SARAJI EAST MINING LEASE PROJECT

Environmental Impact Statement

Chapter 21
Matters of National Environmental Significance

BHP

Contents

Saraji East Mining Lease Project

21 Matters of National Environmental Significance

21.1 Introduction

This chapter assesses the Commonwealth protected Matters of National Environmental Significance (MNES) that have potential to be impacted by the Saraji East Mining Lease Project (the Project) proposed to be developed by BM Alliance Coal Operations Pty Ltd (BMA).

The Terms of Reference (ToR) for the Project's Environmental Impact Statement (EIS) require the preparation of a stand-alone chapter addressing the relevant impacts of the Project on MNES defined in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Relevant impacts are impacts that the action will have or is likely to have on MNES. The Project has also addressed the principles of ecologically sustainable development set out in the EPBC Act (refer Section 21.3.4).

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 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).

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. Mitigation measures for surface water impacts are discussed in Section 21.10.1.1.
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. Mitigation measures for surface water impacts are discussed in Section 21.10.1.1.

MNES	Relevance to Project
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. Mitigation measures for surface water impacts are discussed in Section 21.10.1.1.
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 21.8.2 • Six (6) EPBC Act listed flora species with description of preferred habitat, status under Commonwealth legislation and likelihood of occurrence discussed in Section 21.8.3 • 20 EPBC Act listed fauna species with description of preferred habitat, status under Commonwealth legislation and likelihood of occurrence discussed in Section 21.8.4. Significant impact assessment for these matters is in Section 21.11.
Listed migratory species	The EPBC Act Protected Matters Search indicates 12 migratory bird species may potentially be found within in the vicinity of the Project Site (AECOM, 2020). Historical ecological assessments for the Saraji Mine 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. Mitigation measures for threatened species and ecological communities apply (refer Section 21.10.2).
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.

MNES	Relevance to Project
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 21.11.

21.2 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 2016 financial year, the total royalties and taxes paid to the Queensland Government by BMA and BHP Billiton Mitsui Coal (BMC) was $381 million (BHP Billiton, 2016). 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 the State of Queensland. Key benefits will 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.

21.3 Project alternatives

The following key objectives were considered when planning the Project:

- utilise BMA owned land on the adjacent existing Saraji Mine mining leases (ML) to minimise the environmental impacts from additional infrastructure and to provide Project efficiencies
- operate a profitable Project to provide high-quality hard coking coal, semi hard coking coal and pulverised coal injection coal to the export market
- design, construct and operate a Project that:
  - minimises adverse impacts on the surrounding biophysical and social environments
  - complies with all relevant statutory obligations and continues to employ processes which enhance sound environmental management

Project alternatives considered as part of the Project included a do nothing alternative and alternative locations for key project elements. The principles of ecologically sustainable development were also considered during development of the project and are described in Section 21.3.4.

21.3.1 'Do Nothing' alternative

The 'Do Nothing' alternative, whereby the Project is not progressed, would result in:

- loss of economic benefit
- local, state and nationwide job opportunities would not be realised
- reduction in demand and income for support industries and service suppliers
- loss of primary and secondary employment opportunities for local, state and national workforces
- available resources in the area would not be realised
- missed opportunity for employee opportunities, apprenticeship programs, support of local businesses and financial donations to community groups and local projects
- State royalty payments and Commonwealth tax revenue from the coal resources would be foregone.

The do nothing alternative is inconsistent with the Project objectives and was therefore not pursued.

21.3.2 Alternative locations

The exploitation of other resources in the Bowen Basin is being considered as part of the BMA growth plan and is necessary to meet the growing demand for these coal products in India, China and other international markets.

The resource is located predominantly in Mining Lease Application (MLA) 70383 which is contiguous with leases currently held by BMA for the existing Saraji Mine. The Project location has been identified as a potential site for incremental and strategic expansion because the extent and nature of the resource is well understood due to extensive exploration and historic mining in the area. Hence, BMA can bring this project into production reasonably quickly compared to less well-known resources. The resource is a high-quality resource that will meet current and expected future market requirements and demands.

The Project configuration within the chosen location was developed based on the following:

- proximity of the proposed rail loop and loading infrastructure to the existing rail line
- sufficient sizing and practical location of the coal handling and preparation plant (CHPP) to enable efficient coal transportation between the underground mine and the rail load out
- locating proposed infrastructure outside of areas which would be impacted by future mining
- minimising disturbance of environmentally sensitive areas by utilising previously disturbed areas of the existing Saraji Mine, where feasible.

Developing the Project at an alternate location would result in key infrastructure being positioned further away from existing infrastructure and mining operations resulting in higher developing and operational cost and potentially greater and longer term impacts on MNES, including water resources and nationally listed threatened species and communities.

The proposed mine plan benefits from utilising existing access from the open pit highwall, shared infrastructure and existing knowledge of the area. The proposed Project Site offers well understood structural geology, low complexity, and favourable mining conditions that presents low risk for water resources. In conclusion, there is no short-term or long-term benefit in locating the mining operations at an alternate location within MLA 70383.

21.3.3 Alternative mine plan

Two mine plan options were considered for the Project, including:

- Option 1 – Maximised mine plan
- Option 2 – Optimised mine plan.

Both options allow for mining of coal in the desired location and benefit from using the existing Saraji Mine facilities. Both mine plan options would result in similar potential impacts to water resources and nationally listed threatened species and communities, though the optimised mine plan impacts a smaller area.

The options are discussed below and shown in Figure 21-1.

Maximised mine plan

The maximised mine plan option considers the maximum mining capacity available within the area (Figure 21-1). This option includes 17 longwalls to follow a production schedule over a period of 19 years (financial year (FY) 2023-2041). This option was not considered the most effective use of the coal resource when considering the Project objectives outlined in Section 21.3. As such the maximised mine plan was not the preferred option for the Project.

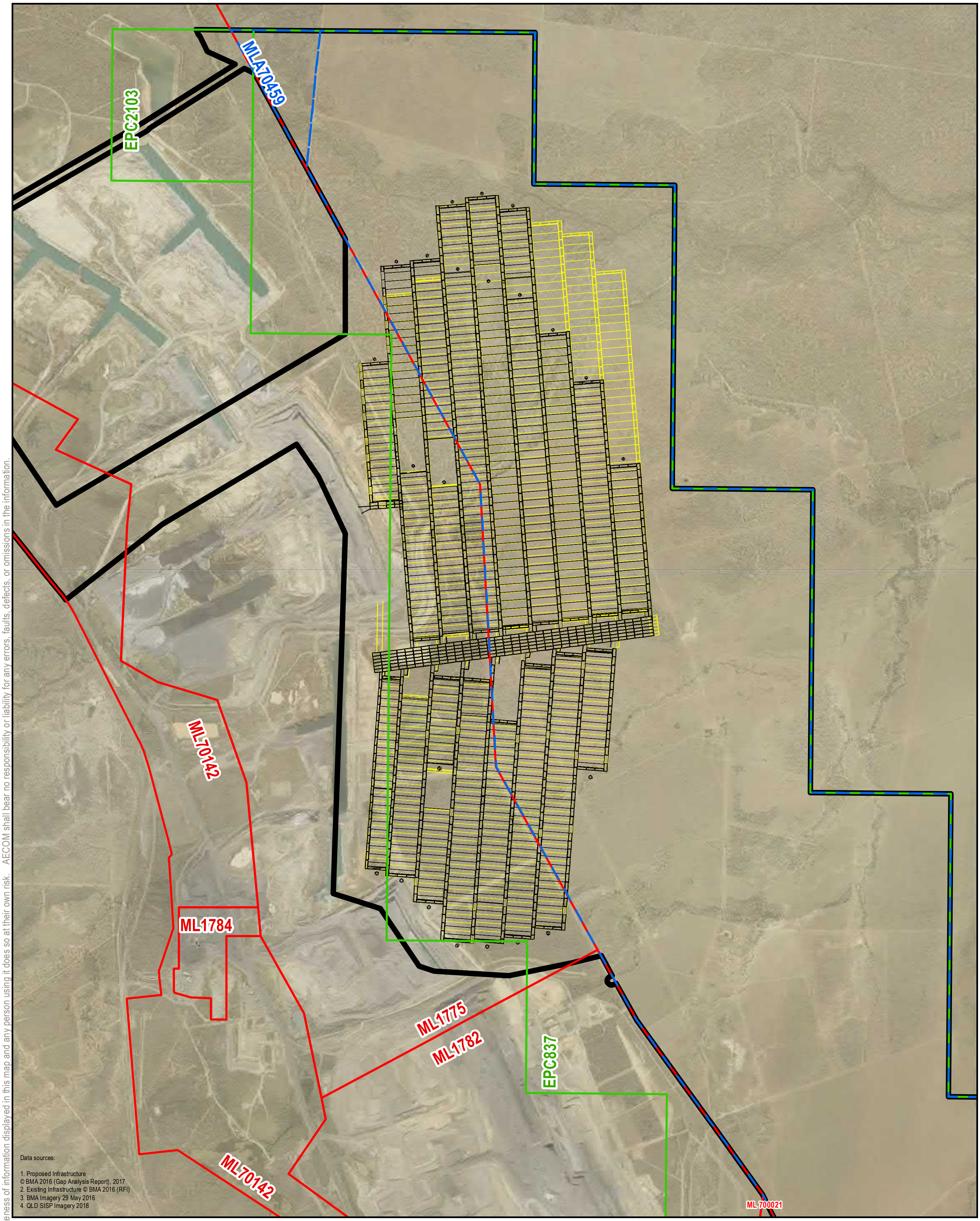
However, to provide a conservative assessment, where appropriate, technical investigations presented in the EIS have considered a project footprint based on the potential ground and surface disturbance associated with a maximised mine plan. The maximised mine plan relates to the mining capacity of known resources within the area for which a production schedule is yet to be developed.

Optimised mine plan

The optimised mine plan option considers the optimum mining capacity of high quality coal within the project site (Figure 21-1). This option was developed based on consideration of a range of factors including resource recovery, coal quality, production rates and site constraints including the potential extent of environmental impacts.

The optimised mine plan was considered the preferred option for this Project as it provides the most effective use of the coal resource and would best meet the objectives of the Project in the short and long-term.

To the extent that the optimised and maximised layouts do not overlap (an area of approximately 20 ha in the north-western panels), BMA will not mine past the modelled limit of subsidence until further subsidence and any other necessary environmental impact assessments are undertaken to address any relevant risks to environmental values.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground layout (optimised)
- Underground layout (maximised)

N

Figure 21-1
Alternative Mine Plan

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.25 0.5 1
Kilometres

Scale: 1:60,000 (when printed at A4)

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

BHP

DATE: 6/10/2020 VERSION: 4

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\02 Project Alternatives\60507031_G342_v4_A4P.mxd

21.3.4 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) (refer to EIS, Chapter 2 Project alternatives and justification (BMA, 2020). The Project addresses the principles of ecologically sustainable development as outlined in Table 21-2.

Table 21-2 Integration of EPBC Act ESD principles into the Project 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 21.6.
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. Land disturbed by the Project will be progressively rehabilitated to a safe and stable landform that is 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 21.13.
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.

21.4 Project overview

The Project is located approximately 170 km south-west 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 Saraji Mine, 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 is a greenfield single-seam underground mine development to be located 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 3,425 ha; this is referred to as the Project Footprint. The Project Site and Project Footprint are presented in Figure 21-2.

The Project Site is located adjacent to, and in some cases overlaps, areas which are currently approved as the existing BMA Saraji Mine. The existing Saraji Mine 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 21-3.

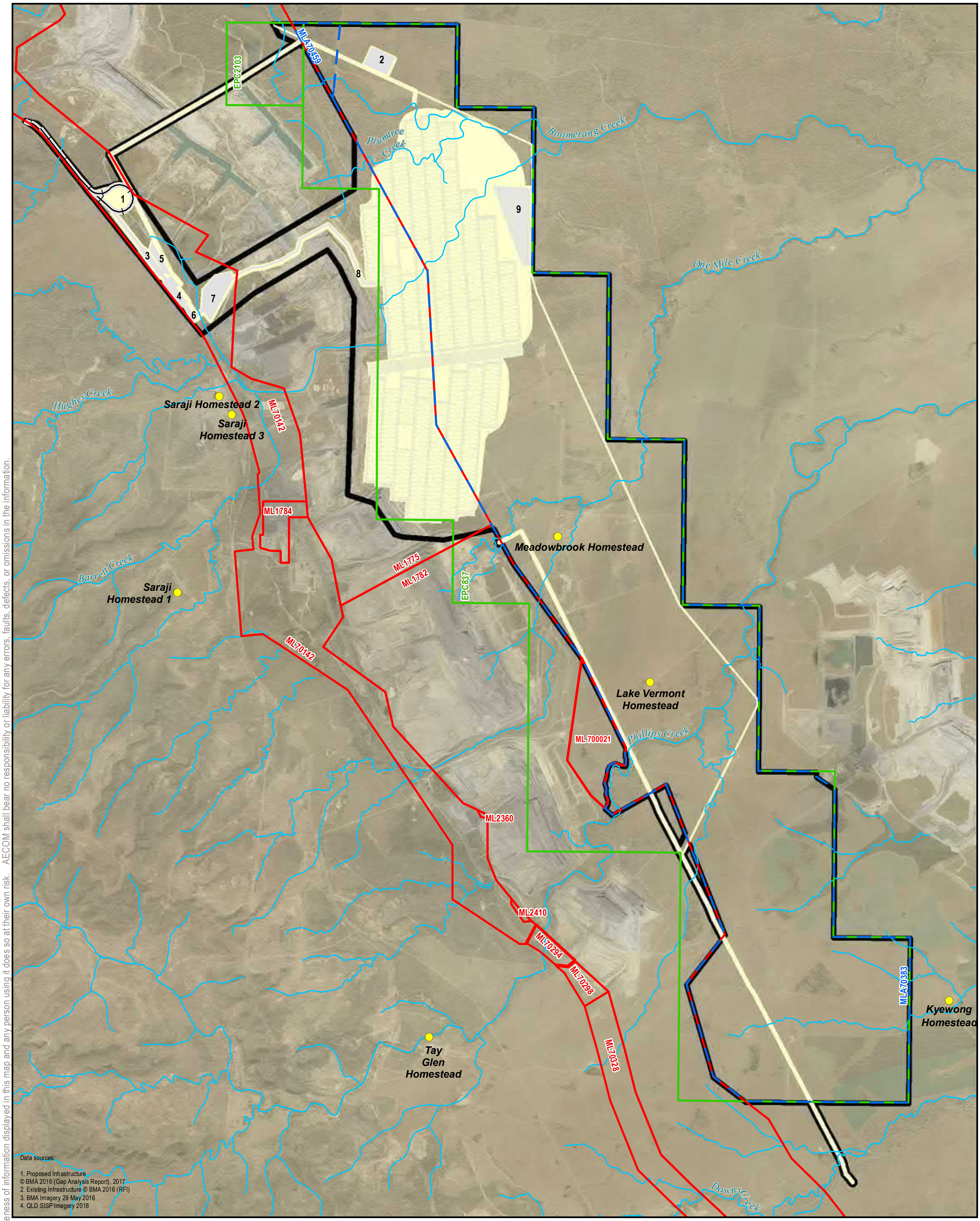
The existing Saraji Mine is approved to undertake open cut operations on ML 1775, ML 70142, ML 1784, ML 1782, ML 2360, ML 2410, ML 70294, ML 70298, ML 70328 and ML 700021 under Environmental Authority (EA) Permit No. EPML00862313. The existing Saraji Mine is not within the scope of this report and BMA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

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

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 CHPP, proximity to rail loading infrastructure, future mining and minimising disturbance of environmentally sensitive areas.

The Project will utilise the existing approved Saraji Mine 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 infrastructure area (MIA) and a new rail spur and balloon loop to be located on the Project Site where it overlaps the existing adjacent Saraji Mine. 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 21-2.

The key features of the Project are summarised in Table 21-3.



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Homestead
- Underground layout (optimised)
- Surface infrastructure
- Rail loop
- Watercourse

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

N

Figure 21-2
Project Site

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

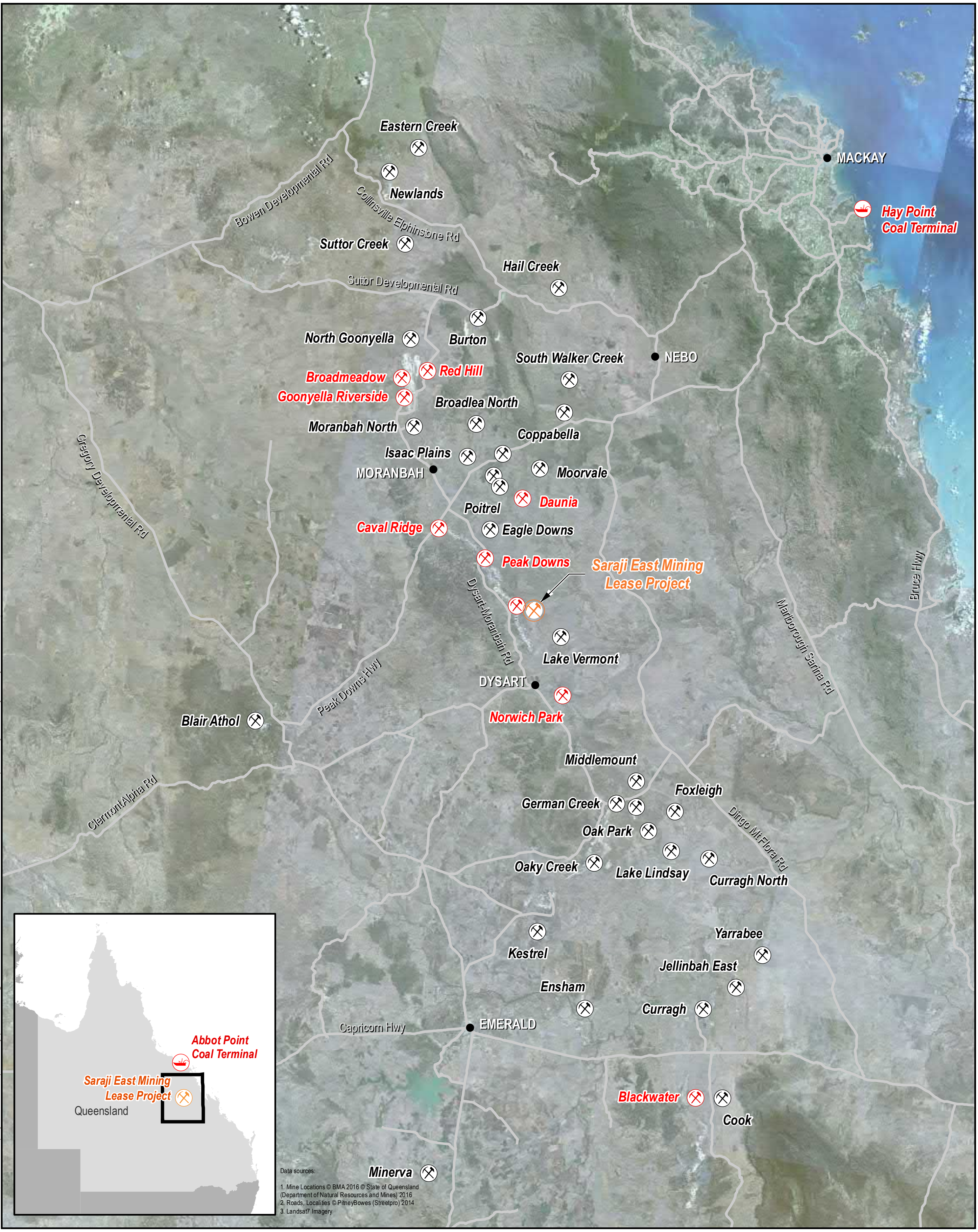
Scale: 1:110,000 (when printed at A4)

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

BHP

DATE: 19/08/2020 VERSION: 2

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G337_v1_A4P.mxd



LEGEND

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

N

Figure 21-3
Nearby Resource Projects

Environmental Impact Statement
Saraji East Mining Lease Project

0 5 10 20
Kilometres

Scale: 1:1,500,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 30/09/2020 VERSION: 2

Table 21-3 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 production schedule 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 with a maximum of 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 9 of Figure 21-2).
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 Saraji Mine operations. The Project assumes the following additional components: • a new MIA located on ML 1775 (refer Surface Infrastructure area 7 of Figure 21-2) • a new CHPP located on ML 70142 (refer Surface Infrastructure area 4 of Figure 21-2) • 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 21-2) • ROM stockpile and product stockpile pads located on ML 70142 (refer Surface Infrastructure area 3 and 6 of Figure 21-2) • a new rail spur, balloon loop and signalling system on ML 70142 (refer Surface Infrastructure area 1 of Figure 21-2) • network of incidental mine gas (IMG) management 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 21-2) • dewatered tailings and reject disposal within spoil on the Saraji Mine (refer Surface Infrastructure area 5 of Figure 21-2)
Mine Water Management System (WMS)	Levees, dams, diversions and drains will be required to support mining operations as well as provide protection to potential downstream environmental impacts on water resources. Required water infrastructure will consist of: • Process Water Dam – 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 to the Process Water Dam located on MLA 70383. • Temporary Gas Dewatering Storage – Pre-drainage for IMG management will result in the production of water that will be collected in local facilities near the well head. These facilitates will act as a balancing storage to allow transfer at a constant rate to the Process Water Dam.

Project feature	Description
	• Raw Water Dam – With no local catchment, the Raw Water Dam will receive clean water inflows from the BMA's existing water allocations delivered via BMA's existing pipeline network. The Raw Water Dam will also receive direct rainfall and will lose water through surface evaporation. Water from the Raw Water Dam will be used to satisfy the Project's potable water and underground mining equipment demands. It will be located on ML 70142. • Additional Highwall pumps – The access portal to the underground workings will be via the highwall of the Saraji Mine's existing Bauhinia pit. Water collected in the highwall portal pit sumps will be pumped to the Mine Water Dam to maintain the flood immunity of the underground workings. • Pipelines: – Existing Eungella Water Pipeline Company (EWPC) Southern Extension Water Pipeline will be relocated and reconnected 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 Process Water Dam on MLA 70383 – Water transport associated with the Project will be achieved via the utilisation, and enhancement where necessary, of BMA existing water pipeline network connecting Saraji Mine to BMA mines to the north and south of Saraji Mine. • Minor drainage infrastructure: – Sediment dams, bunds and drains to capture and treat run-off from disturbed areas including ROM and product pads.
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 Saraji Mine). 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. Saraji Mine currently has an authorised maximum demand of 43 megawatts (MW). The current maximum demand of the mine is between 26 MW and 30 MW. The anticipated demand for the Project (underground and surface infrastructure) is estimated to be between 25 MW and 30 MW.
Public and private roads	Construction of an access road within the new infrastructure and transport corridor to 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 • Dysart-Moranbah Road and existing Saraji Mine identified access point for the CHPP and MIA.
Communications	Communications will be provided by extending the services from the Saraji Mine via the existing service corridor. Telecommunications will be controlled and monitored through a new Project control room.

The easements for linear components are summarised in Table 21-4Table 21-4; for conservative assessment, direct disturbance/impacts are modelled on a 100 metre (m) corridor for roads, powerlines and gas drainage to allow for slight variation in alignment.

Table 21-4 Easements 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)

21.4.1 Construction

The timing of the Project is yet to be finalised. For EIS-related impact assessment purposes, construction is assumed to commence in FY 2021 with site setup and construction of the underground mine access portal. The initial construction period is expected to occur over three years (FY 2021-2023), with most work occurring over 18 months between FY 2021 and FY 2022. Construction phase forms Stage 1 of the Project.

21.4.2 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. Mining will then alternate north and south of the main heading, progressing to the east down dip. The rationale for the proposed mining program is to mine the thickest section of the Dysart Lower seam first to maximise high-quality hard coking coal production in the early years.

The proposed underground extraction sequence is expected to commence in FY 2023 with annual production over the nominal 20-year production schedule, subject to BMA investment decision. An indicative coal production schedule is shown in Table 21-5; the final production sequence will depend on sales and infrastructure constraints. The operational phase forms Stage 2 and Stage 3 of the Project, with Stage 2 covering the initial 10 years of coal production and Stage 3 covering the 10 – 20-year period of coal production.

Table 21-5 Indicative coal production schedule

Financial year	Mining activities	Stage	ROM	Product coal
2021-2023 i.e. Project years 1-3	Development of the mine portal and associated infrastructure areas; direct and impacts.	Stage 1	-	-
2023-2042 i.e. Project years 3-20	Thick seam mining commences within the Dysart Lower (D24 and D14) seam; indirect impacts.	Stage 2 Stage 3	Up to 11 Mtpa	Up to 8 Mtpa

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 Saraji Mine 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.

Gas drainage and management

Incidental Mine Gas (IMG) is present 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 infrastructure to drain and manage IMG to enable the safe and efficient mining of coal.

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.

An example of the IMG pre-drainage process is illustrated in Figure 21-4.

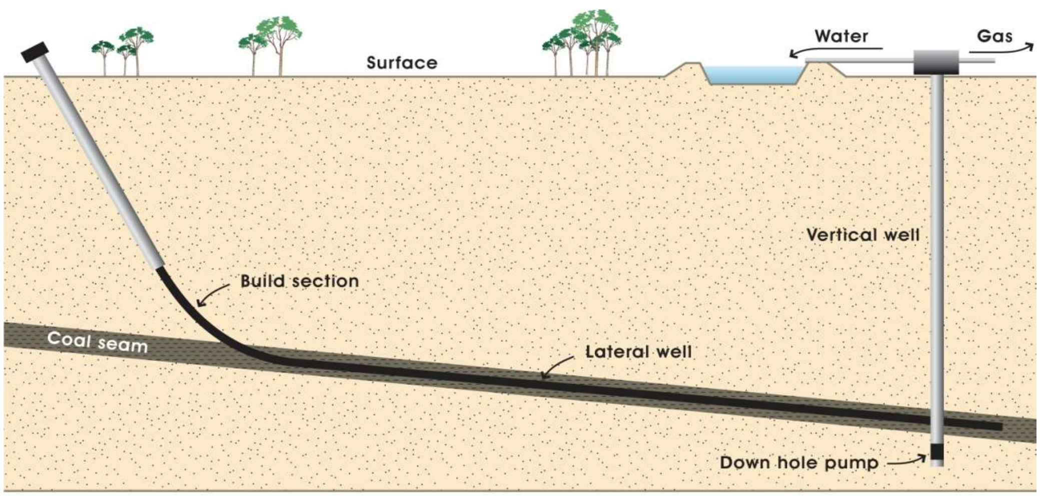


Figure 21-4 Incidental mine gas pre-drainage process

21.4.3 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 relevant EA. The following strategies will be implemented for decommissioning the Project:

- all mine roads will be rehabilitated, unless otherwise agreed with the subsequent landowner and in accordance with the EA
- all 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
- all major infrastructure, including the CHPP, will be decommissioned and removed offsite
- concrete pads will be covered with benign waste rock or ripped and removed, then topsoiled and re-vegetated

- 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, 2020) and is discussed further in Section 21.10. The post mining land use proposed is an undulating landscape that could be used as grazing land, consistent with the surrounding pastoral land use that dominates the region. Where small areas of remnant native bushland are disturbed, the post mining land use is woodlands habitat and a mix of native and non-native species compatible with pre-existing biodiversity values may be implemented. Post mining land uses 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 21-6 As the life expectancy of the Project is expected to align with the existing Saraji Mine, no changes are anticipated to the existing RMP timing.

Table 21-6 Indicative mine rehabilitation schedule

Phase	Year rehabilitation starts	Year progressive rehabilitation ends
Phase 1	2024	2043
Phase 2	2043	2045
Phase 3	2045	2046
Phase 4	2046	2048
Phase 5	2048	2052

21.4.4 Environmental management systems and compliance

Saraji Mine is licensed to operate under EA (EPML00862313). Operation of the Saraji Mine is anticipated to extend beyond 2040 under approved and proposed ML boundaries. An amendment was made to the EA in 2017 to permit the extension of the Grevillea Pit to access further coal resources in MLA 700021 over ten years from 2022. Future operations may include mining development within MLA 7083.

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 2020 financial year reached (US) $149.6 million (BHP, 2020).

The Saraji Mine 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 Saraji Mine and the Project are two independently operated operations, relevant environmental management plans will be updated where necessary to address operational overlap.

21.5 Regulatory framework

21.5.1 Commonwealth

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is administered by the Department of Agriculture, Water and the Environment (DAWE). 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 DAWE (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 (AECOM, 2019) and is also discussed further in Section 21.13. Final offset requirements are subject to the final clearing footprint and assessment and approval from the DAWE.

21.5.2 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 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 Environmental Offsets 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.

21.6 Methodology

21.6.1 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 21-7 and further detailed in the Groundwater Technical Report (AECOM, 2019) and Surface Water Technical Report (AECOM, 2020).

Table 21-7 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.	21.6.1
✓	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.	21.5
✓	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.	21.4
✓	A description of how impacted water resources are currently being regulated under state or Commonwealth law, including whether there are any applicable standard conditions.	21.5
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.	21.7.4
✓	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.	21.7.5.2
✓	Description of the likely recharge, discharge and flow pathways for all hydrogeological units likely to be impacted by the proposed development.	21.7.5.2 21.9.1.2

	IESC information requirements checklist	Section
✓	Values for hydraulic parameters (e.g. vertical and horizontal hydraulic conductivity and storage characteristics) for each hydrogeological unit.	21.6.1.2.3 21.7.5.2
✓	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.	21.9991
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.	21.6.1.2.2 21.6.1.2.3 21.9.1.2
✓	Undertaken in accordance with the Australian Groundwater Modelling Guidelines, 2009), including peer review.	21.6.1.2.3
✓	Calibration with adequate monitoring data, ideally with calibration targets related to model prediction (e.g. use baseflow calibration targets where predicting changes to baseflow).	21.6.1.2.3
✓	Representations of each hydrogeological unit, the thickness, storage and hydraulic characteristics of each unit, and linkages between units, if any.	21.7.5.2 21.6.1.2.3 Table 21.9
✓	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.	21.6.1.2.3 21.9.1.2
✓	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.	21.9.1.2
✓	Identification of the volumes of water predicted to be taken annually with an indication of the proportion supplied from each hydrogeological unit.	21.9.1.2.3
✓	An explanation of the model conceptualisation of the hydrogeological system or systems, including key assumptions and model limitations, with any consequences described.	21.6.1.2.3 21.9.1.2
✓	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.	21.9.1.2.3
✓	Sensitivity analysis of boundary conditions and hydraulic and storage parameters, and justification for the conditions applied in the final groundwater model.	21.9.1.2
✓	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.	21.9.1.2.3
✓	A program for review and update of the models as more data and information become available, including reporting requirements.	21.10.1
✓	Information on the time for maximum drawdown and post-development drawdown equilibrium to be reached.	21.6.1.2.3
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	21.9.1.2

IESC information requirements checklist		Section
	between 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.	21.7.6
✓	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.	21.9.1.2 21.11.1
✓	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.	21.7.5.2
✓	An assessment of the cumulative impact of the proposal on groundwater when all developments (past, present and/or reasonably foreseeable) are considered in combination.	21.14.1.1
✓	Proposed mitigation and management actions for each significant impact identified, including any proposed mitigation or offset measures for long-term impacts post mining.	21.10.1.2
✓	Description and assessment of the adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	21.10.1.2 21.11.1
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.	21.6.1.2.3
✓	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.	21.10.1.2
✓	Long-term groundwater monitoring, including a comprehensive assessment of all relevant chemical parameters to inform changes in groundwater quality and detect potential contamination events.	21.7.5.2
✓	Water quality monitoring complying with relevant National Water Quality Management Strategy (NWQMS) guidelines and relevant legislated state protocols.	21.10.1.2
Surface water – context and conceptualisation		
✓	A description of the hydrological regime of all watercourses, standing waters and springs across the site including:	21.7

IESC information requirements checklist		Section
	• 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). • 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.	21.7.5.1
✓	Assessments of the frequency, volume and direction of interactions between water resources, including surface water/groundwater connectivity and connectivity with sea water.	21.7.5.1
Surface water – analytical and numerical modelling		
✓	Conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	21.6.1.1
✓	Methods in accordance with the most recent publication of Australian Rainfall and Runoff13.	21.6.1.1
✓	A programme for review and update of the models as more data and information becomes available.	21.10.1.1
✓	Description and justification of model assumptions and limitations, and calibration with appropriate surface water monitoring data.	21.6.1.1
✓	An assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	21.6.1.1
✓	A detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	21.6.1.1
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.	21.9.1.1
✓	Existing water quality guidelines and targets, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	21.7.5.1

IESC information requirements checklist		Section
✓	Identified processes to determine surface water quality and quantity triggers which incorporate seasonal variation but provide early indication of potential impacts to assets.	21.9.1.1
✓	Proposed mitigation actions for each trigger and identified significant impact.	21.10.1.1
✓	Description and adequacy of proposed measures to prevent/minimise impacts on water resources and water-dependent assets.	21.10.1.1 21.11.1
✓	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.	21.12.1
✓	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.	21.11.1
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.	21.7.6 Table 21.18
✓	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.	21.7.6
✓	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).	21.7.6
✓	An estimation of the ecological water requirements of identified GDEs and other water-dependent assets.	21.7.6
✓	Identification of the hydrogeological units on which any identified GDEs are dependent.	21.7.6 Table 21.19 Table 21.20 Table 21.21
✓	An outline of the water-dependent assets and associated environmental objectives and the modelling approach to assess impacts to the assets.	21.7.6
✓	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).	21.7.6
✓	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).	21.7.6
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.	21.7.5 21.7.6
✓	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.	21.6.1.2.3

IESC information requirements checklist		Section
✓	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.	21.9.1.2
✓	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.	21.9.1.2
✓	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.	21.9.1.2
✓	An assessment of the overall level of risk to water-dependent assets that combines probability of occurrence with severity of impact.	21.9.1.2
✓	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.	21.9.1.2
✓	Proposed mitigation actions for each identified impact, including a description of the adequacy of the proposed measures and how these will be assessed.	21.10.1.2
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.	21.10.1.2
✓	Concurrent baseline monitoring from unimpacted control and reference sites to distinguish impacts from background variation in the region (e.g. BACI design).	21.10.1.2
✓	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.	21.10.1.2
✓	Regular reporting, review and revisions to the monitoring programme.	21.10.1.2
✓	Ecological monitoring complying with relevant state or national monitoring guidelines.	21.10.1.2
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.	21.6.1.1.2
✓	Description of water requirements and onsite water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	21.6.1.1.2
✓	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.	21.8.1.1 21.8.1.2
✓	Salt balance modelling, including stores and the movement of salt between stores taking into account seasonal and long-term variation.	21.9.1.1
Cumulative impacts – context and conceptualisation		
✓	Cumulative impact analysis with sufficient geographic and time boundaries to include all potentially significant water-related impacts.	21.13.1.2 21.14.1

IESC information requirements checklist		Section
✓	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.	21.13.1.2 21.14.1
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).	21.14.1
✓	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 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.	21.14.1
Cumulative Impacts – mitigation, monitoring and management		
✓	Identification of modifications or alternatives to avoid, minimise or mitigate potential cumulative impacts	21.14.1
✓	Identification of measures to detect and monitor cumulative impacts, pre and post development, and assess the success of mitigation strategies	21.14.1
✓	Identification of cumulative impact environmental objectives.	21.14.1
✓	Appropriate reporting mechanisms.	21.14.1
✓	Proposed adaptive management measures and management responses.	21.14.1
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.	21.9.1
✓	Description of subsidence monitoring methods, including use of remote or on-ground techniques and explanation of predicted accuracy of such techniques.	21.10.1
✓	Consideration of geological layers and their properties (strength/hardness/fracture propagation) in subsidence modelling.	21.6.1.2.3 21.9.1
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	21.9.1

	IESC information requirements checklist	Section
	water flow, erosion and habitat fragmentation of water-dependent species and communities.	
✓	An assessment of the adequacy of modelling, including surface water and groundwater quantity and quality, lake behaviour, timeframes and calibration.	21.6.1.2 21.9.1.2
✓	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.	21.9.1.2 21.12.1
	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
✓	Identification of the presence and volume of potentially acid-forming waste rock and coal reject/tailings material and exposure pathways.	21.4 21.9.1
✓	Handling and storage plans for acid-forming material (co-disposal, tailings dam, encapsulation).	21.10.1
✓	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.	21.11.1
✓	Identification of other sources of contaminants, such as high metal concentrations in groundwater, leachate generation potential and seepage paths.	21.7
✓	Description of proposed measures to prevent/minimise impacts on water resources, water users and water-dependent ecosystems and species.	21.10.1

21.6.1.1 Surface water

Surface water resources assessment for this Project comprised:

- Water quality assessment (AECOM, 2020) to identify environmental values of surface waters within the Project Site and immediately downstream that may be affected by the Project and define relevant water quality objectives (WQOs) applicable to the environmental values (Section 21.6.1.1.1).
- Mine water balance (AECOM, 2019) 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 (AECOM, 2016) (Section 21.6.1.1.2).
- Hydrology, hydraulics and geomorphology study to evaluate risks associated with predicted changes to land surface, surface water and geomorphic characteristics of watercourses affected by the Project (Alluvium, 2019) (Section 21.6.1.1.3).
- Predictions of surface subsidence and cracking following successive stages of longwall panel excavation by the longwall top caving (Minserve, 2017) (Section 21.6.1.1.4).

21.6.1.1.1 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 that may be affected by 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.

Datasets that were identified for use in this assessment comprise:

- Gauge Industrial and Environmental (2014) – Receiving Environment Monitoring Program
- Hydrobiology (2016) - Receiving Environment Monitoring Program Annual Report
- CQU (2016) – Saraji Mine Trend Report 2011-2016.

The assessment was informed by release data, reporting of Receiving Environment Monitoring Programs (REMP), trend reports and some raw data from the existing Saraji Mine. Monitoring data provided for this assessment covered a period from 2010 to 2019. Monitoring data was available for various upstream and downstream locations surrounding the Project Site. This data was collected from downstream of the existing Saraji Mine and therefore is representative of the existing baseline conditions of the Project Site. These are discussed in greater detail in Appendix E-1 Surface Water Quality Technical Report (AECOM, 2021).

21.6.1.1.2 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 mine WMS
- development of the proposed mine WMS required to meet the key objectives and considerations
- validation of proposed mine WMS through water balance assessment
  - development of schematic for mine WMS
  - confirmation of mine plan and all model input data
  - development of and confirm water balance model
  - validation of proposed mine WMS meets outline key objectives and considerations.

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, 2021). The WMS is assumed to be in line with best management practice for mine water management including:

- 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 where possible (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.

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 Saraji Mine 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 raw water dam (RWD), which has been sized to meet all 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.

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 historical climatic conditions, with the aim of:

- estimating the potential quantity and quality of mine affected water (MAW) that may be generated during the operation of the Project
- estimating f 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 and reuse objectives
- identifying the required transfer capacities to move MAW around the mine WMS so that containment, productivity and reuse objectives are met
- estimating the potential volumes of raw water required to satisfy Project consumptive demands that either:
  - cannot be satisfied through the reuse of MAW, or
  - when stored volumes of MAW are unavailable following periods of prolonged drought
- development of an understanding of the potential risk of overflow to the receiving environment. The WBM was developed to dynamically simulate the proposed 20 year production schedule.

This allowed for key model inputs such as climate data, water demands and groundwater inflow to vary with each simulated mine year. In this manner, the WBM provided for a more representative simulation of the Project as it allowed for ready identification of critical WMS stress points such as maximum containment requirements and peak raw water demand.

21.6.1.1.3 Hydrology, hydraulics and geomorphology

The assessment required the establishment of baseline environmental values (existing conditions) against which changes caused by subsidence could be compared. Determining the magnitude and nature of impacts and changes involved the creation of one-dimensional (1D) and two-dimensional (2D) hydraulic models for pre- and post-subsidence conditions. Modelling was undertaken for a range of flow events to inform the likely hydrologic, hydraulic and geomorphic responses and appropriate mitigation options. Predicted subsidence will have no impact on the flows entering the Project Site from upstream, therefore the same flow estimates were used for both the pre- and post-subsidence modelling.

21.6.1.1.4 Subsidence

Background information provided by BMA, including detailed geological logs and in situ stress measurements, was used to carry out an assessment of potential surface subsidence and cracking that may be incurred over the longwall panels. Analysis using the longwall top coal caving 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.

21.6.1.2 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 21.6.1.2.1) to utilise available historical groundwater monitoring bore data, hydrogeological studies and management reports for the existing Saraji Mine and groundwater studies for other projects in the region to characterise the hydrogeological system.
- Mine plan assessment (Section 21.6.1.2.2) to update geological and groundwater baseline conditions and conceptualisation of current groundwater resources (previously compiled for the Grevillea Open-Cut Extension Project) (AECOM, 2016).
- Impact assessment (Section 21.6.1.2.3) through construction and calibration of a predictive numerical groundwater flow model based on a conceptualisation of the geology and groundwater resources to predict groundwater ingress and evaluate the potential impacts of the Project.

21.6.1.2.1 Data review

Groundwater database

A search of the Department of Natural Resources, Mines and Energy (DNRME) Groundwater Database (GWDB) was undertaken during May 2018 to identify registered groundwater bores within and adjacent to the underground mining footprint. The search identified 42 registered groundwater bores within a 15 km radius of the underground mine layout. Of these:

- Five (43639, 90475, 165162, 165326 and 13040179) are described as being abandoned or destroyed (not potential useable/impacted bores, excluded from further discussion)
- Five (158010, 158011, 158012, 158013 and 158014) within the existing Saraji Mine groundwater monitoring network located on BMA owned land.

A bore census was undertaken in the Project area in 2007 identified 12 unregistered landholder bores within 15 km of Project that are not listed on the DNRME GWDB (AGE, 2007). Two of the identified landholder bores (MB31 and MB32) were subsequently monitored as part of the Saraji Mine EA conditions.

A summary of information available for each bore is shown in Table 21-8.

Table 21-8 Bore census data

Bore ID	Property	Location		Standing water level (m)	Bore depth (m)	Water quality		Status
		Latitude	Longitude			pH	EC	
MB1	Meadowbrook	-22.3434	148.4127	20.63	79.4	7.62	2,760	Pump removed
MB2	Meadowbrook	-22.3491	148.3200	22.86	60.9	-	-	Not equipped
MB3	Meadowbrook	-22.3490	148.320	23.82	50	6.67	6,990	Not equipped
MB4	Meadowbrook	-22.3491	148.3200	23.53	27.1	-	-	Not equipped
MB5	Meadowbrook	-22.4131	148.3713	-	-	7.11	7,270	Equipped
MB6	Meadowbrook	-22.3486	148.3142	-	-	8.23	5,880	Equipped
LV1	Lake Vermont	-22.4278	148.3846	23.77	>100	7.32	916	New unequipped bore
LV2	Lake Vermont	-22.5040	148.3361	-	-	7.87	758	Equipped
SJ1	Saraji Station	-22.4000	148.2224	7.85	-	7.74	8,250	Equipped
SJ2	Saraji Station	-22.4802	148.2641	-	-	-	-	Equipped – not operational
TG1	Tayglen	-22.5210	148.3147	9.42	15.06	8.23	1,940	Not equipped
TG2	Tayglen	-22.5061	148.3366	-	-	7.88	754	Equipped

Source: AGE (2007)

Of the 12 bores identified during the bore census, four bores (MB2, MB3, MB4, and MB6) were identified adjacent to two registered bores; RN132631 and RN136689. There is no water quality data for the two registered bores (RN132631 and RN136689); however, construction details indicate both bores are screened between 315 m and 325 m depth indicating they access groundwater hosted in one of the deeper coal seams. Of the non-registered groundwater bores:

- MB2 to MB4 are between 27 m and 60 m deep and not equipped with any pumps
- MB6 is equipped with a pump but its depth is unknown.

A search of the Queensland Water Entitlement Database showed that none of the registered groundwater bores had water licences and are only used for stock and domestic purposes.

Groundwater bore monitoring data

The existing Saraji Mine groundwater monitoring network comprised two landholder bores and five single pipe monitoring bores, five monitoring locations comprising three nested groundwater piezometers (i.e. 15 monitoring points in total) and eight vibrating wire piezometers (VWPs) located within three holes. Monitoring locations were drilled and constructed between 2011 and 2012, except the landholder monitoring bores (MB31 and MB32).

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 Saraji Mine 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 dating back to 2008.

These bores provide detailed groundwater resource data for the Project.

Previous studies for existing Saraji Mine

In 2011, AGE prepared a groundwater impact assessment using an earlier (now outdated) underground longwall mine plan and schedule for this Project and reported predicted inflows to the underground mine workings and drawdown extents (AGE, 2012b).

Key references for the groundwater impact assessment specific to the Project included:

- 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.

Several previous groundwater studies have been undertaken at the adjacent Saraji Mine. Most recently, a groundwater technical report was prepared by AECOM (2016) to support an amendment to the Saraji Mine EA to include an extension of the existing open-cut Grevillea Pit. Other investigations at the Saraji Mine 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 (specific to the Saraji Mine) included:

- AECOM (2016). Saraji Open-Cut Extension Project – Groundwater Technical Report
- AGE (2013). Annual Review of Groundwater Data and Monitoring Network – 2031 - Saraji Mine
- AGE (2012a). Review of Groundwater Monitoring Data – Saraji Mine, dated December 2012
- AGE (2007). Report on Hydrogeological Regime and Impact Assessment - Saraji Mine
- Gauge (2016). Annual Groundwater Monitoring Report - Saraji Coal Mine - September 2016
- Gauge (2015). Annual Groundwater Monitoring Report - Saraji Coal Mine - June 2015
- 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. Prepared for AECOM Australia Pty Ltd.

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

Other groundwater studies in the region

Numerous studies have 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 relevant to the Project:

- Arrow (2012). Arrow Bowen Gas Project EIS - Chapter 14 – Groundwater
- JBT Consultants (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.

21.6.1.2.2 Mine plan assessment

Evaluation of the target coal seam, mining layout and mine plan (sequence) were evaluated to allow for optimum groundwater modelling simulations to conservatively estimate the largest potential impacts of mining on the groundwater resources. In summary, the assessment considers the following:

- the Project is a single-seam operation involving extraction of the Dysart Lower (D14 / D24) seam and assesses potential impacts of mining the Dysart Lower seam (within the MLs and MLAs)
- coal will be mined by longwall methods consisting of a northern region of panels and a southern region of panels separated by a main heading, which will be progressively mined down dip as mining

progresses. Panels within the northern region will be oriented northwest-southeast whilst panels in the southern section will be oriented northeast-southwest

- the maximised footprint corresponding with the maximised underground mine layout (Figure 21-5) relating to the maximum limit of predicted subsidence as estimated by subsidence modelling (Minserve, 2017). It is considered that the use of the maximised footprint allows for a conservative assessment which considers the largest potential impacts of mining on groundwater resources
- A production schedule (from FY 2023 (Mine Year 1) to FY 2042 (Mine Year 20)) that spatially relates to the optimised mine plan (Figure 21-5), referred to as the optimised layout. Mining will commence from the western end within ML 1775, adjacent to the existing Saraji open-cut operations and progressing towards the east into MLA 70383.

The mine plan representing the maximised footprint and production schedule for the optimised underground mine layout illustrated in Figure 21-5 allowed for a conservative assessment of the maximised footprint from a spatial perspective and the optimised footprint from a coal extraction perspective. The assessment allowed for the inclusion of the potential goaf alteration due to longwall mining as estimated in the subsidence modelling (Minserve, 2017).

