine drains north to Phillips Creek, which in turn drains east to Isaac River. The Lake Vermont REMP Report (BBC, 2020) outlines the environmental values for watercourses such as rivers and creeks on and in the surrounds. For the waterways of relevance for the Lake Vermont site, environmental values included: crop irrigation; aquaculture (Isaac western upland tributaries only); drinking water supplies; primary and secondary contact recreation; visual recreation; human consumers of wild, stocked fish, shellfish, crustaceans; protection of cultural and spiritual values; industrial use; stock watering; and farm supply use.

Existing BMA water supply network

The Project will have minor water demand to be met through BMA’s existing surface water allocations and licences. Water supply for the Project will be provided via the existing water network allocations supplying BMA operations. BMA holds allocations of water from the Fitzroy and Burdekin water catchments and numerous licences to take water across BMA’s mine sites. BMA operates a water pipeline network in Central Queensland, servicing its mines, landholders and towns; BMA’s current allocations are sufficient to meet the needs of the Project.

For the Project, water will be managed through a series of diversion drains and dams designed to contemporary standards to comply with regulatory requirements. Runoff from undisturbed areas will be segregated from disturbed areas to convey clean water downstream.

Raw water will be used to supply a small proportion of water demands of the Project, including potable uses (drinking, washrooms) and a minor component (typically 3 per cent) for the CHPP. Raw water from existing BMA surface water allocations will be piped to the Project Site to a raw water dam to supply clean water.

Under normal operating conditions, most Project water supply will be mine affected water (MAW) and the Project mine water system will operate independently of the existing SRM water system. Should sufficient Project MAW not be available for CHPP process and dust suppression, MAW or raw water may be imported from the existing SRM water system, following water quality testing to confirm that water is of an appropriate quality, for the intended use. Similarly, where additional water demands at the existing SRM need to be met, water that satisfies water quality testing may be exported from the Project to SRM.

According to Appendix E-2 Mine Water Balance (Table 32), the initial water demand increase on the existing BMA water supply network associated with the Project is in the order of 2.39 mega litres per day (ML/d) for the first year of the Project with a daily water demand of 6.29 ML required for Year 2 to 20 of the Project (AECOM 2023).

BMA holds allocations of water from the Fitzroy and Burdekin water catchments and numerous licences to take water across BMA's mine sites.

Proposed water management system

The Project water management system (WMS) has been designed to operate self-sufficiently with the benefits of being connected to the broader BMA network to allow water sharing where beneficial.

The Project WMS has been designed with adequate capacity to avoid releases. However, BMA is seeking authority and licence conditions to conduct the controlled release of MAW from the PWD to allow responsible flexibility and contingency management of MAW inventories. In the rare event the site experiences extreme rainfall conditions exceeding the containment volume developed for each storage, BMA will be able to release as a water management strategy in preference to allowing spills from MAW dam emergency spillway structures. Spillway release from the process water dam proposed to be directed to Boomerang Creek has potential to impact on water quality and dependent ecosystems in the receiving environment.

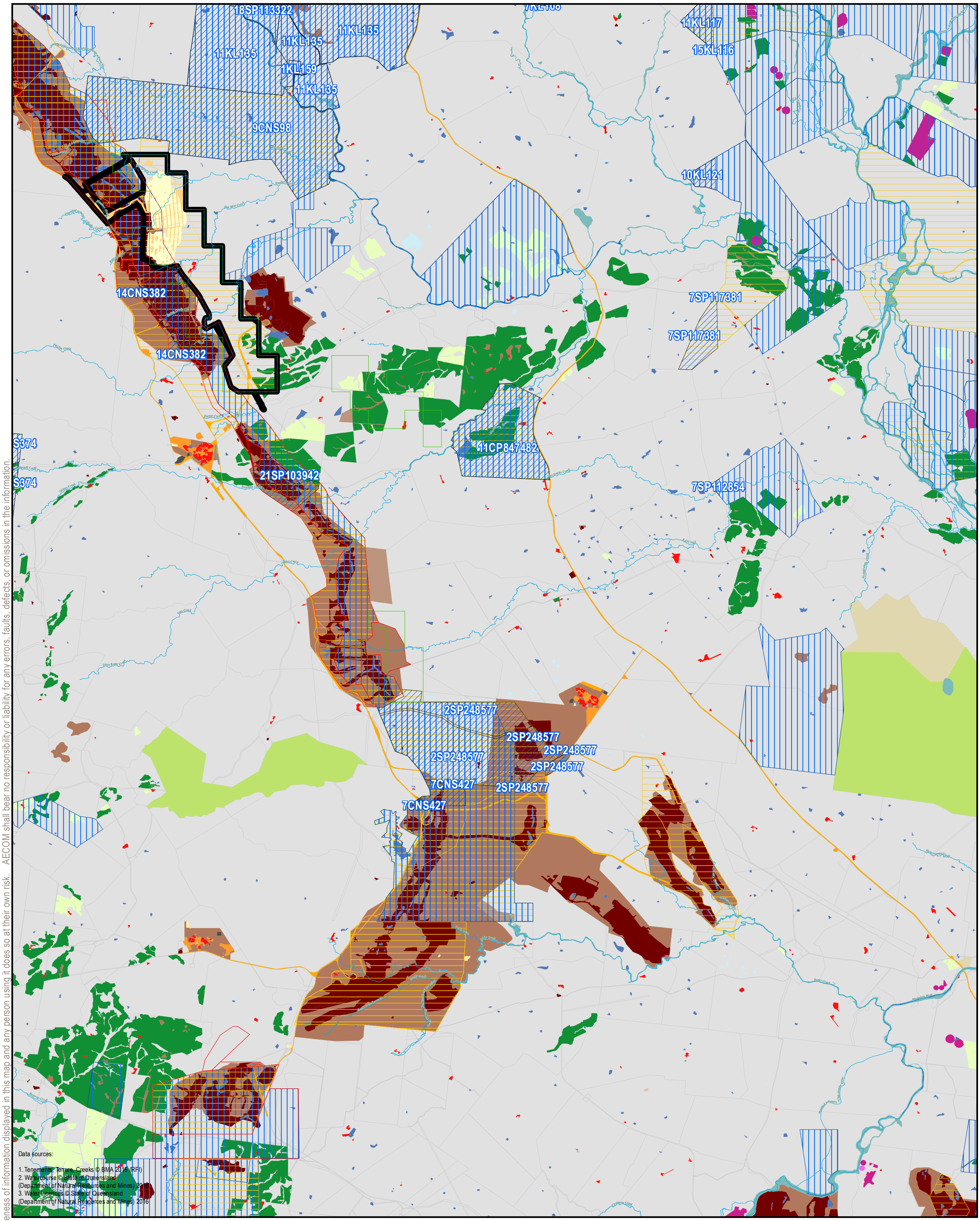
For the Project, water will be managed through a series of existing diversion drains and dams designed to contemporary standards to comply with regulatory requirements. Runoff from undisturbed areas will be segregated from disturbed areas to convey clean water downstream.

The water from the raw water dam will be used to supply a proportion of water demands of the Project, including dust suppression and a proportion of demand from the CHPP. Raw water from existing BMA surface water allocations will be piped to the Project Site in a raw water dam to supply clean water, including the water requirements of the CHPP and longwall mining equipment as well as to supplement site water demands as required.

This raw water demand forms a very small portion of the overall site water use for potable uses (drinking, washrooms).. While most of the water demand for the CHPP is met through recycled MAW, a minor component (typically 3 per cent) of the CHPP water use requires raw water.

In accordance with the BMA Mine Water Management Standard, BMA will prepare, update and maintain a Water Management Plan assuring a prioritisation of MAW over raw water supply. The Plan will recognise raw water to be used for Project operations will be sourced via an off-take from the existing water pipelines developed to support BMA's current and future mining operations, along with various other purposes. Further, this Plan will recognise that water will be sourced from the Eungella Dam and/or the Burdekin Pipeline. The Project will have an internal BMA allocation to draw water from as part of the BMA-related water allocations.

These allocations are held by BMA directly or indirectly via contractual arrangements with SunWater in accordance with the Burdekin Water Resource Plan and the Water Act.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Watercourse
- Cadastre
- Existing Water User

Water Licence Authorisation Type

- Licence to Take Water
- Licence to Interfere

Land Use

- Nature conservation
- Managed resource protection
- Other minimal use
- Production native forests
- Grazing modified pastures
- Cropping
- Grazing irrigated modified pastures
- Irrigated cropping
- Intensive animal production
- Manufacturing and industrial
- Residential and farm infrastructure
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake
- Reservoir/dam
- River
- Marsh/wetland

N

Figure 21-30 Surface Water Extraction Licences

Environmental Impact Statement
Saraji East Mining Lease Project

0 3.5 7 14
Kilometres

Scale: 1:500,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.4.5.2 Groundwater

Groundwater monitoring network

Groundwater values relevant to the Project can be described using the existing SRM groundwater bore network comprising:

- Two landholder bores
- Ten single pipe monitoring bores
- Seven monitoring locations comprising three nested groundwater piezometers (i.e. 21 monitoring points in total)
- Eight vibrating wire piezometers (VWPs) located within three holes.

These bores described in Table 21-34 provide detailed groundwater resource data for the Project. Except for landholder monitoring bores (MB31 and MB32), all monitoring locations were drilled and constructed between 2011 and 2019.

The two landholder monitoring bores (MB31 and MB32) and single (stand) pipe monitoring bores (MB33, MB34, MB35, MB36 and MB37) are required to be monitored as part of the SRM EA conditions. Groundwater levels and water quality have been measured on a quarterly basis within all seven of these EA bores since July 2011. It is noted that MB31 and MB32 also contain additional monitoring data from 2008.

The monitoring records for the nested (individual standpipe bores constructed adjacent to one another, screened in different hydrostratigraphic units) groundwater monitoring bores and VWPs are variable and can be summarised as follows:

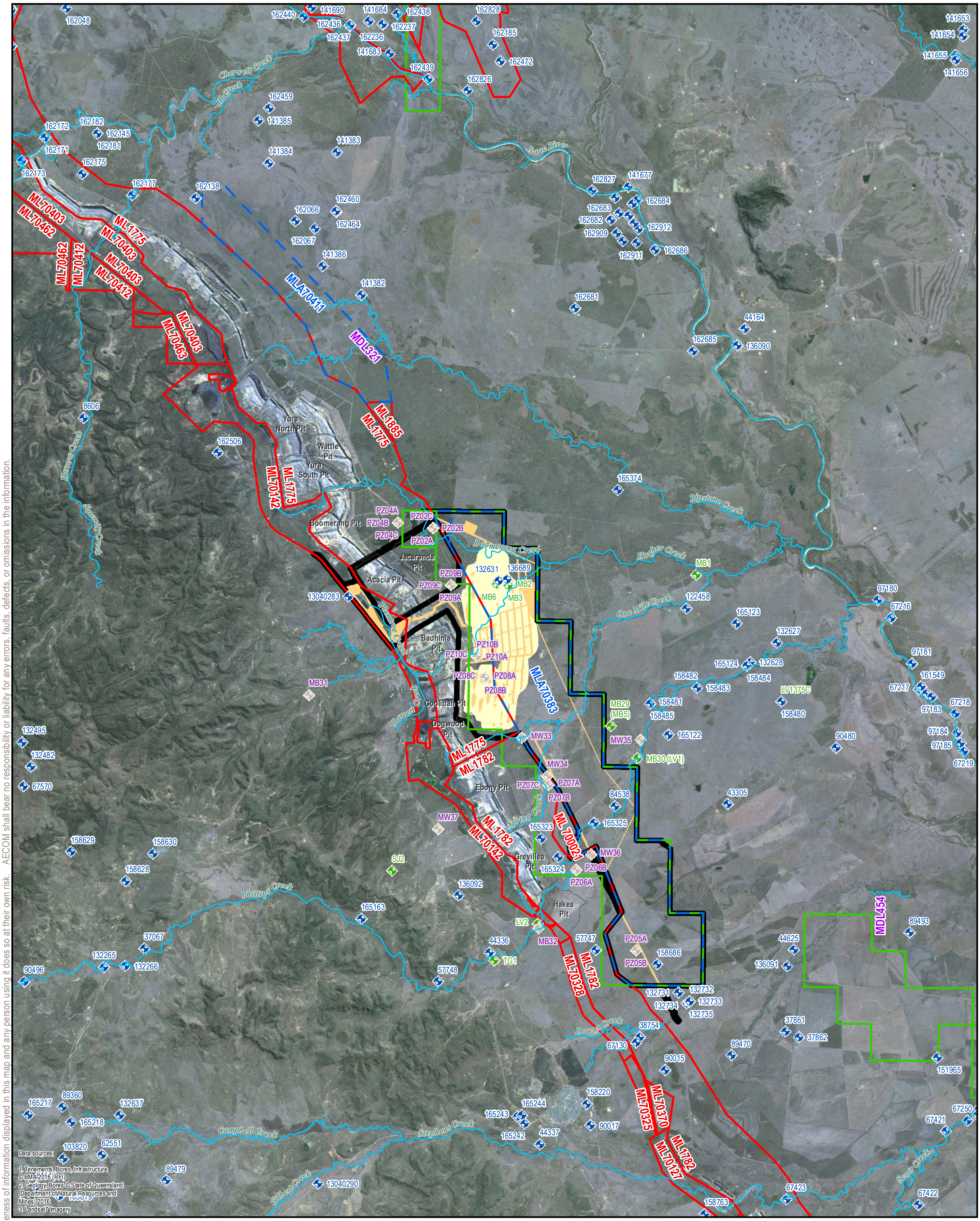
- Nested groundwater monitoring bores PZ09A and PZ10A were drilled ‘dry’ into Tertiary sediments and have not been monitored since 2012.
- All other nested groundwater monitoring bores contain sporadic monitoring data (water levels and quality) measured between November 2011 and March 2012.
- Records of VWP are available for the period June 2011 to December 2011.

Table 21-34 Groundwater monitoring bores

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
Single Pipe Groundwater Monitoring Bores							
MB35 (RN158010)	642646	7520110	34.5	Fair Hill Formation	18.41 (166.87 mAHD)	-	Compliance
MB36 (RN158011)	640150	7514283	32.0	Fair Hill Formation	17.96 (178.97 mAHD)	0.09	Compliance
MB37 (RN158012)	632389	7515571	42.5	Back Creek Group	12.80 (221.86 mAHD)	0.02	Reference / background
MB34 (RN158013)	637926	7518269	107.0	Moranbah Coal Measures	23.10 (172.51 mAHD)	0.05	Compliance
MB33 (RN158014)	636640	7520199	37.5	Moranbah Coal Measures	21.28 (172.83 mAHD)	0.08	Compliance
MB38 / MB19SRM01A (RN165894)	639919	7515681	8.5	Alluvium	Dry	-	Compliance

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
MB39 / MB19SRM03P (RN169278)	639904	7515697	91.5	Permian	18.09	0.009 – 0.2	Compliance
MB40 / MB19SRM02T (RN 169277)	639913	7515688	27.0	Tertiary	18.0	0.001 – 0.016	Compliance
MB19SRM04P / MB19SRM04P_HY	637059.895	7511041.104	208.74	Permian	20	0.011 – 0.7	Catchment scale Monitoring / Management
MB20SRM01A / MB20SRM01_PZ	635922	7527665	10.5	Alluvium	Dry	-	
MB20SRM02T	635914	7527670	36.5	Tertiary	23.5	0.05 – 0.075	
MB20SRM03P	635907	7527677	242.7	Permian	50.5	0.005 – 0.015	
MB20SRM04A	631397	7530470	12.0	Alluvium	9	0.05 – 0.1	
MB20SRM05A / MB20SRM05A_PZ	634476	7525798	24.0	Alluvium	Dry	-	
MB20SRM06A / MB20SRM06A_PZ	636482	7520008	9.75	Alluvium	6.10	?	
MB20SRM07P	641362	7507960	177.0	Permian	38	0.05 – 0.1	
Landholder Monitoring Bores							
MB31	625942	7522560	44.23	Coal	7 – 22 (variable due to use)	-	Reference / background
MB32	637595	7510716	19.52	Alluvium	11 - 14	-	Reference / background
Nested Groundwater Bores							
PZ02A	632013.15	7530682.68	26	Tertiary - Regolith	-	-	Historic monitoring bore - nest
PZ02B	631930.75	7530683.38	170	Sandstone	-	-	
PZ02C	632013.15	7530682.68	278	Dysart D24	-	-	
PZ04A	630233.34	7530952.35	30	Tertiary - Regolith	-	-	Historic monitoring bore - nest
PZ04B	630233.34	7530952.35	66	Harrow Creek H16	-	-	
PZ04C	630233.34	7530952.35	180	Coal D47	-	-	
PZ07A	637881.99	7517644.04	14	Tertiary - Claystone	-	-	Historic monitoring bore - nest
PZ07B	637881.99	7517644.04	198	Sandstone	-	-	
PZ07C	637881.99	7517644.04	303	Harrow Creek H16	-	-	
PZ09A	632905.13	7527785.31	-	Tertiary - Clay	Dry	-	

Bore ID	Easting (GDA94)	Northing (GDA94)	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Purpose
PZ09B	632905.13	7527785.31	75	Harrow Creek H16	-	-	Historic monitoring bore - nest
PZ09C	632905.13	7527785.31	195	Dysart D24	-	-	
PZ10A	634233.26	7524164.41	-	Tertiary - Regolith	Dry	-	Historic monitoring bore - nest
PZ10B	634233.26	7524164.41	70	Harrow Creek H16	-	-	
PZ10C	634233.26	7524164.41	184	Dysart D24	-	-	
Vibrating Wire Piezometers							
PZ05A	642219.84	7509222.83	203	Harrow Creek H16	168.8 mAHD	-	2 VWPs in one borehole
PZ05B	642219.84	7509222.83	239	Coal D52	166.3 mAHD	-	
PZ06A	639263.48	7513335.58	40.5	Sandstone	185.9 mAHD	-	3 VWPs in one borehole
PZ06B	639263.48	7513335.58	78.5	Harrow Creek H16	179.6 mAHD	-	
PZ06C	639263.48	7513335.58	167	Coal D142	183.4 mAHD	-	
PZ08A	634645.96	7523075.77	38.5	Coal P07	177.6 mAHD	-	3 VWPs in one borehole
PZ08B	634645.96	7523075.77	65	Harrow Creek H16	173.6 mAHD	-	
PZ08C	634645.96	7523075.77	180	Dysart D24	-	-	



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Existing Open-Cut Extent
- Watercourse
- Registered Bore
- Saraji Monitoring Bores
- Census Bore

N

Figure 21-31
Groundwater Bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 2 4 8
Kilometres

Scale: 1:250,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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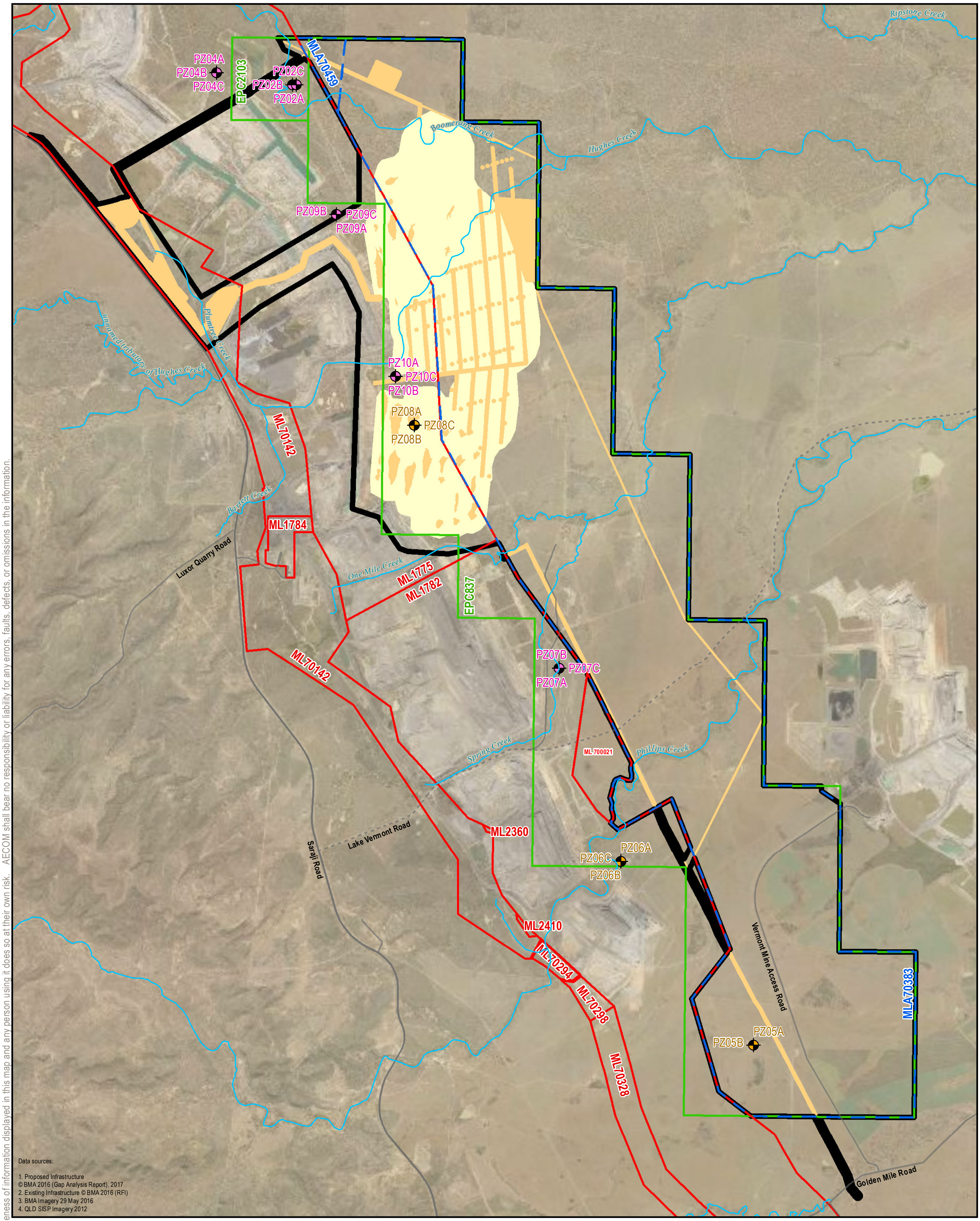

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LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Private Access Road
- Public Road
- Vibrating Wire Piezometers
- Nested Groundwater Bores

N

Figure 21-32
Historic nested piezometers and VWPs

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
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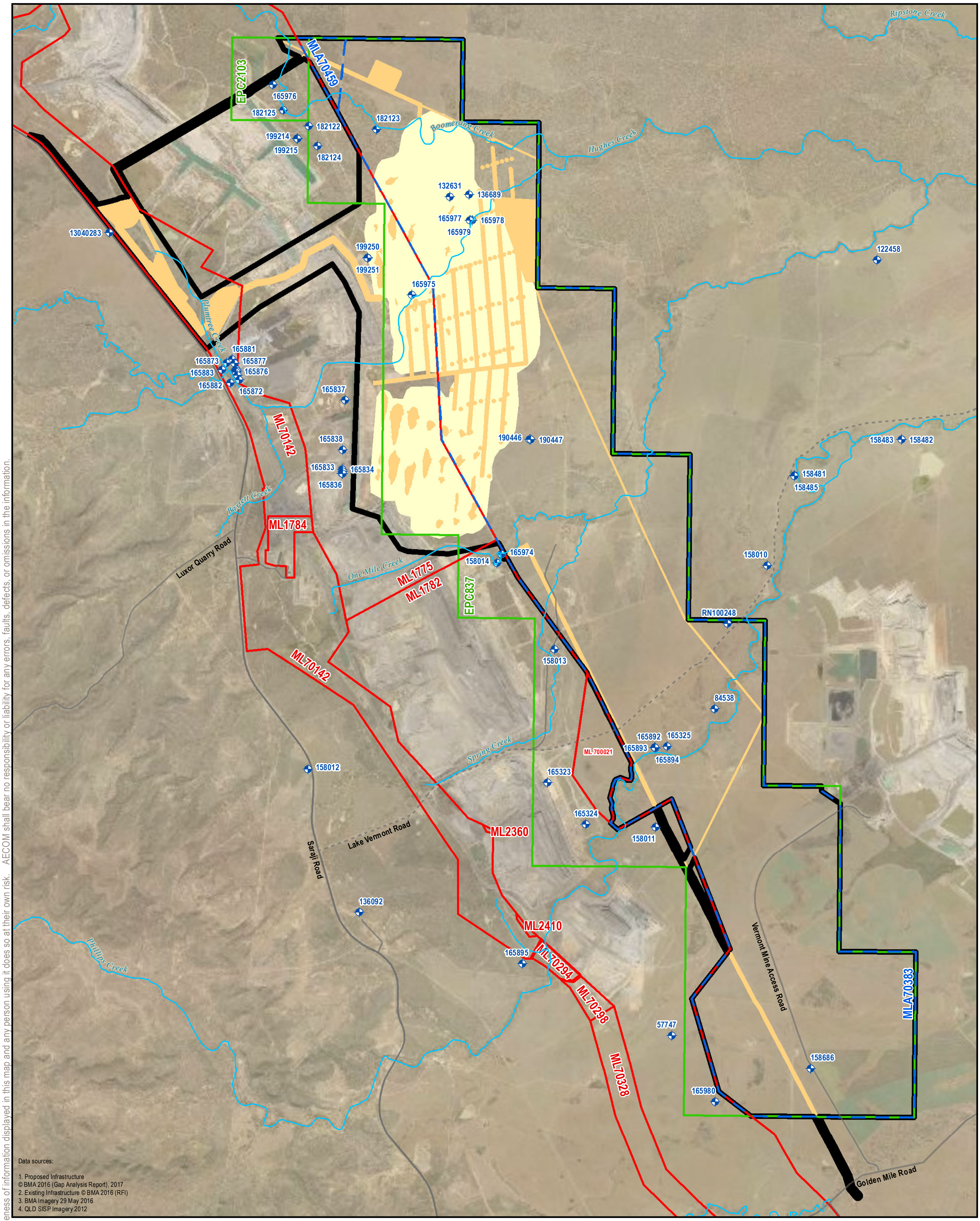
Registered groundwater bores

A search of the Department of Regional Development, Manufacturing and Water (DRDMW) Groundwater Database (GWDB) was undertaken during January 2023 (updated May 2023) to identify registered groundwater bores within and adjacent to the underground mining footprint. The search identified 90 registered groundwater bores within and adjacent to the existing SRM (Figure 21-33). Of the 90 registered bores identified along strike and down dip of the underground mine footprint:

- Seven are described as being abandoned or destroyed (not considered potential usable/impacted bores)
- Eleven were drilled dry (in *italics* in Table 21-35)
- Six water supply bores (in **bold** in Table 21-35)
- One petroleum and gas well
- Six are VWPs.

The remaining 59 bores are mine monitoring bores. Registered bore details as recorded in the GWDB are summarised in Table 21-35.

Several large yielding water supply bores, constructed within the Back Creek Group (RN136092, RN57747, RN132631, RN122458) have been identified using the data included on the GWDB bore cards. Groundwater yields attributed to the Back Creek Group in the bore cards are considered to be inaccurate and that the Back Creek Group sediments have limited groundwater potential, as included in the model (basement aquitard). None of these Back Creek Group water supply bores are predicted to be impacted by the Project.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Registered Bore

N

Figure 21-33
Registered Bores Along Strike and Down Dip of Saraji Mine

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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Table 21-35 Registered groundwater bores

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
Registered Groundwater Bores							
158014	636496	7519991	37.5	MCM	21.3	0.08	MB33 / Saraji Mine
158013	637781	7518065	107.0	MCM	23.1	0.05	MB34 / Saraji Mine
158012	632271	7515395	41.4	Back Creek Group	12.8	0.02	MB37 / Saraji Mine
158011	640035	7514095	32.0	Fair Hill Formation	17.96	0.09	MB36 / Saraji Mine
158010	642528	7519939	34.5	Fair Hill Formation	18.41	0.09	MB35 / Saraji Mine
165978	*635945*	*7527652*	*10.5*	*Quaternary*	*Dry*		*MB20SRM01A(MB20SRM01_PZ)*
165979	635904	7527647	36.5	Tertiary	23.5	0.05 – 0.075	MB20SRM02T
165977	635885	7527652	242.0	Back Creek Group	50.5	0.005 – 0.015	MB20SRM03P
165976	631494	7530679	12.5	Quaternary	9	0.05 – 0.1	MB20SRM04A
165975	*634596*	*7525982*	*24.0*	*Quaternary*	*Dry*		*MB20SRM05A/ MB20SRM05A_PZ*
165974	636599	7520190	9.75	Quaternary	6.10		MB20SRM06A / MB20SRM06A_PZ
165894	640032	7515860	8.5	Quaternary	8.1		Saraji Mine monitoring
165892	640018	7515876	91.5	MCM	12.2	0.3	Saraji Mine monitoring
165893	640026	7515867	27	Tertiary	19		Saraji Mine monitoring
165325	*640296*	*7515897*	*18.5*	*Quaternary*	*Dry*		*Piezo 3*
84538	641354	7516737	109.7	Open hole 27.4 to 109.7 mbGL	18.3	0.67	
165323	*637620*	*7515091*	*15*	*Quaternary*	*Dry*		*Piezo 1*
165324	*638481*	*7514161*	*15*	*Quaternary*	*Dry*		*Piezo 2*
136092	**633416**	**7512196**	**22**	**Back Creek Group**	**12**	**1.10**	**Water supply**
165895	637063	7511046	42.5	Back Creek Group	12.7	0.2	Mine monitoring

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
190446	637223	7522750	33.8	FCCM	25.7	0.04	SRMMB12 _01 / Mine monitoring
190447	637251	7522750	232.8	MCM		0.5	SRMMB12 _03 / Mine monitoring
57747	**640392**	**7509441**	**126.5**	**Back Creek Group**		**4.42**	**Squirrel Bore / Water supply**
165980	641365	7507960	177.0	Back Creek Group	38	0.2	MB20SRM 07P
182125	631724	7530111	28.5	Tertiary	11.2	0.01	BH01
182122	632287	7529754	32	Tertiary	10.5	0.01	BH03
182124	632484	7529311	38.0	Tertiary	11.5	0.01	BH02
182123	633800	7529686	34.0	Tertiary	10.1	0.01	BH04
132631	**635440**	**7528179**	**328.0**	**Back Creek Group**	**31**	**15**	**Water supply**
136689	635868	7528234	328.0	Duaringa Formation	31	15	Duplicate of RN132631
13040283	627834	7527375	68.5	Back Creek Group	38.14		NAP Isaac River Site 12 / DRDMW monitoring
165837	633101	7523636	42	Spoil	23.8	1	BH05
165838	633043	7522522	77.0	Spoil, bedrock at 66 mbGL	49	0.33	BH06
165833	633038	7522086	54.0	Clay, gravel	39.8	0.02	BH01
165834	633043	7522043	60.0	Clay, sand, gravel		0.13	BH02
165836	633024	7521999	54.0	Spoil, bedrock at 45.5 mbGL	36.5	0.01	BH04A
165835	633045	7521986	54.0	Spoil, bedrock at 53.5 mbGL	38.3	0.2	BH03
165881	*630581*	*7524539*	*17.0*	*Quaternary*	*Dry*		*MP07D*
165873	630457	7524462	10.0	Quaternary	4.5	0.23	MP10
165877	630632	7524461	15.0	Quaternary	9.5	0.14	MP06
165883	630353	7524308	7.0	Quaternary	2.6		MP09
165876	630672	7524328	18.0	Quaternary	10.2		MP01D
165850	630648	7524297	23.0	Quaternary	10.5		MP05D

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
165875	630692	7524283	18.0	Quaternary	10.5	0.01	MP02D
165874	630671	7524261	14.0	Quaternary	10.1		MP03D
165851	630698	7524184	18.0	Quaternary	9.8		MP04D
165872	630732	7524084	14.5	Quaternary	7.7		MP07
165882	630536	7524019	12.0	Sandstone	5		MP08
158686	643499	7508708	210.0	Coal	60	0.13	MW9P
122458	**644983**	**7526770**	**50.5**	**Back Creek Group**	**26**	**1.88**	**Water supply**
165123	647515	7526007	136.0	Rangal Coal Measures			LV2372R / VWP Mine monitoring
132627	**649564**	**7525028**	**70.0**	**Duaringa Formation**	**30**	**0.95**	**Water supply**
132628	**648220**	**7524052**	**120.0**	**Duaringa Formation**	**77**	**0.76**	**Water supply**
158484	648038	7523875	19.0	Quaternary			LV2370 / Mine monitoring
165124	648038	7523864	82.0	Rangal Coal Measures			LV2375W / VWP Mine monitoring
158482	645525	7522752	147.0	Rangal Coal Measures			LV2218 / VWP Mine monitoring
158483	*645525*	*7522751*	*20.0*	*Quaternary (clay)*	*Dry*		*LV2369 / Mine monitoring*
158481	643132	7521949	102.0	Rangal Coal Measures			LV2226 / VWP Mine monitoring
158485	*643132*	*7521943*	*22.0*	*Quaternary (clay)*	*Dry*		*LV2371 / Mine monitoring*
199088	626405	7541912	41.0	Permian siltstone	35	0.0	Mine monitoring
199089	626402	7541905	265.0	Permian coal		2.0	Mine monitoring
199090	626412	7541903	183.0	Permian coal		1.1	Mine monitoring
100291	626431	7542882	524.1	German Creek Coal Measures	17.16		Petroleum or gas bore
141382	628490	7542693	52.0		18.36	0.02	MB5
182363	631318	7542814	83.0	Blackwater Group			Mine monitoring

Registered Number (RN)	Easting	Northing	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
182362	631743	7543062	65.0	Sandstone	30	0.17	Mine monitoring
182364	633262	7543161	56.0	Blackwater Group	38	0.08	Mine monitoring
182365	634668	7541867	60.0	Blackwater Group			Mine monitoring
162681	*639329*	*7542012*	*10.0*	*Isaac River Alluvium*	*Dry*		*IF3835P (GW06S)*
165640	639334	7542009	203.0	Fort Cooper Coal Measures			IF3836P (GW06D) / VWP Mine monitoring
182925	626827	7538493	42.0	Blackwater Group		0.20	PDNMB05_02 / Mine monitoring
182868	626828	7538498	81.0	Blackwater Group			PBMMB05-03 / Mine monitoring
182630	*629971*	*7539627*	*7.0*	*Quaternary*	*Dry*		*EDS_MB02 / Mine monitoring*
190144	*634716*	*7537427*	*10.0*	*Quaternary*	*Dry*		*EDS_MB01 / Mine monitoring*
182403	628880	7532630	30.5	Back Creek Group	11.5	0.20	Mine monitoring
182401	630100	7532833	167.0	Back Creek Group	14.6	0.20	Mine monitoring
182402	630114	7532835	10.0	Quaternary	6.5	0.1	Mine monitoring
165374	641498	7532790	42.5	Duaringa Formation	20	0.14	VE3831P (GW12S) / mine monitoring
165642	641492	7532790	520.0	Rangal Coal Measures			VE3832P (GW12D) / VWP mine monitoring
199214	632035	7529483	40	Tertiary	26.5	0.02	Mine monitoring
199215	632044	7529474	115	MCM	34	0.02	Mine monitoring
199250	633605	7526818	186	MCM	138	0.15	Mine monitoring
199251	633605	7526803	38	Tertiary	27.11	0.02	Mine monitoring

Blanks – no data; *Italics* represent dry bores; **Bold** represents water supply bores.
Abandoned and destroyed bores: RN100248, RN182406, RN182926, RN100252, RN13040179, RN13040178, RN13040177

Bore census

A bore census was undertaken in the Project Area in 2007, which identified 12 unregistered landholder bores which were not at that time listed on the GWDB. Two of the identified landholder bores (MB31 and MB32) were subsequently monitored as part of the SRM monitoring program.

A summary of available information for each of the bores identified during the bore census is presented in Table 21-36. The location of these bore census bores is included in Figure 21-34.

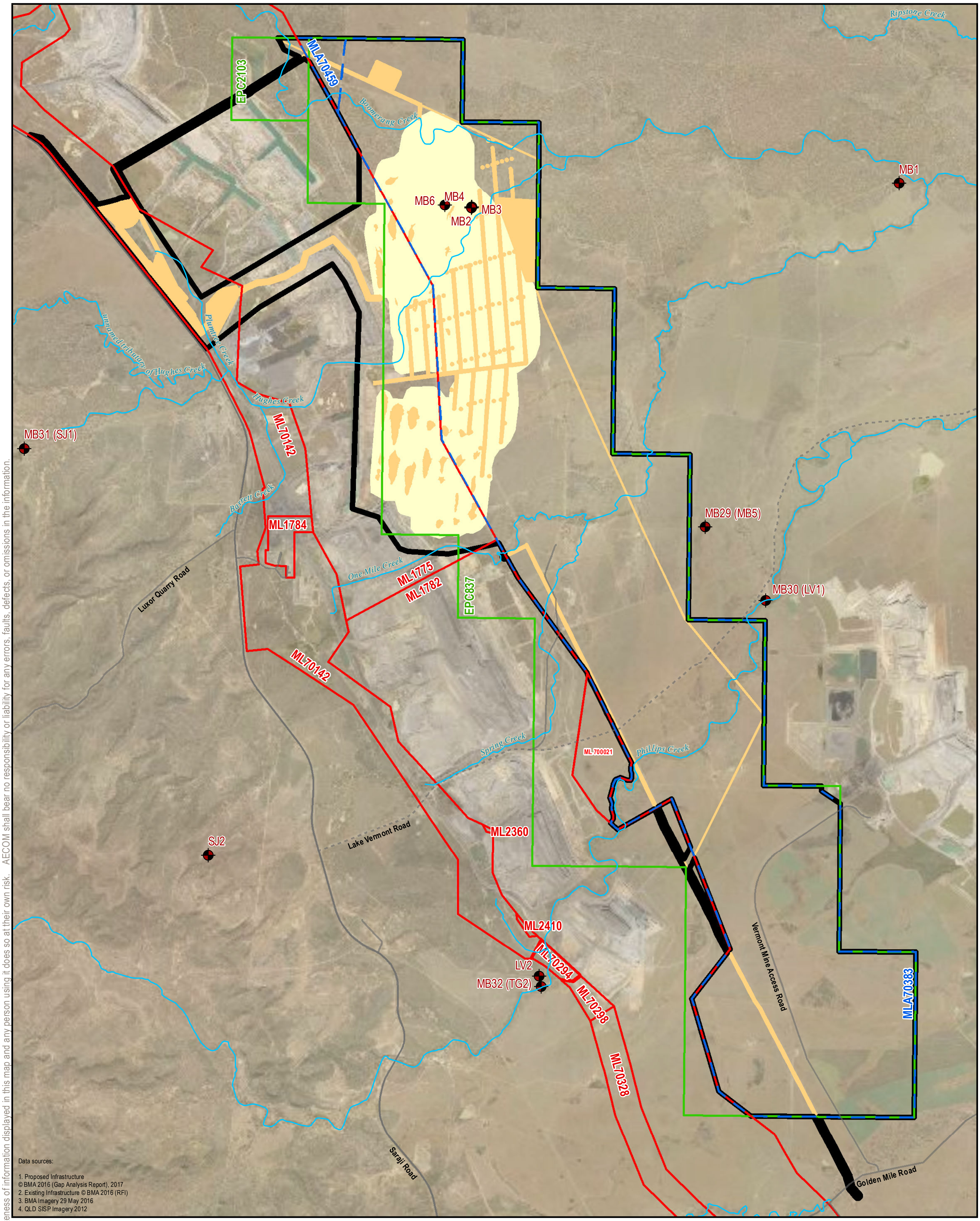
Table 21-36 Bore census bores

Registered Number	Latitude	Longitude	Depth (m)	Geology	Water Level (mbGL)	Yield (L/s)	Type / Name
Unregistered	625942	7522560	44.23	Back Creek Group	7.85 (217.19 mAHD)	-	MB31 (SJ1)
Unregistered	637479	7510539	19.52	Phillips Creek Alluvium	10.4 (197.73 mAHD)	-	MB32 (TG2)
Unregistered	641146	7520803	-	Unknown	-	-	MB29 (MB5)
Unregistered	642497	7519163	>100	Coal	23.77	-	MB30 (LV1)
Unregistered	645477	7528481	79.4	Unknown	20.63	-	MB1
Unregistered*	635924	7527947	60.94	Unknown	22.86	-	MB2
Unregistered*	635935	7527947	50	Unknown	23.82	-	MB3
Unregistered*	635924	7527936	27.1	Unknown	23.53	-	MB4
RN132631?	635327	7527997	-	Unknown	-	-	MB6
Unregistered	637429.6	7510772	-	Unknown	-	-	LV2
Unregistered	630045	7513471	-	Unknown	-	-	SJ2
Unregistered	656437	7508703	15.06	Unknown	9.42	-	TG1

*MB2, MB3, and MB4 identified during the bore census are in the vicinity of RN136689 and RN132631, which are considered the same bore based on the bore card details. MB2, MB3, and MB4 were all, however, measured to be markedly shallower than the two registered bore (total drill depth 328 m).

Based on drill dates and depths included in the bore cards for registered bores in proximity to the bore census bores, only MB6 may be an existing registered bore, RN132631.

Although these bores have not been registered or validated since the bore census, they have been included in the Project impact assessment.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Private Access Road
- Public Road
- Watercourse
- Unregistered Bores

N

Figure 21-34
Bore census bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 2

Hydrogeology

The hydrogeological understanding of the Project area was assessed based on a combination of previous groundwater investigations (Section 21.3.1.2.1), data from the existing SRM groundwater monitoring network (described in Section 21.4.5.2), BMA exploration drilling and State groundwater database and other information (described in Section 21.3.1.2.1).

An aquifer is defined as a groundwater bearing formation permeable to transmit and yield water in useable quantities. Three aquifer systems and one aquitard were identified within the Project area. These aquifers and aquitard are likely to be in hydraulic connection to the Project and are therefore sensitive to the Project's groundwater impacts. Three aquifers are associated with geological strata:

- quaternary alluvium
- tertiary sediments
- coal seams contained with the Permian Coal Measures.

The aquitard is formed by the Permian overburden and interburden (i.e. shale, mudstone, siltstone, and sandstone).

Quaternary alluvium

Quaternary aged sediments, comprising alluvium, is not mapped within the footprint of the proposed underground mine. Outside of the proposed underground mine but within the Project area alluvium is mapped associated with the Phillips Creek. The Phillips Creek alluvium is considered to have limited potential as a groundwater resource for the following reasons:

- a review of bores drilled near Phillips Creek indicated most of these bores did not intersect groundwater i.e. the drilling results indicate limited or no sustainable groundwater resources associated with the alluvium
  - three hand augur bores (Table 21-29) results indicate discontinuous saturated alluvium.
  - only one bore (MB32) within the alluvial sediments of Phillips Creek (Figure 21-31), has been reported to contain water during all groundwater monitoring events.
  - monitoring bore MB38 (MB19SRM01A), monitored monthly during 2020, was always dry as included in Table 21-37 (i.e., no effective recharge or groundwater storage capacity occurs in the alluvium in places, resulting in sporadic discontinuous groundwater resource).
- Phillips Creek is ephemeral and does not provide a permanent recharge source to the alluvium.

Available hydrological data suggests water infiltrates/drains to the base of the alluvium relatively quickly after rainfall events where more permeable units occur at the surface. It is conceptualised that the Quaternary alluvium will not contain permanent groundwater as recharge to the alluvium seeps downwards into the underlying sediments or downgradient due to low effective storage.

Table 21-37 MB38 groundwater level monitoring records for January 2020 to February 2021

Registered Number	Date	Depth-to-water (mbGL)
MB38 (MB19SRM01A)	30/01/2020	169276, NO SAMPLES TAKEN; BORE IS DRY
	14/02/2020	bore is dry
	18/03/2020	dry
	21/04/2020	dry
	19/05/2020	Dry
	17/06/2020	bore dry
	1/07/2020	bore dry
	17/08/2020	bore dry
	16/09/2020	bore dry

Registered Number	Date	Depth-to-water (mbGL)
	18/11/2020	bore dry
	9/12/2020	bore dry
	13/01/2021	bore dry
	17/02/2021	dry

Hand augur bores and installed (2020) groundwater monitoring bores, as detailed in Section 21.4.4, indicate the limited alluvium along the non-perennial creeks (Boomerang Creek, Plumtree Creek, One Mile Creek, and the former Hughes Creek). These drilling results indicate:

- Thin moist to dry alluvium within these creeks
- Shallow bedrock below the non-perennial creeks
- Limited effective storage in the river sand (i.e., dry due to drainage from the sand)
- The deepest alluvium within the Project footprint was 3.75 m deep.

Groundwater recharge, discharge and flow

The alluvial aquifers are primarily recharged during creek flow events. As all creeks are ephemeral and can be dry throughout the year, recharge to the alluvium is likely to occur by the discontinuous recharge from surface water flow, ponding, or flooding, or infiltration of direct rainfall and overland flow where permeable river sand alluvial deposits are exposed, and no substantial clay barriers occur in the shallow sub-surface.

Available hydrological data suggests water infiltrates/drains from the alluvium relatively quickly after rainfall events (i.e., limited effective storage as the sands were dry). Based on deep water levels within the underlying Tertiary and Permian age sediments (some 20 mbGL) and the perched alluvium water level (6 to 10 mbGL), as included in Table 21-34, limited vertical hydraulic connection is identified (i.e., steep vertical gradient and > 10 m separation).

Based on these site-specific data, it is conceptualised that the Quaternary alluvium does not contain permanent groundwater as recharge to the alluvium migrates downstream / downgradient within the creeks more readily than into the underlying bedrock and older sediments.

Discharge from the alluvium is likely to include the following mechanisms:

- Discharge to Phillips Creek during or after flow events as base flow. Limited effective storage (recognised due to the dry bores in the alluvium) results in the alluvium dewatering under gravity.
- Evapotranspiration from vegetation growing in the creek beds and along the banks.
- Minor stream loss and recharge to the underlying formations where the creeks intersects more permeable bedrock or sediments.

Groundwater flow is considered to mimic topography and is limited to the alluvium within or immediately adjacent to the creeks.

It is also considered that discontinuous perched water may occur within the alluvium, which does not readily flow. This can occur in more porous sand surrounded by clay-rich sediments. This is considered to occur due to highly saline alluvium water being reported within the Project.

Hydraulic properties

More extensive alluvial systems occur outside the Project Area, associated with ephemeral water courses such as the Isaac River (approximately 15 km to the east of the underground mining footprint).

Based on available information from the nearby Caval Ridge Mine, Quaternary alluvium deposits associated with creeks and main river tributaries could be expected to have a bulk hydraulic conductivity of approximately 0.1 m/day (URS, 2009).

For the alluvium intersected within the five alluvium monitoring bores installed at the SRM during 2020 (GHD, 2023), the bore construction included development to remove drilling fines, foreign materials and to enhance hydraulic connectivity with the surrounding aquifer. Site-specific aquifer hydraulic information compiled during the bore development included:

- Development on bore MB20SRM06A (MB20SRM06A_PZ) was not completed as BMA decided plug and abandon this bore and to redrill at this location at a later date.
- MB20SRM04A was developed using a bailer because of the low water volume within the bore and slow recharge. The estimated yield for this bore was 0.05 to 0.1 L/s (4 to 9 m^3/day)
- MB38 (MB19SRM01A) had an estimated yield of 0.0008 L/s (0.07 m^3/day).
- MB20SRM01A (MB20SRM01_PZ) and MB20SRM05A (MB20SRM05A_PZ) were dry and could not be developed.

These results indicate little or no groundwater yield capacity within the alluvium, when saturated. Detailed hydraulic conductivity of the alluvium and permeability estimates are presented in the Project groundwater resources assessment (AECOM, 2023).

Water levels

Due to the sporadic, discontinuous and seasonal nature of the Quaternary alluvium groundwater level data is limited. For this unit depth-to-water measurement data includes:

- Seven bores (158484, 162681, 162685, 165323, 165324, 165325, 165326) with no water level data
- Twenty bores (MB38 (MB19SRM01A), MB20SRM01A (MB20SRM01_PZ), MB20SRM05A (MB20SRM05A_PZ), 165325, 165323, 165324, 165881, 165877, 165883, 165876, 165850, 165875, 165874, 165851, 165872, 158483, 158485, 162681, 182630, 190144) which were drilled dry
- Monitoring bore MB38 (MB19SRM01A) has been monitored monthly since December 2019 and has been dry at all times (Gauge, 2021)
- Five bores (MB20SRM04A, MB20SRM06A, 165833, 165873, 182402) with a single recorded water level measurement
- One bore (MB32) with transient water level data.

Bore MB32 is a historic stock watering bore (used for stock watering until 2007) identified during a bore census. This bore is located upstream of the SRM on Phillips Creek. The available groundwater level data for MB32 shows fluctuations over an approximately 6 m range. Groundwater levels within MB32 readily correlates with the CRD due to rainfall leading to surface water flow and recharge from Phillips Creek (i.e. not solely recharged from rainfall).

Groundwater monitoring data (depth to water measurements) review (Gauge, 2021) indicated groundwater levels have gradually declined since 2017 in reference bore MB32. The general decline trend is not readily identifiable when groundwater data is converted to mAHD. The CRD data indicates decreased monthly rainfall between 2019 and 2021 (Figure 21-19) The water level data indicates the effective storage within the alluvium, at MB32, does not readily discharge to the creek (i.e. minimal baseflow component from groundwater in Phillips Creek at MB32). Additional long term groundwater level data compiled by Gauge (2021), indicate limited natural fluctuation due to changes in wet and dry seasons.

Alluvium water quality

Groundwater quality of alluvial sediments associated with creeks and river systems within the Isaac-Connors sub-catchment are considered moderately to highly variable, ranging from fresh to very saline (URS, 2012).

The groundwater monitoring bores across the area reported to be screened through the alluvium are dry, except for bore MB32. Available water quality data for MB32 was compiled by Gauge (2021) to provide an indication of the groundwater quality associated with saturated alluvium adjacent to the Project Area is generally brackish and bicarbonate dominant. The concentrations of total dissolved solids indicate that the water is not suitable for drinking but can be used for livestock watering.

Tertiary sediment

The Tertiary sediments maintain permanent groundwater resources particularly within the deeper basal unit. The primary groundwater bearing strata of this unit is the basal sand/gravel unit, where it is locally extensive but discontinuous.

Observations from the open-cut pits at SRM indicate that groundwater discharges slowly from the Tertiary sediments and at the boundary (unconformable contact) between the Tertiary sediments and the underlying Permian strata. Based on these observations, the Tertiary sediments are considered to contain a series of poorly connected water-bearing horizons of low to moderate permeability, with drainage from the upper to lower horizons delayed by lower permeability horizons.

Groundwater ingress rates to the SRM open-cut pits are very low, resulting in damp pit walls. Evaporation rates are higher than the seepage such that this groundwater does not report directly or require management in the pits.

Based on bore logs reviewed, the sandy lenses and/or basal sand/gravel units are the primary storage for groundwater. The depth and occurrence of groundwater within the Tertiary sediments is considered variable and dependent on the extent and location of these porous, sandy layers within the sequence.

Hydraulic properties

Recharge to the Tertiary aquifers is considered the result of direct infiltration of rainfall and/or surface water runoff where the sediments subcrop or outcrop at the surface, or leakage from overlying alluvium, where present. Primary discharge mechanisms in the Tertiary sediments are likely to include throughflow into underlying and/or adjacent aquifers such as the coal seams (possible hydraulic connection based on depth-to-water measurements), evapotranspiration and groundwater extraction (including local mine dewatering).

Groundwater flow is recognised to be elevated in the north due to possible artificial recharge from existing mine waste and water storage infrastructure. Groundwater flow is recognised to mimic surface water flow from west to east across the Project Area. Flow back towards the west is, based on limited data, recognised due to RN19924, which is located adjacent to the SRM open-cut pits (i.e., the lowest groundwater elevation, 156.5 mAHD, influences the contouring).

Results of rising head permeability tests undertaken by AGE (2011) at groundwater monitoring bores PZ02A, PZ04A, and PZ07A indicated a permeability range for the Tertiary unit between 0.01 m/day and 0.002 m/day (2 to 3 orders of magnitude lower than the alluvium). Site-specific aquifer hydraulic information compiled during the development on bore MB20SRM02T resulted in an estimated yield of 0.001 to 0.016 L/s (0.09 to 1.4 m^3/day).

As the extent and nature of the Tertiary sediments are highly variable, the porosity and permeability of the aquifer is also likely to be highly variable. As a result, usable yields of groundwater are only expected to occur within the higher permeable sand and gravel lenses near the base of the sequence.

Water levels

Groundwater levels within the Tertiary sediments from monitoring bores near the Project Area are reported to be at depths shallower than the recorded water strikes from drilling and installation. This indicates that the aquifer is confined to semi-confined because of the clayey sediments in the upper Tertiary sequence.

BMA drilled several bores into the Tertiary sediments as part of their groundwater monitoring program. Bores PZ02A, PZ04A, and PZ07A were constructed as standpipe monitoring bores within the Tertiary sediments. PZ09A and PZ10A were also drilled to intersect Tertiary sediments but both were drilled dry. PZ07A was contaminated with bentonite and not used for monitoring.

Groundwater level measurements, compiled during 2011 and 2012, indicate variable groundwater levels across the Project area with tertiary monitoring bores generally dry during the monitoring period as a result of sampling, indicating limited sustainable yields. Tertiary groundwater levels measured in PZ02A (sample depth 26 mbgl) and PZ04A (sample depth 21 mbgl) indicate groundwater levels are generally greater than 20 m below ground level.

Groundwater level monitoring occurs within MB40 (MB19SRM02T), a monitoring bore intersecting the Tertiary gravel, clay and silt. This monitoring bore is 21 m deep located on Phillips Creek. The longer term groundwater level data within MB40 (MB19SRM02T) has been relatively stable with ~1 m fluctuation, indicating no marked response to recharge or discharge.

Tertiary sediments water quality

Tertiary groundwater quality was determined from historic SRM monitoring bores PZ02A and PZ04A. A representative sample could not be collected from bore PZ07A, constructed to target the Tertiary sediments, due to bentonite invading the screened zone in that bore.

Tertiary groundwater ranges from slightly acidic to slightly alkaline and is dominated by sodium and chloride with total dissolved solids (TDS) exceeding 6,000 mg/L. This means the water is brackish to saline and exceeds the livestock guideline level for cattle.

Permian sediment

Permian sediments in the Project area include the FCCM and the MCM. While the Permian sediments do not outcrop in the underground mining footprint, they subcrop under the Tertiary sediments.

As is the case throughout much of the Bowen Basin, the individual coal seams are typically the main water bearing units within the Permian coal measures. Groundwater movement and storage occurs within the coal seam cleats and fissures and within open fractures that intersect the seams. The coal seams are often the first unit where useable volumes of groundwater are encountered during drilling along the western edge of the Bowen Basin and therefore the coal seams often provide local groundwater supplies where yields and quality are suitable for cattle stock watering or industrial purposes.

Other sediments in the coal measures, the overburden and interburden, are relatively impermeable and generally form aquitards.

Hydraulic properties

Permian sediments are categorised into the following hydrogeological units:

- hydraulically 'tight' and hence very low yielding sandstone, siltstone, mudstone, carbonaceous shale and claystone that comprise the Permian overburden and interburden sediments
- low to moderately permeable coal seams which are the main water bearing strata within the Permian coal measures.

Hydraulic conductivity for the Permian coal seams and interburden material were derived from several aquifer hydraulic tests, which have been undertaken across the Project area. Results show that the coal seams generally exhibit low to moderate hydraulic conductivity.

The hydraulic conductivity data indicates a reducing hydraulic conductivity of the coal with depth. Based on the decrease in permeability with depth, the following exponential equations for the coal seams were derived:

- Harrow Creek Horizontal Hydraulic Conductivity (K) = 0.045919 x $e^{-0.016}$ x depth
- Dysart Horizontal Hydraulic Conductivity (K) = 0.006499 x $e^{-0.0104}$ x depth

The deeper Dysart seam being slightly less permeable (less than one order of magnitude) than the overlying Harrow Creek seam.

Water levels

Groundwater monitoring bores constructed to intersect the Permian sediments have water levels that are higher in elevation than the horizon at which the water was first intersected, indicating that groundwater within the Permian sediments is confined. The regional groundwater flow pattern in Permian sediments across the Project area indicates flow from north-west to south-east. Overall, Permian groundwater levels indicate no marked seasonal fluctuations (response to dry and wet seasons) and no influence of mining (even though the mining at SRM has been operating since 1974). The transient groundwater level data does not readily indicate the direct or indirect impact of mining on these bores, rather the data indicates complex response to wet and dry climate conditions.

Coal seams water quality

Representative samples of the Permian coal seam aquifers for bores across the Project area indicate that the Permian coal seam groundwater ranges from slightly acidic to alkaline and is dominated by sodium and chloride with TDS levels ranging from 3,300 mg/L to 20,000 mg/L. Metal concentrations for all parameters analysed were either below the laboratory detection limit or below the relevant guideline level. The coal seam water is brackish to saline and typically not suitable for stock watering.

Groundwater values

The Project is located within the Isaac River sub-basin of the Fitzroy Basin as described in Schedule 1 of the EPP (Water). Environmental values and water quality objectives for groundwater within the Isaac River sub-basin are provided in 'Isaac River Sub-basin Environmental Values and Water Quality Objectives' (EHP, 2011).

In summary, the evaluation of groundwater environmental values in the area enveloping the Project indicates groundwater associated with the tertiary and Permian sediments are of limited value for most uses. Groundwater associated with the alluvium, which has recorded saturated alluvium with good quality groundwater quality, is sporadic and seasonal and is not considered to provide a sustainable supply in the Project area to allow for evaluation. Based on available groundwater resources (potential and chemistry) the only recognised groundwater environmental value to be enhanced or protected within the Project area is stock watering. Groundwater values to be enhanced or protected in the Project Area are described in Table 21-38.

Based on an assessment of existing water quality data, extracted water is expected to be of poor quality and have high salinity. As a result, extracted water will not be discharged and will instead be used in the CHPP with losses through evaporation.

Table 21-38 Environmental values for groundwater

Value	Definition	Description
Aquatic ecosystems	'A community of organisms living within or adjacent to water, including riparian or foreshore area' (EPP (Water), schedule 2). The intrinsic value of aquatic ecosystems, habitat and wildlife in waterways and riparian areas. For example, biodiversity, ecological interactions, plants, animals, key species (such as turtles, platypus, seagrass and dugongs) and their habitat, food and drinking water. Waterways include perennial and intermittent surface waters, groundwaters, tidal and non-tidal waters, lakes, storages, reservoirs, dams, wetlands, swamps, marshes, lagoons, canals, natural and artificial channels and the bed and banks of waterways.	Desktop data and site-specific studies shows no known aquatic or subterranean GDEs within the Project, and there is a low potential for Terrestrial GDEs to be present. Aquatic ecosystem values are described in Section 21.4.5.3.
Irrigation	Suitability of water supply for irrigation. For example, irrigation of crops, pastures, parks, gardens and recreational areas.	The ANZECC guidelines (2000) state that the threshold salinity tolerances for plants grown in loamy to clayey soils are 600-7,200 micro-Siemens per centimetre (µS/cm). Given that groundwater salinity within Tertiary and Permian aged sediments is generally greater than 5,000 µS/cm, groundwater is not considered suitable for irrigation. A lack of licensed groundwater bores within 15 km of the Project also suggests that groundwater is not useable as a source of irrigation water.

Value	Definition	Description
Farm water supply/use	Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.	The high salinity of the groundwater generally precludes it from being suitable for farm supply uses such as laundry or produce preparation.
Stock watering	Suitability of water supply for production of healthy livestock.	The review of DRDMW registered bores and the bore census data indicates that groundwater in the area is used for stock watering. Although the groundwater is generally within the guidelines for livestock, the ANZECC guidelines (2000) states loss of production and a decline in animal health occurs if stock are exposed to high salinity water for prolonged periods. For beef cattle, this limit is in range the range of 5,000-10,000 mg/L. Given the variable salinity levels for groundwater hosted in the Tertiary and Permian aged sediments are within this range and there are some cases of salinity greater than 10,000 mg/L, the regional groundwater will generally not be considered suitable for livestock.
Primary recreation	Health of humans during recreation which involves direct contact and a high probability of water being swallowed, for example, swimming, surfing, windsurfing, diving and water-skiing. Primary recreational use, of water, means full body contact with the water, including, for example, diving, swimming, surfing, water-skiing and windsurfing (EPP (Water), s.6).	This category of environmental value is considered not applicable to groundwater in-situ. There are also no registered groundwater springs in the Project area that could be considered for recreational use. Groundwater seepage from the alluvium and/or Tertiary units into watercourses can provide short duration baseflow into rivers and creeks immediately after heavy rains or flooding; however, after larger flood events suitability of these waters for recreation may be limited by other factors. There is currently no evidence to suggest that groundwater is directly used for recreational or aesthetic purposes in the Project area.
Drinking water supply	Suitability of raw drinking water supply. This assumes minimal treatment of water is required, for example, coarse screening and/or disinfection.	The suitability of water for human consumption is defined in the Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011). The groundwater quality data indicates groundwater is unsuitable for human consumption before treatment due to elevated levels of salinity. Groundwater resources within the Project area are, therefore, considered to require significant treatment before utilisation for drinking. The availability of rainwater tanks and the generally low sustainable yield and poor quality of the groundwater bores in the area are also factors that preclude the usage and potential for usage of the groundwater as a drinking water source.
Cultural and spiritual values	Indigenous and non-indigenous cultural heritage, for example: custodial, spiritual, cultural and traditional heritage, hunting, gathering and ritual responsibilities symbols, landmarks and icons (such as waterways, turtles and frogs) lifestyles (such as agriculture and fishing). Cultural and spiritual values of water, means its aesthetic, historical, scientific, social or other significance, to the present generation or past or future generations (EPP (Water), s.6).	There are no registered groundwater springs or seeps that supply surface water bodies in the Project area. No springs are known to have Indigenous and/or non-Indigenous cultural heritage associations.

21.4.5.3 Groundwater dependent ecosystems

GDE are defined as ecosystems that require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes, and ecosystem services (Richardson *et al,* 2011). GDEs can be grouped into three categories in Queensland, based on their type of groundwater reliance:

- aquatic GDE depend on the surface expression of groundwater and rely on groundwater after it has been discharged to the surface i.e. groundwater-fed wetland systems (swamps, lakes and rivers).
- terrestrial GDE depend on the subsurface expression of groundwater and access subsurface groundwater to meet all or some of its water requirements i.e. terrestrial vegetation with typically deep-rooted trees.
- subterranean GDE occur within caves (with some degree of groundwater connectivity) and aquifers. Aquatic animals living in groundwater are referred to as stygofauna.

Mapping of GDE completed at a national level by the Bureau of Meteorology (BOM) to produce the GDE Atlas (BOM 2020) identifies potential aquatic, terrestrial and subterranean ecosystems. BOM (2020) mapping of GDEs over the Project Site and surrounds shows:

- aquatic GDE: no springs mapped within proximity to the Project area; 'High Potential' for aquatic GDE on Phillips Creek (south of mining impacts) and 'Moderate Potential' aquatic GDE on parts of Boomerang Creek.
- terrestrial GDE: 'Low Potential' for terrestrial GDE associated with elevated residual plains and 'High Potential' and 'Moderate Potential' for terrestrial GDE associated with Boomerang and Hughes Creek.
- subterranean GDE: no mapped subterranean GDE.

A GDE assessment conducted for the Project (3D Environmental, 2022) collated field data to describe GDE within the Project Site; particularly, terrestrial GDE on Phillips Creek and Hughes Creek, which host variable groundwater volumes seasonally recharged via surface flows and flooding. Areas of known potential GDE mapping is shown in Figure 21-35.

Aquatic GDE

There is no indication that Phillips Creek represents an aquatic GDE, which is consistent with the assessment completed for the Lake Vermont-Meadowbrook Project (3D Environmental 2022) to the east of the Project. The most significant control on groundwater dependence is a consistent lack of well-developed alluvial deposits, with only thin slivers attenuating along the larger drainage lines of Phillips Creeks. The lack of significant alluvium means that away from the drainage channels, groundwater is confined to the base of the Tertiary sediments, as well as coal seams (3D Environmental, 2023).

Survey Site 13_AU1 is a surface feature and vegetation fringing Boomerang Creek does not meet the hydrological or ecological criteria for an aquatic GDE as there is no indication of hydrological linkage between surface water and groundwater.

There is no shallow groundwater reported in the alluvium along Hughes Creek.

Terrestrial GDE

Field data indicates Phillips Creek is highly likely to function as a terrestrial GDE. The narrow strip of alluvium associated with Phillips Creek has capacity to host variable quantities of fresh groundwater, both in riverbed sands and the fringing alluvial terraces, on a seasonal basis. The highest degree of groundwater usage occurs post seasonal flooding events, which recharge groundwater in associated alluvial deposits.

Vegetation fringing Hughes Creek within EPC 837 does not meet the hydrological or ecological criteria for a terrestrial GDE; although a terrestrial GDE intrusion may extend into the Project Site from the east, mapped in conjunction with the contiguous Lake Vermont-Meadowbrook Project. The transition of

Hughes Creek into a terrestrial GDE to the east of the Project Site is most likely associated with a thickening and widening of creek alluvium eastward toward the Isaac River where there is greater capacity for storage of perched groundwater.

On Boomerang Creek, Survey Site 13_AU1 is a surface feature with fringing wetland vegetation does not meet the hydrological or ecological criteria for a terrestrial GDE as there is no indication of hydrological linkage between surface water and groundwater. Within the Project Site, the alluvial landform hosting Hughes and Boomerang creeks is extremely shallow, with outcropping sedimentary basement evident in some channel exposures. The Boomerang Creek site does not meet the hydrological or ecological criteria for a terrestrial GDE.

Vegetation on Tertiary plains, typically RE11.5.3 and 11.4.9, has limited potential for groundwater dependency, due to both the shallow rooted nature of the dominant poplar box and brigalow and the significant depth to the groundwater table.

Vegetation fringing One Mile Creek and adjacent woodland does not meet the ecological and hydrological criteria for a terrestrial GDE with field assessment confirming that moisture requirements of vegetation are supported within the unsaturated portion of the soil profile.

No specific impediment to tree water use of Tertiary or Permian groundwater is recognised based on salinity values. However, water held in these aquifers is an unsuitable resource to support GDEs due to the potentiometric surface being generally >17 mbgl, which is significantly below the maximum rooting depth of facultative phreatophytes associated with the major drainage channels across the Project.

No known springs are present within the Project Site; closest spring being over 150 km from the Project.

Subterranean GDE

The alluvium in and adjacent to the Project area is ephemeral, discontinuous and can be saline, and does not contain enough permanent suitable groundwater to support stygofauna populations. Low potential for subterranean GDEs to exist within the Tertiary and Permian sediments is due to:

- the saline nature of the Tertiary and Permian sediments (>5,000 µS/cm) and depth to groundwater (>17 m) are likely to preclude the presence of stygofauna.
- site specific sampling of the Tertiary and Permian sediments did not detect any stygofauna taxa.

4T Consultants (2012) desktop review to assess the potential for stygofauna within the Bowen Basin found:

- aquifer type and associated hydraulic conductivity and pore space are the primary determinants for the presence or absence of stygofauna.
- no stygofauna have been detected in coal seams within the Bowen Basin.
- most stygofauna identified in the Bowen Basin were found within shallow (less than 29 mbgl) unconsolidated sediments, such as alluvium, at salinity levels less than 2,000 µS/cm and pH 6.5-8.5.
- for unconsolidated sediment aquifers, stygofauna are more likely to be located where the depth to water is less than 20 m. In fractured rock aquifers, most stygofauna have been located where the depth to water is less than 30 m.

ALS (2012) suggested salinity values of less than 5,000 µS/cm were most preferable for stygofauna with the highest number of taxa present where the water table was less than 10 mbgl.

During the September 2011 and December 2011 sampling events undertaken by IESA in seven groundwater monitoring bores on the Project Site screened across Tertiary and Permian sediments, no stygofauna species were detected.

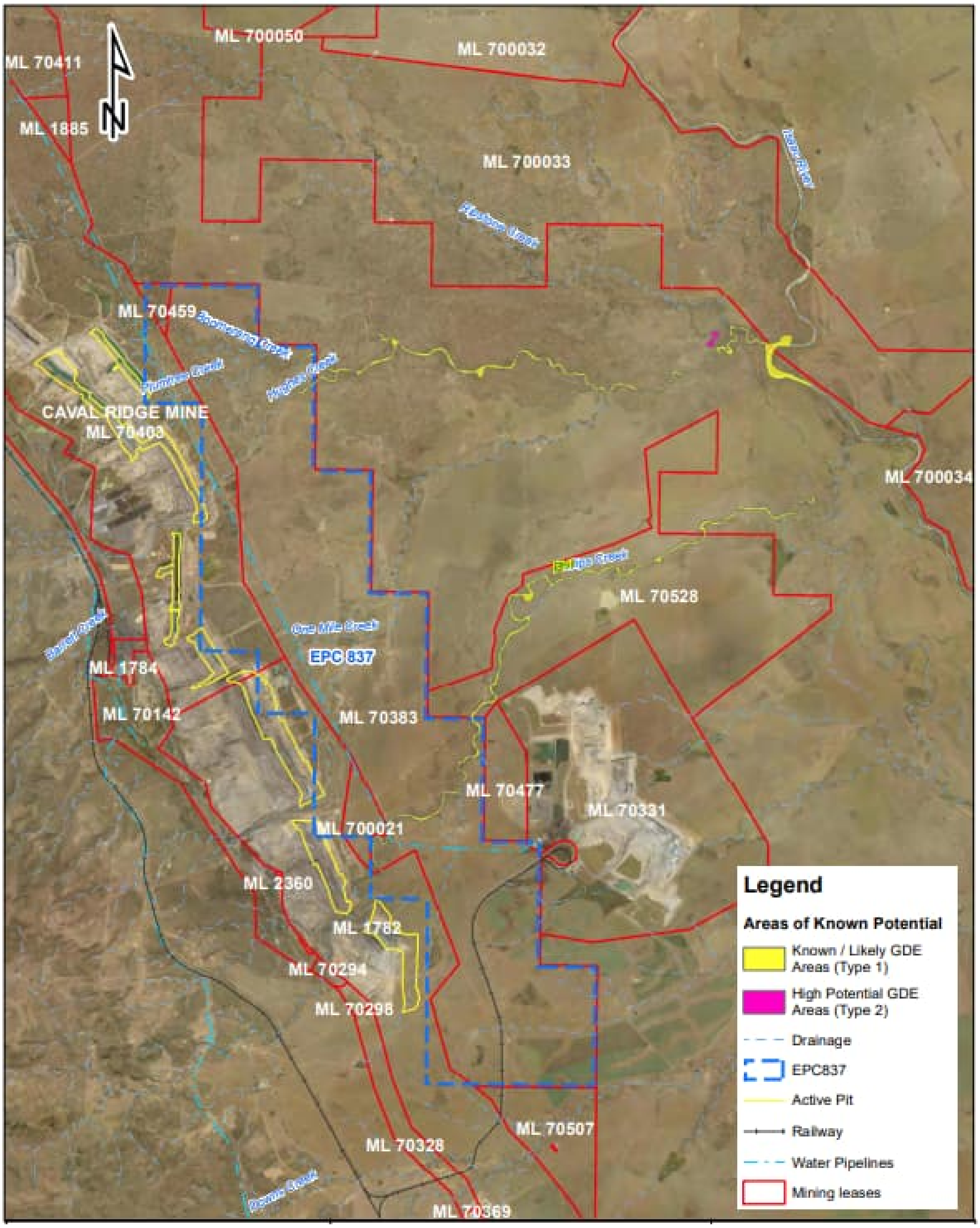


Figure 21-35 Mapped groundwater dependent ecosystems

21.4.6 Flora and fauna

Within Isaac Comet-Downs subregion, significant areas of the landscape have been historically cleared for grazing and cropping and continue to be utilised for this land use. Areas of remnant intact vegetation do occur within the Project Site. The contiguous tracts of vegetation within the Project Site are primarily linked by riparian corridors associated with the local creek and river systems, including:

- Boomerang Creek (and Hughes Creek)
- One Mile Creek
- Phillips Creek.

