



**STAGE 3 ECOLOGICAL
ASSESSMENT REPORT
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Ensham Residual Void Project

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FINAL

March 2019



STAGE 3 ECOLOGICAL ASSESSMENT REPORT

Ensham Residual Void Project

FINAL

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on behalf of
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Executive Summary



Background

The Ensham Mine is an open cut and underground, bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald along the Nogoa River in Central Queensland. The mine commenced production in 1993 and operates under existing mining leases (MLs) and a single Environmental Authority (EA).

Condition G16 of the EA requires that Ensham complete and submit a Residual Void Project (RVP) to identify appropriate outcomes for the mine voids, to the administering authority by 31 March 2019. Ensham prepared a Terms of Reference (ToR) for the RVP, which was approved by the administering authority on 21 July 2017. The ToR allows Ensham to develop the RVP over five stages.

This report has been prepared to address Stage 3 of the RVP and involves the assessment of ecological Environmental Values with potential to be affected by the RVP. This assessment has been undertaken of the ecological Environmental Values that occur both on the Project area (consisting of ML7459, ML7460, ML70049, ML70326, ML70365, ML70366 and ML70367) and within the locality of the Project area (the area within 5 km of the Project area).

This report presents the current ecological condition of the Project area (based on a desktop assessment), and provides an impact assessment and identifies remaining gaps to be addressed in the Ecological Impact Assessment (EIA) once the preferred option selection has been made. This assessment is based upon the requirement to assess post relinquishment impacts only.

Summary of Stage 3 Preferred Options

The preferred options addressed within this report consist of:

- **Preferred Option 1:**
Landform Levee (Option 1: LL) - This option will convert the current engineered levees into permanent landforms, augmenting the existing earthworks to exclude the residual voids from the floodplain.
- **Preferred Option 2:**
Flood Mitigation and Beneficial Use (Option 2: FMBU) - This option will capture a small fraction of flood event flows from the Nogoa River, and store this water in the residual voids. It will be released to the Weemah Channel in a controlled manner for irrigation purposes.

- **Preferred Option 3:**

Backfill to Probable Maximum Flood (PMF) Level (Option 3: BTP) - This option will backfill residual mining voids within the extent of the PMF to the approximate pre-mining elevations/surface levels.

A treed corridor is proposed by Ensham to be planted along the highwalls associated with each option adjacent to Pit A and Pit B between Corkscrew Creek to the Nogoa River. This treed corridor is intended to prevent vehicles driving over residual high walls once an option has been selected and constructed with the added benefit of providing a new linkage between remnant vegetation associated with both Corkscrew Creek and the Nogoa River.

Summary of Baseline Ecological Conditions

The following broad terrestrial habitats were identified from the Regional Ecosystem (RE) mapping prepared by DES (2017) (Version 10.1) for the Project area and locality included:

- Riparian wetlands consisting of 'Of Concern' RE 11.3.25(e) and 'Endangered' RE 11.3.3, as well as 'Endangered' RE 11.4.8.
- Woodland consisting of 'No Concern' RE 11.5.9, RE 11.7.2 and RE 11.7.4 and 'Of Concern' RE 11.7.1.
- Open Forest consisting of 'Endangered' RE 11.3.1.
- Disturbed Lands/Pasture/Cropping/Rehabilitation.

Aquatic habitats of the Project area and locality include the Nogoa River, which flows through the Project area from west to east. During peak flows, the main channel forms an Anabranch that subsequently becomes isolated from the main channel as conditions dry. The main channel and anabranch support riparian vegetation and aquatic habitats. Winton Creek, and an un-named creek entering the Nogoa River from the west, also support riparian vegetation and aquatic habitats.

The review undertaken in this report identified three flora species of conservation significance, namely *Cerbera dumicola*, *Dichanthium queenslandicum* and *Acacia spania* as having been recorded either on the Project area, or in habitats in proximity to the Project area and as such may also occur in the Project area. Of these species, Option 1 and Option 2 have potential to impact upon suitable habitat of *Dichanthium queenslandicum*.

The review process identified that terrestrial fauna species of conservation significance, including Curlew Sandpiper, Red Goshawk, Grey Falcon, Squatter Pigeon, Koala, Ornamental Snake, Yakka Skink, Grey Snake, Dunmall's Snake, Satin Flycatcher and Rufous Fantail as having potential to occur in the Project area. Several of these species are known to utilise habitats in close proximity to the RVP areas. In addition to the terrestrial species, a number of aquatic bird species including the Australian Painted Snipe and a variety of migratory bird species are known to occur or have potential to occur in this area.

No conservation significant aquatic flora or insect species were identified during the literature review process.

Two conservation significant turtle species are known to occur within the Nogoa River, namely the Fitzroy River Turtle and the Southern Snapping Turtle.

A number of weed and pest species are known to occur in the Project area.

Summary of Impact Assessment

The impacts arising from the preferred options are generally expected to occur within the existing disturbed/cleared mining areas. The following identifies potential impacts that may occur outside of the existing approved mine footprint:

- The landform levees proposed for Option 1, specifically the proposed regrading of the outer slopes of the levee walls will result in the levees being widened up to 40 metres (m). This Option will result in the clearing of non-regulated regrowth/previously disturbed vegetation and has limited potential for disturbance of threatened species habitat.
- Option 2: FMBU will involve construction of intake structures to capture water from the Nogoia River and the Anabranh and will impact approximately 3 ha of riparian vegetation (11.3.25e) associated with this river. The existing water pipeline, previously used to pump water between pits, may also require replacement where it crosses the Nogoia River, just west of the convergence of the Nogoia River and the Anabranh.
- Options 3: BTP is considered unlikely to result in the loss of any regional ecosystems or associated habitats outside the approved mine footprint.

Summary of Rankings of Impacts on Ecological Environmental Values of the Project area

An assessment of the potential impacts of each of the three preferred options on relevant environmental values (EVs) has been undertaken based on the outcomes of the studies presented in this report.

Table ES1.1 below provides a summary of the assessment using the adopted ranking criteria ranging from -3 (significant negative impact), 0 (no impact or benefit), to +3 (significant benefit).

Table ES1.1 Summary of Assessment Rankings for Impacts on Ecological Environmental Values Associated with Option 1, Option 2 and Option 3

Environmental Aspect	Environmental Value	Parameter	Option 1 LL	Option 2 FMBU	Option 3 BTP
			Option life - perpetuity	Option life	Option life - perpetuity
Water	Aquatic Ecosystems (Biodiversity & Habitat)	Downstream River Quality	0	0	0
		Aquatic GDE's (Stygofauna)	0	0	0
		Impact on run-off quality	0	0	0
Ecology (Flora and Fauna)	Terrestrial Ecosystems	Habitats/Wetlands/ Riparian Areas	+1	-1	+1
		Terrestrial Subterranean Fauna Habitat	0	0	0
Biosecurity	Ecosystem Vulnerability	Pests	0	0	0
		Weeds	0	0	0
		Over Abundant Native Species	0	0	0
	Bioaccumulation	Void Water Quality	-1	0	0

The impact on EV of 'Aquatic Ecosystems (Biodiversity & Habitat)' was assessed by considering downstream river quality, aquatic groundwater dependent ecosystems (stygofauna) and impact on run-off quality. All options were identified as scoring 0 on each of the parameters, as it is expected that there will be minimal downstream impacts on water quality, impacts on aquatic groundwater dependent ecosystems (stygofauna) or impacts on run-off quality based on study findings.

The impact on EV of 'Terrestrial Ecosystems' was assessed by considering impacts on Habitats/Wetlands/Riparian areas (consisting of an amalgamation of vegetation, threatened species habitat, essential habitat, wildlife corridor areas, wetlands/riparian areas) and terrestrial subterranean fauna habitat.

Analysis of impacts on habitats/ wetlands/riparian areas identified that:

- Option 1 resulted in a score of +1. This option is expected to have minimal impacts on REs, and the associated habitats they provide, however there is expected to be a minor ecological benefit through the creation of a treed corridor, which may provide a potential fauna linkage from Corkscrew Creek to the Nogoa River.
- Option 2 scored -1 as there will be approximately 3 ha of clearing associated with the construction of the intake structures and the potential requirement for the re-installation of the pipeline crossing the Nogoa River on RE 11.3.25e. While there would be a minor ecological benefit in the planting of a treed corridor linking Corkscrew Creek to the Nogoa River, this benefit is outweighed by the loss of remnant vegetation and associated potential habitats for the construction of the intake structures and pipeline.
- Option 3 scored +1 as this option is not expected to impact upon any habitats/ wetlands/riparian areas or subterranean fauna habitat, but a treed corridor will be planted providing a potential fauna linkage between Corkscrew Creek to the Nogoa River.

An analysis of impacts on terrestrial subterranean fauna habitat identified that all options were identified as scoring 0, as there are no impacts on identified terrestrial subterranean fauna within the Project area.

The impact on EV of 'Ecosystem Vulnerability' was assessed by considering impacts associated with pests, weeds and over abundant native species. All options were scored 0, as on-going management practices will be implemented, which will include weed, pest and overabundant native species management.

The impact on EV of 'Bioaccumulation' was assessed by consideration of the Stage 3 Water Quality Results prepared by Hydro Engineering & Consulting (HEC)(2018). Option 1 scored -1 as the resultant waters within the respective remaining voids will progressively deteriorate in quality, through evapo-concentration of both salts and metals/metalloids including Arsenic, Molybdenum and Selenium, and have the potential to bio-accumulate in sediments and aquatic life within the resulting void waters. It is anticipated that the resultant waters associated with Option 1 will gradually become inhospitable to aquatic invertebrate and fish species, thereby reducing the potential use of the residual water bodies to a wading resource only. There will be no bio-accumulation with respect to Options 2 and 3 as there will either be no void water remaining or the void water will be managed to eliminate the prospect of bio-accumulation.

Summary of Recommendations

It is recommended that targeted ecological surveys be undertaken in potential disturbance areas for the selected option should that option result in impact beyond the existing approved mine footprint (i.e. expansion of levee footprints for Option 1: LL or for the proposed intake structures and the potential re-installation of the existing water pipeline that crosses the Nogoa River for Option 2: FMBU).

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Appendix A	Assessment of Potential Occurrence of Conservation Significant Flora
Appendix B	Assessment of Potential Occurrence of Conservation Significant Fauna

1.0 Introduction

1.1 Background

Ensham Mine, an open cut and underground bord and pillar coal mine located approximately 35 kilometres (km) east of Emerald in Queensland (refer to **Figure 1.1**), is operated by Ensham Resources Pty Ltd (Ensham), a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd (Idemitsu), on behalf of the Ensham Mine Joint Venture (JV) Partners. The JV Partners and holders of the Environmental Authority (EA) are Bligh Coal Limited, Idemitsu and Bowen Investment (Australia) Pty Ltd. EA EPML00732813, dated 28 July 2017, is the relevant environmental authority under which Ensham operates the mine.

Condition G16 of the EA states that a Residual Void Project (RVP) must be completed and submitted to the administering authority for review and comment by 31 March 2019. The minimum content of the RVP is specified within Condition G16 of the EA as:

- a) Terms of Reference;
- b) Residual Void Study;
- c) Progress Reports; and
- d) Rehabilitation Success Criteria for Voids.

In compliance with Condition G19 of the EA, “the Residual Void Project (RVP) must be carried out in accordance with the approved Terms of Reference”. Terms of Reference (ToR) (Ensham Resources, 2017a) were approved by Queensland’s Department of Environment and Science (DES, formerly the Department of Environment and Heritage Protection, DEHP) on 21 July 2017.

Condition G20 of the EA identifies the minimum content of the RVP identified in Condition G16.

In accordance with the ToR, the RVP has been divided into five stages:

- Stage 1 – Project Definition and Options Identification;
- Stage 2 – Preferred Options Technical Studies;
- Stage 3 – Preferred Options Detailed Design;
- Stage 4 – Most Preferred Option Identification; and
- Stage 5 – Regulatory Documentation.

Stage 1 – Project Definition and Options Identification for the RVP has been completed. The Stage 1 Options Assessment Report has been finalised and issued to DES, the Department of Natural Resources, Mines and Energy (DNRME) and the Community Reference Group (CRG). The report was independently peer reviewed and revised to address peer review comments. The final report has been delivered to DES, DNRME and the CRG.

The Options Analysis workshop held in Stage 1 of the RVP identified two options:

- Option 1: Landform Levee; and
- Option 2: Flood Mitigation and Beneficial Use.

DES required a third option, Backfill to Probable Maximum Flood level, be included in the study.

All three options have been advanced through Stage 2 and into Stage 3 of the RVP and are referred to as the 'preferred options'. The preferred options as provided by Ensham are discussed in **Section 3.1 to Section 3.3** of this report.

Stage 2 identified the Environmental Values (EVs) in the immediate and surrounding area of Ensham Coal Mine and determined which EVs are likely to be affected by each preferred option. Similar to Stage 1, the Stage 2 EV report and technical studies have been Independently Peer Reviewed and issued in final to DES, DNRME and the CRG.

Stage 3 builds on the technical studies completed in Stage 2 to develop feasibility level designs required to prevent or minimise the potential impacts to EVs for each preferred option. Detailed designs for each of the preferred options will inform a risk assessment of each option and includes as a minimum:

- The long-term stability of the final landform;
- Safety of access to the site; and
- The short, medium and long-term risks associated with each preferred option.

The output of Stage 3, in addition to the associated technical reports, will be an Environmental Assessment report for each preferred option, which identifies the design and management practices, which will be implemented to minimise impacts on the identified EVs.

On completion, each preferred option report will be peer reviewed by an independent suitably qualified third party before submission to the administering authority for review and comment.

1.2 Purpose of this Report

The purpose of this report is to present the findings of the Stage 3 Ecological Assessment undertaken to evaluate the ecological EVs on and adjacent to the Project area and the potential for impacts associated with each of the three Preferred Options identified from Stage 1 of the RVP on those EVs. This report identifies benefits / impacts where applicable for each option and informs the overall Environmental Impact Assessment, the Economic Impact Assessment and the Social Impact Assessment reports.

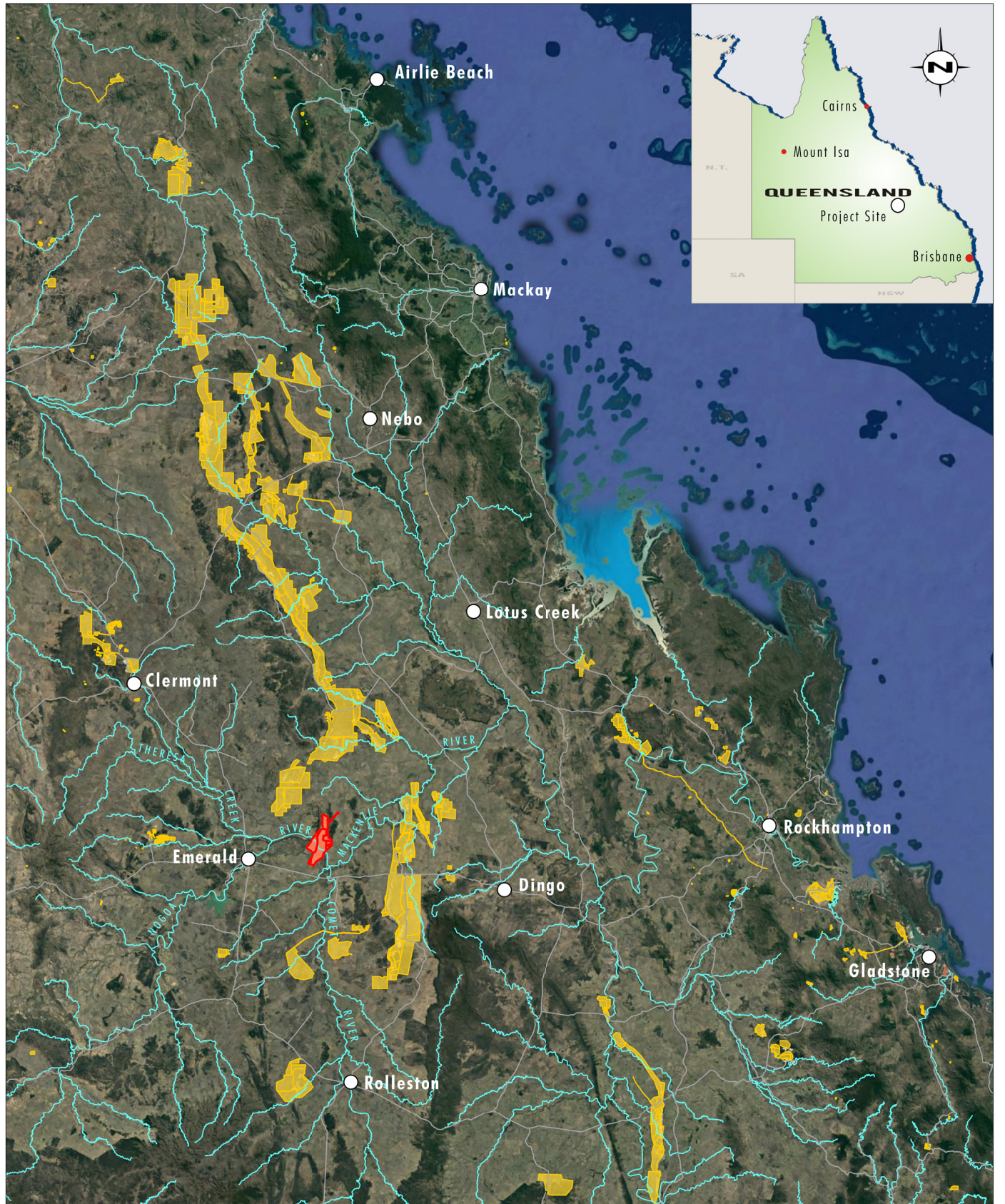


Image Source: Google Earth
Data Source: Queensland Government (2018)

0 25 50 100 km
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Legend

- Project Area
- Mining Tenements
- Drainage Lines
- Roads

FIGURE 1.1

Location of
Ensham Mine

1.3 Scope

This ecological assessment included the following key tasks:

- Review of relevant Commonwealth, state and local government environmental legislation and policies;
- Identification of any additional field surveys required;
- Identification of EVs potentially affected by the RVP Project; and
- Assessment of the impacts of each option on the identified EVs.

The RVP ToR specifies the environmental assessment to be undertaken for each of the three Preferred Options where applicable. The ToR provides the scope and level of detail to be considered as part of Stage 3 for each Preferred Option. Broadly, this component of the environmental assessment addresses the considerations that must form part of Stage 3 for each Preferred Option relevant to the Project area, as per the ToR.

An outline of the scope prescribed in the ToR is as follows:

- Site description;
- Description of the EVs as identified in the EV workshop report;
- A review of available baseline information relevant to the EVs and the Preferred Options;
- Assess the impacts on the EVs including:
 - Short-term and long-term impacts;
 - The scale, intensity, duration, irreversibility and the risk of harm;
 - Cumulative impacts;
- Management and mitigation measures; and
- The ability of the Preferred Options to meet acceptable environmental objectives and regulatory requirements.

The EVs investigated within this report, with respect to the RVP options, consist of the following:

- Land (terrestrial and aquatic flora and fauna habitats);
- Wetlands;
- Groundwater (Groundwater Dependent Ecosystems and subterranean fauna); and
- Surface Water (riparian or aquatic habitats).

1.4 Definitions

The following terms are used throughout this report:

- **Baseline Ecological Conditions** – the ecological values of the mine site as they appear at the time of this report (operations as approved under the current EA);
- **Project area** – comprises the Ensham Mining Leases (ML) ML7459, ML7460, ML70049, ML70326, ML70365, ML70366 and ML70367 (as shown in **Figure 2.1**);
- **MNES** – Matters of National Environmental Significance, which are matters protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) including listed threatened species and ecological communities and migratory species protected under international agreements;
- **MSES** – Matter of State Environmental Significance, which includes environmental values that are protected under relevant Queensland legislation including:
 - *Nature Conservation Act 1992* (NC Act);
 - *Marine Parks Act 2004*;
 - *Fisheries Act 1994*;
 - *Environmental Protection Act 1994* (EP Act);
 - *Regional Interests Planning Act 2014*;
 - *Vegetation Management Act 1999* (VM Act); and
 - *Environmental Offsets Act 2014*.
- **Locality** – An area within 5 km of the Project area; and
- **Study Area** – An area within a 50 km radius of the centroid of the Project area, which has been used for database searches to identify the potential presence of threatened species.

1.5 Format of Report

An overview of the layout of this report is presented below:

Executive Summary

Section 1.0 **Introduction**

Section 2.0 **Site Description**

Section 3.0 **Preferred Options**

Section 4.0 **Methodology**

Section 5.0 **Legislative Review Results**

Section 6.0 **Summary of Other Relevant Stage 3 Technical Findings**

Section 7.0	Ecological Baseline Results
Section 8.0	Biosecurity
Section 9.0	Gap Analysis
Section 10.0	Impact Assessment and Proposed Management and Mitigation Measures
Section 11.0	Summary of Impacts on Environmental Values
Section 12.0	Conclusions and Recommendations

2.0 Site Description

2.1 Ensham Mine

The Ensham Mine is an open cut and underground coal mine located 40 km east of Emerald along the Nogoa River in Central Queensland. It is a large scale operation currently producing up to 5.2 Million tonnes per annum (Mtpa) from dragline/truck/shovel operations in the northern pits and underground bord and pillar operations.

The EA covers seven mining leases (ML7459, ML7460, ML70049, ML70326, ML70365, ML70366 and ML70367) (see **Figure 2.1**). A summary of the ownership and sizes of the mining leases is provided in **Table 2.1** below (Ensham Resources, 2017).

Table 2.1 Ensham Mine Tenements

Mining Tenement	Area (ha)	Lot on Plan	Owner
ML7459	6,154.00	Lot 31 CP864573 Lot 32 RP908643 Lot 30 CP864574 Lot 33 RP864576	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
ML7460	774.34	Lot 31 CP911009 Lot 32 RP908643	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
ML70049	1,648.00	Lot 3 CP911009 Lot 2 SP254309	• MD, ME, EM, JD & SM Shaw • RH & RJ Simmons
ML70326	25.66	Lot 31 CP864573	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
ML70365	2,763.00	Lot 31 CP864573 Lot 32 RP908643	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
ML70366	254.20	Lot 30 CP864574	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
ML70367	1,003.00	Lot 31 CP864573 Lot 32 RP908643	• Bligh Coal Ltd (47.5%) • Idemitsu Australia Resources Pty Ltd (37.5%) • Bowen Investment (Australia) Pty Ltd (15%)
Total	12,622.20		

The Project area is located within freehold land owned by Ensham and on private land owned by the Shaw and Simmons (ML70049) families. The mine is serviced by administration and workshop facilities, an on-site workforce accommodation camp and includes a coal processing plant; rail loop and train loading facility (refer to **Figure 2.1**).

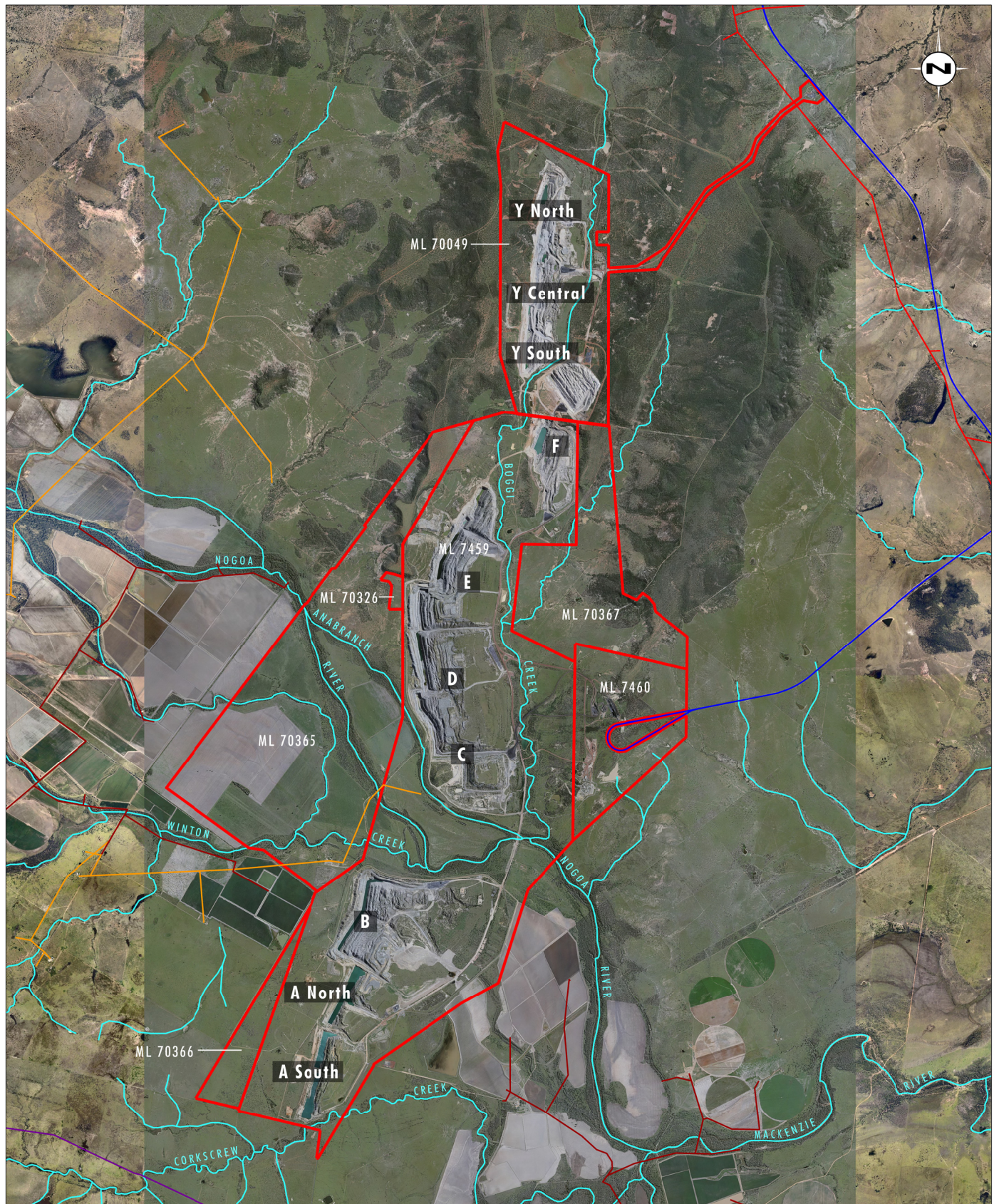


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017), Queensland Government (2018)

0 2.0 4.0 6.0 km
1:125 000

Legend

- ▬ Project Area
- ▬ Drainage Lines
- ▬ Rail line
- ▬ 12kV Transmission Line
- ▬ 19kV Transmission Line
- ▬ 22kV Transmission Line
- ▬ 66kV Transmission Line

FIGURE 2.1

Ensham Mine
Project Area

Ensham open-cut mine consists of 7 pits; A Pit to F Pit and Y Pit (Yongala pit). A Pit and B Pit lie south of the Nogoa River with A Pit divided into A Pit South and A Pit North and B Pit lying partly in the Nogoa floodplain, protected by 1 in 1,000 year Average Recurrence Interval (ARI) levees (**Figure 2.1**). C Pit to Y Pit lie to the north of the river, with C Pit and D Pit occupying part of the floodplain and are also protected by 1 in 1,000 year ARI levees. Y Pit is divided into three separate pits, Y Pit Southern, Y Pit Central and Y Pit Northern. In all, the complex comprises 10 pits although the floors of individual pits are not always contiguous and water may currently collect in one part and not another of the same pit.

2.2 Project Setting

The Ensham Mine lies within the Brigalow Belt North bioregion, which has a semi-arid to tropical climate with predominantly summer rainfall. The land types in this bioregion include undulating to rugged ranges and alluvial plains. The mine lies within the Fitzroy Basin which is the second largest seaward draining Basin in Australia. The Basin includes 11 catchments and an extensive river system that flow to the Fitzroy River and estuaries and eventually to the Great Barrier Reef.

The topography of the Project area is generally flat to gently undulating and includes the Nogoa River and its floodplain. The Nogoa River is naturally ephemeral but generally has constant low flows due to regulated water supply releases from Fairbairn Dam. Fairbairn Dam is located approximately 60 km upstream of the Project area. Within the Project area, the river has a secondary anabranch channel that flows intermittently during high flows to the main channel. Winton Creek traverses the mining area from the west and joins the Nogoa River near the eastern limit of the open cut area.

2.2.1 Geology

The surface geology of the Project area is described using the Emerald and Duaringa sheets of the Australia 1:250,000 Geological Series (Veevers *et al.*, 1964, Malone *et al.*, 1965).

The Nogoa floodplain, in which A, B and C Pits are located, is part of the Quaternary Alluvium and is bounded to the south-west by an area of extensive soil cover. The Tertiary geology in the northern sections of the Project area is comprised of claystone, sandstone, siltstone, pebbly sandstone and gravel. In the most northern part of the Project area, this geology has formed plateaus and dissected Tertiary sediments. Claystone, sandstone, siltstone, pebbly sandstone and gravels occur in all Ensham Pits.

In the north-west of the Project area, extensive areas of soil, sand and gravel from an undifferentiated time between the Quaternary and Tertiary, are interspersed with claystone, sandstone, siltstone, pebbly sandstone and gravel. Pit B, Pit C, Pit F and Pit Y are located in this geology. A small extension of the Upper Permian Fair Hill Formation consisting of lithic and feldspathic sandstone, conglomerate tuff, tuffaceous sandstone and mudstone is situated in central eastern sections of the Project area. This geology occurs in all pits as it is overlying the coal measure (La Tierra, 2017). A larger surface extent of this formation can be found to the east of the Project area.

The average thickness of the Quaternary layer occurring in the central mining areas is 14 m, ranging from 1 to 25 m. The economic coal in the Project area occurs in the Aries and Castor seams of the Rangal Coal Measures, which was formed in the Upper Permian (Hansen Consulting, 2006).

2.2.2 Groundwater

Groundwater occurs throughout Queensland in Mesozoic sedimentary basins and overlying Cainozoic deposits. Broad types of geologies that are sources of groundwater include unconsolidated sedimentary material (Quaternary alluvial and colluvial deposits, Quaternary sand deposits), consolidated sedimentary rocks (sandstone), fractured rocks (Cainozoic igneous rocks) and cavernous rocks (karst caves) (Harrington and Cook, 2014).

The groundwater occurrence in the alluvium at Ensham is highly variable, with thin saturated zones of poor quality water in deeper sections of an otherwise largely unsaturated formation (AGE, 2006). Water level data show the seasonal variability in groundwater to be limited and coincident with the heterogeneous distribution of these sediments (AGE, 2006). Generally, the groundwater in the alluvium was more saline than in the coal seam aquifers with groundwater tests results exceeding 5000 $\mu\text{S}/\text{cm}$ (AGE, 2006). Shallow silts and clays in the Nogoa River appear to isolate the river, limiting leakage from the river into the basal sands and gravels. It is possible that leakage may occur where these clays are absent or where the basal sands are exposed within the river. However, this is conceptually thought to occur only in localised areas. This hydraulic separation of the alluvium from the Nogoa River means that whilst the water in the river is fresh, the underlying alluvium can be brackish to highly saline (HS, 2018).

The alluvium can therefore be considered as a largely unconfined system which is recharged by rainfall and upward leakage from the underlying Rewan Group or Rangal Coal Measures. The alluvium may also receive localised base flow recharge from the Nogoa River, in areas where clay and silt layers are absent (HS, 2018).