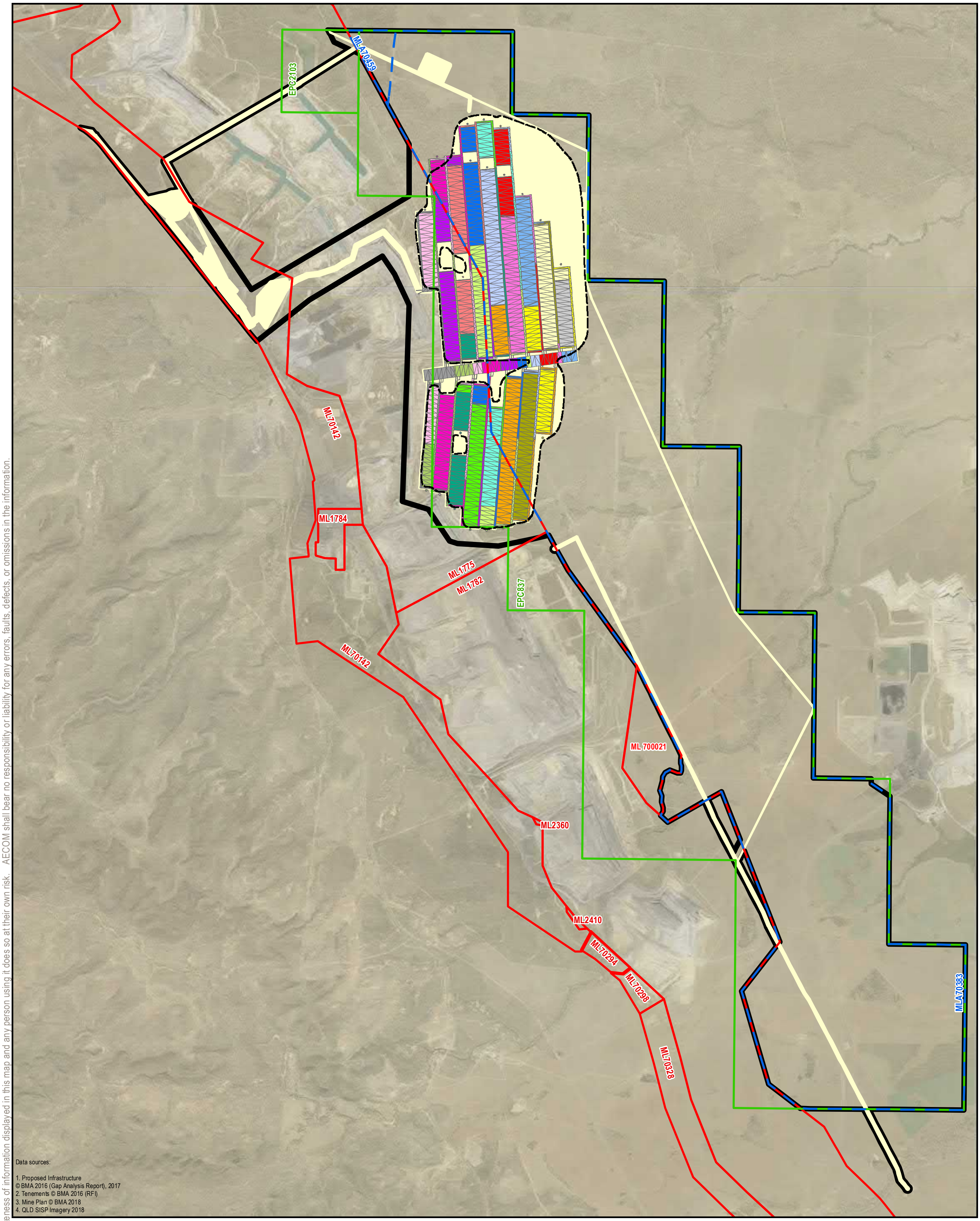
Open-cut considerations

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 are scheduled to 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 that 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 21-7.

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.

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 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 Saraji Mine open-cut mining.



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Underground layout (optimised)
- Limit of subsidence

Optimised Mine Plan (Financial Year)

2023	2030	2037
2024	2031	2038
2025	2032	2039
2026	2033	2040
2027	2034	2041
2028	2035	2042
2029	2036	

N

Figure 21-5
Optimised underground mine layout and maximised footprint (limit of subsidence)

Environmental Impact Statement
Saraji East Mining Lease Project

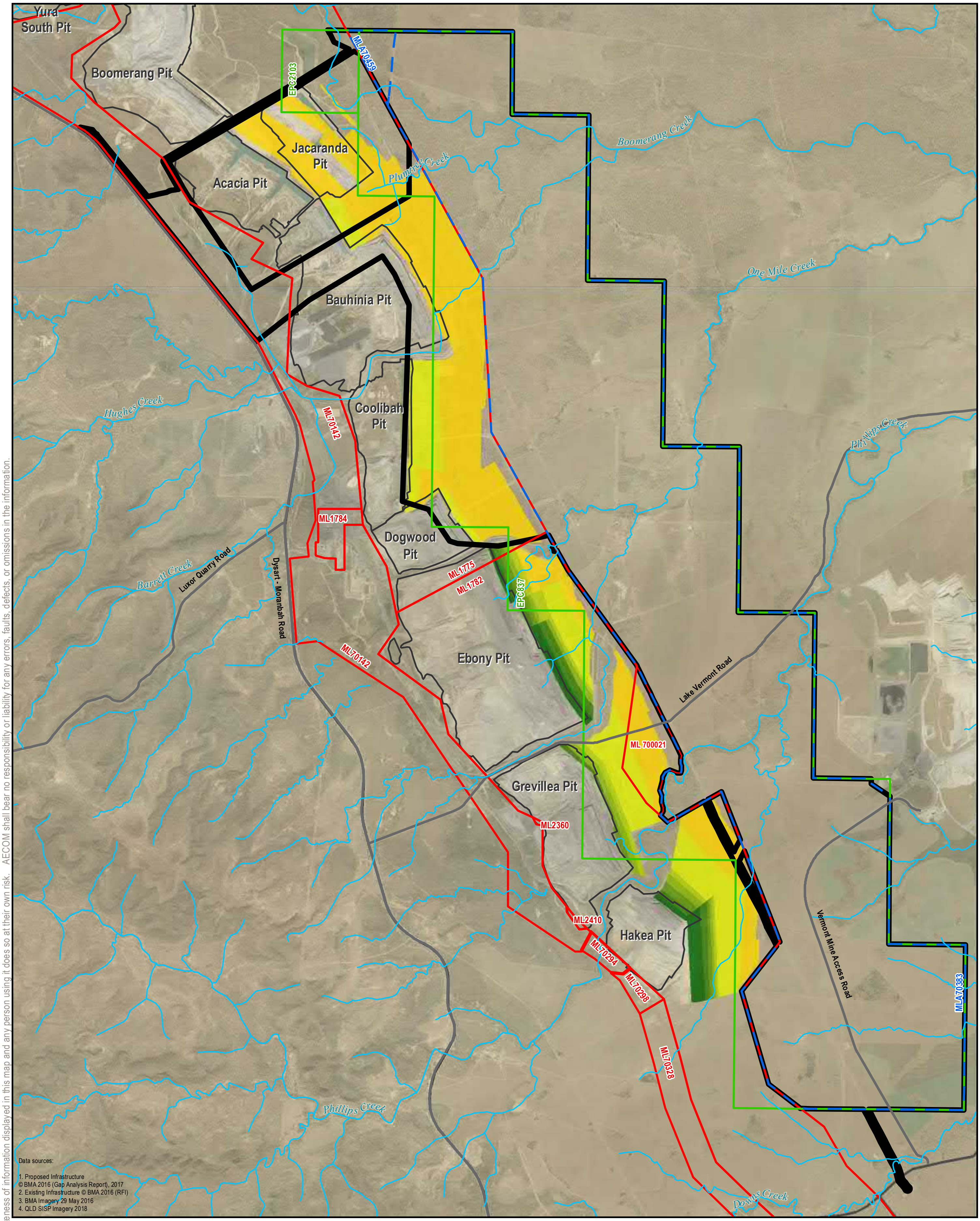
0 0.5 1 2
Kilometres

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

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

BHP

DATE: 19/08/2020 VERSION: 0



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Existing Open-Cut Extent
- Watercourse
- Public Road

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)

BHP

DATE: 19/08/2020 VERSION: 0

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G353_v0_A4P_ApprovedSarajiOpenCutMinePlan.mxd

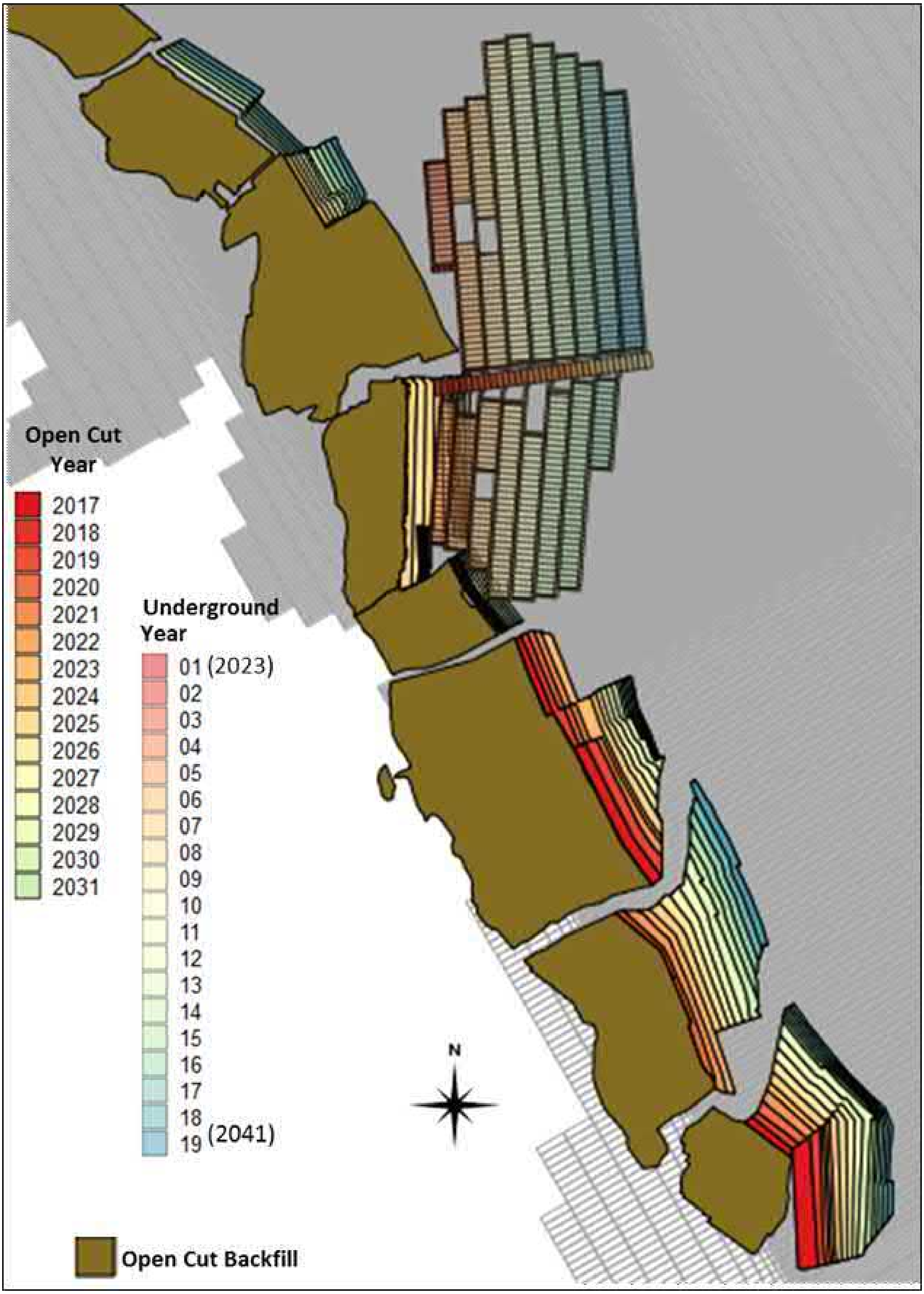


Figure 21-7
Underground mine plan and the Saraji Mine open cut pit mining sections per year

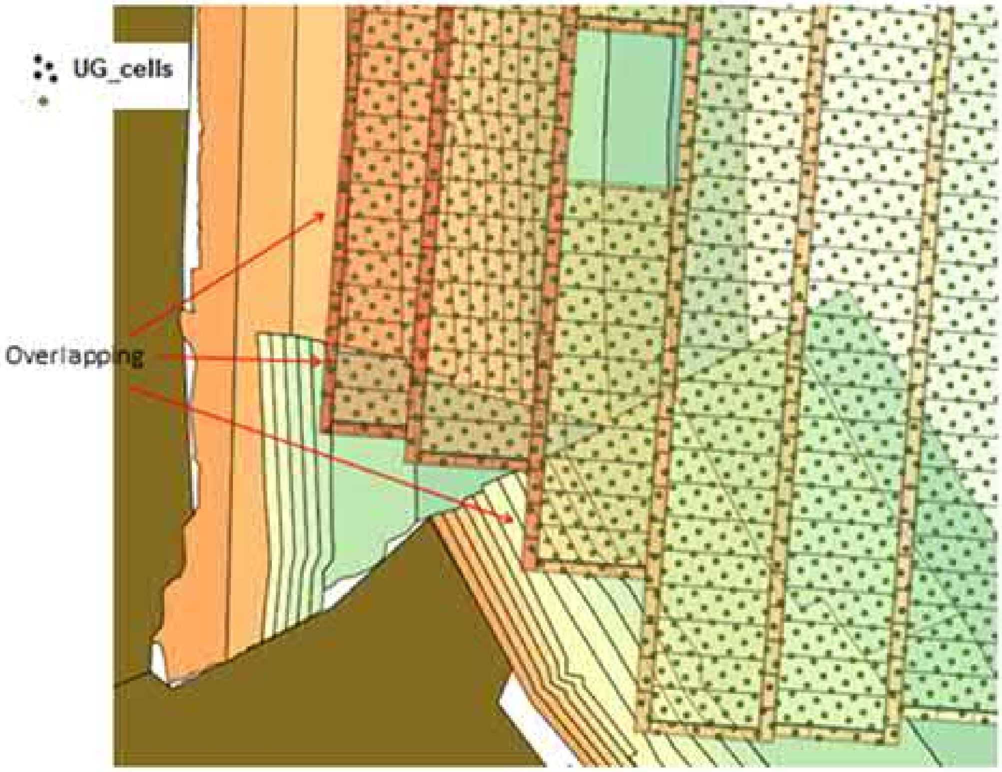
Environmental Impact Statement
Saraji East Mining Lease Project

BHP

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

DATE: 15/07/2020 VERSION: 0

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G354_v0_A4P.mxd



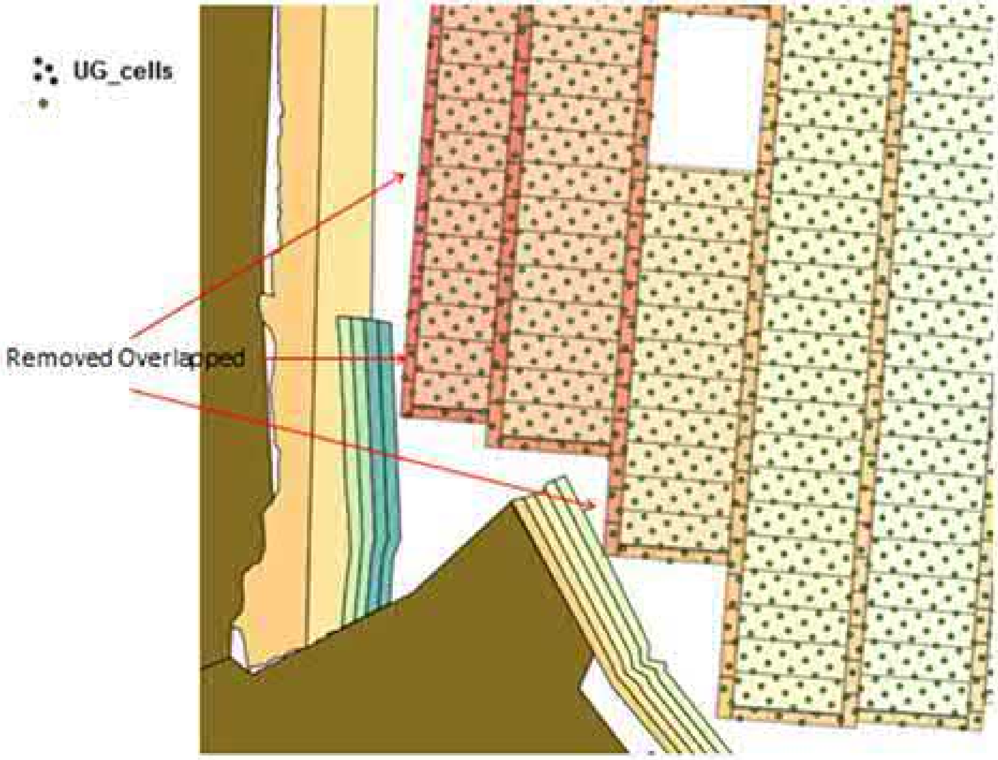


Figure 21-8
Project mine plan and Saraji open cut mine plan overlap

Environmental Impact Statement
Saraji East Mining Lease Project

BHP

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

DATE: 15/07/2020 VERSION: 0

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G356_v0_A4P.mxd

21.6.1.2.3 Impact assessment on water resources

Potential impacts of the Project on groundwater resources were assessed using predictive groundwater modelling. The modelling looked at mine dewatering impacts (groundwater ingress and groundwater level drawdown) considering the approved Saraji Mine open-cut workings with and without the Project. Predictive simulation of groundwater level drawdown, groundwater ingress and groundwater level recovery were conducted with and without the Project.

The objective of groundwater modelling was to produce a tool that can suitably represent the current conceptual understanding of the groundwater systems relevant to the Project area and predict changes in groundwater conditions due to the Project.

Historical studies and field data (Section 21.6.1.2.1) were used to develop a conceptual understanding of the groundwater regime(s) across the Project area. The development of the numerical model was based on this conceptual understanding.

The existing AGE finite difference numerical groundwater model (2012), utilised and refined by AECOM (2016), was further refined as part of this assessment to assess the potential impacts from the proposed underground mining. The predictive groundwater modelling objectives were to:

- estimate groundwater ingress into the mine over the life of the proposed underground mine
- predict the zone of influence on pre-project groundwater levels (due to mine dewatering), including the level and rate of drawdown at specific locations
- predict the impact of mine dewatering on groundwater discharges and existing groundwater users
- assess groundwater level recovery and long-term groundwater flow patterns after cessation of the underground mining.

Numerical model

A numerical groundwater model was constructed, based on the conceptual model, using the MODFLOW SURFACT code referred to as SURFACT. SURFACT was used for the simulation of groundwater flow for the Project as it can simulate unsaturated conditions (critical for underground coal mine where panels are progressively dewatered during mining). Modelling involved:

- review the existing AECOM (2016) SURFACT model
- assess existing data compiled since the model was constructed and calibrated in 2016, including additional mining, DNRME registered bore data and groundwater monitoring
- review the existing open-cut mining areas, pit depths and backfill areas
- account for the proposed underground mine plan and scheduling
- run model predictions and ingress estimates for the proposed underground mining through assessing scenarios of the approved open-cut mining with and without the Project (refer to mine plan considerations in Section 21.6.1.2.2).

Model geometry

The model domain comprised 94,292 active cells aligned in 417 rows and 213 columns. The cell sizes range in size from 50 m x 50 m up to 500 m x 500 m. The model extent was 30.5 km x 40.5 km, covering an area of approximately 1,235 km^2.

Model boundaries

The Project groundwater model was constructed to include a variety of boundary conditions across the model domain, including constant head boundaries and river cells to enable the simulation of surface water bodies within the model domain.

The major surface drainage alignment in the model area is the Isaac River, which runs in a south south-east direction close to the model's eastern boundary. Constant head boundaries were defined where the river enters and exits the model. This boundary condition assumes a fixed groundwater level for the entire period of simulation, allowing water to pass into and out of the model domain depending on the direction of flow defined by the relative groundwater levels in the adjoining portion of the model.

It is noted that surface discharge of groundwater to surface water was included in the model using the SURFACT river (RIV) package (in the uppermost 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 riverbed conductance. The river elevations (reference levels) were set to between 1 and 5 m below the ground surface elevations.

It is noted that all creeks in the Project Area are ephemeral with only intermittent flow. It was conceptualised that the alluvial sediments will not contain permanent groundwater as recharge to the alluvium seeps downwards into the underlying sediments. None of the creeks in the Project Area have permanent groundwater baseflow that contributes to surface flows.

The north and south boundaries have been selected suitably distant from the approved and planned underground and open-cut mining areas so as not to markedly influence model predictions.

Except for the constant head boundaries, the numerical model domain has an inactive or “no flow” boundary at the active model extent and at the base of the model (Model Layer 11).

Model layers

The Permian rocks form a regular layered sedimentary sequence that was simplified for the numerical model by merging several formations/strata into 11 model layers summarised in Table 21-9. The thickness and extent of the model layers within the model domain were interpreted from geological surfaces provided by BMA. Within the overlying Permian coal measures, coal seam aquifers and interburden aquitards are considered as one hydrogeological model layer allowing for higher vertical hydraulic conductivity than can be expected with interburden aquitards. The target coal seams are included preserving the measured thickness to ensure the transmissivity of these seams. The model consists of Alluvium, which is not laterally or vertically extensive across the model domain; it was included within Layer 1 as a separate zone, but not as a separate layer.

Table 21-9 Model layers

Model Layer	Hydro-stratigraphic unit	Model Layer	Thickness
1	Tertiary sediments	Variable	1 to 35 m
2	FCCM overburden	Variable	1 to 240 m
3	MCM overburden	Variable	1 to 760 m
4	P02 coal seam	Uniform	3.5 m
5	MCM interburden	Variable	1 to 10 m
6	Harrow Creek (H16) coal seam	Variable	1 to 10 m
7	MCM interburden	Variable	1 to 90 m
8	Harrow Creek (H15, H19) coal seam	Uniform	3.3 m
9	MCM interburden	Variable	1 to 86 m
10	Dysart Lower (D14, D24) coal seam	Variable	1 to 15 m
11	Back Creek Group	Uniform	20 m

Model calibration

Groundwater levels measured and calibrated in 2012 by AGE were projected, using the Saraji Mine open-cut mine and backfill sequence plus open-cut sizes and water levels, to 2016 for use as initial heads in the model.

The groundwater model was calibrated to groundwater level measurements determined to be representative of water levels (groundwater levels collected from correctly constructed bores, screened across one known acquifer) 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. Backfill areas and pit depths were estimated based on landform data provided by BMA.

Field permeability testing was adopted for the calibration of the existing groundwater model. Where little or no site-specific hydraulic parameter data was available, for the alluvium and Tertiary sequences, parameters were adopted from previous experience within the Bowen Basin. The reducing hydraulic conductivity (exponential equations) of the coal seams with depth was used for the Harrow Creek and Dysart coal seams.

The recharge rate was calibrated at 1.43 mm/year for the Quaternary alluvium (0.2% of the mean annual rainfall) and 0.89 mm/year for the rest of the model domain (0.13% of mean annual rainfall). Surface discharge of groundwater was modelled using the SURFACT RIV package in model Layer 1 that removed water at a rate specified by riverbed conductance where aquifer water level was above river elevation reference levels.

Groundwater inflow to the mine workings was modelled using the SURFACT Drain (DRN) package. Using drains involved the setting of a reference (drain target) elevation (base of the target Dysart Lower (D14 / D24) seam and a conductance (leakage) term.

Model calibration statistics indicated a standardised root mean square error (RSME) of 9.5% (< 10%) that is considered fit for purpose. The mean error is -0.42 indicating minimal bias in the model. The difficulty with achieving more accurate calibration includes:

- Long term mining (since 1974) in the area
- Complex heterogenity and simplified representation of strata and permeability
- Representativeness of the “snap-shop” water levels selected for calibration
- Uncertain bore log stratigraphy possibly resulting in incorrect model layer assignment.

Model classification

The groundwater flow model is considered a Class 2 model (Barnett et al, 2012) based on the model confidence level classification presented in the Australian Groundwater Modelling Guidelines. The calibration statistics are reasonable, and the model is considered suitable for predicting impacts on medium value acquifers, providing estimates of dewatering requirements and associated impacts.

Predictive simulations

The calibrated groundwater model was used to evaluate groundwater level drawdown in the target Dysart Lower coal seam (model Layer 10), Harrow Creek coal seam (model Layer 6) and overlying Tertiary and Quaternary sediments (model Layer 1). The predictive model simulations predicted:

- groundwater levels at end of life of proposed underground mining operations (Model layers 1, 6 and 10)
- groundwater level recovery to assess rebound within underground workings noting that final void dewatering is ongoing at Saraji Mine
- groundwater ingress into the approved open-cut operations (including Grevillea Pit) with and without the proposed underground mining, allowing for the estimate of ingress into the underground mine.

The simulation timings were undertaken as per Table 21-10.

Table 21-10 Simulation timings

Model Year	Simulation
1	Open-cut mining commence
5.5	Commence incidental mine gas management*
6.5	Commence underground mining
15	Stop open-cut mining
24.5	Stop underground mining

Model Year	Simulation
75.5	50 years of recovery (post mining)

* 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. Details of the gas extraction modelling and inclusion in the predictive groundwater modelling is included in the Groundwater Technical Report (AECOM, 2018a).

Long-term recovery simulations

Groundwater drawdown was predicted for the end of underground mining for the following model layers:

- Model layer 1 - Quaternary/Tertiary
- Model layer 6 - Harrow Creek (H16) coal seam
- Model layer 10 - Dysart Lower (D14, D24) coal seam.

The modelled drawdown contours provided an estimate of the largest zone of influence related to the mine dewatering.

The groundwater model was then used to provide a prediction of long-term groundwater level rebound (for 50 years post-mining). It is noted that for this long-term prediction included consideration of the Saraji Mine open-cut operations, which are assumed to cease at the end of 2031 (when the open-cut pits reach the approved ML boundaries) and all underground mining will cease at the end of 2042; this in line with the current open-cut approvals and the proposed Project life of mine.

Groundwater recovery was predicted in the model, using select bores, such that groundwater level time series hydrographs were generated to show groundwater rebound. The post-mining modelling, included for increased permeability in the underground goaf and open-cut backfill, natural low recharge across the model domain and evaporative losses from the final open-cut voids. The complex recovery was simulated noting the influence of:

- Open-cut final voids
- Limited rainfall recharge
- Long term (since 1974) groundwater removal from storage
- High evaporation across 22.5 km strike length (negative climate balance)
- Low aquifer hydraulic properties

The simulation of groundwater level response in selected (monitoring and registered) bores (for impact assessment on local groundwater resources) allowed for the simulation of groundwater recovery in the different model layers. This is evident in monitoring bore MB29, which allowed for the assessment of recovery in all 11 model layers (AECOM, 2019).

Simulation of longwall mining – goaf

To estimate mine impacts and estimates of groundwater ingress from underground longwall mining activities, aquifer alteration due to 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 can hold up the overburden without failure. Where propagation extends to the land surface, subsidence of the land surface occurs.

Based on subsidence modelling results (using the maximised mine footprint), it was estimated that the fractured zone extends 150 m above the mined panel which was included in the groundwater model. Vertical and horizontal hydraulic conductivity were conservatively estimated to increase 100 times in the subsidence model for those model layers that intersected the fractured zone and to simulate the development of fractures and bedding planes over time in the SURFACT model.

Simulation of incidental mine gas extraction

Groundwater intersected in the underground workings will be removed as part of Incidental Mine Gas extraction, as detailed in the gas Drainage Planning at Saraji East (GeoGas, 2016). 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. The 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.

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 for the maximised underground layout (GeoGas, 2016) separated the maximised underground layout into five regions representing differing gas characteristics and simulated gas and associated water extractions to achieve pre-determined gas contents within three years, five years and eight years following gas and water extraction. The eight-year gas and water extraction predictions were adopted for the inclusion in the groundwater modelling to allow 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.

Gas drainage, simulated in the predictive groundwater model, included the pumping of gas extraction bores commencing one year prior to underground mining and continued for a period of 8 years (as envisaged by GeoGas), allowing for the effective management of incidental mine gas.

Groundwater extraction associated with the Project includes for gas dewatering, allowed for the assessment of drawdown of groundwater levels and potential impacts to groundwater quality.

Model groundwater balance

Using the predicative groundwater model, 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 model simulations
- Assessing water movements in and out of the model domain.

The difference between the calculated model inflows and outflows at the completion of the model calibration (known as the mass balance error), was 0%. This indicates an accurate numerical solution and overall stability of the model.

Observations from the open-cut pits at Saraji Mine indicate that groundwater discharges slowly from the Tertiary sediments and the underlying Permian strata. Groundwater ingress rates to the Saraji 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.

The evidence of damp pit walls and the site-specific aquifer hydraulic conductivity data indicates that the main groundwater contribution to the model mass balance is from the most permeable unit, the target coal seams.

Groundwater ingress into the mining operations, approved open-cut and proposed underground workings, for the 25 year model simulation, was 35.7 Giga-litres (GL). The contribution from the proposed underground workings was estimated at 3.1 GL (8% of total predicted ingress). This is due to the limited underground workings compared to the large scale open-cut mine voids (along a strike length of over 22.5 km).

The available aquifer hydraulic parameter data indicates that the average 0.1 GL/year ingress from the underground workings is derived predominantly derived from the surrounding unmined coal. Little or no groundwater is induced from the overlying Permian and Tertiary aquitards.

Cumulative impact assessment

Cumulative impact assessment considered the existing approved open-cut mining operations together with the proposed underground mine and resource projects in the region. The Project's likely impacts on groundwater resources have been assessed and modelled predictions of underground mining impacts used to evaluate groundwater level drawdown, groundwater ingress and groundwater level recovery with and without the Project.

Model limitations

The groundwater flow model was 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 grid scale, the inaccuracies of measurement data, and the incomplete knowledge of the spatial variability of input parameters.

Best data available has been sourced for hydraulic conductivity values from aquifer tests, core tests, and the spatial distribution with depth. The groundwater model was calibrated to capture the regional groundwater flow trend identified from groundwater levels with the objective of obtaining an acceptable starting condition that represented the regional trend for the predictive simulation and reasonable parameter ranges. Verification of reliability of the predictive model was conducted by undertaking uncertainty analysis.

21.6.2 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.

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 21.6.2.1
- 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 21.6.2.2
- 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 21.6.2.3
- mapping of habitat associated with the MNES values known or having the potential to occur within the Project Site – refer Section 21.6.2.4
- 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 21.6.2.5.

21.6.2.1 Desktop assessment

A desktop assessment was completed to determine the known and likely suite of EPBC Act listed threatened species and TECs occurring across the Project Site. The data sources used included:

- 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 Saraji Mine
  - EcoServe (2007). Biodiversity and Threatened Species Action Plan for Saraji Mine. Final Report Submission 27th June 2007. An unpublished report prepared for BMA Saraji Mine
  - EcoServe (2006). 2006 Winter Vertebrate Fauna Surveys of Remnant Habitats on Saraji Mine. Draft Submission. An unpublished report prepared for BMA Saraji Mine
  - EcoServe (2008). Baseline Fauna Surveys of Rehabilitated Lands on Saraji Coal Mine. An unpublished report prepared for BMA Saraji Mine
  - EcoServe (2009). Baseline Fauna Surveys of Rehabilitated Lands on Saraji Coal Mine. An unpublished report prepared for BMA Saraji Mine

   - 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
- Relevant database searches:
   - DAWE EPBC Act Protected Matters Search Tool (PMST) to identify MNES with potential to occur within a search area extending 15 km from the Project Site (i.e. Project Area) (Department of Agriculture Water and the Environment, 2020a)
   - Queensland Herbarium Regional Ecosystem Description Database (REDD) for current Regional Ecosystem (RE) descriptions and geological and land zone descriptions
   - DNRME Vegetation Management Regional Ecosystem Map, including Essential Habitat, to determine vegetation communities mapped within and surrounding the Project Site (Department of Natural Resources Mines and Energy, 2020)
   - DNRME Regulated Vegetation Management Map to determine the extent of Category A, Category B, Category C and Category R vegetation within and surrounding the Project Site (Department of Natural Resources Mines and Energy, 2020)
   - DNRME *Vegetation Management Act 1999* (VM Act) watercourse mapping (Department of Natural Resources Mines and Energy, 2019)
   - Brigalow Belt Bioregion Biodiversity Planning Assessment (BPA) Version 1.3 (Department of Environment and Science, 2020a) (approximately 100 km buffer surrounding Project Site)
   - Queensland Wildlife Online search results for flora and fauna species records within a search area extending at least 15 km from the Project Site (i.e. Project Area) (Department of Environment and Science, 2020b)
   - Atlas of Living Australia (ALA) for threatened flora and fauna species records (Australian Government, 2020)
- Aerial photography
- Records published in scientific journals, reports and general flora and fauna distribution texts.

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 21-11.

Table 21-11 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	15 km (built into these search coordinates)
Wildlife Online	Latitude: -22.6227 to -22.2247 Longitude: 148.1710 to 148.5180	15 km (built into search coordinates)

Data Source	Search area	Search buffer
Biodiversity Planning Assessment	Latitude: -22.6227 to -22.2247 Longitude: 148.1710 to 148.5180	100 km
State mapping, including REs and Essential Habitat	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 take into account actual presence of suitable vegetation, habitats, geology, soil or climate to support the type of presence reported in the Protected Matters search.

21.6.2.2 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, 2020).

To supplement previous field surveys, four additional biodiversity surveys have been conducted across the Project Site by AECOM between 2016 and 2020 (AECOM, 2020) 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, 2020) provide valid and contemporary data to ground-truth REs and inform identification and assessment of threatened flora and fauna and ecological communities throughout the Project Site.

21.6.2.2.1 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 21.6.2.1.

The surveys employed standard methods including secondary survey sites, tertiary survey sites, quaternary survey sites and random meander search areas (AECOM, 2020). 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 21-9.

21.6.2.2.2 Threatened ecological community assessment

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

- 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% 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:

- RE11.3.1
- 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% (best quality) or less than 50% (good quality)
- Introduced species – of total perennial plant cover, perennial non-woody introduced species are less than 5% (best quality) or less than 30% (good quality).

21.6.2.2.3 Threatened flora species searches

There are no EPBC survey guidelines for threatened flora species.

Flora survey methods (AECOM, 2020) 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.

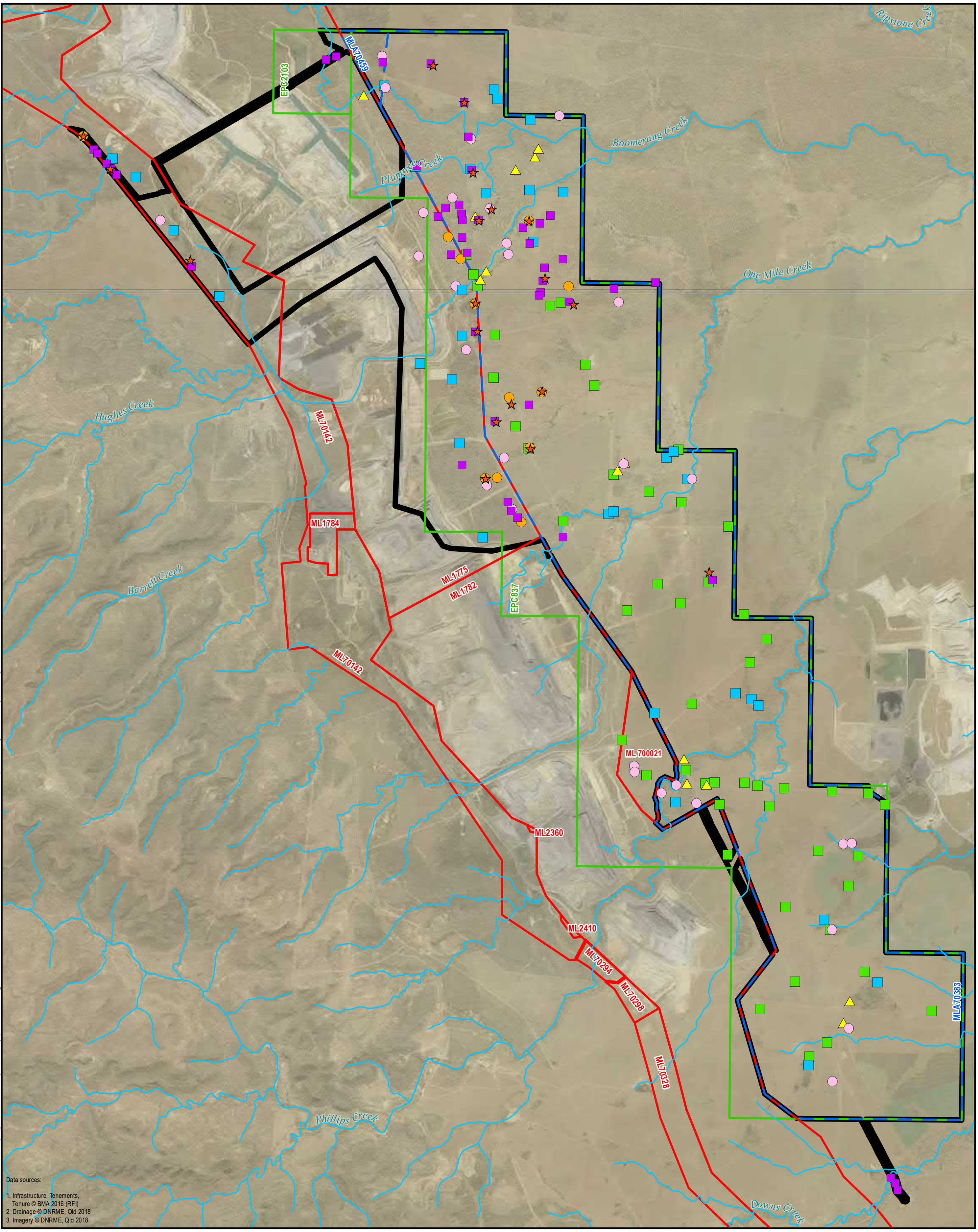
Botanical voucher specimens were collected throughout the field survey to verify site floristics and enable laboratory identification of those species that were problematic. All specimens were able to be confirmed during this process and hence no vouchers were required to be sent to the Queensland Herbarium 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.

21.6.2.2.4 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 21-10. Fauna survey methods (AECOM, 2020) employed to accommodate targeted species are described below and attributed to the various surveys undertaken in Table 21-12.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse

Flora survey sites

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

N

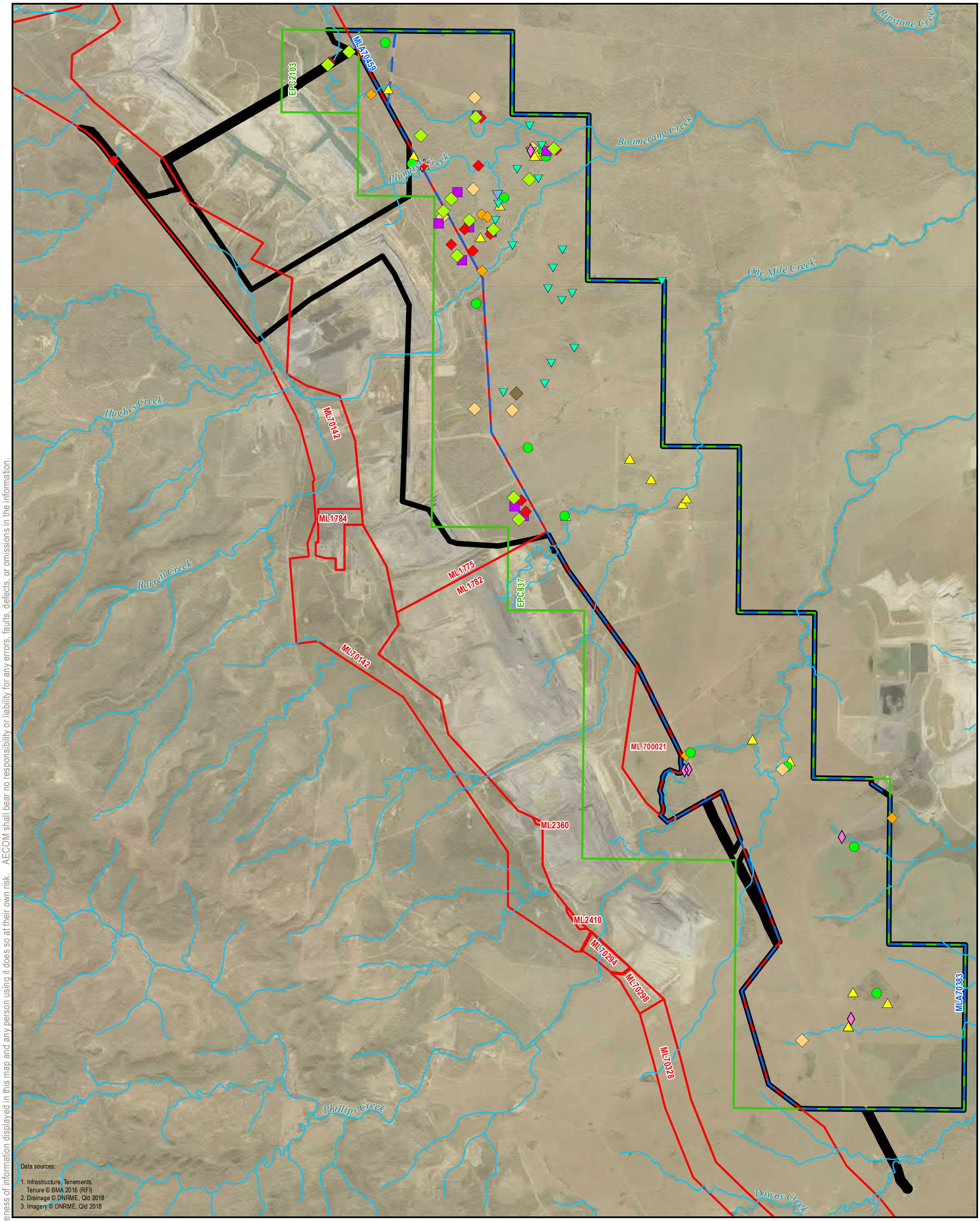
0 0.5 1 2
Kilometres

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

Figure 21-9
Flora survey sites

Environmental Impact Statement
Saraji East Mining Lease Project

DATE: 19/08/2020 VERSION: 1



Legend

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse

Fauna survey sites

- Yakka Skink habitat site (AECOM 2020)
- Squatter Pigeon habitat site (AECOM 2020)
- Greater Glider habitat site (AECOM 2020)
- Active fauna search (AECOM 2020)
- Spotlight location (AECOM 2020)
- Fauna habitat site (AECOM 2017)
- Anabat location (AECOM 2017)
- Spotlight location (AECOM 2017)
- Winter site (SKM)
- Primary site (SKM)
- Secondary site (SKM)

N

Figure 21-10
Fauna survey sites

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)

DATE: 19/08/2020 VERSION: 2

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G238_v2_A4P.mxd

Table 21-12 Fauna survey methods employed during respective survey periods

Survey Method	Survey Nov-2007 SKM	Jan-2010 SKM	Apr-2010 SKM	Jul-2011 SKM	Aug-2016 AECOM	Oct-2016 AECOM	Jan-2017 AECOM	Mar-2020 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 were 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.

21.6.2.2.5 Threatened fauna species

Fauna survey effort undertaken for potentially occurring threatened species listed under the EPBC Act is outlined in Table 21-13. 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 21-13. 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 21-13 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	Survey guidelines for Australia's	**Survey Techniques**	• Active searches conducted: 24-	• Active searches conducted: 12-	• Total active searches	**Yes**

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
(*Erythrotriorchis radiatus*)	threatened birds (Department of the Environment, Water, Heritage and the Arts, 2010)	• 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 nests is the most effective way to detect the species presence. **Seasonal Considerations** No evidence of long-distance seasonal movements or seasonal considerations required.	person hours of bird surveys over 9 days • Incidental bird surveys: 622-person hours of over 33.5 days • Targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	person hours over 3 days • Incidental bird surveys: 86-person hours over 6 days.	conducted: 36-person hours over 12 days • Total incidental bird surveys: 708-person hours over 39.5 days.	Potential nests for the species were searched throughout the surveys. Audio and visual surveys for birds were conducted throughout 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 should be undertaken during daylight hours and preferably in the early morning (<2 hours	• 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	• 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?
		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 its breeding season (October to March).	• Targeted habitat assessments were conducted for the species throughout the duration of the field surveys.			
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.	• 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	• 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

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		• Spotlight shortly after dusk – Survey effort not specified. Difficult to detect even when present. **Seasonal Considerations** Movements are poorly known, and it may be a migratory species. No seasonal considerations for targeted surveys for this species.	water for 5 nights • Targeted habitat assessments were conducted for the species throughout the duration of the field surveys.			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 (Department of the Environment and Energy, 2017)	**Survey Techniques** • Bird surveys in suitable habitat: – 1 x survey in December – 2 x surveys in January – 1 x survey in February. Surveys should 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	• Active searches conducted: 15-person hours during October and 8.5-person hours over 3 days during November • Incidental bird surveys: 330-person hours of over 15.5 days during October and November • Targeted habitat assessments were conducted for the species	• 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 • Total incidental bird surveys: 386-person hours of incidental bird surveys over 21.5 days.	**Requirements partially met** Only a total of two surveys rather than the required 4 surveys has been undertaken. 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?
		(Department of Agriculture Water and the Environment, 2020b). **Seasonal Considerations** Surveys should be conducted between October and February when the species arrive and depart in Australia.	throughout the duration of the field surveys.			
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** Ghost bats vary seasonally in the use of	• 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 identified no roosts or caves	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 identified no roosts or caves • Harp traps: 20 trap nights (4	**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 survey techniques (attended bat recorders, roost searches, 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?
		roosts; individuals congregate in maternity roosts from September to April and disperse in small groups over winter. Surveys targeting this species should 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).	• 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.		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.	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	• 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	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	**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?
		• Harp traps and/or mist nets: – 20 trap nights over a minimum of 5 nights Harp traps and/or mist nets should 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 should also be conducted over water (artificial or naturally occurring). **Seasonal Considerations** Surveys are best conducted on warm nights from October through to April.	over/adjacent to water (two mist nets used over 5 nights) • Targeted habitat assessments conducted for the duration of the field surveys.		water (two mist 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	**Survey Techniques** In the absence of species-specific survey guidelines, Eyre *et al.* (2018) was used to determine suitable survey techniques.	• Spotlighting: 70-person hours over 14 nights • Targeted habitat assessments were conducted for the species	• Spotlighting: 12-person hours over 3 nights • Targeted habitat assessments were conducted for the species	• Spotlighting: 84-person hours over 17 nights • Targeted habitat assessments were conducted for the species	**Yes** Spotlighting survey effort was concentrated in eucalypt woodlands along or adjacent to watercourses with a

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
	(Lindenmayer et al., 2001) Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre et al., 2018) were utilised in the absence of species-specific guidelines	• 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 seasonal considerations for this species.	throughout the duration of the field surveys.	throughout the duration of the field surveys.	throughout the duration of the field surveys.	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 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: 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	• 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	**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

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		• 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 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	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.		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.	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 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?
		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.				
Reptiles						
Adorned Delma (*Delma torquata*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability, Environment, Water, Population and	**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	• Pitfall and funnel trapping during May and November, along a 45 m T fence • Diurnal active searches: 11-	• 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	**Requirements partially met** Hand searches / active searches were conducted in suitable habitat; however not to the required effort detailed in the

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
	Communities, 2011a) 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). 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 and February (warmer conditions), particularly after rain	person hours over 17.5 days • Targeted habitat assessments were conducted for the species throughout the duration of the field surveys.		• Targeted habitat assessments were conducted for the species throughout the duration of the field surveys.	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?
		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	• 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 to

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
		– 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. – 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				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?
		surveys to be undertaken late September to late March.				
Yakka Skink (*Egernia rugosa*)	Draft referral guidelines for nationally listed Brigalow Belt reptiles (Department of Sustainability, Environment, Water, Population and Communities, 2011a) 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)	**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: – 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:	• 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 • No potential burrows or colonies were identified.	• Diurnal active searches: 19.5-person hours over 5 days • Targeted habitat assessments were conducted for the species throughout the duration of the field surveys • No potential burrows or colonies were identified.	• Total diurnal active searches: 30.5-person hours over 22.5 days • Targeted habitat assessments were conducted for the species throughout the duration of the field surveys • No potential burrows or colonies were identified.	**Requirements partially met** Surveys were conducted during the period of maximum activity (post dawn, pre dusk) for the reptile and during the 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?
		– 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 times are late spring and summer. Additionally, referral guidelines recommended surveys to be undertaken late September to late March.				