Two oxbow wetlands exist in the north of the Project Site retain permanent water and provide habitat opportunities for fauna groups. The canopy in riparian zones associated with the oxbow wetlands and creek systems are dominated by *Eucalyptus camaldulensis* (River Red Gum), *Melaleuca fluviatilis* and *Casuarina cunninghamiana* (River She-oak).

The general ecology of the area has been significantly modified by proliferation of the exotic grass *Cenchrus ciliaris* (Buffel Grass), impacts from cattle (trampling of ground cover vegetation), loss of native shrub and groundcover species, soil erosion, compaction, and disturbance and fouling of natural water bodies.

The presence of artificial water supplies such as dams provide habitat and resources for fauna groups, including waterbirds and frogs, and enhances the conditions for exotic fauna such as Cane Toads (*Bufo marinus*) and Feral Pigs (*Sus scrofa*).

Ecological values relevant to assessment of MNES are described further in the following sections.

21.4.6.1 Vegetation communities

Woodlands dominated by *Eucalyptus* or *Acacia* species cover part of the Project Site with the remainder vegetated by non-remnant grasslands (as pasture) and shrubby regrowth. Small areas of native grassland are present. In the drier areas *Eucalyptus populnea* (Poplar Box), *E. cambageana* (Dawson Gum), *Corymbia tessellaris* (Moreton Bay Ash), *Acacia harpophylla* (Brigalow) and *Casuarina cristata* (Belah) generally dominate the canopy, with a sparse mid layer and ground cover of tussocky introduced grasses.

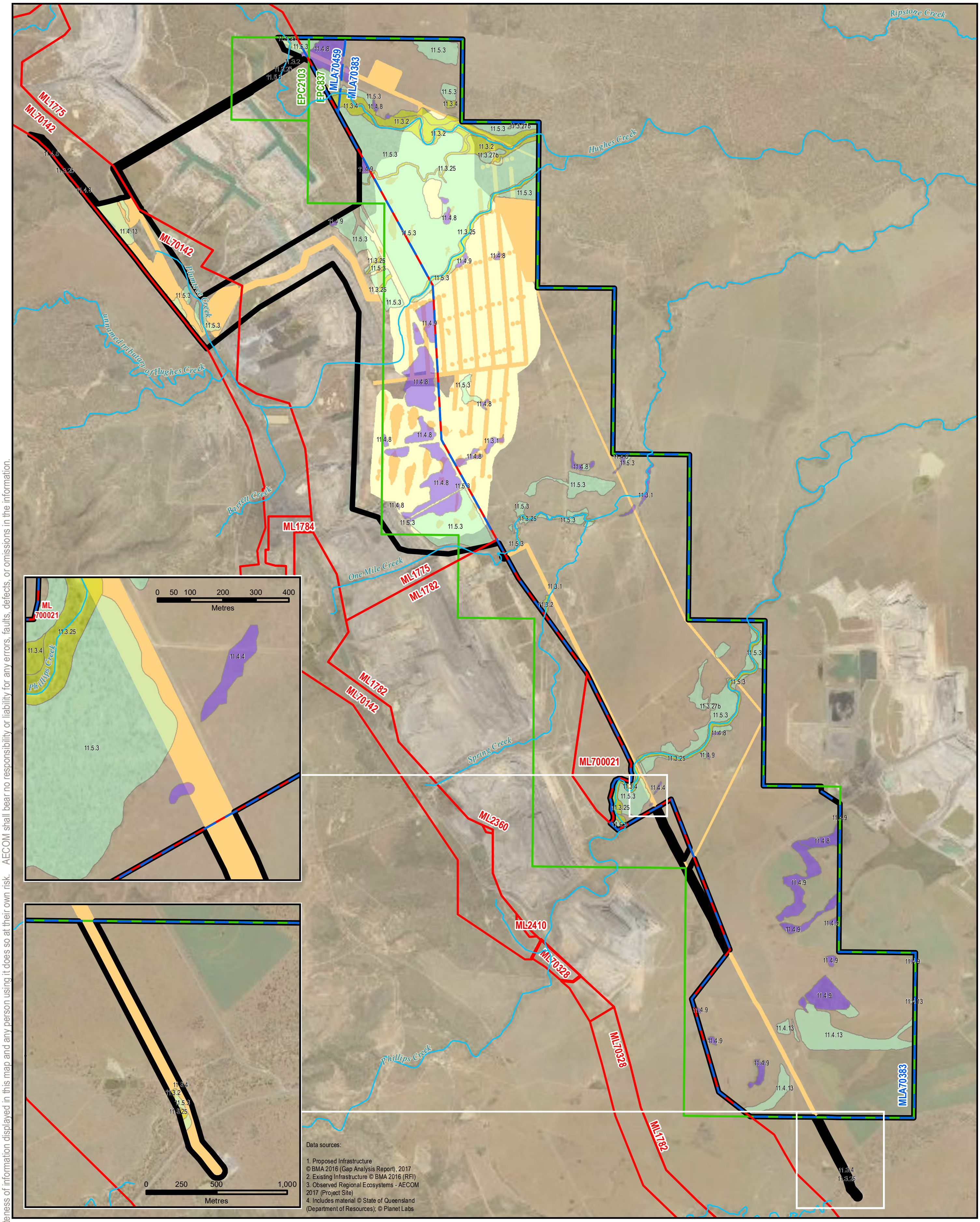
Field surveys confirmed the presence of 315 flora taxa representing 70 families and 190 genera as well as ten vegetation communities, corresponding to RE potentially representing TEC as described in Section 21.3.2.2.2 (AECOM, 2024d). Vegetation communities observed within the Project Site are described in Table 21-39 and their distribution is illustrated in Figure 21-36 .

Table 21-39 Vegetation communities within the Project Site

Community Description	RE	Biodiversity Status[1]	EPBC Act status[2]	Project Site Extent (ha)
Acacia harpophylla and/or *Casuarina cristata* open forest on alluvial plains.	11.3.1	Endangered	Endangered	15.76
Eucalyptus populnea woodland on alluvial plains.	11.3.2	Of Concern	Listed as endangered after submission	151.14
Eucalyptus tereticornis and/or *Eucalyptus* spp. woodland on alluvial plains.	11.3.4	Of Concern	Not listed	23.05
Eucalyptus tereticornis or *E. camaldulensis* woodland fringing drainage lines.	11.3.25	Of Concern	Not listed	192.08
Lacustrine wetland (e.g. lake). Occurs on billabongs no longer connected to the channel flow.	11.3.27b	Of Concern	Not listed	16.64
Dichanthium spp., *Astrebla* spp. grassland on Cainozoic clay plains.	11.4.4	Of Concern	Endangered	1.73
Eucalyptus cambageana woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	11.4.8	Endangered	Endangered	322.35

Community Description	RE	Biodiversity Status[1]	EPBC Act status[2]	Project Site Extent (ha)
Acacia harpophylla shrubby open forest to woodland with *Terminalia oblongata* on Cainozoic clay plains.	11.4.9	Endangered	Endangered	188.57
Eucalyptus orgadophila open woodland on Cainozoic clay plains.	11.4.13	Of Concern	Not listed	222.14
Eucalyptus populnea ± *E. melanophloia* ± *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.	11.5.3	No concern at present	Not listed	1,480.12
N/A	Non-remnant	N/A	N/A	8,813.41

[1] Biodiversity status of the RE based on an assessment of the condition of remnant vegetation in addition to the pre-clearing and remnant extent of a regional ecosystem.
[2] Status of the listed ecological community under the EPBC Act. RE must meet the condition thresholds and diagnostic criteria to be considered TEC. Current at the time of assessment.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Regional Ecosystems biodiversity status

- Endangered
- Of Concern
- No Concern at Present

N

Figure 21-36

Observed vegetation communities

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.4.6.2 Habitat types

The habitat landscape within the Project Site has been significantly altered from its original state; most of the area is cleared for grazing land and improved pasture. The current habitat landscape comprises cleared grazing land dominated by the exotic grass species *Cenchrus ciliaris* (Buffel Grass) traversed by narrow remnants of riparian woodlands. There are larger patches of remnant woodlands in the northern section of the Project Site, connected to more extensive areas of habitat to the north. Fauna habitat that does persist has been subject to disturbance from cattle grazing, selective clearing, weeds and pests. This has led to a general lack of native understorey growth in the remnant woodlands. However, thinning has resulted in an accumulation of ground habitats in the form of logs and large branches.

Despite signs of habitat degradation, several fauna habitat values exist that can support a range of fauna species. Field surveys recorded the presence 188 vertebrate fauna species, comprising 14 amphibians (including one exotic species), 24 reptiles, 117 birds and 33 mammals (including seven exotic species). Nine distinct habitat types have also been confirmed within the Project Site (Table 21-40 and Figure 21-37). A description of these communities and the key fauna habitat opportunities are provided below.

Table 21-40 Fauna habitat types within the Project Site

Habitat Type	Habitat Summary	Analogous REs
1	River Red Gum Riparian Woodland	11.3.25
2	*Eucalyptus* and/or *Corymbia* Open Woodland	11.3.2, 11.4.13; 11.5.3
3	Dawson Gum and Brigalow Woodland	11.4.8
4	Brigalow and Belah Woodland	11.3.1, 11.4.9
5	Oxbow Wetland	11.3.27b
6	Natural Grasslands	11.4.4
7	Modified Grasslands	Non-remnant
8	Shrubby Brigalow Regrowth with Gilgai	Non-remnant
9	Dams	Non-remnant

River Red Gum Riparian Woodland

This habitat type comprises alluvial riparian forest, analogous with RE 11.3.25 along the major creeks and drainage lines, including Boomerang Creek, Plumtree Creek, Hughes Creek, One Mile Creek and Phillips Creek. This community was defined by a tall, open canopy of *Eucalyptus camaldulensis* (River Red Gum), over a mid-storey of *Casuarina cunninghamiana* (River She-oak), *Corymbia tessellaris* (Moreton Bay Ash) and *Melaleuca fluviatilis* with an abundance of grasses along the stream banks. Large, mature River Red Gums (*Eucalyptus camaldulensis*) present in riparian habitats frequently contain hollow limbs which provide denning sites for arboreal mammals and microchiropteran bat species and nesting sites for many bird species such as parrots and owls. Notably two threatened species were recorded in this habitat, the Greater Glider (*Petauroides volans*) and Koala (*Phascolarctos cinereus*).

This community also acts as a food source for insectivorous and nectivorous birds and mammals. Where this habitat forms a continuous corridor, it constitutes a route for dispersing fauna of all types. Ground timber, high ground cover and decorticating bark also provide habitat opportunities for reptiles and ground-dwelling mammals.

Seasonal inundation and flow along the creeks and their tributaries also provide habitat and breeding sites for aquatic or semi-aquatic species such as frogs and their predators such as snakes. Four amphibians were recorded in this habitat type including Ornate Burrowing Frog (*Platyplectrum ornatum*), Short-footed Frog (*Cyclorana brevipes*) and the invasive Cane Toad (*Bufo marinus*) which was noted in large numbers along Phillips Creek. A Keelback Snake (*Tropidonophis mairii*) was observed hunting Cane Toads (*Bufo marinus*) in the dry creek bed of Phillips Creek and a common Tree Snake (*Dendrelaphis punctulata*) was also recorded in this habitat.

Eucalyptus and/or Corymbia Open Woodland

This habitat type occupies large areas of remnant woodland in the north and centre of the Project Site with smaller isolated patches in the south. It is analogous with REs 11.3.2, 11.5.3 and 11.4.13. This community was defined by a canopy comprising Myrtaceous tree species including *Eucalyptus populnea* (Poplar Box), *Eucalyptus orgadophila* (Mountain Coolibah), *Corymbia dallachiana* (Ghost Gum), *E. melanophloia* (Silver-leaved Ironbark), *C. clarksoniana*, *C. tessellaris* (Moreton Bay Ash) and *C. erythrophloia* (Variable-barked Bloodwood). The lower tree layer is sparse primarily due to the cattle damage while the ground layer typically displayed high cover of native and exotic grass species and low shrubs (i.e. *Carissa ovata* (Currant Bush)).

Eucalyptus populnea (Poplar Box) readily forms hollows and hollows in stags were also common where *E. orgadophila* (Mountain Coolibah) dominates. As a result, many trees within these communities possessed one or more such habitat features. Despite this, arboreal mammal diversity was found to be relatively low in this habitat type except microchiropteran bat species, which were regularly recorded.

A Koala (*Phascolarctos cinereus*) record also occurs in this habitat type within Downs Creek, downstream of the Project Site. Thinning of this community has resulted in an accumulation of fallen timber, including large branches and logs, which provide habitat opportunities for reptiles and ground mammals.

Opportunities exist for a range of birds in this habitat including foraging habitat for foliage-gleaners, nectar feeders and raptors. Raptors including Wedge-tailed Eagle (*Aquila audax*) and Pacific Baza (*Aviceda subcristata*) were observed soaring above or perched in the canopy and Brolgas (*Antigone rubicunda*) and Emu (*Dromaius novaehollandiae*) were also noted moving through the ground layer in this habitat type.

Dawson Gum and Brigalow Woodland

This community is analogous with RE 11.4.8 and occurs as fragmented patches across the Project Site. It comprises an open canopy of *Eucalyptus cambageana* (Dawson Gum) with a lower tree layer of *Acacia harpophylla* (Brigalow) and *Lysiphyllum carronii* (Queensland Ebony), and a relatively diverse shrub layer. This community typically features a mid-dense shrub layer that is attractive to woodland bird species. Hollows form in large *Eucalyptus cambageana* (Dawson Gum) and stags which provide valuable habitat for arboreal mammals, microchiropteran bats, parrots and owls. Habitat logs, ground timber and decorticating bark were common and leaf litter cover was typically high, providing habitat resources for reptiles and amphibians. Like the majority of habitat found within the Project Site, these communities are heavily impacted by cattle. The presence of cattle and exotic grass *Cenchrus ciliaris* (Buffel Grass) may deter some ground fauna from utilising these areas.

Brigalow and Belah Woodland

This community occurs as small, fragmented patches across the Project Site and is analogous with RE 11.3.1 and RE 11.4.9.

Acacia harpophylla (Brigalow) or *Casuarina cristata* (Belah) forms a closed canopy often with emergent eucalypt species. Structural complexity was typically high with well-defined shrub and ground layers. Microhabitat features typically included high leaf litter cover, grass tussocks, ground timber and habitat logs. Gilgai formation was observed in some areas and cracking clay also provides opportunities for some amphibian and reptile species including the Vulnerable Ornamental Snake (*Denisonia maculata*). During years of high rainfall or after the wet season, gilgai depressions fill with and maintain water which in turn fosters an increase in local biodiversity (i.e. frogs, snakes, aquatic vegetation and birds).

In the Project site patches of this habitat type were generally small, fragmented and heavily degraded by cattle grazing. They were also found to be generally low in fauna diversity. However, these areas traditionally offer refuge for species that are typically associated with this community.

Oxbow Wetland

This habitat type was found in several open and vegetated freshwater bodies in the north-east of the Project Site and is analogous with RE 11.3.27b. It is a fringing woodland and sedgeland dominated by *Eucalyptus camaldulensis* (River Red Gum) and *Lophostemon grandiflorus* (Swamp Box). This riparian community was noted to provide habitat opportunities for all fauna groups with hollows, flowering canopy trees, grassy banks, decorticating bark and ground timber observed. Large, mature River Red Gums (*Eucalyptus camaldulensis*) present in this habitat type frequently contained hollows in trunks and limbs which provide denning sites for arboreal mammals and microchiropteran bats (nine species recorded) and nesting sites for many bird species such as parrots and owls. Further, tree hollows provide refuge and access to arboreal prey species targeted by reptiles such as arboreal snakes and monitors. Hollows in live trees also provide a stable moist environment, thermal conditions which may be beneficial to some reptile species (Fitzgerald et al., 2006). Flowering canopy eucalypts are also likely to support foraging birds and flying foxes, including the Little Red Flying-fox (*Pteropus scapulatus*) which was recorded within this habitat.

This community provided suitable habitat for amphibians and a permanent water resource for macropods, with both detected during spotlighting and observational surveys. Two amphibian species were observed within this habitat including the Bumpy Rocket Frog (*Litoria inermis*) and Desert Tree Frog (*Litoria rubella*). The complex in stream habitat including, aquatic vegetation, and woody debris provided abundant foraging and breeding habitat opportunities. Two Eastern Brown Snakes (*Pseudonaja textilis*) were also observed exhibiting courting behaviour on a farm track adjacent to the wetland.

Water bodies in the area, both natural and artificial, are attractive as watering points for woodland bird species and provide habitat for a number of waterbird and frog species. Waterbirds noted using this habitat included Little Pied Cormorant (*Phalacrocorax melanoleucos*) and Australian Pelican (*Pelecanus conspicillatus*) and woodland bird species which show preference for areas in close proximity to waterbodies included Rainbow Bee-eater (*Merops ornatus*) and Dollarbird (*Eurystomus orientalis*). Nocturnal predatory birds were also noted using this habitat (Southern Boobook (*Ninox boobook*); Tawny Frogmouth (*Podargus strigoides*)) with suitable amphibian, insect and bat prey species widely available.

Although not noted during surveys, such permanent waterbodies in the area are also important in promoting the survival and proliferation of feral animals such as Feral Pig (*Sus scrofa*) and cane toad (*Bufo marinus*).

Natural Grasslands

This community occurs as a small patch in the middle of the Project Site mapped as RE 11.4.4 and comprise a mixture of native grasses and herbs on black clay. Although no detailed fauna surveys were conducted in this area, common bird species such as Torresian Crow (*Corvus orru*), Magpie-lark (*Grallina cyanoleuca*) and Whistling Kite (*Haliastur sphenurus*) were noted using this community. Notably a large herd of Feral Pigs (*Sus scrofa*) was recorded moving through the grassland and some previous pig damage was evident.

Modified Grasslands

The grasslands found within the Project Site mostly exist as a relic from clearing practices and form the largest community type (approximately 64 per cent of the Project Site). The introduced pasture species *Cenchrus ciliaris* (Buffel Grass) dominates much of this community, although patches of native grasses still exist in places. *Cenchrus ciliaris* (Buffel Grass) does not provide preferred habitat for native ground fauna. However, the modified grasslands support a range of larger mammal species such as the Grey Kangaroo (*Macropus giganteus*) and specialist grassland bird species such as the Nankeen Kestrel (*Falco cenchroides*), Tawny Grassbird (*Megalurus timoriensis*) and the Australasian Pipit (*Anthus australis*). The presence of native grasses found in isolated patches (as described in Natural grasslands above) in the southern area of the Project Site would typically offer better habitat values for native dasyurids, murids and herpetofauna.

Areas of gilgai micro-relief and cracking clays are present within the habitat, but this is restricted to discrete patches only, predominantly within the central section of the Project Site between Boomerang

Creek and Phillips Creek. This provides suitable habitat for frog species and the Vulnerable Ornamental Snake (*Denisonia maculata*).

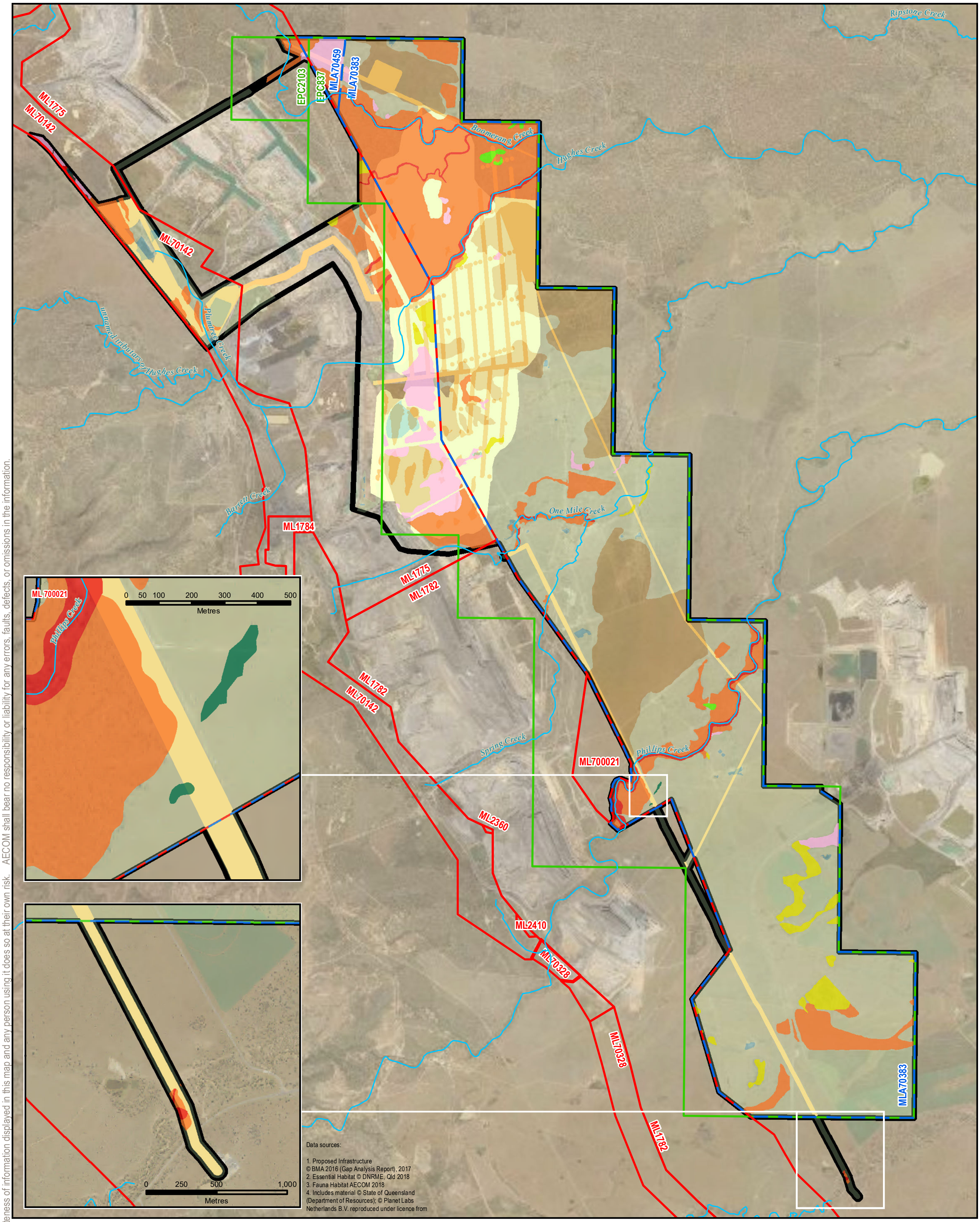
Shrubby Brigalow regrowth with gilgai

Patches of shrubby *Acacia harpophylla* (Brigalow) and *Eucalyptus cambageana* (Dawson Gum) regrowth exist throughout Project Site, ranging from 0.5 m to 5 m in height. Microhabitat features include ground timber accumulation where clearing has taken place with some leaf litter, grass tussocks and gilgai. Where cracking clay and gilgai are present opportunities for reptile and amphibian species such as green tree frog and the Vulnerable Ornamental Snake (*Denisonia maculata*) exist. Ornamental Snake (*Denisonia maculata*) was recorded in this habitat type during field surveys by AECOM in 2020 and by SKM, both after rainfall.

Weed disturbance was found to be high in this habitat type and patches were often found to be heavily disturbed by feral animals such as Feral Pig (*Sus scrofa*) and livestock.

Dams

This habitat type is characterised by open water bodies with limited aquatic vegetation, exposed mud and cattle impacts. As all watercourses within the Project Site are ephemeral and natural waterholes are uncommon, farm dams (and mine dams) act as reliable water sources and refugia for fauna throughout the year. Bird diversity was particularly high at some dams with species such as Black-necked Stork (*Ephippiorhynchus asiaticus*) and Pied Cormorant (*Phalacrocorax varius*) only observed in this habitat type.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Fauna habitat types

- River red gum riparian woodland
- Eucalyptus and Corymbia open woodland
- Dawson gum and brigalow woodland
- Brigalow and belah woodland
- Oxbow wetland
- Natural grasslands

Non-remnant Habitat Types

- Modified Grasslands
- Shrubby Brigalow Regrowth with Gilgai
- Dams

N

Figure 21-37
Fauna habitat types within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.4.6.3 Fauna corridors

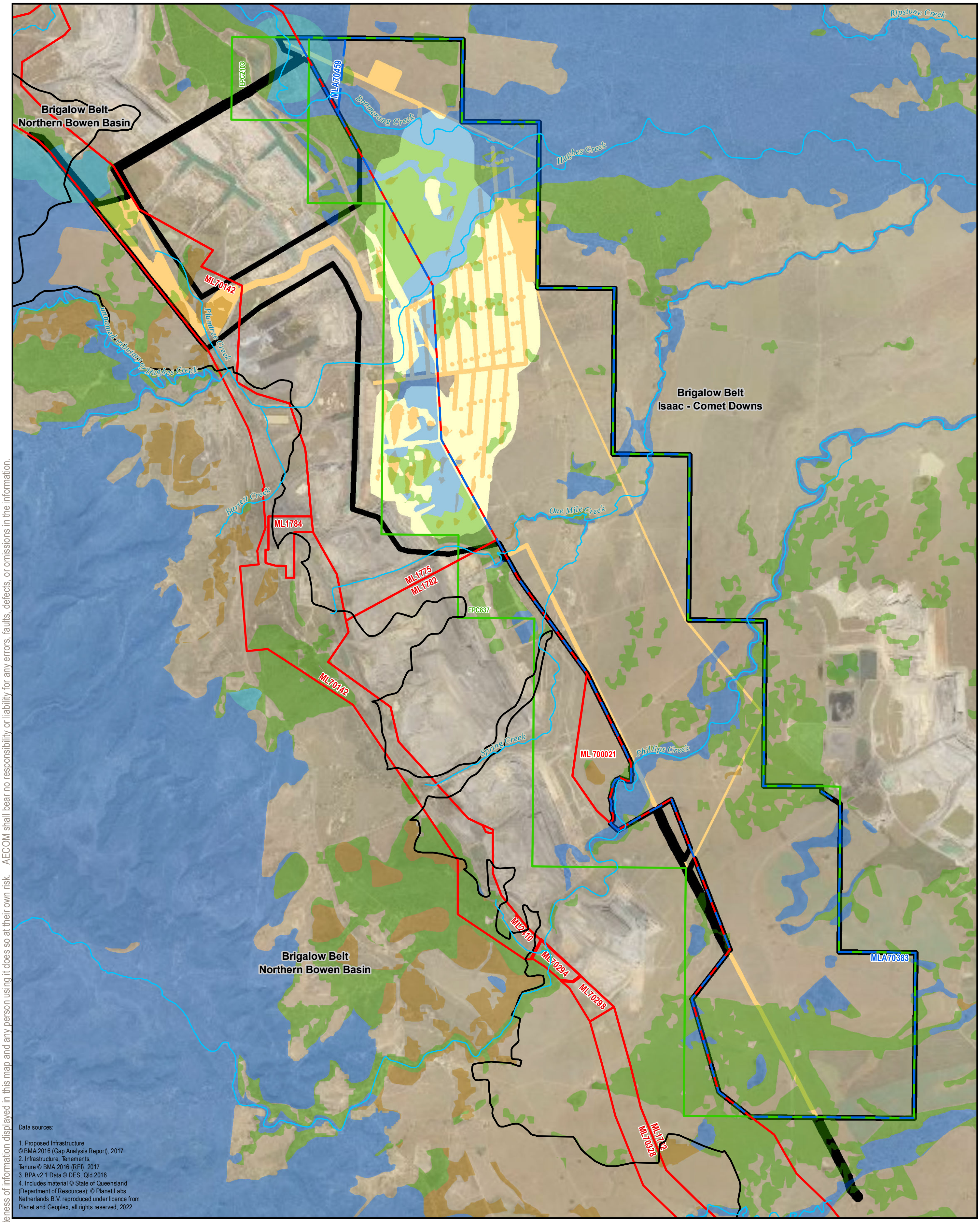
The BPA for the Brigalow Belt Bioregion identifies the following wildlife corridors within the Project Site (Figure 21-38):

- Boomerang Creek (and Plumtree Creek and Hughes Creek) riparian ecological corridor with fringing woodland and adjacent remnant eucalypt woodland (state significance)
- One Mile Creek riparian ecological corridor (state significance)
- Phillips Creek riparian ecological corridor (state significance)
- Downs Creek riparian ecological corridor (regional significance).

These wildlife corridors provide east–west fauna movement opportunities through the landscape. The Project Site is bisected by the Lake Vermont Mine Road and railway corridor as well as Golden Mile Road in the southern extent, and movement opportunities for fauna through the landscape north–south are limited.

The functional habitat connectivity in an east to west direction in a regional context is interrupted by the SRM complex directly west of the Project Site. However, to the east and west of the Saraji mine complex, there are opportunities for fauna movement despite the historical clearing of woodland for grazing.

Whilst large swathes of woodland have been historically cleared, connectivity exists in bands of remnant woodland or along the ephemeral creeks in the area. Therefore, while terrestrial and arboreal fauna movement is generally limited and compromised across the Project Site, there remain opportunities for fauna movement in an east to west direction and to areas beyond the Project Site boundary.



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Infrastructure, Tenements, Tenure © BMA 2016 (RFI), 2017
3. BPA v2.1 Data © DES, Qld 2018
4. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2022

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Biodiversity Planning Assesment (BPA) Subregion

Biodiversity significance

- State Mapped Habitat for Endangered, Vulnerable and Near Threatened taxa
- State Values
- Regional Values
- Local or Other Values

N

Figure 21-38
Biodiversity planning assessment mapping

Environmental Impact Statement
Saraji East Mining Lease Project

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Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.5 Likelihood of occurrence assessment

This likelihood of occurrence assessment specifically relates to the controlling provisions identified in the 2016 EPBC Referral (2016/7791), namely nationally listed threatened species, TEC and water resources in relation to coal seam gas development and a large coal mining development.

21.5.1 Water resources

21.5.1.1 Surface water

The physical setting (Section 21.4.1) and regional catchment context (21.4.5.1) identify surface water features of the Project Site including several ephemeral creeks, larger creek and river catchments downstream and seasonal habitat for aquatic flora and fauna. These aquatic ecosystems are slightly to moderately disturbed from current mining and grazing activities and are classified accordingly in the EPP (Water). Historical land clearing and surrounding land uses such as cattle grazing, cropping and resource activities mean the catchments are not in pristine condition and susceptible to the impacts of existing land use activities.

The Project will have minor water demand to be met through BMA's existing surface water allocations and licences. The Project WMS has been designed with adequate capacity to avoid releases. However, BMA is seeking authority and licence conditions to conduct the controlled release of MAW from the PWD to allow responsible flexibility and contingency management of MAW inventories. In the rare event the site experiences extreme rainfall conditions exceeding the containment volume developed for each storage, licensed release will be used as a water management strategy in preference to allowing spills from MAW dam emergency spillway structures. Spillway release from the process water dam proposed to be directed to Boomerang Creek has potential to impact on water quality and dependent ecosystems in the receiving environment.

The Project's longwall mining methods will likely result in subsidence and has potential to alter goaf. The development of avulsion paths, meander cut offs and head cuts may occur in areas where the energy gradients are increased by subsidence, particularly flow paths which drop into subsided panel zones over pillars or end walls. Some panel catchments will pond water until they fill and spill. Subsidence will have local attenuation effects on low flows through temporary storage in watercourse panel ponds, however BMA will apply minor remedial drainage works to encourage a free draining landform to ensure the impact to downstream flows is negligible.

Potential impacts on surface water flows and quality will be assessed in Section 21.9.

21.5.1.2 Groundwater

The Project is located on the western limb of the geological Bowen Basin and is underlain by Quaternary and Tertiary sediments which overly the Permian strata, which hosts the target coal seam. It is most likely that surrounding mining has already markedly modified the groundwater levels within the immediate vicinity of the mine by depressurisation and/or dewatering. The Project will require additional dewatering (dependent on strata permeability, influence of existing mine dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. The volumes of MAW will be minor and consistent with current operation, but production will be extended over an additional 20-year mine life.

Dewatering can lower groundwater levels and has the potential to reduce groundwater levels in existing bores within the influence of the mine. There is potential for indirect impacts in the form of induced flow from near surface units above the longwall panels and from seasonal flows in surface water creeks; however, surface water systems are separated from the groundwater resources by low permeable sediments, which reduce the potential for the Project to impact on the alluvium and surface water flows.

Groundwater quality is not suitable for drinking, too deep for surface ecosystems, and can be too saline for livestock watering. MAW will be managed through the Project WMS where it will be repurposed for process use and managed to prevent controlled releases and uncontrolled (spillway) discharge the receiving environment through water balance, transfer network and operational rules.

While subsidence and goaf alteration are predicted as likely to occur, the potential for impacts to groundwater levels and quality will be assessed in Section 21.9.

21.5.2 Threatened species and ecological communities

21.5.2.1 Threatened ecological communities

A review of the EPBC Act Protected Matters Search indicated four EPBC listed TECs with having potential to occur within or in the vicinity of the Project Site. The list of TECs, status under Commonwealth legislation and likelihood of occurrence is presented Table 21-41 .

Table 21-41 Likelihood of occurrence assessment for TECs

Ecological community	EPBC Act status	Description	Likelihood of occurrence
Brigalow (*Acacia harpophylla* dominant and codominant)	Endangered	*Acacia harpophylla* (Brigalow) is a distinctive silver-foliaged shrub or tree dominant or co-dominant in open forests or woodlands within Queensland and NSW.	**Known.** This TEC corresponds to REs that have been identified within the Project Site by Queensland Government mapping and confirmed during field surveys.
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	Native tussock grasslands typically composed of a mixture of forbs (i.e. herbs that are broad-leaved and not grass-like) and native grasses that usually occur where fine grained sedimentary rocks occur on alluvial plains, flat ground or gently undulating rises in subtropical climate.	**Known.** This TEC has been identified by SKM within the Project Site and confirmed by AECOM during biodiversity surveys in 2016.
Semi-evergreen vine thickets (SEVT) of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Dry seasonal subtropical rainforest on medium-high fertility soils, generally characterised by the prominence of vines, twining or scrambling plants on mixed evergreen, semi-evergreen and deciduous tree species with microphyll sized leaves (2.5–7.5 centimetres (cm) long) and the frequent presence of Swollen-stemmed “Bottle Trees” (*Brachychiton australis, B. rupestris*) as emergent from the vegetation.	**Unlikely.** REs analogous to this TEC have not been mapped by DES within the Project Site and the TEC was not identified during ecological surveys.
Weeping Myall Woodlands	Endangered	Open, shrubby or grassy woodland in which Weeping Myall (*Acacia pendula*) trees are the sole or dominant overstorey species with understorey comprising an open layer of shrubs above an open ground layer of grasses and herbs.	**Unlikely.** Analogous RE (RE 11.3.2) was mapped by DES within the Project Site, however it was not identified through extensive ecological surveys.

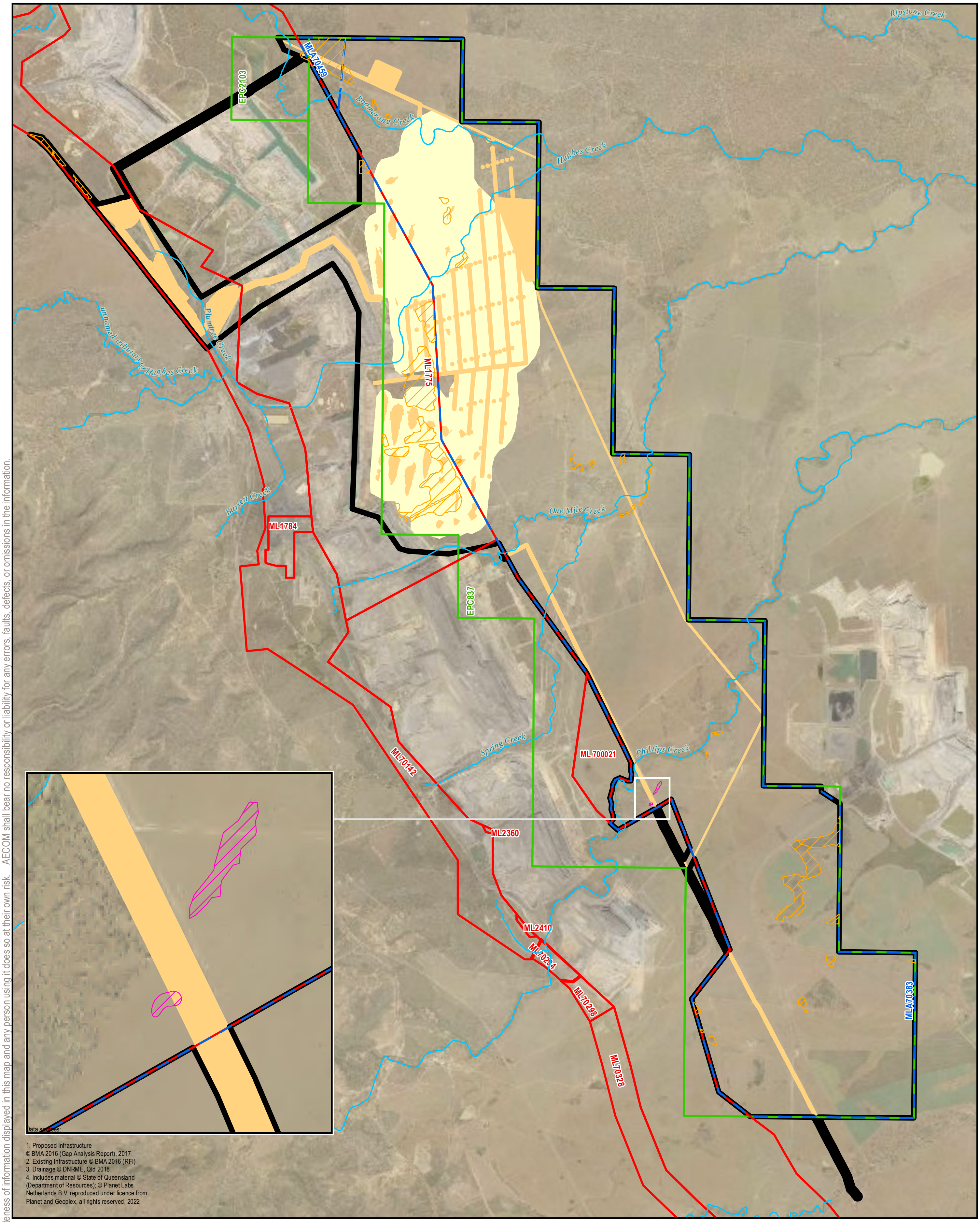
Field surveys undertaken as described in Section 21.3.2.2 confirmed the presence of two EPBC Act listed TECs within the Project Site:

- natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
- brigalow (*Acacia harpophylla* dominant and co-dominant).

Within the Project Site, a total of 1.73 ha of Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin and 396.54 ha of Brigalow (*Acacia harpophylla* dominant and co-dominant) TECs was ground-truthed and delineated. This included areas field validated to meet the relevant key diagnostic criteria and condition thresholds. The TECs present within the Project Site are described according to analogous REs and distribution in Table 21-42 and illustrated in Figure 21-39.

Table 21-42 Observed TECs within Project Site

EPBC TEC	EPBC Act status	Analogous REs	Project Site extent (ha)	Project Footprint extent (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	RE 11.3.1 RE 11.4.8 RE 11.4.9 (only polygons meeting criteria for this TEC)	396.54	210.31
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	RE 11.4.4	1.73	0.08



LEGEND

- Project Site
- Pipeline
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Threatened ecological community

- Brigalow (Acacia harpophylla dominant and co-dominant)
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

N

Figure 21-39
Threatened ecological communities observed within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 4

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\21 MNES Ecology\60507031_G242_v4_A4P.mxd

21.5.2.2 Threatened flora

The literature review and desktop searches indicated that six EPBC Act listed flora species are potentially present within in the Project Site. The assessment of likelihood of occurrence of each species is based on a comparison of the species' preferred habitat against the habitat present within the Project Site and whether the species has been recorded in the area. The likelihood of occurrence of these species is detailed in Table 21-43.

Of the six EPBC Act listed flora species identified in the desktop search, field surveys confirmed the presence of one: *Dichanthium setosum* (Bluegrass), which is listed as Vulnerable under the EPBC Act. Field surveys located the EPBC Act listed *Dichanthium setosum* (Bluegrass) within the Project Site, south of Phillips Creek (Figure 21-39) where it was observed as one of the dominant species within RE 11.4.4 (*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains which forms part of the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC). No other EPBC Act listed flora species were recorded during the field surveys.

In addition to the known occurrence of *Dichanthium setosum* (Bluegrass), the likelihood of occurrence assessment concluded one species was likely to occur, one species has the potential to occur and three species are unlikely to be present. *Dichanthium queenslandicum* (King Bluegrass) was not identified during the field surveys but is considered likely as this species is known to inhabit similar areas to *Dichanthium setosum* (Bluegrass). *Aristida annua* has a distribution often associated with the Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC found within the Project Site and has a potential presence within the area.

Table 21-43 Likelihood of occurrence for EPBC Act threatened flora species within the Project Site

Threatened flora	EPBC Act Status	Habitat/Distribution	Likelihood of occurrence
Aristida annua	Vulnerable	Annual grass growing to approximately 50 cm in height. Occurs in eucalypt woodland and is restricted to black clay soils and basalt soils. This habitat is limited on site. Distribution is associated with the *Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* TEC.	**Potential** Suitable habitat within natural grassland habitat within the Project Site.
Cadellia pentastylis Ooline	Vulnerable	Ooline is a medium-sized spreading tree typically growing to 10 m high, but occasionally up to 25 m. Its distribution is from the NSW north-west slopes to Carnarvon Range and the Callide Valley in Queensland. Ooline occurs within dry rainforest, semi-evergreen vine thickets and sclerophyll communities. Ooline is a large, conspicuous species which is unlikely not to have been identified during extensive field surveys had it existed on site. No records are available within the area.	**Unlikely** Ooline is a large, conspicuous species which is unlikely not to have been identified during extensive field surveys had it existed on site. No records are available within the area.
Cycas ophiolitica	Endangered	*Cycas ophiolitica* occurs from Marlborough to the Fitzroy River near Rockhampton, in woodland or open woodland dominated by eucalypts, often on serpentinite substrates.	**Unlikely** No suitable habitat within the Project Site.
Dichanthium setosum Bluegrass	Vulnerable	An upright bluegrass less than 1 m tall. Associated with heavy basaltic black soils and found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. In Queensland its distribution includes the Leichhardt, Moreton, North Kennedy and Port Curtis regions.	**Known** *Dichanthium setosum* (bluegrass) was recorded within RE 11.4.4 in the south of the Project Site (Figure 21-39). This was found to be a dominant species within this vegetation community.

Threatened flora	EPBC Act Status	Habitat/Distribution	Likelihood of occurrence
Dichanthium queenslandicum King Bluegrass	Endangered	A perennial grass growing to 80 cm in height. Occurs on black cracking clay in tussock grasslands. Mostly occurs in natural bluegrass grasslands including the *Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin* TEC which occurs within the Project Site. *Dichanthium queenslandicum* (King Bluegrass) was not identified during the field surveys. However, these species are known to inhabit similar areas to *Dichanthium setosum* (Bluegrass) and therefore has been considered as a High potential of occurrence within the Project Site.	**Likely** Suitable habitat within natural grassland habitat within the Project Site.
Samadera bidwillii Quassia	Vulnerable	*Samadera bidwillii* (*Quassia bidwillii*) is a small tree or shrub that is endemic to Queensland. It is distinguished by its red floral clusters (November to March), slender flower stalks and smooth red fruits (February to April). Branchlets are ribbed with fine, pale brown hairs. Leaves are stiff, narrowly elliptical and leathery with a glabrous upper surface and sparsely hairy lower surface. It commonly occurs in rainforest margins, low land rainforest with a canopy dominated by Hoop Pine (*Araucaria cunninghamii*) or open eucalypt forests in moist areas such as creek lines and riverbanks and in locations up to 510 m. The species can also occur on ridges and disturbed habitats such as roadside vegetation.	**Unlikely** The Project Site does not fall within the known distribution of this species and the species was not recorded during extensive ecological surveys.

21.5.2.3 Threatened fauna

The literature review and desktop searches indicated that 20 EPBC Act listed fauna species potentially present within the Project Site. The likelihood assessment of each species is based on an analysis of the species' preferred habitat and the habitat present within the Project Site and whether the species has been recorded in the Project Site or surrounds. The likelihood of occurrence of these species is discussed in Table 21-44.

Of the 20 fauna species identified in the desktop search, field surveys determined presence of five EPBC Act listed fauna species within the Project Site:

- Ornamental Snake (*Denisonia maculata*), identified as Vulnerable under the EPBC Act
- Australian Painted Snipe (*Rostratula australis*), identified as Endangered under the EPBC Act
- Squatter Pigeon (*Geophaps scripta scripta*), identified as Vulnerable under the EPBC Act
- Greater Glider (*Petauroides volans*), identified as Vulnerable under the EPBC Act
- Koala (*Phascolarctos cinereus*) (combined populations of Qld, NSW and the ACT) identified as Vulnerable under the EPBC Act.

Figure 21-40 illustrates observed species locations.

In addition, the likelihood assessment concluded four EPBC Act listed fauna species have the potential to occur throughout the Project Site. These species are:

- Yakka Skink (*Egernia rugosa*), identified as Vulnerable under the EPBC Act
- Dunmall's Snake (*Furina dunmalli*), identified as Vulnerable under the EPBC Act

- Curlew Sandpiper (*Calidris ferruginea*), identified as Critically Endangered and migratory under the EPBC Act
- Painted Honeyeater (*Grantiella picta*), identified as Vulnerable under the EPBC Act.

Table 21-44 EPBC Listed Threatened Fauna Species Potentially Occurring in the Project Site

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Denisonia maculata Ornamental Snake	Vulnerable	This species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai mounds and depressions in Queensland RE Land Zone 4, but also lake margins and wetlands. This species' habitat is likely to be found in *Acacia harpophylla*, *Acacia cambagei*, *Acacia argyrodendron* or *Eucalyptus coolabah*-dominated vegetation communities, or pure grassland associated with gilgais. These are commonly mapped as Queensland REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9, 11.5.16 or mapped as cleared but where the above REs formerly occurred (Department of Sustainability Environment Water Population and Communities, 2011a). This species is known only from the Brigalow Belt North and parts of the Brigalow Belt South biogeographical regions. The core of the species' distribution occurs within the drainage system of the Fitzroy and Dawson Rivers (Department of Agriculture Water and the Environment, 2020b).	**Known.** The Ornamental Snake (*Denisonia maculata*) has been recorded in the Project Site on multiple occasions: • Two locations during surveys by AECOM (2020) • Three locations during surveys by SKM (2012)
Egernia rugosa Yakka Skink	Vulnerable	Habitat requirements are poorly known; however, this species is known from rocky outcrops, sand plain areas and dense ground vegetation, in association with open dry sclerophyll forest (ironbark) or woodland, brigalow forest and open shrubland. In the Brigalow Belt bioregion, core habitat includes: Poplar Box (*Eucalyptus populnea*) Woodland, Mulga (*Acacia aneura*) Woodland, White Cypress Pine (*Callitris glaucophylla*); usually in association with Eucalypt Species such as *E. populnea*, *E. melanophloia* or *Corymbia tessellaris*, Ironbark (typically *E. melanophloia*) woodland, and disturbed, treated and cleared areas of suitable habitat, grazed or ungrazed, where suitable microhabitat features still remain (Ferguson and Mathieson, 2014). Colonies have been found in large hollow logs, cavities or burrows under large fallen trees, tree stumps, logs, stick-raked piles, large rocks and rock piles, dense ground-covering vegetation, and deeply eroded gullies, tunnels and sinkholes (Department of Sustainability Environment Water Population and Communities, 2011a). The known distribution of the Yakka Skink (*Egernia rugosa*) extends from the coast to the hinterland of sub-humid to semi-arid eastern Queensland. This vast area covers portions of the Brigalow Belt, Mulga Lands, South-east Queensland, Einasleigh Uplands, Wet Tropics and Cape York Peninsula Biogeographical Regions (Department of Agriculture Water and the Environment, 2020b).	**Potential.** Suitable habitat (*Eucalyptus populnea* (Poplar Box) Woodland (RE 11.5.3 and RE11.3.2) for the Yakka Skink (*Egernia rugosa*) is found within the Project Site. No nearby records occur. Most records are found south of the Project Site with the nearest recent recorded occurrence at the Jellinbah Mine (ALA), 100 km south of the Project Site in 2000.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Elseya albagula Southern Snapping Turtle	Critically Endangered	The southern snapping turtle prefers clear, flowing, well-oxygenated water associated with their ability to extract oxygen from the water via cloacal respiration. Populations occur at much lower densities where flow is reduced (upstream of dams, weirs etc.). This species occurs only in three catchments (Burnett, Mary and Fitzroy) and is considered a habitat specialist (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Streams in the Project Site are ephemeral and are subject to variable flow regimes, with the availability of permanent water largely accounted for by on-stream farm dams. The condition of the streams within the Project Site are poor to moderate with low habitat and channel diversity. No nearby records occur.
Furina dunmalli Dunmall's Snake	Vulnerable	This species has been found in a broad range of habitats, including: forests and woodlands on black alluvial cracking clay and clay loams dominated by *Acacia harpophylla*, *Acacia burrowii, Acacia deanei, Acacia leiocalyx*, *Callitris* spp. or *Allocasuarina luehmannii*; and various *Corymbia citriodora*, *Eucalyptus crebra* and *Eucalyptus melanophloia*, *Callitris glaucophylla* and *Allocasuarina luehmannii* open forest and woodland associations on sandstone derived soils. The Dunmall's Snake occurs primarily in the Brigalow Belt region in the south-eastern interior of Queensland. Records indicate sites at elevations between 200–500 m above sea level (Department of Agriculture Water and the Environment, 2020b).	**Potential.** Suitable habitat in the form of brigalow woodland on clay (RE 11.3.1 /11.4.8/ 11.4.9) is present across the Project Site. The nearest recent recorded occurrence was in 1999 located near Clermont, 80 km to the west of the Project Site.
Lerista allanae Allan's lerista, retro slider	Endangered	Suitable habitat for this species is described as vegetation occurring on mid to dark-brown-coloured, non-cracking clay soils in Queensland REs 11.8.5 and 11.8.11/11.8.5 and grassy open-woodland mapped as cleared but where the above REs formerly occurred (Department of Sustainability Environment Water Population and Communities, 2011a). The retro slider's range is believed to occur within the area bound by coordinates: 21°00'–24°00' South (S) and 147°00'–149°00' East (E). This area is within the Brigalow Belt North Bioregion (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** This species is known only from black soil downs in the central Brigalow Belt Region from three localities: Clermont, 55 km north-east of Clermont and 30 km northwest of Capella.
Rheodytes leukops Fitzroy River Turtle	Vulnerable	Fitzroy River Turtles (*Rheodytes leukops*) are generally attributed to fast-flowing clear freshwater rivers and rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles, commonly in association with Eucalyptus tereticornis, Casuarina cunninghamiana, Callistemon viminalis, Melaleuca linariifolia and Vallisneria sp. The bulk of records for this species are associated with the large primary streams of the Fitzroy River system: the Nogoa, Comet, MacKenzie, Connors, Isaac, Dawson and Fitzroy Rivers (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** No suitable habitat for this species is found within the Project Site and no nearby database records are available.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Calidris ferruginea Curlew sandpiper	Critically Endangered/ Migratory	Curlew Sandpipers (*Calidris ferruginea*) mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They occur in both fresh and brackish waters. In Australia, curlew sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers (Department of Agriculture Water and the Environment, 2020b).	**Potential.** Wetlands in the north of the Project Site may provide limited suitable habitat. No records are available from previous surveys and no records from Wildlife Online or Atlas of Living Australia databases are available within ten km. The nearest recorded inland occurrences are at Lake Maraboon, 125 km south of the Project Site.
Erythrotriorchis radiatus Red Goshawk	Vulnerable	The Red Goshawk (*Erythrotriorchis radiatus*) occurs mostly in extensive areas of coastal and subcoastal open forest and woodland that support a mosaic of vegetation types. The vegetation types include eucalypt woodland, open forest, tall open forest, gallery rainforest, swamp sclerophyll forest, and rainforest margins. Permanent water (watercourses and wetlands) is usually present in close proximity, with tall emergent trees used for nesting. The red goshawk is thought to have a very large home range covering between 50 and 220 km^2. Sparsely distributed across coastal and sub-coastal Australia, from the western Kimberly to northern New South Wales. Appears to have been a contraction in range in recent years. Occasionally recorded from gorge country in central Australia and western Queensland (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Suitable habitat is not present in the Project Site. No nearby records occur.
Geophaps scripta scripta Squatter Pigeon (Southern)	Vulnerable	The Squatter Pigeon (southern) (*Geophaps scripta scripta*) occurs in dry grassy woodland and open forest, mostly in sandy areas close to water. Breeding and foraging habitat is centralised around water resources such as dams and creeks. This sub-species is ground-dwelling that inhabits the grassy understorey of open eucalypt woodland, as well as sown grasslands with scattered remnant trees, disturbed areas (such as roads, railways, settlements and stockyards), scrubland, and *Acacia* regrowth. This sub-species is now largely (if not wholly) restricted to Queensland, from the New South Wales border, north to the Burdekin River, west to Charleville and Longreach, and east to the coast to Townsville and Proserpine (Department of Agriculture Water and the Environment, 2020b).	**Known.** The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) was recorded in the Project Site by SKM (2012) and AECOM (2017).

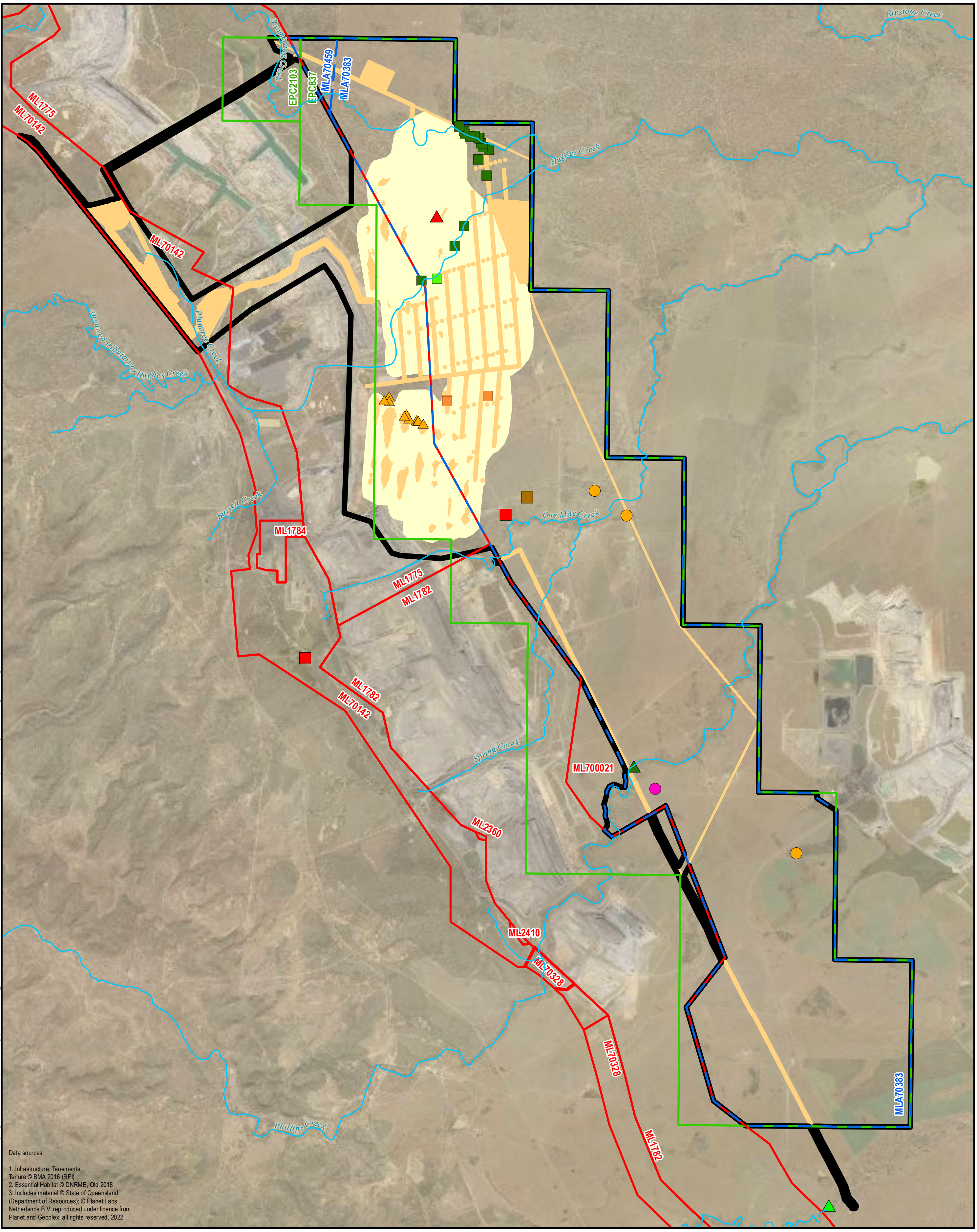
Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Grantiella picta Painted Honeyeater	Vulnerable	The painted honeyeater occurs in dry forests and woodlands, where its primary food is mistletoes in the genus *Amyema*, though it will also take some nectar and insects. It is also known to occur in riparian woodland communities dominated by eucalypt species such as *Eucalyptus camaldulensis*, although its breeding distribution is dictated by the presence of mistletoes which are largely restricted to older trees. The species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The greatest concentrations and almost all records of breeding come from south of 26º S, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland (Department of Agriculture Water and the Environment, 2020b).	**Potential.** Broad habitat types for this species exist within riparian zones however mistletoes on which they depend for a feeding resource were rare. Recent record of Painted Honeyeater in a property adjacent to the Project Site.
Neochmia ruficauda ruficauda Star Finch (Eastern)	Endangered	The Star Finch (Eastern) (*Neochmia ruficauda ruficauda*) occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water. It also occurs in cleared or suburban areas such as along roadsides and in towns. Studies at nine former sites of the star finch (eastern) found that the habitat consisted mainly of woodland. These habitats are dominated by trees that are typically associated with permanent water or areas that are regularly inundated; the most common species are *Eucalyptus coolabah*, *Eucalyptus tereticornis*, *Eucalyptus tessellaris*, *Melaleuca leucadendra*, *Eucalyptus camaldulensis* and *Casuarina cunninghamii*. Based on the small number of accepted records, the distribution of this species formerly extended from Bowen in central Queensland, south to the Namoi River in northern New South Wales, and west to the Blackall Range. Recent records have been obtained only from scattered sites in central Queensland (i.e. between 21°S and 25°S, and 141°E and 150°E) and, consequently, the Star Finch (Eastern) (*Neochmia ruficauda ruficaud*) now appears to be extinct in both south-eastern Queensland and northern New South Wales (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Suitable habitat occurs within the Project Site however no confirmed sightings of this species have been made since 1995.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Poephila cincta cincta Black-throated Finch (Southern)	Endangered	The Black-throated Finch's (Southern) (*Poephila cincta* cinta) preferred habitat is grassy open woodland/forest dominated by *Eucalyptus*, *Melaleuca* or *Acacia*, but they are also known from pandanus flats and scrubby plains. The black-throated finch (southern) feeds on the seed of native grasses from the ground. Three resources are required for the species to persist: water, grass seeds and trees providing suitable habitat. If any of these three resources are not available, Black-throated Finch (Southern) (*Poephila cincta* cinta) is unlikely to be present. Since 1998, birds likely to be of the southern subspecies have been recorded at the following sites: Townsville and its surrounds; Ingham, and sites nearby; and scattered sites in central-eastern Queensland (Great Basalt Wall, Yarrowmere Station, Moonoomoo Station, Doongmabulla Station, Fortuna Station and Aramac) (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Suitable habitat occurs within the Project Site; however, this species is now restricted to three key sites within Queensland. No nearby records occur.
Rostratula australis Australian Painted Snipe	Endangered	Preferred habitat includes shallow inland wetlands, brackish or freshwater, that are permanently or temporarily inundated. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum Muehlenbeckia or canegrass or sometimes tea-tree (*Melaleuca*). Breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. This species has been recorded from wetlands in all Australian states; most common in eastern Australia, especially the Murray-Darling Basin. Individuals are nomadic, and there is some evidence of partial migration from south-eastern wetlands to coastal central and northern Queensland in autumn and winter (Department of Agriculture Water and the Environment, 2020b).	**Known.** This species was observed from an area of flooded *Acacia harpophylla* (Brigalow) woodland within the Project Site during SKM surveys in 2007.
Dasyurus hallucatus Northern Quoll	Endangered	The Northern Quoll (*Dasyurus* hallacatus) occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. Northern quoll is also known to occupy non rocky lowland habitats such as beachscrub communities in central Queensland. Northern Quoll (*Dasyurus* hallacatus) habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. In Queensland, the Northern Quoll (*Dasyurus* hallacatus) is known to occur as far south as Gracemere and Mount Morgan, south of Rockhampton, as far north as Weipa in Queensland and extends as far west into central Queensland to the vicinity of Carnarvon Range National Park (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Limited suitable habitat for this species exists in the Project Site in the form of open woodland with ground timber; however, these areas are isolated and are unlikely to support a population of northern quoll. The closest record is from 1969, located approximately 60 km south-east of the Project Site.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Macroderma gigas Ghost Bat	Vulnerable	The Ghost Bat (*Macroderma gigas*) currently occupies habitats ranging from the arid Pilbara to tropical savanna woodlands and rainforests. During the daytime they roost in caves, rock crevices and old mines. Roost areas used permanently are generally deep natural caves or disused mines with a relatively stable temperature of 23−28°C and a moderate to high relative humidity of 50−100 per cent. Most of the colony disperses (up to 150 km) from permanent roosts during the non-breeding season in the cooler months. During this time this species use large numbers of caves, rock shelters, overhangs, vertical cracks, and mines during the year as day roosts. This species is recorded from a wide range of habitats from rainforest, monsoon and vine scrub in the tropics to open woodlands and arid areas. In Queensland this species is currently distributed in only four to five highly disjunct populations along the coast and inland from the McIlwraith Range in Cape York to Rockhampton. The major colony occurs at Mount Etna (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Suitable roosting habitat does not exist within the Project Site; however, some potential habitat may exist within rocky outcrops to the west of ML 1775. As this species is known to forage up to several kilometres from roost sites, the Project Site may provide suitable foraging habitat. Nonetheless, no database records are available from Wildlife Online or Atlas of Living Australia within 50 km of the Project Site.
Nyctophilus corbeni South-eastern Long-eared Bat	Vulnerable	The South-eastern Long-eared Bat (*Nyctophilus corbeni*) is found in a wide range of inland woodland vegetation types. These include box/ironbark/cypress pine woodlands, *Allocasuarina luehmannii* woodlands, *Acacia harpophylla* woodland, *Casuarina cristata* woodland, *Angophora costata* woodland, *Eucalyptus camaldulensis* forest, *Eucalyptus largiflorens* woodland, and various types of tree mallee. This species is more abundant in extensive stands of vegetation in comparison to smaller woodland patches. The South-eastern Long-eared Bat (*Nyctophilus corbeni*) is found in southern central Queensland, central western New South Wales, north-western Victoria and eastern South Australia, where it is patchily distributed, with most of its range in the Murray Darling Basin. Most records are from inland of the Great Dividing Range (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** Although some suitable habitat does exist within the Project Site, no database records are available from Wildlife Online or Atlas of Living Australia.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Petauroides volans Greater Glider	Vulnerable	During the day, this species spends most of its time denning in hollowed trees, with each animal inhabiting up to twenty different dens within its home range. It is primarily folivorous, with a diet mostly comprising the leaves and flowers of Myrtaceae (e.g. eucalypt) trees. The Greater Glider (*Petauroides volans*) is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows. The Greater Glider (*Petauroides volans*) is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria, with an elevational range from sea level to 1200 m above sea level. An isolated inland subpopulation occurs in the Gregory Range west of Townsville, and another in Einasleigh (Department of Agriculture Water and the Environment, 2020b).	**Known.** Greater Glider (*Petauroides volans*) was located in mature *Eucalyptus camaldulensis* (River Red Gum) woodlands fringing Phillips Creek in the south of the Project Site by SKM (2012) and a total of 19 records were made along Boomerang Creek, Hughes Creek and in adjacent Eucalyptus and Corymbia open woodland by AECOM (2020). Several records are available from Atlas of Living Australia approximately ten km west of the Project Site and the species was recorded from Peak Downs Mine East to the north of the Project Site by AECOM in 2018.
Phascolarctos cinereus Koala	Vulnerable	Koalas (*Phascolarctos cinereus*) inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus*. Koalas (*Phascolarctos cinereus*) eat a variety of eucalypt leaves and a few other related tree species, including *Lophostemon*, *Melaleuca* and *Corymbia* species. Koalas (*Phascolarctos cinereus*) are found in higher densities where food trees are growing on more fertile soils and along watercourses. They do, however, remain in areas where their habitat has been partially cleared and in urban areas. In Queensland, the Koala's (*Phascolarctos cinereus*) distribution extends inland from the east coast: from the Wet Tropics interim biogeographic regionalisation of Australia bioregion, into the Einasleigh Uplands bioregion; from the Central Mackay Coast bioregion, through the Brigalow Belt North bioregion to the Desert Uplands and Mitchell Grass Downs bioregions, and from the South-east Queensland bioregion, through the Brigalow Belt to the Mulga Lands and Channel Country bioregions in the southwest of the state (Department of Agriculture Water and the Environment, 2020b).	**Known.** One Koala (*Phascolarctos cinereus*) was recorded within the Project Site during the AECOM 2020 survey and two records also exists directly adjacent to the Project Site from previous surveys. One record of Koala (*Phascolarctos cinereus*) is also available from Atlas of Living Australia (2014); approximately four km west of the Project Site.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Pteropus poliocephalus Grey-headed Flying Fox	Vulnerable	Grey-headed Flying-foxes (*Pteropus poliocephalus*) occupy the coastal lowlands and slopes of south-eastern Australia from Bundaberg to Geelong and are usually found at altitudes < 200 m. Areas of repeated occupation extend inland to the tablelands and western slopes in northern New South Wales and the tablelands in southern Queensland. Grey-headed Flying-foxes (*Pteropus poliocephalus*) require a continuous sequence of productive foraging habitats, the migration corridors or stopover habitats that link them, and suitable roosting habitat within nightly commuting distance of foraging areas. Areas supporting these characters are considered to be habitat critical to the survival of the Grey-headed Flying-fox (*Pteropus poliocephalus*) (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** The Project Site is approaching the western limit of the species' range and no records are available within 100 km.
Maccullochella peelii Murray Cod	Vulnerable	Murray Cod (*Maccullochella peelii*) are frequently found in the main channels of rivers and larger tributaries. This species is, therefore, considered a main-channel specialist. Preferred microhabitat consists of complex structural features in streams such as large rocks, snags (pieces of large submerged woody debris), overhanging stream banks and vegetation, tree stumps, logs, branches and other woody structures. The natural distribution of the Murray Cod (*Maccullochella peelii*) is within the Murray-Darling Basin extending from southern Queensland through the south-eastern states and territories. Within Queensland, many attempts at translocation have resulted in some introduced populations existing in the Burnett and Fitzroy River basins and the Cooper Creek system (Department of Agriculture Water and the Environment, 2020b).	**Unlikely.** The Project Site is not within the natural distribution of the species or the known areas of introduced populations. No records are available within 20 km of the Project Site.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Threatened Fauna and Flora Records

- Ornamental Snake (SKM 2012)
- Ornamental Snake (Australian Living atlas 2016)
- Ornamental snake (AECOM 2020)
- Koala (URS 2014)
- Koala (AECOM 2020)
- Greater glider (AECOM 2020)
- Greater Glider (SKM 2012)
- Squatter pigeon (AECOM 2017)
- Squatter Pigeon (SKM 2012)
- Painted Snipe (SKM 2012)
- Bluegrass

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Figure 21-40
Observed threatened flora and fauna within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 2

21.6 Potential impacts

21.6.1 Water resources

Potential impacts associated with the Project on water resources include the reduction of surface water flow, water quality and groundwater drawdown. A summary of potential impacts of mining activities on water resources has been compiled based on the proposed mining activities.

Construction

During construction, the proposed mining activities will start within the existing open-cut pits (high wall) where the start of the portal is constructed to facilitate access to the longwall mining panels underground. Construction earthworks will progress underground with new surface infrastructure constructed only where additional capacity is required. In this way, potential impacts generally associated with construction are avoided e.g. erosion and sedimentation typically associated with vegetation clearing and earthworks.