2.2.3 Surface Water

The major watercourses within the current receiving environment of the Study Area include Boggy Creek, Corkscrew Creek, Winton Creek, the Nogoa River (and Anabranh), and the Mackenzie River.

The Nogoa River flows through the Project area from northwest to southeast (refer to **Figure 2.1**). During peak flow, the main channel forms an Anabranh that subsequently becomes isolated as conditions dry. The main channel and anabranh support riparian vegetation and aquatic habitats. Winton Creek and an unnamed creek, entering the Nogoa River from the west, also support riparian vegetation and aquatic habitats.

Boggy Creek has been previously modified to permanently divert flows around the Ensham Mine voids. Boggy Creek skirts the eastern edge of the Y North and Y Central Pits then crossing between Y Central and Y South Pits then flowing south along the eastern edges of Pit E, Pit D and Pit C, before discharging into the Nogoa River to the south of the Ensham Mine. Boggy Creek is considered to be ephemeral; however several waterholes persist throughout much of the year. The portions of the Nogoa and Mackenzie River as shown in **Figure 2.1** are considered perennial, largely as a result of regulated releases from Fairbairn Dam, though contain little flow during the dry season. Fairbairn Dam is located approximately 60 km upstream of the Project area.

2.2.4 Land Use

The Project area is surrounded by agricultural properties, which include non-irrigated and irrigated cropping on the floodplain of the Nogoa River, and stock grazing on areas beyond the floodplain. The neighbouring agricultural properties contain a number of isolated rural residences (Hansen Consulting, 2006).

The Project area occurs on a historically cleared landscape. Of the 3,500 hectares (ha) of the Project area identified for the original Ensham Mine EIS (prepared by Hollingsworth, Dames and Moore, 1990), it was calculated that 90% of the Project area had already been cleared for either cropping or grazing activities prior to mining commencing. **Figure 2.2** shows a 1984 aerial photograph with the current mining leases shown in red outline. Large parts of the floodplain appear to have been cleared for cropping, while disturbance of the higher elevation of the Project area indicate clearing resulting from other agricultural activities.

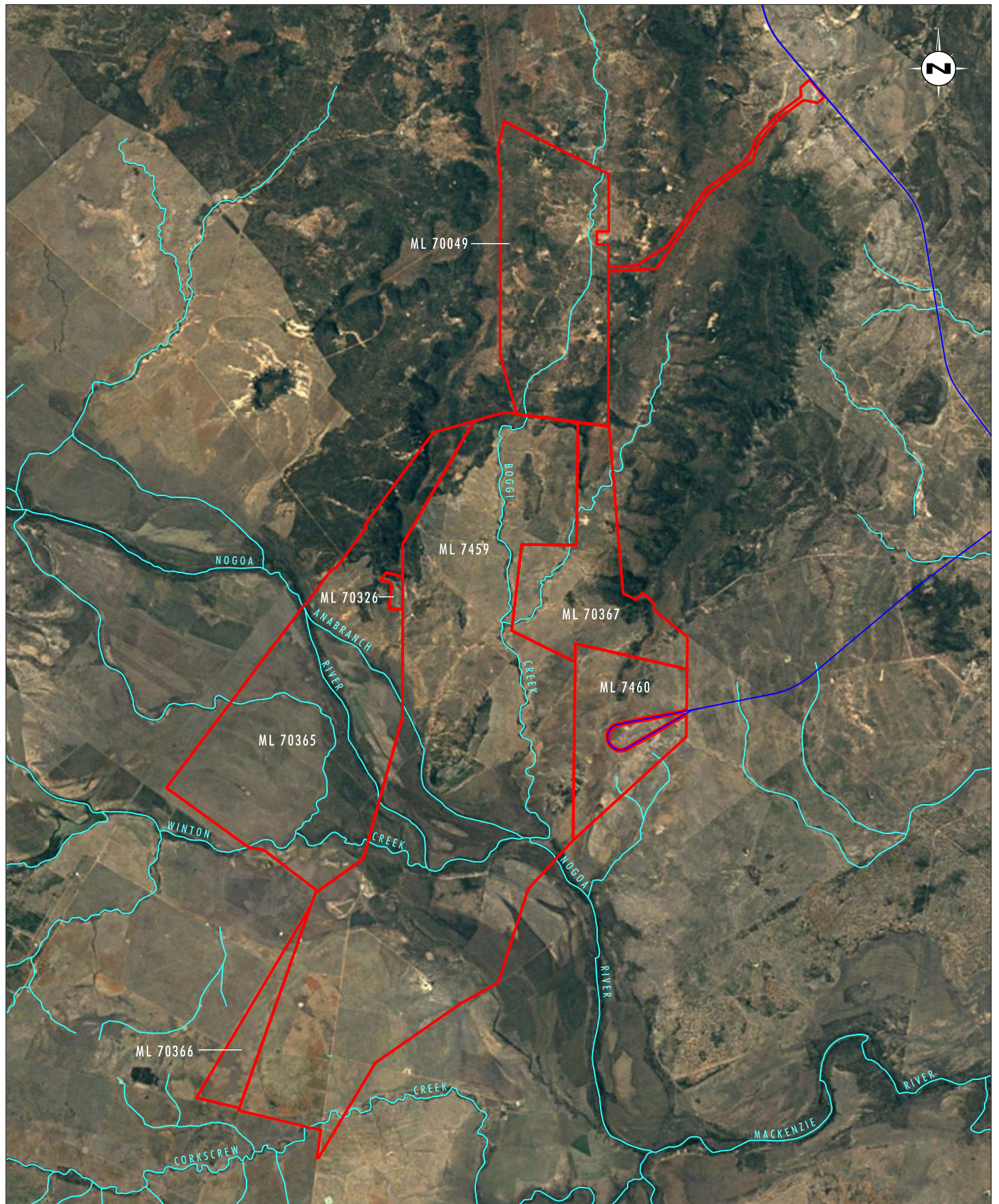


Image Source: Google Earth (1984)
Data Source: Ensham (Apr 2017), Queensland Government (2018)

0 2.0 4.0 6.0 km
1:125 000

Legend

- Project Area
- Drainage Lines
- Rail Line

FIGURE 2.2

1984 Aerial Photograph
of the Project Area

3.0 Preferred Options

3.1 Option 1 - Landform Levee 1 Description

Having conceptually evolved since Stage 1, the proposed Option 1: LL will develop permanent landforms along the existing levee alignment to provide flood immunity for the 0.1% (1 in 1,000) Annual Exceedance Probability (AEP) flood event having had consideration of the risk of a Probable Maximum Flood (PMF) level event (as proposed in the Stage 2 assessment). **Figure 3.1** illustrates the current placement of the landform.

When compared to the landform levee designed at a PMF level (as considered in Stage 2) the proposed 0.1% AEP landform along the existing levee alignment:

- Eliminates afflux impacts for upstream landholders in a greater than 0.1% AEP event.
- Eliminates any potential increased impacts on downstream landholders associated with widening the river floodplain.
- Eliminates the need to realign the Nogoia anabranch.

It is proposed to incorporate the existing levees into the landform design with overburden emplacement areas behind the levee being reshaped in a manner that achieves the minimum stable landform slope requirements.

In addition to any impacts associated with the existing farm levees and mining pit levees, flood levels in the vicinity of Ensham Mine are significantly affected by the confluence of flood flows from the Comet River and Nogoia River, which occurs immediately downstream of the mine. Pits would be subject to rehabilitation in accordance with the approved Ensham site Rehabilitation Management Plan and the landform design criteria.

A treed corridor will be developed along the western (highwall) side of the rehabilitated A and B pits to provide connectivity between Corkscrew Creek and the Nogoia River flood plain as seen in **Figure 3.1**.



Figure 3.1 Option 1: Landform Levee

(Source: Ensham Resources Pty Ltd)

3.2 Option 2 – Flood Mitigation and Beneficial Use

Option 2 proposes to utilise the post-mining voids to form water storages to capture a proportion of high flow flood water and store this water for potential beneficial use as shown in **Figure 3.2**. Flood water harvesting is able to quickly fill the post-mining voids with minimal downstream impact, achieving improved water quality to support a range of reuse options and/or environmental and social values.

This option is founded on the concept of capturing a small fraction of larger magnitude flood event flows in the Nogoa River, storing this water in residual voids and releasing it back to irrigation and industrial users via a series of pipes to the Weemah Channel and Yamala Inland Port. There will be no discharge to the Nogoa River by this option.

The design of rehabilitation should comply with the current site Rehabilitation Management Plan and landform design criteria to optimise water capacity. Overburden emplacement areas located adjacent to the water storage voids are to be reshaped in a manner that achieves stable landform slopes without resulting in significant void backfilling. Low wall areas are to be reshaped in-pit to achieve minimum stable slope requirements to ensure safe access and stability of exposed slope surfaces.

Option 2 would utilise storage afforded by residual voids remaining in A Pit and B Pit south of the Nogoa River, and C Pit and D Pit north of the river. The quantity of water likely to be required to operate the system – or put another way, the headroom storage in the pits – is likely to be negligible when compared to overall discharges during flood events from the Nogoa River catchment into the Mackenzie River located downstream of the Ensham Coal Mine. However, in the context of irrigation usage, the headroom storage represents a significant volume and a potential economic asset.

Future assessment and optimisation of Option 2 will consider the potential for interactive operation of the voids with Fairbairn Dam to improve water use efficiency across the water supply system.

Currently Fairbairn Dam's southern irrigation channel, known as the Weemah Channel, extends eastward to within approximately 10 km of Ensham Coal Mine. Water captured from the upper Nogoa River catchment and retained in Queensland's second largest but relatively shallow Fairbairn Dam, is subject to significant evaporative losses. Furthermore, allocated water releases from the dam into the Weemah Channel (and the corresponding northern Channel, the Selma Channel) experience significant seepage and seasonal evaporative losses before reaching their intended customers, particularly where these customers are close to the end of the Weemah Channel. This option includes linking the residual voids located to the south of the Nogoa River to the existing Weemah Channel with large diameter pipes and pumps to transfer water to and from the voids.

Water captured in Fairbairn Dam would be released into the Weemah Channel when hydrologic conditions are likely to result in minimal evaporative and seepage losses (i.e. at times when the catchment is receiving rainfall, the ground is saturated and evaporation is minimal). Whilst the water may not be required by customers at these times, the water would be transferred to the residual voids via the proposed Weemah Channel(s) (refer red line on **Figure 3.3**) and stored in the more evaporatively-efficient residual voids at Ensham. In times of irrigation water demand at the lower reaches of the Weemah Channel (i.e. where the evaporative and seepage distribution losses are likely to be greatest), water would be returned to the Weemah Channel from the residual voids via the Weemah Channel.

Because the Weemah Channel and proposed channel(s) lie on the southern side of the Nogoa River floodplain, it would be necessary to maintain a hydraulic connection between the residual voids on the northern flanks of the floodplain and those on the southern flanks. It is proposed that an upgrade of the existing water distribution main, that runs parallel with the main haulage route between B Pit and C Pit, be undertaken early in the project to provide the required hydraulic connection (refer blue line on **Figure 3.3**).

Option 2 proposes that pontoon-based pumping stations would be sited at each pit to transfer water as required. The Weemah Channel coming into the mining lease would be configured to deliver water initially to A pit. Similarly, pumping from the mine to the Weemah Channel would be done from A Pit.

An offtake from the pipe to Weemah Channel would be used to meet water demand for the prospective Yamala Inland Port located to the south west of Ensham Mine.



Figure 3.2 Option 2 – Flood Mitigation and Beneficial Use

(Source: Ensham Resources Pty Ltd)



Figure 3.3 Conceptual drawing of the Weemah Channel and Yamala Inland Port (red) pipeline connection and the mine internal pump system (blue)

(Source: Ensham Resources Pty Ltd)

The intakes from the Nogoa River to B and C Pits would allow temporary storage of peak flood flows during flood events. As the river rises during a flood event, it would reach the overflow level of the inlet structures constructed in the levee (the intakes) and flow into the residual voids. The water would rise in the voids to reflect the height of the flood. As flood levels recede, water would ebb back into the river floodplain through the intakes to the base level of the intakes leaving the voids at full level. The intake level for B and C Pits has been considered as part of Stage 3.

A further key aspect of Option 2 is the depth of the residual voids. Shallow expansive voids experience greater evaporative water losses and hence potential salt concentration. Hence improved water quality outcomes are likely to be delivered with deeper inundated pits.

There remain several opportunities to manage power demands of the scheme including solar-power to generate an income to cover some or all of the overall annual operating cost of this option.

Residual voids that are not within the floodplain, for example E, F and Y pits, would be rehabilitated to achieve minimum stable slope requirements and comply with currently approved site Rehabilitation Management Plan and landform design criteria.

A treed corridor will be developed along the western (highwall) side of the rehabilitated A and B pits to provide connectivity between Corkscrew Creek and the Nogoa River flood plain as seen in **Figure 3.2**.

3.3 Option 3 - Backfill to Probable Maximum Flood (BTP)

Preferred Option 3 comprises backfilling residual mining voids located within the pre-mining floodplain up to the elevation of the original floodplain within the lateral extent of the pre-mining Probable Maximum Flood (PMF) level.

Conceptually, the residual voids lying within this PMF extent would be backfilled up to the approximate original (pre-mining) topography with an additional surcharging to accommodate settlement of the backfill. In practice, it may be necessary to extend the backfilling beyond the modelled extent of the PMF to ensure stability of the backfilled areas within the PMF extent and protect against collapse into the adjacent residual voids. Excess mining spoil, that is currently present in the floodplain and that is not required for backfilling of residual mining voids, would be retained as seen in **Figure 3.4**.

The existing levees constructed to protect the voids from flooding would be removed, with the material re-used for backfilling voids. Material required to backfill residual voids would be drawn from the nearest cost-effective source e.g. low wall spoil. Any negative material balance will need to be met from adjacent low wall and high wall spoils.

Virgin rock typically exhibits an increase in volume when excavated - this is referred to as 'bulking'. The degree of bulking will vary with the geo-mechanical properties and size distribution of the excavated rocks and the methods used in excavation and transport. Furthermore, it is likely to vary both along the linear extent of the open cut mine and within different parts of spoil tips created through the extraction of rock dominated by lithologies characterising the local stratigraphy. Re-excavation of spoil and re-emplacement within voids within the modelled PMF will again exhibit bulking. Whether subjected to dynamic compaction or allowed to settle with subsequent loading by overlying backfill, the spoil within the voids will inevitably exhibit uncontrolled settlement. This will lead to the development of low areas within the PMF extent which, though shallow, lie below the original level of the floodplain. These low areas will not necessarily be connected and are likely to collect surface water runoff but be subject to intense evaporation and surface accumulation of evaporative salts which would be flushed clean by fluvial flood events.

Static surcharging of the replaced spoil material may reduce the risk of long-term settlement below original floodplain. However, this will require material to be placed above the original floodplain elevation in direct contradiction of the intent of this option.

Beyond the modelled extent of the PMF, residual voids would be rehabilitated in accordance with a combination of Option 1 and Option 2 landform criteria requirements.

Replaced spoil, however comprehensively compacted, is unlikely to provide durability equal to the original virgin rock and hence during times of fluvial flood, of magnitudes such that the current floodplain pinch point between B Pit and C Pit begins to develop afflux, it is likely that the Nogoia River would scour spoil within the adjacent backfilled pits. This has the potential over time to result in sink holes and ultimately a repeat of the 2008/2010 inundation events with the Nogoia River cutting a channel into one or more backfilled pits and flooding the remaining un-backfilled parts of each pit. Additionally, impacts on turbidity downstream of the backfilled areas would need to be considered.

As part of the rehabilitation process, the establishment of a treed corridor along the western (highwall) side of the rehabilitated A and B pits is proposed to link Corkscrew Creek and the Nogoia River flood plain as seen in **Figure 3.4**.



Figure 3.4 Option 3 - Backfill to PMF

(Source: Ensham Resources Pty Ltd)

4.0 Methodology

The methodology for this report comprises three distinct phases:

- The identification of the ecological baseline of the Project area, including a review of relevant legislation and guidelines;
- A gap analysis to determine if any further ecological studies or data collection activities are required to meet the objectives of the RVP; and
- Impact assessment to determine the degree of potential impact on the identified EVs of the three preferred options. (It must be noted, impacts associated with mine operations, including the construction of the RVs, are considered covered by the approved EA).

4.1 Methodology for Identification of Ecological Baseline

The methodology for the identification of the ecological baseline of the Project area was broken into the following key tasks:

- Review of relevant environmental legislation;
- Review of relevant environmental guidance documents, such as policies and guidelines;
- Review of ecological databases and government vegetation mapping;
- Review of previous ecological reports;
- Determination of the likelihood of threatened species to occur in the Project area; and
- Consideration of Survey Guidelines.

The methodology for each of the above tasks is provided in the following sections.

The ecological baseline assessment also considered the findings of other relevant Stage 3 technical reports prepared for the Stage 3 RVP preferred options (described in **Section 6.0**).

4.1.1 Review of Environmental Legislation

The requirements of each of the following Acts or associated Regulations have been assessed to determine their relevance to the ecological values associated with the RVP:

- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth);
- *Planning Act 2016* (QLD);
- *Mineral Resources Act 1989* (QLD);
- *Environmental Protection Act 1994* (QLD);
- *Environmental Protection Regulation 2008* (QLD);
- *Environmental Offsets Act 2014* (QLD);

- *Biosecurity Act 2014 (QLD)*;
- *Environmental Protection (Water) Policy 2009* (QLD Government, 2013) (specifically Schedule 1 and the associated prescribed Environmental Values and water quality objectives);
- *Fisheries Act 1994 (QLD)*;
- *Nature Conservation Act 1992 (QLD)*;
- *Nature Conservation (Wildlife Management) Regulation 2006 (QLD)*;
- *Nature Conservation (Protected Plants) Conservation Plan 2000 (QLD)*; and
- *Vegetation Management Act 1999 (QLD)*.

4.1.2 Review of Environmental Guidance Documents

Relevant guidance documents included in this review were:

- Commonwealth and State Survey Guidelines for Birds, Bats, Reptiles, and Mammals which provide indications of key habitats and distributions for threatened species;
- Queensland government mapping/databases used in the literature review for the preparation of this report included the following: Matters of State Environmental Significance (MSES);
- Review of the Queensland Back on Track Species Prioritisation Framework (Back on Track) (DES, 2017). The Back on Track framework is an initiative of the Queensland Government;
- Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DSITI, 2015);
- Australian Groundwater Dependent Ecosystems Toolbox Part 1: Assessment Framework (SKM, 2011);
- Queensland Wetland Policy;
- Queensland Guideline: Works that interfere with water in a watercourse—watercourse diversions (DNRM, 2014);
- Queensland Environmental Protection Water Policy (2009) Fitzroy River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Fitzroy River Sub-basin September 2011;
- Queensland Environmental Protection (Water) Policy (2009) Mackenzie River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Mackenzie River Sub-basin September 2011; and
- Ecological Assessment considerations under the Central Highlands Local Environmental Plan.

4.1.3 Review of Ecological Databases and Government Mapping

The desktop assessment for this report was undertaken in January 2018 and included a review of the Commonwealth and State databases listed below:

- The Department of Environment (DoEE) Protected Matters Search Tool to identify MNES within a 50 km radius of a central point (-23.45228, 148.49097) of the Project area, accessed 7 August 2017;

- Terrestrial GDE, Subterranean GDE (Caves ecosystems) and Potential GDE Aquifer mapping provided in Queensland Globe (<https://qldglobe.information.qld.gov.au/>), accessed 7 August 2018;
- The QLD Department of Environment and Science (DES) Wildlife Online database to identify any flora, fauna species listed under the *Nature Conservation Act 1992* within a 50 km radius of a central point (-23.45228, 148.49097), accessed 7 August 2018;
- Queensland State-wide Biodiversity Corridors mapping provided in Queensland Globe (<https://qldglobe.information.qld.gov.au/>), accessed 7 August 2018;
- Essential Habitat mapping accessed via Queensland Globe (<https://qldglobe.information.qld.gov.au/>), accessed 7 August 2018;
- Atlas of Living Australia to obtain a record of aquatic vertebrates occurring within an approximate 10 km radius of the Project area (<https://biocache.ala.org.au/explore/your-area#-23.4069746|148.498168>), accessed 7 August 2018;
- Review of Regional Ecosystem (RE) mapping (Version 10.1) prepared by the Queensland Herbarium (2017) to determine the presence or proximity of endangered ecological communities identified under the *Vegetation Management Act 1992* potentially occurring within an approximate 50 km radius of the Project area provided in Queensland Globe (<https://qldglobe.information.qld.gov.au/>), accessed 1 August 2018.);
- Bird data from Birds Australia Database as defined as a 50 km radius search from a central point (-23.45228, 148.49097) of the Project area; accessed 7 August 2018; and
- Records from the Atlas of Living Australia within an approximate 50 km search radius of a central point (-23.45228, 148.49097) to the Project area, accessed 7 August 2018.

4.1.4 Review of Previous Ecological Reports

A review of previous terrestrial ecological studies relevant to the Study Area has been undertaken to identify the terrestrial ecosystems and habitat values including the following:

- Ensham Project: Brigalow Assessment Report (AARC, 2004);
- Ensham Coal Project Final Impact Assessment Study – Volume 1 Impact Assessment Study (Hollingsworth, Dames and Moore, 1996);
- Bio-condition Assessment Report, the Ensham Central Project (ECOSM, 2010);
- Ensham Central Project, Environmental Impact Statement (Hansen Consulting, 2006); and
- Ensham Central Project Supplementary Environmental Impact Statement (Hansen Bailey, 2009).

A review of previous aquatic studies of the Project area (including Hollingsworth, Dames and Moore (1996), Hansen Consulting (2006), Hansen Bailey (2009) and C&R Consulting (2010)) was undertaken to identify the aquatic ecosystems and habitat values within the Study Area. These studies identified aquatic flora and fauna species, groundwater dependent ecosystems and conservation significant species that may utilise these habitats.

The results of these ecological studies are described in more detail in **Section 7.0**.

Ecological assessments were also reviewed from nearby mine sites within the Study Area. These reports present field verified records of threatened communities and species for the Study Area. This information can provide an indication of what may be present in the Project area where similar habitats may occur. Publicly available information from the following sites was incorporated into the literature review of this report:

- Curragh North (formerly Pisces) Coal Project EIS Assessment (EPA, 2004);
- Central Northern Extension – Jellinbah Coal Mine, Environmental Authority Amendment – Supporting Information (AARC, 2015);
- EIS Report under the *Environmental Protection Act 1994*, Minyango Project- Blackwater Coal Pty Ltd (State-wide Environmental Assessments, DEHP, 2014); and
- Kestrel Mine Site Environmental Assessment Report Kestrel Extension #4 (Rio Tinto, 2012).

4.1.5 Likelihood of Threatened Species (Terrestrial and Aquatic) Occurrence

Based upon the analysis of habitats, records and species utilisation of particular habitats, species were assigned to one of the following categories:

- **Known to Occur:** this category includes all species or communities previously recorded on the Project area;
- **Potential to Occur:** this category includes species or communities previously recorded in proximity to the Project area, and which have potential habitat features available on site which may support the species; and
- **Unlikely to Occur:** this category includes those species for which the Project offers limited or no potential habitat, is outside their known range and/or is without broader habitat requirements.

4.1.6 Consideration of Survey Guidelines

The species identified as having potential to occur were also used for context for recommended survey requirements to satisfy Commonwealth and State regulations. When making recommendations regarding the scale and extent of additional survey, applicable guidelines relating to survey methodology were referred to where relevant. These guidelines are listed as follows:

- Survey guidelines for Australia's threatened reptiles - Guidelines for detecting reptiles listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment, Water, Heritage and the Arts (DEWHA), 2011a);
- Guidelines for detecting birds listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2010a);
- Guidelines for detecting bats listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA, 2010b);
- Guidelines for detecting mammals listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (DEWHA, 2011b);
- Flora Survey Guidelines – Protected Plants (DES, 2014);
- Terrestrial Vertebrate Fauna Survey Guidelines (DSITIA, 2014);

- Environmental Assessment Guideline No. 12 Consideration of Subterranean Fauna in Environmental Impact Assessment in WA (Environmental Protection Authority, 2013);
- Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DSITIA 2014);
- Australia-Wide Assessment of River Health: Queensland AusRivAS Sampling and Processing Manual, Monitoring River Health Initiative Technical Report No 12 (DNRM, 2002); and
- Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification and a biotic index (Chessman, 1995).

4.2 Gap Analysis Methodology

The gap analysis utilised the results of the baseline ecological environmental assessment (provided in **Section 7.0**), as follows:

- An assessment was made of the suitability of the previous ecological surveys and assessments in the context of the three Options. The review considered the scope, seasonal considerations, accuracy/reliability, level of detail, and currency of the historical survey data and/or assessment results, as well as whether methods employed in the past meet current requirements;
- A review of ecological and environmental reports held by Ensham as well as databases held by the Commonwealth and State governments were interrogated to augment existing data sources;
- A description of any further ecological studies or data collection activities that will be required to meet the objectives of the RVP has been prepared in **Section 10.0** of this report. This step considered the Project area and project footprints of each of the options. This step also considered processes or activities proposed as part of the options that have the potential to impact ecological values; and
- Further, an assessment has been made on the required survey levels for any subsequent approvals. This involved provision of advice on the likely level of survey effort (i.e. man hours, and recommended methods etc.) required to satisfy the requirements of an impact assessment under the EPBC Act or state government approvals for the Project area. This advice includes:
 - Recommended survey effort and duration;
 - Recommended season(s) for survey or if multiple seasons or years are required;
 - Consideration of Survey Guidelines; and
 - For each Option, comment on any survey schedule limitations in the context of reporting requirements for regulators.

4.3 Impact Assessment Considerations

The impact assessment utilised the information collated from the Baseline Ecological components of this report and other relevant technical studies prepared for Stage 3 (described in **Section 6.0**). Key project assumptions (provided by Ensham) are outlined in **Section 1.0**. These assumptions have been considered in this impact assessment and include:

- A focus on post relinquishment for impact assessment (at which time it is assumed all landforms will have been rehabilitated to a safe, stable and non-polluting condition).

- Each Option will not extend the footprint beyond that currently approved, except potentially Option 1 if the levee regrade on the river side extends into the riparian area; and specifically with Option 2, where intake structures will be constructed within the riparian areas to allow harvesting of high flow event waters via the pipeline to the Weemah Channel.
- A high level assessment only of the proposed pipeline connecting the RVP to the Weemah Channel. Detailed assessment will be undertaken of this Option 2: FMBU component, should Option 2 be ultimately selected.

The results of the Stage 3 technical studies including hydrology, water quality, geochemistry, civil design and landform design have been considered in this assessment where relevant, and appropriate management strategies have been provided. The risk of environmental harm and management strategies are identified within this Stage 3 Ecology report. The intensity, duration, and cumulative effect were considerations in determining the significance of the impacts.

5.0 Legislative Review Results

5.1 Review of Ecological Legislation and Policy

Table 5.1 and **Table 5.2** identify Commonwealth, State and Local Government ecological legislation and policies that are potentially relevant to the RVP.

Table 5.1 Review of Applicable Ecological Legislation

Legislation	Summary of Requirements	Relevant criteria for identification of Environmental Values
Commonwealth		
<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	Provides regulatory mechanisms for the protection of MNES.	Protected matter search tool used to identify potential Matters of National Environmental Significance.
State		
<i>Planning Act 2016</i>	The <i>Planning Act 2016</i> establishes a state wide, applicant driven development assessment system, by which local governments (and state agencies in particular circumstances) assess and make decisions on the various land-use and development proposals the public propose.	The <i>Planning Act</i> applies to activities outside the Mining Lease.
<i>Mineral Resources Act 1989</i>	Provides for the assessment, development and utilisation of mineral resources to the maximum extent possible under primary consideration of sound economics, and land use management.	The environmental effects of mining activities are regulated under an environmental authority under the <i>Environmental Protection Act 1994</i> .
<i>Environmental Protection Act 1994 and Environmental Protection Regulation 2008</i>	This Act and Regulation set out the environmental approval process for mining activities in Queensland and provides the framework for administering the process of granting an Environmental Authority for Environmentally Relevant Activities.	An amendment to the existing Ensham EA may be sought.
<i>Water Act 2000</i>	The project is located within the Fitzroy River catchment and subject to the Water Resource (Fitzroy Basin) Plan 2011 (Fitzroy WRP) and its implementation tool, the Fitzroy Basin Resource Operations Plan (January 2004, amended October 2011). The Fitzroy WRP regulates the taking of overland flow water from the Fitzroy Basin.	Riverine Protection Permit Exemption Requirements set out criteria that must be met for filling or excavation in a watercourse, other than in accordance with a Riverine Protection Permit.

Legislation	Summary of Requirements	Relevant criteria for identification of Environmental Values
Fisheries Act 1994	Provides for the use, conservation and enhancement of the community's fisheries resources and fish habitat by providing for, amongst other things, the protection of fish habitats.	No fish habitat as identified in this Act occurs on or adjacent to the Project area. Refer to <i>Guide for determination of waterways using the spatial data layer Qld Waterways for waterway barrier works</i> .
Nature Conservation Act 1992 and Nature Conservation (Wildlife Management) Regulation 2006	The NC Act deals with the legal status and management of listed threatened flora and fauna species identified under the <i>Nature Conservation (Wildlife Regulation 2006)</i> . It prohibits the destruction or removal, unless authorised, of listed threatened flora and fauna species.	Protected flora and fauna are identified under the <i>Nature Conservation (Wildlife) Regulation</i> . A 'Flora Survey Trigger Map for Clearing Protected Plants in Queensland' identifies high risk areas where plants that are endangered, vulnerable or near threatened wildlife are present or are likely to be present.
Vegetation Management Act 1999	In determining MSES, Biodiversity Status as contained within the mapping prepared for the <i>Vegetation Management Act 1999</i> is relevant to assessments under the <i>Environmental Protection Act 1994</i> .	The regional ecosystem description database identifies regional ecosystems and their conservation status.
Environmental Offsets Act 2014	Under the <i>Environmental Offsets Act 2014</i> an environmental offset is defined as an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter.	Following approval of the final design of the selected option, an assessment will be required to determine if there is, or the scale of, any significant residual impact on any MSES
Biosecurity Act 2014	The Act provides comprehensive biosecurity measures to safeguard the Queensland economy, its agricultural and tourism industries, its environment and way of life, from pests, diseases and contaminants.	The RVP will consider relevant measures to remove, control and limit the spread of pests and diseases.
Central Highlands Regional Council		
Biodiversity Overlay Code	Identifies regional planning consideration including MSES.	Matters of Local Environmental Significance are not relevant to mining activities on a mining tenure, but as they align with MSES in this case, these are considered in this report.