Species	Survey guidelines	Survey guideline requirement	Effort undertaken prior to March 2020	Effort undertaken March 2020	Total effort undertaken	Requirements met?
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. Pitfall and funnel trapping were conducted during both seasonal surveys. Four pitfall buckets were used at

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.				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.

21.6.2.3 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.

21.6.2.4 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 21-14 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.

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 21.11.

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 21-14 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 provides 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.

21.6.2.5 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 that may 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 all of 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 to provide an overarching analysis of Project related impacts (refer to Section 21.9). Mitigation measures have also been developed to address identified potential impacts (refer to Section 21.10). 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 21-15. Results of the generic impact assessment were utilised to inform the significant impact assessment. 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)
- EPBC Act referral guidelines for the Vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (Department of the Environment, 2014).

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 *Petauroides volans* (Greater Glider) (Threatened Species Scientific Committee, 2016)
- Approved Conservation Advice for *Phascolarctos cinereus* (combined populations in Queensland, New South Wales and the Australian Capital Territory) (Threatened Species Scientific Committee, 2012)
- Approved Conservation Advice for *Denisonia maculata* (Ornamental Snake) (Threatened Species Scientific Committee, 2014a).

Table 21-15 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.

MNES	Criteria	Key definitions
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.

21.7 Environmental values

21.7.1 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 that includes 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 Saraji Mine. The target Dysart coal seam plies vary in thickness between 4.9 m and 7m. 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)[1], 2016) indicates that most of the Project Site is flat, with elevations ranging from 180 metres (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.

Eleven intermittent watercourses cross the Project Site, making their way from the ranges in the west to the downs in the east (DNRME, 2015). These watercourses ultimately drain into Isaac River, which is 15 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.

21.7.2 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 (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 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.

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. While consistent significant or some loss of landscape function and

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

substantial reduction in woody cover (largely due to clearing) across the Brigalow Belt North region, these trends indicate increasing degraded areas, potential loss of biodiversity, weed spread (e.g. Parthenium and rubbervine) and opportunities for woodland thickening in remnant areas and regrowth of previously cleared woody vegetation in non-remnant areas.

21.7.3 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 shows that the mean annual rainfall is 666 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.

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 area has experienced below average rainfall since 2013.

Groundwater levels in unconfined aquifers that receive direct rainfall recharge could be expected to show a trend that mirrors that of the CRD. Figure 21-11 presents the CRD for the period 1900 to 2018.

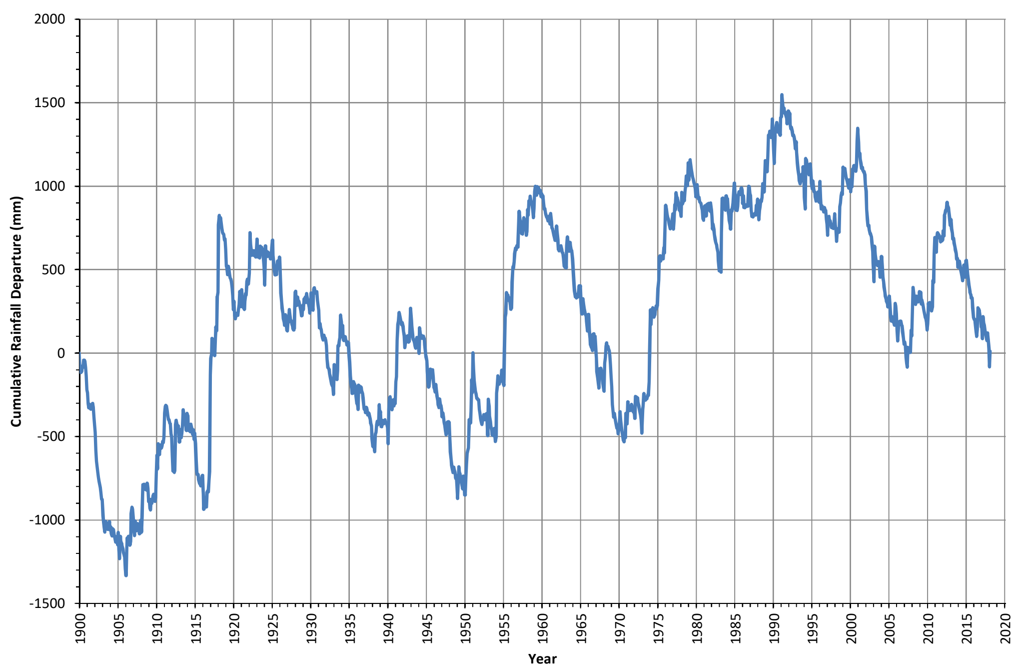


Figure 21-11 Cumulative Rainfall Departure plot

21.7.4 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 the following:

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

Structural geology

The Project area comprises both normal and thrust faults with mapped trends that describe two dominant structural domains: one trends north north-west, the second trends north south. The Isaac Fault 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.

No known faults are mapped within the footprint of the underground mine workings. Geological cross-sections and exploration bores (AECOM, 2019) indicate:

- sediments dip gently towards the east within the MLAs, with an average dip of approximately eight (8) degrees
- no marked disruption of coal seams or sediments because of faulting.

Stratigraphy

The mapped geology indicates that the stratigraphy typically comprises regular Permian coal measures overlain by a variable thickness of unconsolidated to poorly consolidated Tertiary and Quaternary sediments. Tertiary sediments are more complex and irregular with a maximum thickness of approximately 45 m across the underground mine footprint, while Quaternary sediments are associated with the channels of the Isaac River and Phillips Creek. Little or no alluvium is mapped within or adjacent to the Hughes Creek, which drains across the underground mining footprint. Stratigraphy of the Project and surrounds is summarised in Table 21-16.

Table 21-16 Stratigraphy

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

21.7.5 Water resources

21.7.5.1 Surface water

Catchment context

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 21-12.

Watercourses

Watercourses defined as a watercourse under the Water Act 2000 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 potential area of subsidence. Watercourses are identified in Figure 21-13.

Boomerang Creek, Hughes Creek and Plumtree Creek are ephemeral streams with catchments 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. Plumtree Creek commences within the existing Saraji Mine and joins Boomerang Creek within the Project Site. Boomerang Creek and Hughes Creek converge approximately 1 km downstream (east) of the Project Site.

Surface water values

The Project is located within the Isaac River sub-basin of the Fitzroy Basin. The Lower Fitzroy and Fitzroy Barrage Water Supply Schemes are located 250 km downstream of the confluence with the Isaac River; each has 28,621 ML and 62,335 ML of allocated water, respectively. The total catchment area upstream and within the Project Site is about 60 ha, equating to less than 0.0004 % of the total catchment area for these water supply schemes (142,665 km^2).

Environmental values for water are the qualities of water that make it suitable for supporting aquatic ecosystems and human water uses. These environmental values need to be protected from the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.

As described in Schedule 1 of the Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water and Wetland Biodiversity)), environmental values for waters in the Isaac River sub-basin are published 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)’. The environmental values identified for the Isaac Western Uplands Tributaries sub-catchment (within which the Project Site is located) 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).

DNRME database search identified existing surface water users with surface water extraction licences near to the Project Site prior to the confluence with the Isaac River. Of the five surface water licences returned, two licences were for stock watering purposes downstream of the site, with the remaining three licences for BMA to divert a watercourse and for site water management of the existing Saraji Mine. The stock licences (provided in Table 21-17 and illustrated in Figure 21-13) are located within 8 km of the downstream extent of the Project Site.

Table 21-17 Surface water extraction licences

Lot/Plan	Creek	Purpose
9/CNS98	Ripstone Creek	Stock watering
11/KL135	Ripstone Creek	Stock watering

Relevant WQO for the assessment of water quality in the receiving environment were identified from the EPP (Water), local reference data and the Water Quality Guidelines (ANZECC 2000). Datasets used in this assessment comprise monitoring data from locations monitored as part of receiving environment monitoring programs (REMP) for Saraji Mine (SRM) and Peak Downs Mine (PDM) between 2010 and 2020, dependent on location (shown in Figure 21-14). Most of this data was collected from downstream of the existing Saraji Mine and therefore would be similar to the existing baseline conditions of the Project Site as described in Section 21.6.1.1.1.

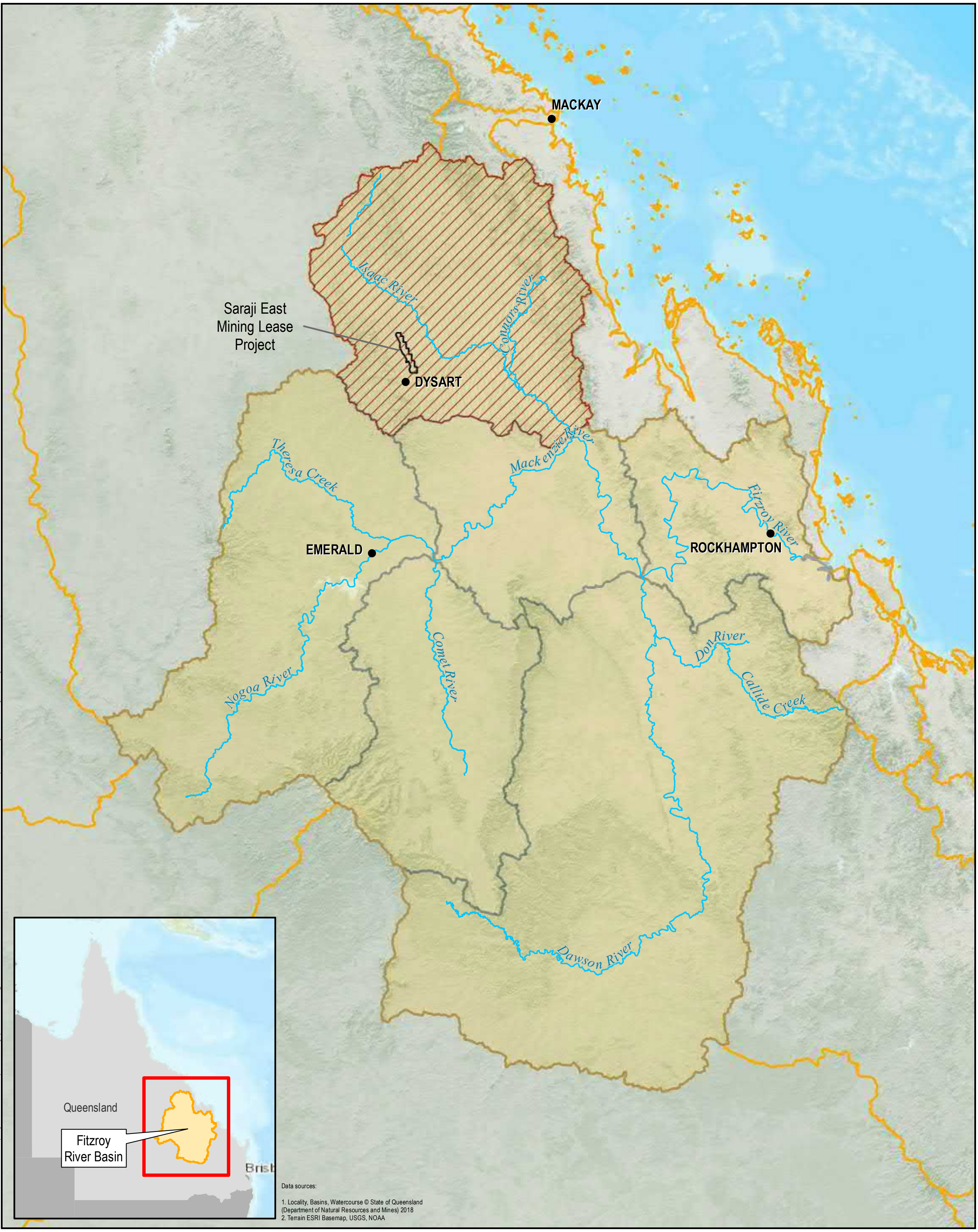
Water quality data shows that water quality were above relevant WQOs for suspended solids and turbidity, electrical conductivity, sulfate and dissolved metals (aluminium, copper, chromium, nickel, and zinc) (see Table 21.18). The local watercourses represent a slightly to moderately disturbed aquatic habitat.

Table 21.18 Summary of water quality data

Water quality parameter	Water quality guideline	Boomerang Creek	Hughes Creek	One Mile Creek	Phillips Creek	Isaac River
Physico-chemical stressors, median value of parameter						
Total suspended solids (TSS)	55 mg/L	101	92	108	698	379
Electrical conductivity (EC)	Base flow: 720 µS/cm High flow: 250 µS/cm	926	536	1,180	336	400
Sulfate (SO_4)	25 mg/L	144	76	75	34	20
pH	6.5-8.5	8.22	7.48	7.91	7.88	7.9
Total nitrogen	500 µg/L	-	(605)	(1,235)	(1,700)	(920)
Ammonia nitrogen	20 µg/L	(35)	20	30	25	50
Oxidised nitrogen (NO_x)	60 µg/L	-	109	929	140	(128)
Total phosphorus	50 µg/L	-	(104)	(61)	(600)	(353)
Filterable reactive phosphorus	20 µg/L	-	(9)	(1)	(-)	(28)
Dissolved oxygen	85% -110 % saturation	(103)	87.5	113.0	85.6	97
Turbidity	50 NTU	(281)	1,379	1,980	1,200	(3,230)

Water quality parameter	Water quality guideline	Boomerang Creek	Hughes Creek	One Mile Creek	Phillips Creek	Isaac River
Toxicants (metals), 95th percentile of parameter						
Aluminium (dissolved)	55 µg/L	(4,483)	4,500	1,255	2,485	1,248
Arsenic (dissolved)	13 µg/L	(2)	1	2	4	1
Chromium (dissolved)	1 µg/L	(4)	1	2	4	2
Copper (dissolved)	1.4 µg/L	(4)	2	12	6	3
Iron (dissolved)	No guideline	(1940)	2,300	2,396	725	730
Molybdenum (dissolved)	150 µg/L (stock) 34 µg/L (Ecosystem)	(5)	2	9	2	2
Nickel (dissolved)	11 µg/L	(4)	5	39	18	3
Selenium (dissolved)	20 µg/L	(10)	10	10	3	10
Uranium (dissolved)	200 µg/L (stock) 0.5 µg/L (Ecosystem)	(1)	2	1	4	1
Zinc (dissolved)	8 µg/L	(9)	5	13	66	6

Result indicates that the guideline is exceeded.
Result from interim dataset comprising a minimum of 8 sampling events, sufficient to comprise an interim reference dataset in accordance with the requirements of the Queensland Water Quality Guidelines (2009).
(Result) indicates that fewer than 8 sampling events contribute to the dataset for that parameter.



Data sources:

1. Locality, Basins, Watercourse © State of Queensland (Department of Natural Resources and Mines) 2018
2. Terrain ESRI Basemap, USGS, NOAA

LEGEND

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

N

Figure 21-12
Regional Catchment

Environmental Impact Statement
Saraji East Mining Lease Project

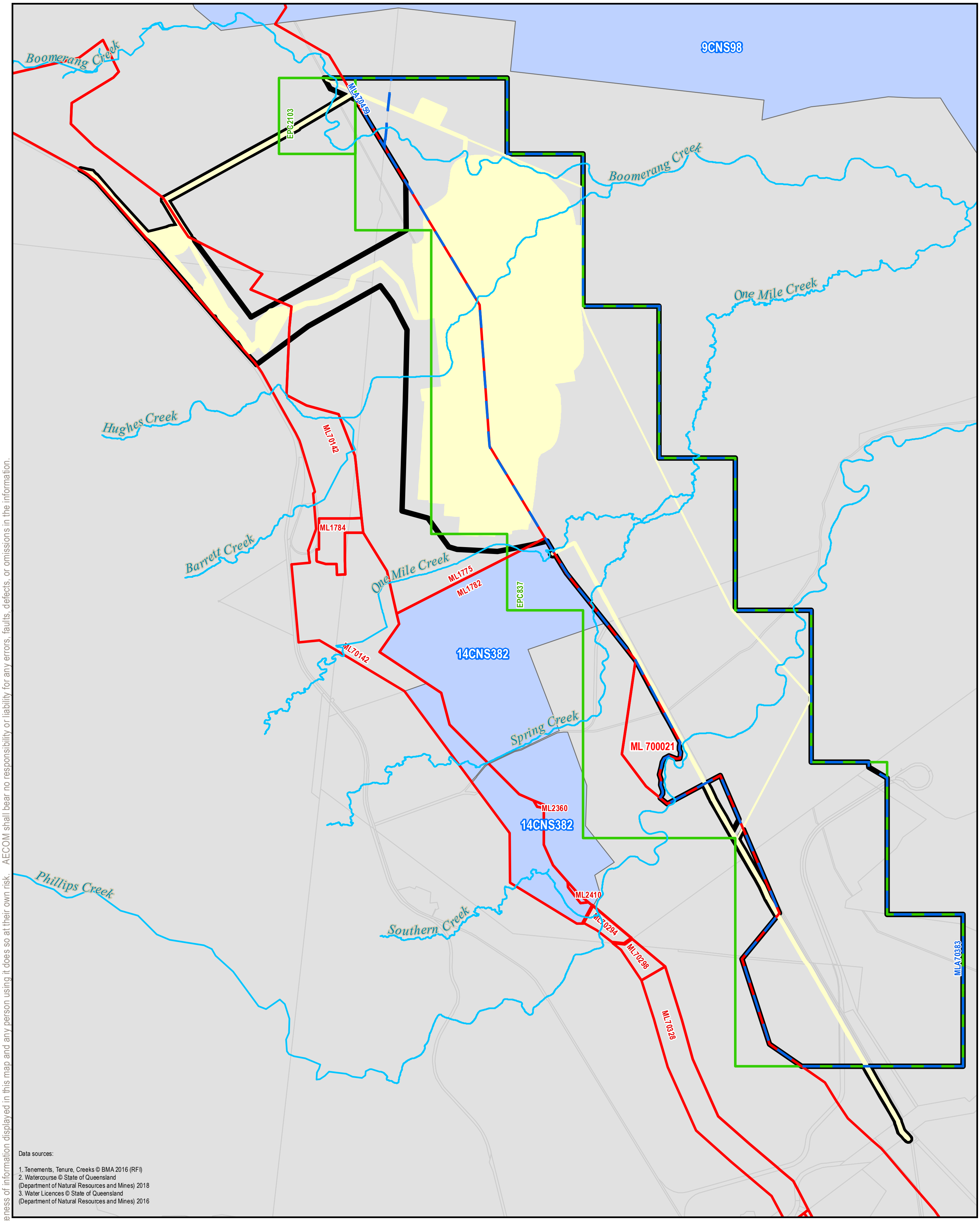
0 25 50 100
Kilometres

Scale: 1:3,000,000 (when printed at A4)

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

DATE: 8/03/2019 VERSION: 1

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\08 Surface Water\60507031_G270_v1_A4P.mxd



LEGEND

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

N

Figure 21-13
Existing Surface Water Extraction Users

Environmental Impact Statement
Saraji East Mining Lease Project

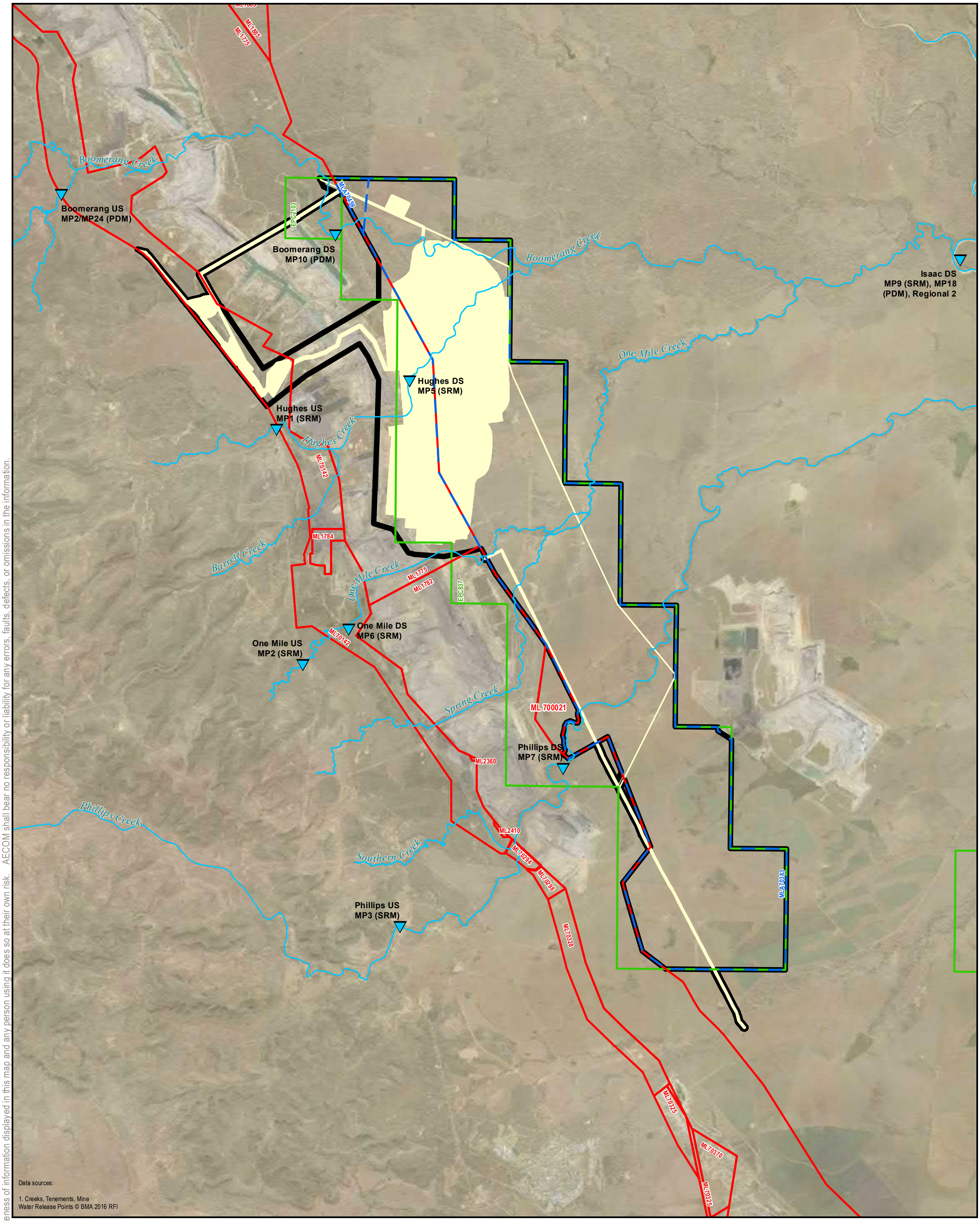
0 0.75 1.5 3
Kilometres

Scale: 1:120,139 (when printed at A4)

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

DATE: 9/07/2020 VERSION: 3

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\08 Surface Water\60507031_G271_v3_A4P.mxd GSWR-25



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Monitoring Locations
- Watercourse

N

Figure 21-14
Watercourses and existing monitoring points

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:150,000 (when printed at A4)

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

BHP

DATE: 26/03/2021 VERSION: 3

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G389_v4_A4P.mxd

21.7.5.2 Groundwater

Hydrogeology

The hydrogeological understanding of the Project area was assessed based on a combination of previous groundwater investigations, data from the existing Saraji Mine monitoring network, exploration drilling and information held by the DNRME (described in Section 21.6.1.2.1). In combination with the bores shown in Figure 21-15, this information provides detailed groundwater resource data for the Project.

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. The aquitard is formed by the Permian overburden and interburden (i.e. shale, mudstone, siltstone, and sandstone). The three aquifers are associated with the following geological strata:

- Quaternary alluvium
- Tertiary sediments
- Coal seams contained with the Permian Coal Measures.

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 indicates that most of these bores did not intersect groundwater i.e. the drilling results indicate limited or no sustainable groundwater resources associated with the alluvium
- Phillips Creek is ephemeral and does not provide a permanent recharge source to the alluvium.

Available hydrological data suggests that 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.

Hydraulic properties

As the alluvial aquifer is seasonal (recharged only during ephemeral flow periods), hydraulic parameters have not been determined in the Project area. No site-specific aquifer data was obtained during previous groundwater investigations for the Saraji Mine due to the dry nature of the alluvium. 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).

Water levels

Baseline water level data is only available for one bore (MB32, refer Figure 21-15) screened across Quaternary alluvium. The available groundwater level data for MB32 show fluctuations over an approximately 7 m range. Groundwater flow is considered to mimic topography and is limited to the areas where the alluvium is present.

Alluvium water quality

The groundwater monitoring bores across the area reported to be screened through the alluvium are dry, except for bore MB32 (refer Figure 21-15). Available water quality data from annual groundwater monitoring reports indicates:

- groundwater associated with the alluvium is generally brackish and bicarbonate dominant (monitoring bore MB32)
- concentration of total dissolved solids (TDS) 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 Saraji Mine 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.

Hydraulic properties

Results of rising head permeability tests indicated a permeability range for the Tertiary aquifer between 0.01 m/day and 0.002 m/day (2 to 3 orders of magnitude lower than the alluvium).

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 level measurements within Tertiary sediments, compiled during 2011 and 2012, indicate variable groundwater levels across the Project area. Tertiary monitoring bores generally become dry during the monitoring period because of sampling, indicating limited sustainable yields.

Groundwater is typically intersected near the base of the Tertiary sediments in the Project area between 13 m (PZ05) and 35 m (PZ02) (refer Figure 21-15) (AGE, 2011). 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. Measured groundwater levels in Tertiary sediments indicate that groundwater levels are generally greater than 20 m below ground level.

Groundwater levels within the Tertiary sediments measured within monitoring bores near the Project 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.

Groundwater flow contours in the Tertiary sediments are expected to mimic topography with flow from west to east towards the Isaac River.

Tertiary sediments water quality

Groundwater quality data for Tertiary sediments is available for two monitoring bores across the Project area. Results indicate that the Tertiary groundwater quality ranges from slightly acidic to slightly alkaline. Metal concentrations for all parameters analysed were either below the laboratory detection limit or below relevant guideline levels. The groundwater is dominated by sodium and chloride with total dissolved solids (TDS) in excess of 6,000 milligrams per Litre (mg/L). This indicates that 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 Saraji Mine has been operating since 1974).

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 that groundwater associated with the Tertiary and Permian sediments are of limited value for most uses. Groundwater associated with the alluvium is sporadic and seasonal and will not provide sustainable supply in the Project area to allow for evaluation. The sensitive groundwater receptors surrounding the Project are users that access groundwater from hydrogeological units for stock watering and ecosystems dependent on groundwater (Section 21.7.6).

Groundwater values to be enhanced or protected in the Project Area are described in Table 21-19.

Table 21-19 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.	Although no known aquatic, terrestrial or subterranean groundwater dependent ecosystems (GDE) have been identified within the Project area, potential aquatic and terrestrial GDEs are mapped within the Project area. Assessment in Section 21.7.6 indicates a low potential for GDE to be present therefore GDE are not expected to be impacted by dewatering or changes in groundwater quality.
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 micro Siemens per centimetre (μS/cm) to 7,200 μS/cm. Given that groundwater salinity within Tertiary and Permian aged sediments is generally greater than 5,000 μS/cm, groundwater is not be 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.
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.

Value	Definition	Description
Stock watering	Suitability of water supply for production of healthy livestock.	The review of 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 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.
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 water courses 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. This value is more common for surface water features that are accessible for recreational use and visual interaction; however, 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 that 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.

Value	Definition	Description
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.

LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Existing Open-Cut Extent
- Underground layout (maximised)
- Saraji monitoring bores
- Registered bore
- Census bore

Surface Geology

- Back Creek Group (Pb)
- Clematis Group (Re)
- Duaringa Formation (Tu)
- Duaringa Formation? (Tu?)
- Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- Ki-CQ (Ki)
- MacMillan Formation (Pbn)
- Moranbah Coal Measures (Pwb)
- Peak Range Volcanics (Tp)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- Qr\b-QLD (Qr\b)
- Rangal Coal Measures (Pwj)
- Rewan Group (Rr)
- TQa-QLD (TQa)
- TQr-QLD (TQr)

N

Figure 21-15
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)

DATE: 20/08/2020 VERSION: 1

21.7.6 Groundwater dependent ecosystems

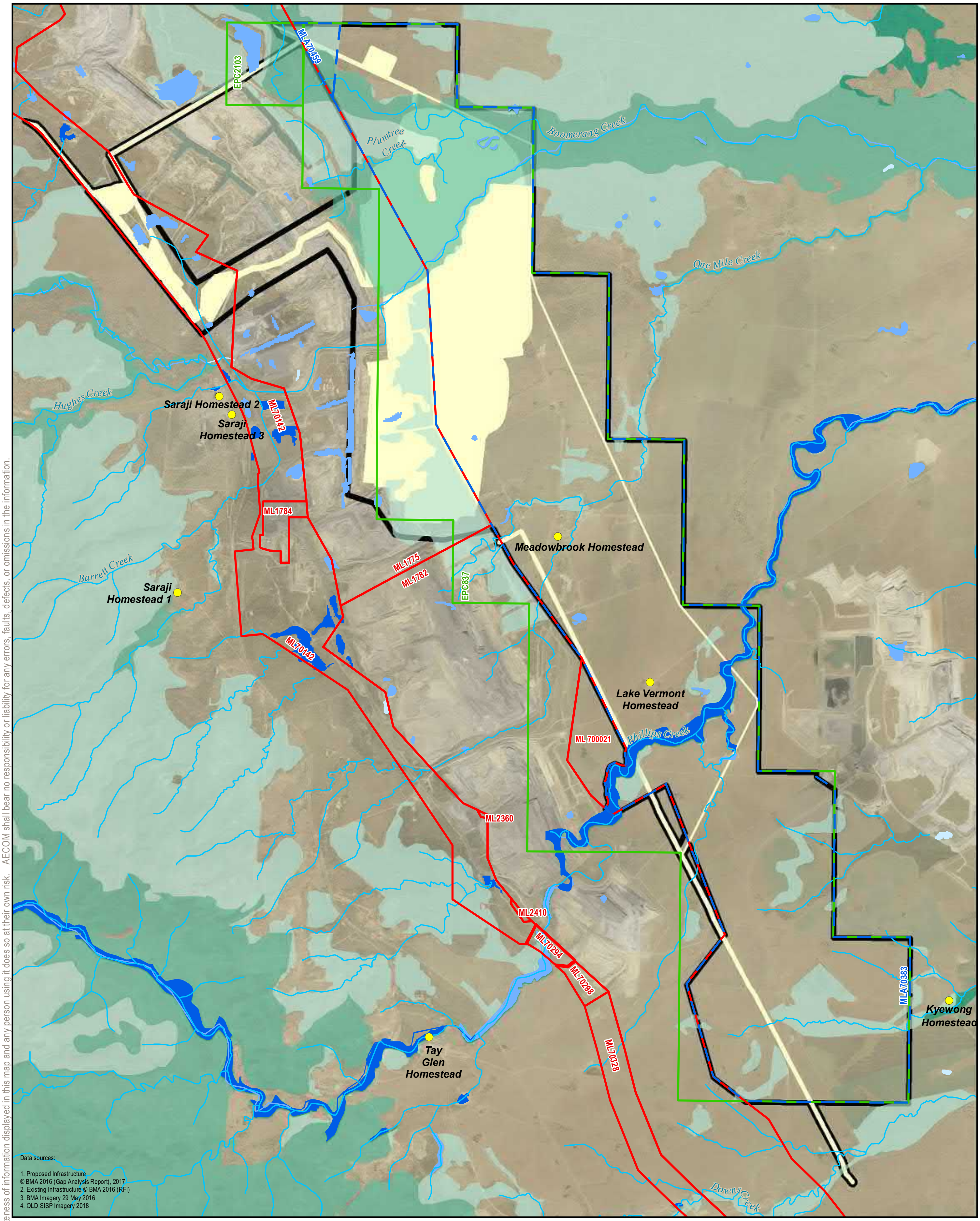
GDEs are defined as ecosystems that require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes, and ecosystem services (Richardson *et al,* 2011). GDEs can be grouped into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

- Aquatic GDEs dependent 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 GDEs dependent 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 GDEs occur within caves (with some degree of groundwater connectivity) and aquifers. Aquatic animals that live in groundwater are referred to as stygofauna.

Identification of GDEs

The National Atlas of groundwater dependent ecosystems (GDE Atlas) was consulted to identify whether GDEs have been mapped within the area. GDE Atlas comprises maps that show the location of both known and potential GDEs across Australia, as well as ecological and hydrogeological information for each GDE. The database containing the GDE mapping is hosted by BoM and accessible through the BoM website (http:\\www.bom.gov.au). GDE Atlas mapping is shown in Figure 21-16.

Where no known aquatic or terrestrial GDEs were mapped within the GDE Atlas, 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). The GDE Toolbox Stage 1 assessment relies heavily on the methodology outlined by Eamus et al (2006) for identifying aquatic and terrestrial GDEs. Eamus et al (2006) pose a series of questions to help determine the likelihood of whether an ecosystem is potentially dependent on groundwater. Where no known subterranean GDEs were mapped within the GDE Atlas; the potential for subterranean GDEs was assessed from a literature review and site-specific sampling results.



LEGEND

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

Groundwater dependent ecosystems (GDE) Atlas

- High potential aquatic GDE
- Moderate potential aquatic GDE
- Low potential aquatic GDE
- High potential terrestrial GDE
- Moderate potential terrestrial GDE
- Low potential terrestrial GDE

N

Figure 21-16
Groundwater Dependent Ecosystems

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)

DATE: 20/08/2020 VERSION: 2

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G363_v3_A4P.mxd

Aquatic GDEs

No known aquatic GDEs have been identified within the Project Site. Aquatic GDEs, as mapped within the GDE Atlas (BOM), are shown in Figure 21-16. According to the GDE Atlas mapping, there is moderate to high potential for aquatic GDEs to exist:

- within those areas of the Saraji Mine that contain open water i.e. tailings dams, evaporation dams and levees.
- along reaches of Phillips Creek to the south of the proposed underground mine and Hughes Creek/Boomerang Creek that overlies the northern portion of the underground mining footprint.

To further assess the likelihood of aquatic GDEs within the Project area, using project specific data and observations, a series of five questions posed by Eamus et al (2006) were answered as shown in Table 21-20.

Table 21-20 Questions to determine likelihood of aquatic GDEs

Question	Comment
Does a stream/river continue to flow all year, or a floodplain waterhole remains wet all year in dry periods?	No. All creeks in the Project area are ephemeral with only intermittent flow. As discussed in Section 21.7.4, it is conceptualised that the alluvial sediments will not contain permanent groundwater as recharge to the alluvium seeps downwards into the underlying sediments. None of the creeks in the Project area have permanent groundwater baseflow that contributes to surface flows (Hydrobiology, 2016).
For estuarine systems, does the salinity drop below that of seawater in the absence of surface water inputs?	Not applicable to the Project.
Does the volume of flow in a stream/river increase downstream in the absence of inflow from a tributary?	No. Creeks flow throughout their length following flood events, water then quickly retreats due to the sandy nature of the creek bed. During retreat, water becomes ponded in areas where clay is present and/or areas which have low elevation. None of the creeks in the Project area are identified as gaining streams (SKM, 2009).
Is the level of water in a wetland/swamp maintained during dry periods?	No. Water levels in tailing dams, evaporation dams and levees (areas identified as moderate to high potential for aquatic GDEs within the GDE Atlas) do maintain permanence throughout the year but are artificial mining features and permanence is related to mining activities.
Is groundwater discharged to the surface for significant periods of time each year at critical times during the lifetime of the dominant vegetation type?	No. There are no springs which have been mapped in the area or which are known to exist within the area. There are no known points where groundwater can be seen naturally discharging to the surface.

Given that the answers to all of the questions in Table 21-20 are either 'no' or 'not applicable', those areas mapped as having moderate to high potential for aquatic GDEs in the GDE Atlas, are considered to have low potential for aquatic GDEs when assessed using site specific data:

- those areas of the mine that contain 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 and it is conceptualised that the alluvial sediments associated with the creeks do not contain permanent groundwater.

Terrestrial GDEs

No known terrestrial GDEs have been identified within the Project Site. Terrestrial GDEs, as mapped within the GDE Atlas, are shown in Figure 21-16. There is low to moderate potential for terrestrial GDEs to exist within the footprint of the proposed underground mine workings and surrounds. To further assess the likelihood of terrestrial GDEs within the Project area, using project specific data and observations, a series of three questions posed by Eamus et al (2006) were answered as shown in Table 21-21.

Table 21-21 Questions to determine likelihood of terrestrial GDEs

Question	Comment
Is groundwater or the capillary fringe above the water table present within the rooting depth of any vegetation?	Unlikely in alluvial sediments. Sections 21.7.4 shows that groundwater is not permanently present in alluvial deposits except MB32 located to the west of Saraji Mine. Groundwater levels in MB32 vary between 7 metres below ground level (mbGL) and 14 mbGL. Not in Tertiary sediments. Section 21.5.3 shows that water levels in Tertiary sediments are greater than 15 mbGL. Froend and Loomes (2004) suggest that groundwater is of reduced importance to vegetation when the water table is at depths greater than 10 m.
Does a proportion of the vegetation remain green and physiologically active (principally, transpiring and fixing carbon, although stem-diameter growth or leaf growth are also good indicators) during extended dry periods?	Not applicable. Previous studies have shown that most floral assemblages within the area are characterised by drought tolerant species with low physiological sensitivity to water availability and are not considered groundwater dependent. No EPBC Act listed GDEs identified such as the endangered TEC i.e. community of native species dependent on natural discharge of groundwater from the Great Artesian Basin.
Is the level of water in a wetland/swamp maintained during extended dry periods?	No. Water levels in tailing dams, evaporation dams and levees (areas identified as moderate to high potential for terrestrial GDEs within the GDE Atlas) do maintain permanence throughout the year but are artificial mining features and permanence is related to mining activities.

Given the answers to the questions in Table 21-21, those areas mapped as having moderate potential for terrestrial GDEs in the GDE Atlas are considered to have low potential for terrestrial GDEs when assessed using site specific data for the following reasons:

- Groundwater levels in 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). This depth is also outside the accessible reach for Eucalypt vegetation (Zolfagher et al, 2014).
- Groundwater is generally not permanently present within alluvial sediments and is therefore unlikely to provide a source of water for terrestrial species.
- Most floral assemblages within the area are drought tolerant with low sensitivity to water availability.

Subterranean GDEs

No known or potential subterranean GDEs have been identified within the GDE Atlas for the Project area and surrounds.

Desktop studies

Several previous investigations have been undertaken to assess the suitability of sediments within the Bowen Basin for stygofauna. 4T Consultants (2012) conducted a desktop review to assess the potential for stygofauna within the Bowen Basin. The main findings of the desktop review are summarised below:

- aquifer type and associated hydraulic conductivity and pore space are the primary determinants for the presence or absence of stygofauna.
- available information indicated that no stygofauna have been detected in coal seams within the Bowen Basin.
- most stygofauna identified in the Bowen Basin were found within shallow (<29 mbGL) unconsolidated sediments, such as alluvium, at salinity levels less than 2,000 µS/cm and pH between 6.5 and 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 that 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.

Field studies

Stygofauna sampling was undertaken in seven groundwater monitoring bores on the Project Site screened across Tertiary and Permian sediments during September 2011 (IESA, 2011a) and December 2011 (IESA, 2011b). The details of the monitoring bores are summarised in Table 21-22.

Table 21-22 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.

Sampling was undertaken in accordance with Draft Guidance No. 54A - Sampling methods and survey considerations for subterranean fauna in Western Australia (WA EPA, 2007). It is noted that this guideline has since been updated.

No stygofauna species were detected during the September 2011 and December 2011 sampling events.

Potential for subterranean GDEs

As the alluvium in and adjacent to the Project area is ephemeral, discontinuous and can be saline, it is unlikely that the alluvium contains enough permanent suitable groundwater to support stygofauna populations. The potential for subterranean GDEs to exist within the Tertiary and Permian sediments is low for the following reasons:

- 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.

Springs

No known springs are present within the Project Site. The closest springs are greater than 150 km from the Project.

21.7.7 Flora and fauna

The Project Site is situated within Isaac Comet-Downs subregion, where 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 Plumtree Creek and Hughes Creek)
- One Mile Creek
- Phillips Creek.

Two oxbow wetlands exist in the north of the Project Site which retain permanent water and provide habitat opportunities for all 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.

21.7.7.1 Vegetation communities

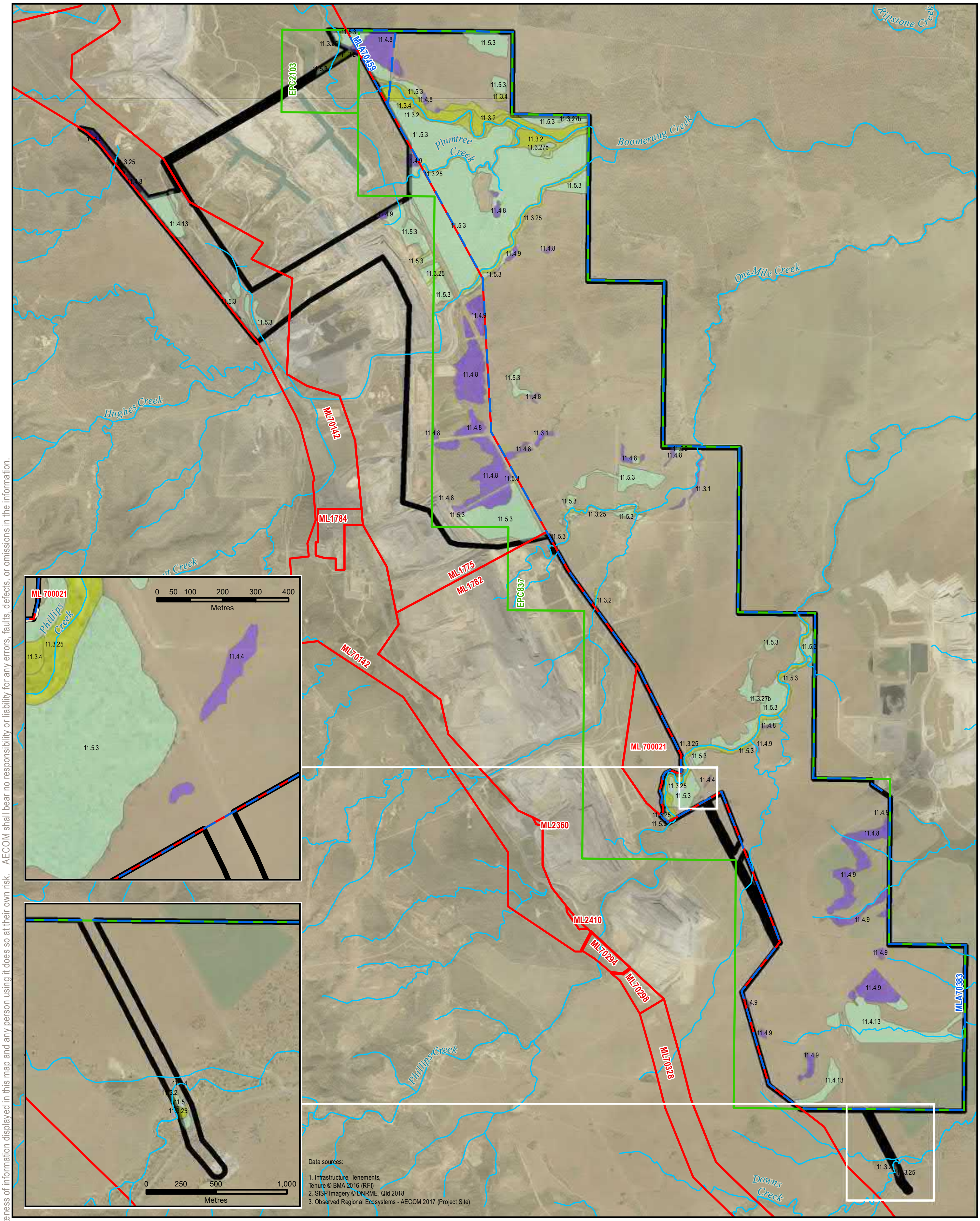
Woodlands dominated by *Eucalyptus* or *Acacia* species cover part of the Project Site with the remainder vegetated by non-remnant grasslands (as pasture) and shrubby regrowth. Small areas of native grassland are present. In the drier areas *Eucalyptus populnea* (Poplar Box), *E. cambageana* (Dawson 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 and their corresponding REs (AECOM, 2018b). Vegetation communities observed within the Project Site are described in Table 21-23 and their distribution is illustrated in Figure 21-17 .

Table 21-23 Vegetation communities within the Project Site

Community Description	RE	Biodiversity Status[1]	EPBC Act[2]	Project Site Extent (ha)
Acacia harpophylla and/or *Casuarina cristata* open forest on alluvial plains.	11.3.1	Endangered	Endangered	1.76
Eucalyptus populnea woodland on alluvial plains.	11.3.2	Of Concern	Listed as endangered after submission	151.15
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	1.74
Eucalyptus cambageana woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains.	11.4.8	Endangered	Endangered	322.16
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	222.06
Eucalyptus populnea ± *E. melanophloia* ± *Corymbia clarksoniana* on Cainozoic sand plains/remnant surfaces.	11.5.3	No concern at present	Not listed	1,480.04
N/A	Non-remnant	N/A	N/A	8,136.23

[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.



LEGEND

- Project Site
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse

Regional Ecosystems biodiversity status

- Endangered
- Of Concern
- No Concern at Present

N

Figure 21-17

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)

BHP

DATE: 18/09/2020 VERSION: 2

21.7.8 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 21-24 and Figure 21-18). A description of these communities and the key fauna habitat opportunities are provided below.

Table 21-24 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*).