As construction is expected to occur in the dewatered sediments immediately adjacent to the high wall, no additional groundwater impacts are predicted during construction.

Outside of the mining area, construction of temporary accommodation, access roads, IMG drainage, transmission lines and pipelines have potential to contribute to increased erosion and sedimentation of receiving surface waters and mobilisation of other contaminants in runoff from the construction site. Sediments generated during construction can enter stormwater runoff or be carried by wind into surface water and affect water quality, sedimentation, geomorphology and productivity of aquatic and benthic ecosystems. Temporary short-term increase in potential for erosion and sedimentation can be managed effectively on site through accepted industry practices.

Operation

There are no new diversions planned as part of the Project; overland flow will continue to be managed through a series of existing diversion drains designed to provide conveyance of clean water flows away from the WMS.

Surface runoff from mine process areas will be collected within onsite storages as MAW contained within the existing WMS. Potential adverse impacts can arise during the operational phase of the Project due to WMS infrastructure malfunctions (storages, pipes, pump failure) and flooding of the mine area, leading to a release of MAW into the environment. To mitigate this risk, the WMS concept was developed to retain MAW at the MIA storm water system or within the WMS if flooding or water infrastructure failure occur. Therefore, the external environmental impact is expected to be minimal.

The sizing of mine water management structures for the Project has been conservatively designed such that controlled releases of MAW to the receiving environment are not required, and capacities are sufficient to mitigate the uncontrolled (spillway) release of MAW to the receiving environment. As such, under normal operating circumstances, there is not anticipated to be any controlled or uncontrolled discharges from the Project Site.

As part of the EA for the Project, BMA are seeking authority and licence conditions to conduct the controlled release of MAW as a result of extreme rainfall event under certain flow conditions. The release point is proposed on Boomerang Creek adjacent to the proposed process water dam, as shown in Figure 21-1. Two new monitoring points are proposed downstream of the controlled discharge point on Boomerang Creek. The indicative locations of the monitoring points are shown in Figure 21-1.

During operation, the underground workings can impact water resources through:

- direct impacts of mine dewatering and ponding where subsidence intersects waterways
- indirect impacts of mine dewatering, including induced flow and alteration of landform, geology and associated aquifer hydraulic properties due to goaf.

Dewatering will be required (dependent on strata permeability, influence of existing mine dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. As a result, groundwater levels will be drawn down during the operational phase.

Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater supplies. Indirect impacts of dewatering longwall panels may include:

- drawdown in the near-surface Tertiary and Quaternary-age units present above the panels
- additional leakage from the overlying altered (due to goaf) Permian units to the dewatered and depressurised target coal seams
- drawdown of the coal seam potentiometric surface that can extend beneath Hughes Creek potentially causing seasonal surface water flows and remnant pools in the creek to decline and increase the frequency or duration of no flow in the creek.

Subsidence effects on within Boomerang and Hughes Creek has potential to impact water quality and quantity through increased erosion and water attenuation, and ponding. Within the predicted areas of subsidence, there is an increased risk waterways develop ponded areas associated with landform changes (Alluvium, 2023). The short-term nature of stream flows in response to high rainfall means that potential impact on hydrological characteristics and stream flow will be low. Reduced stream flow will be a very small to negligible component of the entire Isaac River catchment. Impacts of subsidence will reduce over time as bed load sediments fill in the depressions. An adaptive management framework is suggested to mitigate and minimise subsidence impacts.

As surface water will be suitably managed on site during normal operation, the impacts on the quality of the surface water environment associated with the Project are expected to be smaller than the impacts from other existing land uses in the catchments as indicated by the elevated concentrations of nutrients found in surface water of the catchment. As such the risk of potential impacts to surface water is considered low. As a result, potential impacts of water resources focus on potential groundwater impacts associated with the Project.

<u>Decommissioning</u>

On completion of the proposed underground workings the approved SRM open-cut final voids will be in place. The post closure phase considers the potential impacts on groundwater resources related to the partial backfilling of the open-cut pits (final voids), such that groundwater levels are considered to recover within the underground workings up into the final voids. Reduced groundwater levels and alterations to the groundwater regime are due to ongoing evaporation from final void areas.

Final voids can gradually fill with water once dewatering operations have ceased. Potential evaporation losses from the voids are considered to exceed predicted groundwater inflow and hence the voids are expected to remain mainly dry, except following prolonged heavy rainfall events. In this case, ongoing evaporation from these voids will essentially act as long-term groundwater extractions from within the mine area, with the potential to permanently reduce groundwater levels to the base of proposed final voids.

Long term predictions are for the groundwater to recover within the Project area but not to pre-mining levels due to final voids.

21.6.1.1 Surface water

Potential impacts to surface water include:

- direct impacts of water use, WMS emergency releases, WMS failure, contamination (including erosion and sedimentation) and subsidence
- indirect impacts of subsidence on flooding.

Water use

The initial water demand increase associated with the Project is in the order of 2.39 mega litres per day (ML/d) for the first year of the project. A daily water demand of 6.29 ML will be required for the period from year 2 to year 21 of the Project (AECOM 2023).

Under normal operating conditions, most water supply will be MAW and the Project MWS will operate independently of the existing SRM water system. However, should sufficient MAW not be available for CHPP process and dust suppression at the Project, BMA is authorised to import water (MAW or raw water) from the existing SRM water system under existing approval conditions, following water quality testing to confirm that water is of an appropriate quality for the intended use. Similarly, where additional water demands at the existing SRM need to be met, water satisfying water quality testing can be exported from the Project.

Raw water will be stored in the raw water dam and used to satisfy potable, underground mine, CHPP and dust suppression water demands when MAW is unavailable. Raw water from existing BMA surface water allocations will be piped to the Project Site in a raw water dam to supply clean water, including the water requirements of the CHPP and longwall mining equipment as well as to supplement site water demands as required. This raw water demand forms a very small portion of the overall site water use and includes water treated for potable uses (drinking, washrooms) and a small quantity of water required for the CHPP. While most of the water demand for the CHPP is met through recycled MAW, a minor component (typically 3 per cent) of the CHPP water use requires raw water.

Erosion and sedimentation

Water will be managed through a series of existing diversion drains and dams designed to contemporary standards to comply with regulatory requirements. Runoff from undisturbed areas will be segregated from disturbed areas to convey clean water downstream.

Surface water will be suitably managed on site during normal operation such that impacts on the quality of the surface water environment associated with the Project are expected to be smaller than impacts from other existing land uses in the catchments. This will be indicated by the elevated concentrations of nutrients found in surface water of the catchment.

Erosion and sediment mobilisation can lead to detrimental impacts on downstream water quality and aquatic habitats, although Boomerang, Hughes, One Mile, Spring and Phillips Creek have high turbidity concentrations upstream of the Project. Controls will be installed prior to and during construction in accordance with International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008).

Implications to surface water quality from erosion and sedimentation arise from earthmoving, stripping topsoil, stockpiling run of mine unprocessed material and product, vegetation removal and trenching. During construction, bare earth and uncovered stockpiles have potential to generate silt and contaminant-laden runoff. Sediment mobilised during construction activities enter surface water runoff during rainfall events and discharge to watercourses or carried by wind into surface water bodies. With erosion and sediment controls in place, the quantities of sediment likely to be mobilised from construction activities is likely to be low.

During operation, land disturbing activities may result in increased erosion potential and mobilisation of sediment to surface waters. The installation and operation of incidental mine gas management infrastructure poses the most significant risk in terms of mobilisation of sediment, as disturbance will occur across the area of the underground mine footprint, and access tracks and gas well pads will remain exposed for some time. With design and mitigation measures in place, water quality impacts associated with erosion and sedimentation on the downstream creeks are expected to be minimal.

Chemicals and contaminants

Small quantities of aqueous waste will be generated from removal of stormwater and contaminants from bunded areas and sumps. The main risk for surface water quality will arise from accidental spills and leaks of fuels and oils during the construction of the MIA and internal access roads. While some other chemicals will be utilised during construction, the quantities and natures make the risk of significant environmental harm in the event of a spill is low.

Without appropriate mitigation measures, accidental spills of fuel or any other chemicals stored onsite used during construction could enter the drainage lines and waterways. Contaminants can be mobilised during construction activities through chemical and fuel spills from temporary refuelling facilities, temporary chemical storage facilities (including oil and waste oil), installation and operation of the incidental mine gas system, temporary vehicle washdown areas, construction and commissioning of permanent fuel and chemical storage facilities.

The significance of potential impacts on surface waters will depend on the quantity and nature of contaminants as well as whether the contaminants are directly released to surface waters. If spills or leaks occur in construction areas, contaminants will either soak into soils or be captured by sediment containment devices and/or permanent stormwater systems.

Mine WMS

The conceptual mine WMS includes components such as process water storage, MAW collection storages at each processing area, raw water dam, sump and transfer network of pumps and pipes. MAW from dewatering of the underground mine and runoff collected from each process area will be stored in the process water dam. MAW stored in the process water dam will be the preferred source of water for the CHPP and dust suppression activities.

The proposed Water Management System (WMS) is documented in detail within **Appendix E-2 Mine Water Balance Technical Report** (AECOM, 2024c). Mine water from dewatering the underground mine and from incidental mine gas production will be stored and managed through the proposed mine WMS; this system has been developed to minimise the likelihood of uncontrolled spills.

The proposed WMS dams have been developed to meet containment criteria for MAW dams for a 5 per cent AEP wet season criterion, consistent with a preliminary consequence category of 'significant'. This containment criteria is a design storage allowance, which is the storage volume to be made available in each dam upon the commencement of the wet season (1 November) each year. The design storage allowance is the sum of all catchment runoff, direct rainfall over the dam and process water inflows over the critical wet period (three months duration) and assuming no evaporative or runoff losses. Preliminary assessment has sized the PWD as the primary receiving water storage for MAW across the operation, to contain all inflows up to the 5 per cent AEP criterion without controlled or uncontrolled releases, based on 500 stochastic climate sequences generated for the site location, including considerations of potential future climate change sequences.

The Process Water Dam (PWD) was assessed to hold a capacity of 125 ML and modelling indicates that it would contain less than 40 ML of MAW during general operating conditions, with volumes accumulating to up to 100 ML in wetter than average rainfall scenarios. The spill probability of the PWD was assessed to be < 0.2 per cent which indicates that no spill was modelled during the 500 different climate scenarios. Detailed information about PWD parameters is described in **Appendix E-2 Mine Water Balance Technical Report**, Section 4.8 (AECOM, 2023). This assessment concluded that the developed concept MAW total dam storage includes adequate contingent volume to contain all inflows to the system (pit sump, rainfall, runoff, treated effluent, MAW) such that managed releases are not planned as a tool to actively manage MAW inventory levels for all scenarios up to a 5 per cent AEP wet season. The results demonstrate that the WMS has sufficient capacity to manage the expected inventories of water. Additionally, modelling indicates that containment criteria for the proposed storage structures are satisfied

WMS emergency release

All mine water produced during the operation phase would be stored and managed through the proposed mine WMS, which has been developed to minimise the likelihood of uncontrolled spills. A conservative approach has been taken towards controlled and uncontrolled releases of MAW from the Project. Preliminary capacity estimates for all dams and the water transfer network (using the water balance assessment described in Section 21.3.1.1.2) within the Project conceptual mine WMS have been based on the containment of all potential inflows using historical data and climate change sequences, prioritisation for water reuse and establishing a set of assumed operational rules. This conservative approach ensures:

- Controlled releases of MAW to the receiving environment are not required
- Capacities are sufficient to prevent the uncontrolled (spillway) discharge of MAW to the receiving environment.

Licensed emergency releases will be triggered before uncontrolled spills occur. The developed concept is based on historical climate data and the assumed mine operating conditions. The influence of flooding and subsequent pumping from the highwall entry pit was considered in the water balance modelling with minimal risks of uncontrolled releases. These releases can be the consequence of extreme and rare weather events, and likely present under high flow conditions. Modelling results presented in AECOM's **Appendix E-2 Mine Water Balance Report** demonstrate that the need for licensed releases would be extremely low.

As such, under dry or normal operating circumstances, no controlled or uncontrolled discharges from the Project Site are anticipated; however, provision is made for emergency releases to occur if the rain event is beyond the design capacity of the dam, or if there has been mismanagement in the operation of the dams. As part of the EA for the Project, BMA are seeking authority and licence conditions to conduct the controlled release of MAW from the Project Site. An indicative release point at Boomerang Creek is proposed in the event a controlled release is required is shown in Figure 21-49.

Uncontrolled spills from the process water dam are extremely unlikely and would only occur when the MAW inventory exceeds 100 per cent of capacity (125 ML). In such conditions:

- MAW salinity concentrations in the Process Water Dam are predicted to be highly variable and influenced by the volume of water stored within it. The modelled salinity is generally 600-2,000 mg/L, and EC is expected to be 1,500-4,700 µS/cm according to the Mine Water Balance Technical Report (AECOM, 2024).
- Releases from the mine WMS to the receiving environment may be required if conditions are wetter than the provisions made for in the storage allowance (i.e. wetter than 5 per cent AEP wet season). The proposed WMS includes provision for the PWD to include a licensed release point on Boomerang Creek (Figure 3). The proposed release point has been included as a conservative management approach, as it would only be required in very rare to extreme rainfall conditions. BMA may utilise licensed releases (refer Section 6.1) as a water management strategy in preference to uncontrolled discharge from MAW dams.

WMS failure

The proposed WMS has been developed as a concept with adequate capacity to avoid releases. Preliminary assessment has sized the MAW dams according to the hydraulic criteria described in the *Manual for assessing consequence categories and hydraulic performance of structures* (DES, 2016) for a 'significant' consequence category.

Storage dams will be managed in accordance with the DES Manual for assessing consequence categories and hydraulic performance of structures (2016) and WMS infrastructure in accordance with BMA operational requirements.

The process water dam will be located in MLA 70383. A new pipeline will be co-located with the powerline on the western extent of the Project Site. Runoff from disturbed areas of the Project, including the new MIA, the CHPP, stockpiles, rail loop and spur, will be collected from disturbed areas and transferred via the pipeline to the PWD. The pipeline will include an extension to a discharge point at Boomerang Creek, which could be used for licensed discharges if required.

If a WMS system failure were to occur, this could potentially lead to discharge of MAW to the receiving environment in locations where mine water is able to migrate from the containment area into Boomerang and/or Hughes Creek. Potential failures include:

- A network of pipes and pumps will be used to transfer water to the process water dam and these facilities have the potential for failure.
- Failure to contain – seepage: Storage embankment failure caused by piping failure (potentially resulting from poor construction of embankment maintenance) or overtopping
- Storage dams will be managed in accordance with the DES *Manual for assessing consequence categories and hydraulic performance of structures* (2016) and WMS infrastructure in accordance with BMA operational requirements.
- Failure of pumps could result in an accumulation of MAW upstream of the pump location and/or (depending on water volumes, system configuration and system storage capacity) an overflow towards downstream surface waters may occur.

Temporary pump failure of up to seven days was modelled for significant rainfall events (>100mm of rainfall for up to 3 days) (AECOM, 2023). Results present indiscernible WMS performance differences in stored water volume inventories. This suggests that the system is adequately designed to retain

MAW within the WMS in the event of temporary pump failures, reducing the likelihood of impacts to receiving waters.

Wastewater

Main sources of waste with the potential to generate wastewaters originate from the mine water dams, product coal stockpile, CHPP, ROM Stockpile and MIA. These have the potential to generate wastewaters, which could lead to contamination and toxicity in receiving environments. These wastewaters are to be treated before discharge into the PWD.

Effluent wastewater would be generated from the production of sewage effluent and sludge produced by site infrastructure such as the accommodation village and offices. If not treated and disposed of appropriately, these wastewaters could lead to contamination and toxicity in receiving environments. Effluent wastewater will be treated and discharged to the PWD. Any sludge generated, and sewage from temporary workers accommodation village would be pumped by licensed contractor and transported to a local council sewage treatment plant.

Water quality alteration

Potential coal rejects are expected to generate pH-neutral to mildly alkaline, low-salinity runoff/seepage following surface exposure. The very small quantity of spoil likely to be generated by the Project through the construction of the underground access portals is expected to generate low salinity surface runoff and seepage.

The WMS aims to divert clean water, minimise generation of MAW and volumes stored onsite, and minimise consumption of raw water. However, raw water represents the largest single input to the mine WMS and runoff input is highly variable. Based on assumed water quality for input streams, groundwater represents the largest salt input over the life of mine at approximately 24,000 tonnes or 1,194 tonnes per year.

The process water dam will receive saline water from gas drainage and returns from the underground mining equipment, with concentrations that have the potential to exceed the guideline thresholds for some water quality parameters. It is therefore anticipated that the process water dam will be classified as a regulated dam and will need to be designed and licensed accordingly. The remaining dams on-site are unlikely to be considered regulated dams as they are unlikely to exceed the water quality guidelines as they will contain either raw water or local run-off. The management of water in these dams will be managed under the mine WMS and is discussed in detail in **Appendix E-2 Mine Water Balance Technical Report**.

Subsidence

The Project Subsidence Report produced by Minserve (2022) and the Hydrology, Hydraulics & Geomorphology Report created by Alluvium (2022) present the effects of subsidence over longwall panels on surface water quality and the receiving environment. Land surface deformation is likely to occur over long panels resulting in surface troughs, development of surface cracks and buckling.

Subsidence models in the Project Subsidence Report (Minserve, 2022) suggest Boomerang Creek and Plumtree Creek are subject to subsidence of low intensity whilst Hughes Creek exhibits subsidence at larger volumes. Figure 21-41 suggests areas of increased subsidence for Hughes Creek appear localised on the two most western panels along the stream bed, whereas the rest of the creek bed is subject to only minor levels of subsidence. These will be considered when the Project goes into the phase of detailed planning and amendments to the long wall panels may be an option to reduce impacts of subsidence on Hughes Creek.

<u>Predicted geomorphic response of surface water systems to subsidence</u>

The potential impacts of mining on the geomorphology of the streams within the Project Area are described by Alluvium (2023) based on modelling the predicted subsidence. The following is a summary of the aspects of that report relating to water quality.

Gradual infilling of subsidence in stream beds will occur as longwall panels are installed. Boomerang and Plumtree Creek systems exhibit higher bed sediment transport capacities upstream compared to downstream, which will likely lead to increased sediment accumulation in the subsided areas downstream and rapid infilling of depressions. Hughes Creek presents contrasting conditions with higher sediment transport capacities in the sections of the creek that will be impacted by subsidence, which can introduce instabilities in upstream diversion reach. Watercourses will likely be subject to local incision and bank erosion over pillar zones between panels. Infilling will occur as flow events commence, but the time required for the present bed grade level to be re-established depends on number of subsided panels and sediment transport capacity of the stream. Due to the elevated erosion rate in the upper reaches, sediment supply will be unlikely an issue and infilling of subsidence depressions will be associated with events large enough to transport bedload.

The floodplains could be impacted if flow paths or overland flows drop into subsidised depressions, causing incision and gully development in locally steep terrain. It is predicted that these scenarios only impact minor flow paths while larger flow paths are likely to continue along their original course. Subsidence impacts are predicted to be local and minor; however, alterations to natural flow regimes due to ponding in subsided areas (as assessed in **Appendix E-4 Conceptual Ponding Assessment** (Engeny, 2023)) will be mitigated by providing adaptive drainage management described in detail in the **Appendix K-2 Subsidence Management Plan** (BMA, 2024b).

Water quality in subsidence ponds is likely to be variable over time but following a pattern similar to natural pools in these landscapes. Initial inflows will be from surface water runoff and hence relatively low in salinity but potentially containing suspended solids collected from the catchment. As water is ponded in the altered (subsided) topography, it is lost through evaporation and the concentration of salts and any dissolved contaminants are expected to increase over time, as is observed in ponds formed in existing waterways on the Project Site. There may also be changes to other physicochemical characteristics which, are expected to be consistent with changes in naturally ponded areas.

Bed load starvation will potentially impact Boomerang and Hughes Creek downstream of the mine, elevating the risk of bank erosion in these areas. Erosion of downstream reaches will occur until sediment loads infill the subsided depressions upstream and the sediment supply returns to the existing load. The Hughes Creek system will likely be impacted downstream of the Project up to the Boomerang Creek confluence, for a period of years and possibly decades.

The subsidence resulting from the Project's underground mining may create surface cracks which in turn result in erosion responses in colluvial and alluvial sediments. Cracks in erodible sediment pose the greatest threat when orientated downslope and have the potential to cause rill erosion or gully formation. Alluvium (2022) states surface cracks will likely develop in the area around Hughes creek, where some relief is already present and differential subsidence between pillars and longwall panels is likely to occur. These cracks have the potential to expand where lighter textured soils are present and runoff is concentrated to the crack. Over the entirety of the subsided area, areas of low relief and high sand content will unlikely display enlargement of cracks in case of their emergence. An exposure of surface waters to groundwater through created cracks is unlikely as impacted groundwater resources are separated from surface waters due to low permeable sediments, reducing the potential of groundwater infiltrating alluvium and surface water flows (AECOM, 2024a).

<u>Impacts on water quality downstream through flow alteration</u>

Minor alterations to flow behaviour will be expected due to subsidence (Alluvium, 2023). The general effects will likely include a slight reduction in total flow through the site, and a flow delay due to an increased attenuation capacity of instream ponding. This could potentially lead to an overall reduced water quantity downstream resulting in decreased dilution, increased turbidity and higher concentration of nutrients. Adaptive drainage management to mitigate ponding on floodplains will reduce impacts on natural flow regimes. For instream ponding, impacts on water quality are expected to be minor and of short duration, as over time, pools and channel beds fill in, and ephemeral wetlands will slowly accrete.

During rare high rainfall events (1 per cent AEP), flooding is likely to occur between Boomerang and Hughes Creek, resulting in more frequent flow events in the lower reach of Plumtree Creek. Flooding of these areas also likely leads to mobilisation of sediment and associated nutrients. These processes already occur and alterations through subsidence are likely to be minor outside of extreme weather events.

The subsided landscape will likely develop residual ponding, which can be mitigated with adaptive drainage management to drain water in natural streams. Alterations to stream flows will revert over time to their original states as subsided depressions in creek beds fill in. The time this will take depends on number of subsided panels in relation to flow regimes and transport capacity of the creeks.

In summary, it is expected predicted subsidence over longwall panels can impact surface water quality of watercourse present on the Projectsite, however it is expected that these impacts will be minor and can be further alleviated through appropriate design and mitigation measures outlined in the Project Subsidence Management Plan (SMP) (BMA, 2024).

Flooding

The hydrology report produced by Alluvium (2022) does not depict flooding impacts of Project areas comprising mine infrastructure under 50 per cent AEP, 2 per cent AEP, 1 per cent AEP or 0.1 per cent AEP scenarios. During the detailed design stage of the Project, additional drainage design and hydrological assessment may be required. In the event flooding of the underground mine were to occur, floodwaters have potential to be contaminated with:

- Hydrocarbons from residual fuel and oils and from oily wastes stored in the MIA
- Chemicals from chemical stores (if these are inundated) and from waste storage areas
- Particulates from coal dust and other sediment present on land surfaces.

Hydraulic modelling was undertaken to provide quantification of the geomorphic assessment of subsidence impacts during the 2-year average recurrence interval (ARI) and 50-year ARI events.

Modelling predicts only moderate changes in hydraulic values resulting from subsidence. Ponding will occur in all panels but there is negligible change to the flooding extents. The two most significant changes include increased depth of water ponding upstream of the confluence of Boomerang and Hughes Creeks and, during large events, an increase in flow across the southern end of the southern panels following subsidence.

Water depth increases by up to one to two metres during the 1,000-year ARI event in the north-east corner of the panels within a large area of floodplain inundation that extends to the confluence of Boomerang and Hughes Creeks, though there is little change in extents resulting from subsidence.

The subsided landscape will change flow behaviour from upstream to downstream of the Project Site. This will have different effects at different magnitude flow events. The general effects are a reduction in total flow, more notable for the most frequent and extreme events and a delay in flow associated with the increased attenuation capacity of the subsided landscape. Residual pools will occur in parts of the landscape post-subsidence (without erosion or management intervention, which is not modelled). This will account for the reduction in flow volume leaving the Project Site. In time, with sediment movement in the system, these ponded volumes will decrease.

Residual pools in the system are generally seen as a positive environmental impact as most ephemeral wetlands or in-channel pooling has been lost to erosion and deposition. In time, subsidence pools in Boomerang and Hughes Creek will be infilled with bedload sediment.

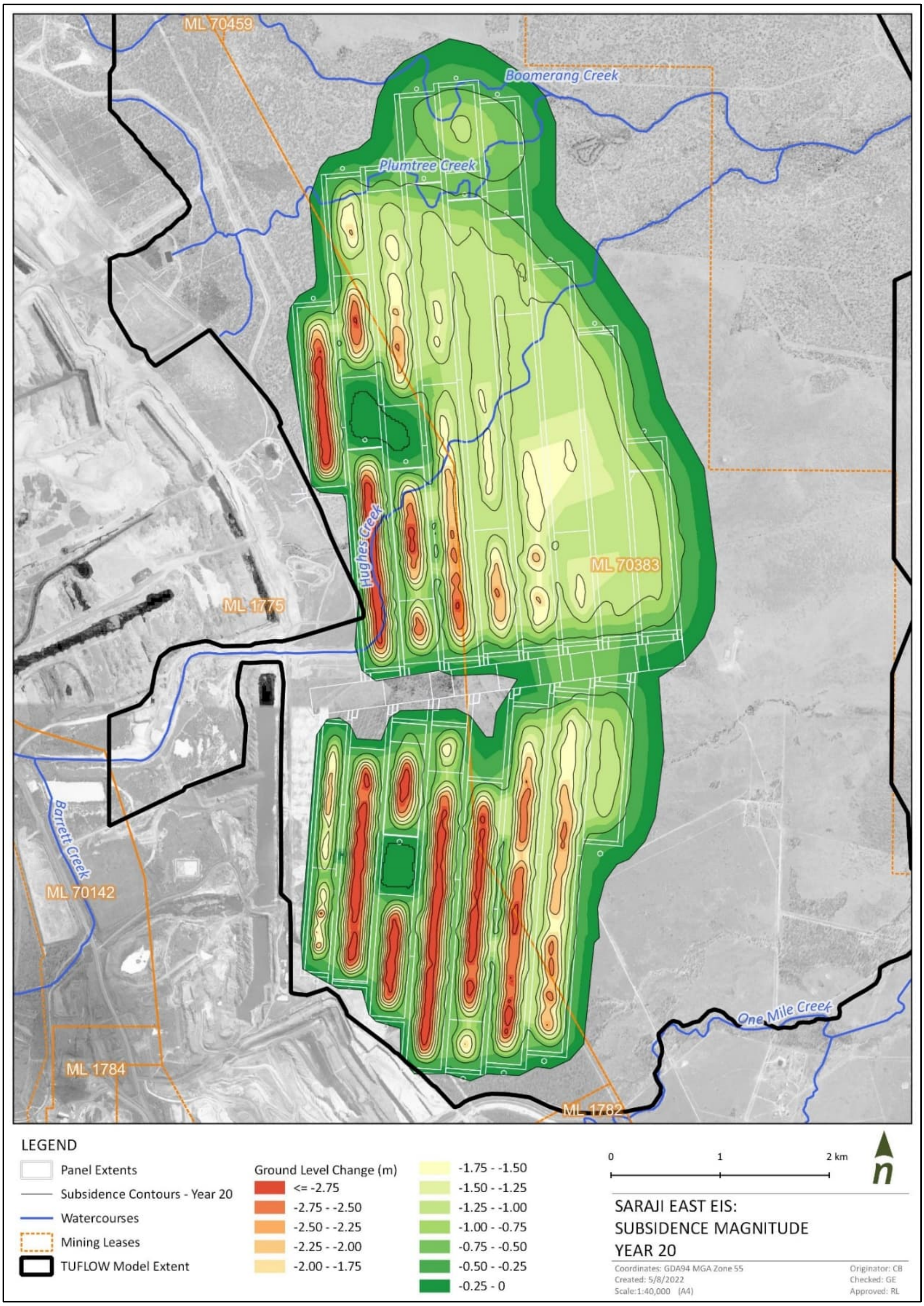


Figure 21-41 Subsidence over longwall panels in proposed underground mine (Alluvium, 2022)

21.6.1.2 Groundwater

21.6.1.2.1 Direct impacts

As the proposed mining activities will start within the existing open-cut pits (high wall), the construction phase activities include the start of the portal to facilitate access to the longwall mining panels. This construction will occur within the dewatered Permian sediments immediately adjacent to the high wall, thus no additional groundwater impacts are envisaged during construction.

The principal activities during the operational phase of the underground workings, which have potential to impact groundwater resources, include:

- Pre-mining incidental mine gas dewatering activities
- Dewatering of workings
- Alteration of geology, and associated aquifer hydraulic properties, due to goaf
- The cumulative drawdown of open-cut mining along strike, with the extended down-dip underground mining.

Mine dewatering

Dewatering will be undertaken (dependent on strata permeability, influence of existing mine dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. As a result, groundwater levels will be drawn down during the operational phase.

Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater supplies.

The dewatering impacts, outside the Project footprint, have been predicted using a regional scale numerical groundwater model (SLR, 2023). Transient predictive modelling was used to simulate the proposed Project underground mining as well as mining at other approved and foreseeable mines within the regional model domain over the same period. The modelling predicted drawdown under three model scenarios:

- Project – all approved and foreseeable mining in region, including SRM open-cut pits plus the Project.
- Approved – all approved and foreseeable mining in region including SRM.
- Null Run – no mining within region.

Mining was simulated by adding drain cells annually at the base of the target coal seam. For the different mining methods, the modelling included:

- A three-year operational window was assumed for mine cells at the SRM open-cut pits. After which time the drains were removed and then spoil properties were assigned to the model cells.
- The drains within the underground workings remained active during mining and one year following the completion of the underground panel.

The drains in the model had high drain conductance of 100 square metres per day (m^2/day), which allowed for the rapid removal of water from the mine workings.

Predictive modelling results presented were based on the best calibrated model realisation (i.e., the base case model) and uncertainty with respect to the model predictions.

<u>Groundwater ingress estimates</u>

The predicted inflows for both the Project and the SRM open-cut pits are presented in Figure 21-42.

These inflow volumes were estimated as time weighted averages of the outflow reporting to the drain cells representing the mine workings at the Project and the SRM open-cut pits.

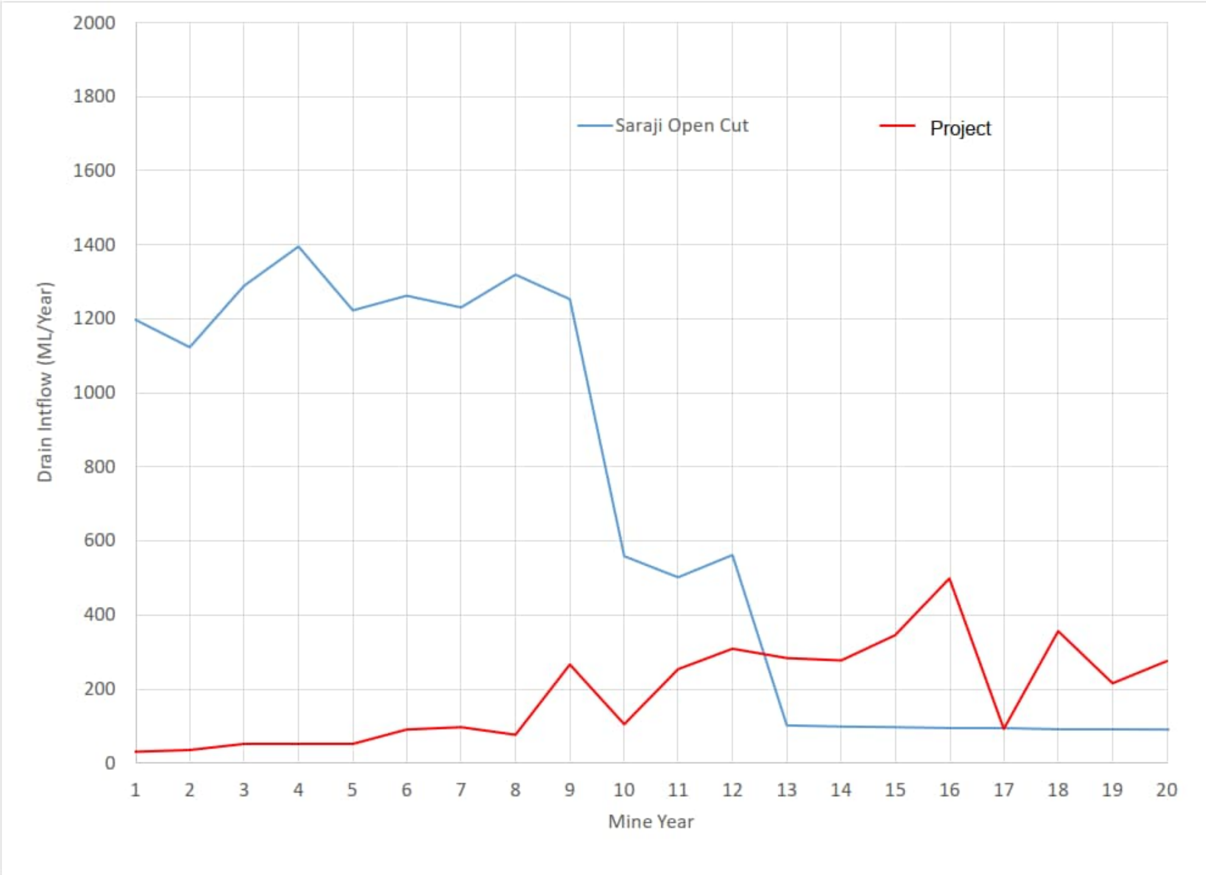


Figure 21-42 Predicted groundwater inflows (in ML/year)

The inflows at the Project are predicted to reach a maximum peak of 500 ML/year (1.4 ML/day) in Year 16 in reaction to the mine plan (longwall panels mined during that year). The average inflow rate for the Project is estimated at 183 ML/year (0.5 ML/day).

The base case model includes all the recent model structure updates from site geological information and the changes to the hydraulic properties based on the model calibration.

The predicted groundwater inflows to the approved SRM open-cut pits, due to size and strike length, are markedly larger than the predicted Project inflows between Year 1 and 9, approximately 1,200-1,400 ML/year (3.3-3.8 ML/day).

It is noted that Year 9 is the final year of the approved SRM open cut mining. The inflows will then decrease gradually and remain at around 100 ML/year (0.3 ML/day) between mine years 13 and 20. This occurs as the SRM open-cut pits will act as groundwater sinks. Groundwater levels are influenced by the open-cut pits, which act as groundwater ‘sinks’ because of water loss through evaporation.

<u>Predicted groundwater level changes</u>

Based on the predicted groundwater ingress into the mine workings, groundwater level drawdown was predicted for the Project and Approved model scenarios. This allowed for the evaluation of the additional contribution of the potential impacts of the Project on the groundwater regimes (alluvium, Tertiary, and Permian hydrostratigraphic units):

- Alluvial: predicted groundwater levels indicate no change to alluvial groundwater levels when comparing the Project to Approved mining scenarios.
- Tertiary: predicted groundwater levels in the Tertiary age units at the end of mining for the Project and Approved mining scenarios indicate dewatering caused by the Project is predicted to result in a slightly larger unsaturated zone within the Project area for the Project scenario compared to the Approved mining scenario.

- Permian: predicted groundwater levels in the target D coal seam at the end of mining for Project and Approved mining scenarios. A regional south-easterly hydraulic gradient is evident across the model for both scenarios towards the Isaac River. Zones of depressurisation at the Project and surrounding mines are shown to cause localised interruptions to the regional flow gradient.

Maximum incremental drawdown

The process of mining directly removes groundwater and reduces water levels in surrounding hydrostratigraphic units. The extent of the zone affected is dependent on the hydraulic properties of the hydrostratigraphic units (aquifers/aquitards) and is referred to as the zone of drawdown. Groundwater drawdown is greatest at the working coalface and decreases with distance from the mine workings.

The maximum incremental drawdown refers to the potential drawdown impact associated with the Project only and was determined by comparing the difference in predicted groundwater levels for the Approved scenario and the Project scenario at matching times (i.e., what additional drawdown is predicted to occur from the Project).

Predicted drawdown figures (Figure 21-43 to Figure 21-44) show where maximum incremental drawdown impacts are predicted to exceed 1 m.

- Alluvial: no incremental drawdown impacts are predicted for the Quaternary alluvium to result from the Project.
- Tertiary: maximum incremental drawdown extent within the model Layer 2 is largely confined to the Project footprint or down dip of only the northern panels as shown in Figure 21-43. The drawdown predictions are influenced by the distribution of saturated zones in the Tertiary. At the northern panels, 1 m drawdown influence is predicted to extend 4.2 km northeast of the Project mine workings.
- Permian: maximum predicted incremental drawdown in the target D seam the coal is shown in Figure 21-44. Coal seams of the Moranbah Coal Measures are the primary groundwater bearing strata at the Project and will experience drawdowns as a result of mining. Groundwater level drawdown within the mined coal seams is influenced by unit structure and is confined to unit extents. This drawdown is limited to the west due to the coal subcrop in this area (i.e., deposition of coal in the western limb of the Bowen Basin). Extent of maximum predicted incremental drawdown in the Moranbah Coal Measures coal seams are generally elongated along strike in the northwest-southeast direction and extents maximum of 5 km and 8 km northwest and southeast of the Project mine extent, respectively. The influence of fault adjacent to the Project footprint is evident and it appears that it limits potential drawdown to the east.

The drawdown shape in the Tertiary (Figure 21-43) is different to the Permian (Figure 21-44) as it is not controlled by strike and fault structures, (i.e., the faults are evident in the more competent Permian bedrock, which do not extend into the younger Tertiary age sediments).

21.6.1.2.2 Indirect impacts

Longwall mining can have indirect dewatering impacts through induced flow, which include:

- drawdown in the near-surface Tertiary and Quaternary-age units present above the longwall panels
- additional leakage from the overlying altered (due to goaf) Permian units to the dewatered and depressurised target coal seams
- drawdown of the coal seam potentiometric surface that can extend beneath Hughes Creek potentially causing seasonal surface water flows and remnant pools in the creek to decline and increase the frequency or duration of no flow in the creek.

On completion of the proposed underground workings the approved SRM open-cut final voids will be in place. The post closure phase considers the potential impacts on groundwater resources related to the partial backfilling of the open-cut pits (final voids), such that groundwater levels are considered to recover within the underground workings up into the final voids. Reduced groundwater levels and alterations to the groundwater regime are due to ongoing evaporation from final void areas.

Final voids can gradually fill with water once dewatering operations have ceased. Potential evaporation losses from the voids are considered to exceed predicted groundwater inflow and hence the voids are expected to remain mainly dry, except following prolonged heavy rainfall events. In this case, ongoing evaporation from these voids will essentially act as long-term groundwater extractions from within the mine area, with the potential to permanently reduce groundwater levels to the base of proposed final voids. Long term predictions are for the groundwater to recover within the Project area but not to pre-mining levels due to final voids.

Bore trigger thresholds

To assist in assessing the potential impacts of the Project on groundwater resources, consideration of regulatory water level trigger thresholds was included. Sections 376(b)(iv) and 376(b)(v) of the *Queensland Water Act 2000* (*Water* Act) refer to bore trigger thresholds in relation to Underground Water Impact Reports (UWIR). As defined in the Water Act, a bore trigger threshold for an aquifer means a decline in the water level that is:

- five (5) metres for consolidated aquifers
- two (2) metres for unconsolidated aquifers.

The area within which water levels are predicted to be lowered in an aquifer by more than the bore trigger threshold within three years, due to water extraction, is referred to as the Immediately Affected Area (IAA). The area within which water levels are predicted to be lowered by more than the bore trigger threshold in the long term, due to water extraction, is referred to as the Long-term Affected Area (LAA). To align with the requirements of the Water Act in relation to UWIRs, groundwater drawdown contours were produced to be consistent with the bore trigger thresholds as follows:

- the Quaternary/Tertiary sediments are unconsolidated and thus two metre drawdown contours were produced, which is consistent with the bore trigger threshold for unconsolidated sediments
- the Permian sediments are consolidated and thus five metre drawdown contours were produced, which is consistent with the bore trigger threshold for consolidated sediments.

The two and five metre triggers relate to change in groundwater levels from the initial groundwater levels at the start of model predictions (i.e. pre-activities).

Impacts on existing groundwater users

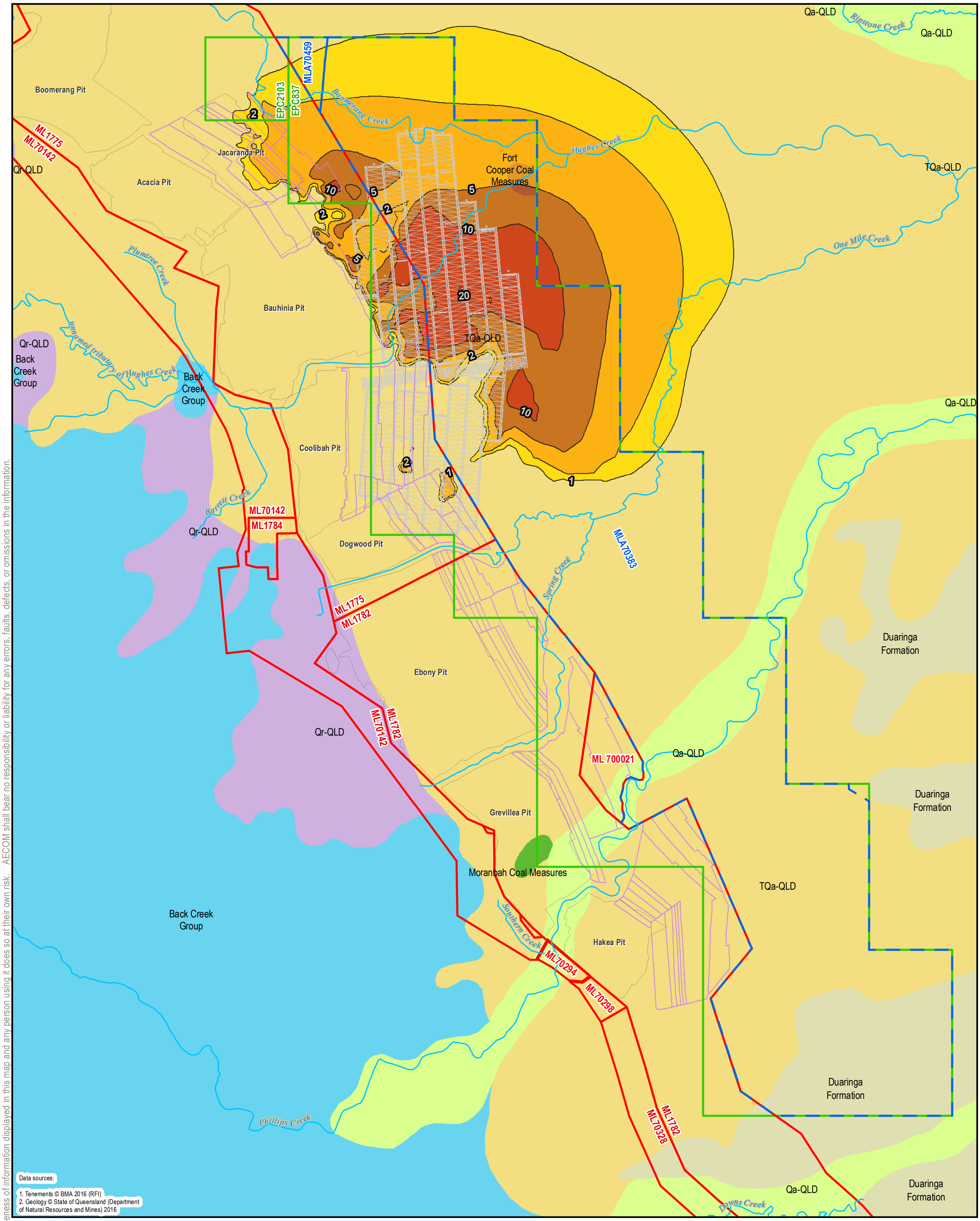
Location of existing registered bores plus additional bores identified during the bore census in relation to the predicted maximum incremental drawdown in the Tertiary and target D seam are shown in Figure 21-45, where the predicted maximum incremental drawdown refers to the potential drawdown impact associated with the Project.

The predicted drawdown of groundwater levels due to the Project were assessed using the bore thresholds as defined in the Water Act to evaluate potential impacts on neighbouring groundwater bores. Figure 21-45 shows the location of existing registered bores plus additional bores identified during the bore census in relation to the predicted maximum incremental drawdown in the Tertiary and target D seam, where the predicted maximum incremental drawdown refers to the potential drawdown impact associated with the Project. These predicted maximum incremental drawdown contours are included in Figure 21-43 and Figure 21-44.

Figure 21-45 shows that there are 24 groundwater bores within the 1-2 m predicted maximum incremental drawdown contours for the Tertiary and target D seam units. These groundwater bores include 20 registered bores and 4 unregistered bores. Bore details are provided in Table 21-45. Of the 24 bores predicted to be impacted, none are identified as potential ‘make-good’ bores for a combination of reasons:

- No water supply bores, recognised in Table 21-35, are located within the Project drawdown zones
- Alluvium bores are either dry or not predicted to be impacted
- They are all located on BMA owned land
- Most of the bores are for mine monitoring purposes
- Deep bores are screened within the Back Creek Group, which is located below the target D seam and not predicted to be impacted.

It is noted that four unregistered bores identified during the bore census are within the predicted Project drawdown zones. There is limited data available for these bores, which are located within the BMA lease area. It is unlikely that BMA would require any 'make-good' agreements for these bores. Thus, it is unlikely that the Project will have any material impacts on existing groundwater users.



LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Existing Open-Cut Extent
- Conceptual Surface Water Mine Plan
- Watercourse

Tertiary Drawdown Contours (m)

- 1
- 2
- 5
- 10
- 20

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

Figure 21-43
End of Mining Drawdown Contours - Quaternary/ Tertiary (Layer1)

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

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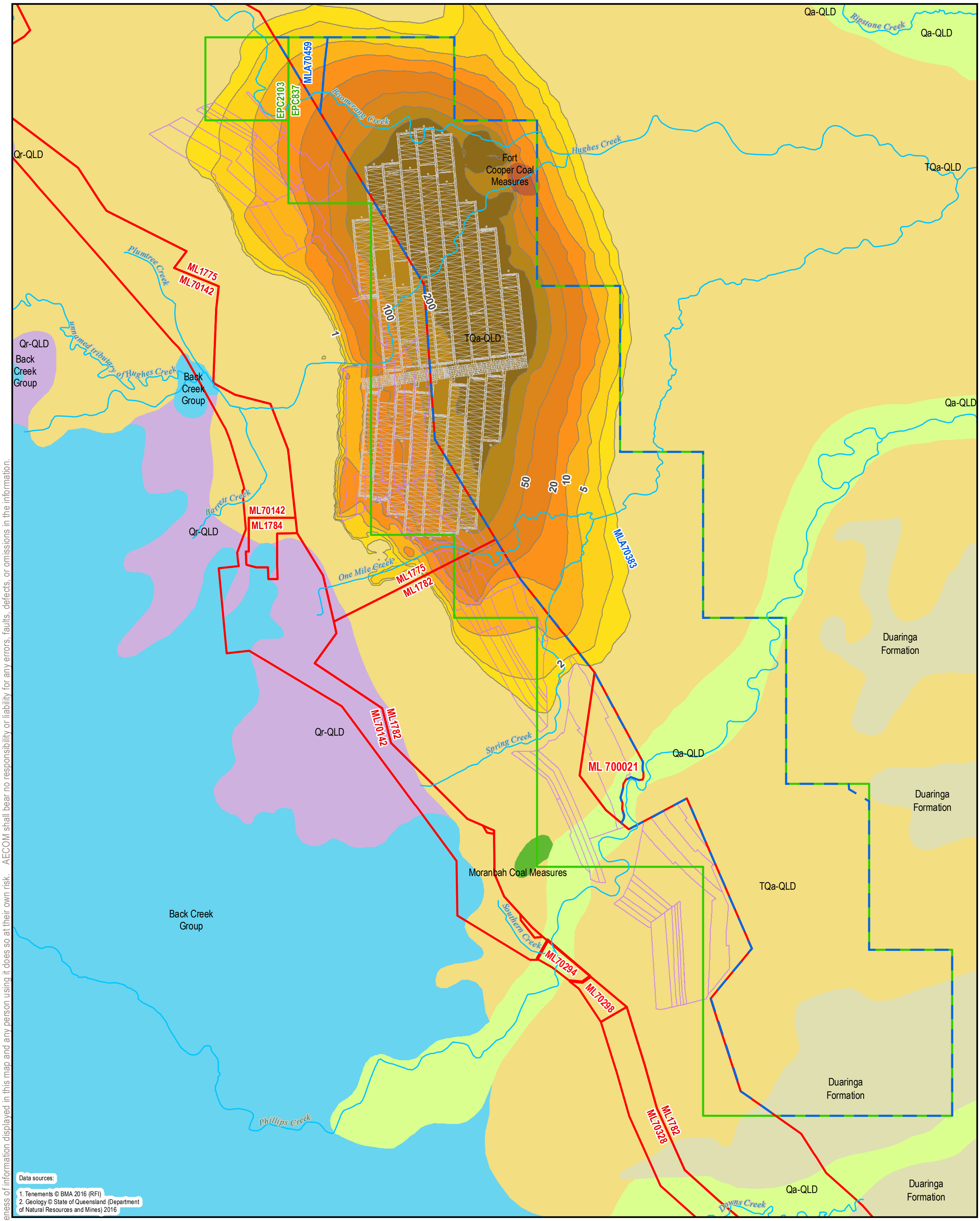

LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Conceptual Surface Water Mine Plan
- Underground Mine Layout
- Watercourse

Drawdown Contours in the D-Seam

- 1
- 2
- 5
- 10
- 20
- 50
- 100
- 200
- 500

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

Figure 21-44
End of Mining Drawdown Contours - Dysart Lower (D14, D24) seam (Layer10)

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Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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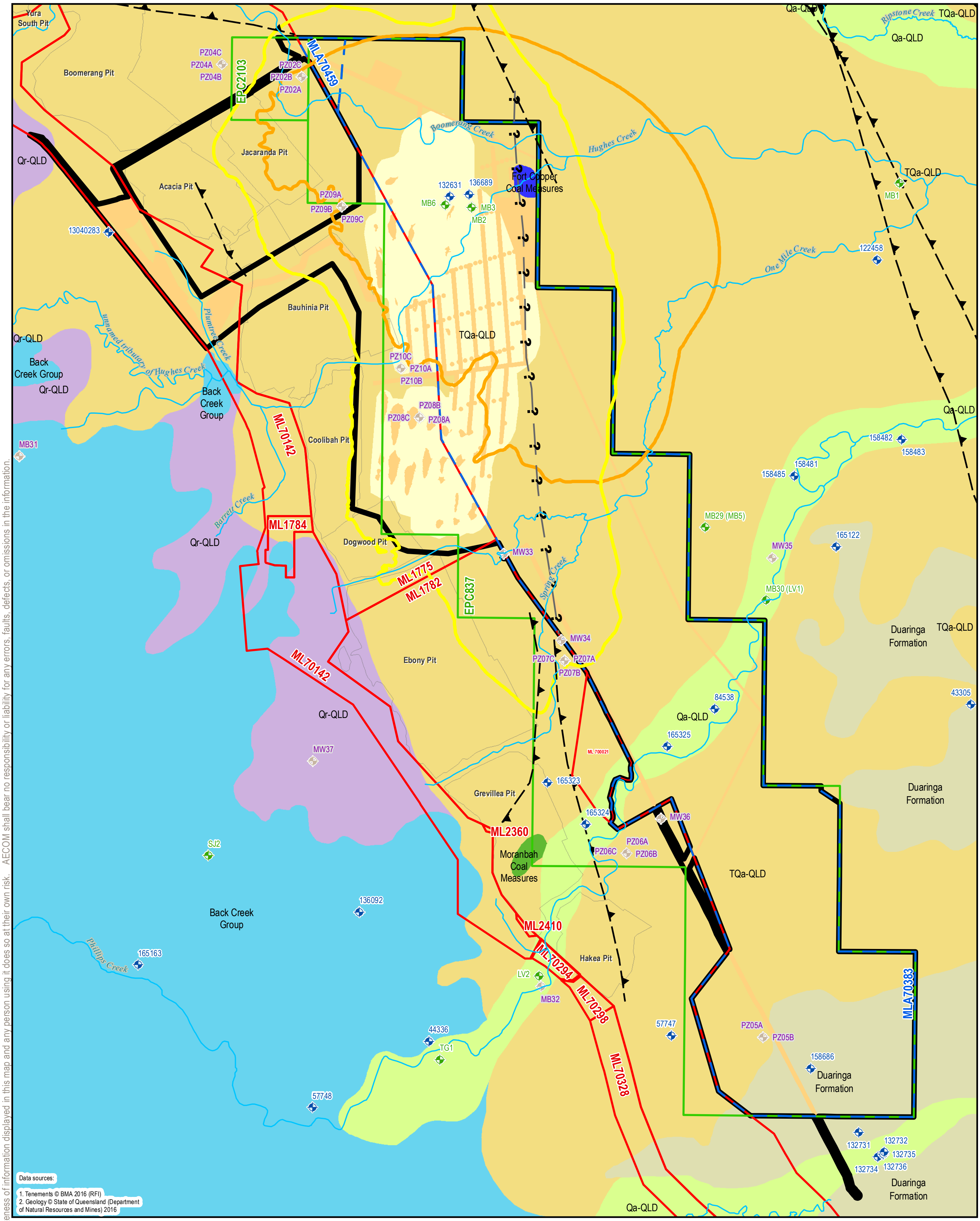
Table 21-45 Potentially impacted bores located within the predicted maximum incremental drawdown in the Tertiary and target D seam

Bore RN	Easting	Northing	Lot/Plan	Land Owner	Depth (mbGL)	Geology	Use	Comment
132631	635440	7528179	10/CNS93	Private Landholder	328	Back Creek Group	Unknown / water supply?	Existing. Screened in Back Creek Group below the MCM and not predicted to be impacted.
136689#	635868	7528234	10/CNS93	Private Landholder	328	Duaringa Formation	Unknown / duplicate of 132631?	Existing. Based on depth intersects Back Creek Group below the MCM and not predicted to be impacted.
158013	637781	7518065	1/SP260662	BMA	107	MCM	Monitoring	Existing MB34
182402	630114	7532835	10/SP208611	BMA	10	Quaternary	Monitoring	No drawdown in alluvium due to Project predicted
182401	630100	7532833	10/SP208611	BMA	167	Coal	Monitoring	Screened in Back Creek Group below the MCM and not predicted to be impacted.
165976	631494	7530679	10/SP208611	BMA	12.5	Quaternary	Monitoring	No drawdown in alluvium due to Project predicted
182125	631724	7530111	10/SP208611	BMA	28.5	Tertiary	Monitoring	BH01
182122	632287	7529754	10/SP208611	BMA	32	Tertiary	Monitoring	BH03
199214	632035	7529483	10/SP325345	BMA	40	Tertiary	Monitoring	New monitoring bore 10/2022 in sandstone (EC 27,300 µS/cm)
199215	632044	7529474	10/SP325345	BMA	115	Permian	Monitoring	New monitoring bore 10/2022 in coal (EC 15,500 µS/cm)
182124	632484	7529311	10/SP208611	BMA	38	Tertiary	Monitoring	BH02
182123	633800	7529686	10/CNS93	BMA	34	Tertiary	Monitoring	BH04 on Boomerang Creek
199250	633605	7526818	7/CNS144	BMA	186	Permian	Monitoring	MB 102_02 New monitoring bore 11/2022 in coal and sandstone (EC 13,170 µS/cm)
199251	633605	7526803	7/CNS144	BMA	38	Tertiary	Monitoring	MB 102_01 New monitoring bore 11/2022 in sandstone (EC 18,950 µS/cm)

Bore RN	Easting	Northing	Lot/Plan	Land Owner	Depth (mbGL)	Geology	Use	Comment
165977	635885	7527652	10/CNS93	BMA	242	Permian	Monitoring	MB20SRM03P – drawdown of 400 m predicted
165978	635945	7527652	10/CNS93	BMA	10.5	Quaternary	Monitoring	MB20SRM01A (MB20SRM01_PZ) – dry alluvium bore on Hughes Creek
165979	635904	7527647	10/CNS93	BMA	36.5	Tertiary	Monitoring	MB20SRM02T – drawdown of 7 m predicted
165975	634596	7525982	7/CNS144	BMA	24	Quaternary	Monitoring	MB20SRM05A (MB20SRM05A_PZ) – dry alluvium bore on Hughes Creek
190446	637223	7522750	101/SP310393	BMA	33.8	FCCM	Monitoring	SRMMB12_01
190447	637251	7522750	101/SP310393	BMA	232.8	MCM	Monitoring	SRMMB12_03
MB2*	635924	7527947	9/CNS98	BMA	60.94	Unknown	Unknown	Identified during Bore Census
MB3*	635935	7527947	9/CNS98	BMA	50	Unknown	Unknown	Identified during Bore Census
MB4*	635924	7527936	9/CNS98	BMA	27.1	Unknown	Unknown	Identified during Bore Census
MB6*	635327	7527997	10/CNS93	BMA	-	Unknown	Equipped	Identified during Bore Census

Note: # Formation determined from geological log from adjacent bore RN132631

* Bore has no registered number



LEGEND

- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Existing Open-Cut Extent
- Watercourse
- Saraji Monitoring Bores
- Registered Bore
- Census Bore
- Fault
- Inferred Fault
- Maximum drawdown in the D-Seam
- Maximum drawdown in the Tertiary Layer
- Project Site

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

Figure 21-45
Bores Located within End of Underground Mining (FY42) Predicted Groundwater Drawdown Contours

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Water quality alteration

During mining, a cone of depression will develop around the underground mining footprint due to incidental mine gas management (groundwater extraction) and mine dewatering. The longwall mining method will result in the development of goaf above the longwall panels. The groundwater extraction and alteration of hydraulic properties due to mining will result in localised groundwater flow into the underground panels. The risk of water contained in the underground panels (a blend of groundwater from different strata) impacting on groundwater quality, away from the underground workings, is considered limited as flow will be towards the active mine dewatering.

Post-mining (cessation of active mine dewatering) the groundwater level within the mine workings is predicted to rebound, but only to the level of the final voids in the SRM open-cut pits. A new pseudo-steady state pit water level will occur post-mining, which is dependent on inflow / outflow (evaporation) balance associated with the final voids. Long term groundwater levels are predicted to be influenced by the final voids, which act as groundwater 'sinks' because of water loss through evaporation in a negative climate balance area. This maintenance of a pseudo-steady pit water level will maintain cones of drawdown immediately around the final voids. The final voids acting as groundwater 'sinks' in perpetuity ensure poor water quality (elevated salinity due to evaporation) does not migrate off site within the groundwater.

Surface water groundwater interactions

Based on an assessment of groundwater data in Section 21.4.5.2, two separate groundwater systems were recognised to occur within the Project Area, including:

- localised basal sand and gravel at the base of the Tertiary sediments
- deeper Permian coal seams.

As conceptualised, groundwater recharge occurs from infiltration from the rainfall into the Tertiary and Permian aquifer sub-crop areas, creek flow and minor leakage from overlying aquifers (not evident based on differences in groundwater levels measured in the Tertiary and deeper Permian aquifers indicate that there is limited hydraulic connection between hydrostratigraphic units).

Mine dewatering can result in drawdown of the coal seam potentiometric surface, which can extend beneath the non-perennial creeks which drain across the Project. Seasonal surface water flows and remnant pools in the creeks may decline as a result of possible induced flow from the surface water to the groundwater, in response to the reduction in groundwater levels below the creeks. This has the potential to increase the frequency or duration of no flow in the creeks. Predictive modelling conducted to assess this potential impact (AECOM, 2024) indicated:

- No predicted loss of water from the alluvium along the extent of Boomerang Creek mapped across the Project footprint.
- No predicted loss of water from the Isaac River alluvium due to the Project.
- No predicted change in surface water flows in the local creeks including Boomerang due to the Project.
- No predicted change to surface water flows in the Isaac River due to the Project.

A conservative approach was adopted in the modelling, where no self-sealing of the subsidence fracturing to surface is included in the simulations. Even adopting this approach no impact on alluvium or surface water resources is predicted.

As no drawdown due to Project is anticipated in the alluvium or extend up dip into SRM, there is no predicted impact to SRM water and waste storage facilities.

Subsidence-induced ponding, albeit of short duration, has the potential to increase groundwater recharge over the Project footprint. Subsidence modelling (Minserve, 2022) was used to identify maximum extent of future ponding areas with potential to develop gradually over the life-of-mine (Engeny, 2023). The minor remedial drainage works will reduce persistent ponding in the landscape and mitigate increase in shallow groundwater resources. Subsidence monitoring will detect areas subject to persistent ponding of overland flow and remedial drainage works will ensure a free-draining landform. Subsidence ponding can be further alleviated through appropriate design and mitigation measures outlined in the Project's Subsidence Management Plan (SMP) (BMA, 2024).

The potential impacts of the proposed Project on surface-groundwater interactions are considered low

- The surface water system in the Project Area is ephemeral and limited surface -groundwater interaction is evident, particularly related to GDE.
- The Quaternary age alluvium is thin, discontinuous and sporadic across the Project footprint. The thicker saturated (in places) alluvium associated with the Phillips Creek are located outside the predicted drawdown resulting from the Project.
- The clay-rich Tertiary sediments have low recharge potential and low permeability resulting in insufficient yield and low usage potential.
- The predicted drawdown within the target D seam is predicted to elongate along strike and does not extend to the Isaac River to the east.
- No change is predicted to surface water flows in the Isaac River or associated alluvium groundwater resources due to the Project.
- The groundwater quality in the three hydrostratigraphic units present within the Project Area is not suitable for drinking, too deep for terrestrial ecosystems, and is often too saline for livestock watering
- The surface water systems are separated from the predicted impacted groundwater resources by low permeable sediments, which reduce the potential for the Project to impact on the alluvium and surface water flows.

Recovery

The post-mining recovery modelling included simulation of groundwater level recovery within the Project underground workings. A 2,000-year transient model was created to ascertain post-mining recovery. This recovery model included the SRM open-cut pits.

All drain cells representing the Project were removed at the end of mining, allowing for the start of the groundwater level recovery in the underground workings and the overlying water-bearing strata.

The underground workings maintained the hydraulic parameters adopted in the model cells to reflect mined-out areas and goaf effects from the prediction model. These parameters allow for enhanced vertical and horizontal hydraulic conductivity in the fractured layers overlying longwall panels and the increased storage in the mined seam.

For the SRM open-cut pits, all the open cut mine workings where areas were changed to spoil with only the sections of open-cut pits closest to the Project (i.e., areas mined at the final year of the SRM) were not backfilled and remained as voids. The voids were assigned high horizontal and vertical hydraulic conductivities (1,000 m/day) and storage parameters. This allowed for the simulation of free water movement. No extra recharge or evapotranspiration was applied to the voids, and it was assumed that the voids will be filled through groundwater recovery (SLR, 2023).

Based on two pilot points, located within the northern and southern longwall panels, the groundwater model predicts the groundwater system will reach equilibrium approximately 1,800 years post-mining (Figure 21-46).

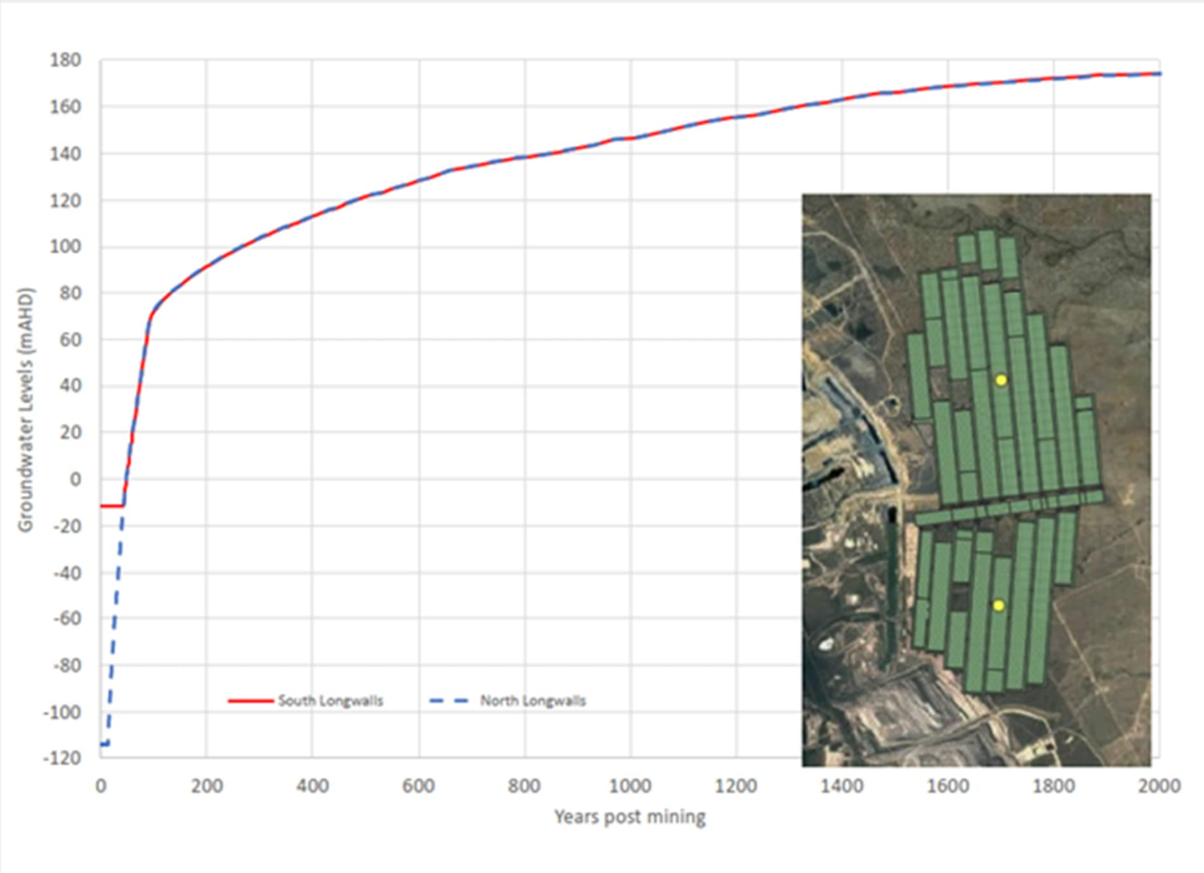


Figure 21-46 Predicted groundwater level recovery within the underground workings

In both the northern and southern longwall panels (yellow dots in Figure 21-46), the groundwater level recovers to approximately 176.5 mAHD and stabilises. This groundwater level is approximately 7.0 m above the pre-mining (all open cut and underground mining) groundwater levels, where the pre-mining groundwater level was derived from the steady-state modelling calibration (SLR, 2023).

The recovered groundwater levels within the northern and southern longwall panels, stabilise at between 10 to 20 m below ground level. This indicates that the influence of the final voids will be limited, resulting in localised drawdown around the voids.

SRM final voids

The SRM transitional PRC Plan (BMA, 2023), which details the closure of the open cut mines, includes an assessment of groundwater interaction with the final voids and predictions of pseudo steady state pit water levels. The hydrogeological study (SLR, 2023b) and the PRC Plan submission was assessed in context of the proposed Project to aid in evaluating the influence of the final voids on groundwater. It is noted that the SRM transitional PRC Plan does not include for the Project (i.e. the initial SRM PRCP was compiled prior to the finalisation of the Project EIS submissions).

<u>SRM final void lakes</u>

The SRM PRC plan study includes for the prediction of pit water levels at the end of mining and post closure (rehabilitation). The final void lake levels were included in a SRM PRC plan groundwater model as part of an iterative modelling approach between the groundwater model and the water balance model. The modelling results identified the residual voids to develop as long-term ‘sinks’ for all climate change scenarios modelled. Stabilised lake levels in all the final voids are predicted to remain below the recovered groundwater levels (SLR, 2023).

Consideration of water level predictions at the Coolibah/Dogwood pits, the pits with the highwall access for the Project, have been summarised for consideration of long-term groundwater flow patterns.

A dedicated final void water balance model, based on the final closure landform design for SRM, was completed for the period 2080 to 2199 (120 years), to understand water balance behaviour (including climate change considerations) within the residual voids over time. The findings for the Coolibah / Dogwood final void was:

- decant level (i.e. where water could overtop/spill from the void) is 190 mAHD.
- After 2120 pit water levels start to stabilise, with simulated mean inflows of 783 ML/year being very similar to mean outflows of 784 ML/year indicating the mean water balance has reached an equilibrium.
- The long-term final void lake levels range between 7-24 mAHD (BMA, 2023).

The numerical groundwater modelling (Appendix F-1, SLR, 2023) shows the establishment of sustained inward groundwater flow gradients to all the voids. The groundwater flow patterns are driven by the evaporative discharges from void lakes. The final void water levels stabilise below the modelled groundwater elevations and below the shallow hydrogeological units, (i.e., alluvium and Tertiary). Therefore, once the final void lakes and groundwater levels have stabilised, the modelling indicates the residual voids will continue to act as groundwater sinks.

<u>Coolibah / Dogwood final void groundwater</u>

Groundwater modelling for the transitional SRM PRC plan submission, considering wet, base, and dry climate conditions, indicated groundwater ingress represents 5 per cent to 13 per cent of the total volumetric inflow to each final void based on the water balance model predictions. Most groundwater ingress comes via the spoil, however, based on the depth of the water within the voids, driven by evaporation (Section 21.3.2.2.4), groundwater from the hydrostratigraphic units within the highwall flow into the final voids resulting in localised groundwater drawdown.

The post-mining groundwater elevations, contours, and drawdown for the target D seam is included in Figure 21-44. The predicted groundwater levels across the Project footprint, based on the SRM recovery predictions, are around 140 mAHD.

Groundwater levels within the Project are predicted to recover to 176.5 mAHD in the long term (Figure 21-46), the simple comparison of groundwater recovery levels in the Project and long-term levels associated with the SRM post-closure indicates groundwater flow will be towards the final void where the Coolibah/Dogwood final void water level is predicted to be 7 to 24 mAHD, >100 m lower than surrounding recovered groundwater levels.