Table 5.2 Review of Applicable Ecological Policy

Policy	Summary of Requirements	Implication for RVP
Commonwealth Survey Guidelines	Provides Commonwealth standards for the ecological survey of threatened flora, fauna and ecological communities.	Any required future flora or fauna surveys should comply with minimum standards of these guidelines.
State Survey Guideline	Provides standards for the ecological survey of flora and fauna species.	Any required future flora or fauna surveys should comply with minimum standards of this guideline.
Environmental Protection Policy (Water)	The quality of natural waters in Queensland (e.g. water in rivers, creeks, wetlands, lakes, estuaries and coastal areas and ground waters) are protected under the <i>Environmental Protection (Water) Policy 2009</i> (EPP (Water)). The EPP (Water) achieves the object of the <i>Environmental Protection Act 1994</i> to protect Queensland's waters while supporting ecologically sustainable development.	Table 1 of the Policy and the accompanying plans WQ1302 and WQ1303 outline the EVs for waters in the Nogoa River Sub-basin. These are based on stakeholder consultations undertaken by the Department and the Fitzroy Basin Association to identify EVs and Water Quality Objectives (WQOs) in the Fitzroy Basin. Consultation results are reported in Fitzroy Basin Association Inc. (2011) Environmental values for the Fitzroy: community consultation. Final report. July 2011.
Wetlands	Natural wetlands including wetlands of high ecological significance and general ecological significance and REs consistent with wetlands. Referrable wetlands under the <i>Environmental Protection Regulation 2008</i> were also reviewed.	No wetlands of High Ecological Significance or General Ecological Significance occur on or in the vicinity of the Project area. Riverine wetlands (i.e. RE 11.3.25e) occur within the Project area and within downstream environments of the Nogoa River.
Central Highlands Regional Council Biosecurity Plan 2017-2022.	The Central Highlands Regional Council local government Biosecurity Plan 2017-2020 has been developed in accordance with the Queensland State Government's requirements under the <i>Biosecurity Act 2014</i> .	Provides listings of priority weed and pest species known to occur in the local government area within which the Project area occurs.

6.0 Summary of Other Relevant Stage 3 Technical Findings

The following technical reports prepared for the Stage 3 Preferred Options were reviewed and relevant findings considered in the development of the ecological baseline (provided in **Section 7.0**) and impact assessment (provided in **Section 10.0**).

6.1 Stage 3 Catchment Hydrology and Flood Modelling (HEC, 2018b)

This report was prepared by HEC (2018b) to determine the extent of flooding with respect to each Preferred Option. The flood modelling results provided in this report concluded the following:

- Option 1 is considered unlikely to result in any changes to the current flooding regime.
- Option 2 is expected to present a minor drop in flooding downstream of the Project area and will result in a decrease of up to 0.3 m in flood heights upstream when compared to the current flooding regime.
- Option 3 will result in the greatest changes, with a significant reduction in upstream flood heights, and a minor increase in flood heights downstream. There are not expected to be any significant terrestrial or aquatic ecosystem impacts associated with these minor changes in periodic flood heights associated with this option.

With respect to this ecology assessment, the potential for changes in flood heights as presented above are not expected to lead to changes in vegetation distribution within the Project area or more broadly in the locality.

6.2 Stage 3 Material Characterisation for the Ensham Final Void Plan (RGS, 2018)

The report prepared by RGS (2018) assessed the potential for acid and metalliferous mine drainage and also saline drainage potential. The report found that the risk of the Project area experiencing any acid drainage issues, or elevated concentrations of metals/metalloids in surface water and groundwater resources, was considered low. The report did identify that elevated salinity from the groundwater and leachates from the spoils will be a key issue that may require management.

With respect to ecological values, the work undertaken by RGS (2018) suggests that salinity within the voids will be a significant constraint for all three Options. Option 1 and Option 3 will have void waters that will progressively increase in salinity through evapo-concentration and the release of salts from the surrounding rehabilitated overburden. This ingress and concentration of salt may limit aquatic life within these pits to those tolerant and capable of living within highly saline waters, and may limit the use of the pit water by terrestrial species to highly transient fauna such as birds, that may wade within the waterbodies rather than consume the water or biota within. The water management associated with Option 2 suggests that the waterbodies have potential to provide a more diverse array of habitats for both terrestrial and aquatic species, as the water quality will generally be of better quality when compared to the other options as water from the Weemah Channel will be mixed with void waters to manage salinity and toxicant concentrations. Further to this, the capture of flood waters in the voids will primarily dilute levels of salinity and other contaminant levels but will also prevent ingress of groundwater into the voids as the pressure of water in the voids will balance with the groundwater inflow, periodically reducing the saline groundwater inflows into the voids.

6.3 Stage 3 Geomorphic Assessment Ensham Mine Residual Void Study (WRM, 2018)

WRM (2018) prepared a geomorphic assessment of the waterways and floodplains within the Project area. The report noted there would be no material difference in velocities and shear stresses experienced along the river channels or the floodplain between the three options.

WRM (2018) noted for Option 3 that low velocity zones are expected across the surface of the infilled voids, suggesting these landforms will be stable in the short to medium term with potentially some sediment deposition occurring during moderate flood events.

The report concluded that all three options are unlikely to significantly alter the geomorphology of the Nogoa River or its Anabranh. Therefore, with respect to ecological values, the risk of geomorphological changes impacting terrestrial and aquatic habitats is considered low.

6.4 Stage 3 Residual Void Project - Groundwater Assessment (HS, 2018c)

HS (2018c) undertook an assessment of groundwater drawdown potential for each of the three options. HS predicted that drawdown in most riverine alluvium would be negligible, and consequently drawdown would have a negligible effect on river-aquifer interaction in general.

With respect to this ecological assessment, it is anticipated that the eventual groundwater recharge is not expected to have detrimental consequences on ecological EVs.

6.5 Stage 3 Void Water Quantity and Quality Balance Technical Report (HEC, 2018c)

HEC (2018c) undertook an assessment of the predicted void water quality and balance for each of the three options, based on nine model scenarios. For Options 1 and 3, there will be no exchange of water between the voids and the river and consequently no potential for impacts on downstream environmental values. For Option 2: FMBU, there is the potential for some interaction between river water and the voids during a significant flood event, if the flood is large enough to fill the voids over the expected 60 year life of the scheme.

Dilution calculations undertaken by HEC (2018c) for backflow from the voids to the river immediately after a peak flow event show that for between 92% and 95% of the time backflow is occurring, the estimated Nogoa River TDS downstream of the voids would be equal to the adopted background TDS of 115 mg/L as contained within the Environmental Approval for the Mine site. Modelling prepared by HEC (2018c) indicates that TDS does not exceed 250 mg/L in these peak flow events. Therefore, impacts from the released water are expected to be minimal.

An assessment of the quality of void water with respect to aquatic values was therefore undertaken for Option 2 using the data provided by HEC (2018c). The *Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin* (Queensland Government, 2013) specifies Water Quality Objectives (WQOs) for each EV for a specific water area and/or type, such as sub-basins.

The potential occurrence of Arsenic (As), Molybdenum (Mo) and Selenium (Se) were modelled by HEC (2018c) to determine their potential concentrations, given these trace elements are known to bioaccumulate if their concentrations are high. It should be noted that Selenium is an important micronutrient for plant and animal cell growth, but only in very small concentrations. The trigger values

within the ANZG (2018) for aquatic ecosystems (i.e. to avoid bioaccumulation, or known toxicity to any organism) are as follows:

- Arsenic: A freshwater trigger value of 0.013 mg/L;
- Molybdenum: A freshwater trigger value of 0.034 mg/L; and
- Selenium (total): A freshwater trigger value of 0.005 mg/L.

For Option 2, no water will be operationally released back to the Nogoa River. All beneficial use waters will be pumped to irrigation channels for distribution. There is potential during high flow events for some exchange of floodwaters to occur with void waters from Pit B and Pit C via the intake structures if the flood is large enough to fill the voids. Due to the pits holding largely river water from the flood event during the filling period of the high flow event, and the resultant dilution caused by these floodwaters, there is expected to be minimal impact to the water quality of the Nogoa River.

Simulated water quality for Pit B and Pit C indicate that where this exchange could potentially occur, the water quality values for Arsenic, Molybdenum and Selenium are below than the ANZECC Water Quality Guidelines for aquatic ecosystems, further reinforcing that there is unlikely to be impacts on downstream ecosystems during this type of event.

The median simulated values for salinity within Pit B and Pits C/D range between 252 $\mu\text{S}/\text{cm}$ and 262 $\mu\text{S}/\text{cm}$ over the 129 year model period. This represents the low salinity class as identified within the *Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin* (Queensland Government, 2013).

The objectives for irrigation water quality for Arsenic, Molybdenum and Selenium are shown in **Table 6.1**. In order to comply with the aquatic ecosystem guidelines, water released for irrigation through implementation of Option 2: FMBU are recommended to be below the values shown in **Table 6.1** for those metals/metalloids. Acceptable salinity levels for irrigation water vary based on irrigation water quality, soil properties, plant salt tolerance, climate, landscape, as well as water and soil management (ANZECC). General salinity classes for irrigation water are shown in **Table 6.2**.

With respect to aquatic ecosystems, a trigger value of 250 (mg/L) Total Dissolved Solids (TDS) has been identified under the *Environmental Protection (Water) Policy 2009 Nogoa River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Nogoa River Sub-basin* (Queensland Government, 2013). As shown in **Table 6.3** and **Table 6.4**, the simulated median TDS levels range between 252 mg/L and 1,093 mg/L. This suggests that the void waters will exceed the trigger value for aquatic systems. It should be noted however that no void waters will be operationally released back to the Nogoa River. There may be some exchange between the Nogoa River and the Pit B and Pit C voids during high flow events, when the voids are full. At this time, it is anticipated that dilution of void water with floodwater will ensure that any impacts from void water entering the Nogoa River are undetectable.

Table 6.1 Irrigation EV: Water quality objectives for heavy metals and metalloids in agricultural irrigation water (reproduced from Queensland Government 2013)

Element	Soil cumulative contaminant loading limit (CCL)(kg/ha)	Long-term trigger value (LTV) in irrigation water (up to 100 years) (mg/L)	Short-term trigger value (STV) in irrigation water (up to 20 years) (mg/L)
Arsenic	20	0.1	2.0
Molybdenum	ND	0.01	0.05
Selenium	10	0.02	0.05

Table 6.2 Salinity classes for irrigation water (reproduced from Queensland Government 2013)

Conductivity (µS/cm)	Salinity class
<650	1 - Low salinity water, suitable for use on all crops except tobacco, with all methods of water application, with little probability of a salinity problem developing.
650 – 1,300	2 - Medium salinity, suitable for use on all but very low salt tolerance crops. Water can be used if a moderate amount of leaching occurs. Plants with medium salt tolerance can be grown, usually without special practices for salinity control. Sprinkler irrigation with the more saline waters in this group may cause leaf burn on salt-sensitive crops, especially at higher temperatures in the daytime when evaporation may be high.
1,300 – 3,000	3 - High salinity - suitable for use on medium and high salt tolerant crops only. Water should not be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required.
3,000 – 5,000	4 - Very high salinity - suitable for use only on high salt tolerant crops. For use soils must be permeable, free draining, and water must be applied in excess to provide considerable leaching.
5,000 – 8,000	5 - Extremely high salinity generally unsuitable for irrigation unless soils are permeable, well drained and crops are of very high salt tolerance.
>8,000	6 - Too saline for irrigation

The modelled quality of water in Pit B and Pits C/D is representative of the quality of water that will be distributed for irrigation purposes. The median values of the void waters within Pit B and Pits C/D are presented in **Table 6.3** and **Table 6.4**. **Table 6.3** represents the initial development of Option 2 whereby only Pit A and Pit B are utilised for beneficial use. It is expected that Pits C/D and E under this scenario will experience a gradual increase in salinity and metal/metalloid concentrations. **Table 6.4** represents the water quality results for the full development of Option 2 (i.e., whereby Pits A, B, C and D are managed and utilised). Generally, the quality of void water to be used for irrigation purposes will not exceed either the short or long term trigger values for irrigation as identified in the **Table 6.1** above. This suggests that there should be no impacts on downstream aquatic ecosystems should any irrigation water flow into the Nogoa River or the anabranch.

HEC (2018c) estimates for Option 2 that salinity levels within Pit A will take approximately 7 years (from the commencement of the collection of high flow events) to fall below the irrigation threshold for salinity, and the waters within Pit B will take approximately 1 year to fall below the irrigation salinity threshold. It is anticipated that shandying of water can be undertaken with the Ensham water allocation, and between waters contained within Pits A and B to allow irrigation water to be supplied once the project commences.

Table 6.3 Modelled Water Quality Results for Initial Development of Option 2 (i.e. AB Pits in operation only) for 129 years (Source: HEC, 2018c)

Option 2 AB Pits (129 year Model) Run 3		Conductivity (µS/cm)	TDS (mg/L)	As (mg/L)	Mo (mg/L)	Se (mg/L)
Pit A	Max	7,936	5,317	0.035	0.083	0.054
	Median	1,436	962	0.012	0.027	0.016
Pit B	Max	8,090	5,420	0.005	0.010	0.006
	Median	391	262	0.004	0.006	0.004

Table 6.4 Modelled Water Quality Results for Full Development of Option 2 (i.e. Pits AB and CD Pits in operation) for 129 Years (Source: HEC, 2018d)

Option 2 ABCD Pits (129 year Model) Run 4		Conductivity (µS/cm)	TDS (mg/L)	As (mg/L)	Mo (mg/L)	Se (mg/L)
Pit A	Max	7,903	5,295	0.026	0.067	0.044
	Median	1,631	1,093	0.012	0.024	0.015
Pit B	Max	8,090	5,420	0.005	0.010	0.006
	Median	427	286	0.004	0.006	0.003
Pit CD	Max	7,285	4,881	0.004	0.007	0.004
	Median	376	252	0.003	0.003	0.001
Pit E	Max	7,591	5,086	0.013	0.043	0.029
	Median	972	651	0.005	0.016	0.011

7.0 Ecological Baseline Results

7.1 Vegetation

7.1.1 Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified four Commonwealth listed Threatened Ecological Communities (TECs) as potentially occurring in the Study Area. These are shown in **Table 7.1** below.

Table 7.1 PMST Search Identified Threatened Ecological Communities

Name	Status	Type of Presence	Recognised REs consistent with TEC
Brigalow (<i>Acacia harpophylla</i> dominant and codominant)	Endangered	Community known to occur within area	11.3.1 and 11.4.8
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	Community likely to occur within area	None
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area	None
Weeping Myall Woodlands	Endangered	Community likely to occur within area	None

7.1.2 Regional Ecosystem Mapping

A review of the vegetation maps prepared by the Queensland Herbarium (Version 10.1) identified nine Regional Ecosystems as occurring on the Project area with an additional 2 REs occurring adjacent to the Project area. These vegetation units provide a baseline to assess potential disturbance outside of the existing mine footprint. Disturbance areas have been identified as a consequence of the Stage 3 Civil Design (WSP, 2018) investigations.

To create landform stability for the proposed Option 1: LL levees, WSP (2018) has created a landform design that generally extends the levees outwards towards the Nogoa River and the Anabran for C and D pits respectively to further address the minimisation of erosion. Further to the outward extension of the levee walls, the WSP (2018) landform design also requires levee realignments in two locations where the levees are too close to the void highwalls to achieve long term stability for the levees. Typically, the average outward extension of the levee ranges up to approximately 40 m from the current levee location. Based upon available aerial imagery, this outward extension will result in the clearing of up to 60 ha of non-regulated regrowth/previously disturbed vegetation. The 60 ha disturbance areas comprises extension of levee footprints, and a 10 m buffer from the toe of the proposed levee landforms for construction activities (noting there will be no disturbance to Riparian Regional Ecosystem 11.3.25e) for each levee.

With respect to Option 2, WSP (2018) has also designed two intake structures that will extend from the existing levee walls on Pit B and Pit C to the Nogoa River and the Anabran respectively. These structures will impact approximately 3 ha of mapped riparian regional ecosystem associated with the Nogoa River and its Anabran.

Using the identified disturbance areas, specific habitats for conservation significant species that may be impacted by the RVP have also been determined for each Option. The distributions of REs as provided by the Queensland Herbarium (Version 10.1) mapping are shown in **Figure 7.1**. These are described in **Table 7.2**, including a short description, biodiversity status, VM Act status, and area within the Project area.

Bio-condition surveys of the vegetation present on the Project area by ECOSM (2010) were used to confirm the identification and distribution of the REs.

It should be noted that the accuracy of this RE mapping was assessed based upon review of previous field surveys undertaken across the Project area (ECOSM, 2010) which indicated that the latest RE Mapping as supplied by the Queensland Herbarium (2017) is sufficiently accurate for the purposes of this Stage 3 assessment. Broad habitat/ecosystem types have been extrapolated from this RE mapping to allow site characterisation with respect to available habitats for threatened species later in this report.

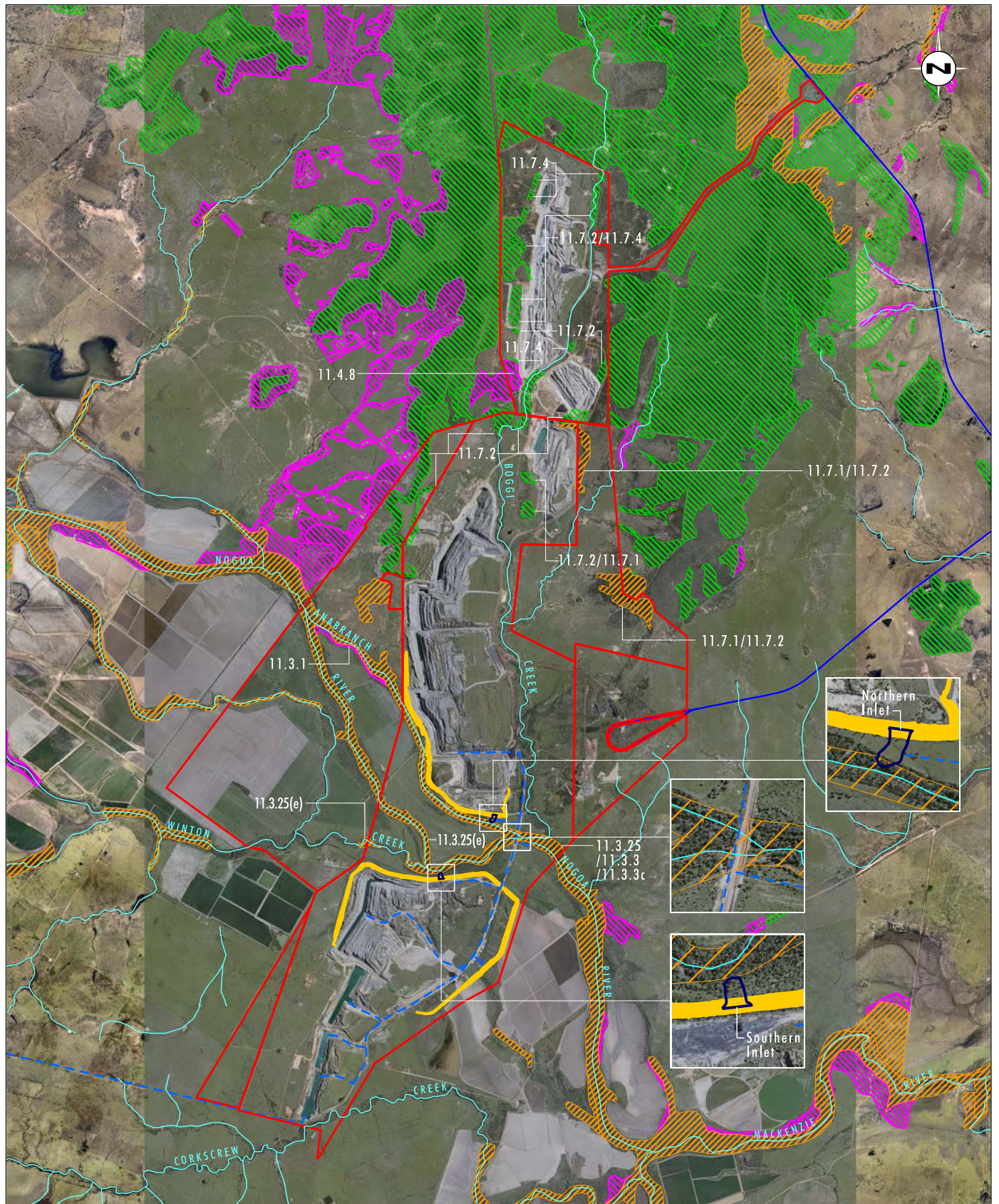


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017)

0 2.0 4.0 6.0 km
1:125 000

Legend

- Project Area
- Proposed Levee Extension
- Inlet Structure
- Proposed Water Pipeline Infrastructure
- Biodiversity Status - Endangered
- Biodiversity Status - Of Concern
- Biodiversity Status - No Concern

- Drainage Lines
- Rail Line

FIGURE 7.1

Regional Ecosystems Identified as
occurring on the Project Area

Table 7.2 Regional Ecosystems Identified on the Project area and within the Locality

RE Code	Short Description	Conservation Significance		Vegetation Structure	Broad Habitat	Habitat Value
		VM Act / BD Status	EPBC Act Status			
11.3.1	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> open forest on alluvial plain.	E/E	E	Mid-dense Open Forest	Open Forest	This vegetation represents MNES and MSES and should be avoided wherever practicable.
-	Mosaic of non-remnant vegetation with un-mapped 11.3.1.	-	-	Mixed structure	Disturbed	Unmapped areas of 11.3.1 may provide habitat for threatened flora species, and hollow bearing trees in this area may provide habitat for threatened fauna species.
11.3.25 (e)	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines.	LC/OC	-	Mid-dense Open Forest	Riparian Wetland	This vegetation may provide habitat for koala, greater glider and various MNES (Migratory Species) and is recognised as a State Biodiversity Corridor under the State Planning Policy. This RE is also mapped as Essential habitat for the NC Act listed Ornamental Snake (<i>Denisonia maculata</i>) by DES.
11.3.25(e)/ 11.3.3	<i>Eucalyptus tereticornis</i> or <i>E. camaldulensis</i> woodland fringing drainage lines and <i>Eucalyptus coolabah</i> woodland on alluvial plains.	LC/OC	-	Mid-dense Open Forest	Riparian Wetland	This vegetation may provide habitat for koala, greater glider and various MNES (Migratory Species) and is recognised as a State Biodiversity Corridor under the State Planning Policy. This RE is also mapped as Essential habitat for the NC Act listed Ornamental Snake (<i>Denisonia maculata</i>) by DES.
11.3.9	<i>Eucalyptus platyphylla</i> , <i>Corymbia</i> spp. woodland on alluvial plains	LC/NC	-	Sparse Woodland	Woodland	May provide habitat for conservation significant flora and fauna.
11.4.8	<i>Eucalyptus cambageana</i> woodland to open forest with <i>Acacia harpophylla</i> or <i>A. argyrodendron</i> on Cainozoic clay plains.	E/E	E	Mid-dense Woodland to Open Forest	Wetland	This vegetation represents a MSES and provides habitat for Ornamental Snake and various MNES (Migratory Species).

RE Code	Short Description	Conservation Significance		Vegetation Structure	Broad Habitat	Habitat Value
		VM Act / BD Status	EPBC Act Status			
11.5.3	<i>Eucalyptus populnea</i> +/- <i>E. melanophloia</i> +/- <i>Corymbia clarksoniana</i> woodland on Cainozoic sand plains and/or remnant surfaces	LC/NC	-	Sparse Woodland	Woodland	May provide habitat for conservation significant flora and fauna.
11.5.9b	<i>Eucalyptus crebra</i> , <i>E. tenuipes</i> , <i>Lysicarpus angustifolius</i> +/- <i>Corymbia</i> spp. woodland on Cainozoic sand plains and/or remnant surfaces	LC/NC	-	Sparse Woodland	Woodland	May provide habitat for conservation significant flora and fauna.
11.7.2	<i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	LC/NC	-	Sparse Woodland	Woodland	May provide habitat for conservation significant flora and fauna.
11.7.4	<i>Eucalyptus decorticans</i> and/or <i>Eucalyptus</i> spp., <i>Corymbia</i> spp., <i>Acacia</i> spp., <i>Lysicarpus angustifolius</i> woodland on Cainozoic lateritic duricrust.	LC/NC		Mid-dense Woodland	Woodland	May provide habitat for conservation significant flora and fauna.
11.7.1/ 11.7.2	<i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> and <i>Eucalyptus thozetiana</i> or <i>E. microcarpa</i> woodland on lower scarp slopes on Cainozoic lateritic duricrust and <i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone.	LC/OC (d)	-	Mid-dense Woodland	Woodland	This vegetation represents a MSES and should be avoided where practicable.
11.7.2/ 11.7.1	<i>Acacia</i> spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone and <i>Acacia harpophylla</i> and/or <i>Casuarina cristata</i> and <i>Eucalyptus thozetiana</i> or <i>E. microcarpa</i> woodland on lower scarp slopes on Cainozoic lateritic duricrust.	LC/OC (sd)	-	Mid-dense Woodland	Woodland	This vegetation represents a MSES and should be avoided where practicable.

Note: E – Endangered for both EPBC Act and VM Act; OC – Of Concern (Biodiversity Status); LC – Least Concern (VM Status); NC – No Concern (Biodiversity Status) under the VM Act; d – dominant where two or more communities are mapped as one polygon and the OC RE is dominant, sd – subdominant where two or more communities are mapped as one polygon.

7.2 Habitats Present within the Project Area

7.2.1 Terrestrial Habitats

The following broad terrestrial habitats were identified from the RE mapping for the Project area and locality including:

- Riparian wetlands consisting of RE 11.3.25(e), 11.3.3, and 11.4.8;
- Woodland consisting of RE 11.3.9, 11.5.3, 11.5.9, 11.7.1, 11.7.2 and 11.7.4;
- Open Forest of RE 11.3.1; and
- Disturbed Lands/Pasture/Cropping/Rehabilitation.

These areas are shown in **Figure 7.2**.

7.2.2 Aquatic Habitats

The Project Area is traversed by a number of watercourses that drain from north to south into the Nogoa River (**Figure 2.1**). The major watercourses within the current receiving environment of the Project Area include:

- Boggy Creek;
- Corkscrew Creek;
- Sandhurst Creek;
- Nogoa River (and its anabranch); and
- Mackenzie River.

A diversion has been built along Boggy Creek to permanently divert flows around the Ensham Mine footprint. Boggy Creek skirts the Ensham Mine to the north, before discharging into the Nogoa River south of the Ensham Mine.

Boggy Creek is considered to be ephemeral; however several waterholes persist throughout much of the year. The portions of the Nogoa and Mackenzie Rivers as shown in **Figure 2.1** are considered perennial, largely as a result of regulated releases from Fairbairn Dam, though contain little flow during the dry season. A number of mine water bodies are present, together with a number of farm dams within the Project area.

The habitats associated with the Nogoa River, the anabranch and the A Pit water body are described in more detail in the following sections.

7.2.2.1 Nogoa River (Main channel)

The aquatic habitat assessments undertaken for the Ensham Central Project area as reported by Hansen Consulting (2006) found that the main channel of the Nogoa River is characterised by muddy banks and silted substrate with no riffle zones. The banks are generally steep with very little macrophyte growth.

At the time of the field surveys for the 2006 assessment, the water was found to be turbid due to the high sediment loads from surrounding land uses. While a number of quiet backwater areas were present adjacent to fallen trees and sediment mounds, the river within the Project area was typified by a fast-flowing current for much of the year due to the regulated releases from the Fairbairn Dam. It was considered that these releases have created an environment which would ordinarily occur much less frequently (e.g. during storm events).

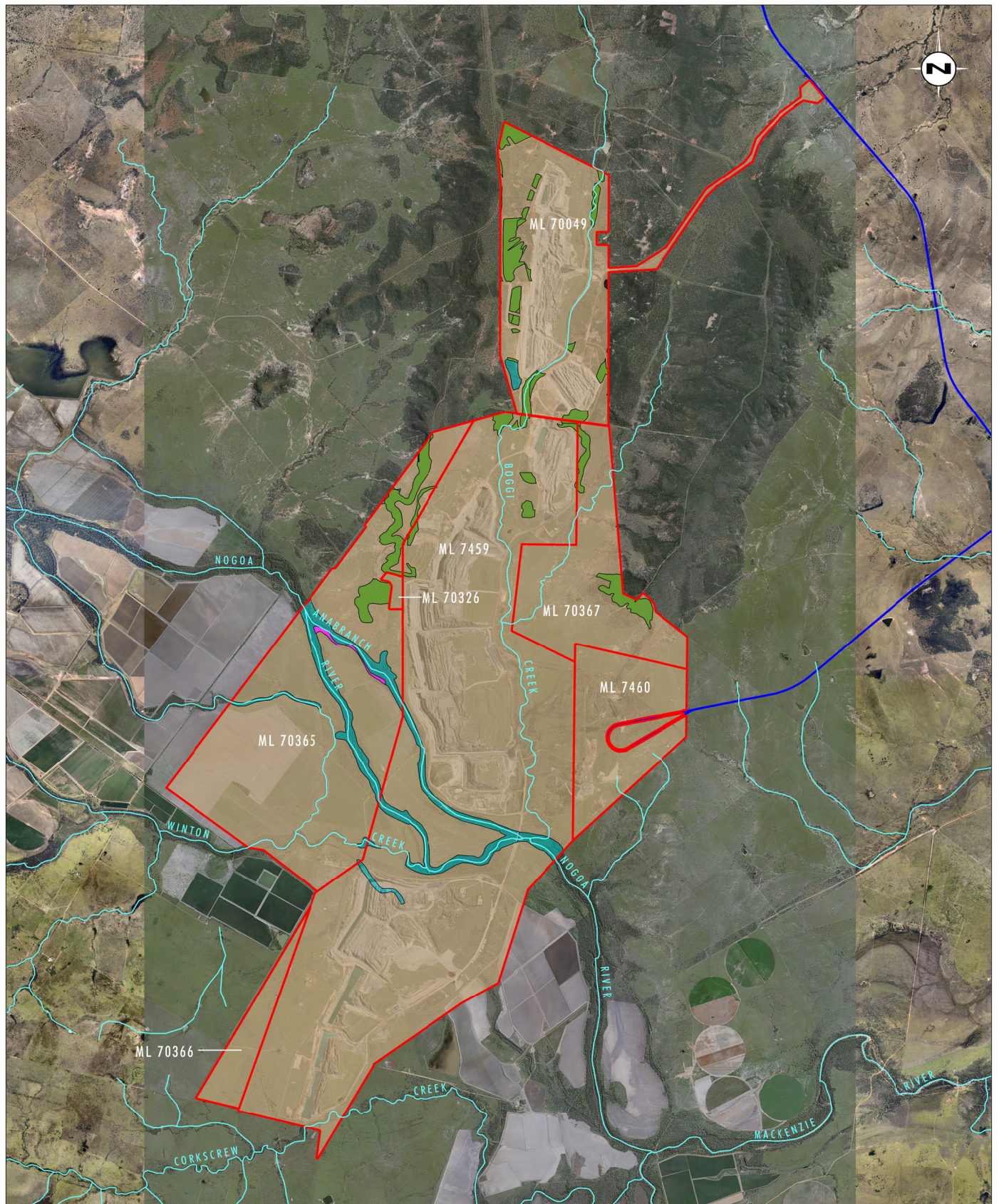


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017) Queensland Government (2018)

0 2.0 4.0 6.0 km
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Legend

- Project Area
- Riparian Wetlands
- Woodlands
- Open Forest
- Disturbed Lands - Pasture - Rehabilitation
- Drainage Lines
- Rail Line

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FIGURE 7.2

Terrestrial and Aquatic Habitats
of the Project Area

Work undertaken in the initial REMP prepared by 4T Consulting (2012) found the channel diversity is either low or very low in the Comet – Nogoia systems, and runs were the most common habitat type, followed by pools. There are few rapids but a number of riffles exist at Riley’s Crossing which is on the Mackenzie River downstream from Ensham (4T Consulting, 2012). There are few backwaters or glides and substrates were found to consist most typically of sand with some gravelly and/or rocky sections where flow velocities are greater. Hydrobiology (2015) installed a monitoring site in a riffle section at Riley’s Crossing downstream of the Ensham Mine Project site to obtain a representative sample of this riffle.