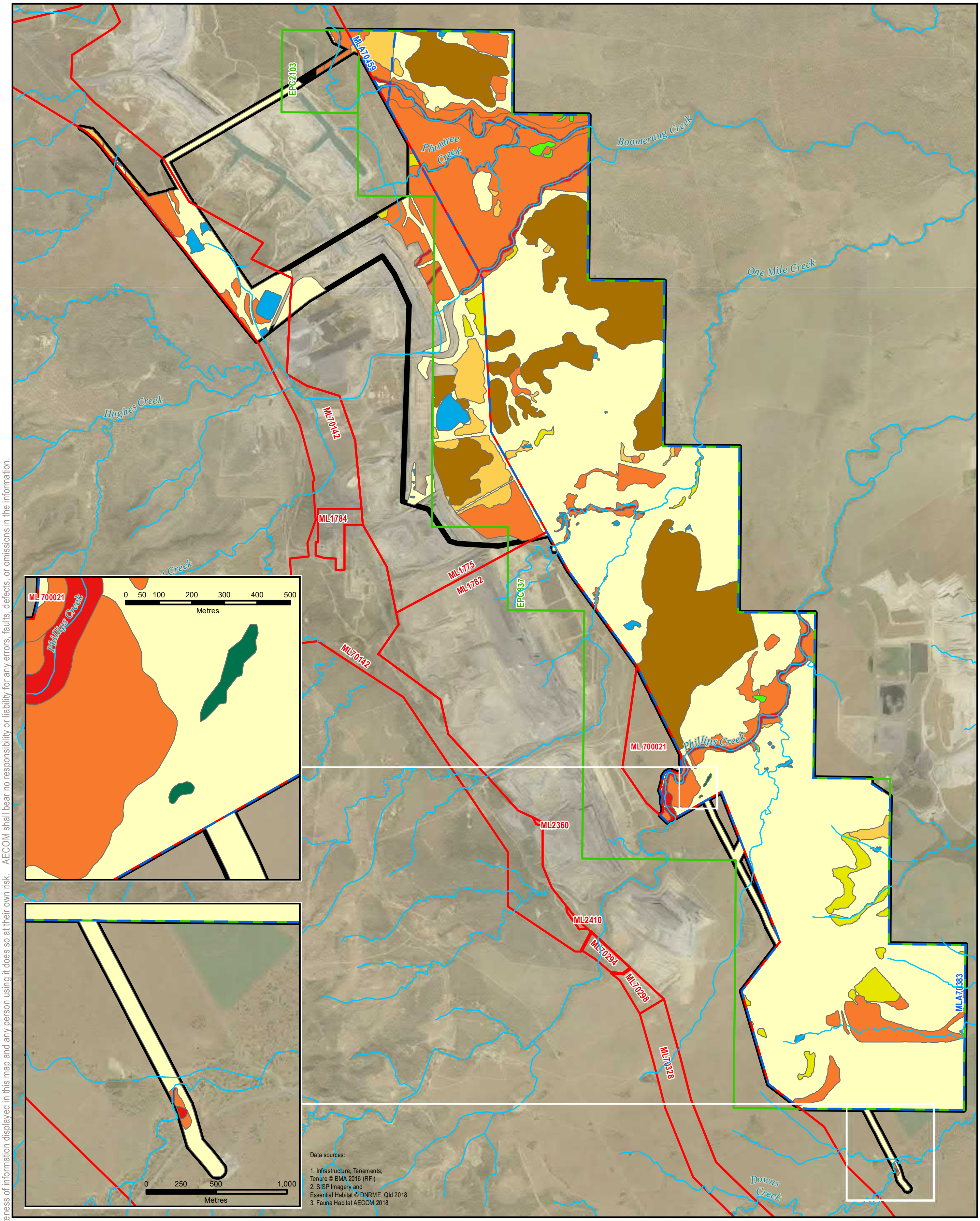
Shrubby Brigalow regrowth with gilgai

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)
- 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
- Modified Grasslands
- Shrubby Brigalow Regrowth with Gilgai
- Dams

N

Figure 21-18
Fauna habitat types 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

DATE: 18/09/2020 VERSION: 1

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G226_v1_A4P.mxd

21.7.9 Fauna corridors

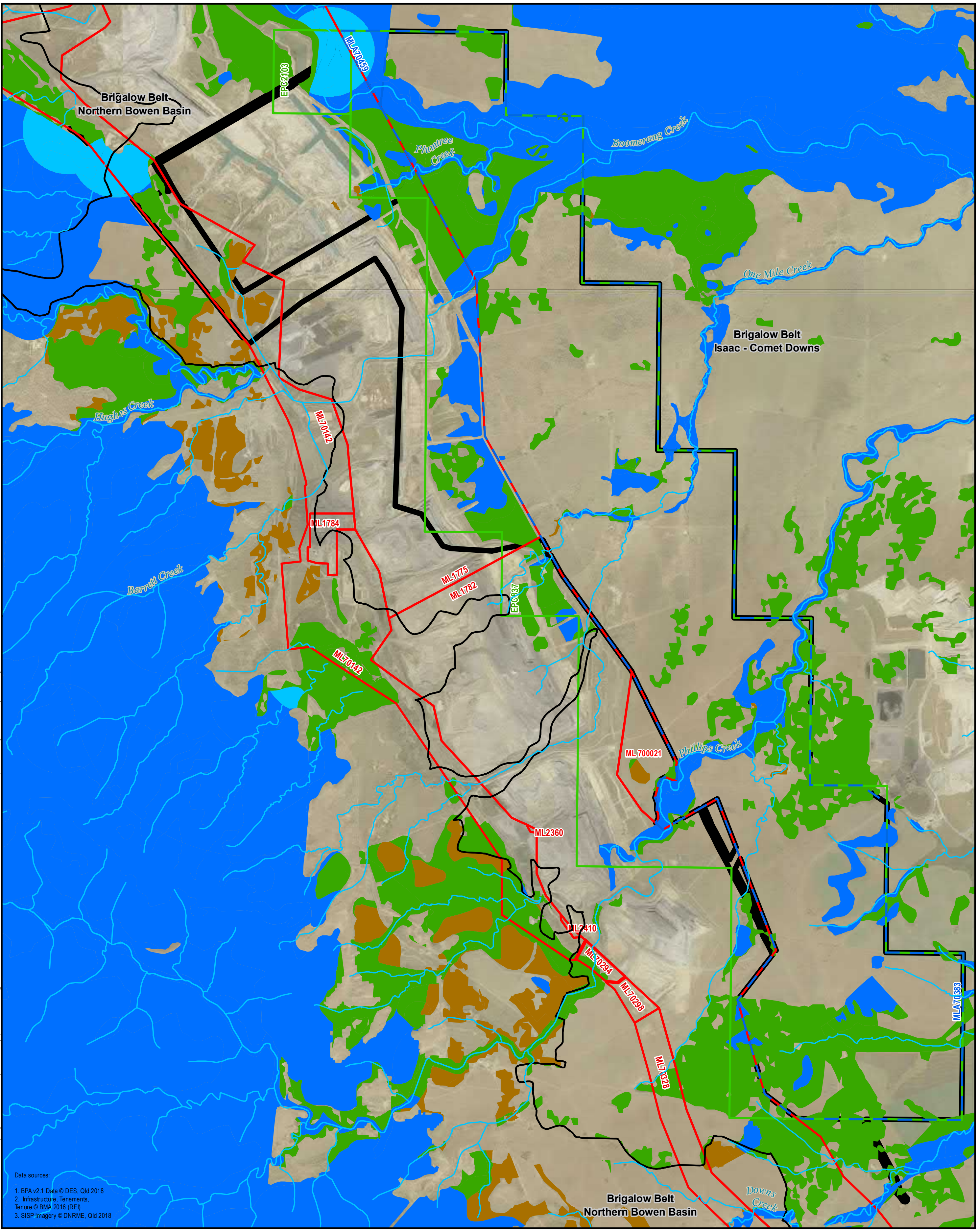
The BPA for the Brigalow Belt Bioregion identifies the following wildlife corridors within the Project Site (Figure 21-19):

- 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 Saraji Mine 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.



LEGEND

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

Biodiversity planning assessment Brigalow belt

Biodiversity significance

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

N

Figure 21-19
Biodiversity planning assessment mapping

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

DATE: 23/09/2020 VERSION: 1

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G227_v1_A4P.mxd

21.8 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, TECs and a water resource, in relation to coal seam gas development and a large coal mining development.

21.8.1 Water resources

21.8.1.1 Surface water

The physical setting (Section 21.7.1) and regional catchment context (21.7.5.1) 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, an open system has the potential for uncontrolled discharge of MAW should a weather event cause a dam spill. As such, BMA will seek authority and licence conditions to conduct the controlled release of MAW from the Project site during emergency scenarios. Spillway release from the process water dam are also proposed to be directed to Boomerang Creek, which has potential to impact on water quality and dependent ecosystems in the receiving environment.

The Project's longwall mining methods are likely to 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 may have local attenuation effects on low flows through temporary storage in panels, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible.

Conservatively, potential impacts from WMS failure, discharges, contamination and subsidence on surface water flows and quality will be assessed as possible.

21.8.1.2 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 may 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 mine affected water will be minor and consistent with current operation, but production will be extended over an additional 20-year life of mine.

Dewatering can lower groundwater levels and has the potential to reduce groundwater levels in existing bores that fall 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 as possible.

21.8.2 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 21-25 .

Table 21-25 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.

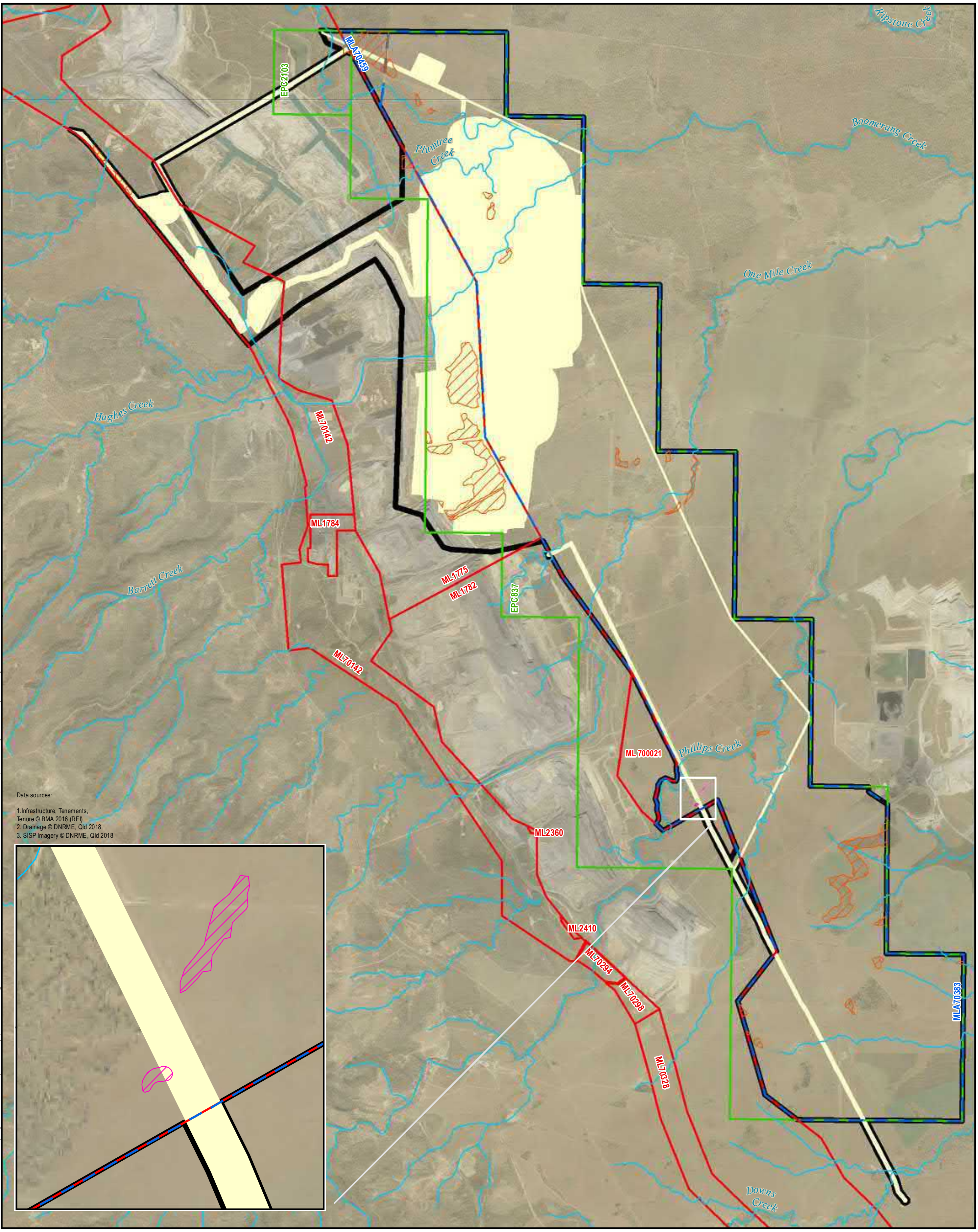
Field surveys undertaken as described in Section 21.6.2.2 confirmed the presence of two EPBC Act listed TECs within the Project Site:

- 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 417.85 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 21-26 and illustrated in Figure 21-20.

Table 21-26 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 that met criteria for this TEC)	417.85	246.07
Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	RE 11.4.4	1.73	0.075



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- 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 21-20
Threatened ecological communities observed 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)

BHP

DATE: 20/08/2020 VERSION: 3

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G242_v2_A4P1.mxd

21.8.3 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 21-27.

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 21-20) 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 21-27 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.

Threatened flora	EPBC Act Status	Habitat/Distribution	Likelihood of occurrence
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 21-20). This was found to be a dominant species within this vegetation community.
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.

21.8.4 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 21-28 below.

Of the 20 fauna species identified in the desktop search, field surveys determined the 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 21-21 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 21-28 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) Essential Habitat for the species is also mapped in the west of the Project Site that relates to 11 previous records associated with studies conducted for the existing Saraji Mine.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
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.
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	Vulnerable	This species has been found in a broad range of habitats, including: forests and woodlands on black alluvial cracking clay and clay loams	**Potential.** Suitable habitat in the form of brigalow

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Dunmall's Snake		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).	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.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
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). Essential Habitat for the species has been mapped in the north of Project Site surrounding an existing record.
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.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
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.
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.

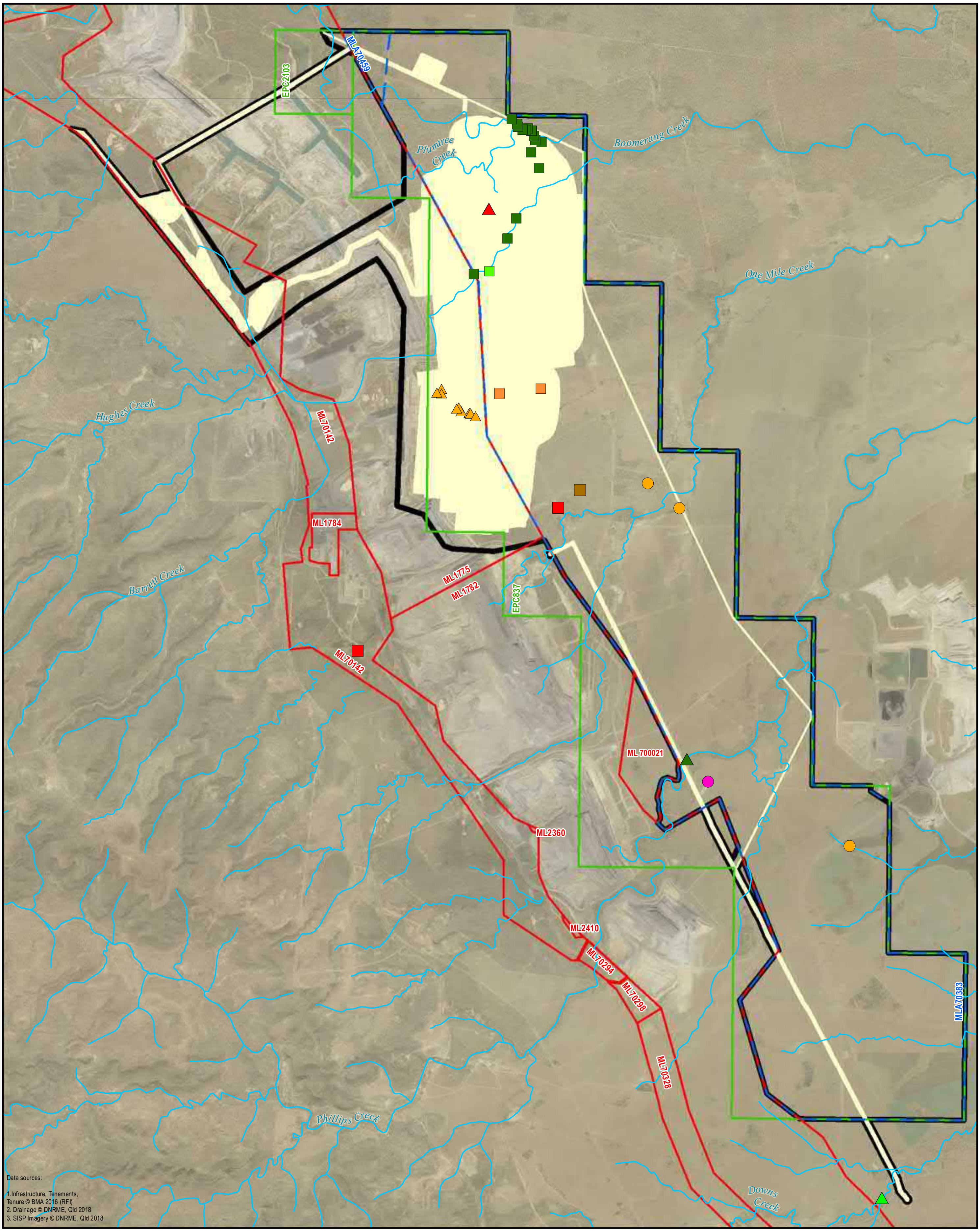
Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
Rostratula australis Australian Painted Snipe	Endangered	Preferred habitat includes shallow inland wetlands, brackish or freshwater, that are permanently or temporarily inundated. Typical sites include those with rank emergent 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%. 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 the 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.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
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.
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.

Threatened fauna	EPBC Act Status	Habitat/distribution	Likelihood of occurrence
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
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse

Threatened fauna and flora

- 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

N

Figure 21-21
Observed threatened flora and fauna 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)

BHP

DATE: 20/08/2020 VERSION: 0

21.9 Potential impacts

21.9.1 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.

21.9.1.1 Surface water

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 for the existing Saraji Mine.

Construction of the proposed underground mine will commence within the existing open-cut pits (high wall) where the portal will 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. Surface runoff from mine process areas will be collected within onsite storages as MAW contained within the existing WMS and assessed as an operational impact.

Outside of mining area (e.g. access roads, transmission lines, etc.), Project activities may 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 may enter stormwater runoff or be carried by wind into surface water and affect water quality, sedimentation, geomorphology and productivity of aquatic and benthic ecosystems. Construction activities may temporarily cause short-term increase in potential for erosion and sedimentation that can be managed effectively on site through accepted industry practices. During operation, the underground workings may impact surface water resources through:

- direct impacts of WMS failure, WMS discharges, contamination (including erosion and sedimentation) and subsidence
- indirect impacts of subsidence on flooding.

Direct impacts

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. Mine affected water 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.

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 21.6.1.1.2) within the Project conceptual mine WMS have been based on the containment of all potential inflows using historical climate data, prioritisation for water reuse and under a set of assumed operational rules. This conservative approach ensures that:

- 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.

As such, under dry or normal operating circumstances, no controlled or uncontrolled discharges from the Project Site are anticipated; however, provision is made for uncontrolled 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 mine affected water from the Project Site.

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 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.

WMS discharges

Preliminary design and sizing of WMS dam structures provide sufficient capacity to contain all MAW inflows without controlled or uncontrolled releases. Uncontrolled releases are only likely 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. Therefore, the basis of the proposed mine WMS is that there will be no controlled or uncontrolled releases of MAW under normal operating conditions, based on 128 years of historical climate data and assumed operating conditions. A risk-based assessment of hypothetical MAW releases during dry, normal and wet conditions shows that no impacts on the receiving environment are expected from these events. 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.

An indicative release point at Boomerang Creek is proposed in the event a controlled release is required. The discharge point is proposed on Boomerang Creek adjacent to the proposed process water dam, as shown in Figure 21-22. 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 21-22.

WMS failure

The proposed WMS has been designed with adequate capacity to avoid controlled or uncontrolled releases. However, WMS failures could lead to discharge of potentially contaminated water to the receiving environment where mine water is able to migrate from the containment area into Boomerang and/or Hughes Creek. 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. Potential failures include:

- Storage containment failure caused by inadequate storage capacity, overfilling of storage, inadequate diversion of clean catchment or extreme storm events
- Storage embankment failure caused by piping failure (related to poor construction of embankment maintenance) or overtopping
- Water management system infrastructure failure including pipeline, pumps, drains, bunds and/or levee failures (caused by machinery damage, weathering, channel erosion, incorrect placement or during relocation).

Contamination

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 aimed 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.

Mine dam structures have been designed to have sufficient capacity to contain all MAW. Overflows to the receiving environment are not expected during dry climatic conditions due to internal requirement for process water, hence there are no impacts to the receiving environment. Uncontrolled releases are only likely 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. Therefore, the basis of the proposed mine WMS is that there will be no controlled or uncontrolled releases of MAW under normal operating conditions, based on historical climate data.

An extreme rainfall event has potential to increase of MAW inventory levels and lead to a release of potentially contaminated water to the receiving environment. Releases are not planned under normal climate conditions, but potential impacts of a managed MAW release during normal climate conditions will be similar to those from MAW releases from existing similar mining operations, which comply with the regulatory requirements and the existing Environmental Authority. Should a weather event cause a dam spill (> 80 per cent capacity), impacts from a discharge of MAW will be negligible due to the lower MAW salinity concentrations (2,500-3,500 µS/cm) and the significant availability of background dilution.

Summary water and salt balance for the water balance model (as a function of the total distribution of all results from all 128 model realisations) are presented in Table 21-29 and Table 21-30 respectively.

Table 21-29 Mine water balance

	Life of Mine (GL)				Annual (GL per annum)			
	Mean	Median	10th	90th	Mean	Median	10th	90th
WMS inputs								
Direct rainfall	6.6	6.6	6.0	7.1	328	328	298	354
Total runoff	6.2	6.4	4.1	7.5	310	318	203	373
Raw water input	32.0	31.9	31.0	33.4	1,602	1,594	1,548	1,671
Groundwater input	3.1	3.1	3.1	3.1	156	156	156	156
Total water input	**47.9**	**47.9**	**46.6**	**48.9**	**2,395**	**2,395**	**2,332**	**2,443**
WMS outputs								
Total evaporation	8.5	8.5	7.3	9.2	423	424	366	462
Total water demand	39.7	39.7	39.7	39.7	1,985	1,985	1,985	1,985
External overflows	0.0	0.0	0.0	0.0	0	0	0	0
Total water output	**48.2**	**48.2**	**47.0**	**48.9**	**2,408**	**2,409**	**2,350**	**2,446**

Table 21-30 Mine salt balance

	Life of Mine (tonnes)				Annual (tonnes per annum)			
	Mean	Median	10th	90th	Mean	Median	10th	90th
WMS inputs								
Total runoff	10.9	11.2	7.4	13.2	546	561	371	658
Raw water input	4.3	4.3	4.1	4.5	215	214	207	224
Groundwater input	23.9	23.9	23.9	23.9	1,194	1,194	1,194	1,194
Total salt input	**39.1**	**39.4**	**35.8**	**41.2**	**1,954**	**1,969**	**1,789**	**2,060**
WMS outputs								
CHPP	12.7	12.6	10.7	13.8	637	629	534	692
Total water demand	40.1	40.4	37.0	41.9	2,003	2,018	1,850	2,097
External overflows	0	0	0	0	0	0	0	0
Total salt output	**40.1**	**40.4**	**37.0**	**41.9**	**2.0**	**2,018**	**1,850**	**2,097**

Chemicals and contaminants

The main potential impact on surface water quality will arise from accidental spills and leaks. The main contaminants of concern in this regard are fuels and oils. While some other chemicals will be utilised during construction, the quantities and natures of these chemicals is such that the risk of significant environmental harm in the event of a spill is low.

Accidental spills of fuel or any other chemicals stored onsite used during construction could enter the drainage lines and waterways. Contaminants may 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 main areas where aqueous waste streams may be produced will be associated with the construction of the MIA. However, there is also a possibility that contaminant spills may occur during construction of internal access roads.

Without appropriate mitigation measures, potentially contaminated drainage generated through these activities could enter into drainage lines, altering the physical and chemical characteristics of the receiving waters. This in turn may have acute or chronic toxicity effects on aquatic plants and animals. These pollutants can also have the potential to be a public health and safety issue if moderate to large quantities are released directly to watercourses.

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.

Small quantities of aqueous waste will be generated from removal of stormwater and contaminants from bunded areas and sumps. Provided this is treated in accordance with the management measures outlined below, this should not cause any impact on surface water quality.

Erosion and sedimentation

Project activities may contribute to increased erosion and sedimentation of receiving surface waters and mobilisation of other contaminants in runoff from the construction site. Most excavation activities will relate to construction of the portal in the open cut mine face that may temporarily cause short-term increase in potential for erosion and sedimentation.

Subsidence

Subsidence can potentially alter the interactions between surface water and groundwater due to goaf induced fracturing, which could increase groundwater to surface water hydraulic connections. This interaction can potentially increase salinity levels in surface water if groundwater is more saline than the surface water. An assessment of groundwater resources, levels and seasonality in the shallow aquifers (Quaternary alluvium and Tertiary sediments) across the Saraji Mine Lease indicates limited shallow groundwater resources (dry bores), seasonal potential surface water discharge to groundwater, and thick clay-rich Tertiary sediments. As groundwater across the Saraji Mine lease is representative of groundwater across the Project site, the risk of enhanced hydraulic connection due to subsidence is limited.

The subsidence resulting from the Project's underground mining may create surface cracks and buckling. This is likely to cause tensile cracking, resulting 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. Assessing the potential impacts of the Project on the waterways and flooding characteristics of the Project Site involved modelling of the post-subsidence terrain using the maximised layout and comparing results with those from pre-subsidence (existing conditions) modelling.

Differences in pre- and post-subsidence terrain models were used to estimate and map the depth of subsidence along each longwall panel of the maximised footprint. Subsidence depth is more variable in the southern panels with typical differentials from panel to pillar of several metres. Subsidence of around 2 m is substantial where watercourse depth shallows to a similar magnitude and floodplain connectivity occurs. The formation of preferential flood flow paths and closed basins in the subsidence troughs/voids predicted for the following watercourses may provide both positive and adverse environmental outcomes. A summary of the potential impacts of subsidence on the relevant waterways are provided below.

- Boomerang Creek – subsidence of 0.5-1.0 m is anticipated as the creek traverses above the Project upstream, with impacts to stability and flow behaviour expected to be local and minor from subsidence of its channel.

- Plumtree Creek – subsidence of approximately 0.3-1.0 m over approximate length of 3.25 km, with downstream 1 km likely to become a pool of 1 m depth with potential to increase depth over time.
- Hughes Creek – subsidence of approximately 2.0 m over approximate length of 5.6 km, likely to develop instability at the upstream limit of subsidence where the channel bed will deepen and destabilise channel banks resulting in some impact downstream through Boomerang Creek for a period of years.

Modelling predicts only moderate changes in hydraulic values resulting from subsidence. The subsidence associated with longwall mining creates panel catchments on the floodplain with flow paths generally forming down the centre of the panel. Some panel catchments will pond water until they fill and spill. Despite the creation of subsidence troughs, the spill point in most cases is similar to the pre-subsidence flow path due to the overriding topography. Subsidence may have local attenuation effects on low flows through temporary storage in panels, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible.

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. Hughes Creek diversion will have a drop of nearly three metre into the first panel it intercepts with the potential for major instability when the channel bed responds by attempting to regrade to a more stable gradient. Within the predicted areas of subsidence, there is an increased risk that tributaries develop avulsion paths, meander migration or cut offs that can accelerate erosion processes; however, avulsion of stream is not identified as a potential impact at this stage (Alluvium, 2019). 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. Any reduction in stream flow will be a very small to negligible component of the entire Isaac River catchment.

Indirect impacts

Flooding

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.

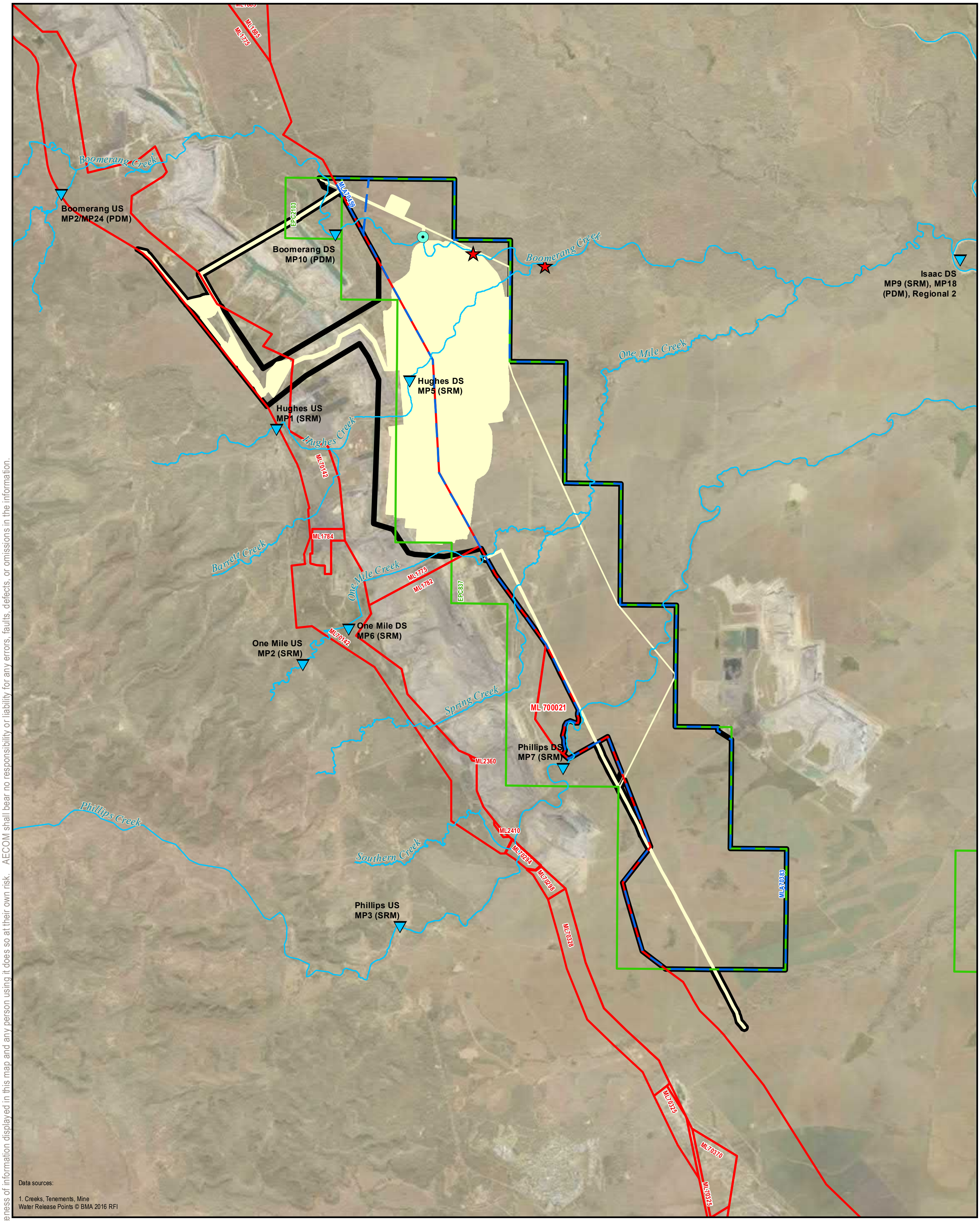
Water depth increases by up to one to two metres during the 1,000-year ARI event in the north-east corner of the panels within a large area of floodplain inundation that extends to the confluence of Boomerang and Hughes Creeks, though there is little change in extents resulting from subsidence.

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.

Flooding of mine infrastructure

The flood model was developed and was utilised to predict the influence of mine infrastructure on flooding and to assess the effectiveness of flood mitigation measures in the protection of the mining operation. Modelled peak flood levels around the mine entrance and the conveyor are within ten to 35 mm water depth for the pre- and post-subsidence cases. Peak flood levels of this depth are unlikely to be consequential to the operation of mine infrastructure and, where required, flood mitigation measures such as bunding would be implemented at the entrance to mitigate localised flooding.



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Monitoring Locations
- Indicative Proposed Monitoring Point Location
- Indicative Proposed Mine Water Release Point
- Watercourse

N

Figure 21-22
Proposed monitoring points

Environmental Impact Statement
Saraji East Mining Lease Project

0 0.5 1 2
Kilometres

Scale: 1:150,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 26/03/2021 VERSION: 3

Filename: L:\Secure\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G389_v3_A4P.mxd

21.9.1.2 Groundwater

Conceptual groundwater model

A conceptualised west to east cross-section showing the proposed underground mine in relation to the regional geological setting is shown in Figure 21-23.

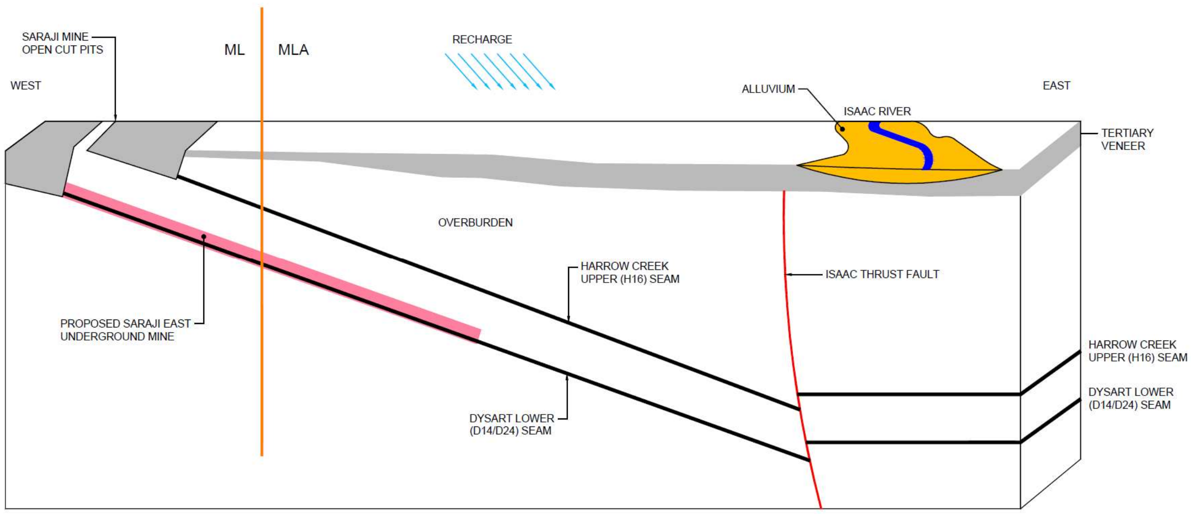


Figure 21-23 Conceptual west to east regional cross section of underground mining (not to scale)

The data used to develop the conceptualisation indicates two separate groundwater systems occur within the Project area; these aquifer systems are associated with the following geological units:

- localised basal sand and gravel at the base of the Tertiary sediments
- deeper Permian coal seams.

The hydrogeological conceptualisation of the Project area is shown in Figure 21-24.

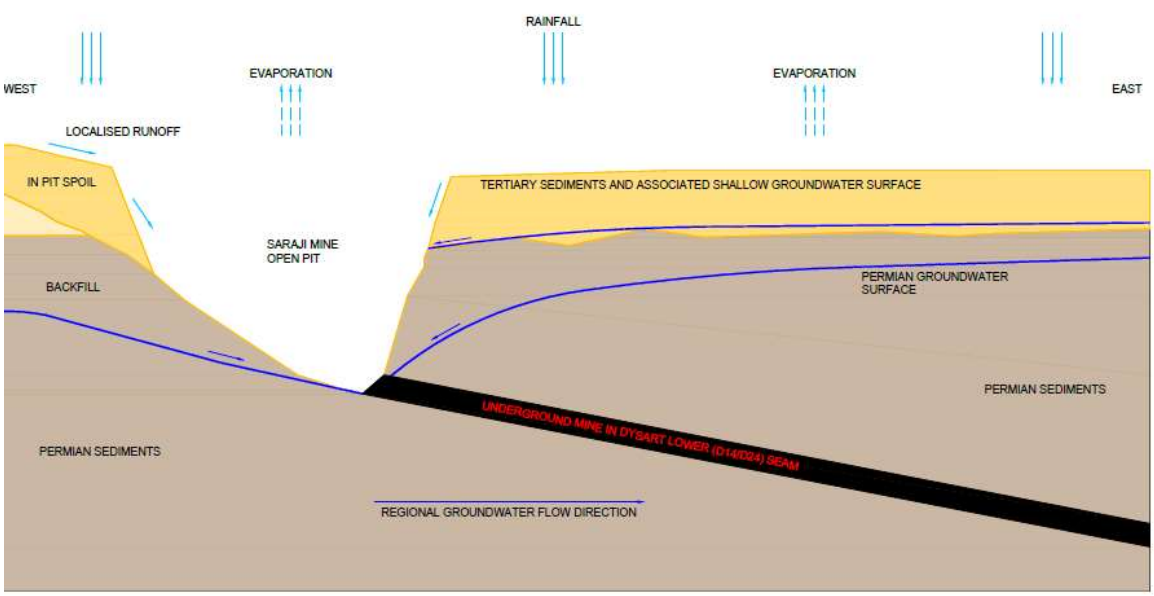


Figure 21-24 Conceptual groundwater model

The hydrogeological conceptualisation included the following:

- there are differences in groundwater levels measured in the tertiary and deeper Permian aquifers indicating limited hydraulic connection between these groundwater systems
- recharge occurs due to infiltration from rainfall and creek flows (losing surface water systems) into the tertiary and Permian aged sediments
- regional groundwater levels are a subdued reflection of the surface topography, except where localised discharge / seepage into the pits results in steeper gradients immediately adjacent to the open-cut mine area
- 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. This suggests that faulting facilitates more complex groundwater movement to the east of the Project.

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. As construction is expected to occur in the dewatered sediments immediately adjacent to the high wall, no additional direct or indirect groundwater impacts are predicted during construction.

During operation, the underground workings may impact water resources through:

- direct impacts of mine dewatering
- indirect impacts of mine dewatering, including induced flow and alteration of landform, geology and associated aquifer hydraulic properties due to goaf.

Potential impacts are considered in conjunction with the conceptualisation of groundwater and mining.

Direct impacts

Dewatering

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. 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. Dewatering and predicted groundwater drawdown at the end of underground mining is illustrated in Figure 21-26.

Indirect impacts

Dewatering

Longwall mining may have some 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 Saraji Mine 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.

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 Saraji Mine 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 that poor water quality (elevated salinity due to evaporation) does not migrate off site within the groundwater.

Surface water – groundwater interaction

Based on an assessment of groundwater data, 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.

These hydrostratigraphic units are included in 21.7.5.2.

As conceptualised in Figure 21-24, groundwater recharge occurs from infiltration from the rainfall 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 (differences in groundwater levels measured in the Tertiary and deeper Permian aquifers indicate that there is limited hydraulic connection between hydrostratigraphic units).

Recharge is also considered from creek flow into the Tertiary and Permian units, where creeks drain across sub-crop areas. As the surface water drainages are ephemeral limited leakage (included in the model using the RIV package) within these sub-crop areas is considered to occur on site (as evidenced in the dry alluvium bores).

To evaluate recharge, including 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% 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 so as 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.

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 (model Layer 1) are unconsolidated and thus two metre drawdown contours were produced, which is consistent with the bore trigger threshold for unconsolidated sediments
- The Permian sediments (model Layer 6 and Layer 10) 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).

End of mining drawdown contours

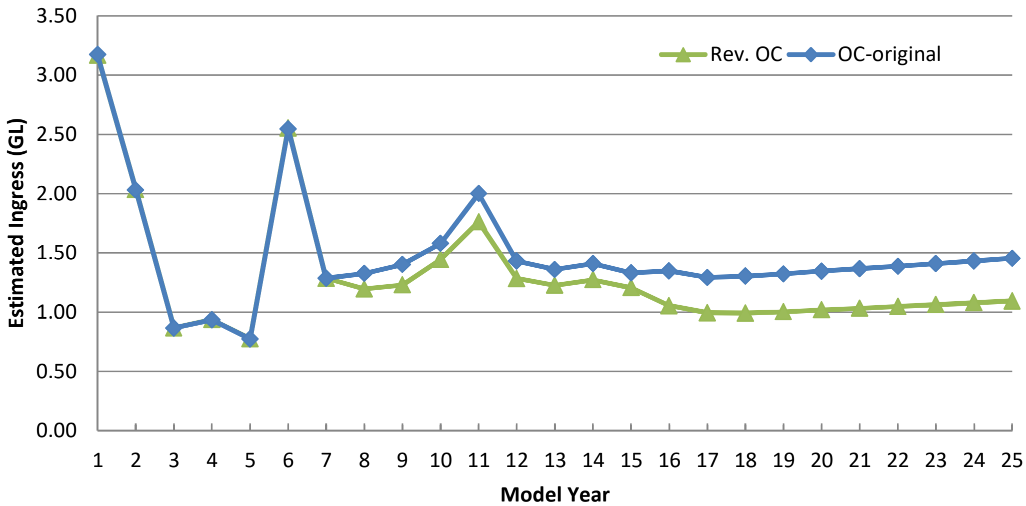
Groundwater drawdown contours at the end of underground mining were generated for the following model layers:

- Layer 1 - Quaternary/Tertiary
- Layer 6 - Harrow Creek (H16) seam
- Layer 10 - Dysart Lower (D14, D24) coal seam.

The modelled drawdown contours provide a conservative representation of the LAA (as defined in the Water Act) due to water extraction from mining activities, which is illustrated in Figure 21-26.

In assessing proposed underground mining drawdown contours, it is noted that the modelling includes the modified open-cut mine plan (see Section 21.6.1.2.2). It was considered that the simulation of the modified open-cut mining has minimal influence on model predictions.

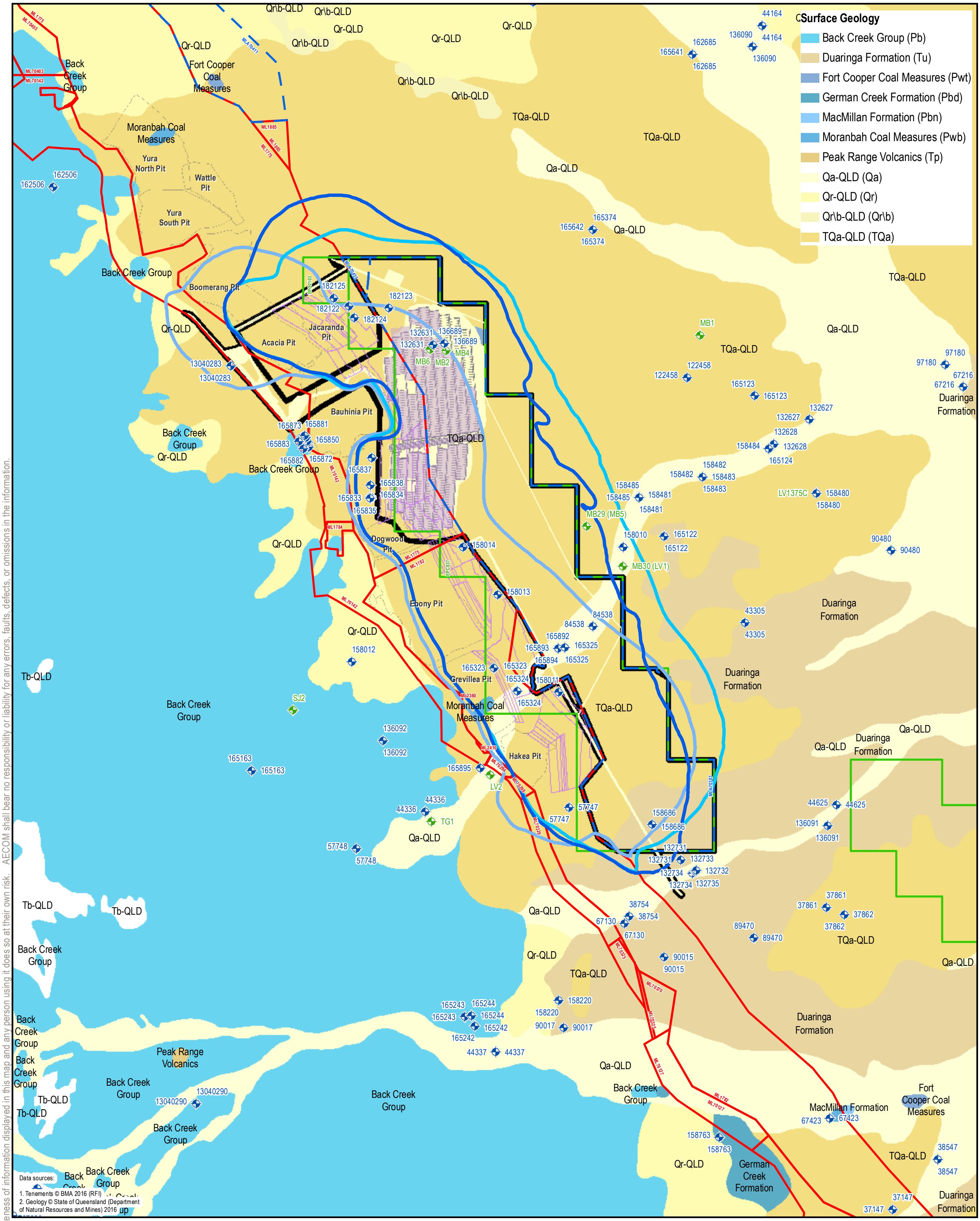
An example of the groundwater ingress for the approved open-cut workings versus the revised open-cut workings is included in Figure 21-25.



Note: OC-original = Original Open-Cut, Rev.OC = Revised Open-Cut (to remove overlap with underground panels)

Figure 21-25 Annual groundwater ingress estimates for approved and revised open-cut Saraji Mine

The reduction of the open-cut footprint of Coolibah and Dogwood Pits has a reduction in groundwater ingress predictions (< 0.5 GL) per year after mining open-cut mining ceases) as these pits will no longer reach the final depths and extent of the approved open-cut pits. Groundwater predictions during mining indicate limited differences in ingress (and consequently drawdown) (Figure 21-26).



