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CONSULTANTS

Ardmore Phosphate Project

Terrestrial Flora and Fauna Report

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prepared for

Centrex Phosphate Pty Ltd

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Executive Summary

Centrex Phosphate Pty Ltd commissioned Northern Resource Consultants Pty Limited (NRC) to conduct a baseline flora and fauna assessment to identify biodiversity values within the mining lease (ML) for the Ardmore Phosphate Rock Project. The purpose of the assessment was to describe the baseline environmental conditions, identify species and communities of conservation significance, and identify appropriate impact avoidance and management strategies for proposed exploration and mining activities.

NRC employed a desktop and field-based approach to the terrestrial flora and fauna assessment using methodology in accordance with best practice survey guidelines. The desktop assessment included a review of various databases and distribution models for records of conservation significant flora and fauna species and communities. The field survey involved a flora and fauna survey programme incorporating systematic and targeted survey techniques.

The results of the flora and fauna assessment revealed an array of species and communities that are generally typical of the North West Highlands bioregion. Eight distinct remnant regional ecosystem (RE) vegetation communities were mapped and described as part of the field survey programme. All of the vegetation communities surveyed have a 'least concern' status under the Queensland *Vegetation Management Act (1999)* and none are listed as threatened ecological communities (TEC) under the Commonwealth *Environment Protection and Biodiversity Conservation Act (1999)*. One vegetation community, RE 1.3.7b, has an 'endangered' biodiversity status as defined in the Regional Ecosystem Description Database. This community therefore equates to a Category B Environmentally Sensitive Area (ESA) as described in the Queensland Environmental Protection Regulation 2008. RE 1.3.7b is a River Red Gum (*Eucalyptus camaldulensis*) riparian vegetation community that occurs in association with the larger drainage and watercourse features within the ML, typically where sandy alluvium has accumulated within the bed of those features. Restrictions apply for carrying out environmentally relevant (e.g. resource) activities within Category B ESAs and prescribed buffer zones. The ground-truthing vegetation community survey revealed the spatial extent of this community to be less than that represented on the Queensland Herbarium Remnant Regional Ecosystem Map. An amendment to the project's Environmental Authority for any exploration or mining activities up to 100m of the prescribed buffer zones was submitted and approved in early 2018. The biodiversity values of this community are mostly restricted to the banks and bed of the watercourse features themselves and consequently direct impacts to this community are readily avoidable. The full ground-truthed extent of this community is heavily degraded from livestock grazing and exotic species invasion. It is unlikely this community would be significantly further impacted by exploration or mining activities up to 100m of the buffer zone.

There are a number of watercourse and drainage features within the study area that are represented on the state published *vegetation management watercourse and drainage feature map*. All of the vegetation communities located within the study area are classified as remnant vegetation and, therefore, the extent of vegetation communities within the defined distance of the banks of the state-mapped watercourse or drainage features is a Matter of State Environmental Significance. Any clearing of remnant vegetation within 5m of the defining banks

of the mapped watercourse and drainage features that is also in excess of the relevant clearing thresholds may be classified as a significant residual impact. In such case, the provision of an environmental offset may be required under the Queensland environmental offsets framework

Very few threatened or near threatened flora species are known from the local area and there are no records within close proximity to the ML. Threatened and near threatened flora species known from the region were targeted during the field survey programme; however, none were recorded within the ML.

The field survey programme revealed an assemblage of fauna species typical of such habitats in the region. Some of the fauna species recorded are of conservation significance and the potential for impacts to these species, as well as recommendations for relevant impact avoidance and management strategies, are presented in this report.

The Purple-necked Rock-wallaby (*Petrogale purpureicollis*) was recorded during the field survey programme at a location in the southwest portion of the ML where large limestone outcrops are present. This species is listed as vulnerable under the Queensland *Nature Conservation Act* (1992). A buffer zone around the area where this species was observed, which incorporates habitat features relevant to this species, has been included in the mapping for this report. There is also an area of state mapped Essential Habitat for this species in the eastern portion of the ML. Essential habitat within the ML contains Spinifex grasslands associated with rocky habitats that may be used for foraging. Favoured shelter habitat of boulder piles, rocky slopes, cliffs and gorges in limestone areas are found to the east and south of the ML. Preparation of a Species Management Plan for the Purple-necked Rock-wallaby will be required as part of the environmental approvals process for the project, including the geographic boundary, an animal breeding place survey report and an impact management plan. Provision of an environmental offset may be required for significant residual impacts to habitat for this species

While some other threatened, near threatened or special least concern species have potential to occur within the study area, these species have been determined as unlikely to be significantly impacted by development within the ML. The basis for this conclusion typically includes:

- A lack of local records for the species.
- The absence of any evidence the species is present within the study area during the field survey programme.
- A lack of suitable habitat or the habitat present is degraded.
- The prevalence of similar habitat/s in the broader regions surrounding the ML.
- The location of known phosphate rock resource areas with respect to relevant habitat features for the species.
- The extent of existing disturbance from current/historical land use activities in the known phosphate rock resource areas.