During the aquatic habitat assessments undertaken for the Ensham Central Project, Hansen Consulting (2006) identified that there were no aquatic flora species recorded in the deeper, free-flowing sections of the Nogoia River. It was considered highly likely however that native Water Ribbonweed species such as *Vallisneria* spp. and *Aponogeton elongatus* were present. These aquatic plants would provide important habitat for native invertebrate and fish species and other aquatic fauna such as the identified threatened turtle species.

7.2.2.2 Nogoia River Anabranh

The anabranh was described by Hansen Consulting (2006) as being characterised by muddy banks and a silted substrate. Waterholes generally had steep banks with very little macrophyte growth. Unlike the main channel, the aquatic environment of the anabranh comprised was found to contain a single water hole approximately 100 m long. This water hole was showing signs of eutrophication and was covered by green algae. Hansen Consulting (2006) described these conditions as being typical of a system which is subject to hot dry conditions for much of the year and that no longer receives flood overflows from the Nogoia River on a regular basis due to the presence of Fairbairn Dam.

7.2.2.3 Aquatic Fauna and Habitats of the Pits

With respect to aquatic fauna and habitats, C&R Consulting (2010) undertook an assessment of pit waters on aquatic fauna, specifically fauna present within A Pit. The key findings of this assessment were:

- the water quality encountered within A Pit at the time of survey was impacted by salinity (electrical conductivity measurements ranged between 6,892 $\mu\text{S}/\text{cm}$ to 8,131 $\mu\text{S}/\text{cm}$ between 0.2 to 3 m depth respectively), but all metal toxicant concentrations were below ANZECC Guidelines (2000) for aquatic ecosystems;
- A Pit, at the time of survey had a relatively species-rich fish population, 11 species from six different families having been observed and/or caught. This compares favourably with the 16 species from nine different families that had been recorded in the Nogoia River adjacent to the mine site at the time of this survey;
- at the time of survey, all fish species caught were in good condition, with some exhibiting breeding potential; and
- the macroinvertebrate assemblage present within A Pit was species poor. According to C&R Consulting (2010), this is commonly encountered in highly disturbed, artificial systems.

This report found that fish species are able to survive in the voids for prolonged periods (approximately three years) following high flow events such as those that occurred in 2008. Based upon the work undertaken by C&R Consulting (2010), it appears that with appropriate ingress of fresh water at suitable ratios, the longevity of fish species can continue for extended periods within voids.

7.3 Biodiversity

7.3.1 Flora of the Study Area

In total 918 species of plant from 111 families have been recorded within the Wildlife Online Database (DES, 2018) within 50 km of the Project area. The dominant families consist of Poaceae (178 species), Asteraceae (51 species), Myrtaceae (47 species), Fabaceae (47 species), Malvaceae (46 species), and Chenopodiaceae (32 species). There are 110 species of introduced flora identified within the Study Area.

Due to the high levels of clearing for agricultural purposes throughout the Nogoa River systems, there has been a substantial decline in the occurrence of native vegetation in much of the floodplain areas. According to Pre-European Regional Ecosystem mapping (Queensland Herbarium, 2017), prior to European settlement, the Study Area would have been dominated by woodland and open forest communities.

7.3.2 Fauna of the Study Area

482 species of fauna have been recorded within the Wildlife Online database (DES, 2018) within 50 km of the Project area. These species consist of 67 species of mammal from 21 families, 99 species of reptile from 12 families, 253 species of bird from 14 families, 14 species of insect from 3 families, 22 species of amphibians from 4 families, and 27 species of ray-finned fish from 16 families. Of these species the following numbers of introduced species have been recorded:

- Amphibians: 1 species;
- Mammals: 10 species
- Reptiles: 1 species; and
- Birds: 5 species.

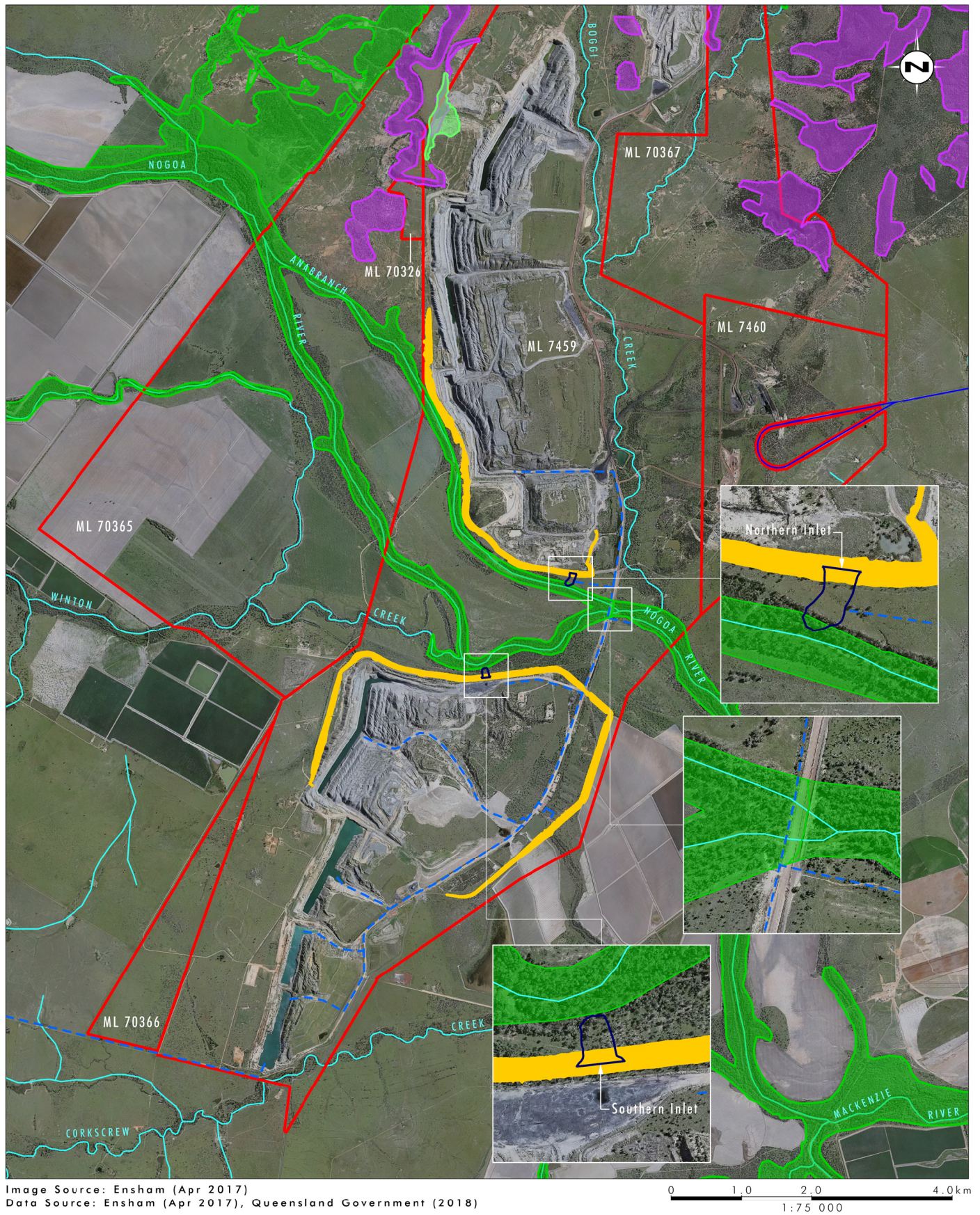
7.4 Threatened Species

7.4.1 Terrestrial Flora and Fauna

Results from the review of the Commonwealth's Protected Matters Search Tool, DES Wildlife Online Database and review of other available sources of data including reports from adjacent mine sites are presented in this section. **Table 7.3** and **Table 7.4** present the consolidated data of the flora and fauna species of conservation significance respectively known or expected to occur within the Study Area.

The species identified in **Table 7.3** and **Table 7.4** were then used in the risk assessments prepared in **Appendix A** and **Appendix B** to determine the likelihood of occurrence of the threatened flora and fauna species within the Project area, in accordance with the methodology described in **Section 4.1**.

While the shrub *Cerbera dumicola* is known to occur on the Project area, this species appears confined to the central western sections of the Project area (**Figure 7.3**), and as such is not considered likely to be impacted by the RVP. Due to the potential presence of the grass *Dichanthium queenslandicum* and the tree *Acacia spania* in proximity to the RVP, and the presence of suitable habitat on the Project area for these species, it is recommended that targeted surveys be undertaken in vegetation communities present on the Project area if potential habitat areas shown in **Figure 7.3** are proposed to be disturbed as a result of the RVP. Any disturbance outside of the existing operational footprint would require field surveys to determine if these species will be impacted. **Figure 7.3** identifies the location of known habitat for the *Cerbera dumicola* and the potential habitats for *Dichanthium queenslandicum* and *Acacia spania* present within the Project area.



Legend

- Project Area
- Proposed Levee Extension
- Inlet Structure
- Proposed Water Pipeline Infrastructure
- Drainage Lines
- Rail Line
- Potential Habitat *Acacia spania*
- Potential Habitat *Cerbera dumicola*
- Potential Habitat *Dicanthium queenslandicum*

FIGURE 7.3

Known and Potential Habitat of
Threatened Flora Species in
and Adjacent to the Project Area

Table 7.5 identifies the threatened fauna species known or expected to occur within the Project area. The Stage 3 Geotechnical investigation has identified that minor changes to the alignment of levees associated with Option 1: LL and Option 2: FMBU will be required. Targeted surveys will be required to be undertaken in accordance with Commonwealth and State Survey Guidelines to ensure impacts on threatened species and their habitats can be avoided where possible. This may involve minor modifications to the alignment or design of levees to potentially reduce the impact on threatened species or their habitats where they are identified. If significant impacts are identified and are unavoidable, appropriate mitigation measures such as relocation of individuals or establishing compensatory habitat components may be considered, and will be determined as part of the Stage 5 regulatory approval process, and prior to any disturbance.

7.4.2 Aquatic Threatened Flora and Fauna

No threatened aquatic flora species were identified during the literature review component of this analysis as occurring on or adjacent to (within 10 km) the Project area.

No threatened insect or fish species were identified during the literature review process as occurring on or adjacent to (within 10 km) the Project area.

Two aquatic reptile species consisting of the Fitzroy River Turtle (*Rheodytes leukops*) and the Southern Snapping Turtle (*Elseya albagula*) were however identified as having potential to occur within the Project area and associated locality (refer to **Appendix B**).

7.4.2.1 Fitzroy River Turtle

The Fitzroy River Turtle was first described in 1980 and is only found in the Fitzroy River and its tributaries, around Rockhampton in eastern central Queensland. The species occurs within permanent freshwater riverine reaches and large, isolated permanent waterholes. The Fitzroy Turtle River is known to feed on the larvae of aquatic insects, sponges and ribbon weed (Limpus *et al.*, 2011).

The breeding season is from September to November. Females excavate a nest in the sand or gravel riverbank during the night and lay approximately 20 eggs in each of one or more clutches, each egg approximately 29 mm long and 21 mm wide. The eggs take about 47 days to hatch (at 30 degrees Celsius) (Limpus *et al.*, 2011).

The Fitzroy River Turtle is sometimes called a "bottom-breathing turtle" due to its highly unusual ability of absorbing oxygen under water through gills in their cloaca (the single opening under the tail used for passing of waste and reproductive material). This enables them to spend virtually all of their time under water and not surface for days in cool running water (Limpus *et al.*, 2011).

This species is known to occur within the Nogoa River.

7.4.2.2 Southern Snapping Turtle

The Southern Snapping Turtle is only found in the Burnett, Fitzroy, Raglan and Mary River drainages of south-east Queensland. It prefers permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees) (Hamman *et al.*, 2007).

The timing of breeding varies between locations with most breeding occurring during autumn and winter. Most turtles lay one clutch per year (average 13 eggs), digging a shallow nest in a sloping river bank. Hatchlings emerge in December or January after an incubation period of around 24 weeks. These turtles may not breed in a year when food is scarce (Hamman *et al.*, 2007).

The Southern Snapping Turtle is mainly a herbivore, eating a range of aquatic plants. Its diet also includes fallen fruit (e.g. native figs) and occasionally aquatic insects, molluscs (e.g. snails) and even small cane toads (Hamman *et al.*, 2007). This species is known to occur within the Nogoia River with this River system representing Essential habitat for this species downstream of the Project area.

Table 7.3 Threatened Flora Recorded from within the Study Area

Common Name	Scientific Name	EPBC Act Status	NC Act Status	PMST	Wildlife Online	Biodiversity Planning Assessment	Ensham Central EIS (2006)	Minyango Mine	Jellinbah Coal Mine	Curragh Mine	Kestrel Mine	Back On Track
King Blue-grass	<i>Dichanthium queenslandicum</i>	E	V	✓	✓	-	-		-	-	✓	Low
Blue-grass	<i>Dichanthium setosum</i>	V	-	✓		-	-		-	-	✓	Low
-	<i>Aristida annua</i>	V	V	✓		-	-		-	-		DD
-	<i>Bertya opposens</i>	V		✓		-	-		-	-		-
Ooline	<i>Cadellia pentastylis</i>	V		✓		-	-		-	-		Critical
-	<i>Solanum elachophyllum</i>	-	E	-				✓	-	-		
Black Ironbox	<i>Eucalyptus raveretiana</i>	V		✓		-	-		-	-		High
-	<i>Marsdenia brevifolia</i>	V		✓		-	-		-	-		-
-	<i>Polianthion minutiflorum</i>	V		✓		-	-		-	-		Low
-	<i>Cerbera dumicola</i>	-	NT	-	✓	-	-		-	-		Low
-	<i>Acacia spania</i>	-	NT	-	✓	-	-		-	-		Low

Note: V- Vulnerable under the EPBC Act and the NC Act; E – Endangered under the EPBC Act and the NC Act; NT – Near Threatened under the NC Act; DD – Data Deficient Species

Table 7.4 Threatened Fauna Recorded from within the Study Area

Common Name	Scientific Name	EPBC Act Status	NC Act Status	PMST	Wildlife Online	Ensham Central EIS 2006	Blackwater Mine Site	Curragh Mine Site	Jellinbah Coal Mine	Kestrel Mine Site	Back On Track
Curlew Sandpiper	<i>Calidris ferruginea</i>	CE, MiW	E	✓	-	-	-	-	-	-	Low
Common Sandpiper	<i>Actitis hypoleucos</i>	MiW	SL	✓	-	-	-	-	-	-	Low
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	MiW	SL	✓	✓	✓	-	✓	-	-	Low
Pectoral Sandpiper	<i>Calidris melanotos</i>	MiW	SL	✓	-	-	-	-	-	-	Low
Marsh Sandpiper	<i>Tringa stagnatilis</i>	MiW	SL	-	✓	✓	-	-	-	-	Low
Little Whimbrel	<i>Numenius minutus</i>	MiW	SL	-	-	-	-	-	-	-	Low
Glossy Ibis	<i>Plegadis falcinellus</i>	MiT	SL	-	-	-	-	-	-	-	Low
Red Goshawk	<i>Erythrorhynchus radiatus</i>	V	E	✓	✓	-	✓	-	-	-	High
Grey Falcon	<i>Falco hypoleucos</i>	-	V	-	✓	-	-	-	-	-	DD
Squatter Pigeon	<i>Geophaps scripta scripta</i>	V	V	✓	-	-	✓	✓	-	✓	Medium
Painted Honeyeater	<i>Grantiella picta</i>	V	V	✓	-	-	-	-	-	-	High
Star Finch	<i>Neochima ruficauda ruficauda</i>	E	E	✓	-	-	-	-	-	-	High
Eastern Curlew	<i>Numenius madagascariensis</i>	CE, M	E	-	-	-	-	-	-	-	Low
Southern Black-Throated Finch	<i>Poephila cincta cincta</i>	E	E	✓	-	-	-	-	-	-	High

Common Name	Scientific Name	EPBC Act Status	NC Act Status	PMST	Wildlife Online	Ensham Central EIS 2006	Blackwater Mine Site	Curragh Mine Site	Jellinbah Coal Mine	Kestrel Mine Site	Back On Track
Australian Painted Snipe	<i>Rostratula australis</i>	E	V	✓	-	-	✓	-	-	✓	Medium
Fork-tailed Swift	<i>Apus pacificus</i>	MiT	SL	✓	-	-	-	-	-	-	-
Horsfield's Cuckoo	<i>Cuculus optatus</i>	MiT	SL	✓	-	-	-	-	-	-	Low
Yellow Wagtail	<i>Motacilla flava</i>	MiT	SL	✓	-	-	-	-	-	-	Low
White-throated Needletail	<i>Hirundapus caudacutus</i>	MiT	SL	-	✓	-	-	-	-	-	Low
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	MiT	SL	✓	✓	-	-	-	-	-	Low
Rufous Fantail	<i>Rhipidura rufifrons</i>	MiT	SL	✓	✓	✓	-	-	-	-	Low
Caspian Tern	<i>Hydroprogne caspia</i>	MiT	SL	-	✓	-	-	-	-	-	Low
Latham's Snipe	<i>Gallinago hardwickii</i>	MiW	SL	✓	✓	✓	-	✓	-	-	Low
Osprey	<i>Pandion haliaetus</i>	MiW	SL	✓	-	-	-	-	-	-	Low
large Pied Bat	<i>Chalinolobus dwyeria</i>	V	V	✓	-	-	✓	-	-	-	Medium
Ghost Bat	<i>Macroderma gigas</i>	V	E	✓	-	-	-	-	-	-	Critical
Corben's Long-eared Bat	<i>Nyctophilus corbeni</i>	V	V	✓	-	-	-	-	-	-	Medium
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	V	-	✓	-	-		-	-	-	Critical

Common Name	Scientific Name	EPBC Act Status	NC Act Status	PMST	Wildlife Online	Ensham Central EIS 2006	Blackwater Mine Site	Curragh Mine Site	Jellinbah Coal Mine	Kestrel Mine Site	Back On Track
Bridled Nail-tail Wallaby	<i>Onychogalea fraenata</i>	E	E	✓	-	-	-	-	-	-	Critical
Koala	<i>Phascolarctos cinereus</i>	V	V	✓	✓	-	-	-	-	-	Low
Greater Glider	<i>Petauroides volans</i>	V	V	✓	-	-	-	-	-	-	Low
Northern Quoll	<i>Dasyurus hallucatus</i>	E	LC	✓	-	-	-	-	-	-	Medium
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	-	SL	-	✓	✓	-	-	-	-	Low
Yakka Skink	<i>Egernia rugosa</i>	V	V	✓	✓	-	-	-	-	-	Medium
Collared Delma	<i>Delma torquata</i>	V	V	✓	-	-	-	-	-	-	High
Ornamental Snake	<i>Denisonia maculata</i>	V	V	✓	-	-	✓	✓	-	✓	Medium
Dunmall's Snake	<i>Furina dunmalli</i>	V	V	✓	-	-	-	-	-	-	Medium
Allan's Lerista	<i>Lerista allanae</i>	E	E	✓	-	-	-	-	-	-	High
Fitzroy River Turtle	<i>Rheodytes leukops</i>	V	V	✓	✓	-	-	-	-	-	High
Southern Snapping Turtle	<i>Elseya albagula</i>	CE	E	✓	✓	-	-	-	-	-	High

Note: MiT – Migratory Terrestrial under EPBC Act, MiW – Migratory Wetland under EPBC Act, V- Vulnerable under the EPBC Act and the NC Act; CE – Critically Endangered under the EPBC Act; E – Endangered under the EPBC Act and the NC Act; SL – Special Least Concern under the NC Act, DD – Data Deficient Species

Table 7.5 Summary of Threatened Species Known or Considered Likely to Occur on the Project area

Common Name	Scientific Name	Status
Curlew Sandpiper	<i>Calidris ferruginea</i>	CE, M (EPBC Act), E (NC Act)
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	M (EPBC Act), SL (NC Act)
Pectoral Sandpiper	<i>Calidris melanotos</i>	M (EPBC Act), SL (NC Act)
Marsh Sandpiper	<i>Tringa stagnatilis</i>	M (EPBC Act), SL (NC Act)
Little Whimbrel	<i>Numenius minutus</i>	M (EPBC Act), SL (NC Act)
Glossy Ibis	<i>Plegadis falcinellus</i>	M (EPBC Act), SL (NC Act)
Red Goshawk	<i>Erythrorhynchus radiatus</i>	V (EPBC Act), E (NC Act)
Grey Falcon	<i>Falco hypoleucos</i>	V (NC Act)
Squatter Pigeon	<i>Geophaps scripta scripta</i>	V (EPBC Act and NC Act)
Eastern Curlew	<i>Numenius madagascariensis</i>	CE and M (EPBC Act), E (NC Act)
Australian Painted Snipe	<i>Rostratula australis</i>	E (EPBC Act), V (NC Act)
Fork-tailed Swift	<i>Apus pacificus</i>	M (EPBC Act), SL (NC Act)
White-throated Needle-tail	<i>Hirundapus caudacutus</i>	M (EPBC Act), SL (NC Act)
Satin Flycatcher	<i>Myiagra cyanolueca</i>	M (EPBC Act), SL (NC Act)
Rufous Fantail	<i>Rhipidura rufifrons</i>	M (EPBC Act), SL (NC Act)
Caspian Tern	<i>Hydroprogne caspia</i>	M (EPBC Act), SL (NC Act)
Latham's Snipe	<i>Gallinago hardwickii</i>	M (EPBC Act), SL (NC Act)
Large-pied Bat	<i>Chalinolobus dwyeri</i>	V (EPBC Act and NC Act)
Corben's Long-eared Bat	<i>Nyctophilis corbeni</i>	V (EPBC Act and NC Act)
Koala	<i>Phascolarctos cinereus</i>	V (EPBC Act and NC Act)
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	SL (NC Act)
Ornamental Snake	<i>Denisonia maculata</i>	V (EPBC Act and NC Act)
Yakka Skink	<i>Egernia rugosa</i>	V (EPBC Act and NC Act)
Grey Snake	<i>Hemiaspis damelii</i>	E (NC Act)
Dunmall's Snake	<i>Furina dunmalli</i>	V (EPBC Act and NC Act)
Fitzroy River Turtle	<i>Rheodytes leukops</i>	V (EPBC Act and NC Act)
Southern Snapping Turtle	<i>Elseya albagula</i>	CE (EPBC Act) and E (NC Act)

Note: M – Migratory under EPBC Act, V- Vulnerable under the EPBC Act and the NC Act; CE – Critically Endangered under the EPBC Act; E – Endangered under the EPBC Act and the NC Act; SL – Special Least Concern under the NC Act.

7.5 Essential Habitat

Essential Habitat mapping (which has recently been updated by DES following state government amendments to the VM Act) indicates that there are some areas of Essential Habitat associated with the Nogoa River and its Anabranche as shown in **Figure 7.4**.

Essential Habitat has been identified for the Ornamental Snake (*Denisonia maculata*) to the west of the Nogoa River and its Anabranche convergence, and includes the riparian areas, and other lowland vegetation. Essential habitat for the southern snapping turtle (*Elseya albagula*) occurs to the east of the convergence and is associated with the Nogoa River.

Option 2 will result in impacts on Essential Habitat due to the installation of intake structures and reinstallation of a water pipeline across the Nogoa River which intersect with areas of essential habitat. Approximately 3 ha of clearing of this habitat will be required for Option 2 as shown in **Figure 7.4**. Option 1:LL and Option 3:BTP do not impact upon the essential habitat as no remnant vegetation will be cleared as a consequence of these options.

7.6 State-Wide Biodiversity Corridor

A state-wide biodiversity corridor strategy was developed for the Queensland *State Planning Policy – State Interests Guideline Biodiversity* (2016) requirements. This identified important areas of vegetation providing biodiversity corridors across the Queensland landscape. This strategy also included provision of a buffer area to the corridor, so that development on or adjacent to the corridor (within the buffer area) is adequately assessed to prevent potential impacts of development on the wildlife corridor.

The Project area is traversed by a recognised state-wide biodiversity corridor as shown in **Figure 7.5** identified under the State Planning Policy (SPP) for the protection of biodiversity. It should be noted that the provisions of the SPP do not apply to components of this project that occur within the existing mine footprint as these have been assessed under the *Environmental Protection Act (1994)* for mineral activities. The components outside of the mining tenements (i.e. the Option 2: FMBU pipeline to Weemah Channel) may be subject to the SPP. Further assessment will therefore be required with regard to project infrastructure that will need to be constructed on private land outside the MLs.

The state-wide biodiversity corridor is associated with the Nogoa River Anabranche and its major tributaries and includes a buffer area. Option 1: LL and Option 3: BTP do not impact upon the biodiversity corridor as no remnant vegetation will be cleared as a consequence of these options.

Works within the existing Ensham Mine site are not bound by any regulatory requirements associated with this corridor as mining activities are not subject to State Planning Policy provisions. Standard conditions of the existing Ensham EA address impacts on this corridor through the prevention of impacts to riparian vegetation, and mitigation measures addressing noise, sedimentation and erosion control.

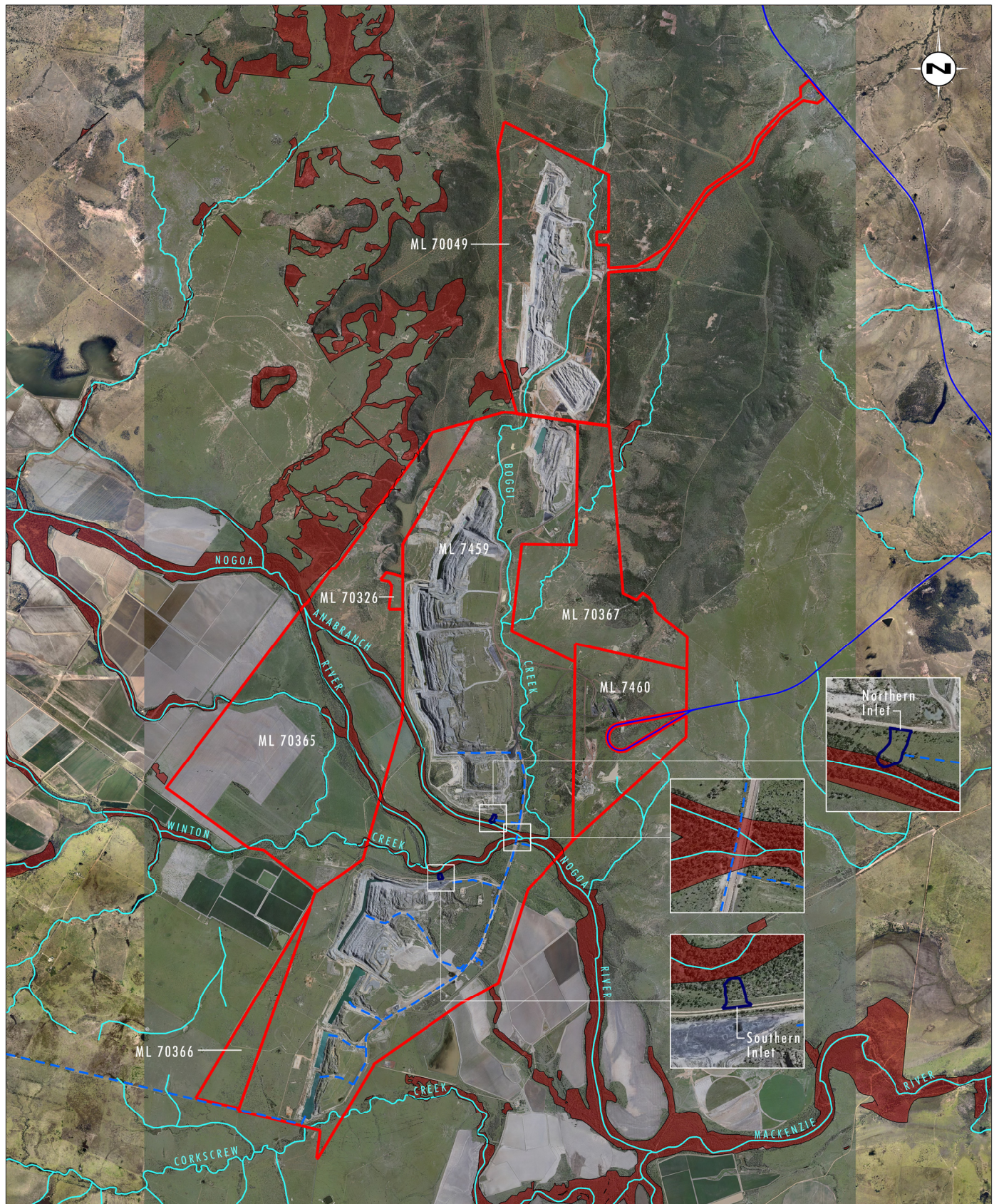


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017), Queensland Government (2018)

0 2.0 4.0 6.0 km
1:125 000

Legend

- ▬ Project Area
- Essential Habitat
- ▬ Inlet Structure
- Proposed Water Pipeline Infrastructure
- Drainage Lines
- Rail Line

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FIGURE 7.4

DES Mapped Essential Habitat on
and Adjacent to the Project Area

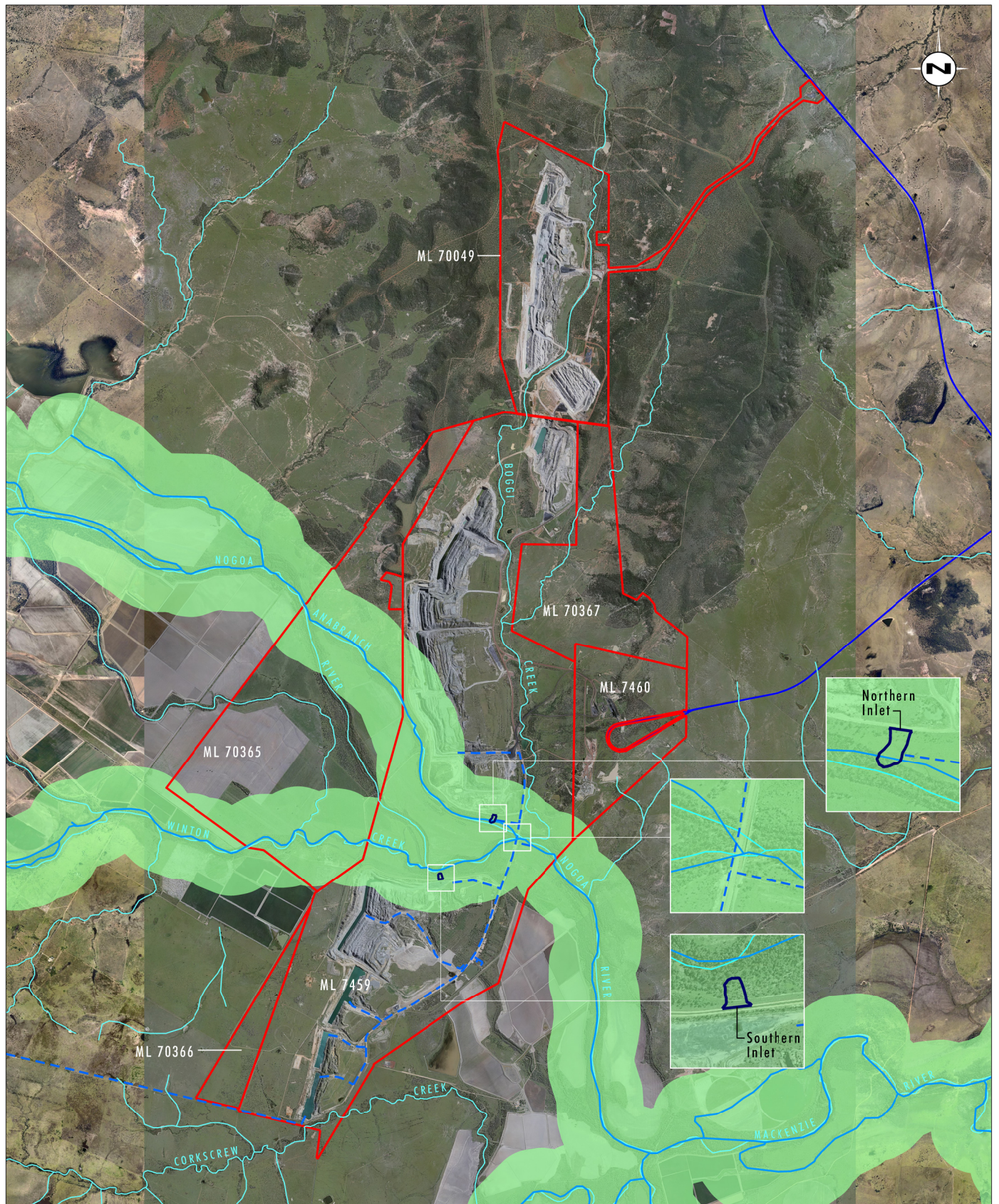


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017)

0 2.0 4.0 6.0 km
1:125 000

Legend

- ▬ Project Area
- ▬ Inlet Structure
- - - Proposed Water Pipeline Infrastructure
- Riparian Corridor
- ▬ Riparian Centreline
- ▬ Drainage Lines
- ▬ Rail Line

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FIGURE 7.5

State-wide Biodiversity Corridor

7.7 Queensland Wetland and Riparian Areas

To understand impacts upon wetland areas, this ecological assessment has considered implications of the three Options with the following:

- *Environmental Offsets Act 2014*;
- *Environmental Protection Regulation 2014*;
- *Vegetation Management Act 1999*; and
- Existing conditions under the Ensham Mine Environmental Authority (EPML00732813) relative to riparian areas (Condition D38).