LEGEND

- Project Site
- Project Footprint
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Registered Bore
- Census Bore
- Conceptual Surface Water Mine Plan
- Underground layout (maximised)
- Underground layout (optimised)
- Existing Open-Cut Extent
- Dysart Lower (D14, D24) seam (Layer 10) - 5 m drawdown contour (Underground and Open-Cut Mining)
- Harrow Creek (H16) seam (Layer 6) - 5 m drawdown contour (Underground and Open-Cut Mining)
- Quaternary/Tertiary (Layer 1) - 2 m drawdown contour (Underground and Open-Cut Mining)

Figure 21-26

Bores Located within End of Underground Mining (2041) Predicted Groundwater Drawdown Contours

Environmental Impact Statement Saraji East Mining Lease Project

0 1 2 4
Kilometres

Scale: 1:200,000 (when printed at A4)

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

BHP

DATE: 10/11/2020 VERSION: 2

End of mining drawdown extent

A summary of the predicted end of underground mining drawdown contours, for each of the three modelled layers, is summarised in Table 21-31.

Overall, proposed underground mining of the Lower Dysart (D14 / D24) seam will result in extension of the drawdown contours towards the east and north. Additional impacts towards the west and south of the mining operations are predicted to be minimal.

Table 21-31 Summary of predicted drawdown

Model layer	Cumulative drawdown (revised open-cut and underground mining)	Additional drawdown due to underground mining (compared to approved open-cut mining)
Model Layer 1 - Tertiary and Quaternary cover	• 2 m drawdown contours not predicted to extend any further than five km to the east from mining operations. • 2 m drawdown contour extends approximately 28.5 km in a north-south direction adjacent to the mining operations.	• 2 m drawdown contours outside the underground mining footprint extends up to two km further towards the east. • 2 m drawdown contours predicted to extend into the underground mining footprint. • 2 m drawdown contours, which previously consisted of two distinct zones, now consists of one continuous zone.
Model Layer 6 - H16 coal seam	• 5 m drawdown contour extends approximately seven km to the east of open-cut operations and two km east of underground operations. • 5 m drawdown contour extends approximately 28 km in a north-south direction adjacent to the mining operations.	• 5 m drawdown contours outside the underground mining footprint extends up to three km further towards the east. • 5 m drawdown contours predicted to extend into the underground mining footprint and up to three km beyond the footprint towards the east and north. • 5 m drawdown contours, which previously consisted of two distinct zones, now consists of one continuous zone.
Model Layer 10 - Dysart Lower (D14 / D24) coal seam	• 5 m drawdown contour extends approximately 7 km to the east of open-cut operations and 2 km east of underground operations. • 5 m drawdown contour extends approximately 30 km in a north-south direction adjacent to the mining operations.	• 5 m drawdown contour extends up to two km further towards the east. • 5 m drawdown contours extend into the underground mining footprint and up to three km beyond the footprint towards the east and north. • 5 m drawdown contours, which previously consisted of two distinct zones, now consists of one continuous zone.

Groundwater ingress estimates

The modelling approach adopted for the drawdown assessment, considering mining activities with and without the proposed underground mine, allowed for the estimate of annual groundwater ingress into the underground mine. The estimate of groundwater ingress is presented in Figure 21-26.

The ingress estimates between the open-cut only scenario and the open-cut with underground mining scenario, were estimated for the life of open-cut to determine the component of ingress that can be attributed to the underground operations. Results show that the total amount of ingress as a result of underground mining is predicted to be 1,527,725 cubic metres (m^3) which is on average 152.77 mega litres per annum (ML/a) for the ten year period from gas drainage commencement until end of open-cut mining.

A sensitivity analysis was also undertaken by varying the recharge rate by ± ten per cent. The sensitivity results suggest that mine ingress is not markedly affected by the recharge rate. Total groundwater ingress estimates resulting from open-cut and underground mining over 25 years is estimated at 35.7 GL, which equates to approximately 45 Litres per second (L/s). Considering the mining operations extend over a strike length of over 22.5 km, this equates to approximately one L/s over 500 linear metres.

This ingress is considered to occur as wet coal (where coal moisture ranges from one to two per cent in the target coal seams) and seepage (damp) pit walls, which is removed by coal extraction and evaporation, respectively. Groundwater intersected in the underground workings will be removed in the Incidental Mine Gas extraction, wet coal, and mine dewatering (from the lowest point in the workings).

Impacts on GDEs and Springs

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.

Aquatic GDEs

No aquatic GDEs have been observed in the Project area, and it has been assessed as having low potential for aquatic GDEs (see Section 21.7.6). The areas of the mine that contain 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 and it is conceptualised that the alluvial sediments associated with the creeks do not contain permanent groundwater.

Terrestrial GDEs

No terrestrial GDEs have been observed in the Project area, and it was assessed as having low potential for terrestrial GDEs (see Section 21.7.6). The groundwater levels in 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). 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).

Groundwater is generally not permanently present within alluvial sediments and is, therefore, unlikely to provide a source of water for terrestrial species.Generally, floral assemblages within the area are drought tolerant with low sensitivity to water availability.

Subterranean GDEs

No known or potential subterranean GDE's have been identified within the Project area, and it has been assessed as having low potential for subterranean GDEs (see Section 21.7.6). Stygofauna sampling was undertaken in seven groundwater monitoring bores screened across Tertiary and Permian sediments during September 2011 (IESA, 2011a) and December 2011 (IESA, 2011b). No stygofauna species were detected during the September 2011 and December 2011 sampling events.

Springs

No known springs are present within the Project area. A review of registered springs indicates that the closest springs are greater than 150 km from Saraji Mine.

21.9.2 Threatened species and ecological communities

The Project Site covers 11,427 ha, within which 2,613 ha of remnant and 8,136 ha of non-remnant vegetation exists. Of this, 1,290.93 ha of remnant and 1,952.97 ha of non-remnant vegetation falls within the Project Footprint and may be disturbed by direct impacts and indirect impacts. Direct impacts include vegetation clearing and habitat loss from the construction of:

- 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 and infrastructure corridor)
- IMG network.

Indirect impacts include potential habitat modification during the operational phase due to the potential subsidence and/or drawdown from water extraction. Other indirect impacts such as weed and pest incursion and edge effects can also result in habitat degradation that can potentially occur in all project phases, including decommissioning.

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 21.11. The impact assessment discussed below is based on the maximised footprint. It also assumes that subsidence will be to an extent that will create negative indirect impacts and that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. Therefore, impacts described reflect a worst-case scenario and maximum extent of disturbance to MNES.

Direct impacts

Vegetation clearing and habitat loss

The total worst-case disturbance area from the construction of the Project (surface facilities, ancillary infrastructure and IMG management network) is 1,071.37 ha. Direct impact of vegetation clearing and habitat loss for vegetation communities and habitat types within the Project Footprint is detailed in Table 21-32. It should be noted that the disturbance calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Some clearing such as within the powerline connection and the transport and infrastructure corridor are anticipated to be lower than estimated for the maximised footprint. Therefore, the calculations provide a conservative estimate of proposed disturbance.

Table 21-32 Vegetation clearing, and habitat loss impacts during construction

Fauna habitat type	RE	Project Site (ha)	Project Footprint (ha)	Direct clearing impacts		
				Surface facilities (ha)	IMG network (ha)	Total (ha)
River Red Gum Riparian Woodland	RE11.3.25	192.08	79.60	6.50	5.41	11.91
Eucalypts and/or Corymbia open Woodland	RE11.3.2, RE11.3.4, RE11.4.13, RE11.5.3	1,876.30	924.91	89.10	26.20	115.30
Dawson Gum and Brigalow Woodland	RE11.4.8	322.16	236.02	24.13	16.89	41.02
Brigalow and Belah Woodland	RE11.3.1, RE11.4.9	204.33	39.15	0.45	8.17	8.62
Oxbow Wetland	RE11.3.27 b	16.64	11.17	0	3.05	3.05
Natural Grasslands	RE11.4.4	1.73	0.075	0.075	0	0.075

Fauna habitat type	RE	Project Site (ha)	Project Footprint (ha)	Direct clearing impacts		
				Surface facilities (ha)	IMG network (ha)	Total (ha)
Modified Grasslands	NA	6,252.43	1,229.62	383.25	193.75	577.00
Shrubby Brigalow regrowth with gilgai	NA	1,776.14	652.63	188.82	95.21	284.03
Dams	NA	107.66	70.72	30.16	0.20	30.36
Total		10,749.17	3,243.90	722.49	348.88	1,071.37

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 *Eucalyptus* 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.

The proposed transport and infrastructure corridor may cause some severance 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, Plumtree Creek, Spring Creek and Phillips Creek. The riparian communities surrounding these creek crossings have a comparatively high faunal diversity. Clearing of these areas will reduce fauna dispersal as well as food and roosting/nesting resources associated with this corridor and may warrant the use of vegetation buffers. However, 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.

The IMG management network will be constructed in a grid like pattern. As a result, vegetation will still occur in patches between the IMG management infrastructure. 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 another potential impact. This is particularly relevant to ground dwelling fauna that may be crushed by machinery and arboreal mammals that may 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 may continue to utilise remaining habitat affected by fragmentation and noise, light and activity disturbance.

Subsidence related impacts

The proposed underground longwall mining operations will result in a varying degree of ground surface subsidence. Current modelling indicates the potential of ground subsidence between 0 m and 3.5 m (Minserve, 2017). The maximum subsidence depth of > 3m is conservatively predicted to occur in only two panels in the north and three in the southern section of the Project Footprint. If subsidence to these levels does occur, any surface cracking is predicted to be restricted to the surrounding local area, including within 100 m to 200 m of the southern panels and 150 m to 380 m of the northern panels. Subsidence will be progressive as mining advances.

Underground mining activities resulting in subsidence do not require clearing of vegetation, but subsidence-induced changes to local topography soils and hydrology can potentially affect vegetation. Subsidence-related movement in soil profiles and the formation of cracks and fissures can lead to stress on the roots of trees and shrubs and localised root shearing, indirectly impacting on vegetation health. As a worst-case scenario, this may result in root failure and premature death of individual trees. This is only a potential and worst-case impact in habitats within the Project Footprint affected by subsidence that contain mature woody vegetation. In areas of grassland habitat and immature regrowth vegetation such as the low shrubby brigalow regrowth within the predicted subsidence impacted areas of the Project Footprint, negligible to minimal impact is expected as root systems are small and restricted to the surface soil layers.

Localised changes in topography from subsidence can alter drainage characteristics where they intersect waterways. The likely scenario for subsidence within southern panels of the Project Footprint is the potential formation of flow paths down the centre of the panel. This will only affect minor flow paths with most larger flow paths continuing along their original course. Realignment of flow paths in the northern panels appears a less likely scenario, due to the shallower subsidence predicted. Major creek lines within the Project Site including Plumtree Creek are characterised as low energy systems with ephemeral channels which are often inactive and at times colonised by terrestrial vegetation. Therefore, any attenuation of water flows through storage in subsidence troughs along watercourses are likely to be localised and temporary with negligible downstream impacts (Alluvium, 2019).

Nonetheless, the development of avulsion paths, meander cut offs and head cuts along watercourses within the Project Footprint may occur in areas where energy gradients are increased by subsidence, particularly flow paths which drop into subsided panel zones over pillars or end walls. This may cause localised streambank instability and destabilise individual large trees along these sections of the creeks until the streambed re-establishes over time through processes of erosion and sediment infilling. The potential loss of individual large trees along the riparian corridors within the Project Footprint could result in reduced canopy connectivity in limited and localised circumstances and the loss of individual habitat trees that provide roosting and nesting habitat as well as food resources for local fauna populations.

Depression of the surface due to subsidence may lead to water ponding within and adjacent to watercourses across the Project Footprint after heavy rain and during periods of flooding. In areas where residual pooling may occur there is the potential for existing habitat to be modified in time. Changes in vegetation may occur as vegetation that is not tolerant to ponding will tend to die back in affected areas, potentially being replaced by vegetation more tolerant to inundation. For impact assessment, it is conservatively assumed that ponding may occur uniformly across the goaf of each longwall.

However, ponding is not predicted to occur across the entire subsidence landscape and is typically localised. Modelling shows that during rainfall for both a 50 and 100 year ARI, residual pooling is modelled to account for a change of approximately half a per cent of total flow volume (Alluvium, 2019). Modelling demonstrates that due to the ephemeral nature of major creek lines within the Project Site and limited change in pre and post subsidence flow conditions, residual pooling would be localised and limited in duration. Residual pools in the system may also be viewed as a positive environmental impact as the occurrence and extent of ephemeral wetlands and in-channel pools is generally limited within the Project Site. In time, it is expected that subsidence pools in Boomerang and Hughes Creek will be infilled with bedload sediment (Alluvium, 2019).

Ponds may vary from areas of intermittent inundation to semi-permanent ponds. Ponds may potentially create new habitat opportunities for some fauna groups. A relatively high diversity of amphibians was recorded in the Project Site and an increase in aquatic habitats will potentially benefit this fauna group in turn increasing food resources for their predators such as the conservation significant species, Ornamental Snake (*Denisonia maculata*). Cane Toads (*Bufo marinus*) are present, and availability of aquatic habitat may also increase their numbers. The availability of permanent water may also benefit larger fauna using the site, including Eastern Grey Kangaroo (*Macropus giganteus*) and pest species such as Feral Pigs (*Sus scrofa*). These changes are gradual, and this may provide opportunity for fauna to move to adjacent areas to the north and east if food and nesting resources in the Project Site are affected. However, for the purposes of impact assessment, these potential benefits have not been considered to mitigate the potential impacts of subsidence.

The maximum extent of subsidence related impacts is outlined in Table 21-33.

Prior to subsidence, vegetation within the IMG management infrastructure footprint will have already been cleared. These areas have been excluded from the area calculations below as impacts for these areas have already been captured in the vegetation clearing and habitat loss calculations. The impacts described below assume that across the full extent of subsidence, that all impacts will result in a negative impact to habitats and that these impacts will occur uniformly across all areas influenced by subsidence. The likelihood of this occurring is low. As such the calculations below are considered conservative and represent a worst-case scenario.

Table 21-33 Habitat modification impacts as a result of subsidence during operation

Fauna habitat type	RE associations	Project Site (ha)	Project Footprint (ha)	Indirect impact (ha)
River Red Gum Riparian Woodland	RE11.3.25	192.08	79.60	67.69
Eucalypts and/or Corymbia open Woodland	RE11.3.2 RE11.3.4 RE11.4.13 RE11.5.3	1,876.30	924.91	819.61
Dawson Gum and Brigalow Woodland	RE11.4.8	322.16	236.02	195.00
Brigalow and Belah Woodland	RE11.3.1 RE11.4.9	204.33	39.15	30.53
Oxbow Wetland	RE11.3.27b	16.64	11.17	8.12
Natural Grasslands	RE11.4.4	1.73	0.075	0
Modified Grasslands	NA	6,252.43	1,229.62	652.62
Shrubby Brigalow regrowth with gilgai	NA	1,776.14	652.63	368.60
Dams	NA	107.66	70.72	40.36
Total		**10,749.17**	**3,243.90**	**2,172.53**

Drawdown from water extraction

Vegetation within the Project Site is not considered groundwater dependent and no known aquatic, terrestrial or subterranean groundwater dependent ecosystems have been mapped within the Project Site as per the National Atlas of groundwater dependent ecosystems. The majority of floral assemblages within the area are characterised by drought tolerant species with low physiological sensitivity to water availability. Froend and Loomes (2004) suggest that groundwater is of reduced importance to vegetation when the water table is at depths greater than 10 m. They assume, however, that at depths between 10 m and 20 m there is still a probability of vegetation groundwater use, but this is thought to be negligible in terms of total plant water use.

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

Indirect impacts

Potential indirect impacts associated with the construction, operational and decommissioning phase that can result in the degradation of remaining habitats 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 - 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 may result in reduced growth rates of vegetation and decreases in floral vigour and overall community health. Vegetation close to construction, operational or decommissioning activities are most susceptible to dust impacts.
- Edge effects – the proposed IMG infrastructure will lead to creation of habitat patches that may be 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 may 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 may 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.

21.9.3 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, and may 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 Saraji Mine) 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.

21.9.4 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.

21.10 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, 2020) 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.

21.10.1 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.

21.10.1.1 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.

Dewatering

The following mitigation and management measures apply to dewatering of water storage dams for operational requirements, such as maintenance:

- Ensure water is disposed of in accordance with the project EA and relevant legislation
- Ensure that pipe and pump network is operating properly before commencing dewatering.

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 Saraji Mine'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 as required.

Mine WMS 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.

Contamination

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, the WMS aims to passively divert runoff originating from undisturbed catchments around the mine WMS. 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 Saraji Mine 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 21-22). 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.

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:

- Refuelling to occur within contained, hardstand areas in accordance with AS1940 The Storage and Handling of Flammable and Combustible Liquids where practical. Where this is not possible, 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 should be directed through oil and grease separators and effluent utilised for dust suppression or other use or directed to the mine WMS for reuse.

Erosion and sediment control

Potential impacts to surface water will be mitigated through the implementation of an Erosion and Sediment Control Plan (ESCP), to align with the principles of International Erosion Control Association (IECA) Best Practice Erosion & Sediment Control guidelines, during construction and operation of the Project. The ESCP will be developed prior to construction and include the following:

- sediment dams will be constructed prior to vegetation clearing and earthworks
- vegetation clearing and earthworks will be undertaken in incremental stages 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
- 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
- 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 should 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 should be stabilised to minimise wash outs and bank erosion
- stabilisation may include 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.

Subsidence management plan

A subsidence management plan (SMP) has been prepared for the Project. It provides 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.
- infrastructure protection or relocation, where necessary.

The SMP identifies a number of mitigation measures for managing the impacts of subsidence upon surface waters, including ripping, tyning, grading, compaction, crack infilling with concrete or clay, progressive rehabilitation, embankment arming, bed stabilisation such as pervious weirs, geomorphological modelling to predict high energy areas of the subsided landform, additional grazing access / controls to mitigate vegetation stripping and bank damage, channel re-profiling and construction of contour banks, vegetation planting, erosion control matting in high energy or erosive area, construction of drop structures at head cut erosion features.

Water quality monitoring

Receiving environment monitoring program

A Receiving Environment Monitoring Program (REMP) will be developed prior to construction and will incorporate a baseline water quality monitoring program to monitor pH, electrical conductivity, total suspended solids and total dissolved solids at upstream and downstream locations. BMA will collect a minimum of 18 data values over at least two years of monthly sampling at upstream and downstream locations to derive site-specific surface water quality trigger values in accordance with Queensland water quality guidelines and the relevant environmental values as defined under EPP (Water and Wetland Biodiversity) Isaac River Sub-basin Environmental Values and Water Quality Objectives (DEHP, 2011). 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. In the interim, water quality will be monitored against interim water quality trigger values defined in Table 21-34 until a full data monitoring program can be undertaken. 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 21-22). Existing upstream locations will continue to be monitored.

Table 21-34 Interim water quality trigger values

Parameter	Unit	Water quality objective	Guideline source
Physico-chemical parameters			
Total suspended solids	milligrams per Litre (mg/L)	55	EPP (Water) (2019)
Turbidity	Nephelometric Turbidity Units (NTU)	50	EPP (Water) (2019)
Electrical conductivity	microSiemens per centimeter (µS/cm)	Base flow: 720 High flow: 250	EPP (Water) (2019)
Sulfate	mg/L	25	EPP (Water) (2019)
pH	-	6.5-8.5	EPP (Water) (2019)

Parameter	Unit	Water quality objective	Guideline source
Ammonia (as nitrogen)	Micrograms per Litre (µg/L)	20	EPP (Water) (2019)
Oxidised nitrogen	µg/L	60	EPP (Water) (2019)
Organic nitrogen	µg/L	420	EPP (Water) (2019)
Total nitrogen	µg/L	500	EPP (Water) (2019)
Filterable reactive phosphorus	µg/L	20	EPP (Water) (2019)
Total phosphorus	µg/L	50	EPP (Water) (2019)
Dissolved oxygen	% saturation	85-110	EPP (Water) (2019)
Metals (dissolved)			
Aluminium	µg/L	5,000	EPP Water (2011) Stock watering**
	µg/L	55	ANZG (2018)*
Arsenic (dissolved)	µg/L	500	EPP Water (2011) Stock watering **
		13 (for As(V))	ANZG (2018)*
Chromium	µg/L	1,000	EPP Water (2011) Stock watering**
	µg/L	1	ANZG (2018)*
Copper	µg/L	400	EPP Water (2011) Stock watering**
	µg/L	1.4	ANZG (2018)*
Iron	-	Not provided	EPP (Water) (2019)
	-	Not provided	ANZG (2018)*
Molybdenum	µg/L	150	EPP (Water) (2011) Stock watering**
	µg/L	34	ANZG (2018)*
Nickel	µg/L	1,000	EPP (Water) (2011) Stock watering**
	µg/L	11	ANZG (2018)*
Selenium	µg/L	20	EPP (Water) (2011) Stock watering**
	µg/L	5	ANZG (2018)*
Uranium	µg/L	200	EPP (Water) (2011) Stock watering**
	µg/L	0.5	ANZG (2018)*
Zinc	µg/L	20,000	EPP (Water) (2011) Stock watering**
	µg/L	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.

During construction, surface water that may be ponded in excavations will be tested and managed in accordance with the stormwater management system to determine whether suitable for discharge to the receiving environment or otherwise disposed of at a licensed facility. Monitoring of the receiving water during construction would be in accordance with the REMP outlined above.

During operation, monitoring of dam water levels for MAW dams (not including sedimentation dams) will be automated and dam water levels will be managed in accordance with the WMS to minimise uncontrolled releases. Where safety and access permit, the receiving water will be monitored at upstream and downstream locations during emergency release events. Monitoring of the receiving water during construction would be in accordance with the REMP outlined above.

The subsidence monitoring program will monitor erosion and sedimentation, surface cracking across the subsidence impacted areas. As a result, surface water runoff from the Project is not expected to alter surface water quality downstream.

In addition, several weirs have been constructed on the Fitzroy and Mackenzie Rivers including Fitzroy Barrage, Eden Bann Weir and Tartrus Weir. These weirs provide an additional barrier to sediments and contaminants from reaching the GBRWHA and Great Barrier Reef Marine Park.

Based on the distance between the Project Site and the mouth of the Fitzroy River and the extent of controls over mine water and site discharges, the GBRWHA and Great Barrier Reef Marine Park is not considered to be relevant MNES to the Project.

21.10.1.2 Groundwater

Potential impacts to groundwater resources that require ongoing monitoring include:

- shallow Quaternary and Tertiary aquifer groundwater levels and quality
- Permian coal seam (Harrow Creek and Dysart seam) groundwater levels and quality
- potential contamination sources including tailings disposal areas.

A Groundwater Monitoring Program will be developed to ensure an appropriate level of detail and scale. The purpose of the program will be to monitor the magnitude and distribution of actual changes to groundwater conditions in response to mining and to provide early detection of any unforeseen impacts to groundwater levels, groundwater flows or groundwater quality.

The objective of the groundwater monitoring network is to monitor potential effects of the proposed mining on overlying and underlying hydrostratigraphic units (aquifers), so that informed management decisions can be made. The fundamental components of the groundwater plan are as follows:

- The existing Saraji Mine groundwater monitoring bore network will be augmented near the proposed underground mine and include water level and water quality monitoring (AECOM, 2018a).
- The monitoring bore network and subsequent monitoring program will be established prior to the commencement of the underground mining. Baseline seasonal trends for groundwater levels and quality will be confirmed within the project footprint to allow comparison with mining-related trends. The frequency of monitoring can be reduced once a baseline dataset has been established to capture the broader regional and seasonal trends.
- Existing vibrating wire piezometers and monitoring bores will be incorporated into the bore monitoring network. As some drawdown impacts are predicted for registered bores, representative private bores (or new sentinel sites) are to be incorporated into the monitoring program.
- Site-specific and regional groundwater quality will be monitored to establish baseline trigger levels, evaluate spatial and temporal trends, and gauge whether water quality objectives are being protected or enhanced for specified environmental values, being stock watering. The program will aim to detect a significant change to water quality values (consistent with the current suitability of the groundwater for domestic and agricultural use) resulting from project activities
- There are no local springs or GDEs to monitor.

The current Saraji Mine groundwater monitoring network provides lateral and vertical coverage of the groundwater resources within and adjacent to the approved mining activities. The existing groundwater monitoring network will be augmented near the proposed underground mine to:

- Assess 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.
- Ensure the extent and magnitude of drawdown in each aquifer near the proposed underground workings is adequately monitored for comparison to modelled projections over time.
- Allow for 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 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).

The existing monitoring bore network and recommended additional monitoring bores, to be utilised during the life of the project and post-closure is summarised in Table 21-35 and illustrated in Figure 21-27.

Table 21-35 Groundwater monitoring bore network

Bore ID	Latitude	Longitude	Depth (m)	Geology	Type	Rationale
158010 / MB35	642646	7520110	34.5	Fair Hill Formation	Standpipe	Saraji Mine monitoring bores – coal and footwall
158011 / MB36	640150	7514283	32	Fair Hill Formation		
158012 / MB37	632389	7515571	41.4	Back Creek Group		
158013 / MB34	637926	7518269	107	Moranbah Coal Measures		
158014 / MB33	636640	7520199	37.5	Moranbah Coal Measures		
MB31 (SJ1)	625828	7522379	44.23	Coal	Water supply	Landholder bores
MB32 (TG2)	637481	7510535	19.52	Alluvium		
PZ02A	632019	7530675	26	Tertiary - Regolith	Nested bores	Saraji Mine monitoring bores – vertical gradients and interaction between units
PZ02B	632019	7530675	170	Sandstone		
PZ02C	632019	7530675	278	Dysart D24		
PZ04A	630242	7530952	30	Tertiary - Regolith		
PZ04B	630242	7530952	66	Harrow Creek H16		
PZ04C	630242	7530952	180	Coal D47		

Bore ID	Latitude	Longitude	Depth (m)	Geology	Type	Rationale
PZ07A	637885	7517636	14	Tertiary - Claystone		
PZ07B	637885	7517636	198	Sandstone		
PZ07C	637885	7517636	303	Harrow Creek H16		
PZ09A	632912	7527779	-	Tertiary -Clay		
PZ09B	632912	7527779	75	Harrow Creek H16		
PZ09C	632912	7527779	195	Dysart D24		
PZ10A	634236	7524164	-	Tertiary - Regolith		
PZ10B	634236	7524164	70	Harrow Creek H16		
PZ10C	634236	7524164	184	Dysart D24		
PZ05A	642327	7509221	203	Harrow Creek H16	VWP	Hydrostatic pressure monitoring – dewatering impacts
PZ05B	642327	7509221	239	Coal D52		
PZ06A	639272	7513326	40.5	Sandstone		
PZ06B	639272	7513326	78.5	Harrow Creek H16		
PZ06C	639272	7513326	167	Coal D142		
PZ08A	634647	7523069	38.5	Coal P07		
PZ08B	634647	7523069	65	Harrow Creek H16		
PZ08C	634647	7523069	180	Dysart D24		
SEMLPMB1	635854	7527351	10 m and 25 m (alluvium and Tertiary)	Hughes Creek Alluvium & underlying Tertiary sediments	Nested bore	Surface water-groundwater interaction
SEMLPMB2	635070	7530680	> 300 m	Harrow Creek and Dysart seam	Standpipe and VWP	Model validation Induced flow assessment
SEMLPMB3	638492	7526177	> 400 m			
SEMLPMB4	638047	7523214	> 300 m			

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), EPP Water and the Murray Darling Basin Commission (1997).

Monitoring bore network

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 Water Commission, 2012) 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 aquifers (i.e. the bore does not act as a connecting pathway).

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), EPP (Water and Wetland Biodiversity) and the Murray Darling Basin Commission (1997).

Water quality

Site-specific and regional groundwater quality are to be monitored to establish baseline trigger levels, evaluate spatial and temporal trends, and gauge whether water quality objectives are being protected or enhanced for specified environmental values, being stock watering.

The monitoring bore network provides an early warning of potential impacts, so that early intervention can be implemented to reduce potential environmental harm. Should monitoring indicate an undesirable trend, the requirement for additional monitoring bores, both in other aquifers and laterally away from the Project is to be assessed, and actioned if deemed necessary.

Different methods exist for the assessment of groundwater monitoring data, one of which is the use of statistical tests for the development of indicator parameter limits that recognise natural data variability and facilitate tracking of quality and quantity trends.

Groundwater samples have and will be obtained from the representative groundwater monitoring points to establish representative groundwater chemistry contaminant levels prior to the Project. Once a statistical groundwater dataset is available (a minimum of 12 sample events statistical), assessment of statistical trends will be derived for representative parameters monitored within each groundwater unit.

The parameter suite for analysis for each groundwater sample is likely to include, but not limited to:

- pH, Electrical Conductivity, (field and laboratory determinations)
- Total Dissolved Solids (laboratory analysis)
- Anions - carbonate, bicarbonate, chloride, sulphate (laboratory analysis)
- Cations - calcium, magnesium, sodium, potassium (laboratory analysis)
- Dissolved metals - aluminium, antimony, arsenic, iron, manganese, molybdenum, selenium, silver, mercury (laboratory analysis)
- Nutrients - nitrate, nitrite, phosphorus, ammonia
- Total petroleum hydrocarbons (TPH).

For each measured parameter for each geological unit possibly impacted by mine operations, these contaminant trigger levels, and contaminant limits can be based on the 85th and 99th percentile values respectively. Trends can be identified, and follow-up investigations initiated per the established approach outlined below. The intent of the investigative follow-up is to identify natural exceptions to the proposed trigger levels and contaminant limits and facilitate revision of the targets as per the adaptive management approach (i.e. an assessment of potential for environmental harm will be conducted and if it is found that the trigger levels are exceeded due to natural conditions (not mine related) then the limits are to be re-evaluated).

First step

Should any agreed groundwater quality trigger levels be exceeded, an investigation will be undertaken within 14 days of detection to determine if the exceedance is a result of:

- mining activities authorised under the project EA
- natural variation
- neighbouring land use resulting in groundwater impacts.

Second step

If the investigation determines that the exceedance was the result of mining, then investigations will be undertaken to establish whether environmental harm has occurred or may occur. This will include:

- the relevant monitoring point(s) will be resampled, and the samples analysed for major cations and anions, and selected dissolved metals
- if elevated concentrations (above trigger levels) are recorded on two consecutive sampling events then an investigation into cause, optimum response, and the potential for environmental harm will be conducted.

Water levels

It is recognised that drawdown, because of mine dewatering or depressurisation, can impact on groundwater resources and potentially cause environmental harm. To identify potential drawdown impacts the monitoring points will act as early warning and model prediction validation points, when assessing underground mine drawdown impacts.

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.

Most of the groundwater monitoring bores are located within the zone of predicted groundwater level drawdown due to the mining operations. Therefore, changes in groundwater levels would be compared to predicted groundwater trends to evaluate any deviations from the model predictions. The monitoring points will act as early warning bores for impacts beyond those predicted.

At a minimum, groundwater levels within the groundwater monitoring network are reviewed annually. Most of the groundwater monitoring bores will have permanent groundwater level monitoring devices (either VWP pressure sensors or automated water level loggers) installed. These data loggers compile water level data at a minimum weekly interval, with the data being downloaded and assessed on a regular basis (during groundwater sampling events).

Trends will be identified, and follow-up investigations initiated if non-compliance (exceedances to the triggers / limits are reported). The intent of the investigative follow-up is to identify natural exceptions to the non-compliance and evaluate the potential for environmental harm. If the investigation identifies the cause of an exceedance is due to approved mining operations, then the following will be conducted:

- installation of additional monitoring bores in selected (impacted) aquifers
- undertaking more frequent monitoring of groundwater to assess predictions and instigate mitigation to prevent environmental harm
- refine and revise the predictive groundwater model
- review of the latest numerical groundwater model and estimate the predicted take of water
- develop management, prevention and remediation of impacts, including water replacement (make-good) and substitution (mine to supply water to reduce overall groundwater extraction).

AECOM does not warrant the accuracy or completeness of information displayed in this map and any person using it does so at their own risk. AECOM shall bear no responsibility or liability for any errors, faults, defects, or omissions in the information.

LEGEND

- Existing Bores
- Proposed Bore
- Underground layout (optimised)
- Existing Open-Cut Extent
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)

Surface Geology

- Back Creek Group (Pb)
- Duaringa Formation (Tu)
- Fort Cooper Coal Measures (Pwt)
- German Creek Formation (Pbd)
- MacMillan Formation (Pbn)
- Moranbah Coal Measures (Pwb)
- Peak Range Volcanics (Tp)
- Qa-QLD (Qa)
- Qr-QLD (Qr)
- Qr\b-QLD (Qr\b)
- TQa-QLD (TQa)
- Tb-QLD (Tb)

N

Figure 21-27
Existing and Proposed Monitoring Bores

Environmental Impact Statement
Saraji East Mining Lease Project

0 1 2 4
Kilometres

Scale: 1:200,000 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 5/08/2020 VERSION: 0

Filename: P:\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\09 Groundwater\60507031_G259_v0_A4P.mxd

21.10.2 Threatened species and ecological communities

To minimise vegetation removal, habitat loss or degradation, the Project has been designed to utilise the existing approved Saraji Mine infrastructure and optimise siting of new infrastructure. There is flexibility in the location of surface infrastructure such as the construction accommodation village, powerlines and roads which can be located to avoid, to the greatest extent possible, areas of ecological value.

The CHPP, conveyors and product stockpiles are located within the existing Saraji Mine ML and, while vegetation clearing is required, this vegetation is already disturbed and fragmented. The proposed MIA and the raw water dam will be in an already disturbed area within Saraji Mine 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.

While design of the layout of the IMG 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. Wherever possible, the wells required for IMG infrastructure 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.

For clearing of vegetation for surface facilities, BMA will implement the following mitigation measures:

- areas for clearing will be visually delineated to avoid inadvertent clearing
- habitat features such as felled trees and logs will be considered for relocation to other areas where practical to provide microhabitat
- the workforce will be made aware of mitigation management requirements in induction training.
- when working in the riparian zone associated with Phillips creek, use of low impact work (i.e. pruning vegetation instead of clearing) will be implemented
- induction training and work instructions will be provided to the workforce with contact details of a suitably qualified spotter catcher where fauna is present in the project site and needs to be removed, or fauna are accidentally injured
- heavy vehicles (and where practical, light vehicles) will not traverse vegetated areas outside designated construction zones, but 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
- topsoil will be removed as per the topsoil management plan and used to progressively rehabilitate existing disturbed areas where practical
- erosion and sediment control measures will be installed and maintained
- dust suppression measures will be utilised to minimise deposition of dust on adjacent vegetation.

Suitably qualified spotter catchers will be required during vegetation clearing (all spotter catchers will hold appropriate permits under the *Nature Conservation Act 1992* (NC Act)). If fauna are injured by vehicles during operations, the RSPCA or local wildlife carers will be contacted for assistance. Following construction in each area, disturbed areas no longer required will be stabilised and progressively rehabilitated. Mitigation and monitoring will be managed throughout all project phases by a hierarchy of management plans.

21.10.3 Management and monitoring plans

Prior to construction, BMA 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 an iterative process (for continual improvement. Key management and monitoring plans and procedures are described in Table 21-36. Detailed management plans presented as part of this EIS include Rehabilitation Management Plan (**Appendix K-1**) and Subsidence Management Plan (**Appendix K-2**).

Table 21-36 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: – 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

Plan	Phase	Description
		• site specific ground truthing surveys following impacts to determine the actual level of disturbance and confirm significant residual 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.
Weed and Pest Management Plan	Construction	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 • 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 – monitoring for pest plants and fauna within subsided areas where ponding occurs will be undertaken to determine the need for management.

Plan	Phase	Description
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, 2020).
Rehabilitation Management Plan (RMP)	Construction and operation	BMA has prepared a RMP (**Appendix K-1**; BMA, 2020) 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 post-mining land use. The Project will adopt BHP's Queensland Coal Rehabilitation Completion Criteria (BHP, 2018a) including completion criteria for meeting satisfactory rehabilitation for post mining land uses, including: • Cattle grazing • Dryland cropping • Woodlands habitat • Watercourses • Water storage. Post mining land uses for the Project will be confirmed prior to construction. Post mining land use 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 post mining land use 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. In accordance with the existing Saraji Mine 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 Saraji Mine 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** 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

Plan	Phase	Description
		• progressive rehabilitation as mine advances and panels subside.

21.11 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.

21.11.1 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.

21.11.1.1 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 21-37.

Table 21-37 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 dust suppression, only using raw water sourced from BMA's existing surface water allocations where process water is unavailable. 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. Residual pooling may occur in the landscape post-subsidence (without erosion or management intervention); in time, these ponded volumes will decrease with sediment movement in the system. 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. *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 pits results in the steeper gradients around the pits. 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 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.

Aspect	Comment
	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 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. 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 may extend 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. Although unlikely due to the overlying geology, this impact could potentially increase frequency or duration of no flow in the creek; however residual ponding may increase in subsided areas. *Not a significant impact*
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% 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	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 that limit discharges to emergency conditions

Aspect	Comment
as a result of the change in water quality	and 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. *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 environment	Possible contaminants within the surface water will be collected and managed within the WMS, during operations and post closure. Discharge of Mine Affected Water only occurs in compliance with existing Environmental Approval conditions for the Project. *Not a significant impact*
Seriously affects the habitat or lifecycle of a native species dependent on a water resource	Vegetation within the Project Site is not considered groundwater dependent and no known aquatic, terrestrial or subterranean groundwater dependent ecosystems have been mapped within the Project Site as per the National Atlas of groundwater dependent ecosystems. The majority of floral assemblages within the area are characterised by drought tolerant species with low physiological sensitivity to water availability. 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	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

Aspect	Comment
local or regional water quality objectives)	quality can be monitored during the Project. Discharge of Mine Affected Water will only occur in compliance with Environmental Approval conditions for the Saraji Mine. 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 Mine Affected Water will only occur in compliance with Environmental Approval conditions issued for the Project. Any uncontrolled discharge of Mine Affected Water 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 Mine Affected Water will only occur in compliance with Environmental Approval conditions issued for the Project. *Not a significant impact*

21.11.1.2 Groundwater

A predictive groundwater model was used to predict potential impacts on groundwater levels from approved open-cut mining (associated with the existing approved Saraji Mine) and the Project. Predictions show that drawdown will extend up to an additional 3 km further to the north and east as a result of the proposed underground mining.

The impact assessment showed that there are 18 groundwater bores which are located within the end of underground mining drawdown thresholds (Figure 21-26). Of the 18 bores predicted to be impacted, 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 any ‘make-good’ agreements, it is unlikely that any 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 21.9.1)
- 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 that 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 21-38.

Table 21-38 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 mine dewatering. Post-mining groundwater level rebound is predicted to the level of the final voids in the Saraji Mine 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 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 Saraji Mine 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 Discharge of Mine Affected Water only occurs in compliance with existing Environmental Approval conditions for the Saraji Mine. *Not a significant impact*
Seriously affects the habitat or lifecycle of a native species dependent on a water resource	Although no known aquatic, terrestrial or subterranean groundwater dependent ecosystems (GDE) have been identified within the Project area, potential aquatic and terrestrial GDEs are mapped within the Project area.

Aspect	Comment
	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*
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 Mine Affected Water only occurs in compliance with existing Environmental Approval conditions for the Saraji Mine. *Not a significant impact*

21.11.2 Threatened ecological communities

21.11.2.1 Brigalow TEC

Description and status under the EPBC Act

The 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* (Belah)). 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, the Brigalow TEC is defined using the RE framework, where REs are considered analogous with the TEC, provided that other key diagnostic criteria and condition thresholds are met. Areas meeting Brigalow TEC are depicted in Figure 21-28.

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:

- 17th to 21st November 2007
- November 2008

- 27th to 29th August 2016
- 6th and 10th October 2016
- 30th January and 3rd February 2017
- 23rd to 29th 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).

Occurrence

The Brigalow TEC was recorded within the Project Site during the field surveys and was found to be analogous to RE11.3.1, RE11.4.8 and RE11.4.9 (Figure 21-28). The Brigalow TEC within the Project Site occurs on alluvial plains adjacent to creeks and gullies (Boomerang, Plumtree and One Mile Creeks) as well as undulating hills found throughout the Project Site.

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 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).

Within the Project Site this equates to 417.85 ha of habitat, of which 246.07 ha falls within the Project Footprint.

Habitat critical to the survival of the ecological community

The majority of Brigalow TEC patches within the Project Site are small and fragmented. Whilst larger patches with greater patch viability do occur within the Project Site they are still fragmented by highly modified areas such as cleared grazing areas dominated by *Cenchrus ciliaris* (buffel grass). As such all areas of Brigalow TEC within the Project Site are susceptible to ongoing threats that will continually impact on the ecological integrity of the community. The ability of these patches to act as refuges for the community from increasing climatic events such as bushfire is also compromised.

The patches of Brigalow TEC within the Project Site do not contain any unique characteristics or conditions (biotic and abiotic) that do not exist in other patches of Brigalow TEC in the local area and across the region. Similar habitat currently supporting Brigalow TEC within the Project Site is available across the region and will allow the community to continue to persist within its current distribution.

Based on all of these factors, habitat within the Project Site is not considered critical to the survival of the Brigalow TEC and is not considered to play a critical role in the long-term maintenance of the community.

Project impacts

Potential impacts to the Brigalow TEC are often associated with the construction and operational phase of mining projects are associated with both direct disturbances and indirect effects, including:

- vegetation clearing and loss
- fragmentation and edge effects
- weed incursion
- dust

- subsidence
- alterations to hydrological regime
- erosion and sedimentation.

As discussed in Section 21.9, development of mining operations within the Project Footprint will involve direct clearing for surface facilities and ancillary infrastructure as well as direct clearing and fragmentation for the IMG management network. Ongoing operational impacts may include subsidence due to the development of the Project.

The proposed construction village will be located in non-remnant vegetation with predominantly low (approximately one to two metres in height) *Acacia harpophylla* (Brigalow) regrowth, which does not meet TEC status. However, the transport and infrastructure corridor dissect several REs, including Brigalow TEC conforming areas of RE 11.3.1 and RE 11.4.8. The location of the rail loading balloon loop will also require clearing of RE 11.4.8, that meets TEC status.

Installation of the IMG management network will require clearing of vegetation for the construction of gas wells and corresponding infrastructure including gas pipelines, water pipelines and service roads. The nature of the clearing required will mean that the area will be divided into a grid like pattern. Vegetation conforming to brigalow TEC in the form of RE 11.4.8 will experience some clearing for the network, which may facilitate additional fragmentation of small areas of brigalow TEC. Fragmentation will also likely have an impact through the potential for weed incursion. *Cenchrus ciliaris* (Buffel Grass) is widespread through the Project Footprint and may more readily infiltrate Brigalow TEC areas fragmented from construction of the mining project. Further weed incursion could result in existing areas of TEC falling below condition thresholds and loosing TEC status.

Dust impacts generated during the construction and operation of the Project may negatively affect vegetation, particularly if excessive levels are sustained over extended periods. Excessive dust 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 due to physical effects may result in reduced growth rates of brigalow TEC vegetation and decrease floral vigour and overall community health.

Subsidence may cause a range of additional changes in remaining flora and vegetation communities. Areas of RE 11.4.8 and RE 11.4.9 analogous to brigalow TEC occur with the subsidence area and may potentially be subject to subsidence related changes. These changes may include localised changes in topography, tension cracking and altered drainage characteristics (localised ponding). As subsidence occurs, some further changes may affect the condition of this TEC, although brigalow is generally relatively tolerant of periodic inundation.

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. This is even more pronounced for any areas of Brigalow TEC considering the shallow, horizontal root system of brigalow trees (Johnson *et al.*, 2016).

The extent of potential direct and indirect impacts to Brigalow TEC resulting from the Project are outlined in Table 21-39 below. Indirect impact calculations relate to potential impact from subsidence only and assume full extent of subsidence, that all impacts will result in a negative impact to habitats and that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. As such the calculations below are considered worst case scenario.

Table 21-39 Direct and indirect impacts to Brigalow TEC within the Project Footprint

Impacts within Project Footprint	Area (ha)
Direct impacts (including surface facilities and IMG network)	43.14
Indirect impacts (including subsidence areas)	202.92
Total Impact to Brigalow TEC within Project Footprint	246.06

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 IMG extraction wells and infrastructure. REs 11.3.1, 11.4.8 and 11.4.9 which met 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 strategy 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. As it will not be possible to avoid all impacts to brigalow TEC, offsets will be required to mitigate residual impacts.

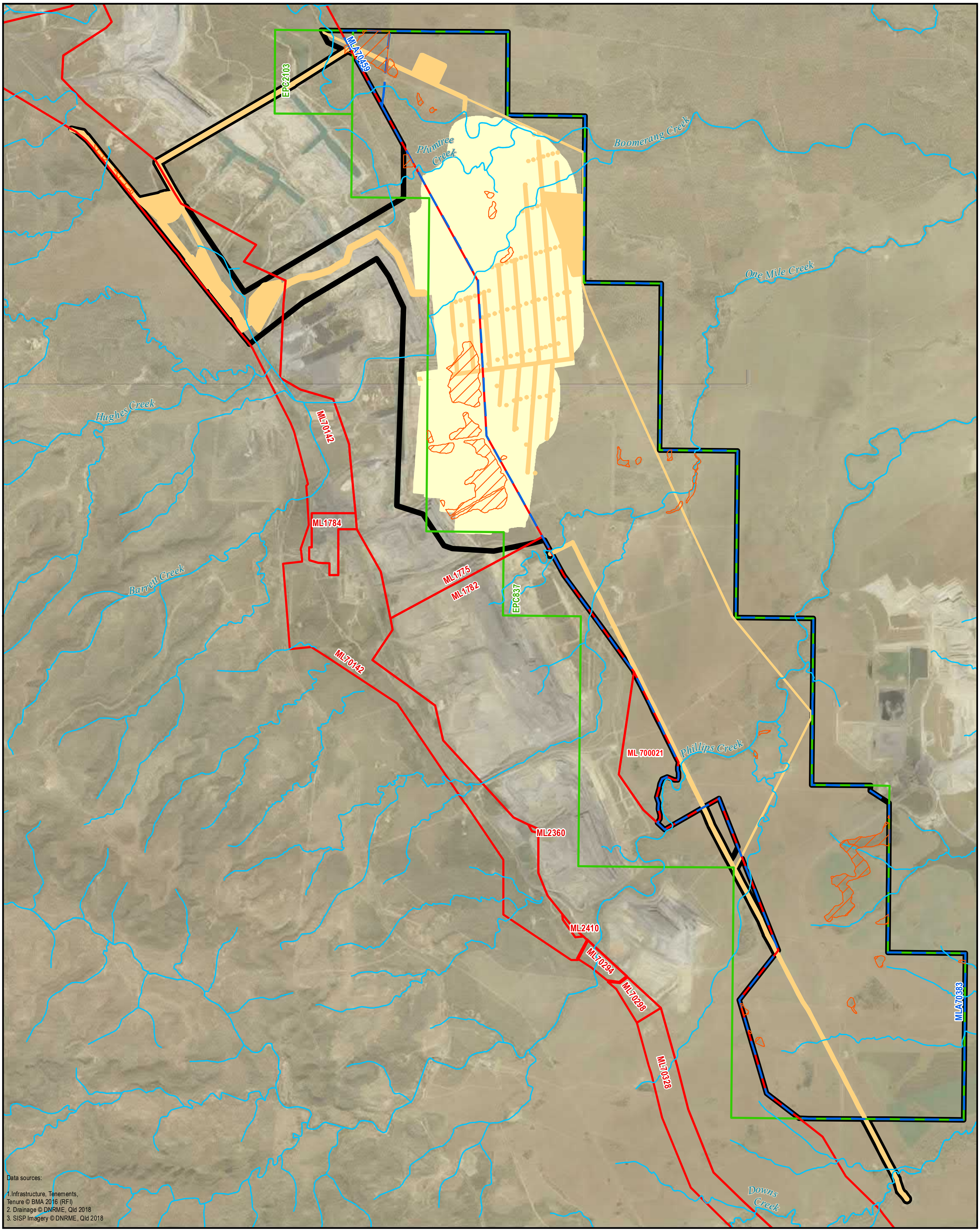
Significant impact assessment

An assessment of the potential significance of impacts on the brigalow TEC the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a) is provided in Table 21-40 . The assessment indicates that due to the area of potential disturbance to the TEC from the proposed action, the impacts of the Project on the TEC may be significant. This finding indicates that offsets are likely to be required, which is discussed in Section 21.12. An Environmental Offset Strategy has been developed for the Project (AECOM, 2019).