21.6.1.3 Groundwater dependent ecosystems

Based on assessment of groundwater drawdown in Section 21.6.1.2 and known potential GDE presented in Section 21.4.5.3, the Project is considered to have little or no impact on GDE.

Aquatic GDE

No aquatic GDEs have been observed in the Project Area (no indication Phillips Creek represents an Aquatic GDE), and it has been assessed as having low potential for aquatic GDE. The areas of the mine containing open water (i.e. tailings dam, evaporation pits and levees) only have permanence of water due to them being artificial mining features.

The creeks in the area are ephemeral with only intermittent flows. Mine dewatering can result in drawdown of the coal seam potentiometric surface, which can extend beneath the non-perennial creeks across the Project. Seasonal surface water flows and remnant pools in the creeks can decline due to possible induced flow from the surface water to the groundwater in response to the reduction in groundwater levels below the creeks. This has the potential to increase the frequency or duration of no flow in the creeks. Predictive modelling was conducted to assess this potential impact.

The potential impact of Project drawdown will not extend to the closest springs more than 150 km from the Project.

Terrestrial GDE

Terrestrial GDEs are present on Phillips Creek and were identified on Hughes Creek mapped on the margins of EPC837. While Phillips Creek has capacity to support groundwater dependent vegetation, the thicker saturated (in places) alluvium associated with the Phillips Creek are located outside the predicted drawdown resulting from the Project. Vegetation fringing Hughes Creek does not meet the hydrological or ecological criteria for a terrestrial GDE, and there is no indication of ecological and hydrological linkage between groundwater and surface water of Boomerang Creek (Survey Site 13_AU1). Groundwater is generally not permanently present within alluvial sediments and is, therefore, unlikely to provide a source of water for terrestrial species. The clay-rich Tertiary sediments have low recharge potential and low permeability resulting in insufficient yield and low usage potential. Generally, floral assemblages within the area are drought tolerant with low sensitivity to water availability.

21.6.2 Threatened species and ecological communities

The following sections outline the potential impacts associated with the Project on terrestrial ecological values. The impact assessment discussed below is based on the potential impacts associated with the construction and operational phases of the Project. Disturbance calculations incorporate direct impacts relating to:

- construction:
    - surface facilities and ancillary infrastructure (direct)
    - incidental mine gas (IMG) drainage network (direct).
- operation:
    - subsidence from underground mining (indirect)
    - groundwater drawdown from water extraction (indirect).

The following sections outline the potential impacts associated with the Project on general environmental values. Potential impacts on MNES relevant to the Project as well as an assessment of significance is outlined in Section 21.8.

21.6.2.1 Construction

Facilities and infrastructure associated with the Project includes the MIA, CHPP, water management infrastructure, roads, the IMG drainage network, as well as water and power supply to the Project Site. The construction of this infrastructure will occur in three stages:

- site preparation and temporary construction accommodation village
- civil works including water storage and transport network and powerlines/connections
- MIA building and CHPP construction, and IMG drainage.

To manage and facilitate the construction of Project infrastructure, temporary facilities, including offices, will be constructed close to the work centres such as the MIA. The facilities will be located within the Project Footprint prioritising locating in previously disturbed areas. The construction accommodation village will only be required to support construction before the facilities are decommissioned, and the area rehabilitated.

The Project Site covers approximately 11,427 ha, within which 2,613.58 ha is remnant and remaining is non-remnant vegetation. Of this, 1,220.35 ha of remnant and 2,127.65 ha of non-remnant vegetation is within the Project Footprint with potential to be disturbed. This includes disturbances from construction components of the Project, including:

- surface facilities and ancillary infrastructure (construction village, CHPP, ROM pad, MIA, process water dam, raw water dam, proposed product stockpiles, conveyor, 66 kV powerline connection, transport infrastructure corridor)
- IMG drainage network comprising cleared gas well pads and parallel corridors for the pipelines and associated access tracks (conservatively assessed as 100 m width; however, actual vegetation clearing will be minimised to 20-50 m in the case of vehicle tracks and 10-20 m for the pipeline with sections of vegetation and habitat, approximately 260 m wide, retained between corridors).

21.6.2.1.1 Direct impacts

Disturbance of remnant vegetation (ground-truthed RE) resulting from the construction is 180.38 ha, including surface infrastructure (120.55 ha) and IMG drainage network (59.82 ha). Direct impact of vegetation clearing and habitat loss for vegetation communities and habitat types within the Project Footprint is detailed in Table 21-46.

Impacts on vegetation and habitat will occur throughout the life of the Project. On commencement of construction, areas required for the proposed infrastructure will be cleared; however, surface infrastructure will be preferentially sited in previously disturbed areas. IMG drainage infrastructure will be installed as early as possible to allow adequate time to drain gas prior to mining. This is discussed further in **Chapter 3 Project Description** of this EIS. While the maximum corridor width for linear infrastructure has been assessed, detailed design will further refine the layout within existing disturbed areas and reduce corridor widths to minimise actual disturbance. For the powerline, clearing will generally only be required for the towers and a narrow access easement.

Table 21-46 Direct impacts to vegetation and habitat during construction

Fauna habitat type	RE	Project Site (ha)	Project Footprint (ha)	Construction direct impacts		
				Surface facilities (ha)	IMG network (ha)	Total (ha)
River Red Gum Riparian Woodland	RE11.3.25	192.08	73.42	6.49	5.41	11.90
Eucalypt and/or *Corymbia* open woodland	RE11.3.2, RE11.3.4, RE11.4.13, RE11.5.3	1,876.46	882.21	89.22	26.31	115.53
Dawson Gum and Brigalow Woodland	RE11.4.8	322.35	222.45	24.33	16.89	41.22
Brigalow or Belah Woodland	RE11.3.1, RE11.4.9	204.33	39.15	0.45	8.17	8.62
Oxbow Wetland	RE11.3.27b	16.64	3.04	-	3.04	3.04
Natural Grasslands	RE11.4.4	1.73	0.08	0.08	-	0.08
Modified Grasslands	NA	6,418.86	1,420.13	458.00	194.71	652.71
Shrubby Brigalow regrowth with gilgai	NA	1,781.99	636.89	190.92	95.22	286.14
Dams	NA	107.66	70.72	30.16	0.20	30.36
Total		**10,922.10**	**3,348.09**	**799.65**	**349.95**	**1,149.60**

Clearing for the proposed infrastructure will have direct impacts on fauna, as well as fauna habitat during vegetation clearing activities. Habitat types likely to be impacted include *Eucalypt* and/or *Corymbia* open woodland, Brigalow or Belah woodland, river red gum riparian woodland, Dawson gum and Brigalow woodland, modified grasslands and shrubby Brigalow regrowth with gilgai. As vegetation clearing and construction progresses, food and shelter resources associated with these habitat types will be diminished and density of fauna in the area may also diminish.

Clearing extent associated with the powerline and transport corridor is expected to be smaller than estimated. The proposed transport and infrastructure corridor will present a minor disruption of fauna dispersal opportunities. The road alignment passes largely through modified grassland habitat however the alignment will bisect a large patch of *Eucalyptus populnea* (Poplar Box) woodland and will require crossings over Boomerang Creek, Hughes Creek, Spring Creek and Phillips Creek. The riparian communities surrounding these creek crossings have a comparatively high faunal diversity and biodiversity value. Given the width of the proposed clearing, the impact on fauna from the construction of the transport and infrastructure corridor is likely to be minimal for fauna dispersal as well as food and roosting/nesting resources associated with this corridor.

Impacts on fauna from installation and operation of the IMG drainage infrastructure will occur from:

- loss of habitat from direct clearing of vegetation, including habitat trees, which will restrict the ability of fauna to move across the Project Site
- injury or mortality to fauna present during vegetation clearing activities and surface infrastructure construction.

The IMG drainage network will be constructed in a grid like pattern and will be undertaken progressively, such that loss of habitat values will be gradual and there will be opportunities for fauna to move into adjacent habitat or into areas that will have already undergone partial rehabilitation. As a result, vegetation will remain in patches between the IMG network at least 260 m wide. While some patches of vegetation communities and habitats will be retained within the grid formed by the IMG infrastructure, these patches will be isolated and fragmented and may not contribute significantly to the conservation of these vegetation communities at a local or regional level.

Injury or mortality to fauna present during vegetation clearing activities is a potential impact particularly relevant to ground dwelling fauna with potential to be crushed by machinery and arboreal mammals with potential to be trapped in trees as trees are felled. Development of the IMG network will require the construction of access roads for installation and future maintenance of infrastructure. Construction and maintenance activities will be undertaken predominantly during daylight hours. Given this, reptiles are the fauna group most likely to be affected, as they utilise roads to gather warmth and seek prey.

In addition, for fauna species relocating to adjacent habitats during clearing and construction work, competition for resources and territory within these new areas may affect some species; however, most species present on site are relatively resilient and do not have highly specific habitat preferences. Additionally, an increase in predation may occur as a result of dispersing. Many of the fauna species observed within the Project Site are relatively tolerant to disturbed habitats and will continue to utilise remaining habitat affected by fragmentation and noise, light and activity disturbance.

21.6.2.1.2 Indirect impacts

Potential indirect impacts associated with disturbance during the construction phase include:

- erosion and soil loss – mobilisation of sediment into watercourses as a result of exposed dispersive soils or soils on slopes. Impacts to aquatic ecosystems can include build-up of sediment in waterholes with a resultant reduction in available microhabitat and smothering of aquatic plants and substrate. Impacted areas most susceptible to erosion include floodplain areas and riparian vegetation.
- dust – where vegetation occurs close to construction activities, deposition of airborne dust, sand and soil on plant foliage can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Diminished ability to photosynthesise results in reduced growth rates of vegetation and decreases in floral vigour and overall community health.
- edge effects – the proposed IMG infrastructure will lead to creation of habitat patches subject to edge effects, including weed invasion, increased predation and microclimate changes.
- noise and light – fauna will generally move away from noise and light sources or alter feeding and nesting behaviour. Long term effects are not anticipated for most fauna species identified as these species are expected to habituate to higher noise and brighter light levels. Acclimatisation by some species is also likely to occur over the medium to long term.
- pest and feral fauna - introduction of exotic ant fauna is a risk due to import of construction materials. The construction of water storages and dams has the potential to create conditions suitable for a build-up of biting insects. Additional breeding areas can result from the pooling of water in depressions caused by earthworks or subsidence. These areas also support other pest species already in the Project Site such as feral pig and cane toad (Bufo marinus)

- weeds - disturbance to native vegetation and mobilisation of earthmoving equipment and materials can introduce or exacerbate weeds within the Project Site. The most likely causes of weed dispersal will be through the movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery involved with clearing of vegetation and stockpiling mulch and topsoil during earthworks.

Groundwater levels within the upper Tertiary sediments are generally deeper than 15 mbGL, which is at a depth where groundwater has a reduced importance to vegetation (Froend and Loomes, 2004). As such any predicted drawdown within this layer is unlikely to result in indirect habitat degradation impacts on the surface vegetation communities and habitats.

21.6.2.2 Operation

Mining for the Project will occur progressively in a west to east direction. After pre-drainage of IMG, the IMG drainage infrastructure will be decommissioned, and above ground infrastructure removed. Longwall mining will then be undertaken in these areas. In some cases, an estimated 15 years may occur between the two activities. Mining of each longwall is expected to take one to three years, and any associated impacts will progress across the footprint as mining advances.

As longwall mining progresses, the overlying stratum drops in behind resulting in subsidence effects (Palamara et al. 2006). The magnitude of the subsidence effects largely depends on a range of variables, including the current topography, underlying geology, soils and depth of the longwall mining operations as described in detail in **Appendix B-2 Subsidence Modelling**.

Associated impacts from subsidence are typically localised and dependent on the location of vegetation in association with the subsided areas, with impacts generally associated with the depressions (troughs) and longwall panel edges (slopes) as opposed to areas not subject to subsidence (i.e. between mined panels) as illustrated in Figure 21-41. A summary of potential subsidence impacts on vegetation include:

- potential ground subsidence of 0-3.5 m as per modelling predictions (**Appendix B-2 Subsidence Modelling**)
- ground movements and surface cracking at the edge of mined panels affecting root zones of isolated trees (Lechner et al., 2016; Darmody, 2000; Booth and Spande, 1992)
- persistent ponding within deeper depressions where there is no surface drainage system to manage runoff (Lechener et al. 2016)
- chemical or physical changes in soils remaining wet or waterlogged for long periods (Darmody et al., 1989) with potential for denitrification, loss of fertility and anaerobic consumption of organic matter reducing the health and condition of native vegetation present
- accumulated salts with subsequent evaporation leading to localised soil salinity or sodicity and associated physical changes in soil structure (Lechener et al. 2016).

Subsidence may affect isolated trees where ground movements and surface cracking affect root zones, however these impacts are unlikely to materially impact remnant status or habitat values associated with native vegetation (including threatened species and ecological communities). Application of remedial drainage works will ensure a free-draining final landform is permanently established in the final landform avoiding impacts associated with waterlogged areas.

A conceptual model of the potential impacts of subsidence on vegetation is provided in Figure 21-47.

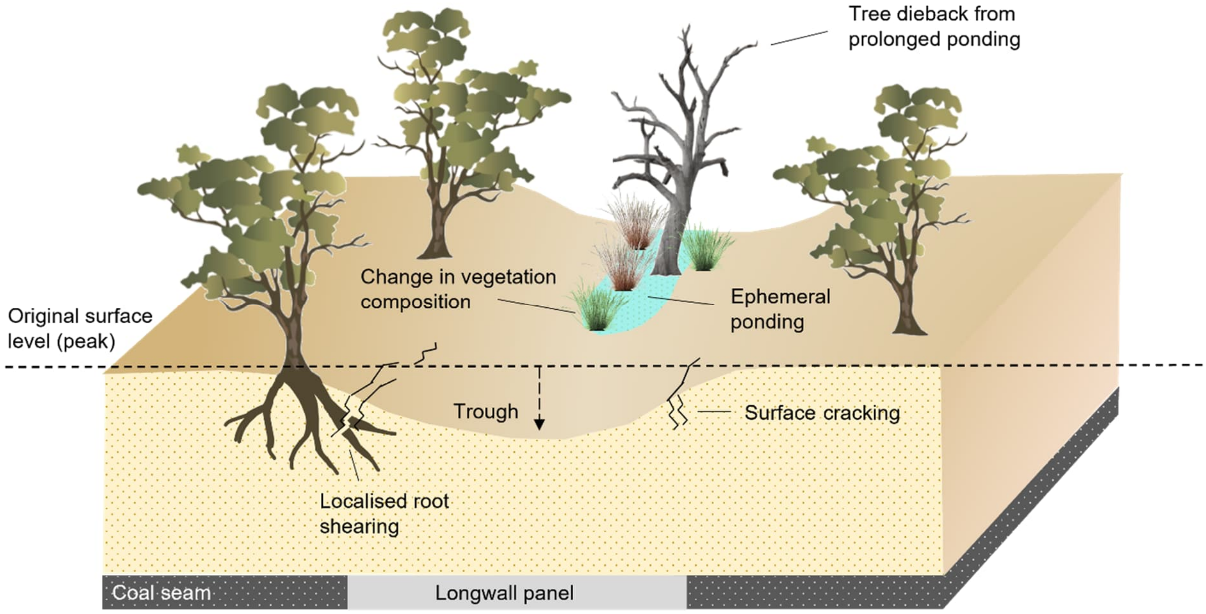


Figure 21-47 Conceptual model depicting potential impacts of subsidence resulting from longwall mining on vegetation

21.6.2.2.1 Direct impacts

Subsidence-induced ponding

Appendix E-1 Subsidence Ponding Assessment presents modelling and water balance over the catchment in the subsided landform, which identified a maximum extent of potential ponded areas comprising 36 discrete ponding areas, spanning 145.66 ha, over the life of the mine (Figure 21-48). Modelling predicted two-thirds of these areas subject to ephemeral ponding will develop over the first 10 years of the Project, with the remainder third developing during the second decade of mining. A summary of the maximum extent of potential ponding impacts to habitat types is provided in Table 21-47 and maximum extent of direct impacts depicted in Figure 21-48 however this represents an outcome in the absence of remedial drainage works which are a proposed mitigation for persistent ponding areas.

The maximum extent of ponding (in the absence of remedial drainage works) provides a conservative (i.e. overestimate) assessment of impacts, which will be managed through minor remedial drainage works to ensure a permanently free-draining landform. Within the ponding areas, potential impacts within the trough areas can include soil compaction, changes in soil composition and ponding of water within deeper depressions. Soil compaction can occur within the central zone of the subsidence area (trough), potentially resulting in higher resistance to root growth and water penetration into the soil profile (Lechner et al., 2016).

Waterlogged areas have potential to accumulate salts from pore water and on-flow, with subsequent evaporation leading to localised soil salinity or sodicity and associated physical changes in soil structure (Lechener et al. 2016).

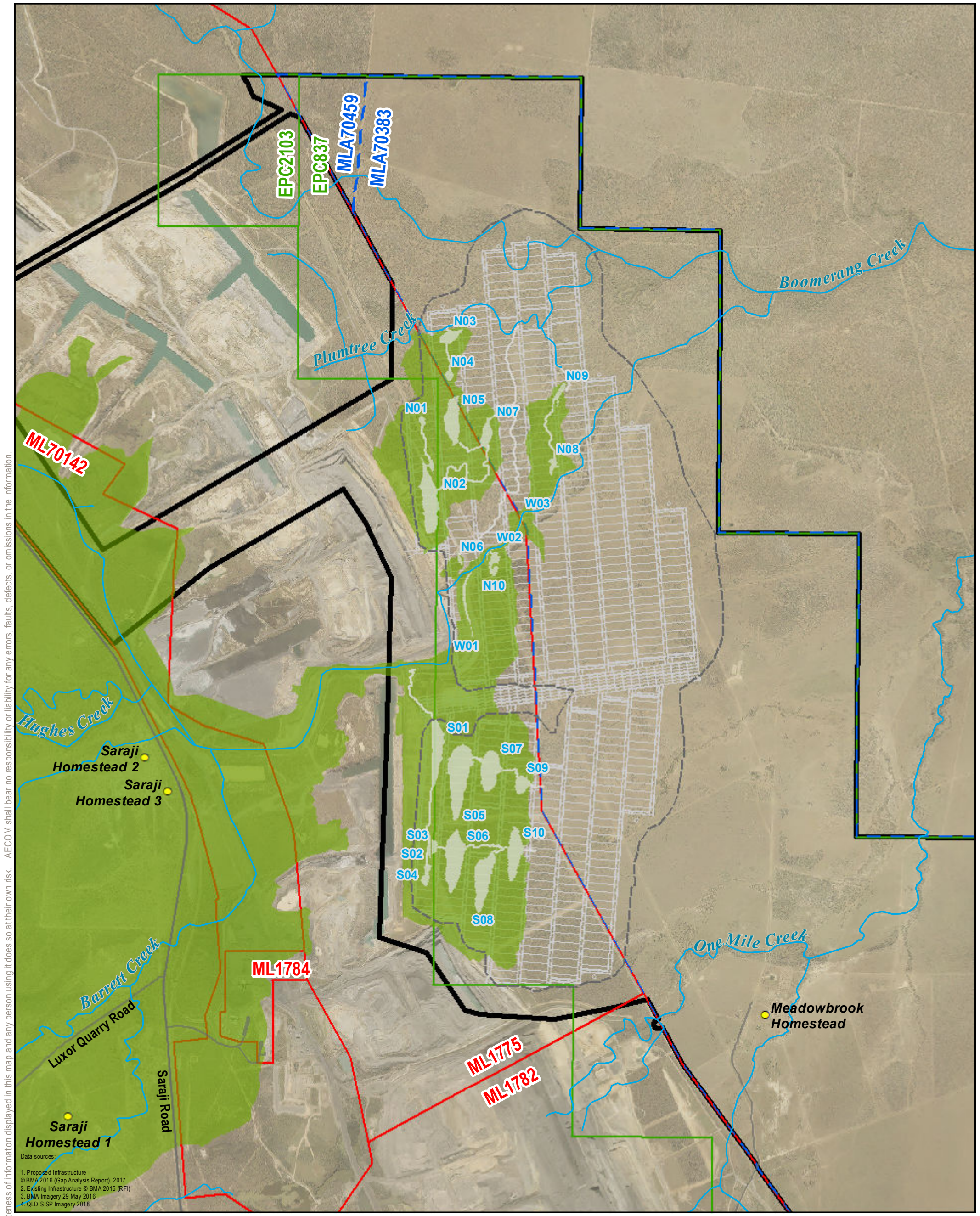
Maximum extent of ponding mapped accounts for disturbance due to formation of surface cracks at the edge of panels, which can lead to increased stress on the roots of isolated woody vegetation with potential for localised root shearing. Disturbance of the root ball from surface cracking, mechanical shaking during active subsidence, or ground tilt can lead to the decline in vigour or potential loss of isolated trees and shrubs (Frazier et al., 2010). Impacted vegetation can also show loss of vigour (i.e. health and resilience), foliar discolouration, partial defoliation or increased susceptibility to pathogenic attack (Coops et al. 2004). While vegetation within the modelled subsidence area may exhibit isolated occurrences of reduced canopy health or tree loss, surface cracking is considered unlikely to result in material impacts to the composition and structure of native vegetation. This is largely attributed to the characteristic of the soils present (e.g. cracking clays), resilience of native species and the extent and depth of likely subsidence.

Without intervention, vegetation within the maximum extent of ponding has potential to be inundated periodically with modelling indicating water from rainfall may be present more than 50 per cent of the time. Where ponding is temporary, typical floodplain species (such as *E. tereticornis*, *E. camaldulensis*) able to tolerate periodic inundation are likely to remain (Jackson, 2005). Where vegetation is intolerant to prolonged inundation (such as *E. populnea*), there is potential for these areas to exhibit tree die back and, in some areas, to be replaced by more tolerant vegetation, including environmental weeds. These changes in flora species composition can also result in modifications to the vegetation type, with grassy woodland communities replaced with shrublands and grasslands.

To understand significance of potential impacts direct impact of operation, represented conservatively as the maximum extent of ponded areas (without intervention), are summarised in Table 21-47 for each of the identified habitat types. Ongoing monitoring of the subsidence, including soil properties and vegetation health will be required to identify decline in vegetation condition to allow appropriate management measures to be implemented. Further assessment of impacts on MNES is presented in Section 21.8.2.

Table 21-47 Direct impacts to vegetation and habitat during operation

Habitat type	RE	Project Site (ha)	Project Footprint (ha)	Project Footprint undisturbed after construction (ha)	Maximum extent of ponded areas (ha)
River Red Gum Riparian Woodland	RE11.3.25	192.08	73.42	61.52	2.94
Eucalypt and/or *Corymbia* open woodland	RE11.3.2, RE11.3.4, RE11.4.13, RE11.5.3	1,876.46	882.21	766.68	37.58
Dawson Gum and Brigalow Woodland	RE11.4.8	322.35	222.45	181.24	12.45
Brigalow or Belah Woodland	RE11.3.1, RE11.4.9	204.33	39.15	30.53	0.09
Oxbow Wetland	RE11.3.27b	16.64	3.04	0.00	0.00
Natural Grasslands	RE11.4.4	1.73	0.08	0.00	0.00
Modified Grasslands	NA	6,418.86	1,420.13	767.42	27.35
Shrubby Brigalow regrowth with gilgai	NA	1,781.99	636.89	350.75	42.33
Dams	NA	107.66	70.72	40.36	22.93
Total		**10,922.10**	**3,348.09**	**2,198.50**	**145.66**



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Limit Of Subsidence
- Watercourse
- Public Road
- Homestead
- Overland Flow Paths Year 10
- Temporary Pond Areas Year 10
- Pond Catchment Areas Year 10

Figure 21-48a
Potential Future Ponding Areas and their Catchments After 10 Years of Mining

Subsidence Management Plan
Saraji East Mining Lease Project

0 0.35 0.7 1.4
Kilometres

Scale: 1:59,840 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
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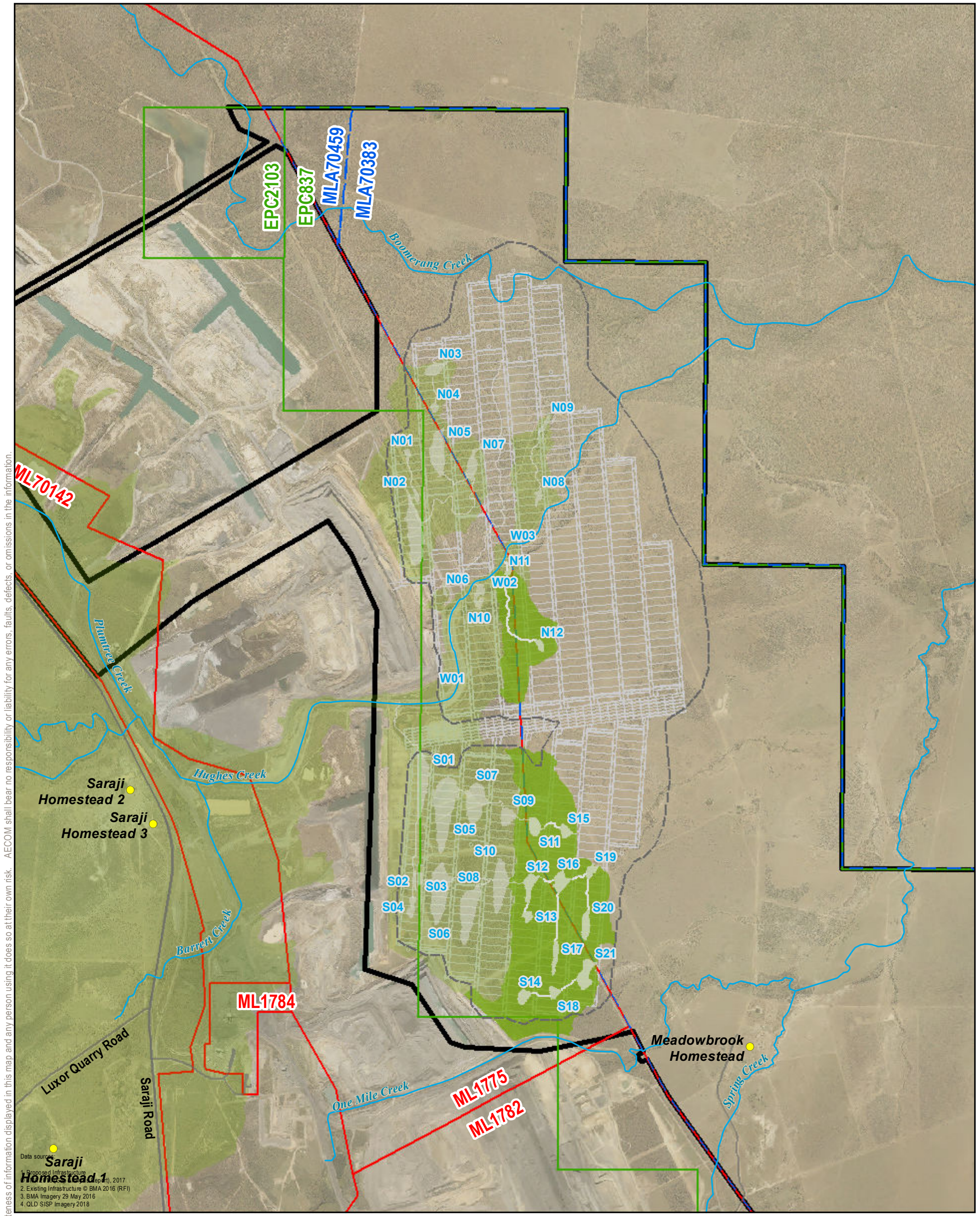
DATE: 21/05/2024 VERSION: 4



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground Mine Layout
- Limit Of Subsidence
- Watercourse
- Public Road
- Homestead
- Overland Flow Paths Year 10
- Temporary Pond Areas Year 10
- Pond Catchment Areas Year 10
- Overland Flow Paths Year 20
- Temporary Pond Areas Year 20
- Pond Catchment Areas Year 20

Figure 21-48b
Potential Future Ponding Areas and their Catchments After 20 Years of Mining

Subsidence Management Plan
Saraji East Mining Lease Project

0 0.35 0.7 1.4
Kilometres

Scale: 1:59,840 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
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DATE: 21/05/2024 VERSION: 5

21.6.2.2.2 Indirect impacts

Impacts to air quality, noise and light

Generally, Project operation will occur underground limiting indirect impacts associated with mining activities; however, haulage and industrial processing will contribute incremental increases of dust, noise and light to the surrounding area.

- dust – where vegetation occurs close to industrial activities, deposition of airborne dust, sand and soil on plant foliage can reduce the amount of light penetration on the leaf surface, block and damage stomata, and slow rates of gas exchange and water loss. Diminished ability to photosynthesise reduces growth rates of vegetation and decreases floral vigour and overall community health.
- noise and light – fauna will generally move away from noise and light sources or alter feeding and nesting behaviour. Long term effects are not anticipated for most fauna species identified as these species are expected to habituate to higher noise and brighter light levels. Acclimatisation by some species is also likely to occur over the medium to long term.

Changes to overland flow

The balance of the Project Footprint within the maximum extent of subsidence has potential to experience changes in localised topography, hydrology and overland flow; however, these changes are not anticipated to materially affect existing vegetation and habitat values.

Where ponded areas form in watercourses or panels, this will temporarily restrict overland flow and change inundation levels along riparian zones. Adaptive drainage management to mitigate ponding on floodplains will reduce impacts on natural flow regimes with impacts on water quality expected to be minor and of short duration as over time pools and channel beds will fill in, and ephemeral wetlands will slowly accrete.

Habitat features associated with riparian corridors, such as along Hughes Creek, may be particularly sensitive to the loss of canopy trees, degrading habitat and reducing the connectivity values for fauna species dependent on these areas. The loss of multiple trees along these corridors will reduce the ability for fauna, particularly arboreal mammals to disperse to adjacent areas of habitat. The loss of canopy trees from subsidence, following vegetation clearing from the IMG Network, will incrementally increase fragmentation of the riparian corridor should it occur.

Cane Toads (*Bufo marinus**) are present, and availability of ponded areas may increase their numbers. The availability of permanent water will also benefit larger fauna using the site, including Eastern Grey Kangaroo (*Macropus giganteus*) and attract frogs as well as pest species such as Feral Pigs (*Sus scrofa**).

Drawdown from water extraction

Appendix D-2 Groundwater Dependent Ecosystems Report identified terrestrial GDEs as potentially occurring in association with riparian vegetation along Phillips Creek and Boomerang Creek. While similar vegetation (i.e. RE 11.3.25) was observed along Hughes Creek and One Mile Creek, analysis of xylem stable isotope and soil moisture potential indicates these communities are unlikely to meet the criteria of a terrestrial GDE.

Impacts of drawdown in the Tertiary groundwater system can occur within the alluvium where areas of enhanced potential for downward drainage to occur. This is most likely associated with sandy sediments with increased hydraulic conductivity or increased density of preferential flow paths. Impacts could also manifest in isolated pockets of groundwater within the Quaternary alluvium, or where seasonal water within the alluvium would have enhanced potential for downward flow due to a lower groundwater level within the underlying Tertiary sediments paths. As identified by **Appendix D-2 Groundwater Dependent Ecosystems Report** the impact of this increased drawdown in the alluvium is predicted to be minor to insignificant to identified terrestrial GDEs as:

- the alluvial groundwater system associated with Phillips Creek and Boomerang Creek are discontinuous along the length of the creek channels and riparian trees have capacity to utilise moisture from multiple sources including soil moisture, surface water and groundwater to support transpiration.

- the alluvial groundwater system that supports terrestrial GDEs on these creeks are recharged by surface flows and flooding which provides the dominant driver to support riparian ecological function.

With implementation of management measures, which includes development of a project Groundwater Dependent Ecosystem Monitoring and Management Plan (GDEMMP), potential impacts to identified terrestrial GDEs will be minimised.

Refer to **Appendix D-2 Groundwater Dependent Ecosystems Report** for more information.

21.6.3 Heritage

The Social Impact Assessment (SIA) and Public Consultation undertaken for the Project identifies risks to MNES in terms of impacts to Aboriginal cultural values and heritage. These matters have been assessed in line with the EPBC Act through the following:

- inclusion of the Project as part of its portfolio for ongoing discussion with the Barada Barna Aboriginal corporation (BBAC)
- providing cultural heritage protection through Cultural Heritage Management Plans (CHMPs)
- including employment and training strategies targeted to Indigenous people.

The Barada Barna people have Native Title interests in land near the Project Site. As the Traditional Owners of the land, the Barada Barna people noted that the 2016 native title determination would enable them to have active involvement in protecting cultural heritage and would strengthen Barada Barna people's pride and knowledge about their long-term connection to country (Queensland Cabinet & Ministerial Directory, 2016). Indigenous social values include cultural values (relevant to past and present relationships with the land and waters), and social values relevant to Indigenous people's community wellbeing and economic participation.

A Cultural Heritage Assessment has been provided as part of the Project's EIS and describes cultural heritage values in the vicinity of the Project Site. The assessment found that there were artefacts and places of cultural significance to the Barada Barna people on the Project Site. These predominately include artefact scatters or isolated artefacts and scarred trees.

A review of historical and archaeological information suggests that Aboriginal cultural heritage sensitivity is highest in areas within 100 m of a watercourse. This is due to watercourse margins being prime living and working locations, with potential to retain cultural heritage sites including hearths, artefact scatters, middens and grinding grooves. There is potential for these to exist in smaller, more temporary sites in the Project Site. This will be highest in areas have not been subject to vegetation clearance or other ground disturbing works, but some potential remains even in previously disturbed areas.

BHP's Reconciliation Action Plan (RAP) commits to acknowledging and respecting the rights of Aboriginal and Torres Strait Islander peoples and contributing to their economic empowerment and social and cultural wellbeing. The current RAP (2017-2020) applies to all new operations or major capital projects, as will the future RAP which will span years after 2020. The Project will:

- seek to reach agreements with Aboriginal and Torres Strait Islander peoples which deliver sustainable improvements in their economic, social and cultural wellbeing
- minimise impacts on aspects of significant heritage value
- develop and implement an Aboriginal and Torres Strait Islander economic empowerment plan
- deliver Aboriginal and Torres Strait Islander cultural awareness and competency training, in consultation with Barada Barna people, to project employees
- maintain grievance and complaints mechanisms which are culturally appropriate and accessible too Aboriginal and Torres Strait Islander peoples.

Throughout the EIS process and prior to commencement of construction, BMA will consult with the BBAC and local Indigenous community organisations, such as Winnaa Pty Ltd and the Barada Barna Kabalbara and Yetimarla people, to, if necessary, amend baseline data of specific relevance to

Indigenous people, and ensure that the SIA's recommended strategies for engagement and employment are still appropriate.

Furthermore, a CHMP for the Project Site (including the existing SRM) was developed between BMA and the relevant Aboriginal Party in 2011 (CLH012020). This CHMP has been approved under the *Aboriginal Cultural Heritage Act 2003* (ACH Act). Due to confidentiality constraints, this document has not been made available for review. However, for the purpose of this EIS, it is assumed that, as a Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP) endorsed CHMP, it meets all the necessary legislative and policy conditions required for the identification, assessment and management of Aboriginal heritage to satisfy the ToR.

21.6.4 Social and economic matters

Throughout 2018 and 2019, a stakeholder and community consultation program was undertaken to assist in the development of a Social Impact Assessment (SIA). The purpose of the community and stakeholder consultation was to ensure that affected and interested parties, including government, business, community and traditional owners, were aware of the Project and have the opportunity to raise key issues of relevance for themselves and the broader community. The stakeholder and community consultation program identified key feedback themes including:

- housing availability and cost
- cumulative mine impacts on infrastructure and health services
- recruitment and retention of staff in non-mining employment
- opportunities for small business and local employment
- changing socialisation patterns with the introduction of the government's social housing program
- attracting families to live in the local government area for greater economic and social stability.

Social impacts

A SIA was undertaken as part of the Project (Elliott Whiting 2019). The SIA focused on the Isaac region considering the social impacts that may result in positive or negative changes to local and regional social conditions. This was achieved through stakeholder engagement and assessment with a focus on population impacts, housing, social infrastructure, community values and employment opportunities. Social impacts from the Project during the Project's construction phase include:

- changes to perceptions of safety or access to services resulting from an increase in non-resident workforce
- safety issues associated with increased traffic volumes
- increased temporary demand on health and emergency services
- creation of additional direct and indirect local and regional employment
- contribution to regional skills shortages and labour market drain into the mining industry
- sustaining and enhancing opportunities for service industries and businesses in the local government area (LGA).

The potential for social impacts to occur during the Project's operational phase include:

- contributions to an increased population growth rate in ISACC LGA
- health and safety issues associated with increased traffic volumes
- increased workforce accommodation requirements affecting local housing affordability in Dysart, Moranbah, Middlemount and other LGA communities
- increased permanent demand on social infrastructure, including mental health, general health and emergency services
- continued provision of educational and training opportunities

- sustained opportunities for service industries and businesses in the LGA
- enhanced economic development opportunities across the Bowen Basin.

Cumulative impacts are likely to be significant, but their likelihood is unknown.

Prior to the Project's construction, BMA will reassess the potential for cumulative impacts and its local and regional implications, to inform further engagement with the DSDMIP, IRC and other proponents. Community sentiment indicates that new mining operations are supported. The Project's location mitigates direct negative impacts on nearby communities, and a range of positive impacts relating to employment opportunities, population growth and reinforcement of Isaac LGA communities' identity and sustainability are likely. Notwithstanding, a Social Impact Management Plan (SIMP) (Elliott Whiting 2019) has been prepared detailing how BMA will work with local and regional stakeholders to mitigate social impacts and maximise opportunities for the local and regional area.

Economic impacts

An economic assessment of the Project included the regional economies most likely to be either directly or indirectly affected by the Project including the Isaac LGA and Mackay-Isaac-Whitsunday (MIW) Statistical Area (SA) (CDM Smith 2019).

The construction costs associated with the Project are estimated at $1,313.0 million, comprising:

- $420.2 million incurred within MIW SA4
- $538.3 million incurred within the rest of Queensland
- $91.9 million incurred within the rest of Australia
- $262.6 million incurred overseas.

Total operational costs are estimated at $5,982.4 million over the life of the Project, comprising:

- $2,852.4 million incurred within MIW SA4
- $1,480.6 million incurred within the rest of Queensland
- $1,641.4 million incurred within the rest of Australia
- $8.0 million incurred overseas.

There is potential to deliver both beneficial and adverse economic impacts.

Positive economic impacts include:

- regionally based project expenditures are estimated to make contributions to value added in the MIW region at an average of $86.3 million per year between FY 2021 and FY 2023 during construction and $115.7 million per year during operation
- state based project expenditures are estimated to make contributions to gross region product (GRP) at an average of $129.9 million per year over years one to three during the construction phase and an average of $56.1 million per year during the operation phase
- project expenditures incurred interstate are estimated to make contributions to GRP at an average of $24.1 million per year over years one to three during the construction phase and at an average of $67.6 million per year during the operation phase
- increased regional supply chain and employment opportunities throughout construction and operation including an estimated average of 683 full-time equivalents (FTE) per annum, including 385 direct FTEs per annum.

Adverse impacts include:

- the opportunity cost of the Project in terms of alternative economic uses estimated by foregone output is estimated to be approximately $0.71 million per annum
- a total area of 1,261 ha of directly impact forestry, woodland, wetland and grassland habitat, anticipated to have ecosystem services impacts of $4.2 million per annum

- additional employment potentially creating inflationary pressure in the labour market
- local and regional property markets in the form of inflationary pressure
- increased traffic volumes on the road network, as well as increased utilisation regional rail networks.

21.7 Mitigation measures

BMA has committed to undertaking mitigation measures throughout all phases of the Project to avoid, reduce or compensate for potential impacts on MNES. BMA has prepared a Rehabilitation Management Plan (BMA, 2024b) and Subsidence Management Plan (BMA, 2020) as part of the EIS submission. BMA has also committed to preparing further management and monitoring plans to address specific impacts and mitigation measures relevant to MNES. Further information relating to these plans is provided in this section.

21.7.1 Water resources

The Project construction and operation has the potential to impact on water resources through hydraulic changes, erosion and sedimentation, and chemical and fuel leaks and spills.

21.7.1.1 Surface water

Potential impacts will be mitigated through measures such as the mine water management system, sediment basins, regulated structures, restrictions to site water discharges, progressive rehabilitation, spill controls and water quality monitoring proposed for the Project.

Water use

While it is planned to reuse MAW, raw water is still required for those consumptive demands for which MAW is not suitable or for when supplies of MAW are unavailable. Mine dewatering is conveyed into the MAW system and the adjacent mine complex's WMS using existing water transfer systems.

Water transfers will be managed under a Site Water Management Plan developed by a suitable qualified person and incorporate any quality and testing requirements. The Plan will recognise that water to be used for Project operations will be sourced via an off-take from the existing water pipelines developed to support BMA's current and future mining operations, along with various other purposes. Further, this Plan will recognise that water will be sourced from the Eungella Dam and/or the Burdekin Pipeline. The Project will have an internal BMA allocation to draw water from as part of the BMA-related water allocations.

The Project's raw water supply will be linked to the existing SRM's water management system. BMA holds contractual rights to approximately 10,000 mega litres per year (ML/yr) of water from the Burdekin Pipeline (owned by SunWater) as a supply source for BMA operations in the vicinity of Moranbah. In addition, BMA has a water allocation of 6,200 ML/yr from the Eungella Dam that is also available for use in BMA operations in the Moranbah vicinity. In securing its water rights, BMA has allowed for the current and potential future use of water from these sources at the SRM and for growth options associated with MLA 70383. These allocations are held by BMA directly or indirectly via contractual arrangements with SunWater in accordance with the Burdekin Water Resource Plan and the Water Act 2000. BMA also holds allocations of water from the Fitzroy and Burdekin water catchments and numerous licences to interfere with and take water across BMA's mine sites.

In relation to the proposed activities on MLA 70383, BMA will prepare, update and maintain a Water Management Plan.

BMA will ensure water is disposed of in accordance with the Project EA and relevant legislation, and the pipe and pump network is operating properly.

Erosion and sediment control

Erosion and sediment control practices will be applied to construction works and mining operations, in accordance with International Erosion Control Association Best Practice Erosion & Sediment Control guidelines (IECA, 2008) to mitigate the generation of sediment and its transport to waterways.

Measures will be prepared by a *Suitably Qualified Person.* A Project specific plan will be developed prior to construction and include the following at a minimum:

- according to risk, erosion control devices will be placed in ditches and drainage lines running from cleared areas, especially on slopes and levee banks
- contour banks, ditches or similar will be formed across cleared slopes to direct runoff towards surrounding vegetation or sediment dams, and away from creeks
- sediment dams will be constructed prior to vegetation clearing and earthworks
- vegetation clearing and earthworks will be undertaken incrementally over the life of the mine
- timing of clearing and earthworks for construction of creek crossings or drainage and overland flow works to occur in the dry season where practical
- outside of designated clearing areas, buffer zones will be retained to maintain and enhance riparian vegetation
- ongoing, proactive erosion and sediment control will be undertaken, including in-stream controls at strategic locations (such as stream crossings) during significant earthworks, installation and operation of incidental mine gas management infrastructure to minimise release of sediment to waterways
- routine inspection and monitoring to ensure the effective implementation of erosion and sediment controls.

Erosion and sediment control practices will be applied to mining operations, to mitigate the generation of sediment and its transport to waterways. Areas of disturbed or exposed soil will be managed to reduce sediment mobilisation and erosion. The following general mitigation measures are proposed:

- permanent stormwater management systems will be installed as early as possible in the construction program
- erosion and sediment control structures will be regularly inspected and maintained
- topsoil will be stockpiled away from drainage lines to protect it from erosion by surface water runoff
- dust suppression measures will be implemented
- vehicle washdown will take place in designated areas away from flood plains and drainage lines
- water from vehicle washdown areas will be treated to remove seeds, oils and other contaminants before reuse for dust suppression or other on-site use or directed to the mine complex water management system for reuse
- road crossings of streams will be stabilised to minimise wash outs and bank erosion, including placement of matting along banks
- regular inspections of road and pipeline alignments will be undertaken to ensure that disturbed surfaces are stable and not subject to concentration of flows or erosion. Repair works will be undertaken proactively to mitigate erosion from occurring or worsening.

The operational areas will be inspected regularly to check that stormwater management systems are effective, and concentration of flow or scouring is not occurring. Detailed design of the MIA and CHPP will address design of stormwater collection and retention systems to ensure that stormwater can be captured and adequately treated. With design and mitigation measures in place, water quality impacts associated with erosion and sedimentation on the downstream creeks are expected to be minimal.

Chemicals and contaminants

The following general mitigation measures are required to manage impacts of spills and leaks of fuels, oils and other contaminants on receiving waters:

- temporary and permanent fuel storage areas to be designed in accordance with AS 1940 The storage and handling of flammable and combustible liquids. This includes provision for secondary containment
- refuelling to occur within contained, hardstand areas in accordance with AS1940 The Storage and Handling of Flammable and Combustible Liquids where practical; or otherwise refuelling activities will be located away from streams and drainage lines and supervised by an appropriately trained operator equipped with a spill kit
- spill clean-up kits will be sited appropriately, based on the risk of a spill occurring and potential volume of material that might be spilled
- all fuel and chemical storages will be designed and operated in accordance with Australian Standards, including AS1940 The Storage and Handling of Flammable and Combustible Liquids and AS3780 The Storage and Handling of Corrosive Substances
- spills are to be contained and cleaned up as soon as practical to mitigate the mobilisation of pollutants in drainage lines or watercourses
- wastewater from vehicle washdown areas will be directed through oil and grease separators and effluent utilised for dust suppression or other use or directed to the mine WMS for reuse.

Mine WMS

The objectives of the Project WMS are to:

- achieve optimal reliability of water supply for coal processing and dust suppression
- minimise the risk of flooding to the underground workings thereby maximising operability and workforce safety
- minimise the take from the surface water allocation
- direct water from undisturbed areas away from Project operations
- minimise uncontrolled releases from the sites.

The Project will adopt the following principles to achieve these objectives:

- runoff from undisturbed areas of the Project Site and its vicinity will be diverted away from disturbed areas by diversion bunds and drains which will drain via diverted creeks and natural watercourses of Hughes and Boomerang Creek
- runoff from disturbed areas of the Project will be diverted away from undisturbed areas and pumped to the process water dam and used preferentially to satisfy the Project’s, dust suppression and CHPP process water demands
- direct rainfall over the SRM’s existing pit areas that comprise the access for the Project’s underground workings would be captured and managed as part of the Project. The highwall portal will be designed to provide ‘1 in 1,000 year’ annual exceedance probability (AEP) flood immunity to the underground workings. This will be provided through in-pit sumps and an elevated entry to the underground workings. Water will be captured in the pits and will be transferred to the process water dam when required to maintain the flood immunity
- raw water from the BMA’s surface water allocations will be piped to the Project Site and used to satisfy the Project’s potable water and longwall mining equipment demands. Raw water will be used to supplement CHPP make-up water.

MWS failure

The following mitigation strategies will be applied to address WMS failure risk:

- mine water storages will be designed with consideration given to the predictions of the water balance model which considers all inputs and outputs, and which has run through a long-term period of climatic data to test storage capacities particularly in high rainfall wet season. If such discharge were to occur this would only be during rare and large events, therefore any release would be subject to dilution and would be similar to the receiving environment.

- all dams for the Project will be constructed in accordance with the Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (DES, 2016). Pipes and pump systems to be designed with consideration to volume requirements predicted from water balance modelling and designed by a suitably qualified engineer.
- regular inspections of mine water storages, pipeline, drain, bund and levees will be undertaken particularly in relation to integrity of constructed embankments.

The development of the Project conceptual mine WMS has been guided by a set of key objectives based on information provided by BMA, previous studies, best management practice for the management of MAW, and previous experience with coal mines in the Bowen Basin.

Water quality alteration

To manage downstream impacts of the Project, measures will be implemented to divert clean water runoff from undisturbed areas around mining areas, manage flood waters, develop a mine WMS and conduct water quality monitoring. Project discharges and water management will be subject to strict regulation by DES under the conditions and requirements of the relevant EA that limit discharges to emergency conditions and minimum quality requirements. The WMS will minimise the quantity of water that is contaminated and released by Project activities by:

- managing the generation, storage, distribution, and reuse of all potentially MAW (including groundwater) captured and generated by the Project
- handling the conveyance of natural runoff originating from undisturbed clean catchments through the Project Site
- managing the storage and distribution of raw water.

Consistent with current practices for mine water management at other BMA operations, the WMS will aim to passively divert runoff originating from undisturbed catchments around the mine. The exclusion of clean, uncontaminated runoff will reduce the volume of MAW generated onsite and available storage capacity for unplanned events e.g. extreme rainfall. The use of catchment drains, bunding and other devices will be used to reduce the risk of clean water flows from entering the mine WMS. Potential controls include:

- automated monitoring of water levels in the mine water management system
- maintaining sufficient freeboard and directing water to dust suppression and other process uses
- transfer of water to existing SRM storages
- import water of similar quality
- trigger action response plans for high rainfall events and pumping failure
- intercept, collect and treat seepage to reduce volumes entering surface water systems
- install piezometers and monitor water levels at Boomerang Creek and downstream.

MAW from dewatering the underground mine and runoff from disturbed/mine process areas within the mine will be collected and stored in the process water dam. MAW stored in the process water dam will be the preferred source of water for the CHPP and dust suppression activities. Raw water will be stored in the raw water dam and used to satisfy potable, underground mine, CHPP and dust suppression water demands when MAW is unavailable.

BMA manage the system to prevent discharges be seeking authority and conditions to conduct the controlled release of MAW from the Project Site during emergency scenarios (e.g. extreme rainfall events). The indicative location for controlled release of MAW is located on Boomerang Creek adjacent to the proposed process water dam (Figure 21-49). In the event of uncontrolled discharges from the process water dam, these will be directed to Boomerang Creek and monitored in accordance with trigger action response plans.

Water quality monitoring

In the event it is required, the release of MAW at release monitoring locations (Figure 21-49) must not exceed the release limits stated in the Model mining conditions (DES 2017, ESR/2016/1936) – refer Table 21-48 and Table 21-49. Licensed releases in the Isaac River catchment are co-ordinated by the Department of Environment and Science to minimise the occurrence of mines in proximity to each other discharging at the same time.

Based on the results of the modelling undertaken for the mine water balance, the likely requirement for licensed releases is very low, and if they were to occur it is not expected that there would be any residual impacts.

Table 21-48 Mine affected water release limits - *Model Mining Conditions* (2017)

WQ Parameter	Release limits	Monitoring frequency
Electrical conductivity(µS/cm)	< 10,000	Daily during release – the first sample must be taken within two hours of commencement of release or as soon as safe access permits
pH (pH Unit)	6.5 (minimum) 9.0 (maximum)	
Turbidity (NTU)	50[1,2] Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water	

1 GLV EPP Water (2019) (Isaac River 1301)
2 Current limit or derived from suspended solids limit and correlated between turbidity to suspended solids historical monitoring data for dam water

Table 21-49 Mine affected water release contaminant trigger investigation levels - *Model mining conditions* (DES 2017)

Toxicant	Trigger Levels (µg/L)	Monitoring frequency
Aluminium	55	A soon as possible after commencement of release and when safe access permits, thereafter weekly during release – one sample per week required
Arsenic	13	
Cadmium	0.2	
Chromium	1	
Copper	2	
Iron	300	
Lead	4	
Mercury	0.2	
Nickel	11	
Zinc	8	
Boron	370	
Cobalt	90	
Manganese	1900	
Molybdenum	34	
Selenium	10	
Silver	1	
Uranium	1	
Vanadium	10	

Toxicant	Trigger Levels (µg/L)	Monitoring frequency
Ammonia	900	
Nitrate	1100	
Petroleum Hydrocarbons (C6-C9)	20	
Petroleum Hydrocarbons (C10-C36)	100	
Fluoride (total)	2000	
Suspended Solids (mg/L)	55[1]	
Sulfate (SO_4^{2-}) (mg/L)	250[2]	

1 Current limit or limit derived from suspended solids limit and demonstrated correlation between turbidity to suspended solids historical monitoring data for dam water
2 Protection of drinking water Environmental Value

Receiving environment monitoring plan

A REMP will be developed and implemented prior to construction. For the purposes of the REMP, the receiving environment is the waters of Boomerang Creek, Hughes Creek, One Mile Creek, Phillips Creek and Spring Creek. The REMP encompasses any sensitive receiving waters or environmental values downstream of the authorised construction activity potentially be affected by construction works. Content of the REMP will follow DES guidelines (DES, 2014), (DES, (2018a) and DES (ESR/2015/1561), including monitoring upstream and downstream of potential construction impacts.

During operation and closure, BMA will participate in the FRREMP together with adjacent Saraji and Peak Downs Mines as outlined in Fitzroy Coal Mine Receiving Water Monitoring for Regulation – Efficiency Review and Gap Analysis (2018). This includes the utilisation of existing monitoring locations, shared data management, coordination of releases between mines, as well as combined mitigation and response procedures.

Monitoring will be undertaken in accordance with the Monitoring and Sampling Manual – Environmental Protection (Water) Policy 2009 (DES, 2018b) (or guideline current at the time of construction). New monitoring locations will be established downstream of the Project Site (refer to Figure 21-49). Existing upstream locations will continue to be monitored.

Wastewater

Wastewater will be treated to the appropriate water quality standards before discharge into the PWD for reuse in accordance with the EA. The basis for the treatment and use will be in accordance with Australian Guidelines for Water Recycling (NRMMC 2006). Regular water quality sampling of treated wastewater is proposed.

Subsidence management plan

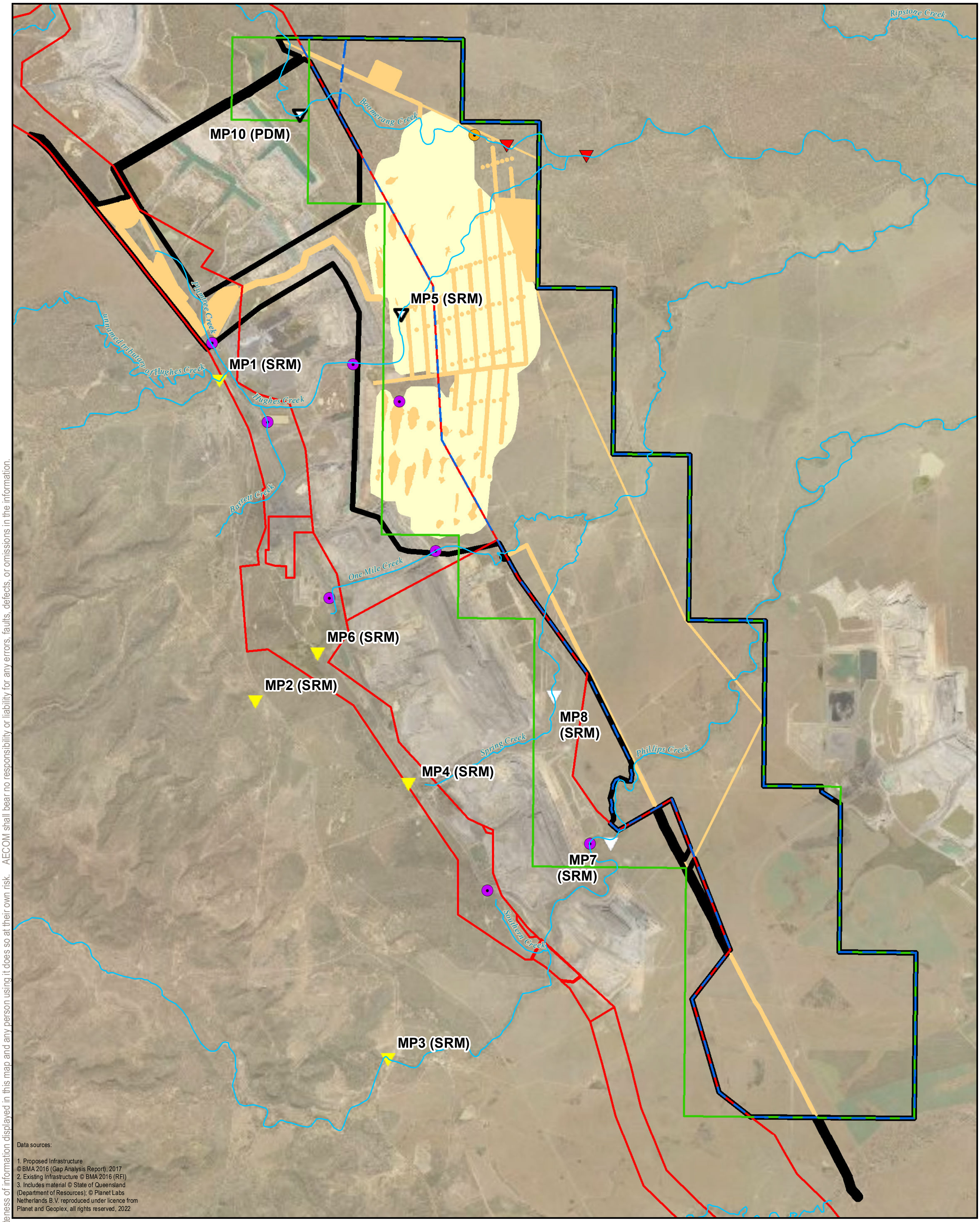
A subsidence management plan (SMP) has been prepared for the Project (BMA, 2024a) providing a plan for documenting and reporting annual progress and management of impacts against objectives. The key components of the SMP are:

- ongoing subsidence monitoring, evaluation, review and improvement program
- managing bed and bank stability
- vegetation management
- panel catchment management, including rehabilitation of subsidence cracking.

Through monitoring, the SMP will identify areas requiring mitigation measures to manage impacts of subsidence on environmental values, including progressive rehabilitation, bed and bank stabilisation, crack infilling with concrete or clay, channel re-profiling and construction of contour banks, embankment arming, erosion control matting in high energy or erosive area, construction of drop structures at head cut erosion features additional grazing access/controls and vegetation planting.

Flooding

During detailed design, further assessment will be undertaken to comply with performance outcomes (PO) of State Code 2: Development in a Railway Environment, PO10 to PO12 of the State Code 6: Protection of State Transport Networks of the State Development Assessment Provisions and Section 2.8 of the Guide to Development in a Transport Environment: Rail. A Stormwater Management Plan and Flood Impact Assessment will demonstrate management of stormwater (quantity) post development can achieve a no worsening impact (on the pre-development condition) for all flood and stormwater events that existing prior to development and up to a 1 per cent AEP.



Data sources:

1. Proposed Infrastructure © BMA 2016 (Gap Analysis Report), 2017
2. Existing Infrastructure © BMA 2016 (RFI)
3. Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2022

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Mine Water Release Point
- Indicative Proposed Mine Water Release Point
- Indicative Proposed Monitoring Point Location
- Data for WQO
- Proposed monitoring location
- Background water quality location

N

Figure 21-49
Existing and proposed monitoring and release points

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 6

21.7.1.2 Groundwater

Surface cracking

The groundwater assessment, using predictive groundwater modelling and uncertainty analysis, identified no discernible drawdown in the alluvium and no material impacts on surface waterways at any level of probability. The assessment assessed the scenario of continuous vertical connectivity (cracks from surface and cracks upward from the goaf) over the shallowest panels (<300 m deep) which will experience the largest subsidence. In addition, the surface cracks were assumed not to heal in the groundwater model, and to be pervasive over the mining footprint, thus the simulated effects of fracturing/cracking are considered highly conservative.

Although the alteration of the overlying geological units, due to longwall mining, have been assessed through a range of differing model layer parameters in the uncertainty analysis, BMA have included a subsidence monitoring program to actively manage surface cracks, reducing the potential for surface water-groundwater interaction.

The Project's Subsidence Management Plan (BMA, 2024) includes the monitoring proposed to be undertaken as part of subsidence management, including to identify requirement for surface crack repairs. Monitoring of the Project area, including waterways within the Project Footprint, will occur during the operational phase of the Project to identify cracks and assess the type/amount of work needed to repair individual surface cracks. Cracks obscured by alluvial sediment within waterways may not be able to be identified visually, however, adverse environmental impacts that occur as a result of these cracks will be identified through other forms of monitoring (e.g. streamflow monitoring, groundwater monitoring, erosion monitoring, riparian vegetation monitoring, etc).

Surface assessment above the longwall panels will be conducted to identify smaller cracks (e.g. less than 50 mm) to determine if repair is required or if the safety and environmental risks associated with the smaller cracks are negligible. Areas disturbed by surface crack repair works will be monitored to ensure that they re-establish vegetation and achieve rehabilitation completion criteria.

Subsidence cracks in the landscape will be managed according to erosion risk and likelihood of self-repair/healing. Mechanical ripping and disturbance within the landscape will be limited and targeted to those areas of high erosion risk and low probability of self-repair. The basis for this approach is to minimise the risk of secondary erosion issues developing from land and vegetation disturbance associated with ripping and ploughing.

Groundwater monitoring bores network

In summary, the impacts requiring ongoing monitoring include:

- Shallow Quaternary age alluvium groundwater levels and quality
- Tertiary groundwater levels and quality
- Permian coal seam target D seam groundwater levels and quality.

Based on the predictive modelling, which allowed for the assessment of additional groundwater drawdown due to the Project (Section 21.6.1.2), no impact on the existing SRM water and waste storage facilities is predicted. As these mine water and waste storage facilities are up dip or on Back Creek Group sediments, the drawdown associated with the Project will not extend to these facilities. As such, no Project related groundwater monitoring is proposed for the existing SRM water and waste storage facilities.

<u>Groundwater Monitoring Plan</u>

A Groundwater Monitoring Program (GMP) will be developed to ensure an appropriate level of detail and scale. The purpose of the GMP will be to monitor the magnitude and distribution of actual changes to groundwater resources in response to the Approved and Project mining and to provide early detection of any unforeseen impacts to groundwater levels, groundwater ingress, or groundwater quality.

The selected groundwater monitoring bore network, to be included in GMP, will monitor potential effects of the proposed Project on overlying and underlying hydrostratigraphic units, so that informed management decisions can be made.

The fundamental components of the GMP are as follows:

- The monitoring bore network and subsequent monitoring program will be developed and established prior to the commencement of the Project underground mining.
    - Baseline seasonal trends for groundwater levels and quality will continue to be collected for the monitoring bores installed in 2019 and 2020
    - Data from SRM groundwater bores will be used to detail the current groundwater quality prior to the Project commencement.
    - This groundwater quality data will be used as comparison with the groundwater quality data compiled during the Project (construction and operation) to assess potential impacts or alteration.
- Where appropriate, groundwater level and quality data from existing monitoring bores will be incorporated into the monitoring data compiled in the GMP.
    - As some drawdown impacts are predicted for registered bores, representative private bores (or new sentinel sites) are likely to also be incorporated into the monitoring bore network.
- Site-specific groundwater quality will be monitored to determine additional bore specific trigger levels, evaluate spatial and temporal trends, and gauge whether water quality objectives are being protected or enhanced.
    - An objective of the GMP will be to detect possible water quality change trends, which could materially water quality (i.e., no longer able to meet WQOs or current use) due to the Project.
- There are no local springs or aquatic GDEs to monitor.

The GMP will include, based on the mines up dip and along strike of the Project are all owned and operated by BMA, opportunities to combine groundwater monitoring data, refine the regional Bowen Basin groundwater models and model predictions, and assess mining operations to evaluate potential cumulative impacts.

The more regional groundwater monitoring, which allows BMA to detect and monitor potential groundwater related cumulative impacts, will assist in developing mine operation and closure plans to avoid, minimise, or mitigate pre- and post-closure impacts.

A summary of the current groundwater monitoring bores, and the relevant hydrostratigraphic unit, to be included in Project GMP is included in Table 21-50. Groundwater level measurements are collected manually from monitoring wells located across the site. Manual readings are procured during each monitoring event (prior to any sampling).

Table 21-50 Existing groundwater monitoring bores for the Project

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (mbgl) / screen depths	Geology	Purpose	Location
MB34	637926	7518269	2013 - ongoing	195.9	107.0 99.5 to 105.5 mbgl	Moranbah Coal Measures interburden Model Layer 13	Validate model predictions	Along strike from Project underground on One Mile Creek
MB33	636640	7520199	2013 - ongoing	194.8	37.5 30 to 36 mbgl	Moranbah Coal Measures Q seam	Validate model predictions	Along strike between Project underground

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (mbgl) / screen depths	Geology	Purpose	Location
						Model Layer 12		and Philipps Creek
MB38 / MB19SR M01A	639919	7515681	2019 - ongoing	194.41	8.5 5.5 to 8.5 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Phillips Creek
MB20SR M04A	631397	7530470	2019 - ongoing	194.95	12.0 6.5 to 9.5 mbgl	Alluvium Model Layer 1	Validate no impact on alluvium	Along strike from Project underground
MB20SR M01A / MB20SR M01 / MB20SR M01_PZ	635922	7527665	2019 - ongoing	186.42	10.5 7.2 to 10.2 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Plumtree Creek
MB20SR M05A/ MB20SR M05A_PZ	634476	7525798	2019 - ongoing	191.43	24.0 6.5 to 9.5 mbgl	Alluvium Model Layer 1	Validate dry alluvium	On Hughes Creek
MB20SR M02T	635914	7527670	2019 - ongoing	186.61	36.5 27.5 to 36.5 mbgl	Tertiary Model Layer 2	Validate model predictions	Above the Project
MB20SR M03P	635907	7527677	2019 - ongoing	185.87	242.7 231 to 237 mbgl	Moranbah Coal Measures P seam Model Layer 14 & 15	Validate model predictions	Above the Project

The existing groundwater monitoring network (Table 21-50) will be augmented near the proposed Project (and over time) to ensure the following:

- The determination of groundwater level responses to mine activities within the Project Area. The comparison of water level decline will allow for the identification of groundwater resources, which may be unduly affected by mine dewatering; unduly affected is where drawdown is projected to be greater than the model predictions.
- The extent and magnitude of drawdown in each hydrostratigraphic unit near the proposed underground workings is adequately monitored for comparison to modelled projections over time.
- The identification and management of any potential impacts on surface water.
- The groundwater monitoring network will, during operations, act as an early warning system for potential drawdown impacts. The monitoring bore network augmentation will ensure the replacement of monitoring points that are lost during mining, and the groundwater monitoring program is to be modified in response to mine activities change (i.e. operations or closure).

Recommended new Project monitoring bores

To ensure the collection of representative groundwater monitoring data, allow for the assessment of the potential predicted impacts of the Project on local groundwater resources, additional monitoring bores are required to be installed and sampled prior to the Project mining activities, these are detailed in Table 21-51 and shown in Figure 21-50.

Table 21-51 New Project monitoring bores

Recommended bore	Easting	Northing	Model Layer	Target
SEMLP1T	637628	7528964	Model Layer 2	Tertiary sediments adjacent to Boomerang Creek, within the mapped fault
SEMLP1P	637735	7528962	Model Layer 18	Target D seam, adjacent to Boomerang Creek, and within the mapped fault (Figure 21-21).
SEMLP2T	637672	7523955	Model Layer 2	Tertiary sediments, within the inferred fault
SEMLP2P	637863	7524055	Model Layer 18	Target D seam, within the inferred fault

These proposed bores are to be located down dip of the Project underground mine panels and along the inferred fault, as discussed in Section 21.4.4.1 and included on Figure 21-22.

These monitoring bores will allow for:

- The verification of drawdown within the Tertiary and target D seam
- The assessment of the fault (and possible refinement of the model)
- The evaluation of the fault in terms of influence on drawdown (i.e., groundwater level change due to compartmentalisation, elongation along fault, or across the fault)
- Assessment of vertical gradients and potential induced flow (from Tertiary to Permian)
- Evaluation of potential blending of groundwater quality
- Recovery (post-closure).

All monitoring bores are to be drilled using a water bore drilling rig, using mud-rotary, air-percussion or other appropriate techniques. The groundwater monitoring bores are to be designed in accordance with the Minimum Construction Requirements for Water Bores in Australia, 4th Edition (National Uniform Drillers Licensing Committee, 2020) or as current. Consideration must be given to casing and annular seal requirements to ensure that no pathway is provided for the movement of water between hydrostratigraphic units (i.e. the bore does not act as a connecting pathway).

Groundwater **monitoring bore network**

The overview of the groundwater monitoring program is shown in Figure 21-50.

The groundwater monitoring bore network, both existing and proposed bores, is summarised in Table 21-52.

Table 21-52 SEMLP Groundwater monitoring bore network summary

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (m)	Geology	Purpose	Location
Existing								
MB34	637926	7518269	2013 - ongoing	195.9	107.0	Moranbah Coal Measures interburden	• Validate model predictions • Assess dewatering trend (9 m decline over time) - located on possible fault leading to preferential drawdown.	Along strike from Project underground on One Mile Creek.
MB33	636640	7520199	2013 - ongoing	194.8	37.5	Moranbah Coal Measures Q seam	• Validate model predictions • Assess groundwater recharge, influence of cracking and ponding • Predicted to go dry.	Along strike between Project underground workings and One Mile Creek and Philipps Creek.
MB38 / MB19SRM01A / MB19SRM01A_ HY	639919	7515681	2019 - ongoing	194.41	8.5	Alluvium	• Validate water level (dry /wet) condition of alluvium • No impact predicted – validate no impact due to the Project noting Saraji Mine Grevillea Pit expansion impacts likely.	On Phillips Creek.
MB20SRM04A	631397	7530470	2019 - ongoing	194.95	12.0	Alluvium	• Validate no impact on alluvium upstream on Boomerang Creek of the Project.	Along strike and up dip of Project underground.
MB20SRM01A (MB20SRM01_ PZ)	635922	7527665	2019 - ongoing	186.42	10.5	Alluvium	• Validate dry alluvium • Assess groundwater recharge, influence of cracking and ponding • Predicted to remain dry.	On Plumtree Creek.
MB20SRM05A / MB20SRM05A_ PZ	634476	7525798	2019 - ongoing	191.43	24.0	Alluvium	• Validate dry alluvium • Assess groundwater recharge, influence of cracking and ponding	On Hughes Creek.