Further to the above, the map of referable wetlands, a state-wide regulatory map under the *Environmental Protection Regulation 2008* was reviewed with respect to the RVP. The map of referable wetlands identifies wetlands of high ecological significance (HES) and general ecological significance (GES) across the state. HES wetlands on the map are identified as matters of state environmental significance (MSES) under the *Environmental Offsets Act* (2014). No referable wetlands were identified on or adjacent to the Project area.

While the provisions of the *VM Act* do not apply to the project components within the existing approved mine footprints, this Act does however recognise the ecological importance of riparian wetland REs such as RE 11.3.25e, RE 11.3.3 or RE 11.4.8, which occur on the Project area. Riparian wetland vegetation is considered an important component to wetland systems and provisions are incorporated into the *VM Act* to protect this vegetation. In addition to the *VM Act*, Condition D38 of the EA, prescribed under the *Environmental Protection Act 1994*, recognises the value of riparian vegetation and requires that flood protection levees not impact on riparian or existing remnant vegetation. Options 2 and 3 are considered compliant with Condition D38 of the EA. Queensland riparian wetlands and watercourses with respect to the Project area and locality are shown in **Figure 7.2**. Option 1 may be compliant with Condition D38 provided the works associated with the regrading of the levee structures for this option remain outside of remnant areas of riparian vegetation.

7.8 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems have been divided into the following systems for assessment within this report:

- Terrestrial GDEs; and
- Potential GDE Aquifers and Subterranean Fauna.

7.8.1 Terrestrial GDEs

Review of the Queensland Globe mapping for Terrestrial GDEs, identified that the Nogoa River and its Anabranche may represent a GDE as shown in **Figure 7.6**.

Terrestrial GDEs are ecosystems that are dependent on the sub-surface presence of groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services. Terrestrial GDE area features include riverine wetlands and deep-rooted regional ecosystems that have some sub-surface groundwater dependency.

Recent studies have found that groundwater occurrence in the alluvium at Ensham is highly variable, with thin saturated zones of poor quality water in deeper sections of an otherwise largely unsaturated formation (AGE, 2006). Water level data shows the seasonal variability in groundwater to be limited and coincident with the heterogeneous distribution of these sediments. Shallow silts and clays are anticipated to be partially isolating the Nogoa River, limiting leakage from the river into the basal sands and gravels. It is possible that leakage may occur where these clays are absent or where the basal sands are exposed within the river. However, this is conceptually thought to occur only in localized areas. This hydraulic separation of the alluvium from the Nogoa River means that whilst the water in the river is fresh, the underlying alluvium can be brackish to highly saline (HS, 2018).

Based on the separation of the riparian alluviums from the deeper impacted alluviums associated with the coal seams, there is not expected to be any adverse impacts on terrestrial GDEs in the Project area.

7.8.2 Potential GDE Aquifers

The Project Area has several types of aquifers, with the two main aquifers being the alluvial aquifer (along the river and tributaries) and the coal seam aquifer of the Rewan Group or Rangal Coal Measures, which contain fine grained sandstone and siltstone. These aquifers have the potential to support subterranean fauna (e.g., stygofauna) (refer to **Section 7.8.3**). The physico-chemical quality of groundwater can indicate the suitability of an aquifer to provide habitat for subterranean fauna. Generally, the aquifers that are inhabited by subterranean fauna exhibit relatively stable water quality, with little variation in temperature, salinity and pH. As such, subterranean fauna are typically highly sensitive to changes in their environment. The Queensland Government has prepared mapping of potential subterranean fauna aquifers as shown in **Figure 7.7**.

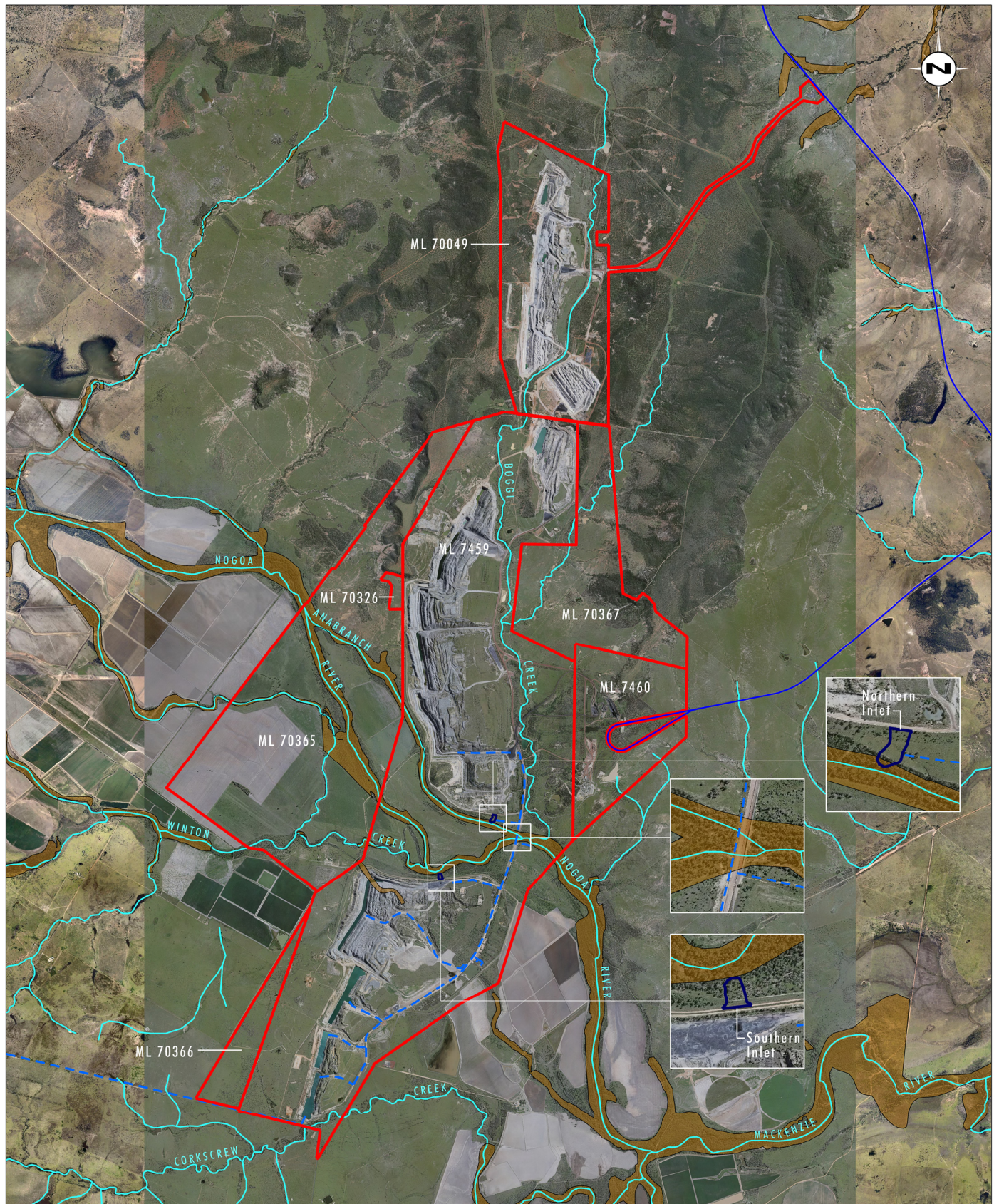


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017), Queensland Government (2018)

0 2.0 4.0 6.0 km
1:125 000

Legend

- ▬ Project Area
- ▬ Inlet Structure
- - - Proposed Water Pipeline Infrastructure
- Terrestrial GDEs
- ▬ Drainage Lines
- ▬ Rail Line

File Name (A4): R02/7029_066.dgn
20181121 10.30

FIGURE 7.6

Terrestrial GDEs In and Adjacent
to the Project area

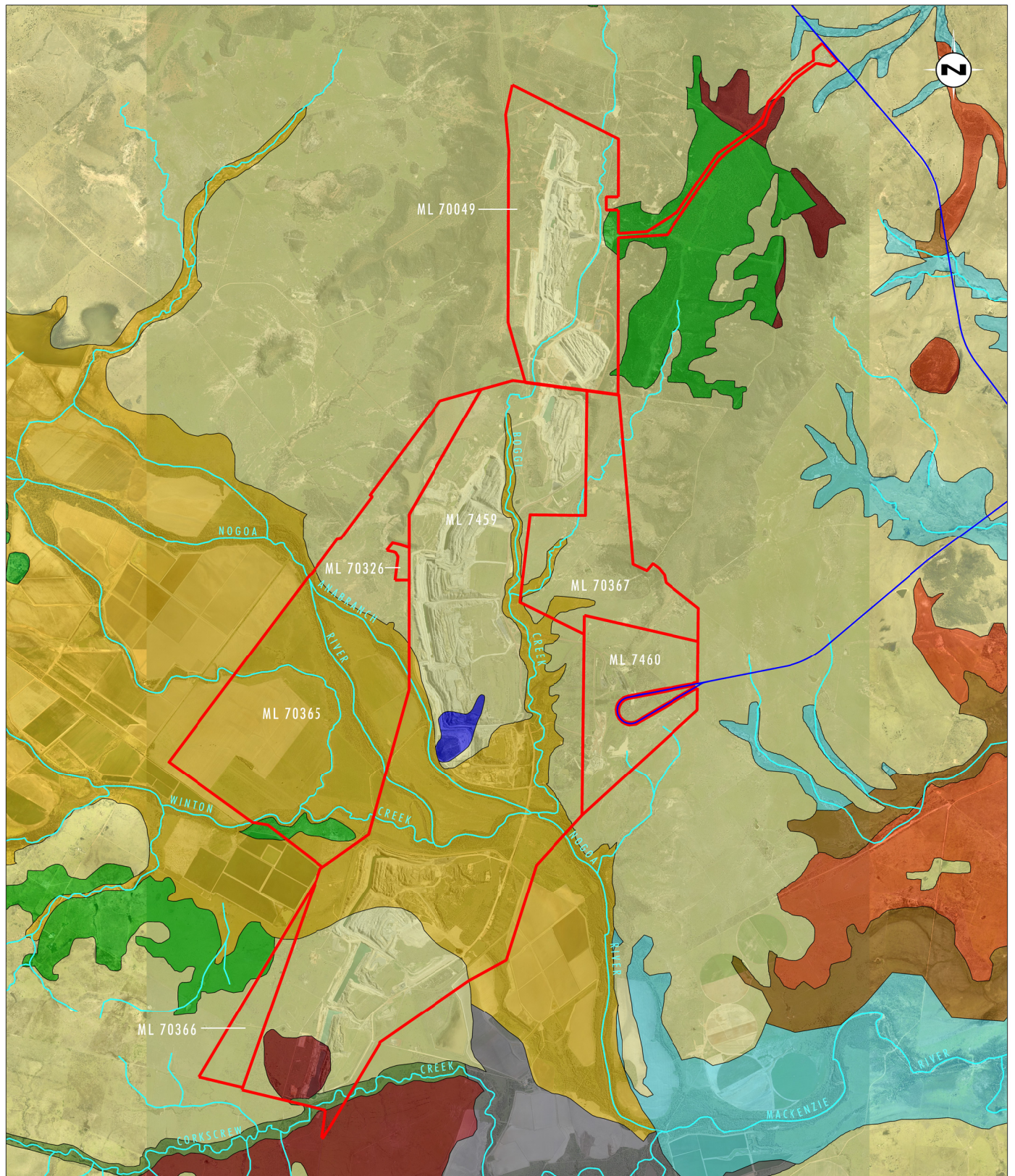


Image Source: Nearmap (2011), Ensham (Apr 2017)
Data Source: Ensham (Apr 2017), Queensland Government (2018)

0 2.0 4.0 6.0 km
1:125 000

Legend

- Project Area
- Exclusion zones
- Permeable consolidated sedimentary rock aquifers with fresh, intermittent groundwater connectivity regime
- Permeable old loamy and sandy plains with fresh, intermittent groundwater connectivity regime
- Permeable rock aquifers (sandstones) with fluctuating, intermittent groundwater connectivity regime
- Permeable sandy plain aquifers with fluctuating, intermittent groundwater connectivity regime
- Quaternary alluvial aquifers overlying sandstone ranges with fresh, intermittent groundwater connectivity regime
- Quaternary alluvial aquifers with fluctuating, intermittent groundwater connectivity regime
- Quaternary alluvial aquifers with fluctuating, intermittent groundwater connectivity regime and unknown pH
- Quaternary alluvial aquifers with fluctuating, intermittent groundwater connectivity regime with neutral pH
- Quaternary alluvial aquifers with fresh, intermittent groundwater connectivity regime
- Drainage Lines
- Rail Line

FIGURE 7.7

Potential GDE Aquifers
in and Adjacent to
the Project Area

Table 7.6 Groundwater quality Ensham Coal Project

(EC = electrical conductivity) (Data source: Ensham, 2018)

Bore Code	Geology	Date	EC	pH	Sodium	Calcium	Magnesium	Potassium	Chloride	Bicarbonate Alk. as CaCO ₃	Sulfate as SO ₄ -	Manganese	Aluminium	Arsenic	Boron	Iron
			(µS/cm)	pH Value	mg/L											
EC03	Alluvium	7/5/2018	14 300	7.31	2450	278	348	3	4770	1230	462	2.13	15.9	0.006	0.24	218
EC07	Alluvium	7/5/2018	25 600	6.88	3700	1180	740	10	9450	1140	781	9.65	46.5	0.047	0.06	76.2
EC09A	Alluvium	7/5/2018	18 900	7.33	3180	484	585	3	6510	1880	534	0.226	0.93	0.004	0.07	161
EC11	Alluvium	7/5/2018	21800	7.13	3340	703	753	7	7940	1630	631	4.59	6.59	0.013	0.06	318
EC13	Alluvium	7/5/2018	17 700	6.75	1970	906	706	13	6840	765	564	26.4	2.28	0.002	0.06	113
EC14	Alluvium	7/5/2018	1070	7.49	171	29	23	4	154	352	5	0.984	54.7	0.012	0.06	62.2
GW01	Alluvium	4/5/2018	5740	8.16	974	48	121	2	1440	624	268	0.113	0.04	0.004	0.17	0.39
Fairhill Bore	Burngrove Formation	5/5/2018	1920	6.98	302	33	28	12	506	191	76	0.003	<0.005	0.003	0.55	<0.025
Yongala Bore	Burngrove Formation	5/5/2018	2880	7.23	386	81	64	15	849	214	48	0.251	0.02	<0.0005	0.78	5.6
Jamar Bore	Rewan Formation	6/5/2018	4200	7.74	624	87	63	5	1320	109	<0.5	0.265	<0.005	0.008	0.32	0.2
Twin Bores	Alluvium	6/5/2018	11200	7.61	1620	187	381	8	3790	449	654	0.17	0.03	0.001	0.78	0.25
Winton Creek Bore	Alluvium	6/5/2018	7530	7.85	1270	132	70	7	2630	239	45	0.202	0.03	<0.0005	0.78	0.28
Railway Bore	Undiff Coal Measures	5/5/2018	6370	7.32	1070	104	174	25	1300	1070	577	0.01	<0.005	<0.0005	0.78	0.66
RB1	Rewan, Rangal	5/5/2018	3430	8.16	677	14	10	3	938	405	4	0.014	0.02	<0.0005	0.78	0.14
RB2	Rewan, Rangal	5/5/2018	10 700	7.69	1970	143	31	7	4030	126	<0.5	0.069	0.01	0.002	0.78	0.65
RB3	Rewan, Rangal	4/5/2018	9840	7.91	1900	64	12	6	3650	174	1	0.032	<0.005	<0.0005	0.78	0.34
RB4	Rewan	6/5/2018	7580	7.96	1430	63	9	8	2670	186	6	0.015	0.05	0.001	0.78	0.3
RB6	Rangal coal	6/5/2018	6940	7.48	813	196	269	9	2280	446	141	0.132	2.32	0.001	0.78	4.54
WSMB2D	Emerald Formation	4/5/2018	12 100	7.16	1960	274	248	14	4100	548	618	0.096	0.03	<0.0005	0.78	171
WSMB3D	Emerald Formation	3/5/2018	6150	7.67	970	130	76	7	1980	123	<0.5	0.101	0.02	<0.0005	0.78	0.57

7.8.3 Subterranean Fauna

Subterranean fauna are defined as fauna that live their entire lives below the ground surface. They are divided into two groups - aquatic and non-aquatic. Organisms that are restricted to aquatic systems below ground are termed stygofauna, and those that inhabit air filled voids and fractures below the surface are classed as troglofauna. Within these two groups there are varying levels of dependence upon the subterranean habitat. Those that spend their entire life cycle below ground are considered to be truly subterranean.

7.8.3.1 Troglofauna

The nature and structure of cavity development is important in determining potential habitat for troglofauna. Cavities must not be filled with sediment, isolated or sealed, with troglofauna requiring interconnected voids that allow for circulation of water, gases and nutrients, as well as animal movement (Eberhard, 2007). By inhabiting environments that have 100 % relative humidity, or by reducing surface area available for water loss, the problem of water loss faced by invertebrates can be overcome (Villani *et al.*, 1999). Troglofauna, while humidity is essential to their existence, do not inhabit spaces that are regularly inundated.

In Queensland, Troglofauna are poorly documented with studies generally restricted to caves and karst systems (Thurgate *et al.*, 2001) such as Chillagoe Karst and Undara lava tubes (Hoch and Hosfeld, 1999). Additionally, unlike Western Australia (EPA, 2012), no troglofauna have been yielded as bycatch in surveys completed as part of Queensland EIAs which may indicate their habitat is restricted to karstic cave systems (Thurgate *et al.*, 2001).

Stage 2 of the RVP did not identify troglofauna habitat in the Project area. Further to this, the Stage 3 Groundwater Report (HS, 2018c) identified that there will be no groundwater drawdown in areas above the floodplain, as a result of the RVP. This finding supports the Stage 2 assessment that there will be no impacts upon troglofauna in and adjacent to the Project area as a result of the RVP. The majority of the Project area, as defined in the ToR, is dominated by floodplain. Floodplains exclude troglofauna due to the periodic inundation of air filled cavities during flood events.

Due to the lack of suitable habitat within the Project area, troglofauna are not considered further in this report.

7.8.3.2 Stygofauna

Stygofauna in Queensland

A review on the status of knowledge regarding stygofauna diversity, ecology and biogeography within Australia was commissioned by ACARP (Hose *et al.*, 2015). Queensland is known to host at least 24 described stygofauna families and 23 described genera across nine of the 17 major stygofauna taxonomic groups. Additionally, undescribed families have been recorded across a further three major stygofauna taxonomic groups. The composition of stygofauna is consistent with communities found in other regions in Australia and globally. However, Queensland assemblages appear to be unusually rich in Oligochaetes and Syncarids (Glanville *et al.*, 2016).

Stygofauna in Queensland have been recorded as inhabiting a wide range of lithologies. These include unconsolidated and consolidated sedimentary material and fractured rocks. Variation in stygofauna yields indicated differences in habitat suitability based on lithology, however there were exceptions to this and given the stygofauna in Queensland still are largely undocumented, groundwater systems cannot be excluded from the possibility of stygofauna being present.

Review of the data in the Queensland Subterranean Aquatic Fauna Database selected data from projects within the Bowen Basin from Projects with similar geologies (**Table 7.7**). Only sites with stygobites were selected from the database and the EIA reports corresponding with the data were reviewed. In general, the alluvial systems were considered depauperate. The Crustacea were the only true stygobites and included the

syncarids and copepods (harpacticoids and cyclopoids) (**Table 7.7**). The highest yields were from the alluvium aquifers. The syncarid family Parabathynellidae occurs across the greatest number of IBRA sub-regions in Queensland, followed by the Bathynellidae and Cyclopidae (copepods). The majority of the stygal families in Queensland occur in alluvium followed by Basalt and Coal aquifers. Sandstone and Silt aquifers had the lowest diversity. The syncarids and copepods also exist in a greater diversity of lithologies than other taxa (Glanville *et al.*, 2016).

Table 7.7 Stygofauna yielded from Queensland coal projects. Data sourced from DESI

Project	Site ID	Lithology	Drainage Basin	Stygofauna yielded
East End No. 5	160	Sedimentary Rock	Calliope	Bathynellidae (Syncarid)
	161			Bathynellidae
	175	Alluvium		Bathynellidae, Parabathynellidae (Syncarid)
Rolleston Coal	192	Basalt	Fitzroy	<i>Notobathynella</i> sp. (Syncarid)
	91			
Elimatta	230	Alluvium		<i>Parastenocaris</i> spp. (Harpacticoid), <i>Dussartcyclops</i> sp. ELIM (Cyclopoid)
	246			
	262			
	266			
Teresa	360	Alluvium		<i>Notobathynella</i> sp.
Ravenswood	288	Granitoid	Burdekin	<i>Parabathynellidae</i>
	342			
	343			
	344			
Byerwen	351	Basalt		<i>Notobathynella</i> sp.
Kevin's Corner Project	10	Sandstone-Mudrock		<i>Notobathynella</i> sp.
Carmichael Coal	133	Coal	<i>Notobathynella</i> sp.	

Stygofauna Habitat in the Project Area

Biological distribution in groundwater is influenced by various properties which include geology, hydrology, physico-chemical and biological (Strayer, 1994). Not all aquifers are suitable for groundwater invertebrates. While stygofauna have been collected from many aquifer types including fractured basalt, fractured sandstone and pesolithic, karstic and alluvial aquifers often have the highest yields and greatest diversity (Hancock *et al.*, 2005; Humphreys, 2008). Endemic stygofauna are not distributed randomly; rather they are concentrated in regions that support diverse communities such as surficial aquifers, with diversity decreasing with increasing depth.

Central sections of the Project area are associated with the Nogoa River and its Anabranh and contain potential GDE aquifers (refer **Section 7.8.2**). Mapping prepared by DEHP indicates that unconsolidated sediments are extensively distributed throughout the Project area along the Nogoa River floodplain channels. Further to this, a sandstone outcrop is also known to occur (**Figure 7.7**). These areas represent suitable habitat for stygofauna.

Based on similar geologies in the Fitzroy Basin, the likelihood of a high stygofauna diversity in the Project area appears low given that similar alluvium with lower salinities does not appear to support diverse communities. Additionally, the alluvium aquifer that follows the Nogoa River and the Anabranche in the Project area is continuous and hydraulically connected to features that are important in maintaining the integrity of subterranean ecosystems as they promote recharge and allow taxa to disperse (Stayer, 1994).

It was also noted within the Groundwater Report (HS, 2018c) that drawdown associated with current approved mining operations has and will occur along the length of the Nogoa River floodplain adjacent to the mine site. According to HS (2018c), the alluvial aquifers do not appear to be connected to the residual voids or the deeper Rangal or Rowan Coal Measure aquifers. As a consequence, drawdown associated with on-going mining operations appears to be restricted to the deeper coal aquifers in and adjacent to the Project area. Given the depth and high salinity of the groundwater within these deeper coal measures, there is not anticipated to be any impacts on subterranean fauna.

Impacts associated with increasing salinity levels as well as metals/metalloid concentrations associated with Option 1 are not expected to impact the alluvial aquifer as the alluvial aquifer is not connected to the residual voids. Further to this, Options 1 and 3 will predominantly act as groundwater sinks until groundwater equilibrium is achieved. As a consequence, there is not expected to be any adverse impacts on the deeper groundwater aquifers present in and adjacent to the Project area.

Option 2 will predominantly act as a groundwater sink, however periodically this may alter under expected management operations. The water quality of Option 2 waters will be maintained with respect to salinity, and potential contaminants, at levels suitable for irrigation purposes. Therefore any water outflow to the deeper aquifers will be of lower salinity, and better quality than the current groundwater quality.

8.0 Biosecurity

Biosecurity at the Ensham Mine Site is carried out in accordance with Weed and Pest Animal Management Policy under the Ensham Mine Environmental Management System. This policy outlines the accepted measures to remove, control and limit the spread of pests, weeds, and disease pathogens on site.

With respect to the RVP, an assessment of the known disease pathogens, weeds, and pests present in the Study Area has been undertaken and compared to the existing Weed and Pest Animal Policy, to ensure all restricted species are addressed. This Policy was prepared with the assistance of the Central Highlands Regional Council.

Further to the above, measures specific to the RVP have been proposed below to ensure the removal, control of disease pathogens, weeds, and pests are controlled and the potential for spread is limited. This includes the development of a monitoring program that will allow the audit of the success of measures, and will assist in determining the success of the Ensham Weed and Pest Management Policy in the longer term.

8.1 Pathogens

Review of the Department of Agriculture and Fisheries plant pests and disease web page¹ indicates there are no pathogens that are likely to affect the Ensham Mine Site. Proposed control methods are proposed in **Table 8.2** below to minimise this risk.

8.2 Weeds

Table 8.1 below identifies the weed species or restricted matters that are known to occur within 10 km of the Project area. Species that are listed as Weeds of National Significance (WoNS) or listed under the *Biosecurity Act 2014* and identified under the *Central Highlands Regional Council Biosecurity Plan 2017-2022* (Central Highlands Regional Council, 2017) are included in this table.

It is of note that Buffel Grass (*Cenchrus ciliaris*) is recognised as a weed of national significance due to its invasive nature into ecosystems. This species is also recognised as an important pasture species in Queensland. The listing of Buffel Grass as a Weed of National Significance provides mechanisms for the control of this species within important conservation significant ecosystems, and also provides recognition of the impact of this species on these systems. This species should be avoided where rehabilitation of native vegetation is proposed.

¹ <https://www.daf.qld.gov.au/business-priorities/plants/health-pests-diseases/a-z-significant> (accessed 20 August 2018)

Table 8.1 Weed Species Known or Expected to Occur within 10 km of the Project area

Scientific Name	Common Name	PMST Type of Presence	Recorded on Wildlife Online (10 km Radius)	Presence on Project area	Biosecurity Act ¹² Priority Status
<i>Acacia nilotica subsp. indica</i>	Prickly Acacia	Species or species habitat may occur within area	-	-	2
<i>Verbesina encelioides</i>	Crownbeard	-	✓	-	-
<i>Symphytotrichum subulatum</i>		-	✓	-	-
<i>Xanthium occidentale</i>		-	✓	-	-
<i>Eclipta prostrata</i>	White Eclipta	-	✓	-	-
<i>Melochia pyramidata</i>		-	✓	-	-
<i>Euphorbia hyssopifolia</i>		-	✓	-	-
<i>Stylosanthes scabra</i>		-	✓	-	-
<i>Malvastrum americanum var. americanum</i>		-	✓	-	-
<i>Gossypium hirsutum</i>		-	✓	-	-
<i>Sida spinosa</i>	Spiny Sida	-	✓	-	-
<i>Sida cordifolia</i>		-	✓	-	-
<i>Malvastrum coromandelianum subsp. coromandelianum</i>		-	✓	-	-
<i>Oxalis corniculata</i>		-	✓	-	-
<i>Antigonon leptopus</i>		-	✓	-	-
<i>Harrisia martinii</i>	Harrisia Cactus	-	✓	✓	2
<i>Portulaca oleracea</i>	Pigweed	-	✓	-	-
<i>Argemone ochroleuca subsp. ochroleuca</i>	Mexican Poppy	-	✓	-	-
<i>Setaria verticillata</i>	Whorled Pigeon Grass	-	✓	-	-
<i>Urochloa mosambicensis</i>	Sabi Grass	-	✓	-	-
<i>Melinis repens</i>	Red Natal Grass	-	✓	-	-
<i>Cenchrus ciliaris</i>	Buffel Grass	-	✓	-	-
<i>Echinochloa colona</i>	Awnless Barnyard Grass	-	✓	-	-
<i>Megathyrsus maximus</i>		-	✓	-	-

² Under the Central Highlands Biosecurity Plan (2017-2022) Weeds and Pests are issued with a Priority Status from 1 Exclusion: from entering Council area, 2. Destruction: of isolated, strategic infestations or populations, 3. Containment: within specified areas, 4. Control: Broadscale control with chemical, biological and trapping, and 5. Monitoring: ongoing survey and assessment of distribution, prevalence and risk.

Scientific Name	Common Name	PMST Type of Presence	Recorded on Wildlife Online (10 km Radius)	Presence on Project area	Biosecurity Act ¹² Priority Status
<i>Cryptostegia grandiflora</i> *	Rubber Vine	Species or species habitat likely to occur within area	-	-	5
<i>Hymenachne amplexicaulis</i> *	Hymenachne	Species or species habitat likely to occur within area	-	-	3
<i>Jatropha gossypifolia</i> *	Cotton-leaved Physic-Nut	Species or species habitat likely to occur within area	-	-	2
<i>Opuntia spp.</i> *	Prickly Pears	Species or species habitat likely to occur within area	✓	✓	5
<i>Opuntia tomentosa</i>	Velvet Tree Pear	-	✓	✓	
<i>Parkinsonia aculeata</i> *	Parkinsonia	Species or species habitat likely to occur within area	✓	✓	3
<i>Parthenium hysterophorus</i> *	Parthenium Weed	Species or species habitat likely to occur within area	-	✓	3

Note: * WoNS Species; ¹ - Weeds Identified under the Biosecurity Act 2014 and in the Central Highlands Regional Council Biosecurity Plan 2017-2022

8.2.1 Management Recommendations

A Weed and Pest Animal Management Policy (Ensham EMS EP 8.1) has been developed for the Ensham Mine site under the sites Environmental Management System. Restricted matters, including Parthenium Weed, Parkinsonia, *Opuntia* spp. and Harrisia Cactus, are currently controlled in accordance with this plan. It is anticipated that these control measures will be carried forward by the ultimate land manager of the Project area.