Table 21-40 Assessment of Significance of Impact – Brigalow (*Acacia harpophylla* dominant and co-dominant)

EPBC Act criteria	Assessment of significance
An action is likely to have a significant impact on an endangered TEC if there is a real chance or possibility that it will:	
Reduce the extent of an ecological community.	Approximately 246.06 ha of this TEC will be potentially impacted as a result of the proposed action (including 43.14 ha of direct impacts and up to 202.92 ha of indirect subsidence impacts under a worst-case scenario). Based on the extent of clearing of this TEC, it is considered that the Project may 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 patches that are functionally connected occur within the Project Site. Rather, this community already occurs as fragmented patches.
Adversely affect habitat critical to the survival of an ecological community.	The patches of Brigalow TEC within the Project Site do not contain any unique characteristics or conditions (biotic and abiotic) that do not exist in other patches of Brigalow TEC in the local area and across the region. Similar habitat currently supporting Brigalow TEC within the Project Site is available across the region and will allow the community to continue to persist within its current distribution. As such, habitat within the Project Site is not considered habitat critical to the survival of the community.

EPBC Act criteria	Assessment of significance
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 proliferation of Buffel Grass has contributed to the endangered status of the brigalow TEC. Management of this species on site through strategic land management strategies may improve the condition of this TEC. 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 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.	The majority of Brigalow TEC patches within the Project Site are small and fragmented. Whilst larger patches with greater patch viability do occur within the Project Site they are still fragmented by highly modified areas such as cleared grazing areas dominated by *Cenchrus ciliaris* (Buffel Grass). While the proposed action will potentially impact a portion of the Brigalow TEC on site, the remaining area would be managed to reduce Buffel Grass and other weed species. Considering current habitat condition, 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.	While the proposed action will potentially impact a portion of the Brigalow TEC on site, those areas that remain would be managed to reduce Buffel Grass, thereby possibly affecting an increase in the quality of the TEC.
Interfere with the recovery of an ecological community.	Approximately 246.06 ha of this TEC will be potentially impacted as a result of the proposed action (including 43.14 ha of direct impacts and up to 202.92 ha of indirect subsidence impacts under a worst-case scenario). It is proposed that areas of the Brigalow TEC that are retained on site will be managed to control exotic species in accordance with the Weed and Pest Management Plan. However, the proposed action may interfere with the recovery of this TEC.



LEGEND

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

Threatened ecological community

- Brigalow (*Acacia harpophylla*) dominant and co-dominant

N

Figure 21-28

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

DATE: 20/08/2020 VERSION: 0

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G344_v0_A4P.mxd

21.11.2.2 Grasslands TEC

Description and status under the EPBC Act

The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC 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 21-26).

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:

- 17th to 21st November 2007
- November 2008
- 27th to 29th August 2016
- 6th and 10th October 2016
- 30th January and 3rd February 2017
- 23rd to 29th 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).

Occurrence

The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC was recorded within the Project Site during the field surveys and was found to be analogous to RE 11.4.4 (Table 21-26). This TEC occurs within the Project Site on clay depressions which occurs south of Phillips Creek. The community is dominated by *Dichanthium sericeum* (Queensland Bluegrass), *Dichanthium setosum* (Bluegrass), *Iseilema membranaceum* (Small Flinders Grass), *Astrebla pectinata* (Barley Mitchell Grass), *Cyperus bifax, Eriochloa crebra* (Spring Grass) with little invasion by *Cenchrus ciliaris* (Buffel Grass) and *Bothriochloa pertusa* (Indian Bluegrass). The location is presented on Figure 21-29.

Habitat critical to the survival of the ecological community

The 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.

The patches of Grassland TEC within the Project Site do not contain any unique characteristics or conditions (biotic and abiotic) that do not exist in other patches of Grassland TEC in the local area and across the region. In addition, areas of Grassland TEC greater in extent and in better condition than areas within the Project Site also occurs within the broader region. As such these areas will allow the community to continue to persist within its current distribution regardless of the presence of habitat within the Project Site.

Based on all of these factors, habitat within the Project Site is not considered critical to the survival of the Grassland TEC and is not considered to play a critical role in the long-term maintenance of the community.

Project impacts

Potential impacts to the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC often associated with the construction and operational phase of mining projects are associated with both direct disturbances and indirect effects, including:

- weed incursion
- dust
- water and soil contamination.

As discussed in Section 21.9, development of mining operations within the Project Footprint will involve direct clearing for surface facilities and ancillary infrastructure as well as direct clearing and fragmentation for the IMG network. Ongoing operational impacts may include subsidence due to the development of the Project.

Vegetation reflecting this TEC is located within and adjacent to the path of an overhead power transmission line and is unlikely to be directly impacted by the project construction activities. Powerline infrastructure will likely span above the two small patches of this TEC which have been mapped within the Project Site. However, for this assessment it has been assumed that these areas may be directly impacted.

Activities including fragmentation, vehicle traverses, erosion and sedimentation 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 low. As underground works are occurring to the north of this TEC, subsidence impacts are unlikely to affect vegetation conforming to this TEC.

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. This is even more pronounced for the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC considering the shallow, horizontal root system of the perennial grassland species associated with this type of vegetation.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-41 below. A total of 0.075 ha of the TEC occurs within the Project Footprint however this area occurs within and adjacent to the path of a proposed overhead power transmission line and is unlikely to be directly impacted by the project construction activities.

Table 21-41 Direct and indirect impacts to Grassland TEC within the Project Footprint

Impacts within Project Footprint	Area (ha)
Direct impacts (including surface facilities and IMG network)	0.075
Indirect impacts (including subsidence areas)	0
Total Impact to Grassland TEC within Project Footprint	**0.075**

Project avoidance, mitigation and management measures

The location of the powerline infrastructure will be refined during detailed design to avoid direct impacts to Natural grasslands of the Queensland central highlands and the northern Fitzroy basin 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
- avoiding placement of powerline infrastructure (including vehicle routes needed for construction) within grassland REs (RE 11.4.4) which met condition thresholds for the natural grasslands of the Queensland central highlands and the northern Fitzroy basin 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 in each area, disturbed areas not required will be stabilised and rehabilitated consistent with the Project's Rehabilitation Management Plan.

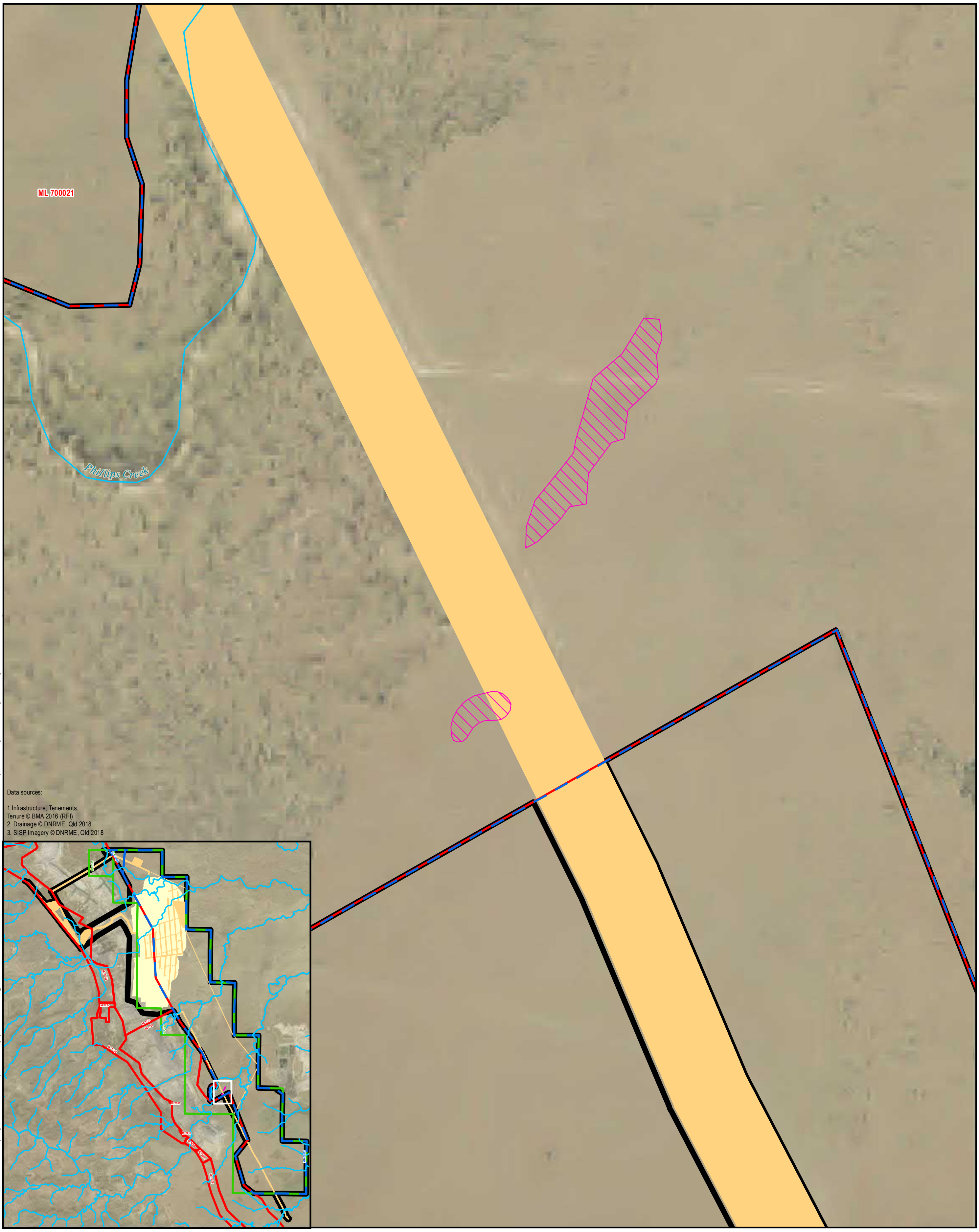
Significant impact assessment

An assessment of the potential significance of impacts on the natural grassland TEC in accordance with the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a) is provided in Table 21-42 . The assessment indicates that due to the limited disturbance to the TEC from the proposed action and the mitigation of impacts through measures proposed in Section 21.10, the impacts of the Project on the TEC are unlikely to be significant.

Table 21-42 Assessment of Significance of Impact - Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

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.	Based upon RE mapping of the analogous RE 11.4.4, 1.73 ha of this TEC is present within the Project Site. However, only very minor disturbance of this TEC may occur during construction. As such it is not expected that the action will lead to a reduced extent of an ecological community.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines.	A 66 kV overhead powerline is proposed near this TEC. Only very minor clearing of this TEC (approximately 0.075 ha) is anticipated within the Project Site and no fragmentation of this TEC is expected as a result of the action.
Adversely affect habitat critical to the survival of an ecological community.	The 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. Therefore habitat within the Project Site is not considered habitat critical to the survival of the community.
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 occurrence of this TEC in association with specific landforms, soil types and inferred drainage requirements indicates that a narrow range of conditions are required for its establishment. The proposed action may remove a small area containing abiotic factors thus reducing potential areas for the distribution of the TEC. The presence of Buffel Grass and parthenium has contributed to the endangered status of this TEC as both species outcompete and suppress native grasslands in the region. Control of these weed species on site will minimise further impacts on the TEC within the Project Site. The

EPBC Act criteria	Assessment of significance
	vegetation species and regional soil/geology types suggest that the level of groundwater dependence is likely to be low within this TEC and the grassland 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 TEC's survival is compromised is highly 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.	Only very minor clearing of this TEC is expected as a result of the proposed action and the area where it does exist would be managed to reduce *Cenchrus ciliaris* (Buffel Grass) and *Parthenium hysterophorus* (Parthenium).
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.	Vegetation reflecting this TEC is located within and adjacent to the path of an overhead power transmission line and is unlikely to be directly impacted by the project construction activities. Powerline infrastructure will likely span above the two small patches of this TEC which have been mapped within the Project Site. However, for this assessment it has been assumed that these areas may be directly impacted by footings or clearing of easements. Therefore only very minor clearing of this TEC is expected as a result of the proposed action and the area where it does exist would be managed to reduce Buffel Grass and Parthenium.
Interfere with the recovery of an ecological community.	It is proposed that areas of the community on site will be managed to control exotic species in accordance with the Weed and Pest Management Plan (to be prepared prior to construction). With mitigation through the control of Buffel Grass and Parthenium, the loss of natural grasslands through the proposed action would not interfere with the recovery of this TEC.



LEGEND

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

Threatened ecological community

- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin

N

Figure 21-29
Natural grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin TEC

Environmental Impact Statement
Saraji East Mining Lease Project

0 1.5 3 6
Kilometres

Scale: 1:348,150 (when printed at A4)
Projection: Map Grid of Australia - Zone 55 (GDA94)

BHP

DATE: 20/08/2020 VERSION: 0

21.11.3 Threatened flora species

21.11.3.1 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:

- 17th to 21st November 2007
- November 2008
- 27th to 29th August 2016
- 6th and 10th October 2016
- 30th January and 3rd 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

Dichanthium setosum was recorded in the south of the Project Site (refer Figure 21-30) where it was observed 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. The extent of potential habitat for the species is summarised in Table 21-43 and is displayed in Figure 21-30.

Table 21-43 Potential habitat for Bluegrass (*Dichanthium setosum*)

Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Naturally derived grasslands or open woodlands on heavy basaltic black soils or stony red-brown hard-setting loam with clay subsoil (Department of Agriculture Water and the Environment, 2020b)	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains (RE11.4.4)	1.73	0.075

Habitat critical to the survival of the species

Habitat for *Dichanthium setosum* within the Project Site aligns with the 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.

The patches of grassland habitat within the Project Site do not contain any unique characteristics or conditions (biotic and abiotic) that do not exist in other patches of grassland in the local area and across the region. In addition, areas of grassland habitat greater in extent and in better condition than areas within the Project Site also occurs within the broader region. As such these areas will allow the species to continue to persist within its current distribution, regardless of the presence of habitat within the Project Site.

Based on all of these factors, habitat within the Project Site is not considered critical to the survival of the *Dichanthium setosum* and is not considered to play a critical role in the long-term maintenance of the species.

Important populations

The SPRAT does not identify ‘important populations’ for *Dichanthium setosum*. 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). *Dichanthium setosum* has been identified by Threatened Species Scientific Committee, (2008) that although there is a lack of quantitative population data, records indicate this species is widely distributed and is found within several national parks.

The Project Site is unlikely to support an important population, given that:

- any population of *Dichanthium setosum* within the Project Site is not necessarily unique, isolated or genetically distinct from any other population occurring in the region. Therefore, the population within the Project Site would not be considered necessary for maintaining genetic diversity, or a key source population for breeding or dispersal
- The Project Site is not near the edge of the species’ range.

Project impacts

Potential impacts to *Dichanthium setosum* often associated with the construction and operational phase of mining projects are associated with indirect effects, including:

- weed incursion
- dust.

As discussed in Section 21.9, development of mining operations within the Project Footprint will involve direct clearing for surface facilities and ancillary infrastructure as well as direct clearing and fragmentation for the IMG network. Ongoing operational impacts may include subsidence due to the development of the Project.

Vegetation mapped as the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC where this species was identified 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 patches of this vegetation which have been mapped within the Project. However, for this assessment it has been assume 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 as a result of the Project is considered to be low. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect *Dichanthium setosum*.

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. This is even more pronounced for *Dichanthium setosum* considering the shallow, horizontal root system of this species.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-44 below. A total of 0.075 ha of potential habitat occurs within the Project Footprint however this area occurs within and adjacent to the path of a proposed overhead power transmission line and is unlikely to be directly impacted by the project construction activities. However, for this assessment a precautionary approach has been adopted and potential direct impacts have been included.

Table 21-44 Direct and indirect impacts *to Dichanthium setosum* within the Project Footprint

Impacts within Project Footprint	Area (ha)
Direct impacts (including surface facilities and IMG network)	0.075
Indirect impacts (including subsidence areas)	0
Total Impact to *Dichanthium setosum* (Bluegrass) within Project Footprint	**0.075**

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 *dichanthium setosum*.
- 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.

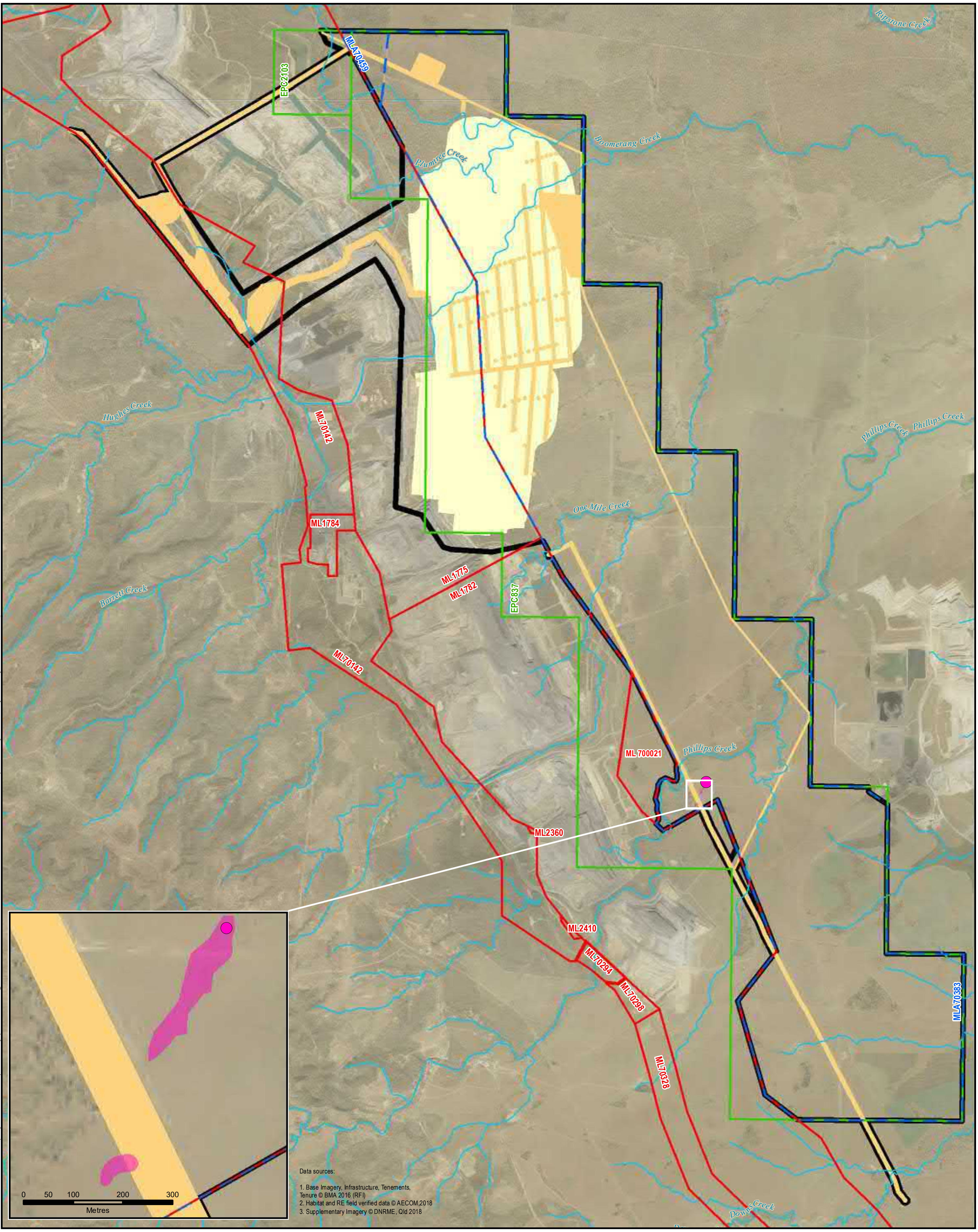
Significant impact assessment

This species is listed as Vulnerable under the EPBC Act. An assessment of the significance of impacts on this species under the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a) is provided in Table 21-45 . The assessment indicates that due to the limited disturbance to suitable habitat from the proposed action and mitigation of impacts through measures proposed in Section 21.10 the impacts of the Project on *Dichanthium setosum* (Bluegrass) are unlikely to be significant.

Table 21-45 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.	Based upon habitat mapping (Figure 21-30), 1.73 ha of grassland habitat has been mapped for this species within the Project Site. 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 an important population of a species.
Reduce the area of occupancy of an important population.	Only very minor clearing of this species may occur as a result of the proposed action and as such the area of occupancy of an important population will not be reduced.
Fragment an existing important population into two or more populations.	No important population of this species would be fragmented due to the proposed action.
Adversely affect habitat critical to the survival of a species.	Habitat for *Dichanthium setosum* within the Project Site aligns with the 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. The habitat to be modified is not considered critical to the survival of the species, since it is considered low-quality, marginal habitat occurring as highly fragmented small pockets. As such habitat within the Project Site is not considered habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population.	No important populations of this species occur 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.	The Project has the potential to facilitate the spread of weed species which could potentially reduce the quality of habitat available to the species. A Weed and Pest Management Plan will be developed for the Project. The proposed action is considered unlikely to decrease habitat availability to the extent that the species is likely to decline given no or very minor clearing of the potential habitat is anticipated. The species and regional soil/geology types suggest that the level of groundwater dependence is likely to be low and that the species is likely to satisfy its water requirements using retained soil moisture. Further, the area of potential habitat available forms only a small portion of the known distribution of the species and that impact will be managed through the proposed mitigation commitments.

EPBC Act criteria	Assessment of significance
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.
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. No or very minor clearing of the potential habitat is anticipated.



LEGEND

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

Threatened flora location and high potential habitat

- Remnant grassland habitat
- Bluegrass

N

Figure 21-30

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)

BHP

DATE: 20/08/2020 VERSION: 1

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G211_v1_A4P.mxd

21.11.3.2 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:

- 17th to 21st November 2007
- November 2008
- 27th to 29th August 2016
- 6th and 10th October 2016
- 30th January and 3rd 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

This species was not recorded within the Project Site, however *Dichanthium setosum* was recorded in the south of the Project Site where it was observed 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. Both Dichanthium species utilise a similar habitat and therefore the presence of this species cannot be discounted. The Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC is likely to provide suitable habitat for *Dichanthium queenslandicum*. The extent of potential habitat for the species is summarised in Table 21-46 and is displayed in Figure 21-31.

Table 21-46 Potential habitat for King Bluegrass (*Dichanthium queenslandicum*)

Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Naturally derived grasslands or open woodlands on heavy basaltic black soils (Department of Agriculture Water and the Environment, 2020b)	*Dichanthium* spp., *Astrebla* spp. grassland on Cainozoic clay plains (RE11.4.4)	1.73	0.075

Habitat critical to the survival of the species

Habitat for *Dichanthium queenslandicum* within the Project Site aligns with the 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.

The patches of grassland habitat within the Project Site do not contain any unique characteristics or conditions (biotic and abiotic) that do not exist in other patches of grassland in the local area and across the region. In addition, areas of grassland habitat greater in extent and in better condition than areas within the Project Site also occurs within the broader region. As such these areas will allow the species to continue to persist within its current distribution, regardless of the presence of habitat within the Project Site.

Based on all of these factors, habitat within the Project Site is not considered critical to the survival of the *Dichanthium queenslandicum* and is not considered to play a critical role in the long-term maintenance of the species.

Project impacts

Potential impacts to *Dichanthium queenslandicum* often associated with the construction and operational phase of mining projects are associated with both direct disturbances and indirect effects, including:

- weed incursion
- dust.

As discussed in Section 21.9, development of mining operations within the Project Footprint will involve direct clearing for surface facilities and ancillary infrastructure as well as direct clearing and fragmentation for the IMG network. Ongoing operational impacts may include subsidence due to the development of the Project.

Vegetation mapped as the Natural grasslands of the Queensland Central Highlands and the northern Fitzroy Basin TEC which supports potential habitat for this species 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 patches of this vegetation which have been mapped within the Project Site. However, for this assessment it has been assume 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 as a result of the Project is considered low. As underground works are being undertaken to the north of the occurrence of this species, subsidence impacts are unlikely to affect *Dichanthium queenslandicum*.

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. This is even more pronounced for *Dichanthium queenslandicum* considering the shallow, horizontal root system of this species.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-47 below. A total of 0.075 ha of potential habitat occurs within the Project Footprint however this area occurs within and adjacent to the path of a proposed overhead power transmission line and is unlikely to be directly impacted by the project construction activities.

Table 21-47 Direct and indirect impacts to *Dichanthium queenslandicum* within the Project Footprint

Impacts within Project Footprint	Area (ha)
Direct impacts (including surface facilities and IMG network)	0.075
Indirect impacts (including subsidence areas)	0
Total Impact to *Dichanthium queenslandicum* (King Bluegrass) within Project Footprint	0.075

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 potentially occurs, where practical. Where unavoidable, offsets will be sourced
- vehicle routes needed for the construction of powerline infrastructure to avoid areas where this species potentially occurs
- 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 *Dichanthium queenslandicum*
- 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.

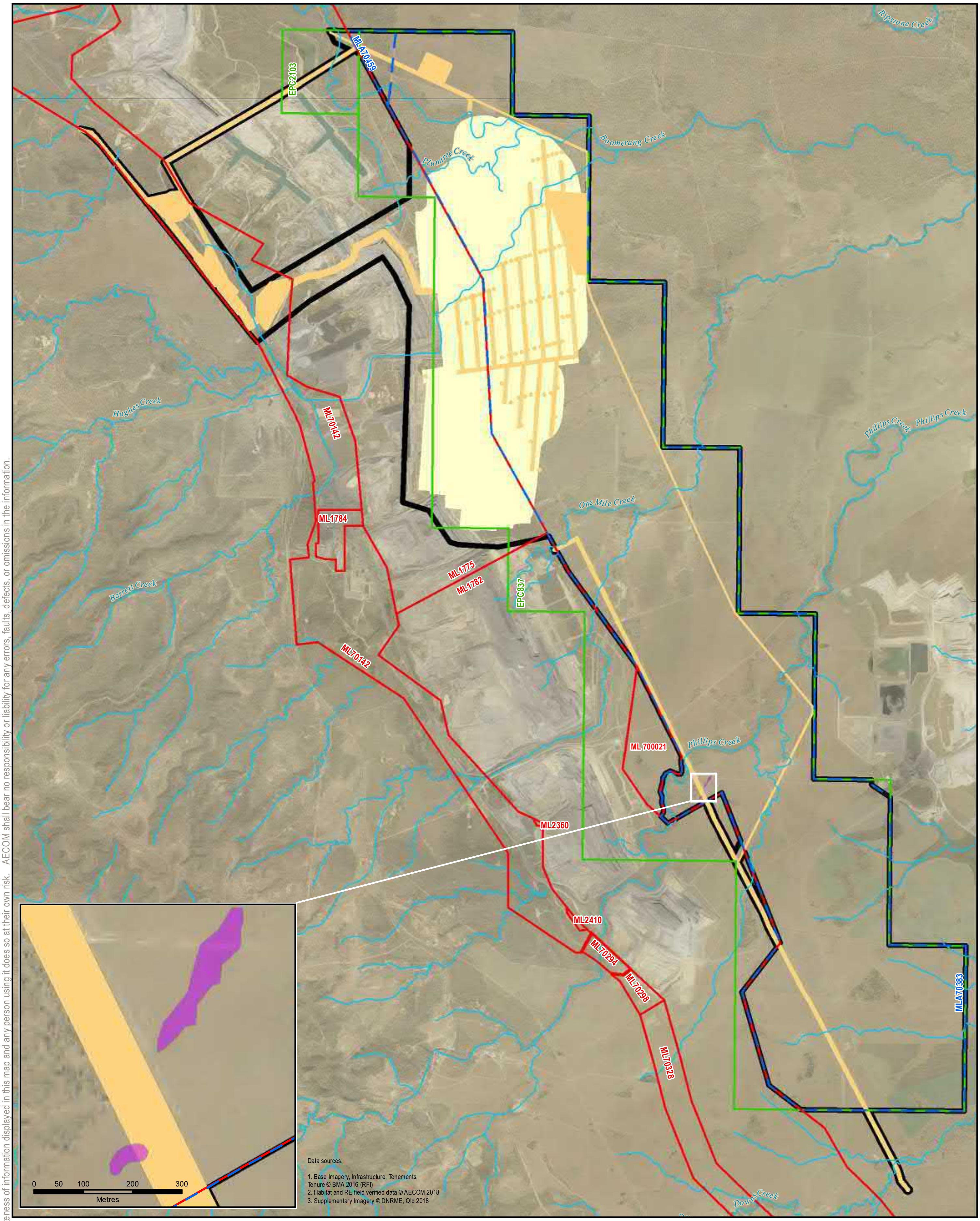
Significant impact assessment

This species is listed as endangered under the EPBC Act. An assessment of the significance of impacts on this species under the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a) is provided in Table 21-48. The assessment indicates that due to the limited disturbance to suitable habitat from the proposed action and mitigation of impacts through measures proposed in Section 21.10 the impacts of the Project on *Dichanthium queenslandicum* (King Bluegrass) are unlikely to be significant.

Table 21-48 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.	Based upon habitat mapping (Figure 21-31), 1.73 ha of grassland habitat has been mapped for this species within the Project Site. 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 this species.
Reduce the area of occupancy of the species.	Only very minor clearing of 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.	Only very minor clearing of habitat for this species may occur as a result of the proposed action and as such no population of this species would be fragmented.
Adversely affect habitat critical to the survival of a species.	Habitat for *Dichanthium queenslandicum* within the Project Site aligns with the 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. Habitat within the Project Site is not considered to comprise habitat critical to the survival of the species.
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.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The Project has the potential to facilitate the spread of weed species which could potentially reduce the quality of habitat available to the species. 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. The proposed action is considered unlikely to decrease habitat availability to the extent that the species is likely to decline given no or very minor clearing of the potential habitat is anticipated. The species and regional soil/geology types suggest that the level of groundwater dependence is likely to be low and that the species is likely to satisfy its water requirements using retained soil moisture. Further, the area of potential habitat available forms only a small portion of the known distribution of the species and that impact will be managed through the proposed mitigation commitments.
Result in invasive species that are harmful to a Vulnerable species becoming established in the Vulnerable species' habitat.	A Weed and Pest Management Plan will be developed and implemented. Species-specific management will be undertaken for identified key weed species at risk of spread through Project activities. Weed control efforts will be increased in areas particularly sensitive to invasion.

EPBC Act Criteria	Assessment of significance
Introduce disease that may cause the species to decline.	Disease has not been identified as a key threat to *Dichanthium queenslandicum*. The 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.	The species is not known to occur in the Project Site, however, 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. No or very minor clearing of the potential habitat is anticipated.



LEGEND

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

High potential habitat

- Remnant grassland habitat

N

Figure 21-31

King 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)

BHP

DATE: 18/09/2020 VERSION: 1

21.11.4 Threatened fauna species

21.11.4.1 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, but have 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.

Occurrence and potential habitat

The Squatter Pigeon (Southern) (*Geophaps scripta scripta*) was recorded in the Project Site by SKM (2012) and AECOM (2017) and Essential Habitat for the species has been mapped in the north of Project Site surrounding an existing record. This species is expected to occur throughout the Project Site, within preferred, suitable and marginal habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). The extent of potential habitat for the species is summarised in Table 21-49 and is displayed in Figure 21-32.

Table 21-49 Potential habitat for Squatter Pigeon (*Geophaps scripta scripta*)

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Preferred	• Remnant or regrowth grassy open forest to woodland dominated by Eucalyptus, Corymbia, Callitris or Acacia with patchy, relatively sparse ground cover vegetation (33%) and sparse shrub layer on well-draining sandy, loamy or gravelly soils within one km of a suitable permanent waterbody. • Preferred habitat may be located on land zones 3, 5, 7, 8, 9 and 10. • Preferred habitat does not include areas dominated by introduced pasture grasses, in particular Cenchrus ciliaris, nor heavily grazed areas but these areas may be included in suitable and marginal habitat as defined below.	The following habitats within 1 km of mapped wetlands and >3rd order streams: • River Red Gum Riparian Woodland • Eucalyptus and/or Corymbia Open Woodland • Oxbow wetland	1,375.27	699.10
Suitable	• Remnant or regrowth grassy open forest to woodland dominated by Eucalyptus, Corymbia, Callitris or Acacia with patchy, relatively sparse ground cover vegetation (< 33%) on well-draining sandy, loamy or gravelly soils between one and three km of a suitable permanent or seasonal waterbody2; and • Non-remnant areas within 100 m of preferred habitat. • Suitable habitat may be located on land zones 3, 5, 7, 8, 9 and 10.	The following habitats within 1-3 km of mapped wetlands and >1st order streams: • River Red Gum Riparian Woodland • Eucalyptus and/or Corymbia Open Woodland • Brigalow and Belah Woodland (associated with land zone 3)	482.27	285.25
Marginal	• Non-remnant areas, regrowth and remnant woodland or forest areas more than three (3) km from a permanent or seasonal waterbody that facilities the movement of the species between patches of preferred or suitable habitat.	The following habitats 3 km from mapped wetlands and >1st order streams: • Eucalyptus and/or Corymbia Open Woodland • Brigalow and Belah Woodland	2,518.19	967.77

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
		• Dawson Gum and Brigalow Woodland • Shrubby Brigalow Regrowth with Gilgai		
Total			4,375.73	1,951.12

[1] Includes mapped wetlands and ≥3rd order streams
[2] Includes 1st and 2nd order streams

Within the Project Site, preferred habitat is primarily located in a consolidated patch where Boomerang, Plumtree and Hughes Creek converge. The preferred habitat patch represents the most valuable habitat for the species and is where breeding will occur if the species is breeding on site. The species was recorded in the preferred habitat area in 2017.

A large patch of suitable habitat exists between the preferred habitat fringing Plumtree and Hughes Creek, with additional small patches of suitable habitat scattered between Hughes Creek and One Mile Creek. These areas of suitable habitat are likely to provide foraging resources for the species and also assist in facilitation movement for the species between the more valuable areas of preferred habitat. The species has been recorded in 2013 in suitable habitat near One Mile Creek. Marginal habitat is concentrated through the centre of the Project Site and is unlikely to provide any extensive foraging opportunities for the species. Marginal habitat across the sites may facilitate movement between patches of preferred and suitable habitat, but does not provide important ecological resources for the species.

Habitat critical to the survival of the species

Large areas of breeding, foraging and dispersal habitat categorised as either preferred or suitable habitat occur across the Project Site, primarily associated with Boomerang, Plumtree and Hughes Creek. Whilst these areas provide a sufficient availability of suitable resources that may be important to the species at a local scale, they are still impacted by threatening processes that are a key contributor to the species ongoing threatened status. This includes the persistence of feral species, specifically feral cats. Therefore, habitat within the Project Site is not considered a refuge for Squatter Pigeon nor is considered to contain any unique characteristics or conditions that do not exist in other areas of habitat that occurs in the region.

In addition, a large extent of habitat for Squatter Pigeon occurs in the local area and across the region, some of which is considered better quality. This high availability of habitat for Squatter Pigeon in the regional will allow the species to continue to persist within its current distribution regardless of the presence of habitat within the Project Site.

Based on these factors, habitat within the Project Site is not considered critical to the survival of Squatter Pigeon and is not considered to play a critical role in the long-term maintenance of the species.

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, and
- any populations potentially occurring in northern New South Wales.

None of these populations exist within the Project Site. Important populations of Vulnerable species are also defined by the Department of the Environment Water Heritage and the Arts (2013) 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.

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 potentially have both direct and indirect impacts to the Squatter Pigeon (Southern) (*Geophaps scripta scripta*). Direct impacts will be predominantly limited to the construction phase and include habitat loss and/or fragmentation and direct mortality or destruction of nests during clearing works. Throughout operation and decommissioning direct mortality from vehicle strike will remain a risk to the species.

Indirect impacts resulting from Project activities may include habitat modification from subsidence such as reduction in canopy cover (from potential tree dieback) as well as 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 Squatter Pigeon (Southern) (*Geophaps scripta scripta*) to these predators. Weed proliferation may also impact the species by reducing the availability of native foraging resources.

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 (i.e. dieback) on the surface habitats, including those identified to be potentially utilised by Squatter Pigeon (Southern) (*Geophaps scripta scripta*). Water resources that may be utilised by Squatter Pigeon (Southern) (*Geophaps scripta scripta*) are either artificial features or ephemeral creeks that do not contain permanent groundwater. Therefore any drawdown impacts will have little effect on the quality or availability of Squatter Pigeon (Southern) (*Geophaps scripta scripta*) habitat resources.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-50 below. Direct impact calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Therefore, these calculations provide a conservative estimate of proposed disturbance. Indirect impact calculations relate to potential habitat modification from subsidence only, assumes full extent of subsidence, that all impacts will result in a negative impact to habitats and that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. As such the calculations below are considered worst case scenario.

Table 21-50 Direct and indirect impacts to Squatter Pigeon (southern) (*Geophaps scripta scripta*) within the Project Footprint

Potential habitat type	Project Footprint	
	Direct impact (Surface facilities and IMG network) (ha)	Indirect impact (Subsidence) (ha)
Preferred	72.09	627.01
Suitable	22.17	263.08
Marginal	377.26	589.51
Total	471.52	1,479.60

Project avoidance, mitigation and management measures

The following mitigation measures specific to potential impacts on Squatter Pigeon (*Geophaps scripta scripta*) have been proposed. Further detail will 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

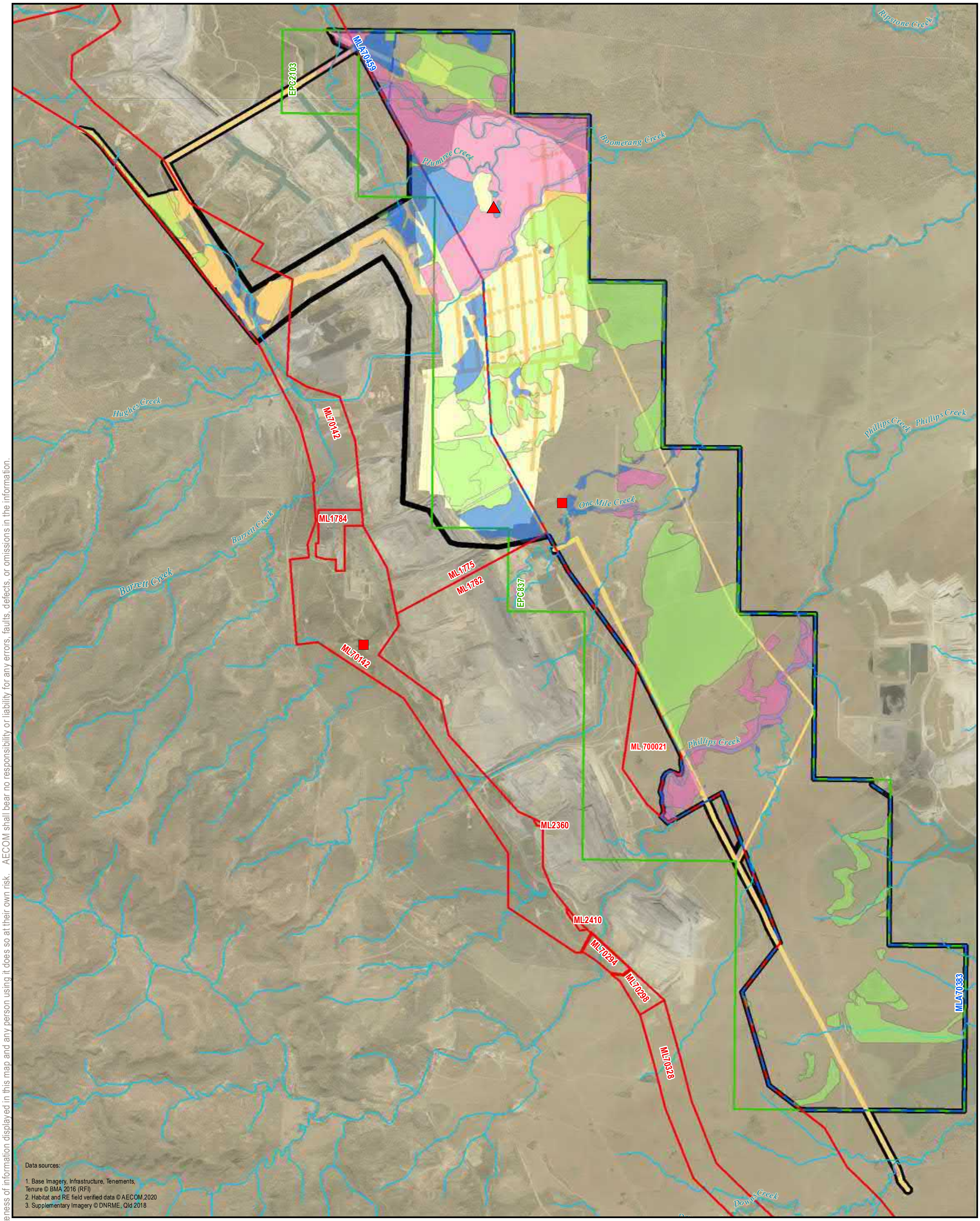
Preferred habitat within the Project Site represents the most important habitat areas that may be influenced by the Project. It is where breeding will occur, if the species is breeding at this site and provides a large and connected patch of habitat across three creek systems. As such, the preferred habitat within the north of the Project Site is considered to be 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).

In order to understand the mechanisms by which the most sensitive, preferred habitat areas 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 21-51 . The assessment concludes that the Project may have a significant impact on the Squatter Pigeon (Southern) (*Geophaps scripta scripta*).

Table 21-51 Assessment of significance of impacts– squatter pigeon

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.	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 to be 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 Saraji Mine 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.
Adversely affect habitat critical to the survival of a species.	It is considered unlikely that the preferred habitat areas that provide potential breeding, foraging and dispersal resources within the proposal area are critical to the survival of the species as they are often impacted by threatening processes, particularly the persistence of feral species, including cats. Preferred and suitable habitat also occurs more broadly in the locality and it is unlikely that the species would be dependent on the foraging resources present in the proposal area solely for survival. Habitat within the Project Site is not considered habitat critical to the survival of the species.
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 699.1 ha of preferred habitat may be impacted as a result of the Project (including 72.09 ha of direct impacts and up to 627.01 ha of indirect subsidence impacts under a worst-case scenario). Preferred habitat is considered to be the most sensitive and valuable habitat for the species across the Project Site, and given the scale of these impact areas 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 and suitable habitat only provides limited resources for Squatter Pigeon and is not crucial for its persistence in the Project Site. Therefore, Project impacts (directly or indirectly) on these habitat categories are not considered to result in or contribute to the species decline.

EPBC Act criteria	Assessment of significance
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.	The federal environment minister has declared that a national recovery plan for the Squatter Pigeon (Southern) (*Geophaps scripta scripta*) is not required; however current threats to this species 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 potential habitat for the species. Clearing for Project infrastructure will result in approximately 72.09 ha loss of preferred habitat and indirect subsidence impacts may occur across a maximum 627.01 ha of habitat (under a worst-case scenario). However, 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
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourse

Threatened Fauna Location

- Squatter Pigeon (AECOM 2017)
- Squatter Pigeon (SKM 2012)

Potential habitat

- Squatter Pigeon marginal habitat
- Squatter Pigeon preferred habitat
- Squatter Pigeon suitable habitat

N

Figure 21-32

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)

BHP

DATE: 18/09/2020 VERSION: 4

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G213_v4_A4P.mxd

21.11.4.2 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 that are 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.

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 five 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.

Occurrence and potential habitat

The Ornamental Snake (*Denisonia maculata*) has been recorded in the Project Site on multiple occasions:

- in two locations during surveys by aecom (2020)
- in three locations during surveys by skm (2012)
- essential habitat for the species is also mapped in the west of the project site which relates to 11 previous records associated with studies conducted for the existing Saraji Mine.

The distribution and number of records available within the Project Site suggests that a viable population of this species is present. This species is expected to occur throughout the Project Site, within suitable habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). The extent of potential habitat for the species is summarised in Table 21-52 and is displayed in Figure 21-33.

Table 21-52 Potential habitat for Ornamental Snake (*Denisonia maculata*)

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Preferred	Gilgai depressions (with or without the presence of brigalow or other canopy vegetation1), mounds and wetlands on cracking clays (predominantly land zone 4) where essential microhabitat features are present including an abundance of deep soil cracks. Other microhabitat features such as fallen woody debris may or may not be present. Seasonal flooding of habitat areas is a requirement.	No habitat within the Project Site that meets definition of preferred habitat	0	0
Suitable	Dispersal areas within 1 km of preferred habitat currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow, including non-remnant areas.	Includes the following habitats to the extent that they contain gilgai or soil cracks: • Shrubby Brigalow Regrowth with Gilgai • Dawson Gum and Brigalow Woodland	2,276.31	925.73

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
		• Oxbow Wetland • Brigalow and Belah Woodland		
Marginal	Areas currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow or non-remnant areas where threats are high (high abundance of weed incursion and cattle compacting soils) but the species still have potential to occur, especially in times where water is present and prey abundance (frogs) is high.	Includes degraded (high weed and cattle incursion) gilgai within the modified grassland habitat	0	0
Total			**2,276.31**	**925.73**

[1] including remnant, regrowth and non-remnant areas as identified in the QLD vegetation mapping framework

The Project Site does not contain any areas of preferred habitat for the species, nor is any marginal habitat present. Suitable habitat for the species is present across the Project Sites in the form of large and reasonably connected patches, primarily in the areas between Hughes Creek and One Miles Creek. Several individuals have been recorded in these suitable habitat areas, with additional records located to the east of the existing operations at the Saraji mine.

Given the size, configuration and location of suitable habitat, as well as the existence of previous records of the species, it is considered that the areas of suitable habitat are the most sensitive and are of most value to Ornamental Snake within the Project Site.

Habitat critical to the survival of the species

Historical imagery across the Project Site identifies a large extent of brigalow dominated gilgai areas that would have once provided core habitat for the species. Clearing and blade ploughing for pasture improvement across the Project Site has now degraded and fragmented the majority of the area into pockets of suitable habitat that are now supporting an isolated abundance of individuals. This habitat is likely to be important to the species at a local scale, but the reduced extent of habitat into only pockets of suitable habitat limits the patch viability and carrying capacity of habitat for Ornamental Snake within the Project Site. Dispersal between these pockets of suitable habitat is possible but reduced and compromised by the modified cleared areas that intersect the area.

Habitat within the Project Site is located in the upper catchment area of the Isaac River, in the very western edge of the floodplain. In comparison to habitat located lower on the Isaac River floodplain, habitat within the Project Site is unlikely to provide refuge habitat in a climate that is becoming increasingly drier. Based on all of these factors, habitat within the Project Site is not considered critical to the survival of Ornamental Snake and is not considered to play a critical role in the long-term maintenance of the species.