Bore ID	Easting (GDA94)	Northing (GDA94)	Monitoring Period	Elevation (mAHD)	Depth (m)	Geology	Purpose	Location
							• Predicted to remain dry	
MB20SRM02T	635914	7527670	2019 - ongoing	186.61	36.5	Tertiary	• Validate model predictions • Assess groundwater recharge, influence of cracking and ponding	Above the Project
MB20SRM03P	635907	7527677	2019 - ongoing	185.87	242.7	Moranbah Coal Measures P seam	• Validate model predictions • Assess rate and fluctuation of groundwater level as per predictions in response to mine plan	Above the Project
Proposed								
SEMLP1T	637628	7528964	-	TBC	TBC	Tertiary	Tertiary sediments adjacent to Boomerang Creek, within the mapped fault	
SEMLP1P	637735	7528962	-	TBC	TBC	D seam	Target D seam, adjacent to Boomerang Creek, and within the mapped fault (Figure 21-21).	
SEMLP2T	637672	7523955	-	TBC	TBC	Tertiary	Tertiary sediments, down dip of the Project and adjacent to the inferred fault. Assess fault barrier or preferential drawdown	
SEMLP2P	637863	7524055	-	TBC	TBC	D seam	Target D seam, down dip of the Project and adjacent to the inferred fault. Assess fault barrier or preferential drawdown	

Groundwater monitoring and sampling program

In accordance with an adaptive management approach, the groundwater monitoring program will establish monitoring attributes modified on an ongoing basis to ensure optimal understanding of the groundwater regimes and the envisaged mining impacts before, during, and after the proposed mining activities.

Groundwater samples have and will be obtained from the representative groundwater monitoring points, which have allowed for establishing representative groundwater chemistry concentrations and trends prior to the Project.

The groundwater units monitored on site, based on the potential for mine activities to impact on these units, include Quaternary alluvium; Tertiary sediments; Permian non-coal bearing strata; and, Permian target coal seam.

Changes in quantity of groundwater (or availability of groundwater), flow volumes in hydrostratigraphic units, and interaction between groundwater and surface water features are primarily determined based on groundwater level/pressure levels and related changes in these levels. The parameter suite for analysis for each groundwater sample is likely to include, but not limited to the following:

- pH, Electrical Conductivity, and turbidity (field and laboratory determinations)
- Total Dissolved Solids (laboratory analysis)
- Anions - carbonate, bicarbonate, chloride, sulphate, fluoride (laboratory analysis)
- Cations - calcium, magnesium, sodium, potassium (laboratory analysis)
- Dissolved and total metals - aluminium, antimony, arsenic, iron, manganese, molybdenum, selenium, silver, mercury (laboratory analysis)
- Nutrients - nitrate, nitrite, phosphorus, ammonia
- Total petroleum hydrocarbons (TPH)
    - TPH $C_6 – C_{10}$
    - TPH $>C_{10}$ -C_{40}.

Groundwater level monitoring is the key parameter for assessing changes to the groundwater regime, particularly as the 'make good' agreements with landholders are typically predicated on a water level change. The primary indicator for groundwater quantity is defined as the temporal change to groundwater level/pressure in a defined hydrostratigraphic unit at an established monitoring location.

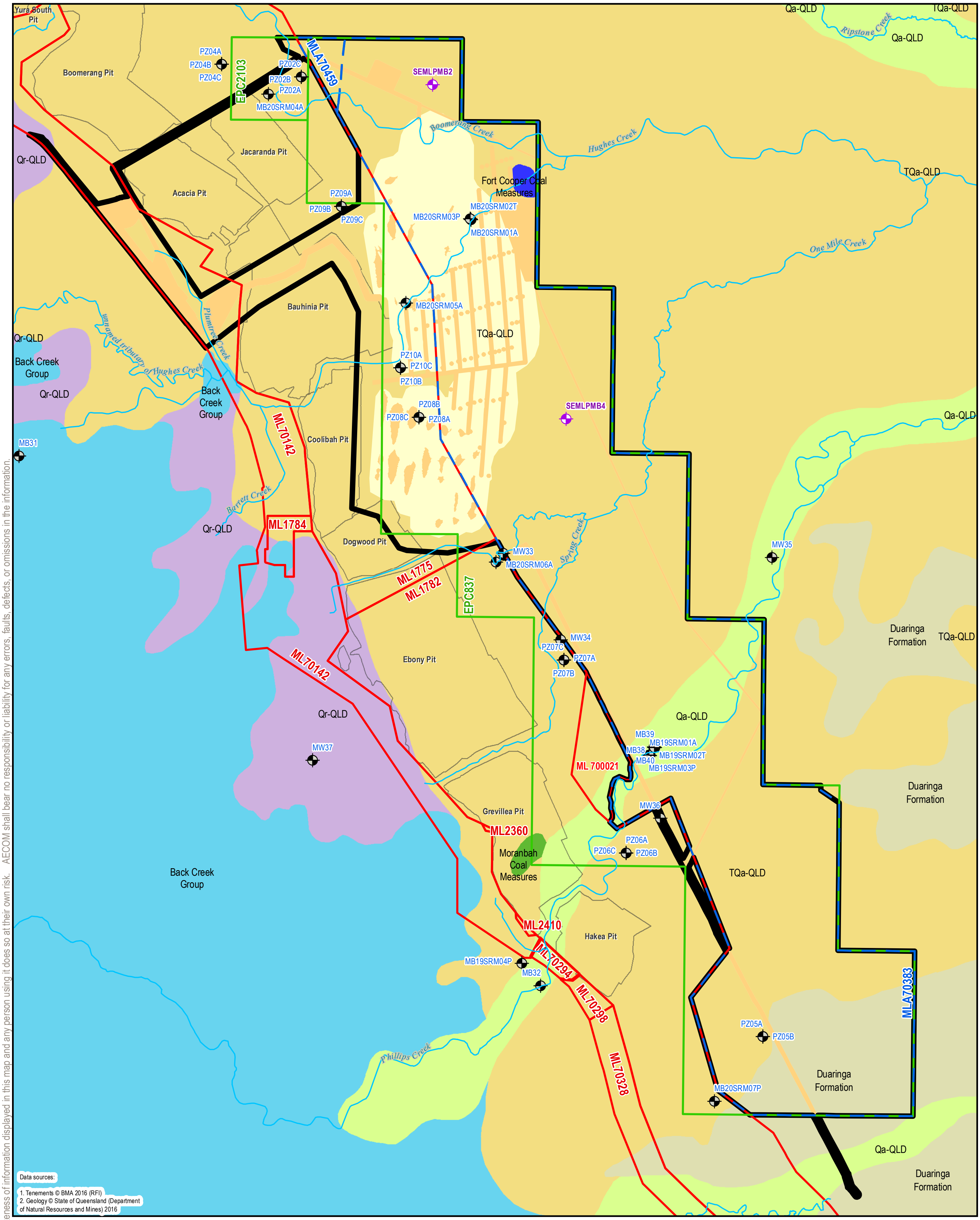
The transient groundwater level data does not readily indicate the direct or indirect impact of mining on these bores, rather the data indicates complex response to wet and dry climate conditions in the different hydrostratigraphic units. The adopting of a simple 2 m per year fluctuation, as included in the SRM EA is not considered suitable for the Permian monitoring bores, based on these water level data trends, for the Project. Groundwater level monitoring data will be compared to the groundwater model predictions. During post closure it is envisaged that the groundwater level data will provide recovery data, which will be compared to long-term model predictions.

The low-flow sampling method is to be adopted to minimise the volume of purge water to be managed while ensuring that samples collected are representative of the groundwater unit.

Groundwater sampling is to be undertaken in accordance with the most recent edition of the DES Water Quality Sampling Manual, which allows for the collection of repeatable representative groundwater data. A rigorous sampling protocol will ensure that representative parameters are measured, and that due diligence is maintained in tracking of the samples and the results. Appropriate quality assurance and quality control (QA/QC) of samples and procedures will be implemented. All groundwater monitoring, water level measurements and sample collection, storage and transportation is to be undertaken in accordance with the procedures outlined by the DES Monitoring and Sampling Manual (2018) and the Murray Darling Basin Groundwater Quality Sampling Guidelines (1997).

In case of future use of the Project model, updates could be conducted to further refine the model if it was deemed that an increase in model confidence level was required, but the applicability of this would be dependent on the purpose of the future modelling and availability of data to inform future changes. As it stands, the current model is deemed fit for purpose for the Project impact assessment.

Once sufficient baseline data has been compiled, then the site-specific groundwater Trigger Action Response Plans (TARP) will be finalised.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Existing Open-Cut Extent
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Existing Bores
- Proposed Bore

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- TQa-QLD (TQa)

N

Figure 21-50
Existing and Proposed Monitoring Bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 5/06/2024 VERSION: 3

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\21 MNES Ecology\60507031_G259_v3_A4P_RePathed_v2.mxd

21.7.2 Threatened species and ecological communities

21.7.2.1 Avoidance

Significant mine engineering design has been undertaken in the development of the Project Footprint. The Project location is defined by the nature and scale of the coal deposit. As such, it is constrained by resource, geographic, existing infrastructure and feasibility considerations. While an alternative option to not proceed with the Project avoids potential environmental impacts, it will also result in substantial socio-economic impacts, including:

- loss of economic benefit
- reduced local, State and nationwide job opportunities
- reduced demand and income for support industries and service suppliers
- resources will not be available to supply high quality coal products to export markets
- missed opportunity for employee opportunities, apprenticeship programs, support of local businesses and financial donations to community groups and local projects.

The finalised layout of the Project aims to optimise mining to access most of the target resource with the smallest footprint to minimise impacts to land, environment, heritage and community values. The Project's target resource is located predominantly in MLA 70383 which is contiguous with leases currently held by BMA for the existing SRM. The Project location has also been identified to enable an opportunity for strategic growth, as the extent and nature of the resource is well understood due to extensive exploration and historic mining in the area. As such, BMA can bring this Project into production reasonably quickly compared to less well-known resources.

At the proposed location, the Project will intersect Hughes Creek and Boomerang Creek already subject to diversions and impacts of mining upstream, with the benefit of being able to avoid further mining impacts to Phillips Creek, Spring Creek and One Mile Creek to the south. An alternate location will result in new impacts and increased disturbance to land and sensitive environmental values as well as key infrastructure being further away from existing infrastructure and mining operations leading to increased disturbance as well as higher development and operational costs in accessing and processing the resource.

The Project will adopt an optimised underground mine plan for the Project to integrate with existing SRM open cut mine and supporting infrastructure, access dipping coal seams and minimise environmental impacts. A maximised mine plan option, comprising 17 longwalls accessed via the existing open cut, was considered to maximise mining of the available coal resource within the mining tenure. This larger underground mining footprint was expected to result in greater surface disturbance, particularly subsidence impacts on associated watercourses, surface water flow and vegetation. As a result of greater environmental impacts and capital costs, this option was not considered the most effective use of the coal resource.

Utilisation of the existing SRM infrastructure and/or disturbance has been incorporated into the Project design to minimise the need for additional disturbance. For example, the management of dewatered tailings will be within the existing SRM in-pit spoil dumps. As a result, the Project will not require new tailings storages. Similarly, the location of surface infrastructure has determined based on the access to existing SRM infrastructure including the existing CHPP, BMA's existing water pipeline network, telecommunications network and electrical power network.

The optimised mine plan provides ideal capacity to mine the target resource within the Project Site with consideration of resource geology and quality, production rates, site constraints and potential environmental impacts.

21.7.2.2 Minimise

The Project has been designed to utilise existing mine infrastructure and previously disturbed land at SRM to minimise further disturbance and further impact to the environment. Use of the underground longwall mining methods will minimise direct impacts to ecological values in comparison to open-cut mining. While vegetation within the modelled subsidence footprint may be subject to isolated loss of trees attributed to surface cracking, native vegetation is unlikely to experience material change to vegetation composition and structure. Modification of vegetation and habitat present will be largely limited to deeper depressions subject to ephemeral ponding, which will be managed.

Access to the underground working areas will be through the existing open cut highwall on the far eastern side of the existing SRM open cut mining area. This reduces the portal complexity, length and quantity of spoil materials generated compared to an above ground configuration. Locating the underground access in the existing open cut also allows for shorter above ground conveyor configuration between the underground mine and CHPP. Use of the existing open cut pit for mine access minimises potential environmental impacts, costs, time and risks involved in construction of a new mine portal from above ground level.

The CHPP, conveyors and product stockpiles are located within the existing SRM ML and, while vegetation clearing is required, this vegetation is already disturbed and fragmented. The proposed MIA and the raw water dam will be located in a disturbed area within SRM and are not anticipated to require removal of remnant vegetation.

Clearing for the powerline connection will only be required for footings and a narrow easement. As such, impacts to high biodiversity values within the powerline connection footprint will be minimised. The width of the corridor is also expected to reduce during the detailed design process.

Further detailed design will refine the siting and disturbance associated with surface infrastructure, IMG drainage network, access, pipelines and powerlines, ensuring where disturbance is required, it will be restricted to the minimum necessary within the Project Footprint. While design of the layout of the IMG drainage infrastructure has not yet been finalised, it is intended to restrict the number of times that the infrastructure crosses these creeks to minimise direct disturbance to this corridor. Well pads for IMG drainage will be installed outside of the riparian zone. Required crossings will be selected where natural breaks in vegetation occur where practical. Some pipeline crossings will be required and these will be trenched crossings, with disturbed areas reinstated to stabilise the river bed and banks. The required crossings will be reduced to the minimal width required.

21.7.2.3 Mitigation measures specific to surface infrastructure

When clearing vegetation for any of the surface facilities, the following mitigation measures will be implemented:

- areas for clearing will be clearly delineated to avoid inadvertent clearing
- if habitat trees can be retained without compromising safety, these will be identified and clearly marked
- habitat features such as felled trees and logs will be considered for relocation to other areas where practical to provide microhabitat
- vehicles and equipment will be cleaned to remove weed seeds before being brought to the site
- workers will be made aware of mitigation management requirements in induction training.

Throughout construction, the following mitigation measures will be utilised to manage impacts from construction activities:

- vehicles and equipment will be cleaned to remove weed seeds before being brought to the site
- topsoil will be removed and used to rehabilitate existing disturbed areas in accordance with the EA and Regional Interests Development Approval
- erosion and sediment control measures will be installed and maintained to Australian Standards and in accordance with the EA
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation

- bushfire risk during construction activities will be mitigated through the following measures:
  - managing vegetation within the MLAs to maintain safe fuel loads
  - any chemicals used in the Project Site will be handled and disposed of in accordance with the relevant Safety Data Sheet
  - implementing access tracks, to be used by Queensland Fire and Rescue Service for emergency purposes; and
  - implementing an Emergency Response Procedure prepared in consultation with emergency services.

Weed monitoring and management will be ongoing throughout construction and operation.

Measures set out above to minimise impacts on flora and vegetation communities will also assist to some extent in minimising impacts on fauna. Other measures to be implemented will include:

- the workforce will be provided with contact details of suitably qualified spotter catchers in the event that fauna is present and needs to be removed, or fauna are accidentally injured. This will be covered in induction training and work instructions
- heavy vehicles (and where practical, light vehicles) will not traverse vegetated areas outside designated construction zones, and will be required to remain on existing tracks
- during detailed design, lighting will be designed so that light spill into adjacent habitat areas is minimised.

Suitably qualified spotter catchers will be required during vegetation clearing (all spotter catchers will hold appropriate permits under the NC Act). If fauna are injured by vehicles during operations, the RSPCA or local wildlife carers will be contacted for assistance.

21.7.2.4 Mitigation measures specific to the IMG drainage network

While the extent of infrastructure required for IMG drainage will mean impacts on significant vegetation communities and plants are unavoidable, there are a range of measures that will be taken to reduce the level of impact of clearing and manage associated impacts. These include the following:

- avoiding placement of IMG extraction wells and infrastructure within Brigalow TEC where practical. Where unavoidable, offsets will be sourced.
- designing and constructing IMG management infrastructure to minimise disturbance to riparian zones along the Boomerang Creek, Plumtree Creek, Hughes Creek and oxbow wetlands and avoiding placement of wells within 50 m of these waterways
- wherever practical, locating infrastructure alignments and gas drainage wells to avoid remnant vegetation
- minimise creek crossings or selecting crossing locations where natural breaks in vegetation occur
- areas where clearing is planned will be distinctly delineated, so that inadvertent clearing of additional areas does not occur
- before being brought onsite, all vehicles and equipment should be cleaned to remove weed seeds
- dust suppression measures will be undertaken to minimise dust deposition on vegetation adjacent to tracks and construction areas
- management measures to remove and control any new weed infestations or areas that have exhibited increased densities and/or extents within disturbance areas, including vegetation fragmented by the IMG Network
- utilising erosion and sediment control measures to Australian Standards and in accordance with the EA for all ground disturbance activities and stream crossings.

The primary impacts on fauna during construction of the IMG drainage network are the loss of habitat and potential risk of mortality associated with the works. Measures to reduce habitat impacts include:

- selecting already disturbed areas for crossings of creeks and drainage lines where practical
- minimising the width of clearing required for crossing, and particularly retaining tall trees on either side of crossing locations wherever this is safe to do so
- minimising placement of gas wells in riparian and woodland areas
- reinstating habitat connectivity.

Suitably qualified spotter catchers will be required during all clearing activities. Spotter catchers will hold appropriate permits under the NC Act. When working remote to the spotter catchers, workers will be provided with contact details for the spotter/catchers in the event fauna is present and need to be removed or are accidentally injured. This will be covered in the induction training and work instructions.

Vehicles will not be allowed to traverse vegetated areas but will be required to remain on existing tracks. Speed limits will be placed on all roads and tracks associated with the IMG drainage network.

Where lighting is required, lighting will be directed away from vegetated areas where practical.

21.7.2.5 Mitigation measures specific to subsidence

An adaptive and iterative approach will be implemented to identify and manage potential subsidence impacts drawing on lessons learnt from subsidence monitoring results from other BMA owned underground operations in the region (e.g. Broadmeadow Mine). The adaptive management approach responds to routine subsidence monitoring using Lidar-derived surface level data for subsided areas to detect timing and severity of impacts, accommodating the wide range of environmental responses to subsidence that might be experienced (e.g. changes to vegetation community structure, changes to sediment transport regimes, etc.). Any changes to the mining schedule during operations (which may mean actual subsidence differs from the predicted subsidence) will also be reassessed and reflected using the adaptive management approach.

Drainage

Ponding areas will be assessed on a case-by-case basis (using the principles of adaptive management) during the operational phase of the Project to determine the likely impacts and progressively select the most effective management strategy based on a comparison of environmental risk.

Where evidence of ponding is detected, the installation of drainage channels will be considered to gravity-drain water from the ponded areas into nearby natural drainage channels, re-establishing a free draining landform. Drainage serves to maintain water flows through the catchment and maintain connectivity for fish passage, sediment transport, etc. However, acknowledging that installing drainage channels may have other environmental considerations or risks (e.g. vegetation clearing, exposure of dispersive soils and increased risk of erosion and sediment accretion) or benefit (e.g. provision of aquatic habitat values and stock water) each location will be considered individually as evidence of ponding develops.

The case-by-case assessments will be completed prior and/or immediately following subsidence that is detected as part of the routine monitoring. Where risk of retaining water outweighs risk of constructing drainage, drainage of ponding areas will be established installing appropriate measures (e.g. earthen drains, rock chutes) to facilitate water reaching the downstream catchment. The drainage strategy will consider the whole of the subsided area and apply key drainage channel design principles including:

- drainage channels will be designed with gradients to protect against erosion and accretion
- where practical, drainage channels will use natural, non-dispersive materials and be reflective of natural drainage channels in the surrounding landscape
- regrading or use of rock armouring to limit head cut erosion may be required
- batter slopes will be designed to be stable and compatible with the slopes in the surrounding landscape
- where dispersive or sodic soils are identified, measures will be implemented to minimise erosion (e.g. amelioration and/or capping with non-dispersive soils).

With the installation of minor remedial drainage earthworks and the re-instatement of free drainage, there will be no significant residual ponding caused by mine subsidence and consequently no impact on vegetation due to ponding of water. Drainage channels will be located to avoid sensitive features and vegetation communities as far as practicable. Any design aims to utilise the topography of the landscape in defining where and what drainage mitigation is required.

The adaptive approach also ensures any assessment/investigation undertaken benefits from the continued collection of monitoring data (e.g. water quality) and refinement of the water balance model over time. The water balance model of the ponding areas will be maintained and refined during the operational phase of the Project and used to assist with the case-by-case assessments. Based on the conceptual water balance model of ponding areas (Engeny, 2023), natural overland flow paths were identified with potential to require minor remedial drainage works to facilitate gravity-flow of ponded water back into the catchment (noting drainage works may not be required at all these locations). Any drainage channels installed will be permanent and incorporated into the PMLU described by the Rehabilitation Management Plan (BMA, 2024).

Fish salvage

Ponded areas within watercourses, subsided panels and drainage channels installed to establish free-draining landform will be monitored to identify instance of stranded fish. Where fish become stranded within ponded water, the fish will be removed by a suitably qualified person with the required permits and approvals under the *Nature Conservation Act 1992* and in accordance with the State guidance on fish salvage (Business Queensland 2024). In addition to general fisheries permit, specific advice regarding site access, safety, location and timing may be required for large or complex fish salvage operations. If possible, the works will be done in the cooler months, when fish are less active and easier to handle.

Based on the Queensland Government fish salvage guidance, fish will be captured using nets with a mesh size to minimise injury or death of the fish. After removing as many fish as possible, water level will be lowered by 25 per cent to further remove as many fish as possible. Where practical, sluicing fish is the preferred method for transferring captured fish, rather than using containers. Fish will be released into adjacent watercourses with equivalent water quality and temperatures (if notably different, exchange the water to equalise the temperature before releasing the fish). Noxious or invasive fish species removed as part of salvage will not be returned to the water.

Surface crack repairs

Subsidence cracks in the landscape will be managed according to erosion risk and likelihood of self-repair/healing. Repairs requiring mechanical ripping and disturbance within the landscape will be limited and targeted to those areas of high erosion risk and low probability of self-repair. The basis for this approach is to minimise the risk of secondary erosion issues developing from land and vegetation disturbance associated with ripping and ploughing.

The initial and least disruptive management strategy for surface cracks developing within the Project area is to allow them to naturally self-seal, which will be monitored as part of the routine subsidence monitoring inspections. Surface cracks that have not self-sealed within 12 months of subsidence will be repaired. As surface cracks and associated repairs will progress in line with mining schedule, the extent of disturbance will be relatively small at any one time.

A high-level overview of the management strategy for surface cracks is as follows:

- Monitoring of the Project area, including waterways within the Project area, will occur during the operational phase of the Project to identify cracks as they develop and assess the type/amount of work needed to repair individual surface cracks. Cracks obscured by alluvial sediment within waterways may not be able to be identified visually, however adverse environmental impacts occurring as a result of these cracks will be identified through other forms of monitoring (e.g. streamflow, groundwater level, erosion, riparian vegetation, etc.).
- A case-by-case assessment will be conducted upon identifying smaller cracks (e.g. less than 50 mm) to determine if repair is required or if the safety and environmental risks associated with the smaller cracks are negligible.

- Repairing individual cracks may involve:
  - Ripping or ploughing the area around minor cracks using a small dozer, grader or tractor, then the area will be allowed to regenerate naturally through inherent seed resources, vegetation propagation from rootstock and recruitment from adjoining undisturbed areas
  - Stripping the area around large cracks of topsoil, excavating and placing clean fill to stabilise the cracks and establish drainage, then respreading the area with topsoil. The area will be seeded if natural regeneration is considered unlikely to be successful. Grasses and shrubs are expected to re-establish relatively quickly. However, canopy trees removed to facilitate crack repair works will take longer to re-establish.

Areas disturbed by surface crack repair works will be monitored to ensure vegetation re-establishes and is consistent with the proposed PMLU and rehabilitation completion criteria in the RMP (BMA, 2024) and the PRCP.

Where works are required to repair surface cracks from subsidence, this will be in accordance with the measures within the Subsidence Management Plan. Clearing of vegetation will be minimised by using smaller machinery where practical. Grasses and other groundcover will be slashed rather than cleared to allow access.

Where machinery is required to repair surface cracks or construct subsidence pond drainage channels, vehicles and equipment will be cleaned of all weed seeds and other potential contaminants before entering the site. Progressive rehabilitation will be undertaken as detailed in the Rehabilitation Management Plan. This will include:

- post subsidence inspections and identification of high risk areas, drainage works (to promote drainage and pump areas of persistent ponding
- rehabilitate with species similar to pre-existing REs of the region that are tolerant of inundation
- installation of interim control devices to divert surface runoff away from rehabilitated areas until groundcover is established
- remediation of surface cracking (ripping, grading, compaction or crack infilling), particularly along ephemeral drainage lines.

Where machinery is required to repair surface cracks or construct subsidence pond drainage channels, vehicles and equipment will be cleaned of all weed seeds and other potential contaminants before entering the site. Progressive rehabilitation will be undertaken as detailed in the Rehabilitation Management Plan (BMA, 2024a). Priority will be given to restoring the habitat connectivity associated with riparian wildlife corridors. Rehabilitation of subsidence impacts will include:

- post subsidence inspections and identification of high risk areas, drainage works (to promote drainage and pump areas of persistent ponding)
- rehabilitate with species similar to native vegetation of the region that are tolerant of inundation
- installation of interim control devices to divert surface runoff away from rehabilitated areas, if assessed as necessary, until groundcover is established
- remediation of prolonged surface cracking (greater than 12 months) (ripping, grading, compaction or crack infilling), particularly along ephemeral drainage lines.

A subsidence monitoring program and adaptive management approach will be implemented to manage potential subsidence impacts to vegetation and habitat from the Project and will be documented within associated monitoring reporting. In the event changes in vegetation/habitat condition are detected, further assessment will be undertaken to identify the extent and potential cause. Adaptive management will involve implementation of measures to avoid re-occurrence. The extent of direct impacts of subsidence on flora and vegetation communities will be mitigated through monitoring to identify persistent ponding in the landscape, with minor remedial drainage works to ensure free-draining landform. Erosion and surface cracking will also be repaired. Further information is presented in the Subsidence Management Plan (BMA, 2024b).

21.7.2.6 Management and monitoring plans

Prior to construction, suitably qualified and experienced personnel will develop management and monitoring plans and procedures to address specific impacts and mitigation measures relevant to MNES that will be implemented during the construction and operational phases of the Project. Each plan will outline SMART (Specific, Measurable, Achievable, Relevant and Time bound) controls and be developed through an iterative process (for continual improvement). Key management and monitoring plans and procedures are described in Table 21-53. Detailed management plans presented as part of this EIS include Rehabilitation Management Plan (**Appendix K-1**) and Subsidence Management Plan (**Appendix K-2**).

Table 21-53 Key management and monitoring plans and procedures

Plan	Phase	Description
Construction Environment Management Plan	Construction	Prior to construction, BMA will develop and implement an overarching **Construction Environmental Management Plan** (CEMP) to outline a preferred hierarchy for environmental management and SMART controls to mitigate and manage impacts and reduce threatening processes to environmental values during the construction phase. This plan will be developed to outline and describe the following: • objectives • risk assessment • environmental management activities and mitigation measures • the timing of actions • a monitoring program, which will include: - performance indicators (clear and concise criteria against which achievement of outcomes are to the measured), which are capable of accurate and reliable measurement - outcomes (time bound outcomes as measured by performance indicators), which might include milestones (interim outcomes) - monitoring requirements (timing and frequency of monitoring to detect changes in the - performance indicators, to determine if outcomes are being achieved, and to inform adaptive management) - trigger values for corrective actions. • potential corrective actions to be implemented if trigger values are reached, and how environmental incidents and emergencies will be managed • roles and responsibilities (clearly stating who is responsible for activities) • auditing and review mechanisms.
Offset Management Plan Prior to Stage 1 (direct) impacts, the Offset Management Plan will confirm suitable offset for up to 100 per cent disturbance.	Construction and operation	In advance of each stage of the Project, BMA will develop an **Offset Management Plan** to finalise the offset mechanism to be used, including but not limited to identifying: • any BMA owned properties that will be secured as offsets, their locations and contribution towards offset requirements • offset requirements that will be secured through the provision of other offset lands • offset requirements that will be secured through an offset payment or other indirect offset proposals • ongoing management actions required at each area, such as: - management of grazing - weed and pest control - management of fire - fencing to restrict informal access - regrading to promote drainage - revegetation and supplementary planting (for areas of non-remnant vegetation) - habitat creation. • monitoring program, performance targets and completion criteria such as:

Plan	Phase	Description
		- photo point monitoring at the commencement of the Plan, and then every 5 years for the remaining 20 years - BioCondition at the commencement (baseline), and then every 5 years for the remaining 20 years • site specific ground truthing surveys following impacts to determine the actual level of disturbance and confirm significant impact.
Threatened Species Management Plan	Construction	Prior to construction, BMA will develop and implement a **Threatened Species Management Plan** prior to construction to comply with Commonwealth and Queensland legislation and promote conservation outcomes for: • Ornamental Snake (*Denisonia maculata*) • Koala (*Phascolarctos cinereus*) • Squatter Pigeon (*Geophaps scripta scripta*) • Australian Painted Snipe (*Rostratula australis*) • Greater Glider (*Petauroides volans*). The Threatened Species Management Plan will include species-specific mitigation measures and SMART controls to minimise and mitigate long term impacts on these species such as: • lighting design to minimise light spill into adjacent habitat areas • suitably qualified fauna spotter catcher with appropriate permits to remove fauna present or accidentally injured • designated access routes and heavy vehicles areas • induction training and work instructions. **Appendix O-1 Commitments** of the EIS provides an overview of the key information to be detailed in this plan.
Weed and Pest Management Plan	Construction and operation	Prior to construction, BMA will develop and implement a **Weed and Pest Management Plan** for the Project to identify targeted mitigation measures and SMART controls to minimise introduction and spread of weeds and pest, including but not limited to: • regular inspection of the Project Site to identify any new incidence of weed infestation • map existing distribution and abundance of weeds • minimise clearing of vegetation to minimum required to enable safe construction, operation and maintenance of the Project, including infrastructure corridors • hygiene and wash down protocols for any vehicles or machinery entering and leaving site • weed control practices (particularly for *Parthenium hysterophorus*) in line with local management practice from the IRC and/or the Queensland Government Pest Fact sheets and/or Queensland Department of Agriculture and Fisheries • monitoring and identification of weed infestations and prioritisation of areas requiring weed treatment • maintaining a clean, rubbish-free environment to discourage feral animals • restrict fauna access to any waste storage facilities associated with the Project • awareness of weed management through Project site induction and provide information to Project staff on the identification of Restricted Matter weed species and their dispersal methods • prioritise rehabilitation activities for disused areas of the mine to minimise opportunity for weed invasion • engage appropriately qualified personnel to undertake periodic monitoring in the Project area, including: - mapping of major weed infestations during pre-clearing surveys - incidental observations for weeds of management concern

Plan	Phase	Description
		- monitoring for pest plants and fauna within subsided areas where ponding occurs will be undertaken to determine the need for management. **Appendix O-1 Commitments** of the EIS provides an overview of the key information to be detailed in this plan.
Topsoil Management Plan	Construction	Prior to construction, BMA will develop and implement a **Topsoil Management Procedure** to facilitate reuse of topsoil in rehabilitation of disturbed areas, including SMART controls for soil stripping, stockpiling and replacement such as: • maintaining topsoil stockpiles as low mounds at a maximum height of 3 m across the surface area, with a greater number of lower mounds preferred. • locating topsoil stockpiles away from drainage lines to protect from erosion by surface water runoff. • deep ripping/rock raking • reapplication of stockpiled topsoil • progressive rehabilitation and replanting only with species stipulated in the Rehabilitation Management Plan (**Appendix K-1**; BMA, 2024).
Rehabilitation Management Plan (RMP)	Construction and operation	BMA has prepared a RMP (**Appendix K-1**; BMA, 2024) in line with the Mined Land Rehabilitation Policy (DES, 2018a) to outline requirements for land to be progressively rehabilitated to achieve completion criteria for a safe, stable and non-polluting landform able to sustain an agreed PMLU. The Project RMP defines completion criteria for meeting satisfactory rehabilitation for PMLUs, including: • Cattle grazing • Dryland cropping • Woodland habitat • Watercourses • Water storage. PMLUs for the Project will be confirmed prior to construction. PMLU will be an undulating landscape that could be used as grazing land consistent with the surrounding pastoral land use that dominates the region. Where remnant native bushland is disturbed, the PMLU for these areas is woodlands habitat (mix of native and non-native species) that is compatible with the pre-existing land use for biodiversity values. As with the existing SRM RMP, rehabilitation of disturbed land will commence within two years of the mined area becoming available. Progressive rehabilitation is proposed in areas disturbed by mining activities associated with the Project. The overall operational mine life of the existing SRM extends to the 2040s, followed by a period of final rehabilitation.
Subsidence Management Plan	Operation	Prior to subsidence impacts occurring, BMA will develop and implement a **Subsidence Management Plan** (**Appendix K-2**; BMA, 2024) for the Project including proactive management and SMART controls to predict and potentially improve the overall condition of the affected area to minimise adverse effects of subsidence, including but not limited to: • pre-subsidence risk assessment will be conducted by suitably qualified personnel to identify suitable measures to mitigate the environmental risks • pre- and post-mining monitoring requirements for landform, surface water, groundwater, ecology (including vegetation health monitoring) and infrastructure. • indicative mitigation measures for the management of different subsidence impacts • progressive rehabilitation as mine advances and panels subside.

Plan	Phase	Description
Groundwater Dependent Ecosystem Monitoring and Management Plan	Operation	Prior to operation, BMA will develop a GDE Monitoring and Management Plan (GDEMMP) to assess extent and condition of potential terrestrial GDE on for Hughes Creek downstream consistent with the intent of the groundwater monitoring program and complementary to GDE monitoring that is undertaken on Hughes Creek under approval conditions for the Lake Vermont - Meadowbrook project. The GDEMMP will outline protocols for: • Collection of baseline ecological condition data (BioCondition and Leaf Area Index) for TGDEs associated with Hughes Creek downstream and to the east of EPC837 where groundwater drawdown in the Tertiary and Quaternary sediments is predicted and reduced surface flows may occur because of mining related subsidence. • Prescriptive methods for GDE monitoring over the life of the mine and post mining periods which are tailored to the assessed levels of ongoing risk to GDE function. • Mitigations and methods of adaptive management which can be implement if impacts to GDEs are detected which can be linked either directly or indirectly to mining operations. Baseline data collection will provide a basis for detection of future declines in ecological condition of GDEs subject to monitoring that can be linked to mining related activities. The recommended period for baseline data collection would be two years, after which a review of requirements for ongoing monitoring can be undertaken, and methods tailored to the assessed level of risk to GDE function. **Appendix O-1 Commitments** of the EIS provides an overview of the key information to be detailed in this plan.

21.8 Significant impact assessment

This significant impact assessment specifically relates to the controlling provisions identified in the 2016 EPBC Referral (2016/7791), namely nationally listed threatened species, TECs and a water resource in relation to coal seam gas development and a large coal mining development. Significant impact assessment for water resources and listed threatened species and TECs, includes only those identified as known or likely to occur within the Project Site. The assessment is based on the maximised footprint. Therefore, described impacts reflect a worst-case scenario and maximum extent of disturbance to MNES.

21.8.1 Water resources

Under the Significant Impact Guidelines 1.3 (DotE, 2013b), a significant impact assessment of the Project against water resources was undertaken. An action is considered significant if there is a real or remote possibility that it will directly or indirectly result in a change to the hydrology or water quality of a resource.

21.8.1.1 Surface water

Assessment of receiving environment flow and quality characteristics and assumed mine water balance for the Project was used to determine mine water demand, optimal WMS design and operational controls to minimise impacts on MNES and the environment. Response to significant impact assessment criteria is provided in Table 21-54.

Table 21-54 Water resources significant impact assessment – surface water

Aspect	Comment
Hydrological characteristics	
Flow regime (volume, timing, duration, and frequency of surface water flows)	The Project does not include abstraction from surface water or watercourses. The Project will prioritise the use of process water (including recycled MAW) in the CHPP and for dust suppression, only using raw water sourced from BMA's existing surface water allocations where process water is unavailable.

Aspect	Comment
	Project water storages have been provisionally sized to prevent to the need to conduct controlled releases of MAW under historical climatic conditions and assumed operational rules. No new diversions are planned as part of the Project. Subsidence modelling was used to identify potential ponding areas. The ponding areas are modelled to develop gradually over the life-of-mine with minor remedial drainage works to reduce persistent ponding in the landscape. A conservative approach was adopted in the modelling, where no self-sealing of the subsidence fracturing to surface is included in the simulations. Assessment of the Hydrology, Hydraulics and Geomorphology response to subsidence (Alluvium, 2023) concludes minor alteration to flow behaviour associated with potential impact/s on streamflow and geomorphology. The Conceptual Ponding Assessment (Engeny, 2023) indicated impacts on stream flow and ponding in a post-subsidence environment will continue to decrease over time as pools and channel beds fill in, ephemeral wetlands slowly accrete, and minor remedial drainage works reduce persistent ponding in the landscape. Similarly, the potential impacts of reduction in flows and dilution after dry spells on water quality will likely be minor and of a short duration, as the predicted variation in flow between pre- and post-subsidence environment will keep decreasing over time as pools and channel beds fill in, and ephemeral wetlands slowly accrete. Subsidence monitoring will detect areas subject to persistent ponding of overland flow and remedial drainage works will ensure a free-draining landform. Subsidence ponding can be further alleviated through appropriate design and mitigation measures outlined in the Project's Subsidence Management Plan (SMP) (BMA, 2024). *Not a significant impact*
Recharge rates to groundwater	Regional groundwater levels are a subdued reflection of the surface topography except immediately adjacent to the open-cut mine area where localised discharge / seepage into the SRM pits results in the steeper gradients around the pits. As all creeks are ephemeral, and can be dry throughout the year, recharge to the alluvium is likely to occur by discontinuous recharge from surface water flow, ponding, or flooding, and infiltration of direct rainfall and overland flow where permeable river sand alluvium deposits are exposed, and no substantial clay barriers occur in the shallow sub-surface. Recharge occurs from infiltration from the rainfall and creek flow into the Tertiary and Permian aquifer sub-crop areas. Minor leakage from overlying aquifers may occur but is not evident based on groundwater level data. The ponded water, albeit of short duration, has the potential to increase groundwater recharge over the Project footprint. This increase in shallow groundwater resources will be mitigated by minor remedial drainage works. The combination of backfill of open-cut pits (recharge), open-cut workings (dewatering), and underground workings (goaf alteration and dewatering) were simulated to allow for the evaluation of groundwater levels in response to complex mining operations. It is unlikely that Project activities will significantly modify recharge rates given the small footprint of infrastructure and disturbance; residual ponding may benefit recharge of alluvial aquifer systems. *Not a significant impact*
Aquifer pressure or pressure relationship between aquifers Groundwater table and potentiometric surface levels Inter-aquifer connectivity	Dewatering to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining will be required (dependent on strata permeability, influence of existing mine dewatering, and model predictions). As a result, groundwater levels will be drawn down during the operational phase. Dewatering can result in drawdown of the coal seam potentiometric surface, which extends beneath Hughes Creek. Structural geology changes and dewatering have potential to induce flow from the surface water to the groundwater in response to hydraulic connectivity and reduction of groundwater levels below the creek; this has potential to reduce seasonal flows. Due to the overlying geology, i.e. hydraulically 'tight' and very low yielding Permian overburden and interburden sediments, it is unlikely this impact will increase frequency or duration of no flow in the creek. Residual ponding may increase in subsided areas with the potential to increase groundwater recharge over the Project footprint will likely be mitigated by minor remedial drainage works. *Not a significant impact*

Aspect	Comment
Surface water-groundwater interactions River-floodplain connectivity	Two separate groundwater systems occur within the Project Area, including localised basal sand and gravel at the base of the Tertiary sediments and deeper Permian coal seams. Surface water-groundwater interactions include: • Infiltration from the rainfall into the Tertiary and Permian aquifer sub-crop areas • Very minor leakage from overlying aquifers (limited hydraulic connection based on groundwater level data) • Recharge from creek flow into the Tertiary and Permian units, where creeks drain across sub-crop areas (as evidenced by dry alluvium bores) To evaluate potential for increased potential for surface water-groundwater interaction (creeks acting as losing streams to groundwater), the site-specific data was assessed using a sensitivity analysis. The sensitivity analysis was conducted to assess the potential impact of altering recharge (by increasing and decreasing mean annual rainfall by 10 per cent in the numerical groundwater model). The alteration (variation in influx into the model) of the recharge, allowed for the evaluation of changing the top model boundary conditions (including stream boundaries). The variation in recharge was found to not be sensitive as there was no marked change in predicted mine ingress volumes. The numerical groundwater model, which was based on the conceptual groundwater model (limited leakage of surface water to groundwater), included for the evaluation of river depth level and aquifer water level to simulate the surface water-groundwater interaction. Based on the approach adopted in the predictive groundwater model, where water was removed at a rate specified by the riverbed conductance, and the results of the sensitivity analysis, the predictive groundwater model was considered fit for purpose and suitable for predicting impacts on medium value aquifers. *Not a significant impact*
Coastal processes	The Project is located in central Queensland. Given the distance to the coast and minimal potential impacts to surface water from the Project, changes to coastal processes will not occur. *Not a significant impact*
Water quality	
Create risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	To manage downstream impacts of the Project, measures will be implemented to divert clean water runoff from undisturbed areas around mining areas, manage flood waters, develop a mine WMS and conduct water quality monitoring. Project discharges and water management will be regulated by DES under the conditions and requirements of the relevant EA and will limit discharges to only in emergency conditions and under minimum quality requirements. In the event of an uncontrolled discharge from the process water dam, surface water flows will be directed to Boomerang Creek and monitored in accordance with a Trigger Action Response Plan. The reduction in flows due to the ponding within subsided areas has the potential to impact on water quality downstream through reduced flows and hence less dilution after dry spells. However, impacts on water quality are likely to be minor and on a short temporal scale, as the predicted variation in flow between pre- and post-subsidence environment will keep decreasing over time as pools and channel beds fill in, and ephemeral wetlands slowly accrete. *Not a significant impact*
Substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses which are dependent on water of the appropriate quality	The Project does not include abstraction from surface water or watercourses. The Project will prioritise use of process water (including recycled MAW) in the CHPP and dust suppression, only using raw water sourced from BMA's existing surface water allocations where process water is unavailable. *Not a significant impact*
Causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the	Possible contaminants within the surface water will be collected and managed within the WMS, during operations and post closure. Discharge of MAW only occurs in compliance with existing Environmental Approval conditions for the Project. *Not a significant impact*

Aspect	Comment
environment	
Seriously affects the habitat or lifecycle of a native species dependent on a water resource	While Phillips Creek has capacity to support groundwater dependent vegetation, the thicker saturated (in places) alluvium associated with the Phillips Creek are located outside the predicted drawdown resulting from the Project. Groundwater is generally not permanently present within alluvial sediments and is, therefore, unlikely to provide a source of water for terrestrial species. No known aquatic, terrestrial or subterranean groundwater dependent ecosystems have been mapped as impacted within the Project Site. The Tertiary and Permian sediments within the Project Site have groundwater levels at depths greater than 15 m below ground level. This depth is also outside the accessible reach for Eucalypt vegetation (Zolfagher et al, 2014) and the root biomass of *Acacia harpophylla* (brigalow) which is typically shallows <2m (Moore et al., 1967). Open woodland communities would obtain groundwater from the soil moisture stored in the capillary fringe of predominantly clay soils. Riparian communities of the Project Site utilise soil moisture retained in stream banks (alluvium material) from ephemeral flows. The proposed underground mining and gas drainage operations will necessitate dewatering and depressurisation; however, underground mining will take place at depths of up to 780 m. This is unlikely to have significant effects on the shallow perched groundwater resources associated with the Quaternary alluvium and Tertiary sediments. *Not a significant impact*
Causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource	Surface aspects of the surface related impact assessment would include the drilling of IMG drainage bore, monitoring bores, and the collection of monitoring data. All vehicles involved in these activities will adhere to the mine's weed and seed clearance requirements. *Not a significant impact*
There is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives)	Overall, local water quality is not superior to local or regional water quality objectives. Water quality monitoring indicates a slightly to moderately disturbed aquatic habitat in the Project Site, which is influenced by upstream mining and agricultural land uses in the catchment. Therefore, it is necessary to develop site-specific water quality objectives against which upstream and downstream water quality can be monitored during the Project. The relevant environmental values as defined under EPP (Water) Isaac River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011) will be considered during the establishment of site-specific water quality objectives in general accordance with Deciding aquatic ecosystem indicators and local water quality guidelines (DES, 2018d). A Receiving Environment Monitoring Program (REMP) will be developed to determine site-specific water quality objectives. REMP monitoring will be carried out to collect a minimum of 18 data values over at least two years to inform the development of site-specific surface water quality objectives to be adopted for the Project. Site specific water quality trigger values based on 20th and 80th percentiles will be developed for the Project based on the results of the REMP monitoring program prior to construction commencing. Controlled discharge of MAW will only occur in compliance with Environmental Approval conditions issued for the Project. Any uncontrolled discharge of MAW will only occur during infrequent sustained rainfall events. Therefore, any release would be subject to dilution and would be similar to the receiving environment in terms of water quality. Consequently, the Project is not expected to result in a significant worsening of local water quality. *Not a significant impact*
High quality water is released into an ecosystem which is adapted to a lower quality of water	Discharge of MAW will only occur in compliance with Environmental Approval conditions issued for the Project. *Not a significant impact*

21.8.1.2 Groundwater

Dewatering may be required (dependent on strata permeability, influence of SRM dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. As a result, groundwater levels will be drawn down during the operational phase.

Mine dewatering can result in drawdown of the coal seam potentiometric surface, which can extend beneath the non-perennial creeks which drain across the Project. Seasonal surface water flows and remnant pools in the creeks may decline as a result of possible induced flow from the surface water to the groundwater, in response to the reduction in groundwater levels below the creeks. This has the potential to increase the frequency or duration of no flow in the creeks.

Predictive modelling to assess this potential impact indicated:

- No predicted loss of water from the alluvium along the extent of Boomerang Creek mapped across the Project footprint.
- No predicted loss of water from the Isaac River alluvium due to the Project.
- No predicted change in surface water flows in the local creeks including Boomerang Creek due to the Project.
- No predicted change to surface water flows in the Isaac River due to the Project.

A conservative approach was adopted in the modelling, where no self-sealing of the subsidence fracturing to surface is included in the simulations. This approach ensures any change to hydraulic and storage properties in the model remain. Even adopting this approach no impact on alluvium or surface water resources is predicted.

Predictions show drawdown will extend up to an additional 3 km further to the north and east from the proposed underground mining. The impact assessment indicated 18 groundwater bores will potentially be located within the end of underground mining drawdown thresholds (Figure 21-45). Of the 18 bores, none are identified as potential ‘make-good’ bores for a combination of the following reasons:

- the bores are located on BMA owned land
- these bores are identified as being abandoned or destroyed, and/or
- these bores are screened within the Back Creek Formation, which is located below the Lower Dysart (D14 / D24) seam (i.e. footwall sediments), which is not predicted to be impacted.

As BMA is unlikely to require ‘make-good’ agreements, it is unlikely significant impacts will occur upon groundwater levels and existing groundwater users.

The proposed underground mine is predicted to contribute to long term locally contained impacts on the quantity and quality of groundwater resources within the Project area. These impacts include:

- localised drawdown (and subsequent recovery) due to mining of underground panels (noting that groundwater levels within the underground workings will recover to the level of the final voids) (see Section 21.6.1)
- localised drawdown around final open-cut voids (hydraulically connected to the underground workings)
- blending (mixing of groundwater from the different aquifers) within the underground mine footprint.

The groundwater assessment concluded the Project will not have a significant local impact on groundwater quality, groundwater uses or levels. Since there is no significant local impact, there will also be little or no alteration of groundwater resources on a catchment-wide or regional scale. Summary of the water resources significant impact assessment for groundwater values is presented in Table 21-55.

Table 21-55 Water resources significant impact assessment – groundwater

Aspect	Comment
Create risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	Dewatering may be required (dependent on strata permeability, influence of existing mine dewatering, and model predictions) to lower groundwater levels to the base of the proposed workings for safe and efficient operation of the underground mining. A cone of depression will develop around the underground mining footprint due to mine dewatering. The longwall mining method will result in the development of goaf above the longwall panels. The groundwater extraction and alteration of hydraulic properties due to mining will result in localised groundwater flow into the underground panels. The risk of water contained in the underground panels (a blend of groundwater from different strata) impacting on groundwater quality, away from the underground workings, is considered limited as flow will be towards the active SRM dewatering. Post-mining groundwater level rebound is predicted to the level of the final voids in the SRM open-cut pits. Long term groundwater levels are predicted to be influenced by the final voids, which act as groundwater 'sinks' because of water loss through evaporation in a negative climate balance area. This maintenance of a pseudo-steady pit water level will maintain cones of drawdown immediately around the final voids. The final voids acting as groundwater 'sinks' in perpetuity ensure that poor water quality (elevated salinity due to evaporation) does not migrate off site within the groundwater. *Not a significant impact*
Substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses which are dependent on water of the appropriate quality	Dewatering has the potential to reduce groundwater levels in existing groundwater bores that fall within the cone of influence of the proposed mine and hence has the potential to impact on existing groundwater supplies. Project potential impacts on groundwater is limited due to: • The Quaternary alluvium will not contain permanent groundwater. The alluvium aquifers are, based on the groundwater level response to rainfall and associated surface water flow, primarily recharged during creek flow events. • Tertiary sediments monitoring bores are generally dry indicating limited sustainable yields. • Coal seam groundwater is brackish to saline and typically not suitable for stock watering and no groundwater use from the same target coal seams. The Project is considered to have little or no impact on GDEs. This is based on an assessment of the likelihood of GDEs being present within and adjacent to the Project. No known springs are present within the Project area. *Not a significant impact*
Causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment	Possible contaminants within the groundwater will be maintained within the SRM open pits, during operations and post closure. The final voids, acting as groundwater 'sinks', ensure that poor water quality does not migrate off site within the groundwater. The Project EA will include contaminant triggers derived for each new monitoring bore and compliance parameters based on review of the monitoring data and review of data trends using the DES (2021) monitoring data assessment methodologies. Discharge of MAW will only occurs in compliance with Environmental Approval conditions for the SRM Project. *Not a significant impact*
Seriously affects the habitat or lifecycle of a native species dependent on a water resource	No known aquatic or terrestrial GDEs were mapped within the GDE Atlas, however, the potential for aquatic or terrestrial GDEs were further assessed by using the Stage 1 assessment approach recommended within the Australian groundwater-dependent ecosystem toolbox part 1: assessment framework (GDE Toolbox) (Richardson et al, 2011). Site specific investigations identified within the Project Area, there is: • Low potential for aquatic GDE to exist in areas of SRM containing open water such as dams and levees as they only have permanence of water due to them being artificial mining features. • Low potential for aquatic GDE to exist along reaches of Phillips Creek, Hughes Creek or Boomerang Creek as ephemeral with only intermittent flows, not gaining groundwater. • Low potential for terrestrial GDE as Tertiary sediments generally at a depth where groundwater has reduced importance to vegetation, not permanently present and most are drought tolerant with low sensitivity to water availability. The GDE assessment indicates a low potential for GDE to be present, therefore, GDE are not expected to be impacted by dewatering or changes in groundwater quality. *Not a significant impact*

Aspect	Comment
Causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource	Surface aspects of the groundwater related impact assessment would include the drilling of IMG drainage bore, monitoring bores, and the collection of monitoring data. All vehicles involved in these activities will adhere to the mine's weed and seed clearance requirements. *Not a significant impact*
There is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives)	The groundwater quality data indicates that groundwater is unsuitable for human consumption before treatment due to elevated levels of salinity. Although the groundwater is generally within the guidelines for livestock, the ANZECC guidelines (2000) states that loss of production and a decline in animal health occurs if stock are exposed to high salinity water for prolonged periods. For beef cattle, this limit is in range the range of 5,000 mg/L to 10,000 mg/L. Given the variable salinity levels for groundwater hosted in the Tertiary and Permian aged sediments are within this range and there are some cases of salinity greater than 10,000 mg/L, the regional groundwater will generally not be considered suitable for livestock. Local groundwater quality is therefore not superior to local or regional water quality objectives *Not a significant impact*
High quality water is released into an ecosystem which is adapted to a lower quality of water	Discharge of MAW will only occur in compliance with Environmental Approval conditions SRM. *Not a significant impact*

21.8.1.3 Groundwater dependent ecosystem

Based on site-specific field data, investigations concluded:

- Terrestrial GDE are present on Phillips Creek and identified on Hughes Creek downstream of the Project mining tenure. These terrestrial GDE host variable groundwater volumes associated with the alluvium and are seasonally recharged via surface flows and flooding.
- Vegetation fringing Hughes Creek does not meet the hydrological or ecological criteria for a terrestrial GDE.
- No specific impediment to tree water use of Tertiary or Permian groundwater is recognised based on salinity values. The groundwater quality in the three hydrostratigraphic units present within the Project Area is not suitable for drinking, too deep for terrestrial ecosystems, and is often too saline for livestock watering.
- There is no indication that Phillips Creek represents an Aquatic GDE.
- Vegetation on Tertiary plains has limited potential for groundwater dependency due to the shallow rooted nature of the dominant vegetation and the depth to the groundwater table.
- Vegetation fringing One Mile Creek and adjacent woodland are being supported within the unsaturated portion of the soil profile.
- Within the Project Site, the alluvium landform hosting Hughes, Boomerang, and Plumtree creeks is extremely shallow.
- Survey Site 13_AU1 on Boomerang Creek is a surface feature with fringing wetland vegetation showing no indication of hydrological linkages.

Assessment of predicted groundwater impacts indicate the potential risk to GDE posed by Project is 'Low to Insignificant'.

The surface water system in the Project Area is ephemeral and limited surface water-groundwater interaction is evident, particularly related to GDE. The surface water systems are separated from the predicted impacted groundwater resources by low permeable sediments, which reduce the potential for the Project to impact on the alluvium and surface water flows.

There are no predicted impacts associated with terrestrial GDE on Phillips Creek as groundwater drawdown does not propagate below the stream channel or fringing riparian habitats. The Quaternary age alluvium is thin, discontinuous and sporadic across the Project footprint with the thicker saturated (in places) alluvium associated with the Phillips Creek are located outside the predicted drawdown resulting from the Project.

The clay-rich Tertiary sediments have low recharge potential and low permeability resulting in insufficient yield and low usage potential. Impacts of drawdown in the Tertiary groundwater system may be propagated into creek alluvium where areas of enhanced potential for downward drainage occur, most likely through sandy sediments with increased hydraulic conductivity or increased density of preferential flow paths.

Modelled drawdown associated with this Project will result in drawdown within the Tertiary groundwater system, with modelling indicating more than 20 m of drawdown is propagated beneath reaches of Hughes and Phillips Creeks where terrestrial GDE have been identified and mapped (3D Environmental 2022). The risk that the Lake Vermont - Meadowbrook Project poses to terrestrial GDE has been assessed as ‘Low’ to ‘Insignificant’ (3D Environmental 2022). Drawdown impacts have potential to manifest along reaches of Hughes Creek where modelled groundwater drawdown extends well to the east of the Project into contiguous Lake Vermont tenements.

The predicted drawdown within the target D seam is predicted to elongate along strike and does not extend to the Isaac River to the east. The Project is not predicted to impact on the Isaac River or associated alluvium groundwater resources.

The assessment indicated no significant residual impacts predicted to GDE as MNES.

Based on the risk assessment undertaken in **Appendix D-2 Groundwater Dependent Ecosystems** (3D Environmental, 2023), unmitigated risk to GDE is classified as ‘Insignificant’ to ‘Low’ risk. Residual risk ranking is ‘Low’ to ‘Insignificant’ following application of appropriate management measures, including mitigations if required. For all impact pathways, initial stages of GDE monitoring require active management (including monitoring) from which mitigations can be adapted if impacts to GDE are identified which can be attributed either directly or indirectly to operations associated with the Project. Management measures will be applied during implementation of a Project GDE Management and Monitoring Plan, after which mitigations can be applied if significant impact GDE function and health is detected.

21.8.2 Threatened ecological communities

21.8.2.1 Brigalow TEC

Description and status under the EPBC Act

Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC (Brigalow TEC) is listed as Endangered under the EPBC Act.

This TEC is characterised by *Acacia harpophylla* (Brigalow) as one of the dominant species in the tree layer. The species may also be co-dominant (in some circumstances with other species, most commonly *Casuarina cristata* (*B*elah)). The community ranges in composition and structure however is typically represented by a combination of a number of species which are associated with acidic and salty clay soils (Threatened Species Scientific Committee, 2013b).

In Queensland, for the Brigalow TEC the RE framework can be used where RE can be considered analogous with the TEC, provided other key diagnostic criteria and condition thresholds are met.

Distribution

The Brigalow TEC occurs in semi-arid eastern New South Wales and Queensland, predominantly west of the Great Dividing Range (Threatened Species Scientific Committee, 2013b). The TEC reaches as far north as Townsville in Queensland and as far south as Narrabri in New South Wales. In Queensland it is found in the following bioregions:

- Brigalow Belt North
- Brigalow Belt South
- Mulga Lands

- Darling Riverine Plains
- Southeast Queensland.

Threats

Key threats to the Brigalow TEC have been identified as those which may lead to further reduction in extent or cause a decline in condition. These are listed and discussed below in order of significance:

Clearing

Listing of this community was a result of extensive clearing. The community has been modified at a landscape scale with clearing resulting in significant fragmentation and reduction in patch size. Clearing for resource extraction and illegal logging are an ongoing threat to the community.

Fire

Due to the species composition of intact Brigalow TEC, fire has not historically threatened the community. However, the introduction of invasive pasture species such as *Chloris gayana, Cenchrus ciliaris* and *Megathyrsus maximus,* can result in significant increases in biomass and fuel load. Further, fragmentation can lead to large edge to area ratios which in combination with higher fuel loads increases the risk of fire to the community (Threatened Species Scientific Committee, 2013b).

Weeds

The infestation of introduced weeds can alter the structure of the community and in turn the habitat for fauna species which it supports. As discussed above invasive pasture species also contribute to greater fire risk. Weed invasion is an ongoing threat to the Brigalow TEC (Threatened Species Scientific Committee, 2013b).

Feral animals

Feral animals are threats to this TEC, many of which are listed as key threatening processes (KTP) under the EPBC Act. Pigs degrade habitat by disturbing soil and destroying young and small plants. Cane toads (*Bufo marinus*), outcompete and feed on native frog species and cause death through toxic lethal ingestion to mammalian carnivores, snakes, birds and goannas. Foxes and feral cats can have devastating impacts to the community through predation on native fauna and noisy miners aggressively exclude other native species, primarily honeyeaters (Department of the Environment, 2013a).

Inappropriate grazing

Cattle grazing is a dominant land use in much of the distribution of the Brigalow TEC. Cattle and other large bodied herbivores can impact the ground layer through disturbing leaf litter, interfering with recruitment, altering the composition of the ground and shrub layer and compacting the soil profile (Department of the Environment, 2013a).

Climate change

Acacia harpophylla and the flora species which typically dominate this community are generally well equipped to cope with climate change due to their ability to tolerate broad environmental stressors. However, adaptability may be compromised with the increased rate of change predicted from future climate change. The fauna which rely on this community are susceptible to impacts from hotter and drier conditions (Department of the Environment, 2013a). This will be particularly problematic where resources become scarce in small habitat patches and fragmentation eliminates their ability to disperse to locate required resources such as refuge, foraging grounds and water.

Survey timing and effort

Flora surveys were conducted as a part of overall biodiversity surveys for the Project and were conducted over six survey periods including:

- 17 to 21 November 2007
- November 2008
- 27 to 29 August 2016
- 6 and 10 October 2016

- 30 January and 3 February 2017
- 23 to 29 March 2020.

Flora surveys involved a botanical assessment at representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches and aerial photograph interpretation. The surveys employed standard methods to identify, classify and assess vegetation communities including secondary transects (15), tertiary transects (43), quaternary survey sites (126) and TEC assessments (19) within the Project Site.

No guidelines for surveying the Brigalow TEC are available, however flora surveys assessed floristic composition and structure of vegetation communities in accordance with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.*, 2019). TEC assessments were undertaken in vegetation patches dominated or co-dominated by brigalow, in accordance with the key diagnostic and condition thresholds outlined in the Conservation Advice (Department of the Environment, 2013a).

Presence in the Project Site

Brigalow TEC was identified within the Project Site during the field surveys. Within the Project Site Brigalow TEC was found to be analogous to RE11.3.1, RE11.4.8 and RE11.4.9 where it occurs on alluvial plains adjacent to creeks and gullies (Boomerang, Plumtree and One Mile Creeks) as well as undulating hills. The extent of Brigalow TEC within the Project Site is shown on Figure 21-51 and totals 396.54 ha.

The condition of the Brigalow TEC varied across the Project Site with areas subject to higher grazing pressure (e.g. along creek lines or small isolated patches) showing relatively lower species diversity within the ground and shrub layers. Larger areas of Brigalow TEC are in better condition with higher species diversity and more developed structure however still showed impacts of vegetation thinning, grazing and weed invasion from *Cenchrus ciliaris* (Buffel grass) and *Parthenium hysterophorus* (Parthenium weed).

Further information on Brigalow TEC within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the ecological community

Several patches of Brigalow TEC have been confirmed in the Project Site. Key diagnostic criteria and thresholds to be met for Brigalow TEC to be confirmed include:

- Brigalow as the dominant or co-dominant species in the tree-layer
- At least 15 years since the last comprehensive clearing event (not just thinned)
- Patch size is ≥ 0.5 ha
- Exotic perennial species comprise < 50 per cent of total vegetation cover.

Habitat considered critical to the survival of Brigalow TEC is any vegetation meeting the criteria listed above (DoE 2013b). Based on these factors, 396.54 ha of habitat critical to the survival of the ecological community (HCSEC) is present in the Project Site for Brigalow TEC. Several patches of RE 11.4.9 within the Project Site did not meet the thresholds listed above as these were dominated by *Casuarina cristata* (Belah) with *Acacia harpophylla* (Brigalow) absent. As such these patches were excluded from mapping and area calculations for both the TEC and HCSEC.

Project impacts

The Project will potentially have direct and indirect impacts to habitat critical to the survival of Brigalow TEC as shown in Table 21-56, comprising 53.49 ha during construction and up to 9.84 ha during operation. Direct impacts will be predominantly limited to the construction phase with maximum extent of vegetation clearing being assessed, without future consideration of micro-siting and refinement of the disturbance associated with construction of surface infrastructure, IMG network or linear infrastructure, or future remedial drainage of ponded areas during operation. During operation, areas of Brigalow TEC within deeper depressions subject to persistent ponding may exhibit isolated occurrences of reduced canopy health or tree loss.

Fragmentation is also likely have an indirect impact through the loss of areas of Brigalow TEC due to reduced patch size (i.e. <0.5ha) and edge effects. Fragmentation impacts during the construction phase, totalling 19.57 ha, includes remaining areas of Brigalow TEC less than 0.5ha in size (no longer meeting TEC diagnostic characteristics and condition criteria) and smaller polygons subject to fragmentation as a result of the IMG network. These areas are likely subject to increased edge effects, such as increased weed incursion. The extent of fragmentation resulting from the Project within the remainder of the Project Site is considered unlikely to cause a substantial reduction in the quality or integrity of remaining patches containing the Brigalow TEC.

Other indirect impacts during construction and operation of the Project may include excessive dust deposition on plant foliage for extended periods, diminishing the plant's ability to photosynthesise. This may result in reduced growth rates of Brigalow TEC vegetation and decrease floral vigour and overall community health.

Ongoing monitoring of the occurrence of and effects of subsidence will be required to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur.

Table 21-56 Direct impacts to Brigalow TEC

MNES	EPBC Act status	Project Site (ha)	Project Footprint (ha)	Direct and indirect impacts (ha)				
				Construction			Operation	Total
				Surface Infrastructure	IMG	Fragmentation	Ponding	
Brigalow (*Acacia harpophylla* dominant and codominant)	Endangered	396.54	210.31	19.21	14.71	19.57	9.84	63.33

Project avoidance, mitigation and management measures

Before clearing vegetation or developing the surface facilities, mitigation measures will be implemented:

- areas for clearing will be delineated and demarcated to avoid inadvertent disturbance
- avoid placement of IMG extraction wells and infrastructure RE 11.3.1, RE 11.4.8 and 11.4.9 meeting condition thresholds for Brigalow TEC where practical; where unavoidable, offsets will be sourced
- topsoil will be removed and used to rehabilitate existing disturbed areas
- erosion and sediment control measures will be installed and maintained
- development of a weed management plan to monitor and limit the impact of weed invasion into Brigalow TEC vegetation
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Following construction in each area, disturbed areas not required will be stabilised and rehabilitated consistent with the Project's Rehabilitation Management Plan (BMA, 2024, **Appendix K-1**). As it will not be possible to avoid all impacts to Brigalow TEC, offsets will be required to mitigate residual impacts.

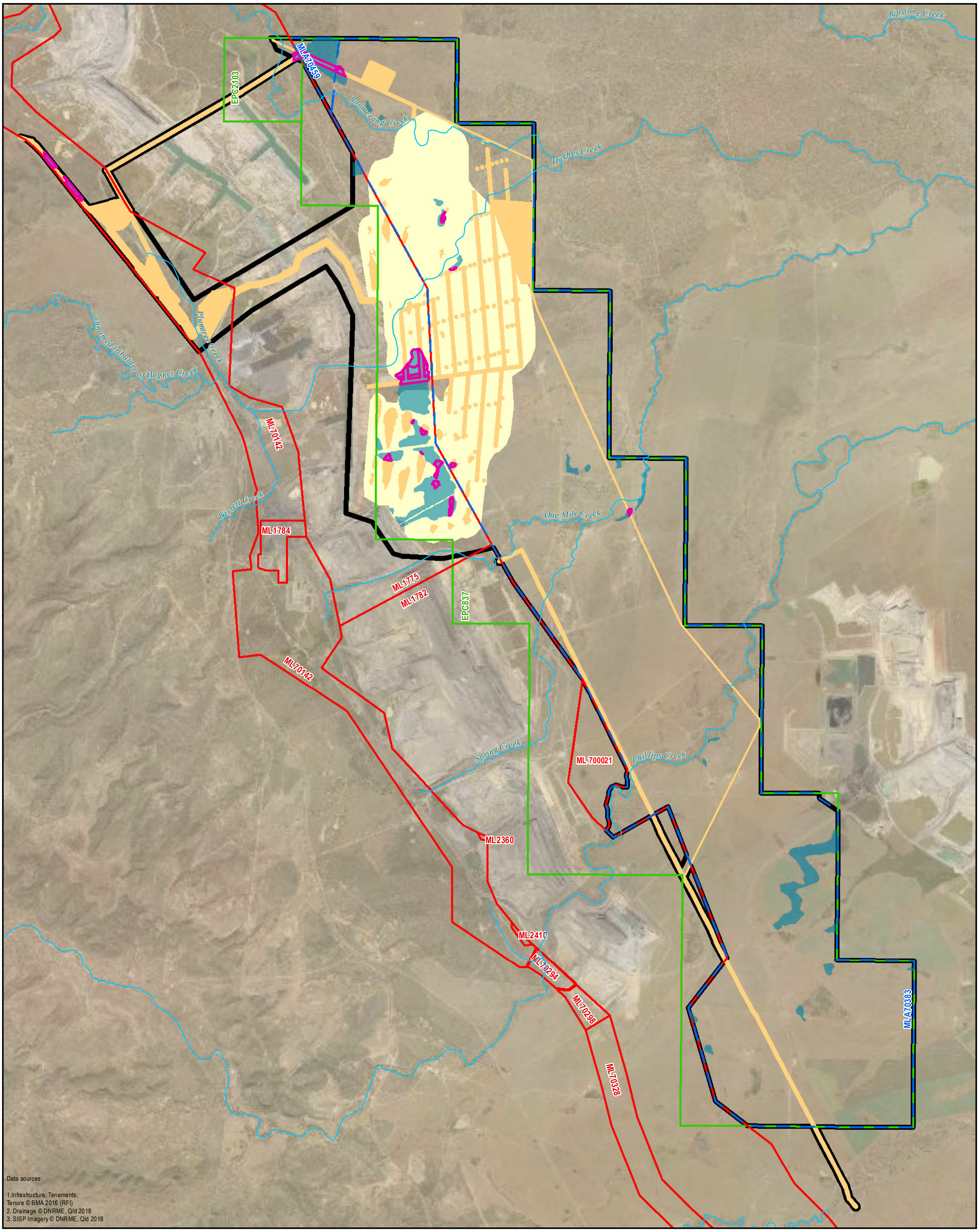
Significant impact assessment

As a result of direct and indirect impacts of construction and operation, the Project will result in impacts to habitat critical to the survival of Brigalow TEC of up to 63.33 ha. Direct and indirect impacts to Brigalow TEC from maximum disturbance of surface infrastructure, IMG drainage network, fragmentation and ponding have been assessed using criteria outlined in the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a). The assessment concludes the Project may have a significant impact on Brigalow TEC.

Table 21-57 **Assessment of significance of impact – Brigalow TEC**

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a TEC if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community.	Up to 63.33 ha of this TEC has potential to be directly and indirectly impacted as a result of the proposed action (with the remaining Project Footprint with potential for indirect disturbance associated with subsidence of up to 146.98 ha). Based on the extent of impacts to this TEC, it is considered likely the Project will reduce the extent of this ecological community.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.	No large functionally connected patches occur within the Project Site; this community already occurs as fragmented patches. With micro-siting, the Project's linear infrastructure will further fragment some patches of Brigalow TEC (up to 19.57 ha). This includes two small patches that have potential to be reduced to a patch size below the TEC key diagnostic threshold (<0.5ha). In addition, one patch of Brigalow TEC has potential to be significantly fragmented as a result of the IMG Network and while not reducing patch size below the threshold, is considered to be compromised and has also been included within the Project impacts.
Adversely affect habitat critical to the survival of an ecological community.	HCSEC consists of any patches of vegetation meeting the key diagnostic thresholds. The Project will result in direct and indirect impacts to 53.49 ha of HCSEC during construction and an additional 9.84 ha of impact during operation assessed as the maximum extent of persistent ponding / inundation (prior to implementation of remedial drainage works). These impacts are likely to be adverse to HCSEC.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	The vegetation species and regional soil/geology types suggest the level of groundwater dependence is likely to be low within this TEC and vegetation is likely to be able to satisfy plant water requirements using retained soil moisture. Modification or destruction of abiotic factors to the extent that the TECs survival is compromised outside of the area of impact is unlikely.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	Most Brigalow TEC patches within the Project Site are small and fragmented. Larger patches with greater patch viability do occur within the Project Site, they are fragmented by highly modified areas such as cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). The proposed action may potentially impact one patch of Brigalow TEC that may be highly fragmented as a result of the IMG Network, increasing risk of edge effects such as weed incursion, and has also been included within the Project impacts.