The Feral Pig (*Sus scrofa**) was the only restricted invasive fauna species (*Biosecurity Act 2014*) detected within the study area during the baseline study programme. This species was observed on one occasion during the March 2018 survey in association with riparian vegetation along Split Creek. In addition to this species being classified under the *Biosecurity Act 2014*, the Feral Pig is also a declared pest within the Cloncurry Shire Council. There is currently no pest management plan available for the Cloncurry Shire Council outlining recommended management strategies for the Feral Pig within the local area. However, an integrated,

collaborative approach to the management of Feral Pigs with relevant stakeholders is recommended to manage impacts of this species to the local area.

In addition to species-specific and community-specific management strategies, this report also provides recommendations for general approaches to minimising impacts to local biodiversity values.

Introduction

1. Background

The Ardmore Phosphate Project is a high-grade phosphate rock deposit located 128km south of the City of Mount Isa in North West Queensland.

Centrex Phosphate Pty Ltd commissioned a terrestrial flora and fauna survey as part of baseline environmental studies to support environmental approvals for development of the Mining Lease (ML)5542.

The study area for this report encompasses the 2,209ha ML as well as an additional 100ha area located along the margins and tributaries of Split Creek immediately to the east of the ML, as depicted in the maps in Appendix A.

2. Purpose

This report details the following aspects of a flora and fauna assessment conducted by Northern Resource Consultants Pty Limited (NRC) within the Ardmore Phosphate Project ML and areas adjacent to the east of the ML along the margins and associated tributaries of Split Creek (the study area):

- Methodologies employed for assessing the terrestrial flora and fauna biodiversity values within the study area.
- The presence and status of species and communities within the local area.
- Potential ecological impacts of the project and recommendations for mitigating impacts, with a focus on species and communities of conservation concern, such as those listed under State and Commonwealth legislation.

3. Regulatory framework

3.1 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian Government Department of the Environment and Energy (DEE). The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES). The MNES listed in the EPBC Act that are relevant to this report are:

- nationally threatened species and ecological communities

- migratory species.

Database searches and field assessments should be conducted as part of any flora and fauna impact assessment. The results of these assessments can be used to determine the presence or likelihood of the presence of any MNES within a proposed project area. If any species or communities listed under the EPBC Act are present or likely to be present, an assessment of significance is required. If the proposed action may have a significant impact on a MNES, it must be referred to DEE for assessment. If DEE determines that the proposed action is likely to have significant impacts, the project will be considered as a controlled action and will require formal assessment and approval. If the proposed action is not likely to be significant, approval is not required if the action is taken in accordance with the referral. Consequently, the action can proceed, subject to any state or local government requirements.

3.2 State legislation

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) is intended “to protect Queensland’s environment while allowing for development that improves total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development)”. The EP Act regulates environmentally relevant activities (ERAs). The Queensland Department of Environment and Science (DES) assesses applications to undertake ERAs and issues environmental authorities (EAs) that identify environmental conditions to be met to ensure the prevention or minimisation of environmental harm caused by the authorised ERAs. An assessment of environmental impacts to identified environmental values is required as part of the EA application.

When making an application to DES for an EA for mining activities, the applicant is required under the Environmental Protection Regulation 1998 to identify environmentally sensitive areas (ESAs) within or adjacent to the proposed ML. An ESA is defined as a location that:

- has environmental values that contribute to maintaining biological diversity and integrity
- has intrinsic or attributed scientific, historical or cultural heritage value
- is important to providing amenity, harmony or sense of community.

Three categories of ESA exist:

- Category A: areas that have significant ecological values including national parks, marine parks, conservation parks, the Wet Tropics World Heritage Area and the Great Barrier Reef Marine Park Region.
- Category B: areas that include regional ecosystems (REs) with an Endangered biodiversity status, Ramsar wetlands (as per the Ramsar Convention on wetlands of international importance, especially as waterfowl habitat), forest reserves, wilderness areas, areas seaward of the highest astronomical tide, fish habitat areas and areas containing marine plants.
- Category C: areas that include nature refuges, state forests, timber reserves, declared catchment areas, river improvement areas and resource reserves.

Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) is administered by the Queensland Department of Natural Resources and Mines (DNRM) and protects Queensland's biodiversity by conserving native vegetation and addressing land degradation issues.

Queensland's vegetation management framework regulates the clearing of certain native vegetation. The VM Act incorporates the RE classification scheme to regulate the clearing of native vegetation. REs are remnant vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. Remnant vegetation is defined under the VM Act as vegetation where the dominant canopy layer has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.

The Queensland Herbarium has mapped the remnant extent of REs for much of the state using a combination of satellite imagery, aerial photography and on-ground studies (ground-truthing). RE maps published by DNRM describe the extent and conservation status of remnant vegetation as REs. REs are classified in the following vegetation management class and biodiversity status categories:

- endangered
- of Concern.
- least concern/not of concern.

The classification of REs is relevant to identifying vegetation communities of conservation significance in a regional context, including those classified as ESAs, and potential environmental offset requirements under the Queensland environmental offsets framework.

In addition to REs the VM Act also identifies and addresses the management of Category C and Category R regrowth vegetation. Accepted management practices associated with these regrowth vegetation classes are described within the 'Accepted development code - Managing Category C regrowth vegetation' (DNRM, 2018) and 'Managing Category R regrowth vegetation - A self-assessable vegetation clearing code'.

Nature Conservation Act 1992

The *Nature Conservation Act 1992* (NC Act) is administered by DES and provides the framework for the declaration and management of protected areas, and protection of wildlife listed under the Nature Conservation (Wildlife) Regulation 2006 (NC Regulation).

Protected areas

Protected areas are declared under the NC Act for the conservation of Queensland's natural and cultural resources. Classes of protected areas under the NC Act include national parks, regional parks and nature refuges. An environmental offset may be required for actions resulting in significant residual impacts within a protected area.

Under the Queensland environmental offsets framework, an impact on a protected area is significant if a prescribed activity results, or is likely to result, in one or more of the following:

- authorised clearing or inundation of all or part of the protected area for the construction of private or publicly owned infrastructure on the area
- the exclusion of, or reduction in, the public use or enjoyment of all or part of the protected area
- a reduction in the natural or cultural values of all or part of the protected area.

Protected wildlife

The purpose of the NC Regulation is to prescribe wildlife as one of the following classes of wildlife:

- extinct in the wild
- endangered
- vulnerable
- near threatened
- least concern.

Threatened wildlife under the NC Act is wildlife that is prescribed under the Act as extinct in the wild, endangered or vulnerable. All native flora and fauna species are protected under the Act and 'permits to take' protected wildlife are required from DES.

DES provides the Wildlife Online database, which can be searched to generate a list of all species recorded within a specified area. This tool is useful for determining the presence or likelihood of occurrence of threatened species in an area.

A Protected Plants Flora Survey Trigger Map is now also available, which shows high risk areas for protected plants (those considered as endangered, vulnerable and near threatened (EVNT) species) and is used to help determine flora survey and clearing permit requirements for a specified area. If the study area is located within a high-risk area, a comprehensive flora survey is required to be undertaken before any clearing of protected plants can occur. This survey will need to comply with Queensland's Flora Survey Guidelines – Protected Plants (Department of Environment and Heritage Protection [EHP], 2014).

If threatened plants are found to occur within the high-risk area during the field survey and these are likely to be cleared or impacted by the proposed project, an application for a clearing permit from DES will be required. This application will need to be accompanied by the flora survey results and potential impact management options for the protected plants that include appropriate avoidance, mitigation or offsetting measures.

In addition to this, if threatened plants are found outside a high-risk area during the field survey, and these plants are likely to be cleared or impacted by the proposed project, a clearing permit will also be required. Where a flora survey identifies that there are no protected plants present or impacts can be avoided, clearing will be exempt from requiring a permit under the NC Act.

Biosecurity Act 2014

The *Biosecurity Act 2014* commenced on 1 July 2016, with the aim to ensure a consistent, modern, risk-based and less prescriptive approach to biosecurity in Queensland. The *Biosecurity Act 2014* replaced the many separate pieces of legislation that were previously used

to manage biosecurity. Under this Act, the Biosecurity Regulation 2016 sets out how the Act is implemented and applied.