Important populations

Due to the lack of population information and difficulty in detection, important populations have not been delineated for this species by DAWE. As a substitute, identification of important habitat is regarded as a surrogate for important population definition as per the *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles* (Department of Sustainability Environment Water Population and Communities, 2011a). Where present on a site, preferred habitat would be analogous to important habitat due to the presence of gilgai depressions and an abundance of deep soil cracks. In the context of the Project Site, no preferred habitat is present, however suitable habitat with gilgais and soil cracks that are infrequent or are shallow is present. Due to the number of individuals that have been recorded through the suitable habitat in the Project Site, this habitat is considered to be ‘important’ for the species at a local scale. Consequently, the population within the Project Site is considered ‘important’.

Project impacts

The Project will potentially have both direct and indirect impacts on the Ornamental Snake (*Denisonia maculata*). Direct impacts are predominantly associated with clearing activities and include habitat removal, degradation, fragmentation and direct mortality. Large areas of suitable breeding and foraging habitat and dispersal pathways will be removed for surface infrastructure. The soil profile in the geology of important habitat is highly susceptible to compaction therefore sheltering individuals may also be crushed during construction and compaction of soil cracks and removal of woody debris may reduce the carrying capacity of the habitat. Local populations of the species may be indirectly impacted by the gradual change in topography and alteration of hydrology in important habitat as a result of subsidence. These changes could alter the condition and stability of wetland and gilgai habitat. The habitat’s function of providing suitable breeding habitat for prey and hence suitable foraging habitat for the Ornamental Snake (*Denisonia maculata*) may also be compromised by these changes.

Although modelling has predicted subsidence of up to 3.5 m in some areas, the extent of the indirect impacts to terrestrial habitat described above is unknown and as such the maximum area has been assessed. It is possible that increased water ponding within surface drainage lines as a result of subsidence may have a positive effect on prey species populations if pools retain their habitat value for amphibian breeding and foraging. However, increased pooling would also support other pest species such as Feral Pigs (*Sus scrofa*) and cane toads (*Bufo marinus*). Destruction of wetland habitat by Feral Pigs (*Sus scrofa*) and lethal toxic ingestion of cane toads (*Bufo marinus*) have been identified as threats to Ornamental Snake (*Denisonia maculata*).

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 land. This can result in direct toxic impacts to fauna including frogs and may result in habitat degradation and is a risk to the species habitat primarily during the construction period.

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 (i.e. dieback) on the surface habitats, including Brigalow habitats identified to be potentially utilised by Ornamental Snake (*Denisonia maculata*). Brigalow vegetation has a low reliance on groundwater resources given its shallow and horizontal root system (Johnson *et al.*, 2016).

Gilgai areas and the aquatic habitats that they can temporarily support are recharged and influenced only by surface water flows. Therefore, any drawdown impacts will have little effect on the quality or availability of Ornamental Snake (*Denisonia maculata*) foraging resources. The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-53 below. Direct impact calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Therefore, these calculations provide a conservative estimate of proposed disturbance. Indirect impact calculations relate to potential habitat modification from subsidence. When considering indirect impacts it has been conservatively assumed that the full extent of modelled subsidence will occur and that all impacts will result in a negative impact to habitats. It is also assumed that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. As such the calculations below are considered to be conservative and represent a worst-case scenario.

Table 21-53 Direct and indirect impacts to Ornamental Snake (*Denisonia maculata*) within the Project Footprint

Potential habitat type	Project Footprint	
	Direct impact (Surface facilities and IMG network) (ha)	Indirect impact (Subsidence) (ha)
Suitable	335.2	590.53
Total	335.2	590.53

Project avoidance, mitigation and management measures

The following mitigations measures specific to potential impacts on Ornamental Snake (*Denisonia maculata*) have been proposed. Further detail will 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 (D*enisonia 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

No preferred habitat is present throughout the Project Site. However, there are a number of large patches of suitable habitat and these have been shown to support a small local population of the species and thus represent the most important habitat areas that may be influenced by the Project. Impacts to these sensitive 'important habitat' areas may be considered significant as per the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a).

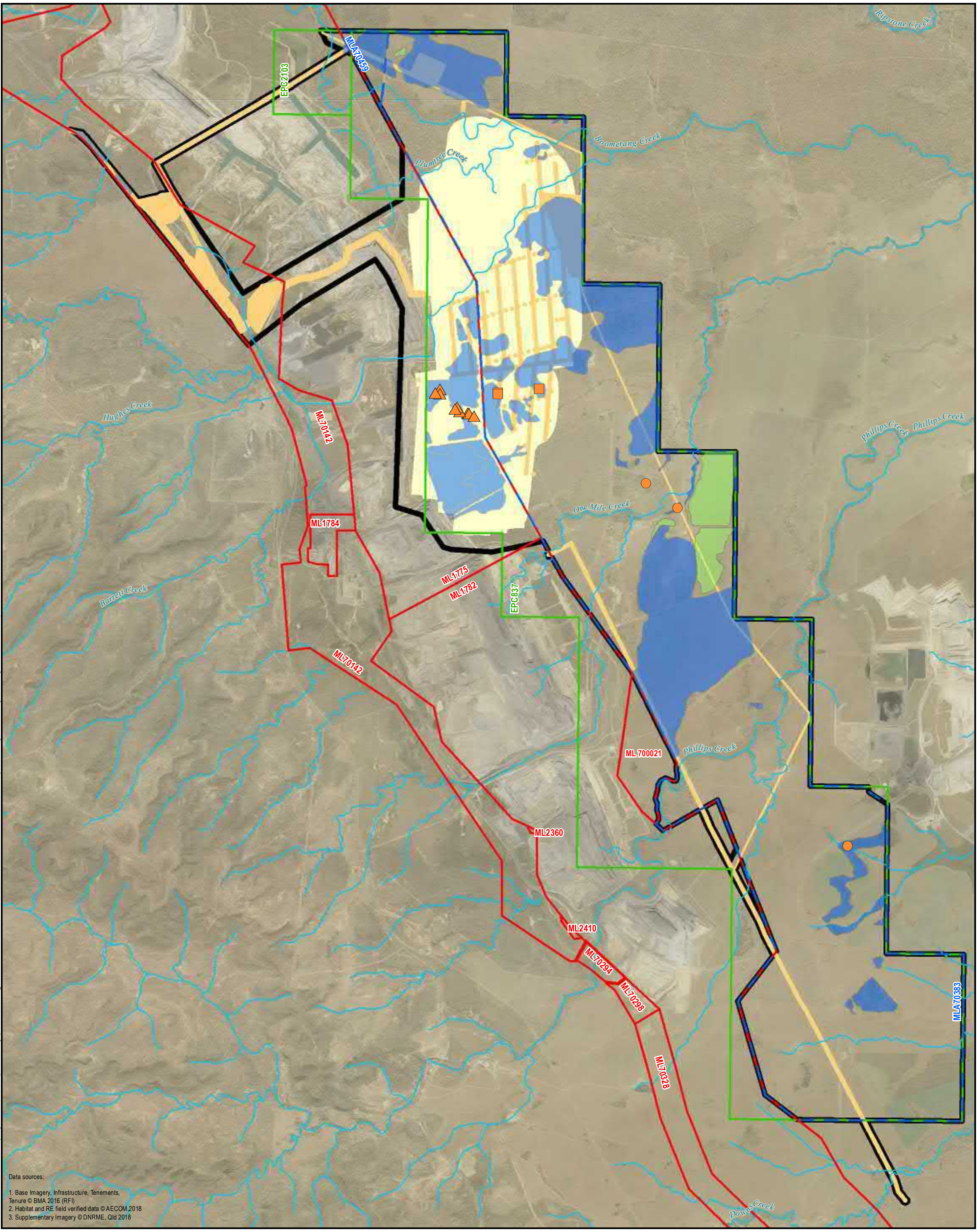
In order to understand the mechanisms by which the sensitive, 'important habitat' areas might be impacted, and to determine the magnitude of significant impacts, an assessment of impacts on this species as per the guidelines has been completed and is provided in Table 21-54 . The assessment concludes that the Project may have a significant impact on the Ornamental Snake (*Denisonia maculata*).

Table 21-54 Assessment of Significance of Impacts on Threatened Species – Ornamental Snake (*Denisonia maculata*)

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.	This species has been identified multiple times during several surveys in suitable habitat within the Project Site including areas which are expected to be impacted by vegetation clearing and/or subsidence. Habitat on site includes gilgai depressions and mounds. Although connectivity across the site is compromised, suitable habitat is considered important habitat for the species, particularly at a local

EPBC Act criteria	Assessment of significance
	scale. Based upon habitat mapping in Figure 21-18 , 335.2 ha of suitable habitat for this species could potentially be directly impacted as a result of the proposed action. A further 590.53 ha of suitable habitat may be indirectly impacted as a result of subsidence under a worst-case scenario. The entire subsidence area may not result in indirect impacts to the species, such as changes to topography and hydrology, however a maximum impact has been assessed for the purpose of this report. With mitigation through measures proposed in Section 21.10, the result of the proposed action will be reduced. However, given the extent of suitable habitat 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, in the context of a local population in and surrounding the Saraji mine operations.
Reduce the area of occupancy of an important population.	As discussed above 335.2 ha of suitable habitat for this species could potentially be directly impacted and a maximum of 590.53 ha of suitable habitat may be indirectly impacted by Project activities. The populations known to occur within the Project Site have been classified as important. Therefore, the Project may reduce the area of occupancy of an important population of the species, in the context of a local population in and surrounding the Saraji mine operations.
Fragment an existing important population into two or more populations.	Significant fauna habitat fragmentation will be associated with the IMG network and infrastructure and transport corridor; which will impact areas of suitable habitat 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 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, but this is relevant only at the local scale.
Adversely affect habitat critical to the survival of a species.	Habitat within the Project Site is not considered habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population.	This species was identified multiple times during several surveys in habitat within the Project Site including 925.73 ha of suitable habitat which is expected to be impacted by vegetation clearing and/or subsidence under a worst-case scenario. Direct impacts from clearing will reduce the availability of this breeding habitat and changes to topography and hydrology associated with subsidence may result in varying degrees of habitat modification. As suitable habitat is the most important and sensitive habitat for the species at the Project Site and given the scale of the impact areas under a worst-case scenario, it is likely that the Project will disrupt the breeding cycle of the Ornamental Snake (*Denisonia maculata*) population within the Project Site.

EPBC Act criteria	Assessment of significance
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	Habitat mapping has identified 335.2 ha of suitable habitat that could potentially be directly impacted and a maximum of 590.53 ha of suitable habitat that may be indirectly impacted by Project activities. Given the scale of these impacts and that the species has been identified multiple times in multiple areas of 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 at a local scale.
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. Under a worst-case scenario changes in topography due to subsidence have the potential to lead to localised ponding. This 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.
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 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 Site does not contain any preferred habitat for the species, however it does contain large areas of suitable habitat within which numerous individuals have been recorded. A number of individuals of the species have also been recorded to the east of the existing operations at the Saraji mine. The Project will result in habitat loss and fragmentation due direct impacts from clearing. The majority of the records of the species within the Project Site are not located in the direct impact area where vegetation will be cleared. Alterations in hydrology around gilgai due to subsidence are considered to be a worst case scenario. Individual areas of impact from indirect impacts may be small in extent, and in isolation would not constitute an adverse impacts on the species habitat. The Project may also result in an increase in the already established population of Cane Toads (*Bufo marinus*) and Feral Pigs (*Sus scrofa*), however this is only considered possible under a worst-case scenario. Overall, the Project is considered unlikely to interfere with the recovery of the species.



LEGEND

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

Threatened Fauna Location

- Ornamental Snake (AECOM 2020)
- Ornamental Snake (Australian Living Atlas 2016)
- Ornamental Snake (SKM 2012)

Potential habitat

- Ornamental Snake suitable habitat
- Ornamental Snake marginal habitat

N

Figure 21-33
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)

BHP

DATE: 16/02/2021 VERSION: 5

21.11.4.3 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.

Occurrence and potential habitat

A solitary Koala (*Phascolarctos cinereus*) was observed to the north-west of the Project Site within the riparian zone associated with Plumtree Creek by AECOM (2020) and one Koala (*Phascolarctos cinereus*) was recorded from Downs Creek adjacent to the Project Site during previous ecological surveys. An additional record exists from Atlas of Living Australia approximately four km west of the Project Site and the species was recorded at Peak Downs Mine East, directly north of the Project Site by AECOM in 2018. This species is expected to occur throughout the Project Site, within preferred, suitable and marginal habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). The extent of potential habitat for the species is summarised in Table 21-55 and is displayed in Figure 21-34.

Table 21-55 Potential habitat for Koala (*Phascolarctos cinereus*)

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Preferred	Contiguous remnant eucalyptus open forest to woodlands on alluvial and/or cracked rock groundwater where palatable food tree species occur frequently (and are usually dominant) This specifically includes stream fringing open forest, open forest or woodland on alluvial terraces where Eucalyptus tereticornis/camaldulensis are dominant or common subdominant elements. Other important food species on the alluvial terraces can include E. *coolibah*, E. *crebra*, E. *melanophloia* and E. *popunea*. Preferred habitat areas located where aquifers persist through most drought cycles, substrates have high fertility and food tree species occur at relatively high frequencies have the potential to support moderate to high density koala populations. Preferred habitat areas represented as E. *crebra*/*drepanophylla* tall woodland on hills and ranges with aquifers that persist in most drought cycles (commonly cracked rock aquifers) have the potential to support a low to moderate density koala population e.g. Clarke-Connors Ranges, Minerva Hills.	Includes the following habitat types that occur in association with watercourses in the Project Site and contain food trees: • River Red Gum Riparian Woodland • Oxbow Wetland • Eucalyptus and Corymbia Open Woodland	374.66	163.4
Suitable	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.	Includes the following habitat types that do not occur in association with watercourses in the Project Site but contain food trees: • Dawson Gum and Brigalow Woodland	1,735.88	978.54

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
		• Eucalyptus and Corymbia Open Woodland		
Marginal	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. An example marginal habitat type is Acacia harpophylla open forest with isolated Eucalyptus tereticornis/camaldulensis, E. coolabah and/or E. populnea. These areas have the potential to support only very low density koala populations.	Includes the following habitat types: • Brigalow and Belah Woodland	234.33	77.05
Total			2,344.87	1,218.99

[1] Permanent and ephemeral water may originate from a variety of sources e.g. groundwater aquifers, nearby wetlands/watercourses, rainfall seepage/runoff. In central Queensland, it is known that riparian vegetation is highly utilised.
[2] Primary food and secondary food trees vary on the location within Central Queensland. Refer to https://www.savethekoala.com/sites/savethekoala.com/files/uploads/20150212_AKF_National_Koala_Tree_Planting_List.pdf for guidance

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, preferred habitat is located within the riparian zones of creeks, with large extents located along Boomerang and Hughes Creek. A known record of Koala is present within the preferred habitat fringing Hughes Creek. The preferred habitat areas provide key foraging resources and facilitate movement of the species across the landscape. Consequently, the preferred habitat areas are the most sensitive and valuable areas of habitat to the Koala within the Project Site.

An additional large, contiguous patch of suitable habitat exists between the area of preferred habitats located along the riparian zones of Boomerang and Hughes Creek. This suitable habitat provides connectivity between the two creek systems and their riparian zones, and is likely to be utilised as a movement corridor for Koala. Additional areas of suitable habitat are located in the southern portion of the Project Site and although they are large in size, for the most part they are not connected to preferred habitat.

Small patches of marginal habitat are scattered across the Project Site, with the largest patch located in the north eastern corner of the Project Site. These areas of marginal habitat are isolated from other areas of suitable and preferred habitat, and are unlikely to be of importance to Koala within the Project Site.

Habitat critical to the survival of the species

The EPBC Act referral guidelines for the vulnerable Koala (*Phascolarctos cinereus*) (DotE, 2014b) identifies habitat critical to the survival as koala habitat that is considered important for the long-term survival and recovery of the Koala (*Phascolarctos cinereus*). The guideline incorporates the habitat assessment tool which assesses the importance of the habitat (through Koala occurrence and vegetation composition) and value from a regional and recovery planning perspective (connectivity, existing threats and recovery value) e.g. valuing habitat that is part of a large congruous patch of Koala habitat which is free from threats and important for Koala recovery. Assessment using the tool indicates aspects of Koala habitat may be considered critical to the survival of the species (with a score greater than 5 as identified within the guideline). Based on the outcomes of the Koala habitat assessment tool, additional assessment of the habitat values and the ecology of the species was undertaken.

Preferred habitat within the Project Site primarily occurs within narrow riparian corridors, with suitable habitat occurring as fragmented patches which feature limit habitat viability, carrying capacity and buffering abilities. Habitat connectivity across the Project Site has been compromised and is restricted to habitat along main watercourses such as Boomerang Creek. The preferred habitat along Boomerang and Hughes Creek is most likely to retain leaf moisture throughout the year and provide important connectivity through and out of the Project Site. This preferred habitat is therefore considered to be the most sensible and valuable to the Koala within the Project Site. While preferred habitat is connected to a substantial area of suitable habitat for Koala to the west (>1,000 ha), the habitat within the wider landscape would be expected to provide a greater extent (in comparison to that within the Project Site) of core habitat, greater abundance of habitat resources and more valuable refuge for the species during drought conditions.

In summary, when applying the Koala habitat assessment tool, some areas of preferred habitat within the Project site, such as along the main watercourse, may be considered habitat critical to the survival of species. However further consideration points out that while the habitat assessment score exceeds the threshold of five, the habitat is also associated with fragmentation and other threats that may limit carrying capacity and reduce the importance of this habitat in relation to the recovery of the species. This habitat is not considered highly unique and habitat with similar characteristics, quality and condition occurs within the region, which will allow the species to continue to persist within its current distribution, regardless of the presence of habitat within the Project site.

Important populations

The SPRAT database does not identify ‘important populations’ of Koala (*Phascolarctos cinereus*) (Department of Agriculture Water and the Environment, 2020b). 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). Based on these criteria, the Project Site may support an important population. Although 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, it has been conservatively assessed as potentially containing habitat critical to the survival of the species based on the Koala habitat assessment tool. Therefore, it is considered that the Project site may support a key source population for breeding and dispersal.

Project impacts

The Project will potentially have both direct and indirect impacts to Koala (*Phascolarctos cinereus*). Direct impacts will be predominantly the loss and/or fragmentation of preferred and suitable habitat. Habitat clearing will be required for the construction of surface infrastructure, the transport and infrastructure corridor.

Surface infrastructure for the Project may also impede dispersal movement in a west-east direction and between the north of the Project Site and adjacent habitat. 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 vehicle strike. Throughout operation and decommissioning direct mortality from vehicle strike will remain a risk to the species.

Indirect impacts resulting from Project activities may include habitat modification from subsidence. This may include localised dieback of Koala (*Phascolarctos cinereus*) food trees or canopy trees that provide connectivity. 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.

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 (i.e. dieback) on the surface habitats, including habitats identified to be potentially utilised by Koala (Phascolarctos cinereus). The creek systems within the Project Site that may provide refuge habitat for the species during drought conditions are ephemeral creeks that do not contain permanent groundwater. Therefore any drawdown impacts will have little effect on the quality or availability of Koala (Phascolarctos cinereus) habitat resources.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-56 below. Direct impact calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Therefore, these calculations provide a conservative estimate of proposed disturbance. Indirect impact calculations relate to potential habitat modification from subsidence only, assume that the full extent of modelled subsidence will occur, and that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. As such the calculations below are considered conservative and represent a worst-case scenario.

Table 21-56 Direct and indirect impacts to Koala within the Project Footprint

Potential habitat type	Project Footprint	
	Direct impact (Surface facilities and IMG network) (ha)	Indirect impact (Subsidence) (ha)
Preferred	33.39	130.01
Suitable	50.47	928.07
Marginal	61.83	15.22
Total	145.69	1,073.29

Project avoidance, mitigation and management measures

The following mitigations measures specific to potential impacts on Koala (*Phascolarctos cinereus*) have been proposed. Further detail will 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.
- where possible, 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

Preferred habitat within the Project Site represents the most important habitat areas that may be influenced by the Project. The preferred habitat is located along riparian zones and most likely to retain leaf moisture throughout the year. It also provides important connectivity through and out of the Project Site, facilitating movement of the Koala throughout the landscape. As such, the preferred habitat along Boomerang, Hughes and One Mile Creek are considered to be 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).

In order to understand the mechanisms by which the sensitive habitat areas 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 21-57. The assessment concludes that the Project may have a significant impact on the Koala (*Phascolarctos cinereus*).

Table 21-57 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.	A national Recovery Plan has not yet been developed for this species and as such ‘important populations’ have not been delineated. However, for the purposes of this assessment it is conservatively considered that the Project Site may support an important population based on the potential presence of habitat critical to the survival of the species, as indicated by the koala habitat assessment tool. The Koala (*Phascolarctos cinereus*) is known to occur in the region however they are typically found in low densities. Any population of Koala (*Phascolarctos cinereus*) inhabiting the Project Site is unlikely to be necessary for maintaining genetic diversity and would not be located near the limit of the species’ range. As such it is expected that any possible decrease in a local population due to activities related to the proposed action would be minor. Approximately 163.4 ha of preferred Koala habitat will be potentially impacted as a result of the proposed action (including 33.39 ha of direct impacts and up to 130.01 ha of indirect subsidence impacts under a worst-case scenario). This habitat may be important at a local scale, however, this habitat is not considered highly unique and habitat with similar characteristics, quality and condition occurs within the region, which will allow the species to continue to persist within its current distribution, regardless of the presence or quality of habitat within the Project site. Therefore, while the Project Site may be capable of supporting an

EPBC Act criteria	Assessment of significance
	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 Koala (*Phascolarctos cinereus*) species.
Reduce the area of occupancy of an important population.	For the purposes of this assessment it is conservatively considered that the Project Site may support an 'important population'. Although 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, it has been conservatively assessed as potentially containing habitat critical to the survival of the species based on the koala habitat assessment tool. Therefore, it is considered that the Project site may support a key source population for breeding and dispersal. Approximately 163.4 ha of preferred Koala habitat will be potentially impacted as a result of the proposed action (including 33.39 ha of direct impacts and up to 130.01 ha of indirect subsidence impacts under a worst-case scenario). Subsidence impacts such as root failure and premature death of individual trees are considered likely to be localised in their occurrence, with individual areas of impact being small in extent and when assessed in isolation not result in adverse impacts on contiguous patches or preferred habitat across the Project Site. this assessment conservatively considers that. If a worst-case scenario is adopted where impacts to habitat occur uniformly across areas affected by subsidence, the Project may reduce the area of occupancy of an 'important population', in the context of a local population that may exist within the Project Site.
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.	The Project has the potential to directly impact 33.39 ha and indirectly impact 130.01 ha of preferred koala habitat based on subsidence modelling. For the purposes of this assessment it has been considered that subsidence would occur to the modelled extent and that impacts to habitat containing mature woody vegetation would occur uniformly. The likelihood of this occurring is considered to be low and therefore this assessment represents a conservative worst-case scenario. Portions of preferred habitat within the Project Site have been conservatively assessed as potentially containing limited areas of habitat considered critical to the survival of the species, based upon the Koala habitat assessment tool. While areas of preferred Koala habitat within the Project Site could be viewed as containing critical habitat (when considering the Koala habitat assessment tool), 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

EPBC Act criteria	Assessment of significance
	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. Therefore, while the Project may affect up to 163.4 ha of preferred Koala habitat it is considered unlikely that 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.	Subsidence impacts such as root failure and premature death of individual trees are considered likely to be localised in their occurrence, with individual areas of impact being small in extent and when assessed in isolation not result in adverse impacts on contiguous patches or preferred habitat across the Project Site. If a worst-case scenario is adopted where impacts to habitat occur uniformly across areas affected by subsidence, an estimated 163.4 ha preferred habitat may be impacted as a result of the Project. Given the direct impact to preferred habitat as a result of vegetation clearing, as well as the extent of habitat potentially impacted by subsidence and the known presence of Koala 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 will potentially experience a local decline in population. Marginal and suitable habitat only provides limited resources for Koala and is not crucial for its persistence in the Project Site. Therefore, Project impacts (directly or indirectly) on these habitat categories 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 dog (*Canis lupis 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.
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.
Interfere with the recovery of the species.	The *EPBC Act Referral Guidelines for the Vulnerable Koala* (Department of the Environment, 2014) identifies five impacts which are likely to substantially interfere with the recovery of the Koala (*Phascolarctos cinereus*). These have been outlined in

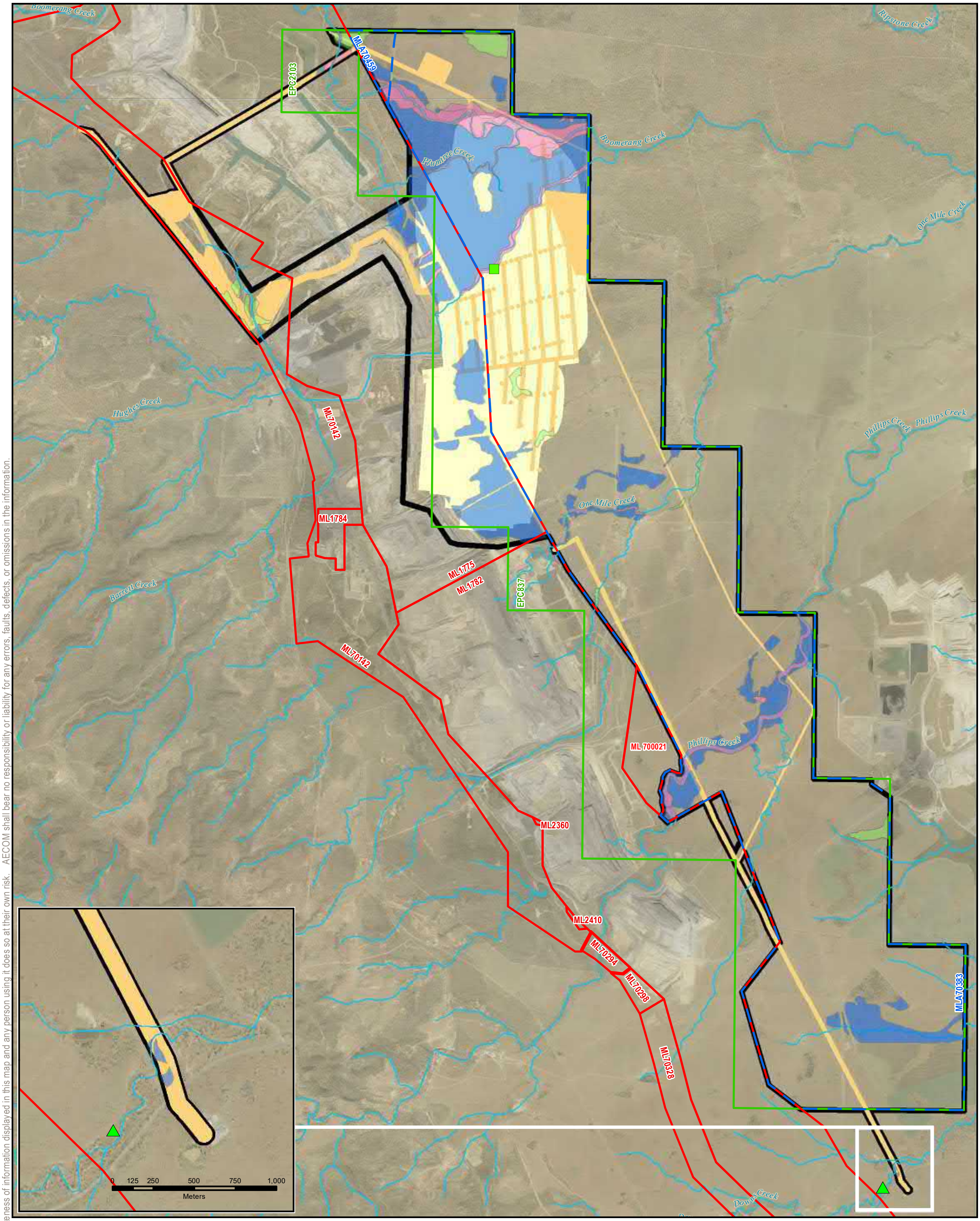
EPBC Act criteria	Assessment of significance
	Table 21-58 with a discussion on whether these impacts are likely to occur as a result of the Project. The outcome of this assessment was that the Project is unlikely to interfere substantially with the recovery of the koala.

Table 21-58 Impacts that are likely to substantially interfere with the recovery of the Koala (Phascolarctos cinereus)

Impacts which are likely to substantially interfere with the recovery of the Koala (*Phascolarctos cinereus*)	Potential for Impact to occur as a result of the Project
'Increasing Koala (*Phascolarctos cinereus*) fatalities in habitat critical to the survival of the Koala (*Phascolarctos cinereus*) due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.'	The Dog (*Canis lupus familiaris*) has already been recorded on numerous occasions within the Project Site. Vegetation clearing may increase visibility of Koalas (*Phascolarctos cinereus*) to dogs during daily or seasonal movements. Dogs may also use manmade tracks and clearings as thoroughfares and therefore the IMG network particularly may facilitate dog movement through the site. However, available Koala (*Phascolarctos cinereus*) habitat consists primarily of open woodland communities with disturbed ground and shrub layers. This open community already provides high visibility for predators and can be easily traversed by large bodied mammals such as dogs. Given that a population of dogs is already present on site the Project is unlikely to result in multiple, ongoing mortalities.
'Increasing Koala (*Phascolarctos cinereus*) fatalities in habitat critical to the survival of the Koala (*Phascolarctos cinereus*) due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities.'	An increase in vehicle movements within the Project Site is expected to occur during clearing and installation, where potential for collisions with construction equipment will be temporarily increased. Operational traffic will also increase with up to 500 additional workers expected to be required in the operation phase. Although mitigation measures described in Section 21.10 will help to reduce risk of vehicle collision, there remains a small possibility that this increase in vehicle movement will result in Koala (*Phascolarctos cinereus*) mortalities. This risk is increased for dispersing individuals which move across the infrastructure and transport corridor where traffic volume and large vehicles movement will be the greatest. However, given only a single koala was observed within the Project Site during multiple survey campaigns it is considered unlikely that vehicle-strikes would occur to a level that is likely to result in multiple, ongoing mortalities.
'Facilitating the introduction or spread of disease or pathogens for example *Chlamydia* or *Phytophthora cinnamomi*, to habitat critical to the survival of the Koala (*Phascolarctos cinereus*), that are likely to significantly reduce the reproductive output of Koalas (*Phascolarctos cinereus*) or reduce the carrying capacity of the habitat.'	The Project is not expected to introduce or exacerbate the spread of disease or pathogens (i.e. *Chlamydia* or *Phytophthora cinnamomi*) that may reduce the reproductive output of Koalas (*Phascolarctos cinereus*) 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

Impacts which are likely to substantially interfere with the recovery of the Koala (*Phascolarctos cinereus*)	**Potential for Impact to occur as a result of the Project**
	However, this disease is not known from the area and the Project is unlikely to lead to new pathways to dispersal into the Project Site for any individuals which may carry the disease. A Weed and Pest Management Plan will be developed and implemented for the Project Site. This will detail vehicle hygiene practices required to prevent the introduction or spread of diseases and pathogens to the Project Site.
'Creating a barrier to movement to, between or within habitat critical to the survival of the Koala (*Phascolarctos cinereus*) that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the Koala (*Phascolarctos cinereus*).	Although Koalas (*Phascolarctos cinereus*) typically move very little under most conditions, dispersing individuals (usually young males) are known to move large distances over areas which are sparsely vegetated. The clearing within Koala (*Phascolarctos cinereus*) habitat for the Project is of a shape and scale which is unlikely to create a barrier to movement for the species. The exact indirect impact from subsidence is unknown however dieback of Koala (*Phascolarctos cinereus*) habitat areas may result in some areas where hydrology or topography change significantly. This may reduce the quality of dispersal habitat although it is unlikely to degrade the habitat to the extent that it would preclude Koala (*Phascolarctos cinereus*) dispersal given their mobility.
'Changing hydrology which degrades habitat critical to the survival of the Koala (*Phascolarctos cinereus*) to the extent that the carrying capacity of the habitat is reduced in the long-term.'	Subsidence may have local attenuation effects on low flows, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible. The most sensitive and valuable habitat to the Koala within the Project Site is located along Boomerang, Hughes and One Mile Creek. Impacts to Boomerang Creek stability and flow behaviour are expected to be local and minor from subsidence of its channel. At Plumtree Creek, some incision of the channel bed upstream from subsidence would be expected where the steepening of bed grade into the panels is greatest, however the current catchment area is very small at this location due to upstream open-cut mining, hence impacts will be minor. Instability may develop in the Hughes Creek diversion where it will be subject to a three metre drop into the first panel it intercepts. This will cause, in the absence of in situ bedrock, channel bed deepening and subsequent bank erosion, which may result in the loss of some Koala (*Phascolarctos cinereus*) habitat trees within a localised refuge area. Although subsidence may result in some habitat degradation within mapped Koala (*Phascolarctos cinereus*) habitat, it is unlikely to do so to the extent

Impacts which are likely to substantially interfere with the recovery of the Koala (*Phascolarctos cinereus*)	Potential for Impact to occur as a result of the Project
	that the carrying capacity of the habitat is reduced in the long-term.



LEGEND

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

Threatened fauna location

- Koala (URS 2014)
- Koala (AECOM 2020)

Potential habitat

- Koala marginal habitat
- Koala preferred habitat
- Koala suitable habitat

N

Figure 21-34

Koala 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

DATE: 16/09/2020 VERSION: 4

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G215_v4_A4P.mxd

21.11.4.4 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.

Occurrence and potential habitat

This species was observed from an area of flooded *Acacia harpophylla* (Brigalow) woodland within the Project Site during SKM surveys in 2007. Potential habitat within the Project Site lacks the required microhabitat features to provide breeding habitat for this species. The species is likely to be a vagrant visitor only and may use wetlands in the Project Site on passage to more suitable breeding or foraging grounds. This species is expected to occur throughout the Project Site, within suitable habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). The extent of potential habitat for the species is summarised in Table 21-59 and is displayed in Figure 21-35.

Table 21-59 Potential habitat for Australian Painted Snipe (*Rostratula australis*)

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Preferred	Shallow, permanent or ephemeral, freshwater wetlands which provide areas of bare, exposed wet mud and a mosaic of ground cover1 (tufted grasses, sedges, small woody plants).	No habitat within the Project Site that meets definition of preferred habitat	0	0
Suitable	Shallow permanent or ephemeral freshwater or brackish wetlands and other inundated/waterlogged areas2 with a variable ground cover (e.g. grasses, shrubs and rushes). Habitat for this species does not include tall, dense reedbeds associated with stabilized water levels, wetlands that are cropped, and areas of low water quality due to nutrient run-off, agricultural chemicals and turbidity.	-	1,861.15	750.14
Total			1,861.15	750.14

[1] May include rushes and sedges up to 1 m in height
[2] Can include gilgais lakes, springs, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice fields, sewage farms and bore drains

The Project Site does not contain any areas of preferred habitat for the species. Suitable habitat is located throughout the Project Site, with a large patch situated in the south. Several other medium to large patches are located throughout the middle of the Project Site and are associated with inundated/waterlogged areas.

There is only one historical record of the species within the Project Site, however the species is a vagrant visitor and is expected to periodically occur. Given the lack of preferred habitat and the transient nature of the species, no areas of suitable habitat within the Project Site are likely to be of high value to the species.

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival of the Australian Painted Snipe (*Rostratula australis*) and at present no recovery plan exists. Therefore, the generic *EPBC Act Significant Impact Guidelines 1.1* definition of habitat critical to the survival of a species has been applied. Based on the specific habitat requirements of the species, no suitable breeding resources was present within the Project Site and the temporally inundated wetlands within the Project Site provide foraging habitat only. This suitable habitat comprises small and isolated patches of which most have been subject to degradation through ongoing cattle grazing. The wetlands are highly ephemeral, provide limited and temporary resources and do not provide refuge habitat for the species. This suitable habitat is not highly unique or highly limited in the surrounding region. The suitable habitat is unlikely to be valuable to the species, even at a local level and the suitable habitat within the Project Site is not considered to be critical to the survival of the species.

Project impacts

Indirect impacts resulting from Project activities may include habitat modification from subsidence such as reduction in canopy cover (from potential tree dieback) in vegetation surrounding wetlands. 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. The habitat's function of providing suitable foraging habitat for the Australian Painted Snipe (*Rostratula australis*) may also be compromised by these changes.

Although modelling has predicted subsidence of up to 3.5 m in some areas, the extent of the indirect impacts to terrestrial habitat described above is unknown and as such the maximum area has been assessed. It is possible that increased water ponding within surface drainage lines 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. However, increased pooling would also support other pest species such as Feral Pigs (*Sus scrofa*) and Cane Toads (*Bufo marinus*), which can degrade and impact on aquatic wetland habitat.

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. This can result in direct toxic impacts to aquatic species and may result in habitat degradation and is a risk to the species habitat primarily during the construction period. Disruption to foraging and dispersal behaviours due to increased light and noise may also result as an indirect impact to the species. Weed proliferation may also impact the species by reducing the quality of suitable habitat.

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 (i.e. dieback) on the surface habitats, including those identified to be potentially utilised by Australian Painted Snipe (*Rostratula australis*). 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. Therefore any drawdown impacts will have little effect on the quality or availability of Australian Painted Snipe (*Rostratula australis*) habitat resources.

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-60 below. Direct impact calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Therefore, these calculations provide a conservative estimate of proposed disturbance. Indirect impact calculations relate to potential habitat modification from subsidence only and assume full extent of subsidence and that all impacts will result in a negative impact to habitats. As such they are considered worst case scenario.

Table 21-60 Direct and indirect impacts to Australian painted snipe within the Project Footprint

Potential habitat type	Project Footprint	
	Direct impact (Surface facilities and IMG network) (ha)	Indirect impact (Subsidence) (ha)
Suitable	321.86	428.28
Total	321.86	428.28

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

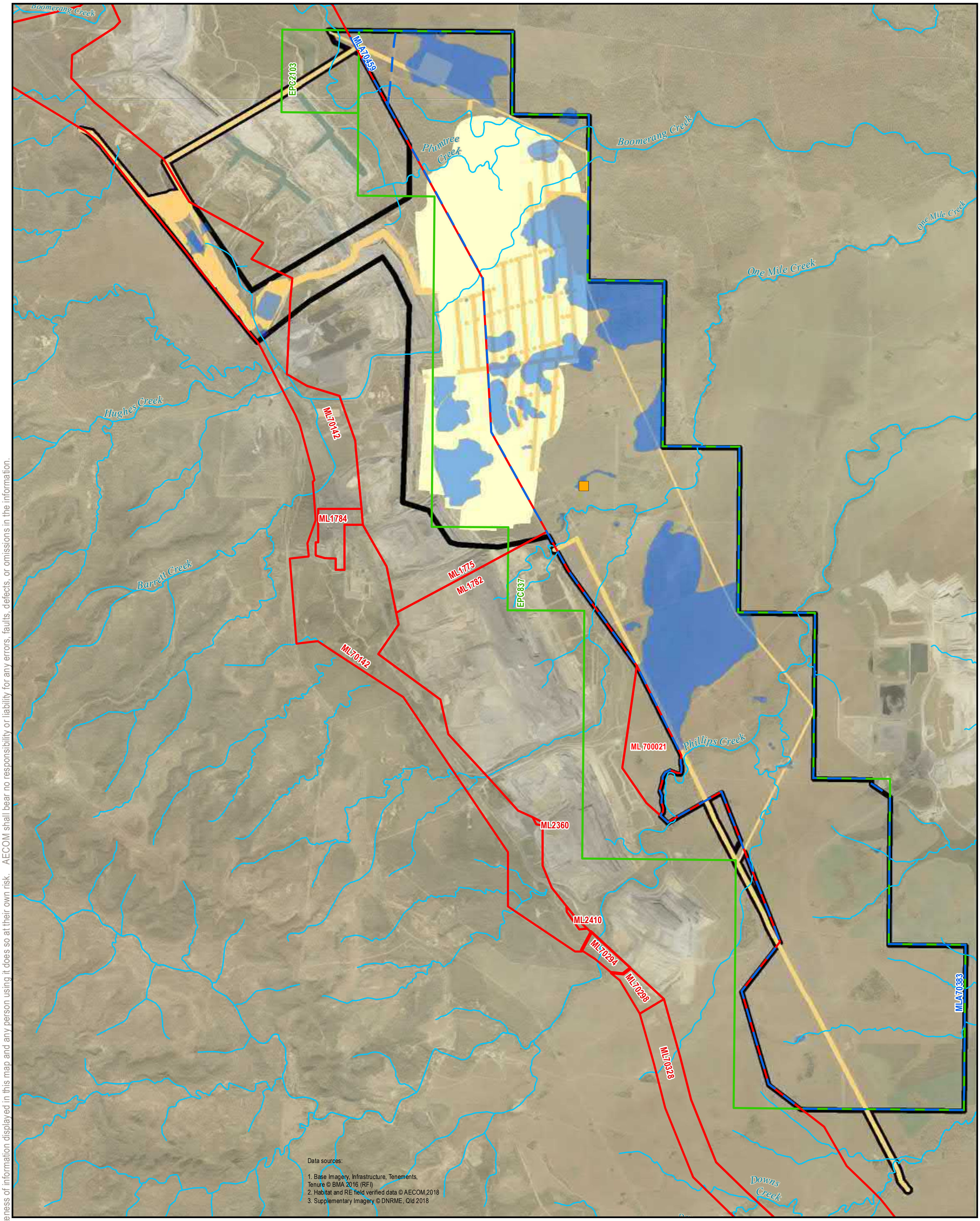
No preferred habitat is present throughout the Project Site and as such, the large patches of suitable habitat represent the only habitat areas to be influenced by the Project. These areas are not highly unique or highly limited in the surrounding region and are unlikely to be valuable to the species, even at a local level.

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 21-61 . The assessment indicates that due to the lack of habitat critical to the survival of the species and with the implementation of mitigation measures proposed in Section 21.10 the impacts of the Project on the Australian Painted Snipe (*Rostratula australis*) are unlikely to be significant.

Table 21-61 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 suitable but 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. A total of 750.14 ha of potential suitable habitat for the species exists within the Project Footprint which may be directly or indirectly impacted by the Project (Figure 21-35). Direct impacts are expected to 321.86 ha which will be unusable after clearing and ground disturbance. Indirect impacts from subsidence are expected to a further 428.28 ha. The indirect impact area calculation is based on a worst-case scenario which has including for any area where any subsidence may occur. However, it is unknown what the impact of subsidence will be to Australian Painted Snipe (*Rostratula australis*) habitat and increased ponding may actually result in additional usable wetland habitat for the species. The species is likely to occur only temporally in small numbers, is unlikely to rely on the Project Site for key life history stages and only for small amount of habitat which may be disrupted by the Project and that the habitat is suitable but sub-optimal. As such it is considered unlikely that the proposed action will lead to a long-term decrease in a population of the species.

EPBC Act criteria	Assessment of significance
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. Habitat critical to the survival 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 habitat present provides some foraging opportunities. The Project is unlikely to adversely affect habitat critical to the survival 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 is non-existent within the Project Site (i.e. preferred habitat). 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.	Available habitat within the Project Site is not highly preferred for this species. As such it is considered unlikely that the proposed action 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.	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
- Project Footprint - Direct Impact
- Project Footprint - Indirect Impact
- Exploration Permit Coal (EPC)
- Mining Lease (ML)
- Mining Lease Application (MLA)
- Watercourses

Threatened fauna location

- Australian Painted Snipe (SKM 2012)

Potential habitat

- Australian Painted Snipe suitable habitat

N

Figure 21-35

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)

BHP

DATE: 16/09/2020 VERSION: 4

21.11.4.5 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.

Occurrence and potential habitat

One 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). Within similar habitat associated with Boomerang Creek and Hughes Creek in the north of the Project Site, another 18 Greater Gliders (*Petauroides volans*) were observed by AECOM in 2020 and one additional individual was also found in *Eucalyptus* and/or *Corymbia* open woodland (RE 11.5.3) (Figure 21-36).

Several records are available from Atlas of Living Australia approximately 10 km west of the Project Site. This species is expected to occur throughout the Project Site, within preferred, suitable and marginal habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L, 2020). The extent of potential habitat for the species is summarised in Table 21.62 and is displayed in Figure 21-36.

Table 21-62 Potential habitat for Greater Glider (*Petauroides volans*)

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Preferred	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.	Includes the following habitat types that directly fringe watercourses within the Project Site and contain sufficient hollow density: • River Red Gum Riparian Woodland • Eucalyptus and Corymbia Open Woodland	190.05	78.18
Suitable	Remnant eucalypt woodlands connected to areas of roosting habitat that does not contain more than two 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.	Includes the following habitat types situated on alluvial plains, containing sufficient hollow density and connected to preferred habitat: • Eucalyptus and Corymbia Open Woodland • Oxbow Wetland • Dawson Gum and Brigalow Woodland	442.75	203.81

Potential habitat type	Habitat definition	Application to Project Site	Total area (ha) within the Project Site	Area (ha) within Project Footprint
Marginal	Remnant or high value regrowth vegetation1 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.	Includes the following habitat types that occur within proximity (<100 m) to preferred habitat: • Eucalyptus and Corymbia Open Woodland • Oxbow Wetland	848.01	524.68
Total			1,480.81	806.67

[1] For high value regrowth to be considered marginal habitat, it needs to include scattered large Eucalypt trees as Smith et al. (2007) did not observe any gliders foraging in non-myrtaceous species or myrtaceous trees <20 cm dbh

Within the Project Site, preferred habitat for Greater Glider is located within the riparian zones of creeks, with the habitat supporting a known local population on Boomerang, Plumtree and Hughes Creeks. The preferred habitat along riparian zones within the Project Site provides key denning (hollows) and foraging resources and has been shown to support a number of individuals.

Suitable habitat is located adjacent to the preferred habitat and follows the same riparian zones of the creek systems within the Project Site. Small portions of marginal habitat are located in the south of the Project Site, in association with Phillips Creek. The area between the Boomerang, Plumtree and Hughes Creeks in the north of the Project contains a large area of contiguous marginal habitat, which connects through to the suitable and preferred habitat.

Habitat critical to the survival of the species

There are no species-specific guidelines for determining habitat critical to the survival of Greater Glider (*Petauroides volans*) and at present no recovery plan exists. Therefore, the generic Significant Impact Guidelines Policy Statement 1.1 (Department of the Environment, 2013b) definition of habitat critical to the survival of a species has been applied.

Habitat within the Project Site primarily occurs within narrow riparian corridors, which limits habitat viability, carrying capacity and buffering abilities. However, habitat is connected, which allows for species dispersal, recruitment and exchange of genetic material. Particularly in the northern part of the Project Site, habitat forms part of a substantial area of suitable habitat for Greater Glider (*Petauroides volans*) and would provide a greater extent of core habitat and greater abundance of habitat resources. Given the presence of denning resources (hollows), connectivity of habitat and the existence of numerous records of the species, it is considered that the area of preferred habitat are the most sensitive and of most value to Greater Glider within the Project Site.