EPBC Act criteria	Assessment of significance
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	While the proposed action will impact a portion of the Brigalow TEC on site, the majority of areas that remain are unlikely to be impacted. The proposed action may potentially impact the quality or integrity of one patch of Brigalow TEC that may be highly fragmented as a result of the IMG Network. The increased risk of edge effects, such as weed incursion, has potential to impact the quality or integrity of this patch and has also been included within the Project impacts. The Project is considered unlikely to cause a substantial reduction in the quality or integrity of an occurrence of a TEC within the remainder of the site.
Interfere with the recovery of an ecological community.	There is no Recovery Plan for Brigalow TEC, however the approved conservation advice is recommended as an effective guide to support the recovery of the TEC. The conservation advice lists numerous priority recovery and threat abatement actions for the community. These include minimising habitat loss, fragmentation, hydrological disruption and spread of pest plant and animals, and appropriate land-use and fire management that considers brigalow conservation. Brigalow TEC within the Project Site already occurs in small, fragmented patches, in varying degrees of condition. Despite further refinement and micro siting to reduce corridor widths disturbed by the installation of the linear access tracks and pipelines for the IMG drainage network, it is not possible to reduce fragmentation further. Considering the landscape context and condition of the Brigalow TEC present on the Project Site, the proposed action is not likely to interfere with the recovery of the ecological community.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Watercourse

Threatened ecological community

- Brigalow (*Acacia harpophylla*) dominant and co-dominant
- Significant impact area

N

Figure 21-51

Brigalow (Acacia harpophylla) dominant and co-dominant TEC

Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 22/11/2024 VERSION: 4

21.8.2.2 Grasslands TEC

Description and status under the EPBC Act

The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC (Grasslands TEC) is listed as Endangered under the EPBC Act.

This TEC is characterised by the presence of native tussock perennial grasses with the shrub layer a minor component and the absence of a tree canopy. The species composition of tussock grasslands varies throughout their range and is influenced by factors such as rainfall, soil, geology and land use history (Threatened Species Scientific Committee, 2009). This TEC is mostly dominated by *Dichanthium* spp. (Bluegrasses), with tropical *Aristida* spp. (three-awned grasses) and *Panicum* spp. (Panic Grasses) also a major component. This ecological community usually occurs on flat ground or gently undulating rises, with soils being cracking or self-mulching and this development of deep cracks may tear tap roots leading to a possible reason for the absence of trees and woody shrubs (Threatened Species Scientific Committee, 2009). Water penetration deep into the soil profile is inhibited by the high-water holding capacity of the clay soils which may provide another reason as to the dominance of ground layer species.

In Queensland, the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC can be defined using the RE framework, where REs are considered analogous with the TEC, provided that other key diagnostic criteria and condition thresholds are met. In addition, the definition of the ecological community extends to all natural grasslands within specified subregions that meet the key diagnostic characteristics and condition thresholds (Threatened Species Scientific Committee, 2009). The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC is analogous to areas mapped as REs 11.3.21, 11.4.4, 11.4.11, 11.8.11, 11.9.9, 11.9.12 and 11.11.17. Within the Project Site this TEC is analogous to RE 11.4.4 (Table 21-42).

Distribution

This ecological community is endemic to Queensland and extends from Collinsville in the north to Carnarvon Gorge National Park at the southern extent. It is contained within the Expedition, Carnarvon, Great Dividing, Drummond and Narrien ranges in the southern extent and within the Clark, Denham, Connors and Broadsound ranges in the northern extent (Threatened Species Scientific Committee, 2009). The ecological community falls within two bioregions these being the Brigalow Belt North and Brigalow Belt South bioregions.

Threats

Key threats to this TEC have been identified as those which may lead to further reduction in extent or cause a decline in condition. These are listed and discussed:

Grazing, cropping and pasture improvement

Persistent heavy grazing can degrade grasslands and increases the risk of weed invasion. Grazing will lead to the displacement of perennial species dominance in favour of annual grasses and forbs, or herbaceous and woody weeds. In addition, expansion of exotic pastures and tree crops replaces most of the native grassland with introduced species or alters the grassland structure by introducing a woody over-storey (Threatened Species Scientific Committee, 2009).

Weeds and pest animals

The infestation of introduced weeds can alter the structure of the community and in turn the habitat for fauna species which it supports. Weeds generally require some form of disturbance, either natural or human-induced, to invade intact grasslands (Threatened Species Scientific Committee, 2009). Weed invasion is an ongoing threat to the Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin TEC.

Pest animals that occur in this ecological community include the Rabbit (*Oryctolagus cuniculus*), Feral Cat (*Felis catus*), European Fox (*Vulpes vulpes*), and House Mouse (*Mus mus*). Pest animals have varied impacts upon the ecological community through predation and competition with native animals, grazing of native plants and soil disturbance through burrowing and diggings (Threatened Species Scientific Committee, 2009).

Mining activities, construction of infrastructure

Mining activities and infrastructure development can lead to the physical destruction of the ecological community as well as the loss habitat for fauna which utilise these grassland areas. Ground disturbance increases the likelihood of weed invasion and erosion.

Climate change

Climate change poses a potential long-term threat to this ecological community with species adaptability being compromised with the increased rate of change predicted. Climate change is likely to exacerbate existing threats and large changes may influence species composition, distribution and the extent of this community (Threatened Species Scientific Committee, 2009).

Survey timing and effort

Flora surveys were conducted as a part of overall biodiversity surveys and were conducted over six survey periods including:

- 17 to 21 November 2007
- November 2008
- 27 to 29 August 2016
- 6 and 10 October 2016
- 30 January and 3 February 2017
- 23 to 29 March 2020.

Flora surveys involved a botanical assessment at representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches and aerial photograph interpretation. The surveys employed standard methods to identify, classify and assess vegetation communities including secondary transects (15), tertiary transects (43), quaternary survey sites (126) and TEC assessments (19) within the Project Site.

No guidelines for surveying the Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin TEC are available, however flora surveys assessed floristic composition and structure of vegetation communities in accordance with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.*, 2019).

Presence in the Project Site

The Grassland TEC has been identified within the south of the Project Site within RE 11.4.4 (*Dichanthium* spp., *Astrebla* spp. Grassland on Cainozoic clay plains). The Grassland TEC occurs in small and isolated patches surrounded by highly modified and cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). Patch viability, connectivity for seed dispersal and recruitment is highly compromised. All areas of Grassland TEC within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of this habitat.

The extent of Grassland TEC within the Project Site is shown on Figure 21-52 and consists of 1.73 ha.

Further information on Bluegrass within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the ecological community

The EPBC Act listing advice provides detailed diagnostic characteristics and condition thresholds for the identification of Grasslands TEC. Key diagnostic features/thresholds for Grassland TEC to be confirmed are:

- The community must be located within the Brigalow Belt North and South subregions
- Tree canopy must be absent or sparse (< 10 per cent projected crown cover), grassland derived from cleared woodland not included in the TEC
- The ground layer must be dominated by native perennial grasses with at least 3 indicator species present

- Are 'best quality' or 'good quality' as per condition thresholds for patch size, and, composition and cover of grasses, shrubs and introduced species.

There are no specific guidelines defining habitat critical to the survival of Grassland TEC. However, for the purposes of this assessment any vegetation confirmed as Grassland TEC as per the criteria above, is considered habitat critical to the survival of the ecological community (HCSEC).

Based on these factors, 1.73 ha of HCSEC is present in the Project Site for Natural Grassland TEC.

Project impacts

The Project will potentially have direct impacts to Natural Grasslands TEC as shown in Table 21-58.

Vegetation mapped as the Grasslands TEC, habitat for this species, was identified within and adjacent to the path of an overhead power transmission line and is unlikely to be impacted by the project construction activities. Powerline infrastructure will likely span above one of the small Grasslands TEC patches which have been mapped within the Project. However, for this assessment it has been assumed this area will be directly impacted.

As there is unlikely to be above ground disturbance, indirect impacts associated with vegetation clearing such as fragmentation and edge effects, erosion and sedimentation will not occur. Activities above ground, including vehicle traverses are unlikely due to above ground works being limited to the construction of a power transmission line. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect Grassland TEC. Therefore, the likelihood of increased or new weed incursions, excessive dust or the contamination of soils and water as a result of the Project is considered to be low.

Table 21-58 Direct impacts to Natural Grasslands TEC within the Project Footprint

MNES	EPBC Act status	Project Site (ha)	Project Footprint (ha)	Direct impacts (ha)			
				Construction		Operation	Total
				Surface Infrastructure	IMG	Ponding	
Natural Grasslands TEC	Endangered	1.73	0.08	0.08	0.00	0.00	0.08

Project avoidance, mitigation and management measures

The location of the powerline infrastructure will be refined during detailed design to avoid direct impacts to Grassland TEC where practical. This will include consideration of minor adjustments in powerline alignment and construction methods.

Before clearing vegetation or developing any of the surface facilities, the following mitigation measures will be utilised:

- areas for clearing will be clearly delineated to avoid inadvertent clearing
- avoid placement of powerline infrastructure (including vehicle routes needed for construction) within grassland REs (RE 11.4.4) which met condition thresholds for the Grassland TEC, where practical; where unavoidable, offsets will be sourced
- topsoil will be removed and used to rehabilitate existing disturbed areas
- erosion and sediment control measures will be installed and maintained
- development of a weed management strategy to monitor and limit the impact of weed invasion into natural grasslands of the Queensland central highlands and the northern Fitzroy basin TEC vegetation
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Following construction, disturbed areas not required to be permanent will be stabilised and rehabilitated consistent with the Project's Rehabilitation Management Plan.

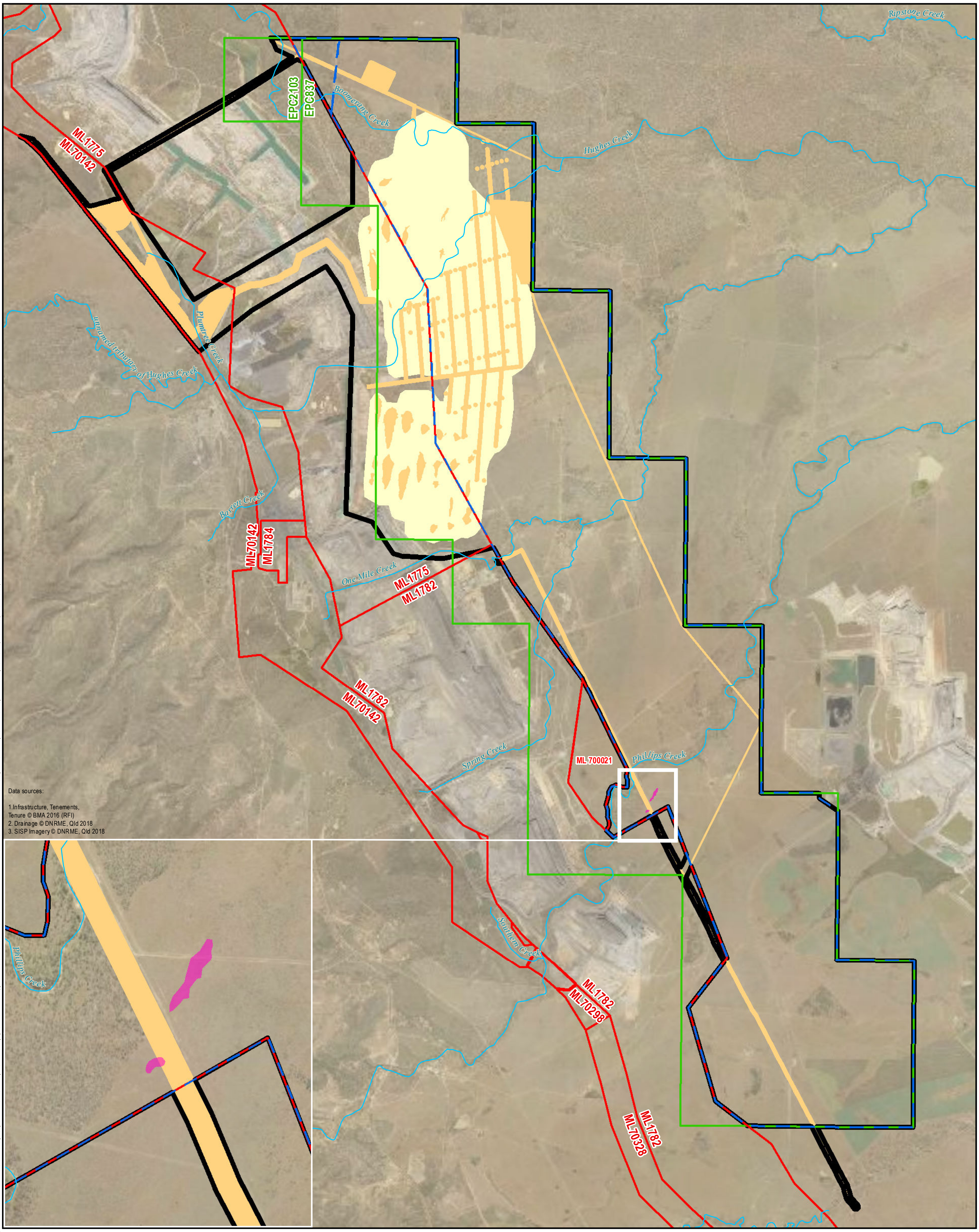
Significant impact assessment

Based on the maximum extent of surface disturbance, the Project is assumed to result in maximum clearing of up to 0.08 ha of HCSEC. Direct impacts to Grassland TEC have been assessed for the maximum disturbance from construction of the powerline using criteria outlined in the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a). The assessment indicates due to the limited disturbance to potential habitat from the proposed action and the mitigation of impacts through measures proposed in Section 21.7 the impacts of the Project on Grassland TEC are unlikely to be significant.

Table 21-59 Assessment of Significance of Impact - Natural Grasslands TEC

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a TEC if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community.	Only very minor clearing of (0.08 ha) Grasslands TEC will occur as a result of the proposed action and as such the extent of an ecological community is unlikely to be reduced.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.	Two small Grasslands TEC patches were identified within and adjacent to the path of an overhead power transmission line and is unlikely to be impacted by the Project construction activities. Powerline infrastructure will likely span above the two patches. As there is unlikely to be above ground disturbance, indirect impacts such as fragmentation and edge effects, erosion and sedimentation will not occur. Activities above ground, including vehicle traverses are unlikely due to above ground works being limited to the construction of a power transmission line. Therefore, it is considered unlikely the Project will fragment or increase fragmentation of an ecological community.
Adversely affect habitat critical to the survival of an ecological community.	Grassland TEC within the Project Site occurs in small and isolated patches surrounded by highly modified and cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). Patch viability, connectivity for seed dispersal and recruitment is highly compromised. All areas of Grassland TEC within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of the community. While a negligible amount (0.08 ha) of HCSEC will potentially be impacted as a result of the Project, this impact (if it occurs) is likely to be only minor and temporary. Underground works are being undertaken to the north of the occurrence of the Grassland TEC which is unlikely to be impacted by subsidence. It is unlikely the Project will adversely affect habitat critical to the survival of Grassland TEC.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns.	While a negligible amount (0.08 ha) of HCSEC will potentially be impacted as a result of the Project, this impact (if it occurs) is likely to be only minor and temporary. Underground works are being undertaken to the north of the occurrence of the Grassland TEC which is unlikely to be impacted by subsidence. The vegetation species and regional soil/geology types suggest that the level of groundwater dependence is likely to be low within this TEC and vegetation is likely to be able to satisfy plant water requirements using retained soil moisture. Modification or destruction of abiotic factors to the extent that the TECs survival is compromised is unlikely.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting.	While a negligible amount (0.08 ha) of HCSEC will potentially be impacted as a result of the Project, this impact (if it occurs) is likely to be only minor and temporary. A Weed and Pest Management Plan will be developed to mitigate and manage the potential spread of pest flora and fauna species. No regular burning or flora and fauna harvesting is proposed or anticipated.

EPBC Act criteria	Assessment of significance
	It is considered unlikely that the Project would cause a substantial change in the species composition.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: assisting invasive species, that are harmful to the listed ecological community, to become established; or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community.	Grassland TEC within the Project Site occurs in small and isolated patches surrounded by highly modified and cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). Patch viability, connectivity for seed dispersal and recruitment is highly compromised. All areas of Grassland TEC within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of the community. A Weed and Pest Management Plan will be developed to mitigate and manage the potential spread of pest flora and fauna species. Grasslands TEC is located within and adjacent to the path of an overhead power transmission line and is unlikely to be impacted by the Project construction activities. Powerline infrastructure will likely span above the two small Grasslands TEC patches and not result in the regular mobilisation of pollutants. It is considered unlikely the Project will cause a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community.	There is no recovery plan for Grasslands TEC however the approved conservation advice is recommended as an effective guide to support the recovery of the TEC. The conservation advice lists numerous priority recovery and threat abatement actions for the community. These include minimising habitat loss, disturbance, and modification, managing and monitoring invasive weeds, and avoiding trampling, browsing or grazing by stock. Grasslands TEC within the Project Site already occurs in small, isolated patches. The Project will not result in the severance of any large patches of Grassland TEC and only a negligible amount (0.08 ha) of HCSEC will potentially be impacted as a result of the Project, this impact (if it occurs) is likely to be only minor and temporary. Grassland TEC retained on site will be managed to control exotic species in accordance with the Weed and Pest Management Plan. In considering the landscape context and the limited and unlikely clearing the proposed action is not likely to interfere with the recovery of the ecological community.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Indirect Impact
- Project Footprint - Direct Impact
- Watercourse

Threatened ecological community

- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

N

Figure 21-52
Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin TEC

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.075 0.15 0.3
Kilometres

Scale: 1:20,213 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 22/11/2024 VERSION: 4

21.8.3 Threatened flora species

21.8.3.1 Bluegrass

Description and status under the EPBC Act

Dichanthium setosum is listed as Vulnerable under the EPBC Act.

Dichanthium setosum (Bluegrass) is an upright perennial grass to a metre in height. This species has mostly hairless leaves, except near the junction, are approximately two to three millimetres in width with nodes that are usually bearded (WetlandInfo, 2019b). The inflorescence is a raceme of one to two, which are densely hairy due to the rachis and pedicels both having long hairs, as well as long and ciliate hairs on the lower glume of the sessile spikelet. The species can form pure swards or occur as scattered clumps (Department of Environment Water Heritage and the Arts, 2008).

Distribution

Dichanthium setosum occurs from Toowoomba in the south to the Lynd Junction in the north, with isolated collections from the Palmer River on the Cape and Lawn Hill NP near the Northern Territory border (WetlandInfo, 2019b). It has been recorded in Brigalow Belt, Cape York Peninsula, Desert Uplands, Einasleigh Uplands, North West Highlands and South East Queensland Bioregions. This species has also been found in NSW and Western Australia. Habitat requirements *Dichanthium setosum* occurs in heavy soils (predominantly cracking clays or alluvium, often in gilgai) in woodland or open woodland usually dominated by Acacia (brigalow) and/or Eucalyptus species. The climate is tropical to subtropical and markedly seasonal with the habitat drying out for part of the year (WetlandInfo, 2019b).

Threats

The main identified threats to *Dichanthium setosum* include:

- heavy grazing by domestic stock
- loss of habitat through clearing for pasture improvement and cropping
- frequent fires, especially regular burning for agricultural purposes
- invasive plants (e.g. buffel grass invasion)
- small populations.

Survey timing and effort

Flora surveys were conducted as a part of overall biodiversity surveys and were conducted over five survey periods including:

- 17 to 21 November 2007
- November 2008
- 27 to 29 August 2016
- 6 and 10 October 2016
- 30 January and 3 February 2017.

Flora surveys involved a botanical assessment at representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches and aerial photograph interpretation. The surveys employed standard methods to identify, classify and assess vegetation communities including secondary transects (15), tertiary transects (43), quaternary survey sites (126) and TEC assessments (19) within the Project Site.

No guidelines for surveying the *Dichanthium setosum* are available, however flora surveys assessed floristic composition and structure of vegetation communities in accordance with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.*, 2019).

Occurrence

No individuals of Bluegrass (*Dichanthium setosum)* have been recorded in the Project Site by AECOM but the species has been previously recorded by SKM (2012) in the south of the Project Site within RE 11.4.4 (*Dichanthium* spp., *Astrebla* spp. Grassland on Cainozoic clay plains). RE 11.4.4 also forms part of the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC (Grassland TEC).

The extent of habitat for the species within the Project Site is shown on Figure 21-53 and consists of 1.73 ha of potential habitat.

Further information on Bluegrass within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival (HCSS) of the species and therefore the generic *EPBC Act Significant Impact Guidelines 1.1* definition of HCSS has been applied. HCSS would likely be large patches of high-quality native tussock and bluegrass grasslands known to contain the species.

The species has not been recorded as part of recent targeted surveys within the Project Site, with suitable habitat comprising two small (<2 ha), isolated patches. Habitat within the Project Site aligns with the area of Grassland TEC, which occurs in small and isolated patches surrounded by highly modified and cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). Patch viability, connectivity for seed dispersal and recruitment is highly compromised. All areas of grassland within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of this habitat.

Based on these factors, no HCSS is present in the Project Site for Bluegrass (*Dichanthium setosum*).

Important populations

No guidance exists in the conservation advice for the species as to what constitutes an important population and therefore, the generic Significant Impact Guidelines 1.1 (DoE 2013) criteria are to be applied, which states an important population is a population that is necessary for a species' long-term survival and recovery.

The Project Site is unlikely to support an important population given that:

- The Project Site is near the edge of the species range
- A population within the Project Site is not necessarily unique, isolated and is unlikely to be genetically distinct from other populations in the region
- For Bluegrass it has been identified by Threatened Species Scientific Committee (2008), although there is a lack of quantitative population data, records indicate the species is widely distributed and found within several national parks.

Project impacts

The Project will potentially have direct impacts to suitable Bluegrass (*Dichanthium setosum)* habitat as shown in Table 21-60. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect these areas of habitat.

Vegetation mapped as the Grasslands TEC and comprising habitat for this species, was identified within and adjacent to the path of an overhead power transmission line and is unlikely to be impacted by the Project construction activities. Powerline infrastructure will likely span above one of the two small Grasslands TEC patches which have been mapped within the Project. However, for this assessment it has been assumed that these areas will be directly impacted.

As there is unlikely to be above ground disturbance, indirect impacts associated with vegetation clearing such as fragmentation and edge effects, erosion and sedimentation will not occur. Activities above ground, including vehicle traverses are unlikely due to above ground works being limited to the construction of a power transmission line. Therefore, the likelihood of increased or new weed incursions, excessive dust or the contamination of soils and water as a result of the Project is considered to be low.

Table 21-60 Direct impacts *to Dichanthium setosum* within the Project Footprint

MNES	EPBC Act status	Project Site (ha)	Project Footprint (ha)	Direct impacts (ha)			
				Construction		Operation	Total
				Surface Infrastructure	IMG	Ponding	
Dichanthium setosum	Endangered	1.73	0.08	0.08	0.00	0.00	0.08

Project avoidance, mitigation and management measures

Before clearing vegetation or developing any of the surface facilities, the following mitigation measures will be utilised:

- areas for clearing will be clearly delineated to avoid inadvertent clearing
- avoiding placement of powerline infrastructure within grassland REs (RE 11.4.4) in which this species occurred, where practical. where unavoidable, offsets will be sourced
- vehicle routes needed for the construction of powerline infrastructure to avoid areas where this species was identified
- topsoil will be removed and used to rehabilitate existing disturbed areas
- erosion and sediment control measures will be installed and maintained
- development of a weed management strategy to monitor and limit the impact of weed invasion upon Bluegrass.
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Following construction in each area, disturbed areas not required will be stabilised and rehabilitated consistent with the Project's Rehabilitation Management Plan.

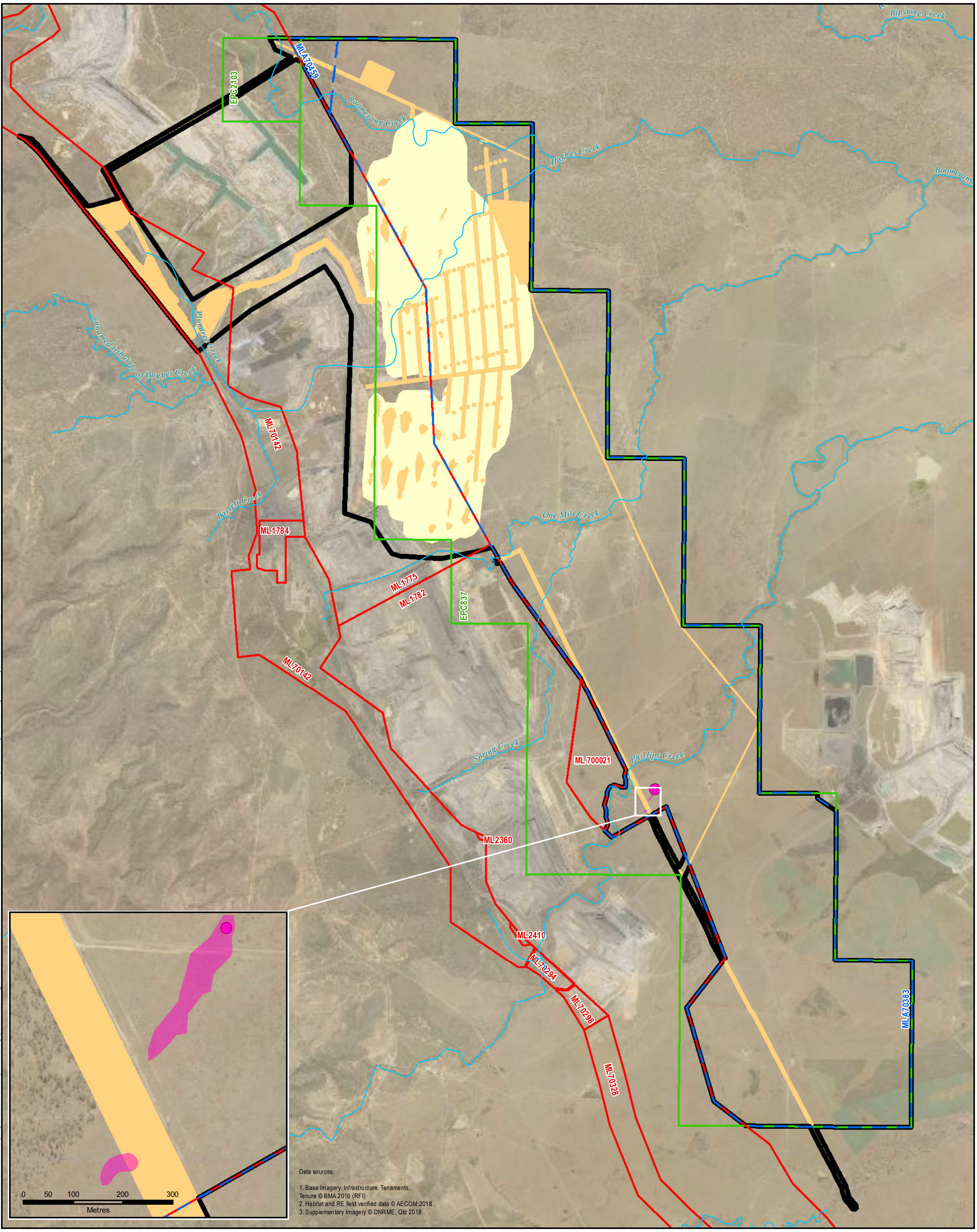
Significant impact assessment

The Project is assumed to result in clearing 0.08 ha of non-critical Bluegrass habitat. Impacts to Bluegrass have been assessed using criteria outlined in the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a). The assessment indicates that due to the limited disturbance to potential habitat from the proposed action and the mitigation of impacts through measures proposed in Section 21.7 the impacts of the Project on Bluegrass (*Dichanthium setosum*) are unlikely to be significant.

Table 21-61 Assessment of Significance of Impact - *Dichanthium setosum* (Bluegrass)

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species.	The Project Site does not support an important population. It is unlikely that the clearing of known occurrences will occur during construction, operation or decommissioning of the Project. However, if clearing is required it will be very minor in extent. As such it is not expected that the action will lead to a long-term decrease in the size of a population of a species.
Reduce the area of occupancy of an important population.	The Project Site does not support an important population. Only very minor disturbance of habitat for this species will occur and as such the area of occupancy of a population will not be reduced.
Fragment an existing important population into two or more populations.	The Project Site does not support an important population, with the species not recorded in recent surveys.

EPBC Act criteria	Assessment of significance
	No population of this species would be fragmented due to the proposed action.
Adversely affect habitat critical to the survival of a species.	The Project Site does not support habitat critical to the survival of Bluegrass. Potential habitat for Bluegrass within the Project Site occurs as low-quality, marginal habitat occurring as highly fragmented small pockets.
Disrupt the breeding cycle of an important population.	The Project Site does not support an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No HCSS for the species will be impacted as a result of the Project, with a total of 0.08 ha of non-critical habitat to potentially be cleared. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect Bluegrass. A Weed and Pest Management Plan will be developed for the Project to mitigate and manage the potential spread of pest flora and fauna species, which can impact on Bluegrass habitat. It is unlikely that the Project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	Invasive flora has been identified as a key threat to the species (TSSC, 2010) including invasive grasses such as such as *Hyparrhenia hirta* (Coolatai Grass), *Phyla canescens* (Lippia) and *Eragrostis curvula* (African Lovegrass). A Weed and Pest Management Plan will be developed to mitigate and manage the potential spread of pest flora and fauna species. Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. The Project is unlikely to result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.
Introduce disease that may cause the species to decline.	Disease has not been identified as a key threat to *Dichanthium setosum* (Bluegrass). The implementation of a Weed and Pest Management Plan will help control and manage the establishment of invasive species (and associated diseases) as a result of the Project.
Interfere with the recovery of the species.	Habitat rehabilitation and restoration activities using seed or seedlings of local provenance are likely to assist, rather than interfere, with the recovery of the species in the local area. Potential clearing of 0.08 ha of non-critical habitat is highly unlikely to interfere with the recovery of the species.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse
- Bluegrass record

Threatened flora record and potential habitat

- Natural grassland habitat

Figure 21-53
Bluegrass potential habitat within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.8.3.2 King Bluegrass

Description and status under the EPBC Act

Dichanthium queenslandicum is listed as endangered under the EPBC Act.

Dichanthium queenslandicum (King Bluegrass) is an upright perennial grass to 80 cm in height. Leaf blades are linear up to 18 cm in length with both the bade and sheath having long spreading tubercular-based hairs (WetlandInfo, 2019a). Inflorescence is a single raceme of paired spikelets up to 10 cm long (Threatened Species Scientific Committee, 2013a) and the rachis and pedicels have long spreading hairs and are sessile (WetlandInfo, 2019a).

Distribution

This species is endemic to Queensland with the main population centred around Emerald (Central Queensland). This species occurs in three disjunct populations: Hughenden district, Nebo to Monto and west to Clermont and Rolleston, and Dalby district, Darling Downs (Threatened Species Scientific Committee, 2013a).

Habitat requirements

Dichanthium queenslandicum occurs on black cracking clay soils in tussock grasslands commonly in association with *Dichanthium* spp. and *Bothriochloa* spp. or other native grass species found on this soil type (WetlandInfo, 2019a). This species is predominantly found in natural bluegrass grassland of central and southern Queensland including the EPBC Act listed the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC.

Threats

Threats to *Dichanthium queenslandicum* have been identified as follows:

- loss of habitat through the continuation and expansion of mining activities
- road construction and other infrastructure developments
- cultivation and crop production
- inappropriate or unsustainable grazing levels/management
- weed invasion.

Survey timing and effort

Flora surveys were conducted as a part of overall biodiversity surveys and were conducted over five survey periods including:

- 17 to 21 November 2007
- November 2008
- 27 to 29 August 2016
- 6 and 10 October 2016
- 30 January and 3 February 2017.

Flora surveys involved a botanical assessment at representative sites within each remnant, non-remnant and regrowth vegetation community as identified from desktop searches and aerial photograph interpretation. The surveys employed standard methods to identify, classify and assess vegetation communities including secondary transects (15), tertiary transects (43), quaternary survey sites (126) and TEC assessments (19) within the Project Site.

No guidelines for surveying the *Dichanthium queenslandicum* are available, however flora surveys assessed floristic composition and structure of vegetation communities in accordance with the methodology employed by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner *et al.*, 2019).

Occurrence and potential habitat

No individuals of King bluegrass (*Dichanthium queenslandicum)* have been recorded in the Project Site however suitable habitat is available. Likely habitat occurs in the south of the Project Site within RE 11.4.4 (*Dichanthium* spp., *Astrebla* spp. Grassland on Cainozoic clay plains) which forms part of the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC (Grassland TEC).

The extent of habitat for the species within the Project Site is shown on Figure 21-54 and consists of 1.73 ha of potential habitat.

Further information on King bluegrass within the Project Site is provided **in Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival (HCSS) of the species and therefore the generic *EPBC Act Significant Impact Guidelines 1.1* definition of HCSS has been applied. HCSS would likely include large patches of high-quality native grasslands.

The species has not been recorded as part of targeted surveys within the Project Site, with suitable habitat comprising two small (<2 ha), isolated patches. Habitat within the Project Site aligns with the area of Grassland TEC, which occurs in small and isolated patches surrounded by highly modified and cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel grass). Patch viability, connectivity for seed dispersal and recruitment is highly compromised. All areas of grassland within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of this habitat.

Based on these factors, no HCSS is present in the Project Site for Bluegrass (*Dichanthium queenslandicum*).

Project impacts

The Project will potentially have direct impacts to suitable King bluegrass (*Dichanthium queenslandicum* habitat as shown in Table 21-62. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect these areas of habitat.

Vegetation mapped as the Grasslands TEC and comprising potential habitat for King bluegrass is located within and adjacent to the path of an overhead power transmission line and is unlikely to be impacted by the Project construction activities. Powerline infrastructure will likely span above one of the two small patches of the Grasslands TEC which have been mapped within the Project. However, for this assessment it has been assumed that these areas may be directly impacted.

As there is unlikely to be above ground disturbance, indirect impacts associated with vegetation clearing such as fragmentation and edge effects, erosion and sedimentation will not occur. Activities above ground, including vehicle traverses are unlikely due to above ground works being limited to the construction of a power transmission line. Therefore, the likelihood of increased or new weed incursions, excessive dust or the contamination of soils and water from the Project is considered low.

Table 21-62 Direct impacts to *Dichanthium queenslandicum* within the Project Footprint

MNES	EPBC Act status	Project Site (ha)	Project Footprint (ha)	Direct impacts (ha)			
				Construction		Operation	Total
				Surface Infrastructure	IMG	Ponding	
Dichanthium queenslandicum	Endangered	1.73	0.08	0.08	0.00	0.00	0.08

Project avoidance, mitigation and management measures

Before clearing vegetation or developing any of the surface facilities, the following mitigation measures will be utilised:

- areas for clearing will be clearly delineated to avoid inadvertent clearing

- avoiding placement of powerline infrastructure within grassland REs (RE 11.4.4) in which this species occurred, where practical. where unavoidable, offsets will be sourced
- vehicle routes needed for the construction of powerline infrastructure to avoid areas where this species was identified
- topsoil will be removed and used to rehabilitate existing disturbed areas
- erosion and sediment control measures will be installed and maintained
- development of a weed management strategy to monitor and limit the impact of weed invasion upon King bluegrass.
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Following construction in each area, disturbed areas not required will be stabilised and rehabilitated consistent with the Project's Rehabilitation Management Plan.

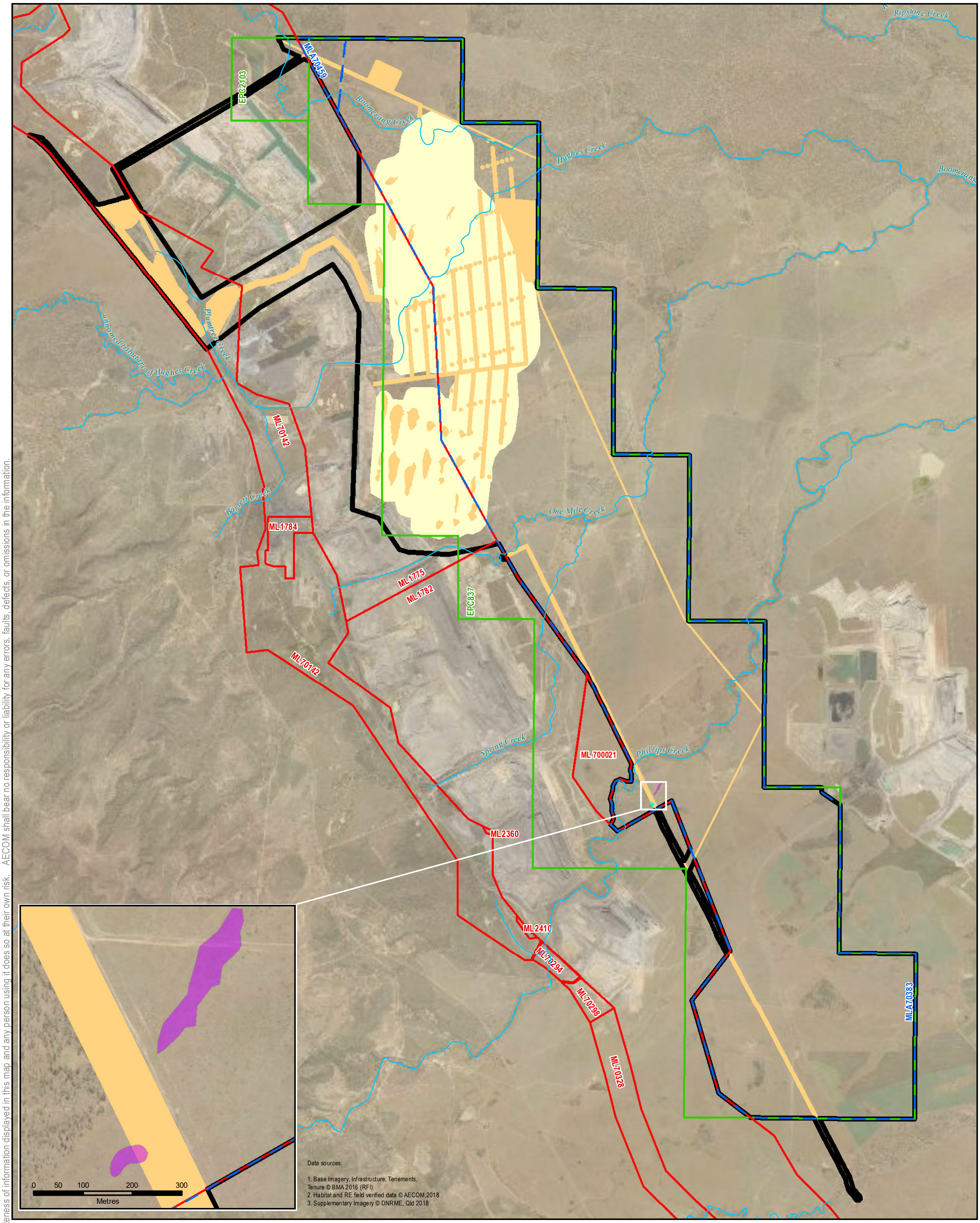
Significant impact assessment

The Project may result in clearing 0.08 ha of non-critical King bluegrass habitat. Direct impacts to King bluegrass have been assessed using criteria outlined in the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a). The assessment indicates that due to the limited disturbance to potential habitat from the proposed action and mitigation of impacts through measures proposed in Section 21.7 the impacts of the Project on King bluegrass (*Dichanthium queenslandicum*) *are* unlikely to be significant.

Table 21-63 Assessment of Significance of Impact - *Dichanthium queenslandicum* (king bluegrass)

EPBC Act Criteria	Assessment of significance
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population of a species.	It is unlikely that the clearing of King bluegrass will occur during construction, operation or decommissioning of the Project. However, if clearing is required it will be very minor in extent. As such it is not expected that the action will lead to a long-term decrease in the size of a population of a species.
Reduce the area of occupancy of a population.	Only very minor clearing of habitat for this species may occur as a result of the proposed action and as such the area of occupancy of a population will not be reduced.
Fragment an existing population into two or more populations.	King bluegrass has not been recorded within the Project Site, no HCSS is present and clearing is likely to not be required or be minor and temporary. It is unlikely the 0.08 ha of potential clearing of non-critical habitat would result in the fragmentation of an existing population.
Adversely affect habitat critical to the survival of a species.	The Project Site does not support habitat critical to the survival of King bluegrass. Potential habitat for Bluegrass within the Project Site occurs as low-quality, marginal habitat occurring as highly fragmented small pockets.
Disrupt the breeding cycle of a population.	It is expected that any disruption to any possible local population of the species would be minor and temporary. It is unlikely the Project will result in the disruption of a breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	No HCSS for the species will be impacted as a result of the Project, there is the potential for only 0.08 ha of non-critical habitat to be cleared. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect Bluegrass. A Weed and Pest Management Plan will be developed for the Project to mitigate and manage the potential spread of pest flora and fauna species, which can impact on King bluegrass habitat. It is unlikely that the Project will modify, destroy, remove, isolate or

EPBC Act Criteria	Assessment of significance
	decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an Endangered species becoming established in the Endangered species' habitat.	Invasive flora has been identified as a key threat to the species (TSSC, 2010) including invasive grasses such as such as *Hyparrhenia hirta* (Coolatai Grass), *Phyla canescens* (Lippia) and *Eragrostis curvula* (African Lovegrass). A Weed and Pest Management Plan will be developed to mitigate and manage the potential spread of pest flora and fauna species. Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities.
Introduce disease that may cause the species to decline.	Disease has not been identified as a key threat to *Dichanthium queenslandicum* (King bluegrass). The implementation of a Weed and Pest Management Plan will help control and manage the establishment of invasive species (and associated diseases) as a result of the Project.
Interfere with the recovery of the species.	Habitat rehabilitation and restoration activities using seed or seedlings of local provenance are likely to assist, rather than interfere, with the recovery of the species in the local area. Potential clearing of 0.08 ha of non-critical habitat is highly unlikely to interfere with the recovery of the species.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

High potential habitat

- Remnant grassland habitat
- Habitat resulting in significant impact

N

Figure 21-54
Natural grassland potential habitat within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.8.4 Threatened fauna species

21.8.4.1 Squatter Pigeon (southern)

Description and status under the EPBC Act

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) is listed as Vulnerable under the EPBC Act.

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) is a medium-sized, ground-dwelling pigeon that measures approximately 30 centimetres (cm) in length and weighs about 190-250 grams (g). Adults are predominantly grey-brown with black and white stripes on the face and throat, blue-grey skin around the eyes, dark-brown (and some patches of iridescent green or violet) on the upper surfaces of the wings, blue-grey on the lower breast and belly, white on the lower region, flanks of the belly and extending onto the under surfaces of the wings, and a blackish-brown band along the trailing edge of the tail. They have black bills, dark-brown irises, and dull-purple legs and feet. The sexes are similar in appearance (Higgins and Davies, 1996).

Distribution

The known distribution of the Squatter Pigeon (Southern) (*Geophaps scripta scripta*) extends south from the Burdekin-Lynd divide in the southern region of Cape York Peninsula to the Border Rivers region of northern New South Wales, and from the east coast to Hughenden, Longreach and Charleville, Queensland. Overall, the subspecies' known distribution is estimated to occur within the latitudes, 17° to 30° S, and the longitudes, 141° to 153° 30' E (Squatter Pigeon Workshop, 2011).

Habitat requirements

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) is a ground-dwelling bird that inhabits the grassy understorey of open woodland (mostly dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* in the canopy), as well as sown grasslands with scattered remnant trees, disturbed areas (such as roads, railways, settlements and stockyards), scrubland, and *Acacia* regrowth (Department of Agriculture Water and the Environment, 2020b). It forages for seeds among sparse and low grass, in improved pastures, and disturbed habitats such as road reserves. This species is unlikely to move far from woodland trees that provide protection from predatory birds. Where scattered trees still occur, and the distance of cleared land between remnant trees or patches of habitat does not exceed 100 m, individuals may be found foraging in, or moving across modified or degraded environments (Squatter Pigeon Workshop, 2011).

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) nests on the ground, and usually lays two eggs under vegetation, a fallen tree or log. This species will breed throughout the year; however, breeding is influenced by rainfall patterns and most commonly occurs during the dry season between May to June. In Queensland, foraging and breeding habitat is known to be associated with the soil landscapes of Land Zone 5 (well drained sandy or loamy soils on undulating plains and foothills) and Land Zone 7 (lateritic soils on low jump-ups and escarpments) (Department of Agriculture Water and the Environment, 2020b).

Breeding habitat is within one km of suitable waterbodies, whereas foraging can occur up to three km from such waterbodies. Waterbodies that are suitable for the species occur on the lower, gentle slopes and plateaus of sandstone ranges (equivalent to Land Zone 10), alluvial clay soils on river or creek flats (represented by Land Zone 3) or non-alluvial clay soils on flats or plains which are not associated with current alluvial deposits (represented by Land Zone 4). Where natural foraging or breeding habitat occurs (i.e. on Land Zones 5 and 7), the Squatter Pigeon (southern) (*Geophaps scripta scripta*) may be found in vegetation types growing on the above soil types (Squatter Pigeon Workshop, 2011).

Squatter Pigeon (Southern) (*Geophaps scripta scripta*) dispersal habitat is any forest or woodland occurring between patches of foraging or breeding habitat, and suitable waterbodies. Such patches of vegetation tend not to be suitable for the species' foraging or breeding, but facilitate the local movement of the species between patches of foraging habitat, breeding habitat and/or waterbodies, or the wider dispersal of individuals in search of reliable water sources during the dry season or during droughts (Squatter Pigeon Workshop, 2011).

Threats

Current threats to the Squatter Pigeon (Southern) (*Geophaps scripta scripta*) include (Garnett and Crowley, 2000):

- ongoing vegetation clearance and fragmentation
- overgrazing of habitat by livestock and feral herbivores such as rabbits
- introduction of weeds
- inappropriate fire regimes
- thickening of understorey vegetation
- predation by feral cats and foxes
- trampling of nests by domestic stock
- illegal shooting.

Survey timing and effort

The survey guidelines for Australia's threatened birds (Department of the Environment Water Heritage and the Arts, 2010b) recommends the following survey methods and effort for the squatter pigeon (southern) (*Geophaps scripta scripta*):

- road driving during day (driving transects)
- active searches: 15 hours over three days in areas less than 50 ha
- flushing surveys: ten hours over three days in areas less than 50 ha
- waterhole searches: survey effort not specified
- no seasonality constraints
- the survey effort undertaken across the Project site includes
  - active searches and flushing surveys: total of 426 person hours over 39.5 days
  - driving transects total of 194 hours over 39.5 days.

Squatter Pigeon in the Project Site

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) was recorded in the Project Site by SKM (2012) and AECOM (2017) and an existing record has been mapped in the north of Project Site. The extent of habitat for the species that occurs within the Project Site consists of:

- 1,375.27 ha of preferred habitat primarily located in a consolidated patch where Boomerang, Plumtree and Hughes Creek converge. The species was recorded in the preferred habitat area in 2017. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of preferred habitat in Central Queensland to comprise:

  Remnant or regrowth grassy open forest to woodland dominated by Eucalyptus, Corymbia, Callitris or Acacia with patchy, relatively sparse ground cover vegetation (33 per cent) and sparse shrub layer on well-draining sandy, loamy or gravelly soils within 1 km of a suitable permanent waterbody.

  It does not include areas dominated by pasture grasses, nor heavily grazed areas. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 these areas mapped are considered most important to the species and contain features crucial for species persistence.

- 475.80 ha of suitable habitat, which occurs as both a large patch between the preferred habitat fringing Plumtree and Hughes Creek, and as additional small patches of suitable habitat scattered between Hughes Creek and One Mile Creek. The species has been recorded in 2013 in suitable habitat near One Mile Creek. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of suitable habitat in Central Queensland to comprise:

Remnant or regrowth grassy open forest to woodland dominated by Eucalyptus, Corymbia, Callitris or Acacia with patchy, relatively sparse ground cover vegetation (<33 per cent) on well-draining sandy, loamy or gravelly soils between 1 and 3 km of a suitable permanent or seasonal waterbody; and non-remnant areas within 100 m of preferred habitat. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

As described in Table 21-25 these areas also provide a resource but the species is unlikely to be undertaking key activities such as breeding or roosting here. The category notes foraging resources may be lower quality or used opportunistically rather than being depended upon.

- 2,524.20 ha of marginal habitat concentrated through the centre of the Project Site. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of marginal habitat in Central Queensland to comprise:

  Non-remnant areas, regrowth and remnant woodland or forest areas more than 3 km from a permanent or seasonal waterbody that facilities the movement of the species between patches of preferred or suitable habitat. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 marginal category habitat areas provide limited resources and while individuals may be detected the species is unlikely to be undertaking key activities such as breeding, roosting or extensive foraging. Individuals are rarely found in this habitat type and it is likely to be unoccupied most of the time.

Further information on Squatter Pigeon habitat within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report** (AECOM, 2024) and **Appendix C-3 Central Queensland Threatened Species Habitat Descriptions** (Kerswell A, Kaveney T, Evans C and Appleby L., 2020).

Habitat critical to the survival of the species

Habitat critical to the survival of the species (HCSS) includes the habitats that contain features that are crucial for the species' persistence in an area, including for activities such foraging, breeding, roosting or dispersal.

For Squatter Pigeon, this is predominantly associated with the preferred habitat category as this provides a grassy understory of eucalypt woodlands near waterbodies where breeding will occur if the species is breeding on site. Preferred habitat is largely located in a consolidated patch where Boomerang, Plumtree and Hughes Creeks converge. In addition, there is suitable habitat mapped between the preferred habitat fringing Plumtree and Hughes Creeks, which is also considered to meet the definition of HCSS. This area provides foraging resources and facilitates movement (dispersal) between preferred habitat areas.

Minor areas of suitable habitat relatively isolated and disconnected within the landscape, totalling 46.80 ha, were excluded from HCSS (refer to Figure 21-55). Similarly, areas of marginal habitat corresponds to areas that may facilitate movement between patches of preferred and suitable habitat but do not provide important ecological resources (foraging or breeding) for the species. The species ability to readily disperse (i.e. fly) across these areas will not be impeded by the Project. As a result, these areas are not considered to meet the definition of HCSS and have been excluded.

Based on these factors, a total of 1,804.25 ha of HCSS is present in the Project Site. A summary of habitat types considered to comprise HCSS and those areas excluded from HCSS are provided in Table 21-64. Habitat critical to the survival of Squatter Pigeon is shown on Figure 21-55. Direct and indirect impacts to HCSS was assessed to be significant as per the EPBC Act Significant Impact Guidelines 1.1 (Department of the Environment, 2013a).

Table 21-64 Habitat areas comprising HCSS for the Squatter Pigeon

HCSS Determination	Description of habitat	Total habitat within Project Site(ha)
Habitat included in HCSS	All areas of preferred habitat	1,375.27
	Areas of suitable habitat that are connected or in close proximity to preferred habitat	429.00
	Total Area HCSS	**1,804.27**
Habitat not included as HCSS	Isolated areas of suitable habitat that are not connected or in close proximity to areas of preferred habitat	46.80
	Areas of Marginal habitat	2,524.20

Important populations

As this species currently has no adopted recovery plan, important populations of Squatter Pigeon (Southern) (*Geophaps scripta scripta*) have been defined as per those listed in the SPRAT database (Department of Agriculture Water and the Environment, 2020b):

- populations occurring in the Condamine River catchment and darling downs of southern Queensland
- the populations known to occur in the Warwick-Inglewood-Texas region of southern Queensland
- any populations potentially occurring in northern New South Wales.

None of these populations exist within the Project Site. This species remains common north of the Carnarvon Ranges in Central Queensland and is distributed as a single, continuous (i.e. inter-breeding) sub-population. Any population of Squatter Pigeon (Southern) (*Geophaps scripta scripta*) in the Project Site does not meet the definition of an important population.

Project impacts

The Project will have direct impacts to HCSS for Squatter Pigeon (Southern) (*Geophaps scripta scripta*) as shown in Table 21-65. Direct impacts during the construction phase (Stage 1) comprise habitat loss associated with the maximum disturbance of surface infrastructure and IMG drainage network, totalling 73.06 ha of HCSS. Throughout operation and decommissioning (Stage 2), direct impacts relate to habitat loss within areas subject to maximum extent of modelled ponding/inundation, totalling 40.52 ha of HCSS. Up to 113.58 ha of HCSS will be directly impacted as a result of the construction and operation phases of the Project.

Table 21-65 Direct impacts *to* Squatter Pigeon HCSS within the Project Footprint

MNES	Project Site (ha)	Project Footprint (ha)	Direct impacts (ha)			
			Construction (Stage 1)		Operation (Stage 2)	Total (ha)
			Surface Infrastructure	IMG	Ponding	
Squatter Pigeon HCSS	1,804.27	890.66	39.72	33.34	40.52	113.58

In addition to the maximum extent of direct impacts, an area of up to 777.09 ha of HCSS occurs within the maximum extent of subsidence. Within this area, indirect impacts have potential to consist of habitat degradation, light and noise, increase in predators' visibility and access to this species and weed proliferation; however, these impacts are considered unlikely to result in materialistic impacts to the composition and structure of native vegetation comprising HCSS. Ongoing monitoring of the occurrence of and effects of subsidence will be required to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur. Further discussion on operational indirect impacts is provided in Section 21.6.2.2.

Project avoidance, mitigation and management measures

The Project will be subject to detailed design and further refinement of Project infrastructure, with potential to micro-site and reduce corridor widths to avoid potential habitat. The following mitigation measures specific to potential impacts on Squatter Pigeon (*Geophaps scripta scripta*) have been proposed with further detail to be provided in the Threatened Species Management Plan:

- prior to clearing, a suitably qualified spotter catcher or environmental officer will delineate the extent of clearing including any buffer zones or 'no go' zones
- where practicable, all vehicles will be restricted to access tracks and roads, to reduce the potential for vehicle strike on squatter pigeon (*Geophaps scripta scripta*) and their nests
- clearing within potential squatter pigeon (*Geophaps scripta scripta*) habitat will be conducted in a sequential manner which directs fauna away from clearing activities
- where practicable direct lighting away from squatter pigeon (*Geophaps scripta scripta*) habitat
- develop and implement a weed and pest management plan for the control of feral herbivores in areas inhabited by squatter pigeon (*Geophaps scripta scripta*)
- site inductions will include information on the potential presence of squatter pigeon (*Geophaps scripta scripta*) (and their habitat) and the management measures to minimise harm Incidental sightings of the species will be reported to the Site Environmental Officer (or delegate) where practical.

Significant impact assessment

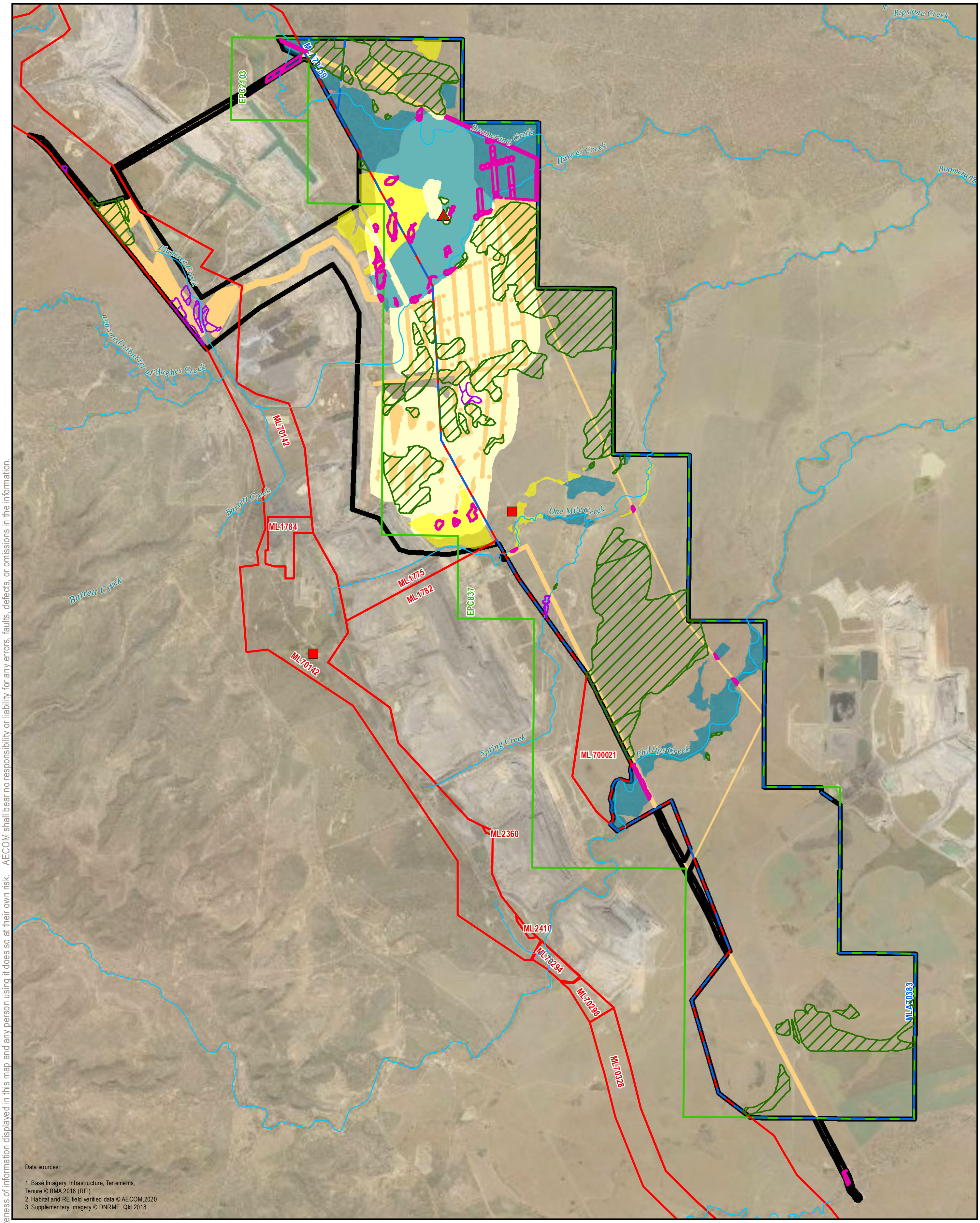
Habitat critical to the survival of the species is the most sensitive and of most value to Squatter Pigeon. Impacts to these sensitive habitat areas may be considered significant as per the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a).

To understand the mechanisms by which the habitat critical to the survival of the species might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species as per the guidelines has been completed and is provided in Table 21-66. The Project will result in the direct disturbance of up to 73.06 ha of HCSS from construction activities and an additional direct impact to 40.52 ha of HCSS during operation from maximum modelled extent of ponding/inundation. The assessment concludes the Project may have a significant impact on the Squatter Pigeon (Southern) (*Geophaps scripta scripta*) and require compensation by offset (refer Section 21.10).

Table 21-66 Assessment of significance of impacts – Squatter pigeon

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a TEC if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species.	As discussed above, no important populations of Squatter Pigeon (Southern) (*Geophaps scripta scripta*) are expected to occur within the Project Site. Therefore, the Project is unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population.	The extent of occurrence has been estimated to be 440,000 km^2 and the area of occupancy to be 10,000 km^2. These estimates were considered of medium and low reliability respectively. However, no important populations are expected to occur within or adjacent to the Project Site and therefore the Project is not expected to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations.	The existing SRM already forms a barrier to movement to the west of the Project Site and other impacts from the mine are not likely to fragment populations as potential habitat is widely available in the surrounding area and the species is highly mobile. Further, no important populations are expected to be present within or adjacent the Project Site.

EPBC Act criteria	Assessment of significance
Adversely affect habitat critical to the survival of a species.	Habitat critical to the survival of the species (HCSS) consists of eucalypt woodland providing a grassy understory associated with and between creek lines (i.e. preferred habitat and suitable habitat close to adjacent areas of preferred habitat). The Project will result in the direct clearing of 73.06 ha of HCSS from construction activities and an additional direct impact to 40.52 ha of HCSS during operation as a result of ponding / inundation. These impacts are likely to be adverse to HCSS. Marginal habitat corresponding to areas that may facilitate movement between patches of preferred and suitable habitat but not providing important ecological resources (foraging or breeding) for the species is not considered to meet the definition of habitat critical to the species' survival.
Disrupt the breeding cycle of an important population.	As discussed above, no important populations of Squatter Pigeon (Southern) (*Geophaps scripta scripta*) are expected to occur within the Project Site. Therefore, the Project is unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	An estimated 113.58 ha of HCSS will be impacted as a result of the Project (including 73.06 ha of direct impacts from construction of surface/IMG infrastructure and 40.52 ha of ponding/inundation). Minor indirect impacts within the balance of the maximum subsidence extent (777.09 ha of HCSS) are not anticipated to result in the loss of habitat and ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. However, given the scale of direct impact and the known presence of the species within the Project Site, it is possible that the Project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Marginal habitat is not considered HCSS and therefore, Project impacts (directly or indirectly) on this habitat type are not considered to result in or contribute to the species decline.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	Threats to the species include overgrazing by feral herbivores such as rabbits, proliferation of weed species and predation by feral carnivores such as foxes and feral cats. The Project Site is already impacted by grazing, clearing and mining activities and invasive species are established in the area including those listed as potential threats above.
Introduce disease that may cause the species to decline.	Disease has not been identified as a threat to the Squatter Pigeon (Southern) (*Geophaps scripta scripta*). Weed and pest management controls for the Project will ensure best practice site hygiene measures.
Interfere with the recovery of the species.	A national recovery plan for the Squatter Pigeon (Southern) (*Geophaps scripta scripta*) is not required; current threats to this species to be managed include ongoing loss and fragmentation of habitat, the degradation of habitat by overgrazing by domesticated herbivores and pest species (i.e. rabbit) and the degradation of habitat by invasive weeds. The Project may exacerbate these threatening processes within areas of sensitive habitat for the species. Clearing for Project infrastructure will result in approximately 73.06 ha loss of HCSS during construction (Stage 1) and maximum extent of ponding/inundation will result in the loss of 40.52 ha of HCSS during operation. Given the scale of these impacts relative to the availability and quality of habitat elsewhere in the region, it is unlikely the Project will interfere with the recovery of the Squatter Pigeon (Southern) (*Geophaps scripta scripta*).



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Threatened fauna records

- Squatter Pigeon (SKM 2012)
- Squatter Pigeon (AECOM 2017)

Squatter Pigeon Habitat Critical to the Survival of the Species (HCSS)

HCSS

- Preferred Habitat
- Suitable Habitat
- Significant impact area

Habitat not considered HCSS

- Suitable habitat
- Marginal habitat

N

Figure 21-55
Squatter Pigeon potential habitat within Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

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21.8.4.2 Ornamental Snake

Description and status under the EPBC Act

The Ornamental Snake (*Denisonia maculata*) is listed as Vulnerable under the EPBC Act.

The Ornamental Snake (*Denisonia maculata*) is typically a shade of grey with a darker patch on the crown of the head and black flecks or spots along outer edges of the throat and ventral scales. It has distinctly barred lips, a white-cream belly and grows to 50 cm in length (Wilson, 2015).

Distribution

The Ornamental Snake (*Denisonia maculata*) is found only in the Brigalow Belt North and some parts of the Brigalow Belt South biogeographical regions. The core distribution of this species in the aforementioned areas is within the Fitzroy and Dawson River drainage systems (Department of Agriculture Water and the Environment, 2020b).

Habitat requirements

Suitable habitat for the Ornamental Snake (*Denisonia maculata*) is low-lying areas with deep-cracking clay soils subject to seasonal flooding, and in adjacent areas of clay and sandy loams. The species is found in woodlands and shrublands, such as brigalow, and in riverine habitats, and lives in soil cracks and under fallen timber. It is also known to persist in cleared, disturbed habitats, particularly where brigalow communities have been cleared.

The Ornamental Snake's (*Denisonia maculata*) preferred habitat is within, or close to, habitat that is favoured by its primary prey - frogs. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai mounds and depressions in Queensland RE Land Zone 4, but also lake margins and wetlands. Suitable habitat for the Ornamental Snake (*Denisonia maculata*) incorporates dispersal habitat within 1 km of preferred habitat currently or previously dominated by brigalow or coolabah communities where gilgai or soil cracks are infrequent or shallow.

Threats

The primary threat to the species is continued modification of potential habitat through broadscale clearing and habitat degradation. The core range of the species is within an area of high human impact through extractive industries (i.e. coal mining; coal seam gas), agriculture and urban development (Threatened Species Scientific Committee, 2014a).

Other threats include destruction of wetland habitat by feral pigs (*Sus scrofa*) which also contributes to degradation of frog habitat and direct competition for their food source, frogs.

Lethal toxic ingestion of cane toads (*Bufo marinus*) is also a potential threat to the species (Threatened Species Scientific Committee, 2014a).

Survey timing and effort

The *EPBC Act Draft Referral Guidelines for Nationally Listed Brigalow Belt reptiles* (Department of Sustainability Environment Water Population and Communities, 2011a) prescribes the following survey methods and effort for the Ornamental Snake (*Denisonia maculata*):

- one-off diurnal search: active searches of microhabitat for 1.5 hours in each hectare of suitable habitat. a minimum of three days with one repeat (six days)
- spotlighting: 1.5 hours in each hectare of suitable habitat. a minimum of three nights
- pitfall and funnel trapping: 6 x 20 litre (l) buckets along a 30 m drift fence two replicates per habitat type, morning and evening checks over 4 days
- opportunistic surveys of roads.

The Ornamental Snake (*Denisonia maculata*) is most likely to be encountered by searching in and around suitable gilgai habitats during the evening when frogs are most active, approximately 1-3 days following heavy rainfall (greater than 5 mm), especially thunderstorms (Department of Agriculture Water and the Environment, 2020b). Additionally, referral guidelines recommended surveys to be undertaken late September to late March.

The survey effort undertaken within suitable habitat included:

- a total of 45-person hours over 22.5 days of diurnal active searches
- pitfall and funnel trapping during May and November, along a 45m drift fence
- a total of 87-person hours of spotlighting over 18 nights
- targeted habitat assessments were conducted for the species throughout the duration of the field surveys.

Ornamental Snake in the Project Site

Ornamental Snake (*Denisonia maculata*) has been recorded in the Project Site by AECOM (2020) and SKM (2012). 11 previous records for the species are also mapped in the west of the Project Site. The extent of habitat for the species that occurs within the Project Site consists of:

The extent of habitat for the species within the Project Site consists of 2,276.31 ha of suitable habitat.

- 2,276.31 ha of suitable habitat in the form of large and reasonably connected patches, primarily in the areas between Hughes Creek and One Mile Creek where prey may be found. The species has been recorded in 2012 and 2020 in suitable habitat areas between Hughes Creek and One Mile Creek. The review of literature, SPRAT, conservation advice (DoTE, 2014) and expert elicitation identified the definition of suitable habitat in Central Queensland to comprise:

  Dispersal areas within 1 km of preferred habitat, which are currently or previously dominated by brigalow or coolibah communities where gilgai or soil cracks are infrequent and/or shallow, including non-remnant areas. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 these areas also provide a resource but the species is unlikely to be undertaking key activities such as breeding or roosting here. The category notes foraging resources may be lower quality or used opportunistically rather than being depended upon.

As described in Table 21-25, no habitat meeting the definition of 'preferred' was detected due to lack of abundance of microhabitat features such as deep soil cracks and fallen woody debris preferred for breeding, and low quality/opportunistic foraging resources. No 'marginal' habitat where threats are high (high abundance of weed incursion and cattle compacting soils) was identified. Further information on Ornamental Snake within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the species

Habitat critical to the survival of the species (HCSS) includes the habitats containing features crucial for the species' persistence in an area, including for activities such foraging, breeding, roosting or dispersal. The draft referral guidelines set out a cascading approach to determining 'suitable' and 'important' habitat for Ornamental Snake, the latter of which is synonymous with critical habitat.

For Ornamental Snake in the Project Site, HCSS includes larger, contiguous areas of suitable habitat providing opportunistic foraging resources for the species. These areas generally lacked an abundance of microhabitat features such as deep soil cracks and fallen woody debris, excluding these areas from preferred habitat. As previously mentioned, no preferred or marginal habitat for the species was identified within the Project Site. HCSS primarily occurs in the low-lying areas prone to flooding between Hughes Creek and One Mile Creek where prey may occur following flooding events.

Minor areas of suitable habitat relatively isolated and disconnected within the landscape, totalling 29.67 ha, were excluded from HCSS (refer to Figure 21-56).

Based on these factors, a total of 2,246.65 ha of HCSS is present in the Project Site. A summary of habitat types considered to comprise HCSS and those areas excluded from HCSS are provided in Table 21-67. Habitat critical to the survival of Ornamental Snake is shown on Figure 21-56.

Table 21-67 Habitat areas comprising HCSS for the Ornamental Snake

HCSS Determination	Description of habitat	Total habitat within Project Site(ha)
Habitat included in HCSS	Large, contiguous areas comprising suitable habitat	2,246.65
	Total Area HCSS	**2,246.65**
Habitat not included as HCSS	Smaller, isolated and disconnected areas of suitable habitat within the landscape	29.67

Important populations

The draft referral guidelines state that given the Ornamental Snake is difficult to detect and population information is limited, important habitat is a surrogate for important populations for the purposes of significant impact assessment. If a project area contains important habitat, it contains an important population. Consequently, as important habitat is present in the Project Site, the population within the Project Site is considered 'important'.

Project impacts

The Project will result in direct impacts to Ornamental Snake (*Denisonia maculata*) as shown in Table 21-68. Direct impacts are predominantly associated with clearing activities and loss of habitat due to clearing for surface infrastructure during construction (Stage 1, up to 331.96 ha) and maximum extent of temporary ponding during operation (Stage 2, up to 54.22 ha). Large areas of suitable breeding and foraging habitat and dispersal pathways will be removed to establish surface infrastructure. Sheltering individuals may also be at risk of crushing during construction and compaction of soil cracks and removal of woody debris may reduce the carrying capacity of the habitat. Throughout construction, operation and decommissioning direct mortality from vehicle strike will remain a risk to the species. In total, up to 386.18 ha of HCSS will be directly impacted.