The residual voids are likely to create waterbodies which may result in the proliferation of aquatic weeds. The Ensham Weed and Pest Animal Management Policy (Ensham EMS EP 8.1) will need to be amended to incorporate monitoring and control procedures to manage potential occurrences of aquatic weed species for all residual voids. It is anticipated that these control measures will be carried forward by the ultimate land manager of the Project area.

Table 8.2 Management Recommendations to Control Weeds

Period	Issue	Management Recommendation
Ongoing Land Management	Inspection vehicles carrying weeds or pathogens.	Vehicles used for any inspections or monitoring activities on site are to be cleaned and inspected prior to entry and exit of the site.
	Vegetated areas to be monitored following significant rainfall events.	Inspections to be undertaken to identify any outbreaks of restricted species. Where restricted species are identified, the owner or operator should control outbreaks in accordance with the control measures identified in the Weed and Pest Animal Management Policy.

Period	Issue	Management Recommendation
	Residual voids may encourage proliferation of aquatic weed species.	Annual inspections for presence of priority aquatic weed species. Outbreaks to be controlled using the measures identified in the Weed and Pest Animal Management Policy.

8.3 Feral Species

Table 8.3 below identifies the feral animal species that may occur or are known to occur within 50 km of the Project area that are listed as having National Significance or listed under the *Biosecurity Act 2014* and identified under the *Central Highlands Regional Council Biosecurity Plan 2017-2022* (Central Highlands Regional Council, 2017).

Table 8.3 Feral Fauna Species Known to Occur within 50 km of the Project area

Scientific Name	Common Name	PMST Type of Presence	Presence on Project area	Central Highlands BioSecurity Plan Priority Status ³	Ensham Mine Site Status
<i>Hemidactylus frenatus</i> *	Asian House Gecko	Species or species habitat likely to occur within area	-		-
<i>Columba livia</i> *	Rock Pigeon	Species or species habitat likely to occur within area	-		-
<i>Sturnus vulgaris</i> *	Common Starling	Species or species habitat likely to occur within area	-	5	✓
<i>Acridotheres tristis</i>	Indian Myna	-	-	1	✓
<i>Anas platyrhynchos</i> *	Mallard	Species or species habitat likely to occur within area	-		-
<i>Streptopelia chinensis</i> *	Spotted Turtle-Dove	Species or species habitat likely to occur within area	-		-
<i>Passer domesticus</i> *	House Sparrow	Species or species habitat likely to occur within area	-		-
<i>Rhinella marina</i> *	Cane Toad	Species or species habitat likely to occur within area	✓	-	
<i>Canis lupus familiaris</i> *	Domestic Dog	Species or species habitat likely to occur within area	-	1	✓
<i>Felis catus</i> *	Cat	Species or species habitat likely to occur within area	✓	3	✓
<i>Lepus capensis</i> *	Brown Hare	Species or species habitat likely to occur within area	✓	-	✓
<i>Mus musculus</i> *	House Mouse	Species or species habitat likely to occur within area	✓	-	✓

³ Under the Central Highlands Biosecurity Plan (2017-2022) Weeds and Pests are issued with a Priority Status from 1 Exclusion: from entering Council area, 2. Destruction: of isolated, strategic infestations or populations, 3. Containment: within specified areas, 4. Control: Broadscale control with chemical, biological and trapping, and 5. Monitoring: ongoing survey and assessment of distribution, prevalence and risk.

Scientific Name	Common Name	PMST Type of Presence	Presence on Project area	Central Highlands BioSecurity Plan Priority Status ³	Ensham Mine Site Status
<i>Oryctolagus cuniculus</i> *	Rabbit	Species or species habitat likely to occur within area	✓	3	✓
<i>Rattus rattus</i> *	Black Rat	Species or species habitat likely to occur within area	✓	-	✓
<i>Sus scrofa</i> *	Pig	Species or species habitat likely to occur within area	✓	1	✓
<i>Vulpes vulpes</i> *	Red Fox	Species or species habitat likely to occur within area	✓	3	✓
Various species	Feral Deer	-	-	1	✓

Note: * -Commonwealth Identified Feral Species; 1 - Pest Fauna Identified under the *Biosecurity Act 2014* and incorporated in the *Central Highlands Regional Council Biosecurity Plan 2017-2022*.

8.3.1 Management Recommendations

A Weed and Pest Animal Management Policy has been developed for the Ensham Mine site under the site's Environmental Management System. Restricted matters, including Red Fox, Pig, Black Rat, Rabbit, Cat, Dog and House Mouse are currently controlled in accordance with this plan. It is recommended that this existing plan be amended to ensure adequate controls are put in place for the appropriate control of restricted pest species for areas to be disturbed prior to implementation of the selected RVP Option. It is anticipated that this plan will form the basis for on-going pest management following mine relinquishment.

Table 8.4 Proposed Management Recommendation to Control Feral Animals

Period	Issue	Management Recommendation
Ongoing Land Management	Presence of pest species.	Annual inspections of RVP areas for presence of restricted pest species. Outbreaks to be controlled using the measures identified in the Weed and Pest Animal Management Policy.

9.0 Gap Analysis

The known biophysical (hydrological, geotechnical, water quality and environmental) aspects of the Project area, were assessed for gaps in information that may have consequences for later stages of the ecological assessment of the RVP. Where any gaps were found, the particular gap was then identified, so it may be addressed in later stages of the project. This analysis has also considered the known processes or activities proposed for each Option that may have the potential to impact the identified ecological values, including threatened flora, fauna, and ecosystems.

The analysis for gaps in ecological data consisted of a review of the ecological policies, Commonwealth and State Government databases, technical reports undertaken for Stage 3, previous ecological reports for the Project area and ecological reports for the locality as identified in **Section 2.2**.

9.1 Biophysical Gap Analysis

9.1.1 Overburden Geochemistry

Stage 3 Geochemical (RGS, 2018) investigations of the surface spoil have found that the spoil is likely to produce relatively benign, slightly alkaline seepage and will result in non-saline runoff occurring. Acid generation from the overburden has been deemed low and no evidence of acid mine drainage has been observed in the groundwater or surface water in the last 10 years (RGS, 2018). The majority of the spoil has very low sulphur content and metal concentrations were also found to present a low risk. Therefore, no gaps in available information are considered to occur for overburden geochemistry.

9.1.2 Water

9.1.2.1 Surface Water

Option 2 relies on harvesting water during high flow events from the Nogoia River and pumping water from the relevant pits to the Weemah Channel pits for beneficial use as required. The gap identified in the Stage 2 Ecology Report centred on the need for an option specific assessment of hydrology, geochemistry and associated water quality, as the surface water must be suitable for both irrigation and aquatic ecosystem purposes to meet water quality objectives for the lower Nogoia River.

The Stage 3 Geochemistry technical report shows that the overburden material presents a low risk of producing acid mine drainage and accordingly low potential to leach heavy metals or metalloids. There is however, the possibility for salt to leach from spoil material.

Low levels of bioaccumulation of metals may occur over the very long term within mine voids, where internal surface flows are directed. Most of Ensham Mine's spoil material is dispersive to highly dispersive (RGS 2018) and thus presents an erosion risk if not managed in accordance with the geotechnical assessment. Dispersive material eroded from the landform levees associated with Option 1 have the potential to impact the nature and quality of downstream watercourses and floodplains if not appropriately managed. The eventual land manager for Option 1: LL will be responsible for monitoring erosion of the landform levees over time. It should be noted that if significant landform levee erosion occurs in the post-relinquishment phase there is the potential that over time, this may contribute to a compromising of the integrity of the landform levees, which may have impacts upon downstream ecosystems should they fail, allowing void water to enter the Nogoia River.

9.1.2.2 River Stability

The Geomorphological Assessment (WSP, 2018) prepared in Stage 3 of this project indicates that the resultant landforms for each Option will remain stable from the short to medium term. This indicates that impacts on downstream ecosystems from the RVP will be minimal over this timeframe.

Armouring will be required along some sections of the landform levees associated within Option 1, where higher flow velocities from the Nogoa River and the Anabranche make initial contact with the levees along their western edges in proximity to the Nogoa River to prevent erosion, and the movement of sediment downstream.

Removal of the levees for Option 3, together with the surcharging of the backfilled floodplain is also expected to result in a stable landform. This is attributed to the slowing of floodwaters through the widened floodplain. This slower moving water is therefore less likely to cause erosion of the backfilled material which would otherwise cause a potential impact on aquatic values downstream of the Project area. WSP (2018) however identified a low risk of differential settling for this option. This may generate holes/cracks within the backfilled spoil, allowing water ingress, resulting in erosion and piping. The land manager responsible for the ongoing management of the Option 3 landscape will be responsible for monitoring and addressing potential erosion issues in this resultant landscape.

9.1.2.3 Groundwater

Determination of any long-term impacts, which are likely to occur following the relinquishment of the mine, have been addressed within the Stage 3 groundwater modelling (HS, 2018c). Stage 3 investigations into the potential impacts of Option 3: BTP found that the backfilled void 'aquifer' level does not approach its ultimate rest point until approximately 100 years after commencement of the simulation (HS, 2018c). Current models predict that after reaching rest, water levels in C Pit, D Pit and E Pit will become groundwater sources, whereas Y Pit will act as a groundwater sink (HS, 2018c). This data suggests that the RVP will not impact upon potential habitat for subterranean fauna with potential to occur in the vicinity of the Project area.

9.2 Ecological Data Gaps

9.2.1 Weemah Channel Pipeline

The proposed pipeline to the Weemah Channel has been briefly assessed within this report. A more detailed ecological assessment for this pipeline is expected to be undertaken should Option 2 be selected as the final option. The assessment will address aquatic, terrestrial, and subterranean impacts on the environment, as a consequence of construction and operation of the pipeline.

9.2.2 Regional Ecosystems/TECs

There have been a number of detailed investigations of the Regional Ecosystems present on the Project area including:

- Ensham Central Project EIS (Hansen Consulting, 2006), and Ensham Central Project Supplementary EIS (Hansen Bailey, 2009) where a detailed ecological assessment was presented by ECOSM; and
- Bio-condition Assessment Report prepared by ECOSM (2010) for the Ensham Central Project.

These assessments provided a rigorous investigation of the Regional Ecosystems as required at the time of their production. For the purposes of this assessment, the Queensland Herbarium (Version 10.1) RE mapping has been utilised, as this is the most recent known available mapping. The findings of the

previous surveys undertaken in 2010 (ECOSM, 2010) support the current Herbarium RE mapping (Version 10.1) however, it appears that some regrowth of vegetation communities fringing 11.3.25e has occurred.

This change in vegetation distribution may be a result of subject analysis, or due to the time difference between the ECOSM (2010) survey and the latest 2018 update of the Regional Ecosystem data. As a consequence it will be necessary to accurately map the distribution of REs in any areas that may be impacted outside of the existing mine disturbance areas (e.g. Option 1 regrading of outward slopes of levees and realignment of levees in two locations, Option 2 construction of intake structures, and replacement of a water pipeline are expected to require some clearance of predominantly non-regulated regrowth/disturbed areas and some minor clearance of RE 11.3.25e).

The occurrence of RE, and the quantities of remnant vegetation to be removed will need to be confirmed during field surveys in later stages of the project.

Distribution of Regional Ecosystems (Option 1 and Option 2)

Based on the WSP (2018) landform levee design and associated construction footprint, approximately 60 ha of non-regulated regrowth/previously disturbed vegetation will be impacted as a result of Option 1. Option 2 will impact 3 ha of RE 11.3.25e vegetation during construction of the intake structures.

It is recommended that should either Option 1 or Option 2 be selected, a survey to delineate any REs within the design footprints be undertaken prior to construction works. Field survey should be undertaken in accordance with the standards provided in Nelder *et al* (2017). There are no seasonal requirements for this vegetation survey. It is recommended that quaternary sites are sampled in throughout the expansion areas, to allow formal identification of any Regional Ecosystems. A secondary quadrat should be established where it is believed REs are identified in this area. Depending upon the results of the quaternary level of survey, should any potential Threatened Ecological Communities be identified, it will be necessary to determine condition thresholds or size limits contained within Commonwealth conservation advice statements for potentially occurring TECs known to occur in the locality of the Project area.

9.2.3 Threatened Flora

It is recommended that targeted surveys for threatened flora known and with potential to occur in the Project area be undertaken should any clearing associated with Option 1: LL or Option 2 be proposed to occur outside of the existing mine footprint in areas. This will ensure threatened species are identified in potential impact areas and that appropriate mitigation measures such as avoidance, or offsetting can be incorporated in these early stages of the Project.

Surveys should be undertaken in any potential additional disturbance areas (outside of existing approved disturbance areas), so that the distribution of these species can be determined, as well as the density of any individuals present.

Threatened Flora Survey Requirements

Table 9.1 provides the optimal season for the survey of known and potentially occurring threatened flora in the Project area. **Table 9.1** also provides the recommended survey techniques. *Cerbera dumicola* is known to occur within the Project area, and *Dichanthium queenslandicum* is known to occur in RE 11.3.25 and *Acacia spania* is known to occur in REs 11.7.1 and 11.7.2. As Option 1 and Option 2 have potential to impact RE 11.3.25e, targeted surveys for *Dichanthium queenslandicum* are recommended in accordance with **Table 9.1**.

Table 9.1 Threatened Flora Survey Requirements

Scientific Name	Common Name	Survey effort required	Seasons of Survey	Survey Guideline	Comments
<i>Dichanthium queenslandicum</i>	King Blue-grass	Targeted survey to be undertaken during RE verification process.	Flowers are recorded throughout the year, particularly in March (following sufficient rainfall)	Flora Survey Guidelines – Protected Plants	This species should be detectable over the summer months. One survey should be undertaken to determine if this species is present in any impact areas.
<i>Cerbera dumicola</i>	Native Frangipani	Targeted survey of potential habitats areas.	Flowers in October, but readily identifiable throughout the year	Flora Survey Guidelines – Protected Plants	This species should be detectable over the summer months. One survey should be undertaken to determine if this species is present in any impact areas.
<i>Acacia spania</i>	-	Targeted survey to be undertaken during RE verification process	Flowers in August-September period. Readily identifiable throughout the year	Flora Survey Guidelines – Protected Plants	This species should be detectable over the summer months. One survey should be undertaken to determine if this species is present in any impact areas.

9.2.4 Threatened Fauna Gaps

Updated fauna surveys (targeted on preferred habitats and occurrence of threatened species) would be required should disturbance of riparian areas be required as a component of Option 1: LL.

Threatened Fauna Survey Requirements

Table 9.2 provides the optimal season for the survey of known and potentially occurring threatened fauna in the Project area. **Table 9.2** also provides the recommended survey techniques for those threatened species with potential to occur within the cleared/disturbed areas adjacent to the existing levee banks, or within riparian habitats associated with the Nogoia River. It is anticipated that during the RE ground verification works should Option 1 or Option 2 be selected, that the habitats these species occur in will be targeted for the respective threatened species. It should be noted that the following surveys can be undertaken simultaneously or can be combined so that a discrete survey period can be undertaken to sample all threatened fauna taxa.

Table 9.2 Threatened Terrestrial Fauna Survey Requirements

Scientific Name	Common Name	Survey effort required	Seasons of Survey	Survey Guideline	Comments
<i>Erythrotriorchis radiatus</i>	Red Goshawk	Targeted survey of riparian areas to be impacted.	Spring, summer and autumn periods	Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010)	No additional considerations.

Scientific Name	Common Name	Survey effort required	Seasons of Survey	Survey Guideline	Comments
<i>Falco hypoleucas</i>	Grey Falcon	Targeted survey of riparian areas to be impacted targeting nest sites.	Spring, summer and autumn periods	Not covered in guideline, but principles for Red Goshawk are appropriate for this species. Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010)	No additional considerations.
<i>Geophaps scripta scripta</i>	Squatter Pigeon	Opportunistic surveys during RE field verification of riparian areas. 3 days of field survey recommended.	Spring, summer and autumn periods	Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010)	No additional considerations.
<i>Numenius madagascariensis</i>	Eastern Curlew	Opportunistic surveys during RE field verification of riparian areas. 3 days of field survey recommended.	Spring, summer and autumn periods	Not covered in guideline, but principles for Australian Painted Snipe are appropriate for this species. Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010)	No additional considerations.
<i>Rostratula australis</i>	Australian Painted Snipe	Quantification of potential habitat to be impacted for this species. Opportunistic surveys during RE field verification. 3 days of field survey recommended.	Spring, summer and autumn periods	Survey Guidelines for Australia's Threatened Birds (DEWHA, 2010)	No additional considerations.
<i>Chalinolobus dwyeri</i>	Large-pied Bat	Targeted survey of potential roost trees. These are to be marked and call detectors used to determine utilisation. 3 days of field survey with 6 detector hours per night recommended.	October through to March	Survey Guidelines for Australia's Threatened Bats (DEWHA, 2010)	No additional considerations.

Scientific Name	Common Name	Survey effort required	Seasons of Survey	Survey Guideline	Comments
<i>Nyctophilis corbeni</i>	Corbens Long-eared Bat	Targeted survey of potential roost trees. These are to be marked and call detectors used to determine utilisation. 3 days of field survey with 6 detector hours per night recommended.	October through to March	Survey Guidelines for Australia's Threatened Bats (DEWHA, 2010)	No additional considerations.
<i>Phascolarctos cinereus</i>	Koala	Targeted survey of known koala food trees in areas to be impacted. 3 days of field survey recommended. Spotlight surveys over 3 nights.	Throughout the year	SPOT Assessment Technique (Phillips and Callaghan, 2011)	No additional considerations.
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna	Fauna spotter catcher to undertake pre-clear inspection of all habitat areas prior to construction activities.	Spring, summer and autumn periods	-	No additional considerations.
<i>Denisonia maculata</i>	Ornamental Snake	Targeted survey of riparian areas to be impacted immediately prior to construction activities by Fauna Spotter Catcher.	Presumably active late spring through summer to early autumn	Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC, 2011).	
<i>Egernia rugosa</i>	Yakka Skink	Habitat assessment and targeted survey for burrows and communal defecation sites. Should be undertaken in in riparian areas to be impacted.	Presumably active late spring through summer to early autumn	Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC, 2011).	Should be undertaken during the warmer months of the year to identify presence.

Scientific Name	Common Name	Survey effort required	Seasons of Survey	Survey Guideline	Comments
<i>Hemiaspis damelii</i>	Grey Snake	Targeted active searching under large objects such as rocks, logs etc. Survey of riparian areas to be impacted. 3 days of field survey recommended	Presumably active late spring through summer to early autumn following rainfall when primary prey Cyclorana species are active	Not covered in guideline, but principles for Dunmall's Snake are appropriate for this species. Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC, 2011).	Should be undertaken during the warmer months of the year to identify presence.
<i>Furina dunmalli</i>	Dunmall's Snake	Targeted active searching under large objects such as rocks, logs etc. Survey of riparian areas to be impacted including spotlighting surveys. 3 days of field survey recommended	Presumably active late spring through summer to early autumn following rainfall when primary prey amphibian species are active	Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC, 2011).	Should be undertaken during the warmer months of the year to identify presence.

9.2.5 Aquatic Ecosystems

9.2.5.1 Aquatic Flora

No threatened aquatic flora has been identified within 50 km of the Project area. No gaps have been identified for threatened aquatic flora within the Project area or its locality.

9.2.5.2 Aquatic Fauna

As works associated with Option 3 will predominantly be restricted to historically disturbed areas or the existing approved mine footprint, there are no anticipated gaps in the existing information available for the Project area with respect to aquatic fauna for this Option.

Option 1 will require regrading of the outward levee walls extending outward up to 40 m. Provided appropriate mitigation measures, including delineation of remnant riparian vegetation, implementation of sediment and erosion control measures (including mitigation structures and on-going monitoring) are undertaken to address construction and operational phases of the project, no impacts are expected to result on aquatic fauna.

In addition to the impacts and mitigation measures identified for Option 1 above, Option 2 is expected to require the trenching of a replacement water pipeline across the Nogoa River as well as the installation of two intake structures, potentially impacting the riparian vegetation of the Nogoa River. This process has potential to involve the disturbance of the habitat of threatened aquatic fauna species.

Ground verification of the location and extent of the Option 2 structures will need to be undertaken to determine the extent of impact upon aquatic fauna. It is anticipated that this will be undertaken at a later stage of the project should Option 2 be selected as the final Option. Based upon available information it is anticipated that Option 2 will not require additional surveys as mitigation measures are expected to be able

to address potential impacts upon these species. These mitigation measures are expected to be outlined in an Aquatic Fauna Management Plan for the proposed construction activities and is expected to include the following requirements:

- Minimising the pipelines or intake structures footprint in habitat areas,
- Minimising the disturbance time to flow regimes as much as possible. This may also include avoidance of fish migration periods along the Nogoa River;
- During dewatering of pipeline or intake structure work areas, a spotter/catcher is on site to collect any turtle species or other aquatic fauna contained in the dewatered construction areas, and
- Appropriate sedimentation and erosion controls are implemented during and following construction to protect aquatic ecosystems downstream of any construction.

Subterranean Fauna

Stage 3 involved the preparation of a desktop assessment in accordance with the Queensland Subterranean fauna survey guidelines as contained within this report. The desktop assessment was structured according to the Western Australian Environmental Protection Authority's (EPA) Environmental Assessment Guideline 12 (EAG 12) (EPA, 2013). The EAG 12 provides information that considers the conservation of subterranean fauna species and ecological communities as listed by the EPBC Act. The Department of Science, Information Technology and Innovation's (Qld Govt) guideline (DSITI, 2015) for the environmental assessment of subterranean aquatic fauna adheres to the EPA's Guidance Statement 54a (EPA, 2007) which provides technical support for the EAG 12.

The desktop assessment found that no subterranean fauna are expected to be impacted by any of the preferred options.

The basis for this conclusion is:

- None of the Preferred Options will result in the loss of habitat as the groundwater table will not be affected as water will not be abstracted or diverted from the Nogoa River.
- The Nogoa River continues to receive recharge from the Fairbairn Dam, this will be beneficial to any groundwater biota which rely on good hydraulic conductivity to replenish food reserves in a normally depleted environment.
- Groundwater quality in the Alluvial aquifer in the Project area and surrounds is typically within the ranges considered acceptable for stygofauna.
- Connectivity along the aquifer remains intact and not obstructed causes isolated areas, allowing taxa to disperse.

While the Project area may support stygofauna in two aquifer types as would be expected compared to areas of similar geology in the Fitzroy and Bowen Basins as shown in the literature. The stygofauna community that may be present within the Ensham Project area would therefore consist of taxa dominated by the syncarid and copepod crustaceans. Dispersal would occur within the Alluvial Aquifer along the river channels. The likelihood of the three Preferred Options impacting any potential stygofauna communities present is therefore considered to be very low.

9.2.6 Migratory Avian Fauna

No information/data gaps were identified with respect to migratory bird species. It is therefore recommended that no additional surveys be undertaken for migratory bird species.

9.3 Summary of Gaps

Table 9.3 provides a summary of the identified ecological and biophysical gaps for the RVP.

Table 9.3 Summary of the Identified Ecological and Biophysical Stage 3 RVP Gaps

		Option 1	Option 2	Option 3
Ecological Gaps	Aquatic Ecosystems			
	Aquatic Flora	No identified Gaps	No identified Gaps	No identified Gaps
	Aquatic Fauna	No identified Gaps	Works within Nogoa River and its Anabranh (pipeline and intake structures) will require additional survey should Option 2 be selected.	No identified Gaps
	Subterranean Fauna	No identified Gaps	No identified Gaps	No identified Gaps
	Terrestrial Ecosystems			
	Terrestrial Flora	Works outside of mine footprint (levee footprint) will require additional survey should Option 1 be selected	Works within Nogoa River and its Anabranh (pipeline and intake structures) will require additional survey should Option 2 be selected. Further detailed assessment will be required for any off lease infrastructure.	No identified Gaps
	Terrestrial Fauna	Works outside of mine footprint (levee footprint) will require additional survey should Option 1 be selected	Works within Nogoa River and its Anabranh (pipeline and intake structures) will require additional survey should Option 2 be selected. Further detailed assessment will be required for any off lease infrastructure.	No identified Gaps
	Migratory Fauna	No identified Gaps	No identified Gaps	No identified Gaps

10.0 Impact Assessment

A risk based approach has been undertaken for this Stage 3 impact assessment of preferred Options 1 to 3 to identify the potential impacts of each Option, outlined in this section. In Stage 4 of the RVP, the Commonwealth Significant Impact Criteria (DEE, 2013) will be used for an impact assessment based upon a detailed design once the preferred option has been selected. These criteria provide a scientifically rigorous process to determine the significance of impacts upon various aspects of threatened species and community ecological requirements.

As outlined within the Introduction, this Stage 3 report has been prepared under the assumption that the impact assessment is based upon a safe, stable and non-polluting landforms post relinquishment for each Option. Once the final Option is selected, a more detailed Ecological Impact Assessment will ultimately be prepared to address construction and on-going impacts for the Final Option, including any potential biosecurity impacts.

10.1 Option 1: LL

10.1.1 Identified Impacts

10.1.1.1 Vegetation

With respect to the RVP and Option 1: LL, it is anticipated that approximately 60 ha of non-regulated regrowth/disturbed vegetation adjacent to the existing levee walls will be cleared to allow for the realignment and regrading of the outward levee batters associated with this Option. This clearing has potential to impact upon non-regulated regrowth habitats associated with the Nogoa River, some of which may provide habitat for threatened terrestrial species. A review of the available RE mapping indicates that no REs will be cleared as a result of this Option.

Should this Option be selected as the final option, a detailed field survey for listed terrestrial threatened species and communities known to be present in or adjacent to the area proposed for clearing should be undertaken. An Impact Assessment should then be prepared in accordance within the Commonwealth Impact Assessment Guideline.

The riparian vegetation associated with the Nogoa River and Anabranh is recognised as a potential Terrestrial GDE habitat in DES mapping. The Stage 3 Hydrology Study (HEC, 2018b) found that the shallow aquifers associated with the river are not connected to the deeper alluvium, or the aquifers associated with the coal measures. Based upon this finding, there is not expected to be any impacts upon the riparian vegetation present within the Project area or in its vicinity due to Option 1.

10.1.1.2 Terrestrial Flora

Based upon the Stage 3 Civil Design (WSP, 2018) as outlined in **Section 10.1.1.1**, impacts on terrestrial flora species are expected to be minimal. Realignment and regrading of sections of the levee walls, where they occur in proximity to void highwalls or where the footprint of the levees will be increased to reduce batter slopes, will result in the clearing of up to 60 ha of non-regulated regrowth/previously disturbed vegetation. No areas of known or potential habitat for threatened flora will be directly impacted by the realignment/regrading of sections of levee associated with this Option.

There are not expected to be any additional indirect impacts on terrestrial flora as a result of Option 1: LL as a result of the RVP.

10.1.1.3 Terrestrial Fauna

Commonwealth and State listed 'Endangered' species with potential to occur in the Project area include Eastern Curlew (*Numenius madagascariensis*) and Australian Painted Snipe (*Rostratula australis*). Habitat of Eastern Curlew and Australian Painted Snipe is predominantly associated with the Nogoa River and its Anabranh. As no clearing of REs will occur as a result of this option, and as clearing will be restricted to approximately 60 ha of previously disturbed land, there is not expected to be any material impacts upon these species.

Commonwealth and State listed 'Vulnerable' species known or with potential to occur in the Project area include Red Goshawk (*Erythrotriorchis radiatus*), Squatter Pigeon (*Geophaps scripta scripta*), Grey Falcon (*Falco hypoleucos*), Large Pied Bat (*Chalinolobus dwyeri*), Corbens Long-eared Bat (*Nyctophilus corbeni*), Koala (*Phascolarctos cinereus*), Ornamental Snake (*Denisonia maculata*), and Yakka Skink (*Egernia rugosa*). These species are known to utilise RE 11.3.25e habitats. Based upon available RE mapping (Version 10.1), Option 1: LL will not result in the removal of any REs. Clearing of disturbed land will occur adjacent to the existing mine levees.

Should Option 1: LL be selected as the final option, it is recommended that a field survey be undertaken to accurately delineate any REs that may occur within or adjacent to the disturbance area. Further to this an assessment for threatened fauna that may occur within the disturbance area should be undertaken. A detailed Impact Assessment can then be prepared in accordance with the Commonwealth Impact Assessment Guideline to more accurately determine the ecological level of impact.

No material indirect impacts (i.e. noise, dust, excess light) are expected to occur on any terrestrial fauna species known to utilise the Project area as a result of the RVP at the post relinquishment phase of the project.

10.1.1.4 Aquatic Flora

No threatened aquatic flora species were identified as having potential to occur within 50 km of the Project area. Aquatic flora are known to occur within the Nogoa River. Option 1: LL of the RVP is not expected to have any direct impact upon the Nogoa River or its Anabranh. No water will be actively returned to the Nogoa River or its Anabranh, therefore there will be no opportunity for water within the RVP to cause indirect impacts such as poor water quality to impact this group of species.

The Stage 3 Material Characterisation for the Ensham Coal Mine Final Void Plan (RGS, 2018) technical report indicates that no acid mine drainage occurs within the Ensham Mine. As a consequence, there is expected to be a low potential for metals or metalloids to impact downstream environments. The implementation of appropriate rehabilitation and ongoing monitoring for erosion and sedimentation will minimise any impacts on aquatic flora due to sedimentation.

10.1.1.5 Aquatic Fauna

Two threatened reptile species were identified as having potential to occur within the Project area. These species are known to occur within the Nogoa River. As no REs will be cleared as a result of this Option, no direct impacts are anticipated on these species.

10.1.1.6 Terrestrial Groundwater Dependent Ecosystems

Mapping prepared by the Queensland Government (2018) indicates that the riparian corridor associated with the Nogoa River is considered a potential terrestrial GDE. Groundwater assessment prepared by HEC (2018) indicates that there are no linkages between the shallow Nogoa River aquifer, and the deeper alluvium or Rangal coal seam aquifers. Therefore, it is considered unlikely that there will be any impacts on terrestrial GDEs should Option 1 be selected.

10.1.1.7 Subterranean Fauna

Troglofauna

Option 1: LL is not expected to result in any impacts on Troglofauna as no suitable habitat for this group of species is expected to occur within the Project area.

Stygofauna

The Project area may support stygofauna in the two aquifer types present (alluvium and the deeper coal measures).

With respect to stygofauna, Option 1 is unlikely to impact any potential stygofauna habitat, namely the alluvium aquifer that extends along the Nogoia River and its Anabranh. The basis for this conclusion is:

- This Option will not result in the loss of habitat as the groundwater table will not be affected as water will not be abstracted or diverted from the Nogoia River.
- As the Nogoia River continues to receive recharge from the Fairbairn Dam, this will be beneficial to any groundwater biota which rely on good hydraulic conductivity to replenish food reserves in a normally depleted environment.
- Groundwater quality in the Alluvial aquifer in the Project area and surrounds is typically within the ranges considered acceptable for stygofauna.
- Connectivity along the aquifer remains intact and no obstructions are planned that would cause the isolation of areas, thereby allowing taxa to disperse.

10.1.1.8 Migratory Species

No migratory species are considered to be significantly impacted by potential measures associated with Option 1: LL. The RVP occurs in a historically operated coal mine area, and this group of highly mobile species can actively avoid operational activities as needed. This option will ultimately result in the presence of residual waterbodies (specifically pits A-E) which are likely to become brackish over time, and where contaminants such as Arsenic, Molybdenum and Selenium will concentrate through evapo-concentration. It is anticipated that aquatic organisms, including fish, will become depauperate in these residual voids over time. This will limit the utilisation of the voids by migratory species to a wading area, rather than a foraging area. As a consequence, due to these species high mobility, and due to the expected resulting depauperate aquatic diversity within the voids, impacts upon migratory species are expected to be minimal.