However, this habitat is not considered highly unique. Habitat with similar characteristics, quality and condition occurs within the region, which will allow the species to continue to persist within its current distribution, regardless of the presence of habitat within the Project site. It is also not considered to provide refuge habitat for the species. Based on these factors, habitat within the Project Site is not considered critical to the survival of Greater Glider (*Petauroides volans*) and is not considered to play a critical role in the long-term maintenance of the species.

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). The Greater Glider (*Petauroides volans*) is largely restricted to eucalypt forests. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.

The Project Site is unlikely to support an important population, given that:

- the population of Greater Gliders (P*etauroides volans*) using the project site is not necessarily unique, isolated or genetically distinct from any other Greater Gliders (P*etauroides volans*) occurring in the region. therefore, the population using the project site would not be considered necessary for maintaining genetic diversity, or a key source population for breeding or dispersal
- the project site is not near the edge of the species' range
- the project Site does not fall within tall, montane, moist eucalypt forest with relatively old trees and abundant hollows where the species is found in highest abundance.

Project impacts

The Project will potentially have both direct and indirect impacts to Greater Glider (*Petauroides volans*). Direct impacts will be predominantly the loss and/or fragmentation of habitat. Habitat clearing will be required for the construction of surface infrastructure, the transport and infrastructure corridor. Surface infrastructure for the Project may also impede dispersal movement in a west-east direction and between the north of the Project Site and adjacent habitat. Habitat of Boomerang, Plumtree, Phillips and Downs Creek will be interrupted by the transport and infrastructure corridor, potential restricting movement and creating a barrier for individuals.

Indirect impacts resulting from Project activities may include habitat modification from subsidence. This may include localised dieback of denning trees or canopy trees that provide connectivity. Increased noise and light, particularly during construction, may have impact on breeding, foraging and dispersal behaviours.

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 (i.e. dieback) on the surface habitats, including those identified to be potentially utilised by Greater Glider (*Petauroides volans*).

The extent of potential direct and indirect impacts resulting from the Project are outlined in Table 21-63 below. Direct impact calculations incorporate an additional buffer of between 50-100 m around the Project Footprint. Therefore, these calculations provide a conservative estimate of proposed disturbance. Indirect impact calculations relate to potential habitat modification from subsidence only, they assume that the full extent of modelled subsidence occurs, that all impacts will result in a negative impact to habitats and that these impacts will occur uniformly across the Project Footprint. The likelihood of this occurring is considered to be low. As such the calculations below are considered conservative and represent a worst-case impact.

Table 21-63 Direct and indirect impacts to Greater Glider (*Petauroides volans*) within the Project Footprint

Potential habitat type	Project Footprint	
	Direct impact (Surface facilities and IMG network) (ha)	Indirect impact (Subsidence) (ha)
Preferred	10.62	68.56
Suitable	23.88	187.93
Marginal	33.21	491.47
Total	67.71	738.96

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 greater gliders (*petauroides volans*) to adjacent native vegetation
- site inductions will include information on the potential presence of 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 greater glider (*petauroides volans*) 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 already disturbed areas for crossings of creeks and drainage lines wherever possible
- 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
- where practical, install suitably sized nest boxes in areas where hollows have been removed
- retain trees with large hollows wherever practicable to retain breeding and refuge opportunities.

Significant impact assessment

Preferred habitat within the Project Site represents the most important habitat areas to be influenced by the Project. It provides key denning (hollows) and foraging resources and has been shown to support a number of individuals. As such, the preferred habitat located along the riparian zones of the creek systems within the Project Sites is considered to be the most sensitive and of most value to Greater Glider. Impacts to these sensitive habitat areas may be considered significant as per the *EPBC Act Significant Impact Guidelines 1.1* (DotE, 2013a).

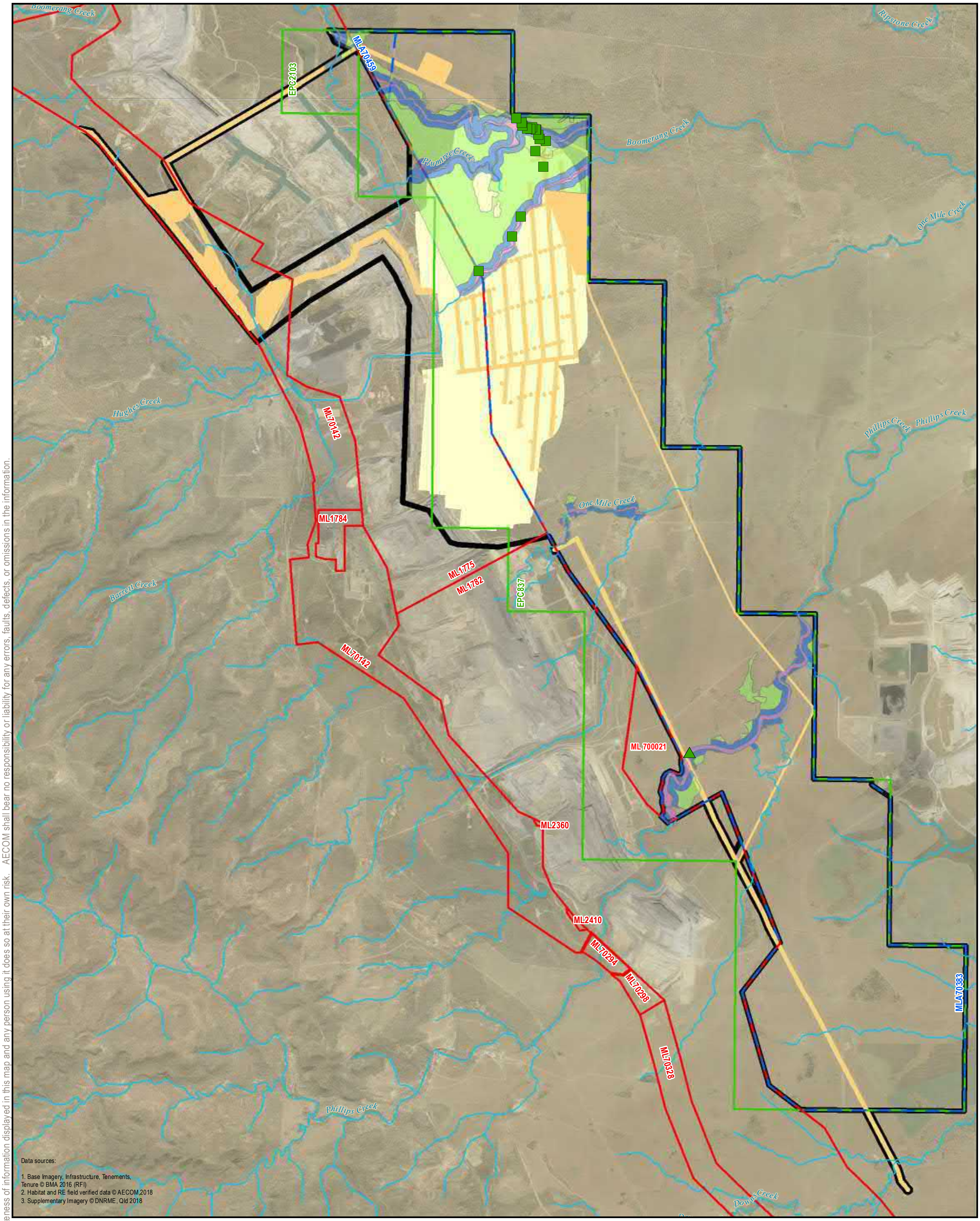
In order to understand the mechanisms by which the sensitive, preferred habitat areas might be impacted, and to determine the magnitude of significant impacts, an assessment of the significance of impacts on this species as per the guidelines has been completed and is provided in Table 21-64 . The assessment concludes that the Project may have a significant impact on the Greater Glider (*Petauroides volans*).

Table 21-64 Assessment of significance of impacts – Greater Glider

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. The population of Greater Gliders (*Petauroides volans*) in the Project Site is unlikely to be necessary for maintaining genetic diversity and the Project Site is not near the limit of the species range, therefore it is considered unlikely that an 'important population' exists.
Reduce the area of occupancy of an important population.	It is considered unlikely that an 'important population' exists within the Project Site. As such the proposed action is not expected to reduce the area of occupancy of an 'important population'.
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, particularly where the clearing impact width

EPBC Act criteria	Assessment of significance
	exceeds the maximum volplane distance of the species. However, as the Project site is unlikely to support an important population, 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.	Habitat within the Project Site primarily occurs within narrow riparian corridors, which limits habitat viability, carrying capacity and buffering abilities Habitat within the Project Footprint is not considered highly unique and habitat with similar characteristics, quality and condition occurs within the region, which will allow the species to continue to persist within its current distribution. Habitat within the Project Site is not considered habitat critical to the survival of the species.
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. However, the habitat within the Project Site is unlikely to support an 'important population' of the species. 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 78.18 ha preferred habitat may be impacted directly or indirectly as a result of the Project (including 10.62 ha of direct impacts and up to 68.56 ha of indirect subsidence impacts under a worst-case scenario). Given the scale of these impact areas 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 and suitable habitat only provides limited resources for Greater Glider and is not crucial for its persistence in the Project Site. Therefore, Project impacts (directly or indirectly) on marginal and suitable habitat categories alone 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 including habitat loss, high intensity or frequency fires, timber production, climate change, barbed wire fencing, hyper-predation by owls, *Phytophora* 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*). The Project will potentially impact directly on 10.62 ha of preferred habitat and indirectly up to 67.56 ha under a worst-case scenario. The species is highly mobile and areas of habitat will remain across the Project Site that will continue to provide key habitat resources, as well

EPBC Act criteria	Assessment of significance
	as facilitate the movement of the species to high value preferred habitat outside of the Project Site. Alterations in habitat resources due to subsidence are considered to be a worst case scenario. Individual areas of impact from indirect impacts may be small in extent, and in isolation would not constitute an adverse impacts on the species habitat. The Project is unlikely to interfere with the recovery of the species.



LEGEND

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

Threatened fauna location

- Greater Glider (AECOM 2020)
- Greater Glider (SKM 2012)

Potential habitat

- Greater Glider preferred habitat
- Greater Glider suitable habitat
- Greater Glider marginal habitat

N

Figure 21-36

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)

DATE: 16/09/2020 VERSION: 3

Filename: \\aubne1fp003\Projects\605X\60507031\4. Tech Work Area\4.99 GIS\02_MXDs\06 Environmental Impact Statement\21 MNES Ecology\60507031_G216_v3_A4P.mxd

21.12 Significant residual impacts

21.12.1 Water resources

Significant residual impacts of the Project on water resources are assessed in Table 21-65. Unmitigated and residual risks are evaluated in accordance with the ratings for likelihood (Table 21-66) and consequence (Table 21-67) to determine risk rating (Table 21-68).

21.12.1.1 Surface water

The creeks within the Project Site are part 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 km2. 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 km2).

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.

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 pond water until they fill and spill. Subsidence may have local attenuation effects on low flows through temporary storage in panels, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible. 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.

21.12.1.2 Groundwater

Residual impacts are anticipated in the short to medium term, over the life of mine and longer term (e.g. subsidence). Residual impacts relate to underground mining impacts on geology, groundwater levels and surface topography (subsidence) are relative to the duration of mining and dewatering. Beyond closure, groundwater (within the surrounding coal seams) will continue to flow into the final voids until a pseudo-steady state pit water level is achieved. During this period the loss of water from the overlying alluvium/Tertiary units and the Permian coal seam aquifers are not predicted to have a significant impact on beneficial use or natural ecosystem values.

The numerical groundwater model was used to provide a prediction of long-term groundwater level rebound, 50 years post mining. Groundwater recovery was predicted, using select bores within the model domain, such that groundwater level time series hydrographs were generated to evaluate predicted drawdown and the groundwater rebound. The post-mining modelling to evaluate groundwater level rebound included:

- Increased permeability related to the underground goaf and open-cut backfill,
- Natural low rainfall recharge across the model domain, and
- High evaporative losses (compared to inflows) from the final open-cut voids.

It is predicted that the groundwater level recovery (as evidenced in the modelled groundwater levels response for a period of 50 years) is slow due to:

- drawdown in all model layers because of on-going extraction (through evaporation) from 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 before marked changes in groundwater levels will be observed

- high evaporation (due to large final void areas) is expected to remain (across the approximately 22.5 km strike length of the open-cut mine), and
- low permeability within the sediments surrounding the open-cut pits.

Groundwater is predicted to rebound following cessation of mining, over time, to the level of the final voids in the Saraji Mine open-cut pits. Groundwater recovery will then be halted to evaporation discharge from the final voids (I.e. the final voids acting as groundwater sinks).

Table 21-65 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 21.10.1.1	Unlikely	Catastrophic	High
Discharge of MAW	Possible	Major	High	Section 21.10.1.1	Possible	Major	High
Water quality (salt)	Possible	Major	High	Section 21.10.1.1	Unlikely	Moderate	Medium
Subsidence	Likely	Major	High	Section 21.10.1.1	Likely	Major	High
Erosion and sedimentation	Likely	Moderate	High	Section 21.10.1.1	Unlikely	Minor	Low
Chemicals and contaminants	Likely	Major	High	Section 21.10.1.1	Unlikely	Minor	Low
Flooding	Possible	Moderate	Medium	Section 21.10.1.1	Rare	Moderate	Low
Flooding of mine infrastructure	Possible	Moderate	Medium	Section 21.10.1.1	Rare	Moderate	Low
Groundwater							
Dewatering	Almost certain	Moderate	High	Section 21.10.1.2	Almost certain	Minor	Medium
Geology	Almost certain	Moderate	High	Section 21.10.1.2	Almost certain	Minor	Medium
Groundwater drawdown	Almost certain	Moderate	High	Section 21.10.1.2	Likely	Minimal	Medium
Bore trigger thresholds	Likely	Major	High	Section 21.10.1.2	Unlikely	Minimal	Low
Water quality alteration	Likely	Major	High	Section 21.10.1.2	Unlikely	Moderate	Medium
Surface water-groundwater interaction	Unlikely	Moderate	Medium	Section 21.10.1.2	Rare	Moderate	Low
Increased groundwater ingress	Likely	Moderate	High	Section 21.10.1.2	Rare	Moderate	Low
Impacts on GDE and springs	Rare	Major	Medium	Section 21.10.1.2	Rare	Moderate	Low

Table 21-66 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 21-67 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 21-68 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

21.12.2 Threatened species and ecological communities

Significant residual impacts to threatened species and ecological communities are identified through the following Project stages:

- Stage 1 – relates to direct impacts anticipated during construction, which is expected to occur over a three-year period (FY 2021-2023) and include:
  - Year 1: Construction of mine portal, construction accommodation village, IMG infrastructure (three western-most gas wells and three western-most locations for the gas pipeline), raw water dam and process water dam.
  - Year 2 and 3: Construction of powerline (close to Meadowbrook homestead), MIA, CHPP, rail loop and load out, vent shafts and water pipelines.
- Stage 2 – relates to 50 percent of indirect impacts during operation including underground mining to extract and process coal
- Stage 3 - relates to the remaining 50 percent of indirect impacts during operation including underground mining to extract and process coal

Significant residual impacts on threatened species and ecological communities are presented based on a worst-case scenario of maximum predicted disturbance from each Project stage; however, the final extent of disturbance is anticipated to be significantly less.

As an example, subsidence induced movement in soil profiles and the formation of cracks can lead to stress on the roots of trees and shrubs and localised root shearing, indirectly impacting on vegetation health. In a worst-case scenario, this may result in root failure and premature death of individual trees. For residual impact assessment, all subsidence affected areas are assumed to experience worst case impacts while, in practice, the final post subsidence landscape is unlikely to be uniformly affected and impacts substantially reduced. There is very low likelihood of uniform subsidence impacts across the Project Footprint (Stage 2 and 3) therefore the impact assessment approach is highly conservative. Monitoring of subsided areas will be conducted on a periodic basis to determine and quantify impacts.

Significant residual impacts also assume ponding occurs uniformly across the goaf of each longwall. In fact, modelling shows ponding is typically localised and not predicted across the entire subsidence landscape. The ephemeral nature of creek lines within the Project Site and limited change in pre- and post-subsidence flow conditions mean that residual pooling will be localised and limited in duration. Residual pooling is shown to account for a change of approximately half a per cent of total flow volume during rainfall for both 50 and 100-year average recurrence interval (ARI) (Alluvium, 2019). Similarly, where ponding does occur, new habitat opportunities for some fauna groups may be created but are not considered in the extent of significant residual impacts as they are difficult to accurately quantify.

In addition to a conservative assessment of significant residual impacts, there is potential for mitigation measures to generate benefits and reduce the extent of predicted impacts that is not accounted for. For example, BMA will use sensitive design and site selection to avoid high-value environmental areas for the protection of MSES and MNES wherever possible.

For TECs and threatened species, a significant residual 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 (Sothern) (*Geophaps scripta scripta*), Ornamental Snake (*Denisonia maculata*) and Greater Glider (*Petauroides volans*). For the extent of remaining adverse impact, this includes the area of direct and indirect subsidence impact on habitat that is most important to the species or ecological community. Within the Project Site this includes all areas of Brigalow TEC, preferred habitat for Squatter Pigeon, Koala and Greater Glider, and important habitat (suitable habitat) for Ornamental Snake.

The quantified extent of maximum predicted significant residual impacts on MNES for the Project are presented in Table 21-69.

Table 21-69 Maximum predicted significant residual impacts on MNES

MNES category	MNES value	Maximum Significant Residual Impact Area (ha)			
		Stage 1	Stage 2	Stage 3	Total
TEC	Brigalow TEC	43.14	101.46	101.46	246.07
Threatened species	Koala preferred habitat	33.40	65.00	65.00	163.40
	Squatter Pigeon preferred habitat	72.09	313.51	313.50	699.10
	Ornamental Snake suitable habitat	335.20	295.27	295.26	925.73
	Greater Glider preferred habitat	10.62	33.78	33.78	78.18

Offset requirements will apply to identified significant residual impacts. 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. This will also inform replacement of these values either through rehabilitation or land-based offsets.

21.13 Offset strategy

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 21.5). BMA has progressed a preliminary assessment of offset availability within the Brigalow Belt Bioregion for the maximum predicted significant residual impact. Habitat quality analysis surveys for Project impacts will be undertaken following the finalisation of the EIS and detailed design to confirm offset requirements.

The objective of the Offset Strategy is to outline BMA's proposed approach to deliver appropriate nature and scale of offsets to achieve compensatory environmental outcomes and facilitate discussion between the DAWE and the Queensland Government Department of Environment and Science (DES) on suitable synergistic offsets for unavoidable losses of biodiversity values incurred by the Project.

Significant residual impacts presented in Section 21.12 are based on a worst-case scenario or maximum predicted disturbance from each Project stage:

- Stage 1 – relates to direct impacts anticipated during construction, which is expected to occur over a three-year period (FY 2021-2023) and include:
  - Year 1: Construction of mine portal, construction accommodation village, incidental mine gas (IMG) drainage infrastructure (three western-most gas wells and three western-most locations for the gas pipeline), raw water dam and process water dam.
  - Year 2 and 3: Construction of powerline (close to Meadowbrook homestead), MIA, CHPP, rail loop and load out, vent shafts and water pipelines.
- Stage 2 (FY2023-2032) – relates to 50 percent of indirect impacts during operation including underground mining to extract and process coal
- Stage 3 (FY2033-2042) – relates to the remaining 50 percent of indirect impacts during operation including underground mining to extract and process coal.

The provision of offsets to address significant residual impacts of the Project will also be staged.

21.13.1 Offset requirement

Maximum predicted significant residual impacts provide for a conservative assessment of potential impacts, but the final extent of disturbance is likely to be significantly less e.g. subsidence is unlikely to be uniform and extent of impacts less than estimated, while residual ponding may generate new habitat opportunities that are difficult to quantify. Final offset requirements are subject to the final clearing footprint and assessment and approval from the DAWE.

While mitigation and management measures for direct and indirect impacts in Section 21.12.2 focus on maximising retention of MNES values across the Project footprint, significant residual impacts on TEC and listed threatened species will remain. Maximum predicted significant residual impact are determined based on:

- TEC and species evaluated to be significantly impacted by the Project
- the extent of adverse impact that will remain following the development of the Project.

Within the Project Site this comprises area of direct and indirect impact on the habitat that is most important to the species or ecological community and therefore triggered a significant residual impact, including:

- all areas of Brigalow TEC (Section 21.13.1.1, shown in Figure 21-28)
- preferred habitat for Squatter Pigeon (Section 21.11.4.1, shown in Figure 21-32)
- important (suitable) habitat for Ornamental Snake (Section 21.11.4.2, shown in Figure 21-33)
- preferred habitat for Koala (Section 21.11.4.3, shown in Figure 21-34)
- preferred habitat for Greater Glider (Section 21.11.4.5, shown in Figure 21-36).

The quantified extent of maximum predicted significant residual impacts on MNES for the Project are summarised in Table 21-70, with a concise discussion outlining the rationale for determining the residual impact extent also provided below.

Table 21-70 Maximum predicted significant residual impacts on MNES

MNES value	Maximum Significant Residual Impact Area (ha)			
	Stage 1	Stage 2	Stage 3	Total
Brigalow TEC	33.8	95.1	95.1	**224.0**
Koala preferred habitat	33.0	65.0	65.0	**163.0**
Squatter Pigeon preferred habitat	72.2	313.5	313.5	**699.2**
Ornamental Snake suitable habitat	335.2	295.1	295.1	**925.4**
Greater Glider preferred habitat	10.6	33.8	33.8	**78.2**

21.13.1.1 Brigalow TEC

Impacts to Brigalow TEC from Stage 1 will be offset in their entirety and offsets for Stages 2 and 3 will be delivered based on additional monitoring and determination of impacts from subsidence up to the potential maximum extent indicated in Table 21-70 subject to field verification for each stage.

Direct impacts of clearing associated with Stage 1 will remove the TEC representing a significant impact that requires offsets. If indirect impacts cause vegetation to lose its status as the Brigalow TEC when assessed against the listing criteria (e.g. due to subsidence causing root cracking or ponding with waterlogging), these impacts will also be considered significant and will be offset, as they will contribute to the cumulative loss associated with the Project. It is important to note that individual impacts from indirect impacts may be small in extent and in isolation not considered significant, however, a good practise approach to compensating for unavoidable Project impacts is being adopted.

Through offset mechanisms, the Project will aim to prevent further decline of endangered Brigalow TEC by protecting and improving quality of remnant and regrowth vegetation in the Brigalow TEC core distribution.

21.13.1.2 Threatened species

Unlike for Brigalow TEC, where vegetation either meets the criteria to be considered the TEC or not, there are substantial variations in the habitat resources and values for threatened fauna across the Project Site.

The Project Site has been ground-truthed with preferred, suitable and marginal habitats identified for the threatened fauna (indicated in Table 21-70) as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L., 2020). These 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.

Preferred, suitable and marginal habitat types are defined generally, with further discussion as to the site and species-specific characteristics in the following sections.

- **Preferred habitats** are those 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 habitat** provides 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 habitat** provides 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 is 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.

As per the EPBC Act Significant Impact Guidelines 1.1 (DotE, 2013), 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 impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DotE, 2013). The Guidelines direct proponents to consider all 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 (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.

Squatter Pigeon (southern)

Preferred habitat for Squatter Pigeon (mapped in Figure 21-32) is defined as remnant or regrowth grassy open forest to woodland dominated by Eucalyptus, Corymbia, Callitris or Acacia with patchy, relatively sparse ground cover vegetation (33%) and sparse shrub layer on well-draining sandy, loamy or gravelly soils within one kilometre of a suitable permanent waterbody as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L., 2020).

Within the Project Site, preferred habitat is primarily located in a consolidated patch where Boomerang, Plumtree and Hughes Creek converge and represents the most important habitat areas to be influenced by the Project. It is where breeding will occur, if the species is breeding at this site, and provides a large and connected patch of habitat across three creek systems. As such, the preferred habitat within the north of the Project Site is the most sensitive and of most value to Squatter Pigeon. This area also intersects with direct impacts (clearing) and indirect impacts (subsidence-related disturbance) and a conservative approach has been taken in assuming any areas where the footprint intersects preferred habitat will be unavoidably impacted. Therefore, these impacts represent the significant residual impact that will be offset, up to the maximum potential impact extents provided in Table 21-70.

BMA will consider the conservation outcomes in The Action Plan for Australian Birds 2000 (Garnett, 2000) in finalising the offset management and monitoring strategies for this species.

Ornamental Snake

In the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L., 2020), preferred Ornamental Snake habitat is defined as gilgai depressions (with or without the presence of brigalow or other canopy vegetation), mounds and wetlands on cracking clays (predominantly land zone 4) where essential microhabitat features are present including an abundance of deep soil cracks and fallen woody debris, subject to seasonal flooding.

These areas are not present within the Project Site. However, individuals of the Ornamental Snake have been recorded within the Project Site in habitats that meet the definition of suitable habitat as defined in the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, 2020). Suitable habitat includes dispersal areas within one (1) kilometre of preferred habitat currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow or non-remnant areas. Suitable habitat also includes areas currently or previously dominated by brigalow or coolibah communities where gilgais or soil cracks are infrequent or are shallow and multiple species records are present. Suitable habitat for Ornamental Snake is mapped in Figure 21-33.

Within the Project Site, these suitable habitat areas are represented as large and reasonably connected patches, primarily in the areas between Hughes Creek and One Mile Creek, with numerous previous records of the species located to the east of the existing operations at Saraji mine. Given both the size, configuration and location of suitable habitat and the existence of previous records of the species, it is considered that this area of suitable habitat are the most sensitive and of most value to Ornamental Snake within the Project Site. This area also intersects with direct disturbance areas and areas of potential subsidence and a conservative approach has been taken in assuming any areas where the footprint intersects suitable habitat will be unavoidably impacted. Therefore, these impacts represent the significant residual impact that will be offset, up to the maximum potential impact extents provided in Table 21-70.

BMA will consider the conservation outcomes for Ornamental Snake (Department of the Environment, 2014) in finalising the offset management and monitoring strategies for this species.

Koala

In the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L., 2020), preferred habitat for Koala is defined as contiguous remnant eucalyptus open forest to woodlands on alluvial and/or cracked rock groundwater where palatable food tree species occur frequently (and are usually dominant). This specifically includes stream fringing open forest, open forest or woodland on alluvial terraces where Eucalyptus tereticornis/camaldulensis are dominant or common subdominant elements. Other important food species on the alluvial terraces can include E. coolibah, E. crebra, E. melanophloia and E. popunea.

Preferred habitat areas located where aquifers persist through most drought cycles, substrates have high fertility and food tree species occur at relatively high frequencies have the potential to support moderate to high density koala populations. Preferred habitat areas represented as Eucalyptus crebra/drepanophylla tall woodland on hills and ranges with aquifers that persist in most drought cycles (commonly cracked rock aquifers) have the potential to support a low to moderate density koala population e.g. Clarke-Connors Ranges, Minerva Hills.

Within the Project Site, preferred habitat is located within the riparian zones of creeks containing food trees (River Red Gum riparian woodland, oxbox woodland and Eucalytpus and Corymbia open woodlands), with large extents located along Boomerang and Hughes Creek. A known record of Koala is present within the preferred habitat fringing Hughes Creek. The preferred habitat areas provide key foraging resources and facilitate movement of the species across the landscape. Consequently, the preferred habitat areas are the most sensitive and valuable areas of habitat to the Koala within the Project Site. Preferred habitat for Koala is mapped in Figure 21-34.

An additional large, contiguous patch of suitable habitat exists between the area of preferred habitats located along the riparian zones of Boomerang and Hughes Creek. This suitable habitat provides connectivity between the two creek systems and their riparian zones and is likely to be utilised as a movement corridor for Koala. These areas support the functionality of preferred habitat, but are unlikely to provide critical habitat resources in a standalone capacity. Additional areas of suitable habitat are in the southern portion of the Project Site and although large areas, for the most part, they are not connected to preferred habitat and therefore are likely to be of lower value to the species, in the local context.

Small patches of marginal habitat are scattered across the Project Site, with the largest patch located in the north eastern corner of the Project Site. These areas of marginal habitat are isolated from other areas of suitable and preferred habitat and are unlikely to be of importance to Koala within the Project Site.

Preferred habitat provides key foraging resources, as they are the areas that are most likely to retain leaf moisture throughout the year. They also provide important connectivity throughout and out of the Project Site, which facilitates movement of Koala across the landscape. Allowing for these connectivity values is important both for facilitating interactions of individuals in low density central Queensland populations, as well as providing corridors to avoid predators and seek refuge from adverse conditions. These preferred habitat areas are therefore considered to be the most sensitive and valuable to the Koala within the Project Site. This area also intersects with direct disturbance areas and also areas of potential subsidence and a conservative approach has been taken in assuming any areas where the footprint intersects preferred habitat will be unavoidably impacted. Therefore, these impacts represent the significant residual impact that will be offset, up to the maximum potential impact extents provided in Table 21-70. Areas of suitable and marginal habitat provide lower or limited habitat value for Koala in the local context of the Project Site. Whilst impacts to these areas are anticipated, they are not expected to significantly interrupt utilisation and functionality of habitat and are therefore not considered to be significant residual impacts. Consequently, offsets for impacts to these areas are not proposed.

BMA will consider the conservation outcomes in Koala referral guidelines (Department of the Environment, 2014) in finalising the offset management and monitoring strategies for this species.

Greater Glider

In the Central Queensland Threatened Species Habitat Descriptions (Kerswell A, Kaveney T, Evans C and Appleby L., 2020), preferred habitat for Greater Glider is defined as remnant connected eucalypt woodlands containing more than two hollow bearing trees/ha, with hollows medium-large in size (>10 cm entrance). 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.

Within the Project Site, preferred habitat for Greater Glider is located within the riparian zones of creeks, with the habitat supporting a known local population on Boomerang, Plumtree and Hughes Creeks. The preferred habitat along riparian zones within the Project Site Resources provide key denning (hollows) and foraging resources and has been shown to support a number of individuals. These areas of preferred habitat also provide important connectivity throughout and out of the Project Site, which facilitates movement of Greater Glider across the landscape. As for Koala, allowing for these connectivity values is important both for facilitating interactions of individuals in low density central Queensland populations, as well as providing corridors to avoid predators and seek refuge from adverse conditions. Preferred habitat for Greater Glider is mapped in Figure 21-36.

Given the presence of denning resources (hollows), connectivity of habitat and the existence of numerous records of the species, it is considered that the area of preferred habitat are the most sensitive and of most value to Greater Glider within the Project Site. This area also intersects with direct disturbance areas and areas of potential subsidence and a conservative approach has been taken in assuming any areas where the footprint intersects preferred habitat will be unavoidably impacted. Therefore, these impacts represent the significant residual impact that will be offset, up to the maximum potential impact extents provided in Table 21-70.

BMA will consider the conservation outcomes for the vulnerable Greater Glider (Department of the Environment, 2015) in finalising the offset management and monitoring strategies for this species.

21.13.2 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 residual impacts. The approach to offset development includes:

- quantify the area of disturbance and habitat quality analysis of potentially impacted biodiversity values
- identify offset options, including land-based, financial payment and co-location opportunities
- prepare Offset Management Plan.

These steps are further detailed below.

21.13.2.1 Quantify offset

The maximum predicted disturbance areas represent a conservative estimate of the likely actual losses.

Terrestrial habitat quality analysis of disturbance areas will involve site specific surveys to verify the baseline condition of the biodiversity values for the site and inform the start quality of impact area in the Offset Management Plan.

Habitat quality is assessed within assessment units 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.its capacity to support a prescribed environmental matter in line with the consistent framework for environmental offsets in Queensland.

Habitat quality analysis of disturbance areas will use the habitat quality scoring methodology as per the Queensland Government *Guide to determining terrestrial habitat quality* (Department of Environment and Heritage Protection [DEHP], 2017) to inform the Commonwealth offset habitat quality calculation requirements. This 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 offsets assessment guide habitat quality components and the Queensland guide are outlined in Table 21-71.

Table 21-71 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
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

21.13.2.2 Offset options

For significant residual impacts to MNES, offset is primarily provided through direct land-based offsets (actions that provide a measurable conservation gain for an impacted protected matter) (DSEWPaC, 2012) with contribution of other compensatory measures that do not directly offset the impacts on the protected matter, but are anticipated to lead to benefits for the impacted matter i.e. funding for research (DSEWPaC, 2012). Direct offsets must make up at least 90% of an offsets package.

The proposed offset approach may use a series of offset options available. The proposed approach by BMA involves the following offset options in order of preference:

1. Use of properties owned by BMA
2. Purchase other offset properties
3. Entering into agreements to secure offsets with third party landholders with land with the relevant characteristics

4. Use of offset payments to allow government bodies to secure the required offsets through negotiation and consultation with government bodies
5. Use of indirect offsets should the options above fulfil a proportion of the offset requirement.

Potential synergies exist between the EPBC Act EO Policy and offset policies administered by the Queensland Government. The EPBC Act EO Policy and Queensland 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 utilise offset areas which satisfy both MNES and MSES.

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 21.13.4.

21.13.2.3 Offset Management Plan

The Offset Management Plan will present results of the habitat quality assessments within the Project Site and the offset areas identified. The Offset Management Plan will:

- finalise the offset mechanism to be used for the Project
  - identify any BMA owned 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
- identify conservation outcomes and performance criteria
- identify ongoing management actions and risks
- identify monitoring and reporting.

Preferred offset proposals and suitability are described in Section 21.13.4. The Offset Management Plan will also include details such as the duration of active management, reporting, monitoring and measures to achieve condition improvement requirements.

The Offset Management Plan will be periodically reviewed for consistency against the EPBC Act EO Policy (2012). Annual reporting may be required to be undertaken to assess the progress of the offset area against biodiversity objectives. The Offset Management Plan will be audited every five years.

Conservation outcomes

The overall desired conservation outcome for the proposed offset area is to reduce threatening processes and increase the habitat quality of the area to a level that provides greater conservation value than the current impact site. More specifically, the desired conservation outcome for ecological communities is to protect and restore current regrowth areas to remnant condition and maintain low level of weed invasion. For threatened fauna offsets, the conservation outcome is to increase the habitat quality of the area and reduce threats to the species.

To ensure conservation values are met, performance criteria will be established for ecological condition, weeds and pests within each offset area. Multiple ecological condition indicators will be measured to achieve minimum scores to demonstrate an increase ecological condition of the offset area. After 20 years of management, 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 – at a minimum:

- The offset site must reach a minimum final condition equal to that of the impact site.
- The final condition score of the offset site will 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.

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 Offset Management Plan and the offset will be protected in perpetuity. be maintained for the life of the approval.

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. A controlled grazing regime will be introduced as part of the Offset Management Plan 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 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 and relevant threat abatement plans. Specific species management measures will be outlined in the Offset Management Plan once an offset site is selected. These management actions will be further developed in the Offset Management Plan:

- access controls
- fencing to restrict informal access
- controlled grazing
- weed suppression and control
- pest control
- management of fire risk
- revegetation and supplementary planting (for areas of non-remnant vegetation).

The responsibility of the offset sites will ultimately be with BHP 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 21-72. A risk assessment update will be carried out during the development of the Offset Management Plan.

Table 21-72 Potential offset availability for maximum predicted significant residual impacts to MNES

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, 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

Monitoring and reporting

The Offset Management Plan will detail the performance targets and completion criteria for improving vegetation condition, and therefore MNES habitat quality, within the offset site, to demonstrate 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 the landowner)
- BioCondition at the commencement (baseline), and then every five years for the remaining 20 years (to be undertaken by a suitably qualified person appointed by the landowner)
- Feral animal and weed monitoring conducted concurrently with BioCondition (to be undertaken by a suitably qualified person appointed by the landowner)
- 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.

Offset Management Plan structure

A proposed Offset Management Plan will include the following:

- A description of the offset area/s, including location, size, condition, environmental values present and surrounding land uses.
- Details of how the offset area/s will provide connectivity with other habitats and biodiversity corridors and/or will contribute to a larger strategic offset for the relevant listed threatened species and communities.
- Maps and shapefiles to clearly define the location and boundaries of the offset area/s, accompanied by the offset attributes (e.g. physical address of the offset area/s, coordinates of the boundary points in decimal degrees, the listed threatened species and communities that the environmental offset/s compensates for, and the size of the environmental offset/s in hectares).
- Specific offset completion criteria derived from the site habitat quality to demonstrate the improvement in the quality of habitat in the offset area/s over a 20 year period.
- Details of the management actions, and timeframes for implementation, to be carried out to meet the offset completion criteria.
- Interim milestones that set targets at 5-yearly intervals for progress towards achieving the offset completion criteria
- Details of the nature, timing and frequency of monitoring to inform progress against achieving the 5-yearly interim milestones (the frequency of monitoring must be sufficient to track progress towards each set of milestones, and sufficient to determine whether the offset area/s are likely to achieve those milestones in adequate time to implement all necessary corrective actions).
- Proposed timing for the submission of monitoring reports which provide evidence demonstrating whether the interim milestones have been achieved.

- Timing for the implementation of corrective actions if monitoring activities indicate the interim milestones have not been achieved.
- Risk analysis and a risk management and mitigation strategy for all risks to the successful implementation of the Offset Management Plan and timely achievement of the offset completion criteria, including a rating of all initial and post-mitigation residual risks in accordance with a risk assessment matrix.
- Evidence of how the management actions and corrective actions take into account relevant approved conservation advices and are consistent with relevant recovery plans and threat abatement plans.
- Details of the legal mechanism for legally securing the proposed offset area/s, such that legal security remains in force over the offset area/s for at least 20 years to provide enduring protection for the offset area/s against development incompatible with conservation.

21.13.3 Offset delivery

BMA is seeking approval for up to 100 per cent disturbance of significantly impacted MNES within the Project Footprint as a worst case due to uncertainty surrounding final significant residual impacts associated with subsidence from long-wall mining. It is highly unlikely that the Project will result in this extent of impact. As such offsets will be provided in stages.

The staged Project offsets will be provided in advance of each stage. Site specific ground-truthing surveys will be undertaken following clearance to determine the actual level of disturbance and significant residual impact. Monitoring of subsided areas will be conducted on a periodic basis to determine and quantify impacts.

An indicative timeframe for various subsidence-related impacts is presented in Table 21-73. Any discrepancy between projected and actual significant residual impact will be reconciled when the offset requirement is calculated for the next stage of the Project. Any surplus offsets will be accounted for and carried over to the next stage offset requirement. If a surplus in offsets is identified at the end of the Project, this will be reconciled and may be utilised as an advanced offset for future BHP projects.

Table 21-73 Potential time frames for various impacts on vegetation

Time	Component of longwall mine subsidence	Potential impacts to vegetation
1 month	Roof collapse	Sprouting and tree mortality e.g. forest gap formation and loss of individual trees from slumping and cracking.
1 year	Panel extraction	Phenology e.g. floristic and structural changes in forest canopy.
10 years	Panel succession	Seral stage e.g. longer-term impacts such as water ponding, potentially leading to an altered progression of woodland community composition and structure.
20 years	Mine completion	Primary-secondary succession e.g. multi-decade change in vegetation community boundaries, as a result of the above impacts and ongoing decommissioning and rehabilitation works.

Indicative forward milestone dates

Subject to the outcome of overall Project planning activities and owners approval for Project construction commencement, the following indicative milestone dates (Table 21-74) form the basis for the planning of offset related works to be undertaken in the post EIS pre-construction phases of the Project.

Table 21-74 Indicative milestone dates

Milestone description	Indicative milestone
Saraji East Mining Lease Project EPBC Act Approval and Environmental Authority approval. Expected conditions to require submission of an Offset Management Plan for the Project with details on Stage 1 offset properties prior to commencement of construction	Project Year 1
Identify suitable candidate offset properties, gain access for investigations to enable ecological assessment documentation plus negotiations to secure use rights over relevant properties.	Project Year 1 to 2
Submit Offset Management Plans for approval for Stage 1 properties based on actual properties that are proposed to be used.	At least 12 months before construction
Target for approval of Offset Management Plans	At least 6 months before construction

21.13.4 Offset availability

All offsets delivered by BMA will be compliant with the EPBC Act. BMA has progressed a preliminary assessment of offset availability within the Brigalow Belt Bioregion for the maximum predicted significant residual impact. Habitat quality analysis surveys for Project impacts will be undertaken following the finalisation of the EIS and detailed design to confirm offset requirements.

21.13.4.1 Offset availability identification methodology

BMA has identified potential offset areas containing degraded vegetation and habitat values with substantial riparian areas within 1 km of permanent water to enable the offset for MNES and MSES to be stacked.

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 offset criteria listed in applicable offset guidelines.

Potential offset areas will be preferentially located within the Brigalow Belt North Bioregion and same broad vegetation group (BVG) status, excluding mining and protected area tenure.

Potential offset areas were 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 to be resolved in finalising the Offset Management Plan:

- identified 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.

21.13.4.2 Offset availability within the region

Potential offset availability for impacts to MSES and MNES including Regulated Vegetation, TECs and listed threatened species habitat within the Brigalow Belt Bioregion is presented in Table 21-75.

BMA has identified five properties (identified as A, B, C, D and E) comprising freehold, leasehold or trust land offering offset potential exceeding the estimated offset requirement for the significant residual impacts of the proposed maximum disturbance from the Project. Of these properties, four occur within Brigalow Belt North Bioregion and one falls in the Brigalow Belt South Bioregion. These properties demonstrate that a substantial extent of potentially suitable offset area is available in the region that can be used to acquit significant residual impacts associated with the Project.

Information presented in Table 21-75 is 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.

Table 21-75 Potential offset availability for maximum predicted significant residual impacts to MNES

MNES	Status/BVG	Max offset required (ha)	Potential offset area availability by property (ha)					
			A	B	C	D	E	Total
Brigalow TEC	Endangered, 25a	984	2,658	0	721	1,489	5,458	**10,326**
Ornamental Snake	Vulnerable, 25a	3,703	2,658	-	721	523	8,786	**12,688**
Koala	Vulnerable, 16a and 17a	654	9,780	14,698	7,885	6,661	11,451	**50,475**
Greater Glider	Vulnerable, 16a and 17a	313	713	2,276	4,487	3,898	9,808	**21,182**
Squatter pigeon (southern)	Vulnerable, 16a, 17a, 25a	314	10,031	17,499	4,788	7,831	12,059	**52,208**

21.13.4.3 Offset site prioritisation

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 the above potential offset analysis show that large areas of potentially suitable vegetation occur.

21.14 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 21.6.1, impacts from underground mining were considered as cumulative impacts with the Saraji Mine 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 DSDMIP 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
- 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 21-3.

21.14.1 Water resources

21.14.1.1 Surface water

As the Project will be largely self-sufficient, the Project's impacts from the Project's water use 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 Saraji Mine, 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 mine water system will operate independently of the existing Saraji Mine water system. However, should sufficient MAW not be available for CHPP process and dust suppression at the Project, this may be imported from the existing Saraji Mine 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 Saraji Mine need to be met, water that satisfies water quality testing may be exported from the Project.

Like other mining operations in the Isaac River catchment such as Red Hill Mining Lease Project, mitigation measures (Section 21.10) 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 have the potential to contribute to sediment loads and turbidity. The impacts on the surface water environment associated with the Project and other mining projects will be incremental to the existing impacts from other existing land uses in the catchments indicated by the elevated concentrations of nutrients found in surface water of the catchment. Based on this assessment, the significance of the overall cumulative impact on surface water will be minor.

21.14.1.2 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. There are no local springs or groundwater dependent ecosystems.

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 (21.9.1.2), prediction of groundwater ingress and an evaluation of groundwater level recovery was conducted with and without the Project.

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 Saraji Mine 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 Saraji Mine 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 18 groundwater bores located within the underground mining drawdown thresholds, none of which will require 'make-good' agreements. Cumulative groundwater impacts of the Project are not anticipated to be significant due to:

- GDE evaluation indicated limited potential within the Project area
- drawdown will occur predominantly within the Permian coal seams, which are separated from surficial groundwater regimes by aquitards and are not expected to impact surface ecosystems
- the largest predicted drawdown extends within the target coal seam, which is understood not to discharge into the down gradient Isaac River; in addition, the drawdown cones do not extend to the Isaac River to the east (also noting that there is a fault between the project and the Isaac River, Figure 21-26).

No subsequent impacts to MNES from groundwater impacts across projects are predicted. 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.

21.14.2 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 may impact approximately 1,290.93 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 21-14. Combined with other projects, potential cumulative impacts to TEC and threatened species are outlined in Table 21-76.

Table 21-76 Habitat clearance from the Project and within the Bioregion

Resource Projects	MNES								
	Brigalow TEC	Grasslands TEC	Bluegrass	King Bluegrass	Squatter Pigeon	Ornamental Snake	Koala	Australian Painted Snipe	Greater Glider
Saraji East Mining Lease Project	246	265	0						806
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	-	-	-	-
Total cumulative impacts	**1,261**	**303**	**189**	**189**	**9,102**	**2,566**	**11,363**	**840**	**6,306**

Clearing proposed for the Project is a small contribution to the cumulative impacts for Brigalow TEC. Additionally, Project impacts on suitable habitat for threatened and endangered species were identified within the minor presential given the surrounding RE 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 has been rearranged during the planning stage to mitigate direct impacts from removal of vegetation during construction disturbance, where possible. Following progressive rehabilitation, land-based offsets will be established and managed to compensate for Project impacts on MNES.

While fragmented and degraded habitat is not necessarily well adapted to climate change and increasing extreme climate events, BMA is well resourced and committed to progressive rehabilitation and land-based offsets that will reinstate vegetation communities and habitats that contribute to ecosystem function and actively reduce threats to biodiversity

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 21.10, the cumulative impacts to MNES across the region is minor.

21.15 Summary and conclusion

21.15.1 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.

21.15.1.1 Surface water

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 pond water until they fill and spill. Subsidence may have local attenuation effects on low flows through temporary storage in panels, however since the subsidence is confined to relatively small sections of the major streams, the impact to downstream flows is negligible. Residual pools in the system may present a positive environmental impact as most ephemeral wetlands or in-channel pooling has been lost to erosion and deposition.

21.15.1.2 Groundwater

Residual impacts are anticipated in the short to medium term, over the life of mine and longer term (e.g. subsidence). Residual impacts relate to underground mining impacts on geology, groundwater levels and surface topography (subsidence) are relative to the duration of mining and dewatering. Beyond closure, groundwater will continue to flow into the Saraji Mines final voids until a pseudo-steady state pit water level is achieved. During this period the loss of water from the alluvium/Tertiary and Permian aquifers are not expected to have a significant impact on beneficial use or natural ecosystem values.

21.15.2 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. These are:

- Brigalow TEC
- Ornamental Snake (*Denisonia maculata*)
- Squatter Pigeon (Southern Subspecies) (*Geophaps scripta scripta*)
- Koala (Phascolarctos cinereus)
- Greater Glider (*Petauroides volans*).

Some potential habitat for one TEC and four other conservation significant species is also expected to be impacted; however significant impacts to these communities and species are not anticipated. These are:

- Natural Grassland TEC
- Bluegrass
- King Bluegrass

- Australian Painted Snipe (*Rostratula australis*).

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 these species:

- Ornamental Snake (*Denisonia maculata*)
- Koala (Phascolarctos cinereus)
- Squatter Pigeon (Southern) (*Geophaps scripta scripta*)
- Australian Painted Snipe (*Rostratula australis*)
- Greater Glider (*Petauroides volans*).

While mitigation and management measures for direct and indirect impacts focus on maximising retention of MNES values across the Project footprint, significant residual 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 residual impact. An Offset Strategy has been prepared for the Project as part of the EIS (attached as 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.