Table 21-68 Direct impacts to Ornamental Snake (*Denisonia maculata*) HCSS

MNES	Project Site (ha)	Project Footprint (ha)	Direct impacts (ha)			
			Construction		Operation	Total
			Surface Infrastructure	IMG	Ponding	
Ornamental Snake HCSS	2,246.65	882.77	213.19	118.77	54.22	386.18

Indirect impacts consist of habitat degradation and disruption to breeding, foraging and dispersal behaviours due to increased light and noise. While subsidence is likely to alter habitat for this species, it is expected that much of this habitat will still retain habitat functionality. This is largely attributed to the characteristic of the soils present (e.g. cracking clays), resilience of native species and the extent and depth of likely subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will also be undertaken to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur. Further discussion on operational indirect impacts is provided in Section 21.6.2.2.

Project avoidance, mitigation and management measures

The Project will be subject to detailed design and further refinement of Project infrastructure, with potential to micro-site and reduce corridor widths to avoid potential habitat. The following mitigation measures specific to potential impacts on Ornamental Snake (*Denisonia maculata*) have been proposed with further detail to be provided in the Threatened Species Management Plan:

- during construction, all practical measures will be taken to locate stockpiling/lay down areas and plant and on cleared land not within mapped Ornamental Snake (D*enisonia maculata*) habitat

- implementation of a best practice weed and pest management controls to reduce the proliferation of Cane Toads (B*ufo marinus*) and feral pigs (S*us scrofa*)
- pre-clearance surveys will be undertaken by a suitably qualified fauna spotter catcher prior to any vegetation clearing activities. the fauna spotter catcher must also be present during any vegetation clearing activities
- clearing within potential Ornamental Snake (D*enisonia maculata*) habitat will be conducted in a sequential manner which directs fauna away from clearing activities
- signage will be installed to increase awareness of the species and its habitat
- site inductions will include information on the potential presence of Ornamental Snake (*Denisonia maculata*) (and their habitat) and the management measures to minimise harm
- incidental sightings of the species will be reported to the site environmental officer (or delegate)
- retain shelter habitat features in place where practicable.

Significant impact assessment

Habitat critical to the survival of the species is the most sensitive and of most value to Ornamental Snake. Impacts to these sensitive habitat areas may be considered significant as per the EPBC Act *Significant Impact Guidelines 1.1* (DotE, 2013a).

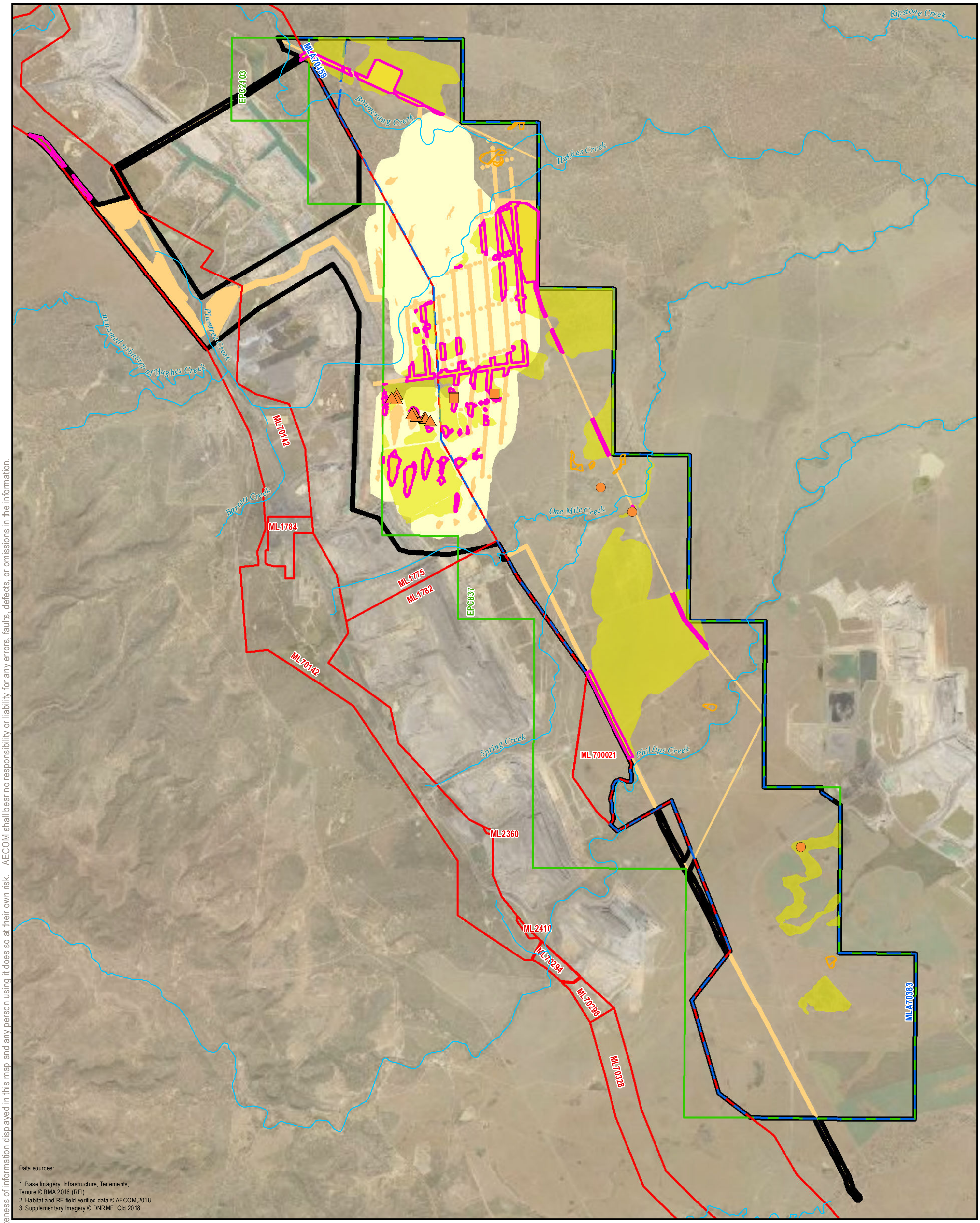
To understand the mechanisms by which the habitat critical to the survival of the species might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species as per the guidelines has been completed and is provided in Table 21-69. The assessment concludes that the Project may have a significant impact on the Ornamental Snake (*Denisonia maculata*) and require compensation by offset (refer Section 21.10).

Table 21-69 Assessment of significance of impacts – Ornamental Snake

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species.	An important population of Ornamental Snake is present in the Project Site, with individuals recorded multiple times during several surveys (refer Section 21.5.2.3). Of the 2,246.65 ha of HCSS within the Project Site, assessment of the maximum extent of impacts indicates up to 386.18 ha of HCSS for this species could potentially be directly disturbed, including up to 331.96 ha during construction (Stage 1) and up to 54.22 ha associated with the maximum extent of temporary ponding during operation (Stage 2). Within the remaining subsidence area, impacts are not anticipated to result in the loss of habitat. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify unexpected impacts to habitat. Given the extent of HCSS being impacted and the confirmed presence of the species in several locations within the Project Site, the Project may lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population.	As discussed above 386.18 ha of HCSS could potentially be directly impacted, with remaining 496.59 ha of HCSS within the Project Footprint unlikely to be disturbed by indirect impacts of subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify unexpected impacts to habitat. An important population of Ornamental Snake (*Denisonia maculata*) has been determined to be present in the Project Site. Therefore, the Project may reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations.	Significant habitat fragmentation will be associated with the IMG network and transport corridor, which will impact areas of HCSS for Ornamental Snake (*Denisonia maculata*). The IMG network will consist of a grid like pattern of access tracks and cleared pads on the surface above the longwall mining operations and the proposed infrastructure and transport corridor will run along the eastern and northern edge of the Project Site. Given the limited mobility

EPBC Act criteria	Assessment of significance
	capacity of the species it is possible that the IMG network may provide a barrier to movement, however tracks will be infrequently used and not wider than 50 m. It is unlikely however that Ornamental Snake (*Denisonia maculata*) will disperse across the infrastructure and transport corridor which will be wider and subject to much higher traffic volume. This will reduce the ability of the species to disperse in a west-east direction between large patches of suitable habitat to the east of the Project Site. Therefore, it is likely that the Project may result in fragmentation of an existing important population into two or more populations.
Adversely affect habitat critical to the survival of a species.	Of the 2,246.65 ha of potential habitat within the Project Site, 386.18 ha of HCSS for this species will be directly impacted. With mitigation measures proposed in Section 21.7, the result of the proposed action will be reduced, however the proposed clearing will likely result in adverse impacts to HCSS.
Disrupt the breeding cycle of an important population.	As large areas of HCSS are available for the species, there is potential the important population is using the resources for breeding; although breeding habitat requirements are not known for the Ornamental Snake, they are likely to be similar to foraging requirements. Of the 2,246.65 ha of HCSS within the Project Site, 386.18 ha of HCSS for this species will be directly impacted with remaining 496.59 ha of HCSS within the Project Footprint unlikely to be disturbed by indirect impacts of subsidence. With mitigation measures proposed in Section 21.7, the result of the proposed action will be reduced. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. However, the Project may disrupt the breeding cycle of the Ornamental Snake (*Denisonia maculata*) population within the Project Site.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	386.18 ha of HCSS could potentially be directly impacted by construction of surface infrastructure and IMG drainage network and maximum extent of persistent ponding, with remaining 496.59 ha of HCSS within the Project Footprint unlikely to be disturbed by indirect impacts of subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. Given the scale of direct impacts to HCSS and the records of the species at multiple locations in the Project Site it is possible that the Project will modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline within the Project Site.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	Poisoning resulting from ingestion of Cane Toads (*Bufo marinus*) and destruction of wetland habitat by feral pigs (*Sus scrofa*) have been listed as major threats in the Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake) (DotE, 2014a). Significant well-established populations of both species already exist within the Project Site. Subsidence has the potential to lead to localised ponding, which may create areas of habitat which supports both Cane Toads (*Bufo marinus*) and feral pigs (*Sus scrofa*) and may contribute to an increase in the local populations of these species that are already present within the Project Site. The implementation of remedial drainage works and a Weed and Pest Management Plan will help to control and mitigate the current established population of cane Toads and feral pigs, as well as control and mitigation the establishment of any additional invasive species as a result of the Project. The Project is unlikely to result in in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.
Introduce disease that may cause the species to decline.	Disease has not been listed as a threat to this species under the Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake) (Threatened Species Scientific Committee, 2014b). Weed and pest management measures for the Project will ensure best practice for site hygiene.
Interfere with the recovery of the species.	The federal environment minister has declared that a national recovery plan for the Ornamental Snake (*Denisonia maculata*) is not required. The Conservation Advice lists threats to this species including loss and fragmentation of habitat, alteration of landscape hydrology in and around gilgai environments, and alteration of water quality through chemical and sediment pollution of wet

EPBC Act criteria	Assessment of significance
	areas. Current priority recovery and threat abatement actions for this species include minimising adverse impacts to land use at known sites, controlling introduced pests such as pigs and Cane Toads (*Bufo marinus*) at known sites and raising awareness of the species. The Project will result in habitat loss and fragmentation due direct impacts from clearing. Most records of the species within the Project Site are not located in the direct impact area where vegetation will be cleared. The implementation of a Weed and Pest Management Plan will help to control and mitigate the current established population of Cane Toads and feral pigs. Overall, the Project is considered unlikely to interfere with the recovery of the species.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)

Threatened fauna record

- Ornamental Snake (AECOM 2020)
- Ornamental Snake (Australian Living Atlas 2016)
- Ornamental Snake (SKM 2012)

Ornamental Snake Habitat Critical to the Survival of the Species (HCSS)

- Suitable
- Significant impact area

Habitat not considered HCSS

- Suitable Habitat

N

Figure 21-56

Ornamental Snake Potential Habitat

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

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BHP Mitsubishi Alliance

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21.8.4.3 Koala

Description and status under the EPBC Act

The Koala (*Phascolarctos cinereus*) is listed as Vulnerable under the EPBC Act.

The Koala (*Phascolarctos cinereus*) is a tree-dwelling, medium-sized marsupial with a stocky body, large-rounded ears, sharp claws and variable but predominantly grey-coloured fur. It is one of Australia's most distinctive and iconic wildlife species (Threatened Species Scientific Committee, 2012).

Distribution

With relation to the combined populations of Queensland, New South Wales and the Australian Capital Territory, the range extends from approximately the latitude of Cairns to the New South Wales-Victoria border. Although the species is often more abundant in coastal areas, inland populations do occur. The species' distribution is not continuous within its range with a number of populations isolated by cleared land or unsuitable habitat (Threatened Species Scientific Committee, 2012).

Habitat requirements

Koalas (*Phascolarctos cinereus*) inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus *Eucalyptus* (Martin and Handasyde, 1999). The distribution of Koalas (*Phascolarctos cinereus*) is also affected by altitude (limited to less than 800 m above sea level), temperature and at the western and northern ends of the range, leaf moisture (Munks, Corkrey and Foley, 1996).

Within central Queensland, Koalas (*Phascolarctos cinereus*) have been studied at Tambo (Mitchell Grass Downs bioregion), Springsure and Blair Athol (both in Brigalow Belt North bioregion). Koalas (*Phascolarctos cinereus*) in this region typically occur in low densities and have large home ranges (Ellis *et al.*, 2002).

The Koala (*Phascolarctos cinereus*) is heavily reliant on eucalypt leaves, a diet that is extremely energy constraining. As a result, the Koala (*Phascolarctos cinereus*) is very inactive and spends around 19 hours per day sleeping (Curtis and Dennis, 2012). Koalas (*Phascolarctos cinereus*) can live to 15 years of age in the wild (Curtis and Dennis, 2012) and females can potentially produce one offspring per year. Young are born between October and May and occupy the pouch for six to eight months (Curtis and Dennis, 2012).

Based on the geographical location of the Project Site and the annual rainfall in the region, the Koala (*Phascolarctos cinereus*) habitat is to be assessed with respect to the inland context described in the Koala (*Phascolarctos cinereus*) EPBC referral guidelines (Department of the Environment, 2014). Thus, Koala (*Phascolarctos cinereus*) habitat is defined as:

- woodlands and forests where koala (*Phascolarctos cinereus*) food trees have reliable access to soil moisture
- box gum or red gum woodlands on heavier soils in remnant or regrowth vegetation patches particularly riparian zones
- small, patchy and sparsely distributed woodlands, shrublands and forest in highly modified, agricultural-grazing landscapes or in and around rural towns.

Koala food trees are species of tree whose leaves are consumed by Koalas (Phascolarctos cinereus). Koala (Phascolarctos cinereus) food trees are defined in the EPBC Act Referral Guidelines For The Vulnerable Koala (Department of the Environment, 2014) those of the following genus: Angophora, Corymbia, Eucalyptus, Lophostemon and Melaleuca. It should be noted that 'primary' and 'secondary' food trees (as defined by some resources) are all considered to be 'food trees' for the purposes of assessment using these guidelines.

Threats

The main identified threats to the species are (Threatened Species Scientific Committee, 2012):

- loss and fragmentation of habitat
- vehicle strike
- disease (i.e. *chlamydia*)
- predation by dogs.

Drought and extreme heat are also known to cause very significant mortality, and post-drought recover may be substantially impaired by the range of other threatening factors (Threatened Species Scientific Committee, 2012).

Survey timing and effort

The *EPBC Act Referral Guidelines For The Vulnerable Koala* (Department of the Environment, 2014) do not prescribe specific survey effort requirements due to the high level of variation of this species across its distribution. Although both this document and the survey guidelines for Australia's threatened mammals recommend the following key survey techniques:

- spotlighting with call playback: survey effort determined on a case-by-case basis
- remote camera: survey effort determined on a case-by-case basis
- SAT surveys (Phillips and Callaghan, 2011): Sampling of a minimum of 30 Koala (*Phascolarctos cinereus*) food trees within suitable habitat. Survey effort determined on a case-by-case basis.

Optimal time period for direct observation surveys is between August and January, as this is when Koala (*Phascolarctos cinereus*) activity is generally at its peak and resident breeding females with back-young are most easily observed. Direct observation surveys conducted outside of this period must take into account the potential for lower Koala (*Phascolarctos cinereus*) activity (reduced detectability) and other relevant seasonal considerations.

Presence/absence surveys in the inland context, conducted during dry periods, should be centred on riparian areas, upper/mid-slope areas and other dry period refugia in order to maximise detectability.

The survey effort undertaken includes:

- 82-person hours of spotlighting over 17 nights
- call playback was conducted concurrently with spotlighting for Koala (P*hascolarctos cinereus*) during field surveys prior to March 2020
- remote cameras: 64 camera trap nights over 12 nights
- three SATS were conducted in suitable habitat
- targeted habitat assessments were conducted for the species throughout the duration of the field surveys.

Koala in the Project Site

A solitary Koala (*Phascolarctos cinereus*) was observed to the north-west of the Project Site within the riparian zone associated with Plumtree Creek in 2020 and one Koala (*Phascolarctos cinereus*) was recorded from Downs Creek adjacent to the Project Site during previous ecological surveys. An additional record is known 4 km west of the Project Site and the species was recorded at Peak Downs Mine East, directly north of the Project Site in 2018. The extent of habitat for the species that occurs within the Project Site consists of:

- 362.03 ha of preferred habitat primarily Eucalyptus woodland associated with watercourses and alluvial terraces. The species was recorded in preferred habitat area in 2020. The review of literature, SPRAT, conservation advice (TSSC, 2022) and expert elicitation identified the definition of preferred habitat in Central Queensland to comprise:

Eucalyptus woodland associated with watercourses and alluvial terraces containing high frequencies of preferred food trees (Eucalyptus tereticornis/camaldulensis dominant) with potential to support moderate to high density koala populations.

It does not include areas dominated by pasture grasses, nor heavily grazed areas. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

As described in Table 21-25 these areas are considered most important to the species and contain features crucial for species persistence.

- 1,748.51 ha of suitable habitat not occurring in association with watercourses but containing food trees. The species was recorded in preferred habitat area in 2020. The review of literature, SPRAT, conservation advice (TSSC, 2022) and expert elicitation identified the definition of suitable habitat in Central Queensland to comprise:

  Remnant and regrowth Eucalyptus open forest to woodlands with more variable aquifers (often seasonal) and that have connectivity to other areas of suitable or preferred habitat.

  As described in Table 21-25, these areas provide food and shelter resources, and connectivity to preferred habitat, but the available resources are lower quality and less frequent due to the aquifers being less reliable during drought cycles. Individuals may be found in suitable habitat, but this habitat type may also remain unoccupied.

- 386.67 ha of marginal habitat isolated from preferred and suitable habitats, includes fragmented and sparsely distributed Brigalow and Belah woodland and shrublands, subject to seasonal water deficit and high bushfire risk. The review of literature, SPRAT, conservation advice (TSSC, 2022) and expert elicitation identified the definition of marginal habitat in Central Queensland to comprise:

  All other fragmented and sparsely distributed woodlands and open woodlands, shrub lands and forests, with some food trees and which experience significant seasonal water deficits and/or are subject to periodic high intensity fires.

  As described in Table 21-25 marginal category habitat areas provides movement opportunities but limited food trees or persistent freshwater to maintain leaf moisture at levels sufficient to sustain a resident koala population. While individuals may be detected the species is unlikely to be undertaking key activities such as breeding or extensive foraging. As marginal habitat has potential to support only very low density koala populations, individuals are rarely found in this habitat type and it is likely to be unoccupied most of the time.

Further information on Koala within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the species

The National recovery plan states habitat critical to the survival of a species is the area that the species relies on to halt decline and promote the recovery of the species. In assessing this, the Recovery plan highlights key considerations, including if the habitat is used to meet essential life cycle requirements and if used by important populations.

Combined preferred and suitable habitats describe eucalypt woodlands along creek-lines in semi-arid environments in central Queensland typically occupied by koalas due to higher tree species richness with higher abundance and correlating leaf moisture content (DAWE, 2022). Marginal habitat is otherwise fragmented and sparsely distributed open woodlands, shrubs and forests providing limited food trees and subject to seasonal water deficits and/or periodic high intensity fires in central Queensland have the potential to support only very low density koala populations (Kerswell, Kaveney, Evans and Appleby, 2020). A landscape across which koalas move, but does not contain palatable tree species, and/or a persistent freshwater aquifer sufficient to maintain leaf moisture at levels sufficient to sustain a resident koala population and/or a habitat structure that provides refuge from predators or the capacity to avoid heat stress, is not considered to provide habitat values for the species.

Within the Project Site, HCSS comprises preferred habitat and suitable habitat where in association with preferred habitat along Hughes Creek, Boomerang Creek, Plumtree Creek and Phillips Creek. These watercourses provide connectivity between areas of preferred and suitable habitat. Marginal habitat isolated from sufficient food trees and refuge habitat to support populations does not provide HCSS.

Based on these factors, a total of 2,110.54 ha of HCSS is present in the Project Site. A summary of habitat types considered to comprise HCSS and those areas excluded from HCSS are provided in Table 21-70. Habitat critical to the survival of the Koala is shown on Figure 21-57. Direct and indirect impacts to HCSS was assessed to be significant as per the EPBC Act Significant Impact Guidelines 1.1 (Department of the Environment, 2013a).

Table 21-70 Habitat areas comprising HCSS for the Koala

HCSS Determination	Description of habitat	Total habitat within Project Site(ha)
Habitat included in HCSS	All areas of preferred habitat	362.03
	All areas of suitable habitat	1,748.51
	Total Area HCSS	**2,110.54**
Habitat not included as HCSS	Areas of marginal habitat largely isolated from sufficient food trees and refuge habitat	386.67

Important populations

There are no species-specific guidelines on what constitutes an important population. Therefore, any population potentially occurring within the Project Site has been assessed against the generic definition in the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013). Important populations of Vulnerable species are defined as those 'that are necessary for a species' long-term survival and recovery' and may include populations which are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

Based on these criteria, the Project Site may support an important population. The population of Koala (*Phascolarctos cinereus*) using the Project Site is not necessarily unique, isolated or genetically distinct from any other populations occurring in the region and the Project Site is not near the edge of the species' range. However, the Project Site contains HCSS and an individual was recorded within this habitat. Given the scarcity of HCSS and the importance of this habitat for providing breeding resources, it has been conservatively considered that the Project site may support a key source population for breeding and dispersal. It is also highlighted in the National recovery plan (DAWE, 2022) the Brigalow Belt population may have traits and underlying genetics that mean they are better adapted to drought and heatwaves than are other Koala populations, and hence they are important to the survival of the Koala into the future.

Project impacts

The Project will result in direct impacts to Koala (*Phascolarctos cinereus*) as shown in Table 21-71. Direct impacts will be likely during the construction phase (Stage 1) and include habitat loss and direct mortality during clearing works. However, the use of mitigation measures such as fauna spotter-catchers will assist in reducing impacts during clearing of potential Koala (*Phascolarctos cinereus*) habitat. During operation (Stage 2), an estimate of habitat loss associated with localised dieback of food trees or canopy trees providing connectivity has been assessed based on the maximum extent of modelled ponding; however, remedial drainage works will reduce persistent ponding and long term impacts of inundation on habitat.

Table 21-71 Direct impacts to Koala HCSS within the Project Footprint

MNES	Project Site (ha)	Project Footprint (ha)	Direct impact (ha)			
			Construction		Operation	Total
			Surface Infrastructure	IMG	Ponding	
Koala HCSS	2,110.54	1,071.10	36.87	47.13	52.33	136.33

Indirect impacts during the construction phase consist of habitat degradation and disruption to breeding, foraging and dispersal behaviours due to increased light and noise. Increased noise and light, particularly during construction, may have impact on Koalas (*Phascolarctos cinereus*) during the breeding season as they rely on auditory cues to find mates. A fragmented landscape will result in Koalas (*Phascolarctos cinereus*) being required to travel on the ground to traverse between habitats. Dispersal corridors for Koala (*Phascolarctos cinereus*) associated with the riparian habitat of Boomerang, Plumtree, Phillips and Downs Creek will be interrupted by the transport and infrastructure corridor, forcing dispersing individuals move across the corridor and increase their susceptibility to direct mortality from vehicle strike and increased risk from predators such as wild dogs.

Up to 934.77 ha of Koala HCSS is mapped within the balance of the maximum extent of subsidence. Effects such as surface cracking is considered unlikely to result in materialistic impacts to the composition and structure of native vegetation and habitat present attributable to the characteristic soils present, resilience of native species and the extent and depth of likely subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will also be undertaken to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur.

Further discussion on operational indirect impacts is provided in Section 21.6.2.2.

Project avoidance, mitigation and management measures

The Project will be subject to detailed design and further refinement of Project infrastructure, with potential to micro-site and reduce corridor widths to avoid potential habitat. The following mitigations measures specific to potential impacts on Koala (*Phascolarctos cinereus*) have been proposed with further detail to be provided in the Threatened Species Management Plan:

- pre-clearance surveys to be undertaken by a suitably qualified fauna spotter catcher prior to any clearing activities. the fauna spotter catcher must also be present during any vegetation clearing activities
- delineate limits of clearing within any Koala (*Phascolarctos cinereus*) habitat identified within the preclearance surveys with flagging material prior to clearing. this will include any habitat trees which can be avoided
- clear vegetation in a sequential manner which directs any escaping fauna to adjacent native vegetation
- where practical, clearing of vegetation will be conducted in a manner which avoids the isolation of habitat or fauna within the clearing impact area
- where a Koala (*Phascolarctos cinereus*) is located during pre-clearance surveys or during clearing activities:
- the individual must not be forcibly relocated
- any tree which houses a Koala (*Phascolarctos cinereus*) as well as any tree with a crown that overlaps that tree will not be cleared until the Koala (*Phascolarctos cinereus*) vacates the tree on its own volition
- allow a clearing buffer surrounding the tree, equal to the height of the tree or deemed suitable by the fauna spotter catcher.
- reduce clearing to avoid high quality micro-habitat areas (i.e. mature habitat trees)

- a speed limit of 40 km per hour (or otherwise as indicated) will be placed on all roads and tracks associated with the IMG management network
- any injured Koala (*Phascolarctos cinereus*) (and fauna in general) should be transported to a vet or recognised wildlife carer
- site inductions will include information on the potential presence of Koala (*Phascolarctos cinereus*) (and their habitat) and the management measures to minimise harm
- where practicable, vehicles will be restricted to roads and access tracks to reduce potential for vehicle strike
- incidental Koala (*Phascolarctos cinereus*) sightings will be reported to the site environmental officer (or delegate), where practical.

Significant impact assessment

Habitat critical to the survival of the species is the most sensitive and of most value to Koala. Impacts to these sensitive habitat areas may be considered significant as per the EPBC Act Significant Impact Guidelines 1.1 (DotE, 2013a).

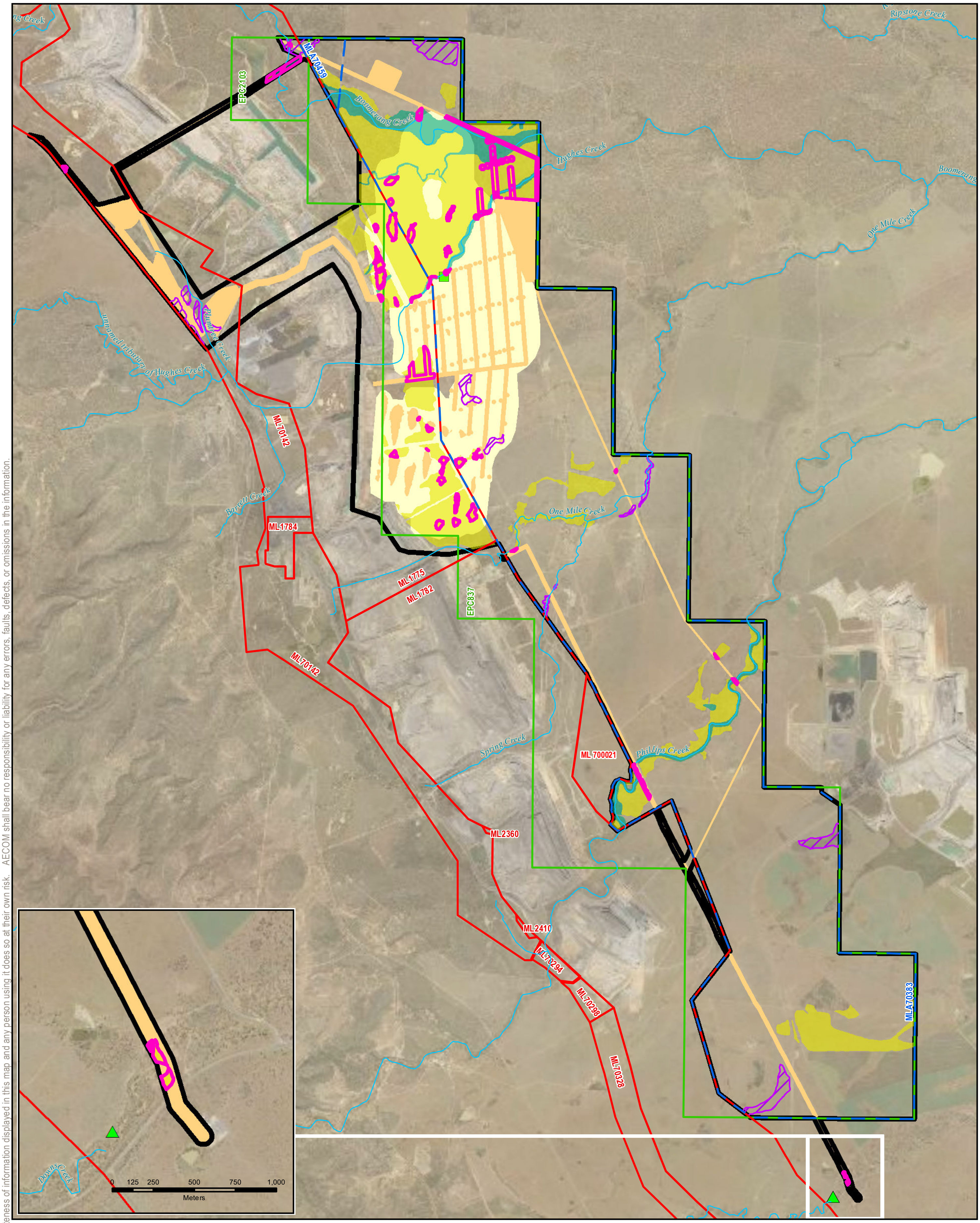
To understand the mechanisms by which the habitat critical to the survival of the species might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species as per the guidelines has been completed and is provided in Table 21-72. The assessment concludes that the Project may have a significant impact on the Koala (*Phascolarctos cinereus*) and require compensation by offset (refer Section 21.10).

Table 21-72 Assessment of significance of impacts – koala

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species.	There are no species-specific guidelines on what constitutes an important population. The National recovery plan (DAWE, 2022) for Koala notes the Brigalow Belt population may have traits and underlying genetics that mean they are better adapted to drought and heatwaves than are other Koala populations, and hence they are important to the survival of the Koala into the future. As an individual has been recorded in HCSS on the Project Site, it has been conservatively considered that the Project Site supports an important population. A total of 136.33 ha of HCSS for this species will be directly impacted as a result of the proposed action, with remaining 934.77 ha of HCSS within the Project Footprint is unlikely to be disturbed by indirect impacts of subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. A long-term decline may occur in the population if mortality rates increase and/or breeding rates decrease beyond that required to sustain the population. It is considered unlikely that the Project would result in either of these scenarios. Approximately 84.00 ha of habitat will be directly impacted during construction, with an additional 52.33 ha within the maximum extent of ponding. HCSS will remain present throughout the Project Area and will continue to be available to support the long-term persistence of the species. Refuge for fauna along riparian zones and connectivity within and out of the Project Site will be maintained as far as practicable. Therefore, while the Project Site may be capable of supporting an important population it is considered unlikely that the proposed action will lead to a long-term decrease in the size of an important population of Koala (*Phascolarctos cinereus*).
Reduce the area of occupancy of an important population.	As discussed above 84.00 ha of HCSS will be directly impacted during construction with 52.33 ha with potential to be impacted by the maximum modelled extent of ponding; however, remedial drainage works will reduce persistent ponding in the landscape. In addition to maximum direct impacts, subsidence (excluding ponding/inundation) also has the potential to impact a further 934.77 ha of HCSS. These impacts are not anticipated to result in the loss of habitat and ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted.

EPBC Act criteria	Assessment of significance
	An important population of Koala (*Phascolarctos cinereus*) has been conservatively considered to be present in the Project Site. Approximately 93 per cent of HCSS for the species mapped in the Project Site will be retained, and mitigation measures will be put in place to manage operational impacts. The removal of up to 84.00 ha of HCSS during construction and potential impacts of up to 52.33 ha of HCSS through ponding will result in very local small scale habitat loss and will not reduce the areas of occupancy of the species. Most shelter, dispersal and foraging habitat will be retained across the Project Area, and this will remain available to individuals for the life of the Project.
Fragment an existing important population into two or more populations.	Potential impacts include the loss and/or fragmentation of habitat. Fragmentation will occur at creek crossings for the transport and infrastructure corridor and powerline connection and at the gas collection lines within the IMG network. This may locally restrict movement of the species. Contiguous areas of connected preferred and suitable habitat are located outside of the direct disturbance areas and potential subsidence areas, meaning they are highly unlikely to be impacted by the Project. These areas will continue to facilitate movement for the species within and out of the Project Site. It is unlikely that the Project will fragment an 'important population' into two or more populations.
Adversely affect habitat critical to the survival of a species.	As discussed above 84.00 ha of HCSS will be directly impacted by maximum clearing anticipated for construction of surface infrastructure and IMG network, with up to 52.33 ha with potential to be impacted within the maximum modelled extent of ponding. Potential impacts to 934.77 ha of HCSS occurring within the maximum extent of subsidence (excluding ponding/inundation) are not anticipated to result in the loss of habitat and ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. While areas of HCSS are within the Project Site, additional site-specific information suggests there are characteristics and threats present within the Project Site that may limit the importance of the habitat in the recovery of the species. For example, preferred habitat within the Project Site primarily occurs within narrow riparian corridors or fragmented patches, which limits habitat viability and carrying capacity. Habitat connectivity across the Project Site is also limited and generally restricted to habitat along main watercourses such as Boomerang Creek. This habitat is not considered highly unique and habitat with similar characteristics, quality and condition occurs within the region. The presence of this regional habitat will allow the species to continue to persist within its current distribution, regardless of the presence or quality of habitat within the Project Site. However, as the Project may directly impact up to 136.33 ha of HCSS, it is considered likely impacts would occur to such an extent that habitat critical to the survival of a species is adversely affected.
Disrupt the breeding cycle of an important population.	Koalas (*Phascolarctos cinereus*) do not have specific breeding habitat requirements. Male koalas are most active during the breeding season and can cover areas of several kilometres with limited vegetation (TSSC, 2012). Impacts from the Project would not fragment habitat to the extent that dispersing males looking for mates would be unable to do so. Therefore, while areas which Koala (*Phascolarctos cinereus*) may utilise to breed do occur within the Project Site it is unlikely that the impacts will be of a magnitude to disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Up to an estimated 136.33 ha of HCSS will be directly impacted as a result of the Project (including 84.00 ha of associated with maximum extent of construction impacts and 52.33 ha of within the maximum modelled extent of subsidence-induced ponding impacts). Potential impacts to 934.77 ha of HCSS occurring within the maximum extent of subsidence (excluding ponding/inundation) are not anticipated to result in the loss of habitat and ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. However, given the scale of direct impact and the known presence of the species within the Project Site, it is possible that the Project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

EPBC Act criteria	Assessment of significance
	Marginal habitat is not considered HCSS and therefore, Project impacts (directly or indirectly) on this habitat type are not considered to result in or contribute to the species decline.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	The primary invasive species which poses a threat to Koala (*Phascolarctos cinereus*) is wild dogs (*Canis lupus familiaris*). This species has already been recorded within the Project Site. The implementation of a Weed and Pest Management Plan will help to control and mitigate the current established population of dogs, as well as control and mitigation the establishment of any additional invasive species as a result of the Project. The Project is unlikely to result in in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.
Introduce disease that may cause the species to decline.	The proposed action is not expected to introduce or exacerbate the spread of disease (i.e. Chlamydia) that may reduce the reproductive output of koalas or reduce the carrying capacity of the habitat. Symptoms of individuals carrying Chlamydia can become overt when subjected to additional stress. Such stress may be caused by habitat clearing associated with the Project. However, due to the low density of the species within the Project Site it is not expected to exacerbate this disease on a population scale. The implementation of a Weed and Pest Management Plan will help to control and mitigate the establishment of invasive species and associated diseases as a result of the Project. The Project is unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species.	The National recovery plan identifies a number of recovery objectives and threats to be managed for the recovery of the species. The key threats to the species listed in the recovery plan that are relevant to the Project include habitat loss, fragmentation and degradation. In relation to these threats: • While design of the layout of the IMG drainage infrastructure has not yet been finalised, it is intended to restrict the number of times that the infrastructure crosses key sensitive habitat features of riparian corridors, minimising direct disturbance to these corridors. Some pipeline crossings will be required and these will be trenched crossings, with disturbed areas reinstated to stabilise the river bed and banks. The wells required for IMG drainage will be installed outside of the riparian zone. With these design measures in place, riparian vegetation connectivity will largely be retained along these creek systems during the construction phase of the Project • Clearing and ponding/inundation of HCSS will be no more than 136.33 ha, approximately seven per cent of the HSCC in the Project Site. • Large areas of suitable habitat will remain in the Project area and will continue to be available to support the long-term persistence of the species • Offsets will be provided to counter-balance unavoidable significant residual impacts to the species. Given these measures, and the expected ongoing persistence of the species within the Project areas, no inference with the recovery of the species is anticipated to result from the Project.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Threatened fauna record

- Koala (URS 2014)
- Koala (AECOM 2020)

Koala Habitat Critical to the Survival of the Species (HCSS)

- Preferred Habitat
- Suitable Habitat
- Significant impact area

Habitat not considered

- Marginal habitat

N

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)

Projection: Map Grid of Australia - Zone 55 (GDA94)

Figure 21-57

Koala potential habitat within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

BMA
BHP Mitsubishi Alliance

DATE: 22/11/2024 VERSION: 7

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.98 GIS 2021\02_MXDs\01 Environmental Impact Statement\21 MNES Ecology\60507031_G215_v8_A4P.mxd

21.8.4.4 Australian Painted Snipe

Description and status under the EPBC Act

The Australian Painted Snipe (*Rostratula australis*) is listed as Endangered under the EPBC Act.

The Australian Painted Snipe (*Rostratula australis*) is a stocky wading bird around 22–25 cm in length with a long pinkish bill. The adult female, more colourful than the male, has a chestnut-coloured head, with white around the eye and a white crown stripe, and metallic green back and wings, barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down its upper back. The adult male is similar to the female, but is smaller and duller with buff spots on the wings and without any chestnut colouring on the head, nape or throat (Department of Agriculture Water and the Environment, 2020b).

Distribution

The Australian Painted Snipe (*Rostratula australis*) has been recorded at wetlands in all states of Australia. It is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia. It has been recorded less frequently at a smaller number of more scattered locations farther west in South Australia, the Northern Territory and Western Australia. It has also been recorded on single occasions in south-eastern Tasmania and at Lord Howe Island (Department of Agriculture Water and the Environment, 2020b).

Habitat requirements

The Australian Painted Snipe (*Rostratula australis*) is a wading bird found in wetland habitats. They generally inhabit shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. However, they have also been known to utilise areas lined with trees, as well as modified habitats such as low-lying woodlands converted to grazing pasture, sewage farms, dams, bores and irrigation schemes (Department of Agriculture Water and the Environment, 2020b).

Australian Painted Snipe (*Rostratula australis*) breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby. Nest records are nearly all from or near small islands in freshwater wetlands, provided that these islands are a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover. The nest is usually placed in a scrape in the ground (Geering, Agnew and Harding, 2007). The Murray-Darling Basin is known to be a preferred breeding area for the species (Department of Agriculture Water and the Environment, 2020b).

The Australian Painted Snipe (*Rostratula australis*) forages on vegetation, seeds, insects, worms and molluscs, crustaceans and other invertebrates. This species is mainly crepuscular (active at dawn and dusk), preferring to sit quietly under cover of grass, reeds or other dense cover during day, becoming more active at dawn, dusk and night. They generally remain in dense cover when feeding, although may forage over nearby mudflats and other open areas such as ploughed land or grassland.

The movements of the Australian Painted Snipe (*Rostratula australis*) are poorly known, and it may be a migratory species. Sightings of individuals are erratic, and it is thought the species is likely to be nomadic in response to suitable conditions, such as floods.

Threats

The main identified threat to the Australian Painted Snipe (*Rostratula australis*) is the loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs. (Lane and Rogers, 2000) Rogers *et al.* (2005) state that the loss of breeding habitat in the Murray-Darling Basin has occurred through:

- the reduced frequency of flooding in previously suitable habitat, exacerbated by a loss of fresh water to irrigation and other diversions
- water levels being stabilised in remaining wetlands so that water becomes too deep, or continuous reed beds develop

- changes to vegetation through increased cropping, and possibly through altered fire regimes at some sites.

These hydrological changes have occurred in parallel with an extended period of drought in Australia and these conditions have intensified the impacts of wetland degradation and water diversion in the Murray-Darling Basin.

Other threats to the Australia painted snipe include (Department of Sustainability, Environment, Water, 2013):

- grazing and the associated trampling of wetland vegetation/nests
- nutrient enrichment
- reduced rainfall and runoff in the Murray Darling basin associated with climate change.
- predation by feral animals (e.g. nest predation by foxes (*vulpes vulpes*) or cats (*felis catus*))
- coastal port and infrastructure development,
- shale oil mining near autumn-winter sites
- the replacement of native wetland vegetation by invasive weeds.

Survey timing and effort

The survey guidelines for Australia's threatened birds recommend (Department of the Environment Water Heritage and the Arts, 2010b):

- area searches or transects through suitable wetlands (for sites of less than 50 ha when wetland holds water but is not flooded): ten hours over three days
- targeted stationary observations at dawn and dusk within suitable wetlands: ten hours over five days
- spotlight shortly after dusk: survey effort not specified
- no seasonality constraints have been listed.

The survey effort undertaken included:

- active searches totalling 372-person hours were completed over 36.5 days
- 56-person hours of incidental bird surveys over six days.

Australian Painted Snipe in the Project Site

The Australian Painted Snipe (*Rostratula australis*) was observed from an area of flooded *Acacia harpophylla* (Brigalow) woodland within the Project Site during SKM surveys in 2007. The extent of habitat for the species that occurs within the Project Site consists of:

- No preferred habitat is mapped within the Project Site as it does not provide highly productive wetland habitats for foraging or suitable cover and resources to build nests providing breeding habitat for this species. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of preferred habitat in Central Queensland to comprise:

  Shallow permanent or ephemeral freshwater wetlands, which provide areas of bare, exposed wet mud and a mosaic of ground cover (e.g. tufted grass, sedges, small woody plants).

  The presence and/or extent of preferred habitat will be influenced by seasonal conditions (e.g. expansion of permanent wetlands or creation of ephemeral wetland habitat). (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 these areas mapped are considered most important to the species and contain features crucial for species persistence.

- 1,931.88 ha of suitable habitat, primarily occurring as a large patch in the south of the Project Site. Several other medium to large patches are located throughout the middle of the Project Site and are associated with inundated/waterlogged areas. The species was recorded by SKM within an area of suitable habitat in 2007. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of suitable habitat in Central Queensland to comprise:

Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/ waterlogged areas with a variation ground cover (e.g. grasses, shrubs, rushes).

It does not include areas dominated by tall, dense reedbeds associated with stabilised water levels, wetlands that are cropped, and areas of low water quality due to nutrient runoff, agricultural chemicals and turbidity. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

As described in Table 21-25 these areas provide foraging resources when inundated, but the species is unlikely to be undertaking key activities such as breeding or roosting here. The category notes foraging resources may be lower quality or used opportunistically rather than being depended upon. Individuals may be found in suitable habitat, but this habitat type may also remain unoccupied.

- No marginal habitat identified as described in Table 21-25.

Further information on Squatter Pigeon habitat within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report** (AECOM, 2024) and **Appendix C-3 Central Queensland Threatened Species Habitat Descriptions** (Kerswell A, Kaveney T, Evans C and Appleby L., 2020).

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival (HCSS) of the species and therefore the generic *EPBC Act Significant Impact Guidelines 1.1* definition of HCSS has been applied. HCSS includes the habitats that contain features that are crucial for the species' persistence in an area, including for activities such foraging, breeding, roosting or dispersal.

No wetland areas comprising suitable microhabitat requirements for breeding or a persistent foraging resource for the species was observed within the Project Site. Temporally inundated wetlands within the Project Site are considered to provide intermittent foraging habitat only. This suitable habitat present comprises small and isolated patches of which most have been subject to degradation through ongoing cattle grazing. The wetlands present are highly ephemeral, provide limited and temporary resources and do not provide refuge habitat for the species. Based on these factors, no HCSS is present in the Project Site for Australian Painted Snipe (*Rostratula australis*) (refer to Table 21-73).

Table 21-73 Habitat areas comprising HCSS for the Australian Painted Snipe

HCSS Determination	Description of habitat	Total habitat within Project Site(ha)
Habitat included in HCSS	No areas of preferred habitat crucial for the species was identified within the Project Site	-
	Total Area HCSS	**-**
Habitat not included as HCSS	Areas of suitable habitat that are not suitable for key activities such as breeding or roosting. Foraging resources may be lower quality or used opportunistically rather than being depended upon. Individuals may be found in suitable habitat, but this habitat type may also remain unoccupied	1,931.88

Populations

The SPRAT does not identify 'populations' of Australian Painted Snipe (*Rostratula australis*) and consequently, any population potentially occurring within the Project Site has been assessed against the generic definition in the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013). A 'population' of an Endangered species is defined as an occurrence of the species in a particular area. Occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion.

The Project Site is unlikely to support a population given that:

- The species has only been recorded once within the Project Site, despite extensive survey across a number of years. No other records exist for the species within 20 km of the Project Site.
- The paucity of records indicate it is unlikely that a geographically distinct regional population or collection of local populations exists within the Project Site
- Individuals using the Project Site are likely to be vagrants on passage to more suitable breeding or foraging grounds.

Project impacts

There is no HCSS present for the species in the Project Site, however direct and indirect impacts may still occur in non-critical habitat that the species may utilise intermittently within the Project Site.

Direct impacts will be predominantly limited to the construction phase and include habitat loss and/or fragmentation of non-critical habitat (387.13 ha). Throughout operation and decommissioning direct mortality from vehicle strike will remain a risk to the species.

Within the balance of the Project Footprint, subsidence (excluding ponding / inundation) also has the potential to impact Australian Painted Snipe (*Rostratula australis*). Modelling suggests that these impacts may occur across and area of up to 325.84 ha of non-critical habitat. Subsidence may also alter the hydrology, potentially impacting the extent of local catchments, run-off characteristics and intensity of flood flows, which can impact on the condition and stability of wetland habitat. It is possible that increased water ponding as a result of subsidence may have a positive effect by creating a greater extent and more permanent wetland areas, if pools retain their habitat value. Water resources that may be utilised by Australian Painted Snipe (*Rostratula australis*) are either artificial features or ephemeral creeks and wetland areas that do not contain permanent groundwater and as such any drawdown impacts will have little effect on the quality or availability of Australian Painted Snipe (*Rostratula australis*) habitat resources.

Indirect impacts resulting from operational activities are related to areas that will be subject to prolonged ponding / inundation and may subsequently result in a change or loss of species present, particularly woody vegetation sensitive to waterlogging. While vegetation within the modelled subsidence area (excluding deeper depressions subject to ponding) may exhibit isolated occurrences of reduced canopy health or tree loss, surface cracking as a result of subsidence is considered unlikely to result in materialistic impacts to the composition and structure of native vegetation.

Ongoing monitoring of the occurrence of and effects of subsidence will be required to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur.

Indirect impacts during the construction phase consist of habitat degradation and disruption to foraging and dispersal behaviours due to increased light and noise. Inappropriate treatment and / or disposal of hazardous liquid and solid wastes produced from construction activities and accidental spills of hazardous materials (e.g. fuel, chemicals) could result in point-source contamination of surrounding wetland areas.

The Project Site supports populations of feral predators and although it is unlikely that the proposed works will significantly result in further proliferation of these species, clearing may increase the visibility of Australian Painted Snipe (*Rostratula australis*) to these predators. Weed proliferation may also impact the species by reducing the availability of native foraging resources.

Further discussion on operational indirect impacts is provided in Section 21.6.2.2.

Project avoidance, mitigation and management measures

The following mitigation measures specific to potential impacts on Australian Painted Snipe (*Rostratula australis*) will be implemented. Further detail will be provided in the Threatened Species Management Plan:

- where practical, disturbance to wetlands will be minimised
- disturbance zones in wetland habitat suitable for Australian Painted Snipe (*Rostratula australis*) (oxbow wetlands) will be delineated and avoided
- site inductions will include information on the potential presence of Australian Painted Snipe (*Rostratula australis*) (and their habitat) and the management measures to minimise harm
- during construction and operation, direct lighting away from areas of Australian Painted Snipe (*Rostratula australis*) habitat.

Significant impact assessment

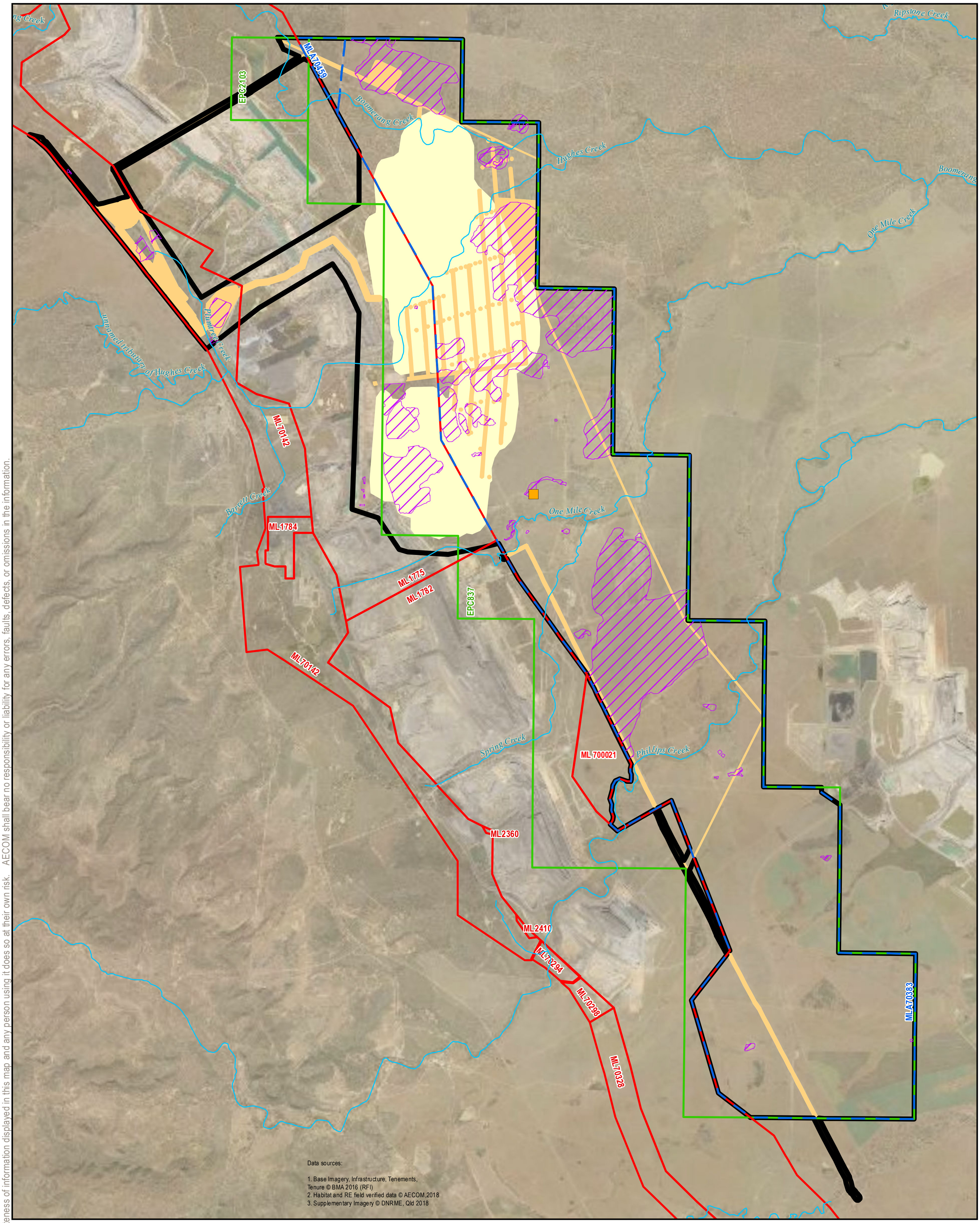
No HCSS is present throughout the Project Site and as such, impacts will only occur to habitat the species uses periodically as it moves to more suitable breeding and foraging resources.

In order to understand the mechanisms by which the suitable habitat might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species under the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a) and is provided in Table 21-74. The assessment concludes that due to the lack of HCSS, the paucity of contemporary records, and with the implementation of mitigation measures proposed in Section 21.7 the impacts of the Project on the Australian Painted Snipe (*Rostratula australis*) are unlikely to be significant.

Table 21-74 Assessment of significance of impacts– Australian Painted Snipe (*Rostratula australis*)

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of a population of a species.	This species was recorded within the Project Site in non-critical habitat (sub-optimal habitat (flooded brigalow)) during SKM surveys in 2007. No other records exist for the species within 20 km of the Project Site. Given the extent of survey that has been conducted within the area and the paucity of records, it is considered unlikely that a geographically distinct regional population or collection of local populations exists within the Project Site and individuals using the site are likely to be vagrants on passage to more suitable breeding or foraging grounds. As such it is considered unlikely that the proposed action will lead to a long-term decrease in a population of the species.
Reduce the area of occupancy of the species.	The area of occupancy of the Australian Painted Snipe (*Rostratula australis*) is estimated, with low reliability, to be 1,000 km². The area of occupancy has undoubtedly declined as approximately 50 per cent of wetlands in Australia have been removed since European settlement. No populations of the species exist within the Project Site, with the species likely to occur only temporally in small numbers and unlikely to rely on the non-critical habitat present in the Project Site for key life history stages. As such it is considered unlikely that the proposed action will reduce the area of occupancy for the species.
Fragment an existing population into two or more populations.	This species was recorded within the Project Site in sub-optimal habitat (flooded brigalow) during SKM surveys in 2007. No other records exist for the species within 20 km of the Project Site. Given the extent of survey that has been conducted within the area and the paucity of records, it is considered unlikely that a geographically distinct regional population or collection of local populations exists within the Project Site and individuals using the site are likely to be vagrants on passage to more suitable breeding or foraging grounds. The species is also highly mobile and moves to suitable habitat if necessary (Marchant and Higgins, 1993). As such it is considered unlikely that the proposed action will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species.	Habitat critical to the survival of the species has not been identified within a recovery plan for this species. HCSS of the species is not considered to be available within the Project Site as preferred habitat is not present and high-quality suitable habitat within the Project Site is very limited. The suitable

EPBC Act criteria	Assessment of significance
	habitat present provides limited foraging opportunities but is unlikely to be relied upon by the species. The Project is unlikely to adversely affect HCSS of the species.
Disrupt the breeding cycle of a population.	Breeding habitat requirements for the species are highly specific and include shallow wetlands, with wet mud, low dense cover and preferably canopy cover. This habitat does not exist within the Project Site and as such it is considered unlikely that the proposed action will disrupt the breeding cycle a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Habitat within the Project Site does not constitute HCSS and is comprises of low quality foraging and dispersal habitat. The species has been recorded once in the Project Site (in 2007) and no other records exist within 20 km of the Project Site. Consequently, the removal of this low quality habitat is considered unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	It is possible that predation by invasive fauna species such as Fox (*Vulpes Vulpes*) and Feral Cats (*Felis catus*) may be a threat to the species, however no evidence currently exists. Both species have been recorded on site however the Project is not expected to exacerbate the population of these species. As such any impacts on any individuals would be minor, particularly following the implementation of a Weed and Pest Management Plan to control and mitigate the establishment of invasive species as a result of the Project.
Introduce disease that may cause the species to decline.	Disease is not listed as a threat to the Australian Painted Snipe (*Rostratula australis*). Implementation of a Weed and Pest Management Plan will help control and mitigate the establishment of invasive species (and associated diseases) as a result of the Project.
Interfere with the recovery of the species.	Population scale movement would be unaffected in the long-term and significant disruptions to breeding cycles and interference to species recovery as a result of the proposed actions are therefore unlikely.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Australian Painted Snipe Habitat Critical to the Survival of the Species (HCSS)

Threatened fauna record

- Australian Painted Snipe (SKM 2012)

Habitat not considered HCSS

- Suitable habitat

N

Figure 21-58
Australian painted snipe potential habitat within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BMA
BHP Mitsubishi Alliance

DATE: 21/11/2024 VERSION: 6

21.8.4.5 Greater Glider

Description and status under the EPBC Act

The Greater Glider (*Petauroides volans*) is listed as Vulnerable under the EPBC Act.

The Greater Glider *(Petauroides volans*) is the largest gliding possum in Australia, with a head and body length of 35−46 cm and a long furry tail measuring 45−60 cm. The Greater Glider (*Petauroides volans*) has thick fur that increases its apparent size. Its fur colour is white or cream below and varies from dark grey, dusky brown through to light mottled grey and cream above. It has large furry ears and a short snout. Its tail is not prehensile (Department of Agriculture Water and the Environment, 2020b).

Distribution

The Greater Glider (*Petauroides volans*) is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1,200 m above sea level. An isolated inland subpopulation occurs in the Gregory Range west of Townsville (Winter *et al.*, 2004), and another in the Einasleigh Uplands (Vanderduys, Kutt and Kemp, 2012).

Habitat requirements

The Greater Glider (*Petauroides volans*) is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. During the day, this species spends most of its time denning in hollowed trees, with each animal inhabiting up to twenty different dens within its home range. It is primarily folivorous, with a diet mostly comprising the leaves and flowers of Myrtaceae (e.g. eucalypt) trees. Home ranges of this species are typically relatively small (one - four ha) but are larger in lower productivity forests and more open woodlands (up to 16 ha) (Threatened Species Scientific Committee, 2016).

Hollows develop extraordinarily slowly in Australian eucalypts, with figures most often quoted as minimum lag times of 150 - 360 years from germination to the beginning of hollow development (Gibbons and Lindenmayer, 2002). A fall in the number of hollows below a minimum critical threshold for Greater Glider (*Petauroides volans*) could cause a decline in any local population and compromise population viability in the longer term if there is not a new cohort of hollow trees available to replace trees lost (Lindenmayer, Cunningham and Donnelly, 1997).

The Greater Glider (*Petauroides volans*) is also considered to be particularly sensitive to forest clearance and to intensive logging. Notwithstanding relatively small home ranges (one - four ha), but in part because of low dispersal ability, this species may be sensitive to fragmentation, have relatively low persistence in small forest fragments, and disperse poorly across vegetation that is not native forest (Threatened Species Scientific Committee, 2016).

Threats

Threats to the Greater Glider (*Petauroides volans*) include:

- habitat loss (through clearing, clearfell logging and the destruction of senescent trees due to prescribed burning) and fragmentation
- too intense or frequent fires
- timber production
- climate change (range contraction)
- barbed wire fencing (entanglement)
- hyper-predation by owls
- competition from sulphur-crested cockatoos
- *phytophthora* root fungus (impacts on the health of eucalypts).

Survey timing and effort

In the absence of species-specific survey guidelines, Eyre *et al.* (2018) was used to determine suitable survey techniques. Survey methods include:

- spotlighting transects (100 x 100 m) per 30-person minutes: survey effort not specified
- no seasonality constraints.

The survey effort undertaken includes:

- a total of 84-person hours of spotlighting of 17 nights
- targeted habitat assessments were conducted for the species throughout the duration of the field surveys.

Greater Glider in the Project Site

The Greater Glider (*Petauroides volans*) was recorded in the south of the Project Site by SKM in 2012. A further 19 individuals were recorded by AECOM in 2020, associated with riparian habitat of Boomerang Creek and Hughes Creek. Several records are available from Atlas of Living Australia approximately 10 km west of the Project Site. The extent of habitat for the species that occurs within the Project Site consists of:

- 190.05 ha of preferred habitat located within the riparian zones, with the habitat supporting a known local population on Boomerang, Plumtree and Hughes Creeks. The species was recorded in the preferred habitat in 2020. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of preferred habitat in Central Queensland to comprise:

  Remnant, connected eucalypt woodlands containing more than 2 hollow bearing trees/ha, with hollows medium-large in size (>10 cm entrance), usually on fertile, wetter soils of riparian zones.

  In central Queensland, preferred foraging and den trees include E. camaldulensis, E. tereticornis, E. fibrosa and Corymbia citriodora. The species has also been observed in Angophora floribunda, Eucalyptus cambageana, E. coolabah, E. crebra, E. laevopinea, E. moluccana, E. orgadophila, E. populnea, E. melanophloia and C. tessellaris in which it may use for foraging and/or denning. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 these areas mapped are considered most important to the species and contain features crucial for species persistence.

- 441.82 ha of suitable habitat located adjacent to the preferred habitat and following the same riparian zones of the creek systems within the Project Site. The species has been recorded in 2020 in suitable habitat near Hughes Creek. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of suitable habitat in Central Queensland to comprise:

  Remnant eucalypt woodlands connected to areas of roosting habitat that does not contain more than 2 hollow bearing trees/ha, medium-large in size (>10 cm entrance). Generally within ~120m of breeding / denning habitat, reflecting the home range of the species. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 these areas provide lower quality and less frequent resources for foraging and breeding/denning.

- 848.95 ha of marginal located outside riparian corridors associated with Phillips Creek and the large area between the Boomerang, Plumtree and Hughes Creeks in the north of the Project, which connects through to the suitable and preferred habitat. The review of literature, SPRAT, conservation advice (TSSC, 2015) and expert elicitation identified the definition of marginal habitat in Central Queensland to comprise:

  Remnant or high value regrowth vegetation adjacent to preferred greater glider habitat where hollows are smaller and/or less frequent. Isolated patches of marginal habitat >100 m from adjacent habitat do not provide habitat for the species due to gliding capabilities.

  Remnant or high value regrowth vegetation on low fertility and low moisture soils, regardless of hollow densities. (Kerswell A, Kaveney T, Evans C and Appleby L., 2020)

  As described in Table 21-25 marginal habitat areas provide limited resources, refuge and gliding opportunities, and while individuals may be detected, the species is unlikely to be undertaking key activities such as breeding or extensive foraging. Individuals are rarely found in this habitat type and it is likely to be unoccupied most of the time.

Further information on Greater Glider within the Project Site is provided in **Appendix C-1 Terrestrial Ecology Technical Report**.

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival (HCSS) of the species and therefore the generic *EPBC Act Significant Impact Guidelines 1.1* definition of HCSS has been applied. HCSS includes the habitats that contain features that are crucial for the species' persistence in an area, including for activities such foraging, breeding, roosting or dispersal.

For Greater Glider (*Petauroides volans*), HCSS is primarily associated with the preferred habitat located within the riparian zones of creeks. This habitat provides key denning (hollows) and foraging resources and has been shown to support individuals. In addition to this, suitable habitat associated with preferred habitat, and providing connectivity between preferred habitat patches, is also considered HCSS. This is due to the habitat being connected, which allows for species dispersal, recruitment and exchange of genetic material. Whereas marginal habitat is mostly previously cleared grazing area with isolated remnant or regrowth vegetation (> 100 m) with much smaller and/or less frequent hollows.

A total of 631.86 ha of HCSS is mapped within the Project Site. A summary of habitat types considered to comprise HCSS and those areas excluded from HCSS are provided in Table 21-75. HCSS for Greater Glider (*Petauroides volans*) is shown on Figure 21-59. Direct and indirect impacts to HCSS was assessed to be significant as per the EPBC Act Significant Impact Guidelines 1.1 (Department of the Environment, 2013a).

Table 21-75 Habitat areas comprising HCSS for the Greater Glider

HCSS Determination	Description of habitat	Total habitat within Project Site(ha)
Habitat included in HCSS	All areas of preferred habitat	190.05
	All areas of suitable habitat	441.81
	Total Area HCSS	**631.86**
Habitat not included as HCSS	Areas of marginal habitat largely disturbed and/or isolated, unlikely to be utilised for key activities such as breeding or extensive foraging	848.95

Important populations

The SPRAT does not identify 'important populations' of Greater Glider (*Petauroides volans*). Therefore, any population potentially occurring within the Project Site has been assessed against the generic definition in the *EPBC Act Significant Impact Guidelines 1.1* (DoE, 2013). Important populations of Vulnerable species are defined as those 'that are necessary for a species' long-term survival and recovery' and may include populations which are:

- key source populations either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range.

The Project Site is not located near the limit of the species range and the population of individuals present are not necessarily unique, isolated or genetically distinct from any other Greater Gliders (*Petauroides volans*) occurring in the region. However, given the high number of individuals recorded, their utilisation of preferred habitat (which contains breeding resources) and the large amounts of habitat present that allow for dispersal through and out of the Project Site, there may be an important population present.

Project impacts

The Project will result in direct impacts to Greater Glider (*Petauroides volans*) HCSS as shown in Table 21-76. Direct impacts will result from habitat loss associated with construction of surface infrastructure and IMG network, and maximum extent of subsidence-induced ponding/inundation during operation.

Table 21-76 Direct impacts to Greater Glider within the Project Footprint

MNES	Project Site (ha)	Project Footprint (ha)	Direct impact (ha)			
			Construction		Operation	Total
			Surface Infrastructure	IMG	Ponding	
Greater Glider HCSS	631.86	267.50	21.83	12.67	4.05	38.55

Indirect impacts during the construction phase consist of habitat degradation and disruption to breeding, foraging and dispersal behaviours due to increased light and noise. The Project Site supports populations of feral predators and although it is unlikely that the proposed works will significantly result in further proliferation of these species, clearing may increase the visibility of Greater Glider (*Petauroides volans*) to these predators.

Habitat of Boomerang, Plumtree, Phillips and Downs Creeks will be fragmented by the transport and infrastructure corridor, potential restricting movement and creating a barrier for individuals. Once operational, surface infrastructure for the Project may impede dispersal movement in a west-east direction and between the north of the Project Site and adjacent habitat.

Up to 228.94 ha of Greater Glider HCSS is mapped within the balance of the maximum extent of subsidence. Effects such as surface cracking is considered unlikely to result in materialistic impacts to the composition and structure of native vegetation and habitat present attributable to the characteristic soils present, resilience of native species and the extent and depth of likely subsidence. Ongoing monitoring of the occurrence of and effects of subsidence will also be undertaken to identify any potential change in vegetation condition and composition within subsidence areas and to allow appropriate management and/or compensatory measures to be implemented if changes occur.

Further discussion on operational indirect impacts is provided in Section 21.6.2.2.

Project avoidance, mitigation and management measures

The following mitigations measures specific to potential impacts on Greater Glider (*Petauroides volans*) have been proposed. Further detail will be provided in the Threatened Species Management Plan:

- clear vegetation in a sequential manner which directs any escaping on Greater Glider (*Petauroides volans*) to adjacent native vegetation
- site inductions will include information on the potential presence of on Greater Glider (*Petauroides volans*) (and their habitat) and the management measures to minimise harm
- incidental sightings of the species will be reported to the site environmental officer (or delegate) where practical.
- limit clearing distance between large eucalypts within mapped habitat of on Greater Glider (*Petauroides volans*) to no greater than 50 m to ensure movement by volplane is still possible
- where clearing distances are larger than 50 m, strategic installation of glider poles or rope bridges will minimise potential impacts to habitat connectivity
- selecting already disturbed areas for crossings of creeks and drainage lines
- minimising the width of clearing required for creek crossings, and particularly retaining tall trees on either side of crossing locations wherever this is safe to do so
- retain trees with large hollows to retain breeding and refuge opportunities and install suitably sized nest boxes in areas where hollows have been removed.