Analysis of the HEC (2018c) Void Water Quantity and Quality Balance Modelling report indicates that there is potential for metals/metalloids to bioaccumulate within void waters. They may therefore exceed aquatic guidelines to various aquatic life forms over time when compared to the trigger values contained in the ANZECC (2000) Water Quality Guidelines. Nevertheless, it is anticipated that the water bodies are likely to provide some wading resources for transitory bird species. It is anticipated that due to the gradually increasing salinity and contaminant levels, the diversity of aquatic species within the resultant water bodies will decline over time. This will mean that this option could result in a waterbody only suitable for wading/resting for these species. It should be noted that the residual voids associated with Option 1 are not designed to create aquatic habitats, but rather as a mechanism to contain void waters so that they cannot impact downstream environments.

10.1.2 Management and Mitigation Measures

As part of the rehabilitation process, following construction of the landform levees, Ensham proposes to establish a corridor using native tree species along the western (highwall) side of the rehabilitated A and B pits. This corridor will be approximately 50 to 100 m in width and will provide a linkage approximately 6.7 km long, linking the vegetation associated with Corkscrew Creek with the Nogoia River (refer **Figure 3.1**).

In addition to creating this linkage, this measure will also augment the available habitats for flora and fauna species on the Project area. This measure is anticipated to be beneficial for a variety of native fauna species increasing the available vegetation cover and associated foraging opportunities in the locality, as well as increasing fauna movement opportunities in this landscape. Ecological values of this treed corridor could be further enhanced through appropriate fencing to restrict stock movement into the corridor, and the placement of habitat features such as nest boxes.

Where practicable, avoidance of impacts on the riparian vegetation due to clearing and regrading of the outside levee batters that occur for Option 1: LL is recommended. To ensure this is achieved, it is recommended that a survey be undertaken to delineate the boundaries of the riparian REs to inform the detailed design. This will provide a current representation of the riparian REs, so that detailed design can be undertaken to avoid/minimise loss wherever practicable. Where any loss of this community is unavoidable, it will be necessary to update the assessment in the later phases of the RVP to identify appropriate mitigation measures.

A field survey is also recommended targeting nesting sites for Red Goshawk (*Erythrotriorchis radiatus*), Squatter Pigeon (*Geophaps scripta scripta*), Grey Falcon (*Falco hypoleucos*), Large Pied Bat (*Chalinolobus dwyeri*), Corben's Long-eared Bat (*Nyctophilus corbeni*). This assessment should also target Koala (*Phascolarctos cinereus*), Ornamental Snake (*Denisonia maculata*), and Yakka Skink (*Egernia rugosa*). A detailed Impact Assessment would then be prepared in accordance with the Commonwealth Impact Assessment Guideline to more accurately determine the ecological level of impacts of this Option. This will guide the determination of appropriate management and mitigation measures specific to the identified impacts of this Option.

10.2 Option 2: FMBU

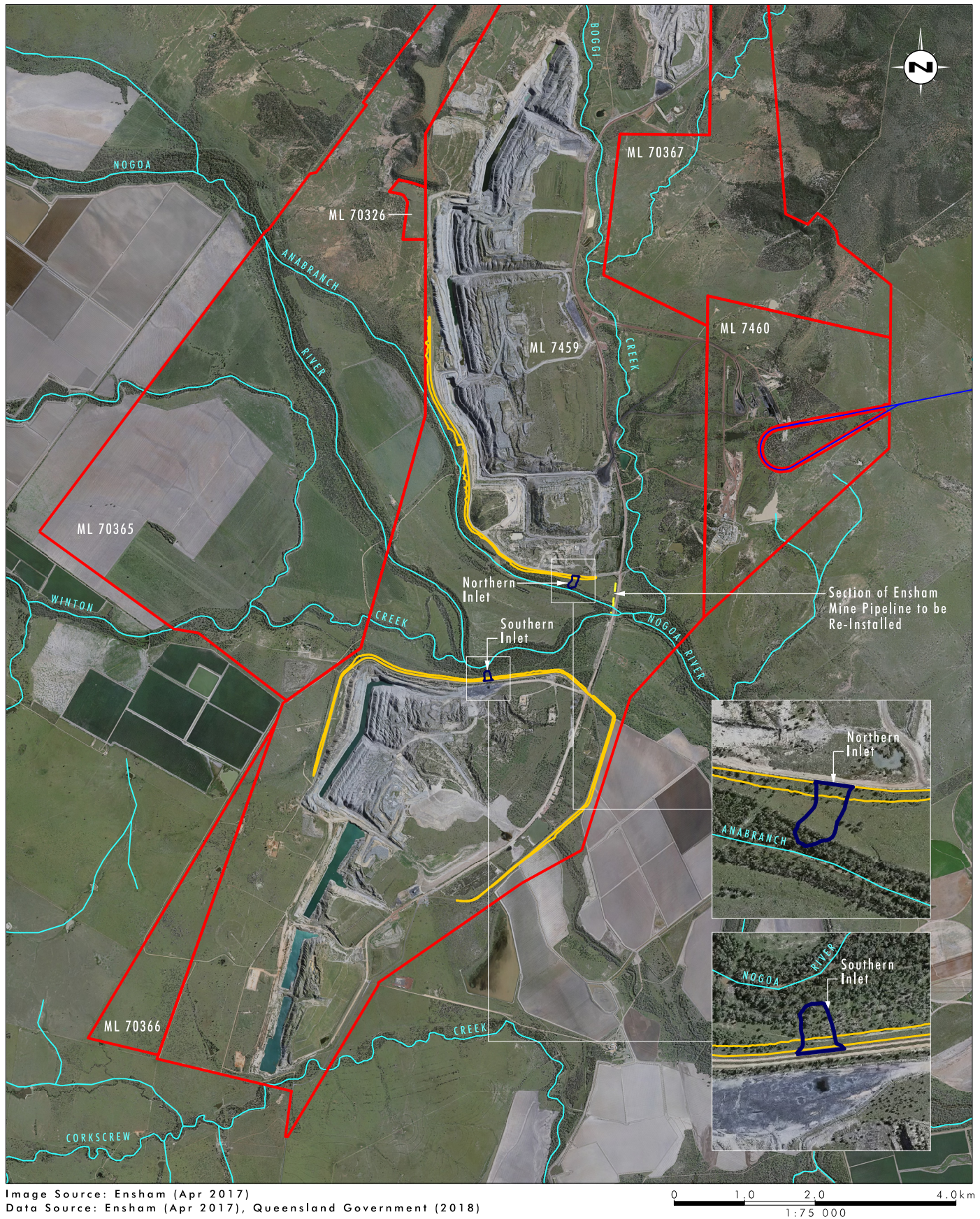
10.2.1 Identified Impacts

Option 2: FMBU has potential to result in the following ecological impacts.

10.2.1.1 Vegetation

Review of the available Version 10.1 Regional Ecosystem mapping indicates that approximately 3 ha of RE 11.3.25e will be cleared as a result of the required water intake structures. There is also potential for the re-installation of the Ensham Mine pipeline across the Nogoia River, which may result in approximately 0.1 ha of disturbance to RE 11.3.25e adjacent to the existing alignment. The areas proposed for clearing for this Option are shown in **Figure 10.1**.

This clearing of approximately 3 ha of land has potential to impact upon riparian habitats associated with the Nogoia River, some of which are recognised as habitat for threatened species. Should this Option be selected as the final option, a detailed Impact Assessment would be prepared in accordance within the Commonwealth Impact Assessment Guideline to more accurately determine the ecological level of impact.



Legend

- ▬ Project Area
- ▬ Proposed Levee Extension (Option 1 only)
- ▬ Northern and Southern Inlets (Option 2 only)
- ▬ Ensham Mine Pipeline to be Re-Installed
- ▬ Drainage Lines
- ▬ Rail Line

FIGURE 10.1

Clearing Required for
Option 1 and Option 2

10.2.1.2 Terrestrial Flora

Based upon the Stage 3 Civil Design (WSP, 2018) as outlined in **Section 3.2**, impacts on terrestrial flora species are expected to be minimal. No areas of known or potential habitat for threatened flora will be impacted by this Option.

Two intake structures, as well as the reconstruction of the Ensham Mine internal water pipeline will be constructed across a section of the 11.3.25e RE. This community may provide habitat for threatened flora species including *Dichanthium queenslandicum*. A targeted flora survey would be required should Option 2 become the selected option. This survey will target potential habitat areas of these species, where construction activities will be required. This will allow for minor alignment changes to occur to avoid or minimise potential impacts should it be determined that these species occur.

No material indirect impacts are expected to occur with respect to threatened terrestrial flora species.

10.2.1.3 Terrestrial Fauna

Commonwealth and State listed 'Endangered' species with potential to occur in the Project area include Eastern Curlew (*Numenius madagascariensis*) and Australian Painted Snipe (*Rostratula australis*). Habitat of Eastern Curlew and Australian Painted Snipe is predominantly associated with the Nogoa River and its Anabranche. As there is some limited clearing of approximately 3 ha of 11.3.25e RE as a result of this option, there are not expected to be any significant impacts upon these species as they are highly mobile species that do not breed within Australia.

Commonwealth and State listed 'Vulnerable' species known or with potential to occur in the Project area include Red Goshawk (*Erythrotriorchis radiatus*), Squatter Pigeon (*Geophaps scripta scripta*), Grey Falcon (*Falco hypoleucos*), Large Pied Bat (*Chalinolobus dwyeri*), Corbans Long-eared Bat (*Nyctophilus corbeni*), Koala (*Phascolarctos cinereus*), Ornamental Snake (*Denisonia maculata*), and Yakka Skink (*Egernia rugosa*). These species are known to utilise RE 11.3.25e habitats. Option 2 will result in the removal of approximately 3 ha of 11.3.25e RE. Further assessment will be required based upon a targeted field survey of available habitats for these species in proposed disturbance areas to accurately determine level of impact, and appropriate mitigation measures.

No material indirect impacts on any fauna species known to utilise the Project area is expected to occur.

10.2.1.4 Aquatic Flora

No threatened aquatic flora species were identified as having potential to occur within 50 km of the Project area. Aquatic flora are known to occur within the Nogoa River. Option 2 of the RVP is expected to have minor impacts on the aquatic habitats of the Nogoa River or its Anabranche due to the construction of intake structures as well as the potential installation of a new pipeline across the Nogoa River. The Stage 3 Material Characterisation for the Ensham Coal Mine Final Void Plan (RGS, 2018) report indicates that no acid drainage occurs, and as a consequence there is low potential for metals or metalloids to impact downstream environments.

10.2.1.5 Aquatic Fauna

Two threatened reptile (turtle) species were identified as having potential to occur within the Project area. These species are known to occur within the Nogoa River. Approximately 3 ha of RE 11.3.25e which may provide riparian habitat for these species will be cleared as a result of this Option. This disturbance is expected to have minimal direct impacts on these species.

On the basis that pits A&E are managed to ensure toxicant levels remain below bio-accumulation values (as specified in the water quality guidelines (ANZG, 2018)), bio-accumulation is not expected to occur.

Additionally, as pit F&Y will not be capable of receiving groundwater, bio-accumulation will not present as an issue at these pits.

10.2.1.6 Subterranean Fauna

Troglofauna

Option 2 is not expected to have any impacts on Troglofauna as no suitable habitat was identified as occurring within the Project area.

Stygofauna

The Project area may support stygofauna in the two aquifer types present (alluvial and the deeper coal measures) as would be expected compared to areas of similar geology in the Fitzroy and Bowen Basins as shown in the literature.

In regards to stygofauna, Option 2 appears unlikely to significantly impact any potential stygofauna habitat, namely the Alluvial Aquifer that extends along the Nogoia River and the Anabranche. The basis for this are:

- This Option will not result in the loss of habitat as the groundwater table will not be affected as water will not be abstracted or diverted from the Nogoia River except under high flow conditions.
- The Nogoia River continues to receive recharge from the Fairbairn Dam, this will be beneficial to any groundwater biota which rely on good hydraulic conductivity to replenish food reserves in a normally depleted environment.
- Groundwater quality in the Alluvial aquifer in the Project area and surrounds is typically within the ranges considered acceptable for stygofauna.
- Connectivity along the alluvial aquifer remains intact and will not be obstructed. Therefore there will be no isolation of the aquifer areas, allowing taxa to disperse freely.

10.2.1.7 Migratory Species

No migratory species are considered to be significantly impacted by potential measures associated with Option 2: FMBU. The RVP occurs in a historically operated coal mine area, and this group of highly mobile species can actively avoid operational activities as needed. This option will ultimately result in the presence of residual waterbodies some of which are likely to become brackish over time. Nevertheless, it is anticipated that the water bodies are likely to provide some foraging and wading resources for these species.

10.2.2 Management and Mitigation Measures

Where practicable, avoidance of clearing riparian vegetation for the construction of the intake channels and structures adjacent to the Pit B and Pit C levees is recommended. . Further to this, delineation of the boundaries of the riparian remnant vegetation should be undertaken to provide a current representation of this vegetation, so that detailed design can be undertaken to avoid or minimise loss where practicable. Where any loss of this community is unavoidable, it will be necessary to update the assessment in the later phases of the RVP to identify appropriate mitigation measures.

As part of the rehabilitation process, following construction of the structures associated with Option 2, Ensham proposes to establish a treed corridor along the western (highwall) side of the rehabilitated A and B pits. This corridor will be approximately 50 to 100 m in width and will provide a linkage approximately 6.7 km long, linking the vegetation associated with Corkscrew Creek with the Nogoia River (refer **Figure 3.2**). In addition to creating this further linkage, this measure will also augment the available habitats for flora

and fauna species on the Project area. This measure is anticipated to be beneficial for a variety of native fauna species.

10.3 Option 3: BTP

10.3.1 Identified Impacts

Option 3: BTP has little potential to result in ecological impacts as outlined below.

10.3.1.1 Vegetation

There are not expected to be any significant impacts on remnant vegetation associated with Option 3. All construction impacts will be restricted to the existing mine footprint.

10.3.1.2 Terrestrial Flora

As no remnant vegetation is proposed to be cleared for this option, there are not expected to be any significant impacts on native terrestrial flora, other than removal of regrowth species associated with rehabilitated areas. This assessment has assumed that disturbance of existing rehabilitated areas for the relocation of spoil to back fill voids can be done in accordance with the current mine approval.

10.3.1.3 Terrestrial Fauna

Commonwealth listed 'Endangered' species with potential to occur in the Project area include the Eastern Curlew (*Numenius madagascariensis*), Australian Painted Snipe (*Rostratula australis*), and the Southern Snapping Turtle (*Elseya albagula*). Based upon the Stage 3 Geomorphological technical report, it would appear that as the width of the floodplain will be substantially increased from the current situation, Option 3: BTP is considered unlikely to have deleterious impacts upon the habitats of these species downstream of the RVP as the potential for erosion of the re-created floodplain was considered low.

Commonwealth listed 'Vulnerable' species known or with potential to occur on the site include Red Goshawk (*Erythrorchis radiatus*), Squatter Pigeon (*Geophaps scripta scripta*), Large Pied Bat (*Chalinolobus dwyeri*), Corbens Long-eared Bat (*Nyctophilus corbeni*), Koala (*Phascolarctos cinereus*), Ornamental Snake (*Denisonia maculata*), and Yakka Skink (*Egernia rugosa*). Impacts upon the habitats of these terrestrial species are considered very minor given the high mobility of the bird species, and the high levels of disturbance already present in the mine areas for bat and reptile species. There will be no additional disturbance of remnant habitats beyond that already approved for the mine and no downstream impacts are anticipated to occur.

10.3.1.4 Aquatic Flora

No threatened aquatic flora species were identified as having potential to occur within 50 km of the Project area. Aquatic flora are known to occur within the Nogoia River. Option 3 of the RVP is not expected to have any impacts on the aquatic habitats of the Nogoia River or its Anabranche. The Stage 3 Material Characterisation for the Ensham Coal Mine Final Void Plan (HS, 2018c) report indicates that no acid drainage occurs, and as a consequence there is low potential for metals or metalloids to impact downstream environments. Provided erosion and sedimentation controls are implemented during construction and stabilisation phases of the backfill and rehabilitation works, there are not expected to be any impacts upon aquatic flora species.

10.3.1.5 Aquatic Fauna

Two reptile species consisting of the Fitzroy River Turtle (*Rheodytes leukops*) and the Southern Snapping Turtle (*Elseya albagula*) were identified as having potential to occur within the Project area. Option 3: BTP

will have no direct impacts upon these species as all works will be restricted to the approved mine footprint. Based upon anticipated water quality it is anticipated that no indirect impacts will occur to these species.

However, these species are known to occur within the broader Nogoa River, and as such Option 3 has potential to indirectly impact upon these species through sedimentation should differential settling be followed by poor land management in the future.

Under this Option the only remaining pits are Pits F and Y. Bio-accumulation is unlikely to present as an issue for these pits as they are not capable of receiving groundwater inflows.

10.3.1.6 Terrestrial Groundwater Dependent Ecosystems

Terrestrial GDE mapping prepared by the Queensland Government and presented in **Section 7.8** shows that the riparian corridor of the Nogoa River represents a terrestrial GDE. Studies undertaken in Stage 3 indicate that there is low potential for impacts on terrestrial GDEs.

10.3.1.7 Subterranean Fauna

Troglofauna

Option 3 is not expected to have any impacts on Troglofauna no suitable habitat was identified as occurring within the Project area.

Stygofauna

In regards to stygofauna, Option 3 appears unlikely to impact any potential stygofauna habitat, namely the Alluvium Aquifer that extends along the Nogoa River and the Anabranh. The basis for this are:

- This Option will not result in the loss of habitat as the groundwater table will not be affected as water will not be abstracted or diverted from the Nogoa River.
- As the Nogoa River continues to receive recharge from the Fairbairn Dam, this will be beneficial to any groundwater biota which rely on good hydraulic conductivity to replenish food reserves in a normally depleted environment.
- Groundwater quality in the Alluvial aquifer in the Project area and surrounds is typically within the ranges considered acceptable for stygofauna.
- Connectivity along the alluvium aquifer remains intact and will not be obstructed. Therefore there will be no isolation of aquifer areas, allowing taxa to disperse freely.

10.3.1.8 Migratory Species

No migratory species are considered to be significantly impacted by potential measures associated with Option 3: BTB. The RVP occurs in a historically operated coal mine, and this group of highly mobile species can actively avoid operational activities as needed. Option 3: BTP will ultimately result in the presence of a number of saline waterbodies with median salinities modelled to range from 8,495 $\mu\text{S}/\text{cm}$ to 19,675 $\mu\text{S}/\text{cm}$ in the residual water bodies associated with E Pit, F Pit and the Yongala Pits (HEC, 2018c). These pits are however expected to provide some additional wading habitat for this group of species.

10.3.2 Management and Mitigation Measures

As part of the rehabilitation process, following backfilling of pits for Option 3, Ensham proposes to establish a corridor using native tree species along the western (highwall) side of the rehabilitated A and B pits. This corridor will be approximately 50 to 100 m in width and will provide a linkage approximately 6.7 km long,

linking the vegetation associated with Corkscrew Creek with the Nogoia River (refer **Figure 3.4**). In addition to creating this linkage, this measure will also augment the available habitats for flora and fauna species on the Project area. This measure is anticipated to be beneficial for a variety of native fauna species increasing the available vegetation cover and associated foraging opportunities in the locality, as well as increasing fauna movement opportunities in this landscape. Ecological values of this treed corridor could be further enhanced through appropriate fencing to restrict stock movement into the corridor, and the placement of habitat features such as nest boxes.

In addition, appropriate land management practices will need to be adopted for this Option to reduce impacts to vegetation and erosion potential following flood events in areas that experience large degrees of differential settlement.

11.0 Summary of Impacts on Environmental Values

11.1 Assessment of potential impacts on environmental values

An assessment of the potential impacts of each of the three preferred options on relevant environmental values (EVs) has been undertaken based on the outcomes of this study. The EVs are described in the Stage 2 environmental values report (Ensham, 2017b) and the criteria relevant to each of the EVs for the Stage 3 studies have been determined by Ensham Resources Pty Ltd.

The assessment of impacts on EVs has been undertaken by assigning a ranking for each of the preferred options to each EV. The adopted scoring criteria are shown in **Table 11.1**. A ranking value of zero represents no impact to an EV. Negative rankings represent likely adverse impacts on the EV, while positive rankings reflect likely benefits to the EV. The definitions used within **Table 11.1** are contained within **Table 11.2**.

Table 11.1 Adopted Scoring Criteria for Assessment of EVs

Scoring Criteria	Ranking
Significant negative impact for this criterion	-3
Medium negative impact for this criterion	-2
Minor negative impact for this criterion	-1
No impact for this criterion	0
Minor benefit for this criterion	+1
Medium benefit for this criterion	+2
Significant benefit for this criterion	+3

Table 11.2 Adopted Definitions of Scoring Criteria for Assessment of EVs

Definitions
Significant impact/benefit - results in a change which is important, notable or of consequence to the EV having regard to its intensity/frequency. For an impact the change will result in not being able to meet published standards (if there are any). For a benefit the change should meet best practice standards (if there are any published)
Medium impact/benefit - results in a change which is potentially important, notable or of consequence to the EV having regard to its intensity/frequency. For an impact, the change will result in occasions where the criterion will not meet published standards (if there are any). For a benefit the change should meet good practice standards (if there are any published)
Minor impact/benefit - results in a change which is identifiable but is not important, notable or of consequence to the EV having regard to its intensity
<i>Note: The definition of significant impact has been based on the Federal Government's definition of significant impact contained within its "Matters of National Environmental Significance , Significant Impact Guidelines 1.1, Environment Protection and Biodiversity Conservation Act 1999"</i>

Table 11.3 Summary of Impacts on Option 1 Environmental Values

Environmental Aspect	Environmental Value	Criteria	Impacts
Water	Aquatic Ecosystems (Biodiversity & Habitat)	Downstream River Quality	0
		Aquatic GDEs (Stygofauna)	0
		Impact on run off quality	0
Ecology (Flora and Fauna)	Terrestrial Ecosystems	Habitat/Wetlands/Riparian Areas	+1
		Terrestrial Subterranean Fauna Habitat	0
Biosecurity	Ecosystem Vulnerability	Pests	0
		Weeds	0
		Over Abundant Native Species	0
	Bioaccumulation	Void Water Quality	-1

Table 11.4 Summary of Impacts on Option 2 Environmental Values

Environmental Aspect	Environmental Value	Criteria	Impacts
Water	Aquatic Ecosystems (Biodiversity & Habitat)	Downstream River Quality	0
		Aquatic GDEs (Stygofauna)	0
		Impact on run off quality	0
Ecology (Flora and Fauna)	Terrestrial Ecosystems	Habitats/Wetlands/Riparian Areas	-1
		Terrestrial Subterranean Fauna Habitat	0
Biosecurity	Ecosystem Vulnerability	Pests	0
		Weeds	0
		Over Abundant Native Species	0
	Bioaccumulation	Void Water Quality	0

Table 11.5 Summary of Impacts on Option 3 Environmental Values

Environmental Aspect	Environmental Value	Criteria	Impacts
Water	Aquatic Ecosystems (Biodiversity & Habitat)	Downstream River Quality	0
		Aquatic GDE's (Stygofauna)	0
		Impact on run off quality	0
Ecology (Flora and Fauna)	Terrestrial Ecosystems	Habitats/Wetlands/Riparian Areas	+1
		Terrestrial Subterranean Fauna Habitat	0
Biosecurity	Ecosystem Vulnerability	Pests	0
		Weeds	0
		Over Abundant Native Species	0
	Bioaccumulation	Void Water Quality	0

12.0 Conclusions and Recommendations

12.1 Option 1: LL Impact Assessment Conclusion

Option 1: LL will require construction activities on the existing levees for a distance up to 40 m on the outside surfaces of the existing levees. There is anticipated to be some loss of non-regulated regrowth vegetation in disturbed areas adjacent to the Nogoia River and the Anabranh. As this option would be restricted to historically disturbed areas totalling approximately 60 ha, impacts on ecological values in the Project area are anticipated to be minimal.

Under this option, there is also proposed to be a treed corridor between Corkscrew Creek and the Nogoia River, which has potential to augment the terrestrial wildlife corridors in this area resulting in a beneficial ecological outcome.

12.2 Option 2: FMBU Impact Assessment Conclusion

There will be a loss of approximately 3.0 ha of 11.3.25e regional ecosystems, which represents potential habitat for a number of threatened terrestrial and aquatic species.

There is also expected to be two beneficial outcomes as a result of this Option as the resultant water bodies in Pits A, B, C, and D are expected to provide foraging and wading habitats for various migratory wader species and fringing habitats for terrestrial species. Further to this, a treed corridor is also proposed. This corridor will increase fauna linkages between Corkscrew Creek and the Nogoia River and may also augment existing habitats for flora and fauna species.

The pipeline to the Weemah Channel will involve trenching of the pipeline through predominantly cleared agricultural lands.

12.3 Option 3: BTP Impact Assessment Conclusion

This option will result in large scale disturbance to already rehabilitated sections of the Project area, but is not expected to result in additional direct disturbance of ecological communities outside the existing and approved mine footprint.

On the basis that the backfilling of voids on the floodplain will be safe, stable and non-polluting, there should be no greater risk of erosion and sediment issues from the voids. Where rehabilitation success criteria are not maintained post relinquishment, there is the potential for impacts to vegetation and an increase in erosion and piping risks associated with flood events, particularly from areas subject to differential settlement of the backfill. This may have a consequential impact on downstream ecological values.

12.4 Recommendations

12.4.1 Vegetation

Targeted surveys of any areas to be potentially impacted by Option 1: LL or Option 2: FMBU should be undertaken to accurately determine the RE type, its condition, and its precise distribution. These surveys will be an important component for approval requirements under current regulatory controls.

12.4.2 Terrestrial Flora

Due to the known occurrence of *Cerbera dumicola* and the potential presence of *Dichanthium queenslandicum* and *Acacia spania* in proximity (within 50 km) to the site and the presence of suitable habitat for these species on the Project area, it is recommended that targeted surveys be undertaken in communities present in the Project area if potential habitat areas for these species is proposed to be disturbed. Potential disturbance outside of the existing mine footprint associated with infrastructure associated with Option 1: LL or Option 2: FMBU is likely to require the survey of disturbance to RE11.3.25e along the Nogoia River and its Anabranche targeting *Dichanthium queenslandicum*. Should additional infrastructure be identified in later stages of the RVP, it is recommended that assessment against the preferred habitat of threatened flora known or with potential to occur be undertaken to identify additional survey areas as required.

To survey these species, it is recommended that surveys be undertaken during the summer months following rainfall events, as the positive identification of *Dichanthium queenslandicum* relies on observing the inflorescence. Surveys for the *Acacia spania* can also be undertaken at this time, as flowers or seed pods should be visible.

12.4.3 Terrestrial Fauna

Any works associated with Option 1: LL and Option 2: FMBU outside of the existing mine footprint including the pipeline to Weemah Channel will require targeted fauna surveys. This should be undertaken in the summer or early autumn period to ensure all species are active. If potential habitat areas for threatened species may be disturbed, as a result of any works, targeted surveys will need to be undertaken in regional ecosystems and within disturbed/regrowth areas proposed for disturbance. Fauna surveys should be undertaken in accordance with Commonwealth and State survey guidelines for the target species identified in the habitat areas to be impacted. Surveys should target important habitat components for the target species to quantify any impacts, which will allow appropriate mitigation measures to be determined.

No additional fauna surveys will be required for Option 3: BTP assuming disturbance will be restricted to existing approved mine areas.

12.4.4 Aquatic Flora

As Option 2: FMBU is expected to require some potential disturbance of the Nogoia River and the vegetation associated with it surveys should be undertaken to determine the presence of aquatic flora adjacent to potential disturbance areas. Surveys for aquatic flora should be undertaken during the summer or early autumn period to ensure most aquatic flora species known in this area will be actively growing. No additional aquatic flora surveys will be required for Option 1: LL and Option 3: BTP assuming disturbance will be restricted to existing approved mine areas or areas immediately adjacent to these existing disturbed areas.

12.4.5 Aquatic Fauna

Option 1: LL and Option 2: FMBU will require some potential disturbance of the Nogoia River and the vegetation associated with it. Provided effective erosion and sedimentation erosion control is provided during and following construction activities, there is not expected to be impacts upon aquatic fauna. Therefore, no additional aquatic fauna surveys are recommended.