Significant impact assessment

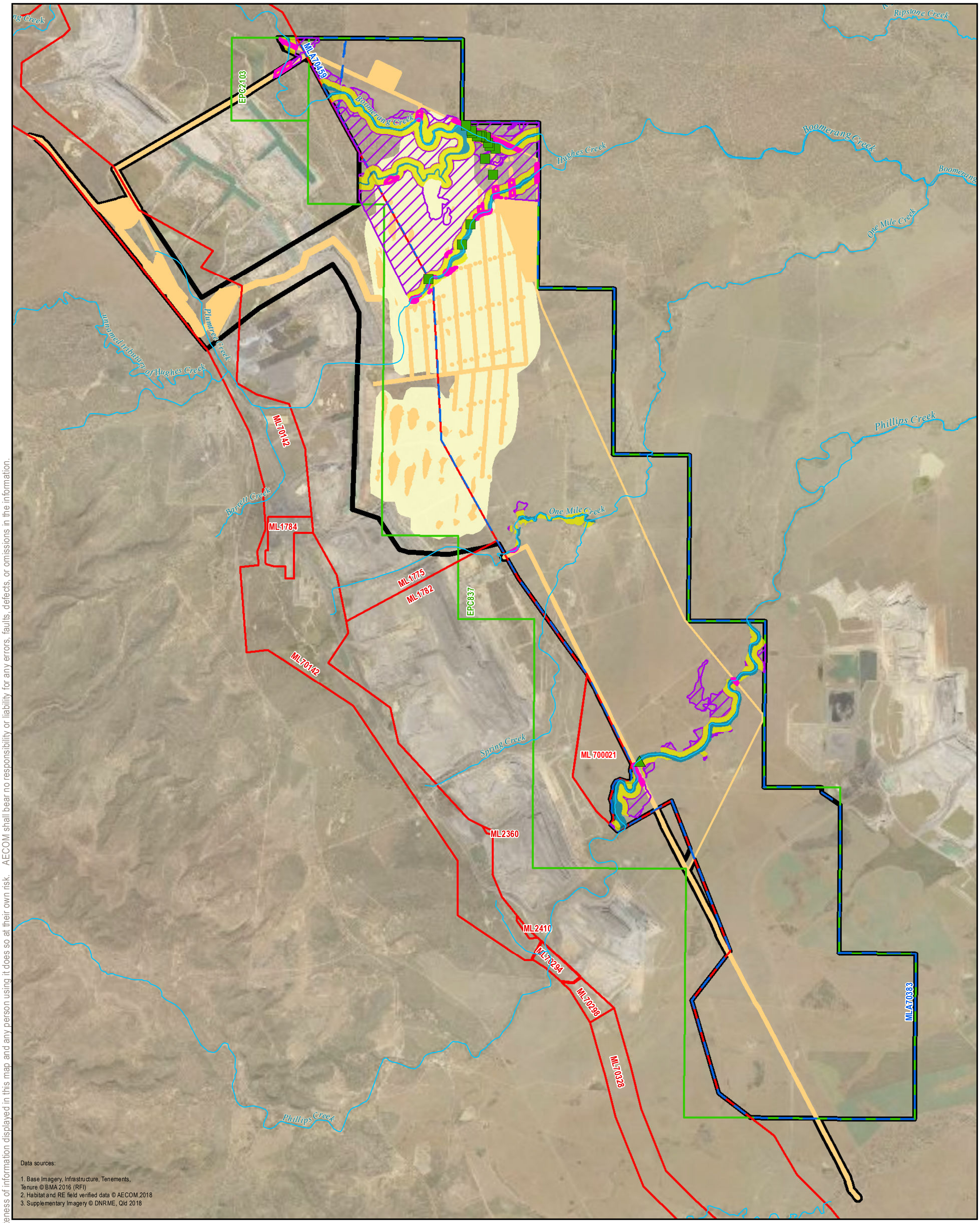
Impacts to HCSS may be considered significant as per the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a). To understand the mechanisms by which the habitat critical to the survival of the species might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species as per the guidelines has been completed and is provided in Table 21-77. The assessment concludes that the Project may have a significant impact on the Greater Glider (*Petauroides volans*) and require compensation by offset (refer Section 21.10).

Table 21-77 Greater Glider – assessment of significance of impacts

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on a Vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species.	'Important populations' have not been defined for this species. Based on the number of individuals recorded within the Project Site and the presence of breeding resources (hollows), it is conservatively considered the Project Site may support an important population of the species. Greater Glider (*Petauroides volans*) shows high site fidelity with large hollow bearing trees a limiting habitat requirement for the species. Individuals were predominantly recorded in the riparian zones of Boomerang and Hughes Creek in the north of the Project Site, with an additional record from the south of the Project Site in association with Phillips Creek. Records within 10 km of the Project Site also exist. With the abundance of hollow bearing trees and connected dispersal habitat allowing for movement through and outside of the Project Site, there is likely to be distribution of the species through the area. Key threats to the species include predation by cats, loss and fragmentation of habitat from vegetation clearing and inappropriate burning regimes, which causes loss of dispersal habitat and loss of large hollow-bearing trees. A long-term decline may occur in the population if mortality rates increase and/or breeding rates decrease beyond that required to sustain the population. It is considered unlikely that the Project would result in either of these scenarios. Approximately 38.55 ha of habitat will be directly impacted, with remaining 228.94 ha of HCSS within the Project Footprint unlikely to be disturbed by indirect impacts of subsidence. Protecting important breeding resources (hollow bearing trees) will be prioritised by: • limiting clearing distance between large eucalypts to no greater than 50 m where practicable to ensure movement by volplane is still possible • where clearing distances are larger than 50 m, the strategic installation of glider poles or rope bridges will be considered to minimise potential impacts to habitat connectivity • selecting disturbed areas for crossings of creeks and drainage lines HCSS will remain present throughout the Project Area and will continue to be available to support the long-term persistence of the species. Connectivity will be maintained as far as practicable. Therefore, while the Project Site may be capable of supporting an important population it is considered unlikely that the proposed action will lead to a long-term decrease in the size of an important population of the Greater Glider (*Petauroides volans*) species.
Reduce the area of occupancy of an important population.	An important population of Greater Glider (*Petauroides volans*) has been conservatively considered to be present in the Project Area. Approximately 85 per cent of HCSS of the species mapped in the Project Area will be retained, and mitigation measures will be put in place to manage impacts to riparian zones and hollow bearing trees in particular. The direct removal of up to 34.50 ha of HCSS during construction and up to 4.05 ha of HCSS during operation will result in local small scale habitat loss and will not reduce the area of occupancy of the species. Most shelter, dispersal and foraging habitat will be retained across the Project Area, and this will remain available to individuals for the life of the Project.
Fragment an existing important population into two or more populations.	Potential impacts include the loss and/or fragmentation of habitat. Fragmentation will occur at creek crossings for the transport and infrastructure corridor and powerline connection and at the gas collection lines within the IMG

EPBC Act criteria	Assessment of significance
	network. This may locally restrict movement of the species, particularly where the clearing impact width exceeds the maximum volplane distance of the species. The species is already known to occur within the riparian zones of both the north and south of the Project Site. Mitigation measures will be utilised to maintain as much connectivity through the Project Site as possible. Consequently, it is considered unlikely that an existing 'important population' will be fragmented into two or more populations.
Adversely affect habitat critical to the survival of a species.	HCSS consists of preferred habitat and suitable habitat in association with the preferred habitat providing connectivity between preferred habitat patches. The Project will result in the direct clearing of 34.50 ha of HCSS during construction and up to 4.05 ha of HCSS during operation associated with the maximum extent of ponding/inundation. These impacts are likely to be adverse to HCSS.
Disrupt the breeding cycle of an important population.	Breeding resources have been identified within the Project Site associated with areas with an abundance of medium to large hollows. Females give birth to single young from March to June and their relatively low reproductive rate may render isolated populations in small remnants prone to extinction. This is not considered to be relevant to the Project Site as the direct impact footprint will not result in the creation of small remnants of HCSS. There is a risk of disruption to the breeding cycle from fragmentation if overlapping male and female ranges are separated by and are no longer able interact as an integrated population unit. This is considered unlikely as mitigation measures will be implemented to retain breeding resources and connectivity, including limiting clearing distances and supplying glider poles and nest boxes. Therefore, the proposed action will not disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	An estimated 38.55 ha of HCSS may be impacted directly by the Project, including 34.50 ha of construction impacts and 4.05 ha associated with the maximum modelled extent of ponding impacts. The remaining 228.94 ha of HCSS within the maximum modelled extent of subsidence is unlikely to be significantly disturbed by indirect impacts. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. However, given the scale of confirmed unavoidable impact and the known presence of the species within the Project Site, it is possible that the Project will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Marginal habitat is not considered HCSS and therefore, Project impacts (directly or indirectly) on this habitat type are not considered to result in or contribute to the species decline.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	Invasive species have not been identified as a known threat to the Greater Glider (*Petauroides volans*) and it is unlikely that the introduction of invasive species not already present will impact the Greater Glider (*Petauroides volans*). The implementation of a Weed and Pest Management Plan will help to control and mitigate the establishment of invasive species as a result of the Project.
Introduce disease that may cause the species to decline.	It is unlikely that the introduction of disease will impact the Greater Glider (*Petauroides volans*), as disease has not been identified as a major threat to the species. The implementation of a Weed and Pest Management Plan will help to control and mitigate the establishment of invasive species and associated diseases as a result of the Project.
Interfere with the recovery of the species.	The SPRAT profile identifies that a Recovery Plan for the Greater Glider (*Petauroides volans*) is required; however, no such plan exists at the time of this report. Known threats to the species include habitat loss, high intensity or frequency fires, timber production, climate change, barbed wire fencing, hyper-predation by owls, *Phytophthora* root fungus, and competition from sulphur-crested cockatoos for suitable hollows. In Queensland, there are no species-specific management actions currently in place for the Greater Glider (*Petauroides volans*). An estimated 38.55 of HCSS may be impacted directly by the Project, including 34.50 ha of construction impacts and 4.05 ha associated with the maximum modelled extent of ponding impacts. The remaining 228.94 ha of HCSS within

EPBC Act criteria	Assessment of significance
	the maximum modelled extent of subsidence is unlikely to be significantly disturbed by indirect impacts. Ongoing monitoring of the occurrence of and effects of subsidence will be required to verify if habitat is impacted. The species is mobile and areas of habitat will remain across the Project Site that will continue to provide key habitat resources, as well as facilitate the movement of the species to high value preferred habitat outside of the Project Site. Individual areas of impact from indirect impacts may be small in extent, and in isolation would not constitute an adverse impact on the species habitat. The Project is unlikely to interfere with the recovery of the species.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Watercourse

Threatened fauna record

- Greater Glider (AECOM 2020)
- Greater Glider (SKM 2012)

Greater Glider Habitat Critical to the Survival of the Species (HCSS)

HCSS

- Preferred Habitat
- Suitable Habitat
- Significant impact area

Habitat not considered HCSS

- Marginal Habitat

N

Figure 21-59
Greater Glider potential habitat within the Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:110,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP Mitsubishi Alliance

DATE: 22/11/2024 VERSION: 7

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21.9 Significant residual impacts

21.9.1 Water resources

Significant residual impacts of the Project on water resources are assessed in Table 21-78. Unmitigated and residual risks are evaluated in accordance with the ratings for likelihood (Table 21-79) and consequence (Table 21-80) to determine risk rating (Table 21-81).

21.9.1.1 Surface water

Four ephemeral upland streams represent the receiving environment of the Project with potential to be impacted by mining; Boomerang Creek, Hughes Creek One Mile Creek and Hughes Creek. Phillips Creek also traverses the Project Site but south of the proposed mining activities.

The creeks within the Project Site are part of the far upstream headwaters of the Isaac River catchment which flows into the Fitzroy River. The total catchment area for all creeks and tributaries upstream and within the Project Site is approximately 590 km^2. Therefore, the total catchment area represents less than three per cent of the Isaac River catchment and approximately 0.4 per cent of the Fitzroy River catchment (142,665 km^2).

BMA operates a water pipeline network in Central Queensland, servicing its mines, landholders and towns. BMA holds contractual rights to approximately 10,000 mega litres per year (ML/yr) of water from the Burdekin Pipeline (owned by SunWater) as a supply source for BMA operations in the vicinity of Moranbah. The Lower Fitzroy River and Fitzroy Barrage Water Supply Schemes have 28,621 ML and 62,335 ML of allocated water, respectively.

The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are approximately 250 km downstream of the confluence with Isaac River. The total catchment area upstream and within the Project Site is less than 0.4 per cent of the total catchment area for these water supply schemes. Therefore, the Project is not expected to impact these water supply schemes.

The Project's raw water supply will be linked to the existing Water Management System for SRM. While it is planned to reuse MAW whenever possible, raw water is still required for those consumptive demands for which MAW is not suitable, or for when supplies of MAW are unavailable.

Potential impacts associated with WMS failure, controlled or uncontrolled discharge and contamination of surface water quality can be effectively mitigated through design, engineering, operational controls and monitoring to reduce residual risk.

Due to subsidence, some panel catchments will temporarily pond water until they fill and spill. Remedial drainage works will mitigate persistent ponding, reduced water quality and impacts on natural flow regimes effectively ensuring a permanent free-drainage landform. Over time, subsided panels will naturally fill with sediments and ephemeral wetlands will slowly accrete; the time will depend on the volumes and sediment transport capacity of the watercourses. Subsidence impacts are expected to be effectively mitigated through adaptive management with ongoing monitoring of subsidence effects.

21.9.1.2 Groundwater

The Project is situated within the Isaac River sub-basin of the Fitzroy Basin. The land use surrounding the Project is predominantly coal mining and cattle grazing. From a hydrogeological perspective, the assessment of available groundwater resources (potential and chemistry) indicates that the only recognised groundwater use within the Project area is stock watering. The groundwater quality data across the site is variable and ranges from brackish to saline, generally marginally suitable for livestock.

Terrestrial GDEs along Phillips Creek and to the east of the Project Area along Hughes Creek are not predicted to be impacted by the Project as they are associated with the alluvium, which is not predicted to be impacted. There are no known aquatic GDEs. No known springs are present within the Project Area.

Groundwater impacts from the approved open-cut SRM operations and the Project underground mining was modelled by SLR in 2023. Given that the underground mine and open-cut mine are intrinsically linked through drawdown contour overlap, operational scheduling overlap and proximity, impacts from underground mining were assessed by simulating continuous operation of the open-cut and underground mining operations. This approach means that drawdown contours and impacts from underground mining were considered as cumulative impacts with the SRM open-cut mining.

To estimate Project mine impacts and estimates of groundwater ingress from underground longwall mining activities, subsidence modelling simulated changes in stress and induced deformation of surrounding rock mass associated with rock fractures and bedding plan separation. These predictions included:

- When overburden thickness is less than 300 m above the target D coal seam, the subsidence modelling results show continual volumetric strain and rock mass damage in the overburden strata extending from longwall edge to the surface.
- When the overburden thickness is more than 300 m, the results indicate that the fractured zone extends to above 30 m to 50 m above the Harrow Creek seam with the overlying units undamaged.

Even in the scenario where modelling assumed no self-sealing of subsidence fracturing over time, no impact on alluvium or surface water resources is predicted. This approach is considered conservative given the overlying Tertiary sediments, particularly those at the surface zone, swell and self-seal over time, and therefore any surface cracks fill with sediments reducing their hydrological effect over time. This phenomenon is recognised in the Bowen Basin, as evident at the Goonyella Broadmeadow Riverside Mine complex, where water ponding occurs above subsided areas.

Predictive modelling of groundwater level drawdown in the alluvium, Tertiary, and the target D seam, as a result of the Project, indicated:

- No impact on alluvium groundwater resources are predicted due to the Project.
- The drawdown predictions are influenced by the distribution of saturated zones in the Tertiary. At the northern panels, 1 m drawdown influence is predicted to extend 4.2 km northeast of the Project mine workings.
- The extent of maximum predicted incremental drawdown impacts in the Moranbah Coal Measures coal seams are generally elongated along strike in the northwest-southeast direction and extents maximum of 5 km and 8 km northwest and southeast of the Project mine extent, respectively.

The inflows at the Project are predicted to reach a maximum peak in mine year 16, of 500 ML/year (1.4 ML/day). The average inflow rate for the Project is estimated at 183 ML/year (0.5 ML/day). This impact is not considered to be significant due to the absence of privately owned bores in the drawdown areas.

Impacts of the mine dewatering associated with the proposed underground workings, considered in connection with the approved SRM open-cut operations, are considered low for the following reasons:

- Surface water creeks in the area are ephemeral and groundwater levels (more than 17 m below surface) are below the level that would provide baseflow to existing alluvium or to root zone of plants.
- Groundwater level drawdown will occur predominantly within the Permian coal seams, which are separated from surficial groundwater regimes by clay-rich Tertiary cover, Permian age aquitard interburden, and are not expected to impact surface ecosystems.

It is unlikely that a significant dewatering impact will occur on ephemeral creeks crossing the Project with no impacts predicted to Phillips Creek or Isaac River to the east. The surface water systems are separated from the predicted impacted groundwater resources by low permeable self-sealing Tertiary sediments, which reduce the potential for the Project to impact on surface water flows. The alluvium is of limited extent, discontinuous and dry in most bores.

Only one landholder water supply bores is located within the predicted drawdown as a result of the Project. This registered bore, RN132631 (duplicate RN136689) is 328 m deep and is complete within the Fort Cooper Coal Measures. No predicted induced drawdown, from the Fort Copper Coal Measures to the target Moranbah Coal Measures, due to interbedded low permeable aquitards is predicted as a result of the Project.

Groundwater levels within the Project are predicted to recover to 176.5 mAHD in the long term, the simple comparison of groundwater recovery levels in the Project and long-term levels associated with the SRM post-closure indicates groundwater flow will be towards the final void where the Coolibah / Dogwood final void water level is predicted to be 7 to 24 mAHD, which is > 100 m lower than surrounding recovered groundwater levels.

Long term groundwater levels are therefore predicted to be influenced by the SRM final voids, which act as groundwater 'sinks' because of water loss through evaporation. This generation of deep water levels below the alluvium and Tertiary age sediments and within the target coal seams, results in localised cones of drawdown immediately around the final voids.

The predictive groundwater modelling also included a no mining within the region model scenario. This scenario aided in the evaluation of predicted cumulative drawdown impacts. Post-closure, the approved SRM open-cut final voids will be in place (for this Project the void created in the last year of open cut mining will remain open). Groundwater level recovery, with the consideration of the open-cut pits, is expected to be slow (due to low hydraulic properties of the host rock, recharge, and increased evaporation in the open-cut pits).

Groundwater aquifers will continue to flow into the SRM final voids until a steady state is achieved. Evaporation losses from the final voids are considered to exceed predicted groundwater inflow and hence the final voids are expected to remain mainly dry, except following prolonged heavy rainfall events. In this case, ongoing evaporation from these final voids will essentially act as long-term groundwater extractions from within the mine area, with the potential to permanently reduce local groundwater levels to the base of proposed final voids.

During this period the loss of water from the Tertiary and Permian aquifers are not expected to have a significant impact on beneficial use or natural ecosystem values as evidenced by SRM having been operating since the 1970s and groundwater resources adjacent to the mine do not indicate material impact to groundwater levels or yields.

The groundwater model was used to provide a prediction of long-term groundwater level variation and recovery, as included in Section 21.3.1.2, Section 21.6.1.2, and Section 21.8.1.2. For this long-term prediction, SRM open-cut operations are assumed to cease when the open-cut pits reach the ML boundaries and all underground mining will cease at the end of FY20 (2042) in line with the current open-cut approvals and the proposed Project life of mine.

As presented in Figure 21-46, it is predicted that there be marked recovery of groundwater levels for the first 100 years following cessation of underground mining, followed by slow recovery. Predictive modelling indicates the groundwater system will reach equilibrium approximately 1,800 years post-mining due to:

- Recovery is slowed drawdown because of on-going extraction (through evaporation) from the open-cut final voids
- The marked groundwater rebound is considered to occur within the goaf and underground workings until water reaches the open-cut final voids
- Limited rainfall recharge over the region
- The long term mine dewatering (since 1974) has resulted in groundwater being removed from storage which needs to be replaced
- High evaporation (due to large final void areas) is expected to remain after 2031 (across the approximately 22.5 km strike length of the open-cut mine)
- Low permeability within the sediments surrounding the open-cut pits.

A hydrograph showing the drawdown and recovery pattern for the target D seam at the location of monitoring bore MB20SRM03P, located within the Project footprint is shown in Figure 21-60.

Groundwater is predicted to rebound following cessation of mining in FY20 (2042), but the rate of recovery is influenced by the natural limited groundwater resources and mechanisms plus the final voids in the SRM open-cut pits.

During the slow recovery to equilibrium, approximately 1,800 years post-mining, deeper groundwater levels are recognised as residual impacts which will reduce available drawdown (water column within neighbouring bores within the zone of influence of the Project). Reduced available drawdown can reduce the bore capacity (extraction volumes and bore yields).

It is noted from the assessment of the impacts on existing groundwater bores (Section 21.6.1.2) concluded it unlikely the Project will have any material impacts on existing groundwater users.

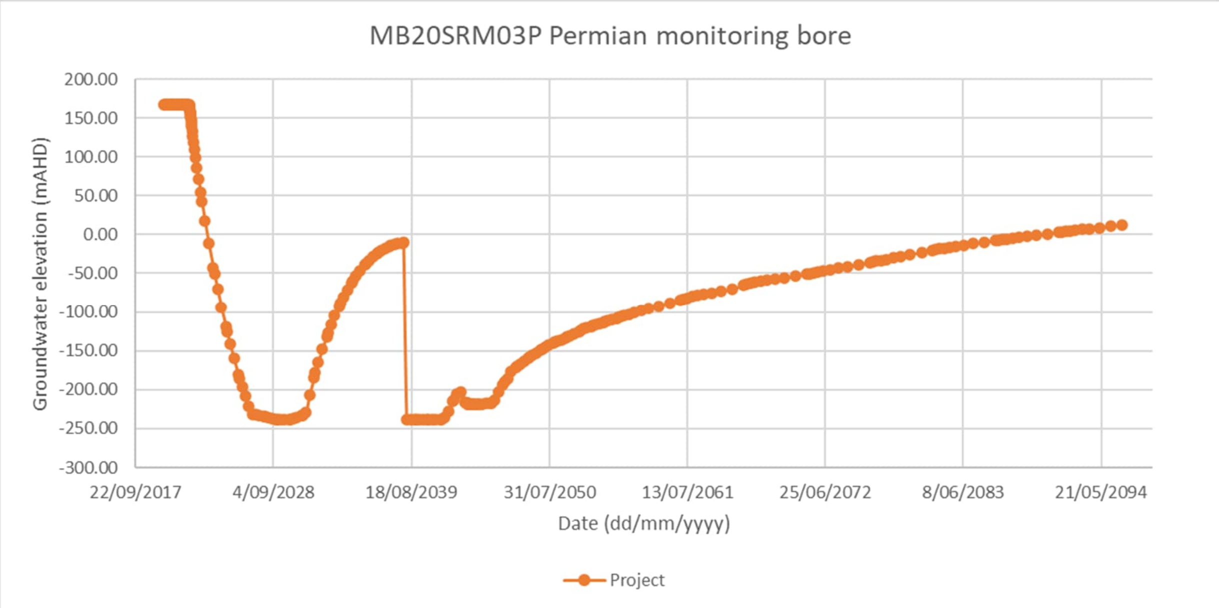

Figure 21-60 Simulated hydrograph for MB20SRM03P

Table 21-78 Water resources residual risk assessment

Potential impact	Unmitigated risk			Mitigation	Residual risk		
	Likelihood	Consequence	Risk rating		Likelihood	Consequence	Risk rating
Surface water							
WMS failure	Possible	Catastrophic	High	Section 21.7.1.1	Unlikely	Catastrophic	High
MAW	Possible	Major	High	Section 21.7.1.1	Possible	Major	High
Water quality (salt)	Possible	Major	High	Section 21.7.1.1	Unlikely	Moderate	Medium
Subsidence	Likely	Major	High	Section 21.7.1.1	Likely	Major	High
Erosion and sedimentation	Likely	Moderate	High	Section 21.7.1.1	Unlikely	Minor	Low
Chemicals and contaminants	Likely	Major	High	Section 21.7.1.1	Unlikely	Minor	Low
Flooding	Possible	Moderate	Medium	Section 21.7.1.1	Rare	Moderate	Low
Flooding of mine infrastructure	Possible	Moderate	Medium	Section 21.7.1.1	Rare	Moderate	Low
Groundwater							
Dewatering	Almost certain	Moderate	High	Section 21.7.1.2	Almost certain	Minor	Medium
Geology	Almost certain	Moderate	High	Section 21.7.1.2	Almost certain	Minor	Medium
Groundwater drawdown	Almost certain	Moderate	High	Section 21.7.1.2	Likely	Minimal	Medium
Bore trigger thresholds	Likely	Major	High	Section 21.7.1.2	Unlikely	Minimal	Low
Water quality alteration	Likely	Major	High	Section 21.7.1.2	Unlikely	Moderate	Medium
Surface water-groundwater interaction	Unlikely	Moderate	Medium	Section 21.7.1.2	Rare	Moderate	Low
Increased groundwater ingress	Likely	Moderate	High	Section 21.7.1.2	Rare	Moderate	Low
Impacts on GDE and springs	Rare	Major	Medium	Section 21.7.1.2	Rare	Moderate	Low

Table 21-79 Likelihood criteria

Likelihood	Description
Almost certain	Expected to occur in most circumstances; 9/10
Likely	May occur in most circumstances; 1/10
Possible	Might occur at some time; 1/100
Unlikely	Could occur at some time; 1/1,000
Rare	May occur in exceptional circumstances; 1/10,000

Table 21-80 Consequence criteria

Consequence	Description
Catastrophic	Fatality/extinction, multiple major incidents; >$1M; offsite impact, remediation; Government intervention
Major	Regional/long term injury/illness; >$250K to $1M; onsite impact, remediation; media intervention
Moderate	Local long term/Restricted work; >$10K to $250K; release at/above reportable limit; owner intervention
Minor	Local short term/medical treatment; >$1K to $10K; release below reportable limit; community attention
Minimal	Insignificant effect; First Aid; </=$1K; small release contained onsite; individual complaint

Table 21-81 Risk assessment matrix

Likelihood	Consequence				
	Minimal	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

21.9.2 Threatened species and ecological communities

The significant impact assessment corresponds to an EIS assessment scenario defined for the purpose of estimating maximum extent of direct unavoidable losses of biodiversity values resulting from the Project. The layout and disturbance footprint of surface infrastructure, powerline and pipeline corridors, and the underground mine layout will be further refined and minimised during a subsequent detailed design process.

Significant impacts have been assessed based on direct impacts correlating with Project stages:

- Stage 1 (Year 1-2) relates to direct impacts anticipated during construction:
  - Surface infrastructure, and transport, powerline and pipeline infrastructure
  - IMG drainage network.
- Stage 2 (Year 2-20) relates to direct impacts anticipated during operation:
  - Maximum modelled extent of ponded areas in the subsided landscape.

Previous assessments of underground mine layout have been enhanced by applying the temporal and spatial distribution of subsidence-related impacts rather than assessment of potential impacts of a worst-case scenario of 100 per cent uniform disturbance from each Project stage. Assessment of potential for significant impacts to vegetation and habitat values is based on the location and timing of subsidence effects, particularly persistent ponding in the landscape, which will be subject to remedial drainage works to ensure a permanent free-draining landscape.

BMA will use sensitive design and site selection to avoid high-value environmental areas for the protection of MSES and MNES, where practical opportunities exist. For TEC and threatened species, a significant impact has been determined based on:

- communities and species evaluated to be significantly impacted by the Project
- the extent of adverse impact that will remain following the development of the Project.

TEC and threatened species with potential to be significantly impacted includes *Acacia harpophylla* (Brigalow) TEC, Koala (*Phascolarctos cinereus*), Squatter Pigeon (Southern) (*Geophaps scripta scripta*), Ornamental Snake (*Denisonia maculata*) and Greater Glider (*Petauroides volans*). The quantified extent of predicted significant impacts on MNES for the Project are presented in Table 21-82.

Significant impacts will be compensated by suitable offset requirements. A vegetation condition monitoring program with baseline performance targets will be conducted to support and inform the actual extent of residual impacts. The monitoring program will assess the extent and condition of MNES prior to and post disturbance (clearing and subsidence) for each Project stage to identify the net loss of values, and inform baseline for reinstating values through rehabilitation or land-based offsets.

Table 21-82 Predicted significant impacts on MNES requiring offset

MNES	Predicted significant impact area (ha)		
	Stage 1	Stage 2	Total
Brigalow TEC	53.49	9.84	63.33
Squatter Pigeon	73.06	40.52	113.58
Ornamental Snake	331.96	54.22	386.18
Koala	84.00	52.33	136.33
Greater Glider	34.50	4.05	38.55

21.10 Offset strategy

BMA is committed to reducing potential impacts on MNES through further avoidance, mitigation and management measures during construction, operation and decommissioning phases of the Project. Recognising there will be a direct loss of sensitive habitat for MNES (Table 21-82), an offset will be provided as a secondary measure to ameliorate residual impacts.

An Offset Strategy has been prepared for the Project as part of the EIS (attached as **Appendix C-2**) as guided by the EPBC Act and EPBC Act Environmental Offsets Policy 2012 (refer to Section 21.2). The objective of the Offset Strategy is to outline BMA's proposed approach to deliver an offset to provide compensatory measures for significant impacts resulting from the Project.

BMA has progressed a preliminary assessment of suitable offset sites available within the Brigalow Belt Bioregion for the maximum predicted significant impacts likely to result from the Project. Final offset requirements are subject to the final clearing footprint, Bio-condition and habitat quality assessment and approval from the DCCEEW.

The approach to identifying, securing and managing these offsets is detailed below.

21.10.1 Offset requirement

While mitigation and management measures for direct and indirect impacts in Section 21.9.2 focus on maximising retention of MNES values across the Project footprint, significant impacts on TEC and listed threatened species are likely to occur. Maximum predicted significant impact is based on:

- TEC and species evaluated to be significantly impacted by the Project
- the extent of adverse impact remaining following the development of the Project.

Within the Project Site this comprises area of direct impact on the habitat that is most important to the species or ecological community and therefore triggered a significant impact for:

- Brigalow TEC (Section 21.8.2.1, shown in Figure 21-51)
- Squatter Pigeon (Section 21.8.4.1, shown in Figure 21-55)
- Ornamental Snake (Section 21.8.4.2, shown in Figure 21-56)
- Koala (Section 21.8.4.3, shown in Figure 21-57)
- Greater Glider (Section 21.8.4.5, shown in Figure 21-59).

The quantified extent of maximum predicted significant impacts on MNES for the Project are summarised in Section 21.9.2 and 21.9 are based on a worst-case scenario or maximum predicted disturbance from each Project stage:

- Stage 1 (Year 1-3) – comprises the offsetting of the significant impacts as a result of construction of surface infrastructure and the IMG network. This stage also accounts for identified fragmentation (indirect) impacts to Brigalow TEC resulting from the construction.
- Stage 2 (Year 3-20) – comprises the offsetting of the significant impact as a result of the predicted extent of ponding due to subsidence.

In the context of this Project, the presence and configuration of habitat types (preferred, suitable, marginal), allows for a robust consideration of the sensitivity, value, and quality of the environment which is impacted (as discussed for each relevant species below). A conservative approach to considering the intensity, duration, magnitude and geographic extent of the impacts has been taken by assuming a worst-case scenario and conservative impact assessment approach for each stage.

21.10.2 Offset approach

BMA is committed to reducing potential impacts on MNES through avoidance and mitigation measures, with offsets employed as a secondary measure to ameliorate significant impacts. Prior to commencement of any ground disturbance for the Project an appropriate offset site for Stage 1 activities will be identified and an offset package developed for regulator approval. The process will consist of the following steps.

- conduct site habitat quality analysis of disturbance area ('impact area').
- identify suitable offset site or sites sufficient to acquit the offset area required for each matter (include land-based, financial payment and co-location opportunities where appropriate) and conduct site habitat quality analysis to confirm the identified site(s) meets the requirements. Calculate the offset area required for each matter using the relevant offset calculator (EPBC Act

offset calculator or EO Act land-based offsets multiplier calculator) offset options, including land-based, financial payment and co-location opportunities.

- prepare an Offset Area Management Plan (OAMP) for each offset site for approval by the regulator.

Following execution Stage 1 activities an accounting process will be completed to compare predicted disturbance extent with actual (in particular for subsidence related impacts, which are based on modelling) such that the extent of offset areas for each matter can be reconciled and confirmed appropriate. Where accounting determines there is a surplus or deficit in the offset secured during Stage 1 the offset developed for Stage 2 impacts will provide an opportunity to adjust where necessary.

Conduct habitat quality analysis for impact area

The EIS has identified matters that will be significantly impacted (as described in this strategy) which represents the maximum disturbance area to be disturbed during Stage 1 and Stage 2. Calculations in this strategy represent a conservative estimate of the likely actual losses.

Terrestrial habitat quality analysis for the Stage 1 impact area will be undertaken through site specific surveys to verify the baseline condition of the disturbance area and define the starting quality scores for the 'impact area' for the relevant offset calculators.

Habitat quality analysis for the impact area will use the habitat quality scoring methodology as per the Queensland Government Guide to determining terrestrial habitat quality (DEHP, 2017) to inform the Commonwealth offset habitat quality calculation requirements. The guide outlines the specific methodology for assessing habitat quality, which is determined by three indicators – site condition, site context and species habitat index. There is no stipulated Commonwealth method for assessing the three components of habitat quality. The terrestrial habitat quality scoring methodology will calculate the Commonwealth habitat quality inputs for the Offsets Assessments Guide (OAG) (Commonwealth Government, 2012).

The linkages between the EPBC Act offsets assessment guide habitat quality components and the Queensland guide are outlined in Table 21-83.

Table 21-83 Comparison of Commonwealth and Queensland habitat quality indicators

Commonwealth habitat quality components	Queensland habitat quality indicators
Site condition: This is the condition of a site in relation to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.	Site condition: A general condition assessment of the following vegetation attributes compared to a benchmark: • Canopy height and cover • Shrub cover • Species richness • Recruitment • Number of large trees • Coarse woody debris • Native perennial grass cover and organic litter
Site context: This is the relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species or ecological community. This includes considerations such as movement patterns of the species, the proximity of the site in relation to other areas of suitable habitat, and the role of the site in relation to the overall population or extent of a species or community.	Site context: An analysis of the site in relation to the surrounding environment based on the following landscape attributes: • Patch size • Connectedness • Patch context • Ecological corridors

Commonwealth habitat quality components	Queensland habitat quality indicators
Species stocking rate: This is the usage and/or density of a species at a particular site. The principle acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and/or context. It includes considerations such as survey data for a site in regards to a particular species population or, in the case of a threatened ecological community this may be a number of different populations. It also includes consideration of the role of the site population in regards to the overall species population viability or community extent.	Species habitat index: The ability of the site to support a species based on the following factors: • Presence and severity of threats to the species • Quality and availability of food and foraging habitat • Quality and availability of shelter • Species mobility capacity • Role of the site to the species overall population in the State

Identify offset area and confirm suitability

At the offset area (identified by desktop analysis) habitat quality will be measured within assessment units defined through a strategic combination of indicators that measure the overall viability of the site and its capacity to support assessment of habitat quality in line with the framework for Commonwealth offset habitat quality calculation requirements. The key indicators for determining habitat quality of an offset site are:

- Site condition: condition of a site in relation to the ecological requirements of a threatened species or ecological community.
- Site context: relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species or ecological community.
- Species stocking rate: usage and/or density of a species at a particular site.

The outputs of the habitat quality measured at both the impact and offset areas will be utilised for implementation of the EPBC Act offset calculator and/or EO Act land-based offsets multiplier calculator to assess and confirm suitability of the offset area chosen.

An assessment of potential offset availability for land-based offsets has been undertaken using a spatial analysis. The methodology and results of this assessment are outlined in Section 21.10.4.

Prepare an Offset Area Management Plan

The OAMP will be prepared for each Stage to present results of the habitat quality assessments for the impact area and the offset area identified. The OAMP(s) will:

- define the offset mechanism to be used for the Project Stage
  - identify the properties that will be secured as offsets, their locations and contribution towards offset requirements
  - identify those offset requirements that will be secured through the provision of other offset lands
  - identify offset requirements that will be secured through an offset payment
  - identify any indirect offset proposals
- detail conservation outcomes and performance criteria, including interim milestones
- document ongoing management actions and risks, and processes for corrective actions
- detail monitoring, reporting and review requirements.

Prior to construction, BMA will develop, submit and implement the OAMP. The OAMP will be periodically reviewed for consistency against the EPBC Act EO Policy (2012). Annual reporting will be undertaken to assess the progress of the offset area against biodiversity objectives. The Commonwealth has introduced requirements for compliance reporting and auditing of the OAMP(s), with which BMA will comply as directed.

Offset Area Management Plan approval

The Project OAMP will be submitted to Regulator for approval prior to the commencement of any disturbance activities.

21.10.3 Offset delivery

Delivery strategy

The key steps for provision of both Stage 1 and 2 offsets are summarised in the graphic below.

Prior to commencement of mining	Construction (Stage 1 disturbance)	Prior to commencement of Stage 2	Operation (Stage 2 subsidence)
➔ Detailed design activities to refine/confirm Stage 1 impact area ➔ Stage 1 impact area and offset site detailed surveys (to capture habitat metric data) ➔ Develop and seek approval for Stage 1 OAMP ➔ Secure Stage 1 offset property(s) in accordance with OAMP	➔ Surface infrastructure and IMG drainage network disturbance ➔ Minimise disturbance footprint where possible ➔ Ongoing management and monitoring of Stage 1 offset property in accordance with OAMP	➔ Quantify actual Stage 1 disturbance for comparison with predicted ➔ Stage 2 impact area and offset site detailed surveys (to capture habitat metric data) ➔ Develop and seek approval for Stage 2 OAMP ➔ Secure Stage 2 offset property in accordance with OAMP	➔ Commence underground mining ➔ Minimise ponding related disturbance utilising drainage management measures ➔ Ongoing management and monitoring of Stage 1 and 2 offset property(s) in accordance with OAMPs

Management actions

Through the implementation of management actions, the condition of the vegetation and offset values within the offset sites will be improved from the baseline habitat quality to achieve the completion criteria within 20 years of commencement of the OAMP(s) and the offset area will be secured for the life of the approval, for the purposes of an environmental offset.

Context improvement will be achieved through the management of the broader property to reduce the likelihood of edge effects, weed invasion and provides security to the habitat connectivity in place. For example, a controlled grazing regime may be introduced as part of the OAMP(s) based on local conditions and knowledge and conform to the published science on grazing in native woodlands and grasslands. Through active management it is anticipated that the selected offset area(s) will provide continued and improved fauna colonisation, particularly through the management of grazing pressure and the control of feral animals.

To achieve the desired conservation outcomes for the offset areas, BMA will implement management actions and restrictions tailored to threats to the MNES with consideration of relevant threat abatement plans. Specific species management measures will be outlined in the OAMP once the offset site(s) is selected and values/threats confirmed. These management actions will be further developed in the OAMP with consideration of activities required to set up the offset and ongoing measures required to maintain and progress to offset toward completion criteria.

To set up the offset activities such as below may be required:

- install access controls – e.g. fencing to restrict informal access, signage
- determine controlled grazing regime to prevent impacts to microhabitat features – suitably qualified person to determine appropriate grazing regime (e.g., no grazing, low intensity grazing). In development of the regime responsibilities for specific actions will be identified and communicated
- capture baseline data with respect to diversity and abundance of weed and pest communities

- determine interim and final completion criteria
- install species specific infrastructure if required (e.g. water points)
- select monitoring points and undertaken baseline data capture (e.g. photograph monitoring points, BioCondition).

Management actions likely to be detailed in the OAMP for implementation throughout the offset period:

- routine monitoring and inspections to allow for management actions to be implemented in response to any risks identified
- inspection/repair of infrastructure following extreme weather events and assessment of status in the event changes in management are required (e.g. change grazing regime, alter restoration action plans)
- pest control measures – specific measures determined through routine inspection outcomes across the offset area. May require coordination with surrounding properties.
- management of fire risk through management of fire breaks and fuel loads (if required)
- revegetation and supplementary planting (for areas of non-remnant vegetation).

The responsibility of the offset sites will ultimately be with BMA who will appoint suitably qualified personnel to undertake management and monitoring requirements within the offset sites. Management measures will be amended as necessary in response to regular reviews, monitoring results and changes in legislation. With routine management activity, the risks associated with offset management can be maintained at a low risk level as indicated in Table 21-84. A risk assessment update will be carried out during the development of the Offset Management Plan.

Table 21-84 Risks associated with offset management and measures to minimise risk.

Management action	Associated risk	Risk*	Proposed measure to minimise risk	Proposed remedial action if risks occur
Grazing / Fencing	Overgrazing / grazing pressures	Low	Monitoring of grazing regimes, grass cover and biomass	Alteration of proposed grazing regimes
	Fence failures	Low	Leaseholder monitoring	Maintenance of fencing
Weed control	New weeds	Low	Weed hygiene protocols and monitoring	Weed control
	Weed infestation	Low	Weed control, grazing and monitoring	Additional weed control
Pest control	Pest outbreak	Low	Pest control and monitoring	Additional pest control
Human disturbance	Unauthorised access and disturbance	Low	Leaseholder monitoring	Security measures and signage
Fire management	High fuel loads	Low	Leaseholder monitoring	Fuel reduction methods and frequency

* Low = requires routine action; Moderate = requires moderate action < 1 month; High = requires priority action < 2 weeks; Extreme = requires immediate action < 1 week

Conservation outcome

The OAMP(s) and the measures defined within will be designed to deliver an overall conservation outcome that improves and/or maintains the viability of each matter significantly impacted by the Project, i.e. improving existing habitat for each protected matter and reducing threats. The overarching objective of the OAMP(s) will be to reduce threatening processes and increase the habitat quality of the area to a level that provides greater conservation value than the impact site.

In the first instance the definition of the offset area will be developed using the OAG which uses the area of impact and quality of habitat to assess the total quantum of impact that needs to be offset. Risk of success of the offset is also reflected in the OAG inputs such that the OAMP(s) can include measures, trigger and remedial actions to manage risk. These aspects during development of the offset area serve to establish an offset commensurate with the scale of impact. In addition, the OAMP will be targeted for each of the relevant matters significantly impacted. Potential targeted measures for the impacted matters are listed in Table 21-85.

Table 21-85 Potential measures to contribute to conservation gains

Matter	Potential measures for achieving conservation gain
Brigalow TEC	• secure protection of an area of Brigalow or Brigalow regrowth from clearing or modification by land use practices • identify threats located at the offset and mitigate where possible. Monitor to assess progress and allow for adaptive management to respond accordingly • manage invasion by weeds • manage disturbance by feral animals • restrict or reduce grazing intensity.
Squatter pigeon (southern)	• secure protection of an area of habitat for the species from clearing or modification by land use practices • manage invasion by weeds • manage disturbance by feral animals • restrict or reduce grazing intensity • consider installation of water sources where beneficial.
Ornamental snake	• secure protection of an area of habitat for the species from clearing or modification by land use practices • manage disturbance by feral animals, in particular pigs • restrict or reduce grazing intensity • prohibit planned fires other than for ecological purposes.
Koala	• secure protection of an area of habitat for the species from clearing or modification by land use practices • manage presence of dogs • establish opportunities for connectivity to other habitat areas locally.
Greater glider	• secure protection of an area of habitat for the species from clearing or modification by land use practices • remove any barbed wire fencing • establish opportunities for connectivity to other habitat areas locally • prohibit planned fires other than for ecological purposes.

To ensure conservation gains are achieved, performance criteria will be established for ecological condition, weeds and pests for the offset area. The final condition score of the offset site will be required to improve by at least one point over the life of the offset. This increase may be greater, if required to ensure the final offset condition is equal to that of the offset site.

Performance targets will be defined to measure performance of the management actions during the offset management period and measure progress toward final completion criteria. The interim performance targets will be established for Years 5, 10 and 15 to provide a means to compare monitoring results and track progress.

Multiple ecological condition indicators will be measured to achieve minimum scores to demonstrate an increase ecological condition of the offset area. The offset area will improve in condition and provide a positive conservation outcome or gain for values that will be lost at the impact site.

Monitoring and reporting

The OAMP will detail the performance targets and completion criteria for improving vegetation condition within the offset site, and therefore MNES habitat quality, such that there can be a demonstration of the success in achieving the overall conservation outcome. Monitoring activities will include:

- photo point monitoring at the commencement of the Plan, and then every five years for the remaining 20 years (to be undertaken by a suitably qualified person appointed by BMA)
- BioCondition Assessment at the commencement (baseline), and then every five years for the remaining 20 years (to be undertaken by a suitably qualified person appointed by BMA)

- feral animal and weed monitoring conducted concurrently with BioCondition Assessment (to be undertaken by a suitably qualified person appointed by BMA)
- manager monitoring of grazing, pest plants, pest animals fencing, access and fire breaks (to be undertaken by a suitably qualified person appointed by the landowner).

All monitoring results (including leaseholder/property manager observations) are to be recorded in documented or electronic form suitable for external audit. Reports will be provided to the relevant authorities for review as required.

The frequency of monitoring will be determined based on the current condition of the offset area and the likely rate of change (improvement or decline). Monitoring frequency is likely to be higher in the initial five years as this is generally the period in which the greatest change occurs, and an important period in ensuring management measures have the offset heading in the right trajectory to reach the performance criteria.

BMA will prepare a report on the implementation of this management plan at year 5, and then every five years for the remaining 15 years or until completion criteria are met (for a minimum of 20 years, whichever is longer). The report will summarise the activities implemented under the plan, and discuss the effectiveness of mitigation measures, based on the results of monitoring activities. Reporting will be conducted through internal BMA compliance reporting.

21.10.4 Offset availability

Biodiversity offsets delivered by BMA will be in accordance with the requirement of the EPBC Act and EO Act. Development of the offset package (including OAMP(s)) will be finalised once all approvals are granted and preparations for the Project execution are underway. A draft offset strategy has been developed to accompany the Project EIS and more detailed analysis of offset availability will be undertaken in future stages. To support decision making a preliminary assessment of offset availability for the relevant matters to the Project is presented here. The purpose of this preliminary assessment is to confirm the likelihood of sufficient land-based offset being available to BMA.

The preliminary assessment comprised a desktop assessment that considered offset availability within land currently owned by BMA (as priority) followed by geospatial analysis using available datasets to assess availability of a suitable offset within the region. The preliminary assessment confirms there is opportunity within BMA owned property and other land in the region to develop an offset suitable to compensate for impacts associated with the Project.

<u>Offset availability identification methodology</u>

Estimation of potential offset availability within the bioregion was undertaken using desktop assessment of available remnant, MSES and High Value Regrowth vegetation within the Brigalow Belt Bioregion and criteria that reflect the identified offset criteria listed in applicable offset guidelines.

Potential offset areas were selected based on lot and plan rather than properties which may contain more than one lot. Offsets may be located on several properties due to the requirements of ornamental snake habitat and the brigalow TEC which are substantially different to the remainder of the MNES potentially being impacted.

The desktop assessment identified limitations, including:

- areas require ground-truthing of environmental values
- potential conflicts may exist between land use areas
- further site-specific habitat quality analyses are required to determine the suitability of the offset and the size of the offset required for each impact
- landholders who own the potential offset areas may not wish their land to be the subject of environmental offsets.

<u>Offset availability within the region</u>

Potential land-based offset availability for significant residual impacts to MNES including TEC and listed threatened species habitat has been identified as present within the Brigalow Belt Bioregion.

Four properties (identified in Table 21-86) owned by BMA, comprising of freehold, leasehold or trust land, have been selected which offer potential to offset identified significant impacts of the Project. In addition to these four identified properties, five further properties (identified as A, B, C, D and E) (see Table 21-87) offer additional offset capacity, and demonstrate ample suitable offset area is available in the region to acquit unanticipated significant residual impacts associated with the Project.

Information presented by this report likely underestimate the full extent of available offset areas within the region. Potential offset area availability does not include younger regrowth vegetation that could also be suitable to address the Project's offset requirements. Furthermore, assessment of suitable areas to address MNES offset requirements has been limited to suitable BVGs to address MSES significant residual impacts, with the intent of co-locating offsets. Other suitable BVGs for offsetting MNES are available in the region. This available area does not include younger regrowth vegetation that could also be suitable to address the Project's offset requirements.

Table 21-86 Potential offset availability for maximum predicted significant impacts to MNES

MNES	Estimated offset required (ha)	Potential offset availability (ha)				
		Terang[7]	Myuna[8]	Croydon[9]	Ganadero[10]	Total
Brigalow TEC	256-512	348.7	1,039.0	-	350.0	**1,737.7**
Ornamental snake	1,556-3,112	379.0	892.0	64.4	297.0	**1,632.4**
Koala	544-1,088	1,707.3	5,112.0	688.3	33.0	**5,007.2**
Greater glider	152-304	92.3	1,514.0	87.5	-	**1,693.8**
Squatter pigeon	532-1,064	2,094.0	5,320.0	108.4	-	**7,522.4**

Table 21-87 Potential offset availability for maximum predicted significant residual impacts to MNES

MNES	Estimated offset required (ha)	Potential offset area availability by property (ha)					
		A	B	C	D	E	Total
Brigalow TEC	256-512	2,658	0	721	1,489	5,458	**10,326**
Ornamental Snake	1,556-3,112	2,658	-	721	523	8,786	**12,688**
Koala	544-1,088	9,780	14,698	7,885	6,661	11,451	**50,475**
Greater Glider	152-304	713	2,276	4,487	3,898	9,808	**21,182**
Squatter pigeon	532-1,064	10,031	17,499	4,788	7,831	12,059	**52,208**

<u>Offset site prioritisation</u>

While proposed offset areas will meet the intent of Commonwealth and State offset policies, prioritisation will be given to those areas that contain multiple offset values and are strategically located. Offsets which contain connectivity values, such as those within regional wildlife corridors, will be prioritised to provide a greater enhancement of biodiversity and long term conservation outcomes.

The final availability and ecological suitability of potential offset areas are dependent on both landholder engagement and ecological equivalence; however, the results of suitable offset availability show large areas of potentially suitable habitat can be secured by BMA.

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[7] E2M Consulting (2022). *Saraji East Offset Suitability Assessment*. Prepared for AECOM Australia on behalf of BM Alliance Coal Operations Pty Ltd.
[8] Eco Logical Australia (2021). *Myuna Property Terrestrial Ecology Assessment*. Prepared for Advisian on behalf of BHP.
[9] E2M Consulting (2022). *Blackwater Mine Northern Extension Project Offsets – Westbridge Paddock Survey Summary*. Prepared for SLR Consulting on behalf of BHP.
[10] Eco Logical Australia (2015). *Ecological Assessment of Ganadero Property: Validation of Commonwealth and State Offset Values*. Prepared for BM Alliance Coal Operations Pty Ltd.

With the exception of potentially one or two relevant ecological values, BMA considers it has sufficient currently unutilised reserve offset land within its existing portfolio of available properties, inclusive of the in progress development of call option arrangements, to address all the MNES and MSES values to be offset in accordance with legislative and policy requirements.

BMA is also actively monitoring commercial developments relating to several other potential target properties to identify the optimal time to secure ownership for additions to its in-reserve portfolio. One trigger for settling arrangements for these target properties would be confirmation during BMA's regular review processes post EIS and pre Project commencement that further offset land is needed because, for example, some of BMA's reserve land is used for other projects or a top up is needed for one or two values e.g. ornamental snake habitat. A second example for a trigger would be if the Commonwealth were able to resolve problems with its Advanced Offsets policy limiting the ability for project proponents to secure offsets prior to the conclusion of a referral and assessment process. This would provide BMA with the confidence to expand its reserve land portfolio.

BMA and its owners have strong financial positions to enable land acquisitions as required. In addition, BMA has a highly successful track record stretching back more than 15 years of securing offset properties before the necessary deadlines associated with many relevant project developments and associated environmental approvals.

21.11 Cumulative Impacts

Cumulative impacts are the total impact on the environment that would result from the incremental impacts of the Project added to other existing impacts, or when multiple projects are proposed, under development or operating in a region. Cumulative impacts may be positive or negative, direct and indirect impacts and the scale and duration will depend on the extent of spatial and temporal overlap of the projects.

Generally, impacts of existing developments such as operational mining activities have already been accounted for in terms of baseline data collection and impact assessment. As discussed in Section 21.3, impacts from underground mining were considered as cumulative impacts with the SRM open-cut mining (revised mine plan) given that the operations are intrinsically linked through proximity, operational scheduling overlap and drawdown contour overlap. In addition, the cumulative impact assessment considers the following regional projects:

- Projects within the wider region listed on the DSDILGP that are undergoing assessment under the State Development and Public Works Organisation Act 1971 (SDPWO Act) for which an EIS is required
- Projects within the region listed on the website of the DES that are undergoing assessment under the EP Act for which an EIS is required e.g. Lake Vermont Meadowbrook Project notified in 2023
- Existing resource operations, including:
  - Red Hill Mining Lease Project
  - China Stone Coal Project
  - Olive Downs Project
  - New Lenton Coal Mine Project
  - Glencore Mine
  - Ensham Mine
  - Carmichael Coal Mine and Rail Project
  - Byerwen Coal Project
  - Winchester South Project
  - Eagle Downs Coal Mine Project
  - Poitrel Coal Mine Project
  - Grosvenor Coal Project.

The above regional projects have been considered in terms of their proximity to the Project site and their potential to interact with water resources, threatened species and ecological communities potentially impacted by the Project. The Ensham Mine, Glencore Mine, New Lenton Coal Mine Project and Winchester South Project are currently in the process of drafting an EIS. As such suitable detail on these projects is not readily accessible and these projects have not been considered in this cumulative impact assessment. Nearby resource projects are illustrated on Figure 21-2.

21.11.1 Water resources

21.11.1.1 Surface water

The Project WMS has been designed to operate self-sufficiently with the benefits of being connected to the broader BMA network to allow water sharing, where beneficial. Project impacts from raw water consumption will be managed within the existing water allocations and will not contribute to cumulative impacts on water resources. If required, additional water can be sourced from existing SRM, within BMA's existing surface water allocations. Therefore, potential cumulative impact from water used in mining activities on environmental flows would be managed through the existing water allocations.

Under normal operating conditions, the Project WMS will operate independently of the existing SRM water system. However, should sufficient MAW not be available for CHPP process and dust suppression at the Project, this can be imported from the existing SRM water system, following water quality testing to confirm that water is of an appropriate quality for the intended use. Similarly, where additional water demands at the existing SRM occur, water satisfying water quality testing may be exported from the Project in accordance with EA conditions.

Like other mining operations in the Isaac River catchment such as Red Hill Mining Lease Project, mitigation measures (Section 21.7) and the mining industry standards and regulations for water quality protection will ensure impacts to the surface water environment are small, temporary and reversible.

Land uses surrounding the Project site contribute to sediment loads and turbidity in the catchment. With proper management, the surface water quality impacts associated with the Project and mining upstream will be incremental. Based on this assessment, the significance of the overall cumulative impact on surface water will be low.

21.11.1.2 Groundwater

Groundwater resources within the Project area are limited due to poor aquifer hydraulic properties and recharge and of limited value for most uses except for stock watering. The Project's likely impacts on groundwater resources has been assessed and modelled predictions of underground mining impacts are presented in this chapter. Predictive simulations, including an evaluation of groundwater level drawdown (21.6.1.2), prediction of groundwater ingress and an evaluation of groundwater level recovery was conducted with and without the Project to inform cumulative impact assessment.

Modelling of the Project with existing and proposed mining operations within the model domain simulated cumulative drawdown to describe the predicted impacts on different hydrostratigraphic units due to the existing approved mining. The simulated cumulative drawdown shows whether the zone of impact from the neighbouring mine operations is predicted to interact with the predicted Project zone of impact in different hydrostratigraphic units (alluvium, Tertiary, and MCM coal seams).

The maximum cumulative drawdowns represent the total impact to modelled groundwater levels resulting from all mining within the model domain. These drawdown predictions are derived by comparing the maximum difference in hydrostratigraphic unit groundwater levels for the Project model scenario with those in the theoretical "no mining" Null Run scenario, for all times during the predictive model period.

Most of the predicted cumulative drawdown impacts are **not** related to the Project but result from existing mining activities represented in the model (SLR, 2023).

- Alluvium: no cumulative drawdown impacts predicted for the Quaternary alluvium within or adjacent to the Project footprint.
- Tertiary: cumulative drawdown impacts within the Tertiary age sediments and basalt appear to connect the Project-related drawdown to the drawdown impacts at the Peak Downs Mine and SRM open-cut pits.

- Permian: maximum predicted cumulative drawdown in the target D seam in the Moranbah Coal Measures is predicted to interact with zone of impact from the Peak Downs Mine and SRM open-cut pits and elongate along the north-south trending fault located adjacent to the Project footprint and.

For the Leichhardt and Vermont coal seams of the Rangal Coal Measures, there was no drawdown interaction between the Project and the neighbouring mines since these seams are not present within the Project area.

Short to medium term impacts to groundwater flow and level are relative to the duration of dewatering. Beyond closure, groundwater will continue to flow into the existing SRM open-cut final voids until a pseudo-steady state is achieved. Following closure, potential loss of groundwater from alluvium, Tertiary and Permian units is not expected to have a marked impact on beneficial use or natural ecosystem values. Groundwater is predicted to rebound within the underground workings following cessation of mining, but only to the level of the final voids in the SRM open-cut pits.

Model predictions show that drawdown associated with proposed underground mining will extend up to an additional 3 km further to the north and east. There are 24 groundwater bores located within the underground mining drawdown thresholds, none of which will require 'make-good' agreements.

The interaction of modelled drawdown on Tertiary and alluvial groundwater systems has potential to compound potential impacts associated with both the Project Lake Vermont -Meadowbrook Project. Based on groundwater modelling from the Lake Vermont Project (JBT 2022), groundwater drawdown in the alluvium and Tertiary sediments will directly interact with drawdown modelled for the Project as described in **Appendix F-1 Groundwater Modelling Technical Report** (SLR, 2023). In conjunction with the potential for reduced flow volumes along Hughes Creek due to mining related subsidence, the interaction between the two projects will increase the risk of impact to mapped GDE associated with Hughes Creek to the east of the Project.

BMA will develop a groundwater plan incorporating an overarching monitoring program to manage impacts and to provide early detection of unforeseen impacts to levels, flows or quality of groundwater resources.

21.11.2 Threatened species and ecological communities

Land uses surrounding the Project Site are predominantly comprised of agricultural activities and coal mining. There are multiple operating mines in the region with potential future expansions or developments proposed. The cumulative effect of these mines and agricultural activities is evident in the landscape, with large tracts of modified (cleared and disturbed) land in the area.

Disturbance due to land use change, invasive species and disease is expected to interact with regional and global changes to climate resulting in threats that undermine resilience persistence of certain types of biodiversity. As a result, changes to ecosystems and biodiversity are likely to come about as a result of from more than one threat. Australia's Biodiversity Conservation Strategy 2010–2030 identifies three national priorities for action to help stop decline in biodiversity: protecting biodiversity, maintaining and re-establishing ecosystem function and reducing threats to biodiversity.

Within the Project Site, the majority of habitat is generally of low conservation value with exception of Brigalow (*Acacia harpophylla* dominant and codominant) and Grasslands TEC identified onsite. Based on ground-truthed field data/mapping, the Project has potential to impact approximately 1,220.35 ha of remnant vegetation communities by proposed underground mining (including subsidence), surface facilities and infrastructure.

Habitat applicable to threatened species is modelled from land zones that are appropriate for activities such as foraging, breeding and dispersal. The habitat mapping assumptions for MNES species impacted by the Project are outlined in Table 21-25. Combined with other projects, potential cumulative impacts to TEC and threatened species are outlined in Table 21-88.

Table 21-88 Habitat clearance from the Project and projects within the Bioregion

Resource Projects	MNES habitat								
	Brigalow TEC	Grasslands TEC	Bluegrass	King Bluegrass	Squatter Pigeon	Ornamental Snake	Koala	Australian Painted Snipe	Greater Glider
Saraji East Mining Lease Project	64	<1	<1	<1	113	386	136	387	38
Red Hill Mining Lease Project	265	79	79	79	-	896	1,217	-	-
China Stone Coal Project	-	-	-	-	1,439	-	3,246	15	-
Olive Downs Coking Coal Project	13	-	-	-	5,387	113	5,500	-	5,500
Carmichael Coal Mine and Rail Project	234	-	-	-	176	257	173	6	-
Byerwen Coal Project	316	84	-	-	10	375	9	9	-
Eagle Downs Coal Mine Project	31	140	140	140	-	-	-	-	-
Poitrel Coal Mine	156	-	-	-	-	-	-	-	-
Grosvenor Coal Project	-	-	-	-	139	-	-	-	-
Cumulative impact (ha)	**1,207**	**303**	**219**	**219**	**7,264**	**2,027**	**10,281**	**743**	**5,538**

Clearing proposed for the Project is a small contribution to the cumulative impacts for Brigalow TEC identified across all projects. Additionally, Project impacts on suitable habitat for threatened and endangered species were identified to be minor given the surrounding habitat values within the broader landscape.

The greatest direct (clearing) and indirect (edge effects and habitat degradation) impacts are expected to occur during initial mine establishment and construction stage. Project infrastructure layout will continue to be optimised during the planning stage to avoid and mitigate direct impacts from removal of vegetation during construction disturbance. Appropriate land-based offsets will be established and managed to compensate for Project impacts on MNES.

Subsidence impacts are included for conservatism, but long-term impacts may be far less, subject to monitoring and confirmation. With the mitigation measures outlined in Section 21.7, the cumulative impacts to MNES across the region is minor.

21.12 Summary and conclusion

21.12.1 Water resources

The assessment has concluded that with the appropriate mitigation and monitoring in place, no significant impacts are predicted for surface water or groundwater resources, or dependent ecosystems.

21.12.1.1 Surface water

The baseline hydrological condition of the waterways at the site location comprises:

- ephemeral watercourses, with nil to negligible flow expected during normal conditions.
- located within 'moderately disturbed' catchments, due to significant mining operations (located immediately upstream of the Project location) and minor agricultural activity in the broader catchment.
- subject to high sediment loads during flow events and have highly variable water quality.

These waterways are located hydraulically up-gradient of the Isaac River, which is a scheduled river system under the Queensland Environment Protection (Water) Policy 2009 within Fitzroy River basin.

A comparison of the regional WQOs within the *Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No.130 (part) including all waters of the Isaac River Sub-basin (including Connors River)* (DEHP, 2011) was completed against reference water quality data at the Project location. It was concluded that the baseline site specific water quality (within the ephemeral creeks) is significantly different to regional water quality (Isaac River), particularly: Ammonia, Kjeldahl nitrogen, Total nitrogen, Dissolved oxygen, Nickel.

Detailed analysis of water quality data was completed to develop site-specific Water Quality Objectives (WQOs). These WQOs were developed according to guideline approaches such as DEHP (2009), ANZG (2018) and DES (2022), and were based upon an analysis of the best available reference data at the site location. Consistent with the intent of the Queensland Water Quality Guidelines (DES 2022) and ANZG (2018) guidelines, the developed site specific WQOs are purposed for long-term improvement of waterway quality.

The need to utilise licensed releases is not expected, however a licensed release point has been included for contingent management of water storages in unforeseen conditions under high flow conditions. The potential impact from licensed releases was assessed in a stress test scenario in **Appendix E-2 Mine Water Balance Technical Report** which considered electrical conductivity (uS/cm) as the limiting pollutant. The modelling of this scenario predicted no significant impact. Discharge criteria and trigger values for the unlikely case of a discharge, have been developed in accordance with Model water conditions for coal mines In the Fitzroy basin, existing EAs of adjacent BMA mines and 80^{th} percentile values of background water quality where appropriate.

A REMP and TARP have been developed in accordance with DES guidelines (DES, 2014), (DES, (2018a) and DES (ESR/2015/1561) prior to construction, as part of the Water Management Plan, with the primary objective of providing trigger values based on the REMP framework for further investigation and outlining the corrective actions and responses if detrimental impacts to surface water quality and stream health are imminent.

To understand the potential risks to surface water due to the Project development, a review of the proposed operations was completed, with key risks identified for the construction and operational phase. Subsequently, mitigation(s) and management measures have been developed for each risk identified.

Table 21-89 Surface water risks and mitigations

Aspect	Risk(s)	Mitigation(s)
Construction Phase		
Erosion and Sediment Mobilisation	Erosion and Sedimentation leading to increased turbidity and nutrient concertation in receiving waters	Management according to guidelines for erosion and sediment control (IECA 2008)
Chemicals and Contaminants of Concern	Spillage of Chemicals and Contaminants leading to contamination of receiving waters	Storage, operations, and handling as per Australian standards Construction Environmental Management Plan
Operational Phase		
Chemicals and Contaminants of Concern	Spillage of Chemicals and Contaminants leading to contamination of receiving waters	Storage, operations, and handling as per Australian standards Incident reports
Subsidence	Geomorphological changes leading to alterations in sediment transport, stream	Implementation of adaptive management framework and proposed subsidence

Aspect	Risk(s)	Mitigation(s)
	flow, water quantity and increased turbidity	management plan proposed in Alluvium (2022). Ongoing subsidence monitoring and review.
Erosion and Sediment Mobilisation	Erosion and Sedimentation leading to increased turbidity and nutrient concertation in receiving waters	Management according to guidelines for erosion and sediment control (IECA 2008)
MAW	Release of MAW could increase levels of salinity and contaminants in receiving waters	Design of water management infrastructure to maintain separation between MAW and other water, water reuse where appropriate, water containment where appropriate Licensed Release
Mine Dewatering	Dewatering activities reduce capacity of MAW storages, resulting in unnecessary licensed releases	Mine dewatering is conveyed into the MWB MAW system and the adjacent mine complex's WMS using existing water transfer systems. Water transfers managed under a SWMP Ongoing water balance modelling for MAW containment adequacy.
Wastewater	Wastewaters from mining or effluent streams could lead to contamination and toxicity in receiving environments.	Effluent wastewater would be treated and discharged to the PWD. Any sludge generated, and sewage from temporary workers accommodation village would be pumped by licensed contractor and transported to a local council sewage treatment plant.

In addition to the proposed mitigation(s) developed for the identified risks, appropriate management of surface water resources will involve the development of Project-specific documentation, which will be developed during the detailed design phase, including:

- A Site Water Management Plan (SWMP) to manage contaminants and containment in regulated water structures.
- Receiving Environment Monitoring Program (REMP) to identify potential impacts to surface waters during operation and licensed releases. Trigger Action Response Plan (TARP) to specify corrective actions in the event of trigger exceedances.
- Subsidence Management Plan (**Appendix K-2**) as proposed by Alluvium (2022) to mitigate the potential impact of subsidence on streams and infrastructure.

In summary, the assessed impacts to surface water potentially could affect surface water quality and aquatic ecosystems. However, impacts can be largely mitigated by applying proposed mitigation/ management measures and the developed conceptual WMS. The REMP together with the implementation of a TARP will provide comprehensive corrective actions and responses for impacts to water quality. As such it is expected that construction and operation of the proposed underground mine will likely have little impact on surface water quality in the Boomerang – Hughes Creek catchment and the Isaac River.

21.12.1.2 Groundwater

Predictive modelling of groundwater level drawdown in the alluvium, Tertiary, and the target D seam, resulting from the Project, indicated:

- No impact on alluvium groundwater resources are predicted due to the Project.
- The drawdown predictions are influenced by the distribution of saturated zones in the Tertiary. At the northern panels, 1 m drawdown influence is predicted to extend 4.2 km northeast of the Project mine workings.
- The extents of maximum predicted incremental drawdown impacts in the Moranbah Coal Measures coal seams are generally elongated along strike in the northwest-southeast direction

and extents maximum of 5 km and 8 km northwest and southeast of the Project mine extent, respectively.

The inflows at the Project are predicted to reach a maximum peak in mine year 16, of 500 ML/year (1.4 ML/day). The average inflow rate for the Project is estimated at 183 ML/year (0.5 ML/day). This impact is not considered to be significant due to the absence of privately owned bores in the drawdown areas.

Impacts of the mine dewatering associated with the proposed underground workings, considered in connection with the approved SRM open-cut operations, are considered low for the following reasons:

- Surface water creeks in the area are ephemeral and groundwater levels (more than 17 m below surface) are below the level that would provide baseflow to existing alluvium or to root zone of plants.
- Groundwater level drawdown will occur predominantly within the Permian coal seams, which are separated from surficial groundwater regimes by clay-rich Tertiary cover, Permian age aquitard interburden, and are not expected to impact surface ecosystems.

It is unlikely that a significant dewatering impact will occur on the non-perennial creeks, which drain across the Project. No Project related impact to Phillips Creek is predicted.

The potential environmental impacts of the Project are considered low as:

- The surface water system at the Project is ephemeral
- The alluvium is of limited extent, discontinuous and dry in the majority of bores
- Tertiary sediments often have insufficient yield/low recharge potential indicating low permeability and low potential for usage
- The Project is not predicted to impact on the Isaac River to the east
- Groundwater quality is not suitable for drinking, too deep for Terrestrial ecosystems at the Project footprint, and is often too saline for livestock watering
- The surface water systems are separated from the predicted impacted groundwater resources by low permeable self-sealing Tertiary sediments, which reduce the potential for the Project to impact on surface water flows.

A GMP will be developed for the Project, which will allow for the validation of model predictions and allow for the instigation of investigations into potential for environmental harm should groundwater monitoring results differ from predictions.

To ensure the collection of representative groundwater monitoring data, allow for the assessment of the potential predicted impacts of the Project on local groundwater resources, and consider the existing groundwater monitoring bore network, additional monitoring bores are recommended prior to the Project mining activities.

21.12.1.3 Groundwater dependent ecosystems

Impacts of drawdown in the Tertiary groundwater system may be propagated into creek alluvium where areas of enhanced potential for downward drainage occur, most likely through sandy sediments with increased hydraulic conductivity or increased density of preferential flow paths. There are no predicted impacts associated with terrestrial GDE on Phillips Creek as groundwater drawdown does not propagate below the stream channel or fringing riparian habitats. Drawdown impacts have potential to manifest along reaches of Hughes Creek where modelled groundwater drawdown extends well to the east of the Project into contiguous Lake Vermont tenements.

Based on the risk assessment undertaken in **Appendix D-2 Groundwater Dependent Ecosystems** (3D Environmental, 2023), unmitigated risk to GDE is classified as 'Insignificant' to 'Low' risk. Residual risk ranking is 'Low' to 'Insignificant' following application of appropriate management measures, including mitigations if required. For all impact pathways, initial stages of GDE monitoring require active management (including monitoring) from which mitigations can be adapted if impacts to GDE are identified which can be attributed either directly or indirectly to operations associated with the Project. Management measures will be applied in during implementation of a Project GDE Management and

Monitoring Plan, after which mitigations can be applied if significant impact GDE function and health is detected.

21.12.2 Threatened species and ecological communities

The assessment process determined that impacts from the Project may have a significant impact on four threatened species and one TEC, including:

- Brigalow TEC
- Ornamental Snake (*Denisonia maculata*)
- Squatter Pigeon (Southern Subspecies) (*Geophaps scripta scripta*)
- Koala (*Phascolarctos cinereus*)
- Greater Glider (*Petauroides volans*).

A range of mitigation and offset strategies are proposed within this chapter to minimise and mitigate potential impacts to MNES, including:

- avoidance of high value areas where practical
- management of threatening processes within retained habitats
- control of pest vertebrate species and weeds
- assisted natural regeneration and active rehabilitation
- ongoing flora and fauna monitoring.

A Threatened Species Management Plan will be developed prior to construction to provide species specific mitigation measures to minimise the long-term impacts on MNES i.e. fauna species.

While mitigation and management measures for direct and indirect impacts focus on maximising retention of MNES values across the Project footprint, significant impacts on TEC and listed threatened species will likely remain. BMA has progressed a preliminary assessment of offset availability within the Brigalow Belt Bioregion for the maximum predicted significant impact. An Offset Strategy has been prepared for the Project as part of the EIS (**Appendix C-2**) to outline a proposed approach and facilitate discussion with the Habitat quality analysis surveys for Project impacts will be undertaken following the finalisation of the EIS and detailed design to confirm offset requirements.

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