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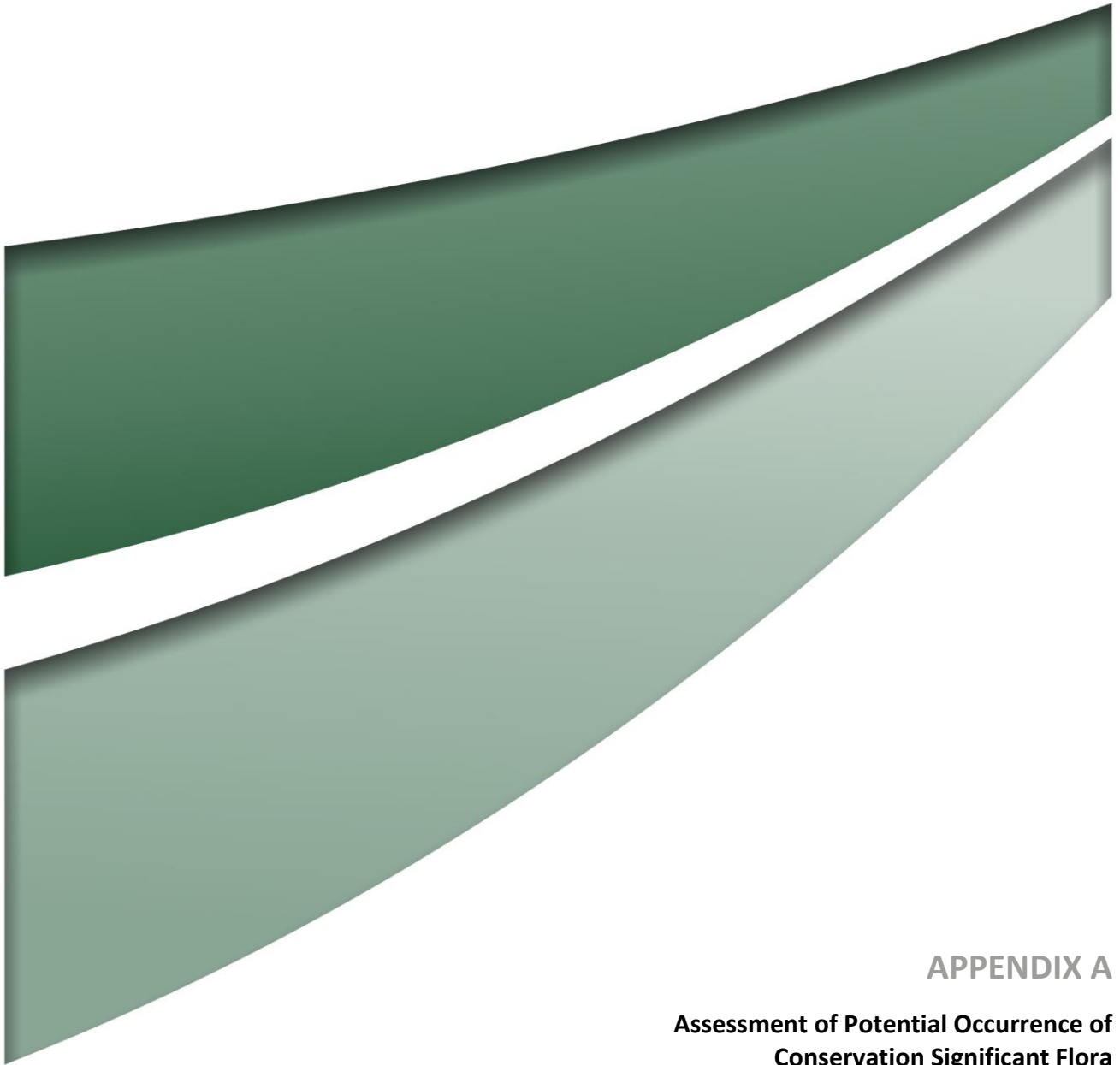
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APPENDIX A

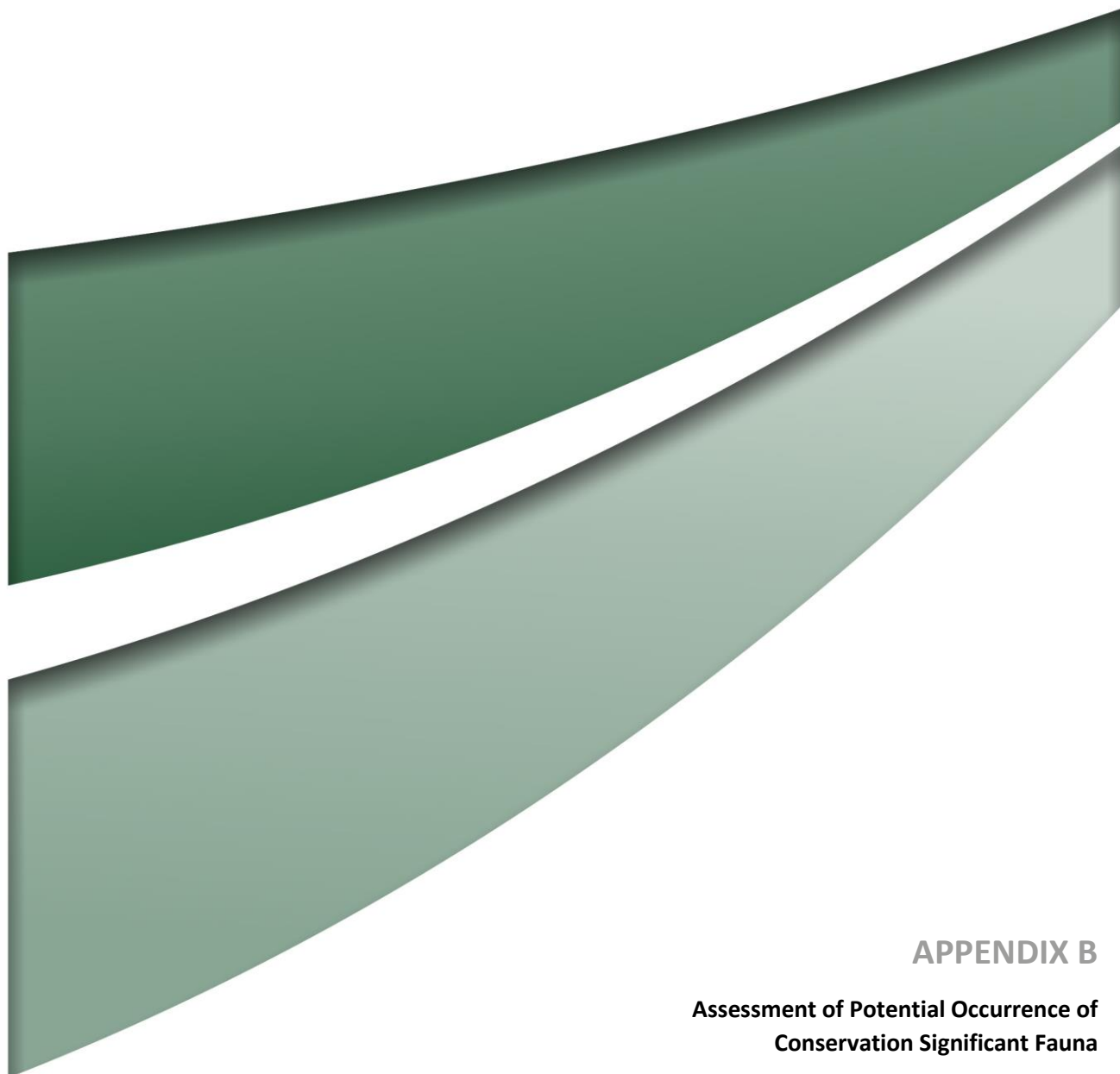
**Assessment of Potential Occurrence of
Conservation Significant Flora**

Table A1 Assessment of Potential Occurrence of Conservation Significant Flora Identified During Literature Review

Family	Scientific Name	Common Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Atlas of Living Aust.	AVH	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Mimosaceae	<i>Acacia spania</i>	-	-	-	3	3	3	NT	<i>Acacia spania</i> grows mostly on rocky sandstone ridges and hills in sandy to loamy soils in eucalypt or Acacia dominated woodland communities. The species sometimes forms relatively pure stands within these communities, and has also been recorded in vine thickets along scarp edges. Altitudinal range from 400 to 600 m. There is one record of the species occurring in grey medium clay (near Roma).	Suitable habitat present on the Project area. Species recorded within 10 km of the Project area. Potential to Occur.
Poaceae	<i>Aristida annua</i>	-	V	Species or species habitat likely to occur within area	0	0	0	V	Grows on black earth, basalt and sandy, red loamy soils. The species occurs in eucalypt woodland with <i>Eucalyptus orgadophila</i> . The species also occurs in disturbed sites such as roadsides with pasture grass.	Suitable habitat present on the Project area. Species not recorded within 10 km of the Project area following various flora surveys. Unlikely to Occur.
Euphorbiaceae	<i>Bertya opponens</i>	-	V	Species or species habitat likely to occur within area.	0	0	0	-	<i>Bertya opponens</i> has been recorded growing in a variety of community types including mixed shrubland, lancewood woodland, mallee woodland, eucalypt/Acacia open forest with shrubby understorey, Eucalypt/Callitris open woodland and semi-evergreen vine-thicket.	Suitable habitat present on the Project area. Species not recorded within 10 km of the Project area following various flora surveys. Unlikely to Occur.
Surianaceae	<i>Cadellia pentastylis</i>	Ooline	V	Species or species habitat likely to occur within area.	0	0	0	V	Occurs in a range of vegetation types including semi-evergreen vine thicket, brigalow-belah, poplar box and bendee communities. Ooline often occurs on the edges of sandstone and basalt escarpments, 200 to 500 m above sea level. In most areas of its range, ooline grows on the moderately fertile soils preferred for agriculture and pasture development.	No suitable habitat present on the Project area. Species not recorded within 10 km of the Project area following various flora surveys. Unlikely to Occur.
Apocynaceae	<i>Cerbera dumicola</i>	Native Frangipani	-	-	2	2	2	NT	Occurs across a range of habitats in central and southern Queensland. Associated vegetation and species include: sandstone hills in open <i>E. umbra</i> subsp. <i>carnea</i> ; on plateaus, in woodland of <i>Acacia shirleyi</i> with <i>Corymbia dolichocarpa</i> ; acidic soils in mine rehabilitation area; woodland of <i>A. catenulata</i> and <i>A. shirleyi</i> with <i>E. thozetiana</i> on a slope of sand/clay soil; semi-deciduous notophyll-microphyll vine forest of <i>Brachychiton australis</i> , <i>Gyrocarpus americanus</i> , <i>Flindersia australis</i> , <i>Pleiogynium timorense</i> , <i>Drypetes deplanchei</i> and <i>Sterculia quadrifida</i> on rhyolite hillslopes; open-woodland of <i>E. melanophloia</i> with occasional <i>Acacia shirleyi</i> , <i>E. populnea</i> and <i>E. brownii</i> ; semi-evergreen vine thicket with <i>Corymbia citriodora</i> and <i>Corymbia aureola</i> emergents; woodland of <i>A. rhodoxylon</i> on brown, sandy loam; and in <i>Corymbia tessellaris</i> - <i>Acacia aneura</i> open woodland (Queensland Herbarium, 2011).	Recorded in the north-eastern portion of MDL 217 where active dumping has encroached on remnant vegetation. Known to Occur.
Poaceae	<i>Dichanthium queenslandicum</i>	King Blue Grass	E	Species or species habitat known to occur within area	4	4	4	V	The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: • Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant); • Weeping Myall Woodlands; • Natural Grasslands on Basalt and Fine-textured Alluvial Plains of Northern New South Wales and southern Queensland; and • Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin.	Suitable habitat present in the Project area. Species has been recorded with 10km of the Project area. Potential to occur.

Family	Scientific Name	Common Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Atlas of Living Aust.	AVH	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Poaceae	<i>Dichanthium setosum</i>	Blue-grass	V	Species or species habitat likely to occur within area	-	-	-	LC	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.	Suitable habitat present on the Project area. Species not recorded within 10 km of the Project area following various flora surveys. Unlikely to Occur.
Myrtaceae	<i>Eucalyptus raveretiana</i>	Black-box	V	Species or species habitat known to occur within area.	0	0	0	-	Occurs on the banks of rivers, creeks and other watercourses, on clayey or loamy soil. There are 23 recorded sites or subpopulations in two main areas of occurrence: Nebo to Ayr, and Apis Creek to Rockhampton. The total population is unknown. This species occurs within Burdekin and Fitzroy (Queensland) Natural Resource Management Regions.	Suitable habitat present on the Project area. Species not recorded within 10 km of the Project area. Unlikely to Occur.
Apocynaceae	<i>Marsdenia brevifolia</i>		V	Species or species habitat may occur within area.	-	-	-	V	Around Springsure <i>M. brevifolia</i> has been collected from woodland dominated by <i>Corymbia erythrophloia</i> and <i>Eucalyptus crebra</i> , with dense <i>Themeda triandra</i> understorey on basalt. Plants occurring north of Rockhampton grow on serpentine rock outcrops or on black crumbly soils derived from serpentine in woodland dominated by <i>Corymbia xanthope</i> and <i>Eucalyptus fibrosa</i> .	No suitable habitat present on the Project area. Unlikely to Occur.
Rhamnaceae	<i>Polianthion minutiflorum</i>		V	Species or species habitat likely to occur within area	0	0	0	V	Usually found in forest and woodland on sandstone slopes and gullies with skeletal soil, or sometimes deeper sands adjacent to deeply weathered laterite. Associated species and vegetation includes: open woodland of <i>Acacia shirleyi</i> , <i>Lysicarpus angustifolius</i> , <i>Corymbia aureola</i> ; woodland of <i>Eucalyptus corynodes</i> , <i>Corymbia trachyphloia</i> , <i>E. cloeziana</i> on sandy soil over sandstone; sandstone plateau with <i>Eucalyptus dura</i> , <i>E. fibrosa</i> , <i>Angophora leiocarpa</i> , and <i>E. major</i> .	No suitable habitat present on the Project area. Unlikely to Occur.
Solanaceae	<i>Solanum elachophyllum</i>	-	-	-	0	✓	✓	V	Grows on fertile cracking-clay soils in open forest of <i>Eucalyptus thozetiana</i> , <i>Acacia harpophylla</i> , with understorey of <i>Geijera parviflora</i> , <i>Casuarina cristata</i> , <i>Macropteranthes leichhardtii</i> , <i>Eucalyptus cambageana</i> , or woodland of <i>E. crebra</i> and <i>E. tenuipes</i> .	Suitable habitat present on the Project area. Species not recorded within 10 km of the Project area following various flora surveys. Unlikely to Occur.

Note: E- Endangered (EPBC Act and NC Act), V – Vulnerable (EPBC Act and NC Act), SL – Special Least Concern (NC Act), NT – Near Threatened (NC Act)



APPENDIX B

Assessment of Potential Occurrence of Conservation Significant Fauna

Table B1 Assessment of Potential Occurrence of Conservation Significant Fauna Identified During Literature Review

Common Name	Scientific Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Bird Atlas Database	Atlas of Living Aust.	QLD Back on Track Species	Literature Review other Studies	NC Act Status	Preferred Habitat	Likelihood of Occurrence
BIRDS											
Curlew Sandpiper	<i>Calidris ferruginea</i>	CE, Mi	Species or species habitat may occur within are	0	0	0	Low	-	E	Mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps, lakes and lagoons near the coast, and ponds in salt works and sewage farms. They are also recorded inland, though less often, including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters.	Suitable wetland habitats present on the Project area. Species not recorded within 10 km of the Project area, but this is a highly mobile species. Potential to Occur.
Common Sandpiper	<i>Actitis hypoleucos</i>	Mi, W	Species or species habitat may occur within area	0	0	0	Low	-	SL	The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags	Suitable wetland habitats present on the Project area. Species not recorded within 10 km of the Project area. Unlikely to Occur.
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	Mi, W	Species or species habitat likely to occur within area	9	9	9	Low	-	SL	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, salt pans and hypersaline salt lakes inland. They also occur in salt works and sewage farms.	Suitable habitat present on the Project area. Species recorded on and within 10 km of the Project area. Known to Occur.
Pectoral Sandpiper	<i>Calidris melanotos</i>	Mi, W	Species or species habitat may occur within area	0	2	2	Low	-	SL	Prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	Suitable wetland habitats present on the Project area. Species recorded within 10 km of the Project area. Potential to Occur.
Marsh Sandpiper	<i>Tringa stagnatilis</i>	Mi	-	4	3	3	Low	-	SL	Lives in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, salt pans, saltmarshes, estuaries, pools on inundated floodplains, and intertidal mudflats and also regularly at sewage farms and saltworks.	Suitable habitat present on the Project area. Species recorded on and within 10 km of the Project area. Known to Occur.
Glossy Ibis	<i>Plegadis falcinellus</i>	MiT	-	6	4	4	Low	-	SL	Habitat for foraging and breeding includes fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation.	Suitable habitat present on the Project area. Species recorded within 10 km of the Project area. Potential to Occur.
Red Goshawk	<i>Erythrotriorchis radiatus</i>	V	Species or species habitat likely to occur within area	1	1 (Historical)	1	High	-	E	Coastal and sub-coastal tall open forests and woodlands, preferring areas with a mosaic of vegetation types, permanent water and abundant small birds. Associated with gorge and escarpment country in partially cleared country in eastern Queensland. In eastern Australia, birds seem to move from inland nest sites to coastal plains in winter. Requires large areas of suitable habitat, occupying home ranges of 50-220km ²	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.

Common Name	Scientific Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Bird Atlas Database	Atlas of Living Aust.	QLD Back on Track Species	Literature Review other Studies	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Grey Falcon	<i>Falco hypoleucos</i>	-	-	1	1	1	-	-	V	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. They also occur near wetlands where surface water attracts prey.	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.
Squatter Pigeon	<i>Geophaps scripta scripta</i>	V	Species or species habitat likely to occur within area	7	1 (Historical)	1	Medium	-	V	Open, dry woodland with grassy understorey, never far from permanent water. Prefers areas of sandy soil with sparser cover of low grasses; less common on heavier soils with dense grass cover	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.
Painted Honeyeater	<i>Grantiella picta</i>	V	Species or species habitat may occur within area	0	0	0	High	-	V	Inhabits mistletoes in eucalypt forests/woodlands, riparian woodlands of black box and river red gum, box-ironbark-yellow gum woodlands, acacia-dominated woodlands, paperbarks, Casuarinas, Callitris, and trees on farmland or gardens. The species prefers woodlands which contain a higher number of mature trees, as these host more mistletoes. It is more common in wider blocks of remnant woodland than in narrower strips	Suitable open forest/woodland habitats present on the Project area. Species not recorded within 10 km of the Project area. Unlikely to Occur.
Star Finch (eastern)	<i>Neochmia ruficauda ruficauda</i>	E	Species or species habitat likely to occur within area.	0	0	0	-	-	E	The star finch (eastern subspecies) inhabits tall grass and reed beds associated with swamps and watercourses. It may also be found in grassy woodlands, open forests and mangroves. The condition of this habitat varies according to season, grazing pressure and fire. Parts of its range occur within conservation reserves.	Not recorded within 10 km of the Project area. Poorly surveyed species whose habitat occurs on the Project area. Unlikely to Occur.
Eastern Curlew	<i>Numenius madagascariensis</i>	CE, MiW	-	6	0	0	Low	1	E	Within Australia, the eastern curlew has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Eastern curlews are rarely recorded inland. They have a continuous distribution from Barrow Island and Dampier Archipelago, Western Australia, through the Kimberley and along the Northern Territory, Queensland, and NSW coasts and the islands of Torres Strait. They are patchily distributed elsewhere.	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.
Southern Black-Throated Finch	<i>Poephila cincta cincta</i>	CE	Species or species habitat may occur within area.	0	0	0	High	-	E	The Black-throated Finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by <i>Eucalyptus</i> spp., <i>Corymbia</i> spp. and <i>Melaleuca</i> spp., and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water.	Poorly surveyed species whose habitat occurs on the Project area. Species not recorded within 10 km of the Project area. Unlikely to Occur.
Australian Painted Snipe	<i>Rostratula australis</i>	E	Species or species habitat likely to occur within area.	2	2	2	Medium	-	V	Shallow freshwater wetlands or saltmarshes, including inundated grasslands, dams and bore drains, generally with good cover of grasses or low scrub. A secretive and difficult species to observe; often will only flush from dense cover at close range.	Species will utilise freshwater wetland habitats. Recorded within 10 km of the Project area. Potential to Occur.
Fork-tailed Swift	<i>Apus pacificus</i>	Mi, MIT	Species or species habitat likely to occur within area	1	-	-	-	-	SL	The Fork-tailed Swift is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground and probably much higher.	Suitable habitat is present on the Project area. Species has not been recorded within 10 km of the Project area. Potential to Occur.

Common Name	Scientific Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Bird Atlas Database	Atlas of Living Aust.	QLD Back on Track Species	Literature Review other Studies	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Horsfield's Cuckoo	<i>Cuculus optatus</i>	MiT	Species or species habitat may occur within area	0	0	0	Low	-	SL	The species uses a range of vegetated habitats such as monsoon rainforest, wet sclerophyll forest, open woodlands and appears quite often along edges of forests, or ecotones between forest types. This cuckoo feeds arboreally, foraging for invertebrates on loose bark on the trunks and branches of trees, and among the foliage, including in mistletoes. It will forage from the ground, but requires shrubs or trees from which it sallies and returns to consume prey items. Caterpillars are a favoured food.	Limited suitable habitat present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Yellow Wagtail	<i>Motacilla flava</i>	MiT	Species or species habitat may occur within area	0	0	0	Low	-	SL	Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Suitable habitats present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
White-throated Needle-tail	<i>Hirundapus caudacutus</i>	MiT	-	1	2	2	Low	-	-	The species is found across a range of habitats, more often over wooded areas, where it is almost exclusively aerial, though does roost in tree hollows and the foliage canopy. It forages for insects on the wing; flying anywhere between "cloud level" and "ground level" and readily forms mixed feeding flocks with other aerial insectivores. The species roosts at night in the crowns of tall trees, mainly in forest habitats. The species moves gradually southward in eastern Australia, and in the south it is most common late in the summer (Feb-Mar or early April), and has become increasingly rare at all times but especially in the Oct-Dec period.	Suitable habitat is present on the Project area. Species has been recorded within 10 km of the Project area. Potential to Occur.
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	MiT	Species or species habitat known to occur within area	1	2	2	Low	-	SL	Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	Suitable habitat present on the Project area. Species has been recorded within 10 km of the Project area. Potential to Occur.
Rufous Fantail	<i>Rhipidura rufifrons</i>	Mi	Species or species habitat known to occur within area	3					SL	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (<i>Eucalyptus microcorys</i>), Mountain Grey Gum (<i>E. cypellocarpa</i>), Narrow-leaved Peppermint (<i>E. radiata</i>), Mountain Ash (<i>E. regnans</i>), Alpine Ash (<i>E. delegatensis</i>), Blackbutt (<i>E. pilularis</i>) or Red Mahogany (<i>E. resinifera</i>); usually with a dense shrubby understorey often including ferns. They also occur in subtropical and temperate rainforests.	Suitable habitat present on the Project area. Species has been recorded within 10 km of the Project area. Potential to Occur.
Caspian Tern	<i>Hydroprogne caspia</i>	MiT	-	9	7	7	Low	-	SL	Mostly found in sheltered coastal embayment's (harbours, lagoons, inlets, bays, estuaries and river deltas) and those with sandy or muddy margins are preferred. They also occur on near-coastal or inland terrestrial wetlands that are either fresh or saline, especially lakes (including ephemeral lakes), waterholes, reservoirs, rivers and creeks. They also use artificial wetlands, including reservoirs, sewage ponds and saltworks. In offshore areas the species prefers sheltered situations, particularly near islands, and is rarely seen beyond reefs	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.

Common Name	Scientific Name	EPBC Act Status	PMST Type of Presence	Wildlife Online Database	Bird Atlas Database	Atlas of Living Aust.	QLD Back on Track Species	Literature Review other Studies	NC Act Status	Preferred Habitat	Likelihood of Occurrence
Latham's Snipe	<i>Gallinago hardwickii</i>	MiW	Species or species habitat may occur within area	1	2	3	Low	-	SL	In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level (Chapman 1969; Naarding 1981). They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity.	Species will utilise freshwater wetland habitats. Recorded within 10 km of the Project area. Potential to Occur.
Osprey	<i>Pandion haliaetus</i>	MiW	Species or species habitat known to occur within area	0	0	0	Low	-	SL	Favoured habitats are coastal areas, especially the mouths of large rivers, lagoons and lakes but also along the larger coastal rivers such as the Clarence where nesting occurs upriver of Grafton, New South Wales.	Suitable habitats present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
MAMMALS											
Large Pied Bat	<i>Chalinolobus dwyeri</i>	V	Species or species habitat likely to occur within area	0	-	0	Medium	✓		Dry eucalypt, Acacia and Callitris forests and woodlands. Roosts in disused mine tunnels, rock overhangs, caves and Fairy Martin <i>Petrochelidon ariel</i> nests, and possibly also tree hollows; exhibit a high fidelity to traditional roost sites.	Suitable habitats present on the Project area. Potential to Occur.
Corbenn's long-eared bat	<i>Nyctophilus corbeni</i>	V	Species or species habitat may occur within area	0	-	0	Medium	✓	V	A range of inland dry forest habitats including River Red Gum <i>Eucalyptus camaldulensis</i> , mallee, Brigalow <i>Acacia harpophylla</i> and other arid and semi-arid habitats; more common in box, ironbark and cypress pine forests on sandy soils in southern Queensland. Most abundant in vegetation with a distinct canopy and a dense, cluttered shrub layer, and in large, continuous remnants; sensitive to habitat fragmentation. Roosts solitarily in tree hollows, crevices, and under loose bark (particularly on dead Bull Oak <i>Allocasuarina luehmannii</i> or Belah <i>Casuarina cristata</i> trees). Rare or uncommon over most of its range.	Suitable habitats present on Project area. Occurs within Expert Maybe area. Potential to Occur.
Ghost Bat	<i>Macroderma gigas</i>	V	-	0	-	0	Critical	-	V	Occurs in a wide range of habitats from rainforest, monsoon and vine scrub, to open woodlands in arid areas. These habitats are used for foraging, while roost habitat is more specific. Favoured roosting sites of the ghost bat are undisturbed caves or mineshafts which have several openings.	Suitable habitats present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Grey-headed Flying Fox	<i>Pteropus poliocephalus</i>		-	0	-	0	Critical	0	LC	Rainforests, open forests, woodlands and melaleuca swamps. Roosting camps are usually in dense riparian vegetation.	Suitable habitats present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Koala (combined populations of QLD, NSW and the ACT)	<i>Phascolarctos cinereus</i>	V	Species or species habitat known to occur within area	6	-	6	Low		V	Koalas inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus. The distribution of koalas is also affected by altitude (limited to <800 m ASL), temperature and, at the western and northern ends of the range, leaf moisture.	Suitable habitat present on the Project area. Records occur within 10 km of the Project area. Potential to Occur.
Bridled nail-tail wallaby	<i>Onychogalea fraenata</i>	E	Species or species habitat known to occur within area	0	-	1 (1881)	Critical		E	Inhabited a wide range of vegetation types, generally characterized as dry woodlands, thickets and grassland. In its current limited distribution it shows a preference for transitional vegetation between dense Acacia scrub and eucalyptus open woodlands with grassy understory, and between pasture and young regrowth of Brigalow <i>Acacia harpophylla</i> .	Not recorded within 10 km of the Project area. Suitable habitat present on the Project area, but species has never been detected on the Project area. Unlikely to Occur.

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Greater Glider	<i>Petauroides volans</i>	V	Species or species habitat known to occur within area	0	-	0	Low	-	LC	Species largely restricted to wet eucalypt forests and woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	Limited suitable habitat present on the Project area. Predominantly a Coastal species. Not recorded within 10 km of the Project area. Unlikely to Occur.
Northern Quoll	<i>Dasyurus hallucatus</i>	E	Species or species habitat likely to occur within area	0	-	0	Medium	-	LC	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 beach scrub communities in central Queensland. Northern Quoll habitat generally encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Rocky habitats are usually of high relief, often rugged and dissected but can also include tor fields or caves in low lying areas such as in Western Australia.	Suitable habitat present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Short-beaked Echidna	<i>Tachyglossus aculeatus</i>	-	-	5	-	6	Low	-	SL	Includes forests, woodlands, shrublands and Grasslands, rocky outcrops and agricultural lands. Echidnas are usually found among rocks, in hollow logs, under vegetation or piles of debris, under tree roots or sometimes in wombat or rabbit burrows.	Suitable habitat present on the Project area. Recorded within 10 km of the Project area. Potential to Occur.
REPTILES											
Collared Delma	<i>Delma torquata</i>	V	Species or species habitat may occur within area	0	-	0	High	-	V	Open eucalypt forest with a shrub and tussock grass understorey. Soil type is usually shallow and deep-cracking or stony; prefers areas with loose surface, rocks, including rocky slopes and ridge tops. Shelters under weathered loose rocks, flattish bedrock outcroppings, logs or mats of leaf. litter, or in soil cracks and crevices among tussock grasses	Suitable habitat present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Ornamental Snake	<i>Denisonia maculata</i>	V	Species or species habitat known to occur within area	0	-	5	Medium	-	V	Lower-lying subtropical areas with deep-cracking clay soils and adjacent slightly elevated ground of clayey and sandy loams, is the preferred habitat for this species. The species is also found in vegetation of woodland and shrub land, including some Brigalow <i>Acacia harpophylla</i> , and also riverside woodland and open forest, particularly on natural levees.	Suitable habitat present on the Project area. Species has been recorded within 10 km of the Project area. Potential to Occur.
Yakka Skink	<i>Egernia rugosa</i>	V	Species or species habitat likely to occur within area	1	-	1	Medium	-	V	Variety of drier forests and woodlands, usually on well-drained, gritty soils, including Poplar Box <i>Eucalyptus populnea</i> on alluvial soils, White Cypress Pine <i>Callitris glaucophylla</i> on sands, Bull Oak <i>Allocasuarina luehmannii</i> , Brigalow <i>Acacia harpophylla</i> , Bendee <i>Acacia catenulata</i> and Mulga <i>Acacia aneura</i> . Lives in burrows, abandoned rabbit warrens, and hollow logs or in deep rock crevices. An extremely secretive species; its presence is often indicated by scats near its shelter sites	Recorded within 10 km of the Project area. Occurs within Expert "maybe" area. Suitable habitat present on the Project area. Potential to Occur.

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Allans Lerista	<i>Lerista allanae</i>	E	Species or species habitat may occur within area	0	-	0	High	-	E	Only known to occur in the root systems of grass tussocks on black soils within undulating plains formed on basalt, shale, sandstone and unconsolidated sediments of the Oxford land system in the central Brigalow Biogeographic Region. Broad habitat types likely to occur within this Region include open grasslands, scattered gums, moderately heavy groves of tea trees and occasional Bottle trees on black and red soil. This habitat now appears to be extensively altered and little original vegetation remains (Brigalow Belt Reptiles Workshop 2010; Covacevich et al. 1996b). Recent records of the skink were from leaf litter and friable soils beneath trees and shrubs (Borsboom et al. in prep.). The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: Brigalow (<i>Acacia harpophylla</i> dominant and co-dominant) and Bluegrass (<i>Dichanthium</i> spp.) dominant grasslands of the Brigalow Belt Bioregions (North and South).	Suitable habitat present on the Project area. Not recorded within 10 km of the Project area. Unlikely to Occur.
Fitzroy River Turtle	<i>Rheodytes leukops</i>	V	Species or species habitat known to occur within area	6	-	6	High	-	V	Is only found in the Fitzroy River and its tributaries, around Rockhampton in eastern central Queensland. The species occurs within permanent freshwater riverine reaches and large, isolated permanent waterholes.	Recorded within 10 km of the Project area. Suitable habitat present on the Project area. Potential to Occur.
Southern Snapping Turtle	<i>Elseya albagula</i>	CE	Species or species habitat likely to occur within area	1	-	1	High	-	E	The southern snapping turtle is only found in the Burnett, Fitzroy, Raglan and Mary river drainages of south-east Queensland. It prefers permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees).	Recorded within 10 km of the Project area. Suitable habitat present on the Project area. Potential to Occur.
Grey Snake	<i>Hemiapsis damelii</i>	-	-	-	-	1	Medium	-	E	Favours woodlands, usually on heavier, cracking clay soils, particularly in association with water bodies or in areas with small gullies and ditches. It shelters under rocks, logs and other debris as well as in soil cracks.	Suitable habitat present on the Project area. Species has been recorded within 10 km of the Project area. Potential to Occur.
Dunmall's Snake	<i>Furina dunmalli</i>	V	Species or species habitat may occur within area	-	-	0	Medium	-	V	Open forest and woodlands dominated by Brigalow <i>Acacia harpophylla</i> , cypress pine. <i>Callitris</i> spp. and Bull Oak <i>Allocasuarina luehmannii</i> . Substrate varies from deep-cracking black clay to loamy soils. Shelters under fallen timber embedded in deep cracking clay soils	Suitable habitat present on the Project area. No records within 10 km of the Project area. Potential to Occur.
FISH											
Murray Cod	<i>Maccullochella peelii</i>	V	Species or species habitat may occur within area	1	-	-	-	-	-	Occurs in a range of flowing and standing waters, from small, clear, rocky streams on the inland slopes and uplands of the Great Diving Range, to the large, turbid, meandering slow-flowing rivers, creeks, anabranches, and lakes and larger billabongs, of the inland plains of the Murray Darling Basin. This species is usually found associated with complex structural cover such as large rocks, large snags and smaller structural woody habitat, undercut banks and over-hanging vegetation.	No suitable habitat present on the Project area as this species is not known to occur within the Fitzroy River. One record within 50 km of the Project area. Unlikely to Occur.

Note: CE: Critically Endangered; E- Endangered (EPBC Act and NC Act), V – Vulnerable (EPBC Act and NC Act), SL – Special Least Concern (NC Act), LC – Least Concern (NC Act), MiW – Migratory Wetland (EPBC Act); MiT – Migratory Terrestrial(EPBC Act), Ma – Migratory Marine (EPBC Act); Mi Migratory(EPBC Act)



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