Under the *Biosecurity Act 2014*, there are three types of invasive plant species:

- prohibited invasive plants
- restricted invasive plants
- invasive plants.

Prohibited invasive plants are not present in Queensland and would seriously threaten Queensland's primary industries, natural environment, livestock, human health and people's livelihoods. If a prohibited invasive plant is found in Queensland, it must be reported to Biosecurity Queensland within 24 hours of the sighting.

Restricted invasive plants also seriously threaten Queensland's primary industries, natural environment, livestock, human health and people's livelihoods, but are already established in Queensland. Under the *Biosecurity Act 2014*, restricted invasive plants may fall into one or more categories, with different restrictions relevant to each category.

Restricted invasive plant categories and restrictions:

- Category 2: the invasive plant must be reported within 24 hours to Biosecurity Queensland.
- Category 3: the invasive plant must not be distributed or released into the environment.
- Category 4: the invasive plant must not be moved.
- Category 5: the invasive plant must not be kept.

Invasive plants include species that are not listed as prohibited or restricted invasive plants, but the species has, or is likely to have, an adverse impact on a biosecurity consideration because of the introduction, spread or increase in population size of the species in an area. Everyone is obligated to take all reasonable and practical steps to minimise the risks associated with invasive plants under their control. Local governments and Biosecurity Queensland provide weed control support services but may also enforce landowner responsibilities if necessary.

Invasive animals are classified in a similar manner to plants and include prohibited and restricted classifications. Landholder responsibilities and restrictions pertaining to these classifications are specific for each category and an invasive animal may be listed under multiple categories. Category actions that must, or must not, be carried out are defined under the *Biosecurity Act 2014*.

Queensland environmental offsets framework

The Queensland environmental offsets framework includes an Act, a Regulation and a single policy, which replaces the five previous single-issue policies.

The Environmental Offsets Regulation 2014 provides details of the prescribed activities regulated under legislation and the prescribed environmental matters (known as Matters of State Environmental Significance or MSES) to which the framework applies. Examples of MSES include:

- Wetlands and watercourses.

- Endangered and of concern RES.
- Connectivity areas.
- Protected wildlife habitat.

For any new development, all impacts to MSES must be avoided or minimised where possible. Where there is a *significant residual impact* to MSES, an environmental offset may be required in accordance with the Queensland Environmental Offsets Policy.

Flora and Fauna Assessment Methodology

1. Overall assessment methodology

NRC employed a joint approach of desktop analysis and field surveys in this study. The study team implemented best practice recommendations from sources such as:

- Terrestrial Vertebrate Fauna Survey Guidelines for Queensland (Eyre *et al.*, 2014).
- Methodology for Survey and Mapping of REs and Vegetation Communities in Queensland (Neldner *et al.*, 2017).
- Flora Survey Guidelines – Protected Plants (EHP, 2014).

The methodology encompassed two phases – scoping and field survey.

The scoping phase encompassed:

- Project planning and definition of objectives.
- Assignment of qualified ecologists.
- Detailed desktop studies.
- Review of previous studies.
- Collation of existing records.
- Literature review of species and potential threats and impacts.

The field survey phase encompassed:

- Systematic, targeted and incidental flora surveys.
- Vegetation community mapping and assessments.
- Systematic, targeted and incidental fauna surveys.

Survey effort was emphasised with respect to the trial mining area within the southern portion of the ML during the March 2018 baseline survey. Additionally, within the eastern portion of the ML, a stretch of approximately 400m along the Diamantina Developmental Road was investigated for Purple-necked Rock-wallaby essential habitat for the purpose of a proposed haul road access development site (See maps in Appendix A). NRC is a registered scientific user with ethics approval to conduct fauna studies from the Department of Agriculture and Fisheries (DAF) Animal Ethics Committee. The survey work involved in this report was conducted under Scientific Purposes Permit number WISP14046014.

2. Desktop analysis

2.1 Literature review and previous studies

There are no known previous flora and fauna studies of the study area or immediate surrounds that would provide specific data relevant for inclusion in the desktop analysis for this assessment. Field guides and scientific publications were reviewed prior to field surveys to determine species likely to be present within the study area and preferred habitat. Focus was given to threatened species identified as having the potential to occur within the study area. Given the lack of previous studies relevant to the study area, the desktop assessment relied primarily on database searches to determine species, communities and species habitat relevant to the study area.

2.2 Database searches

The DEE Protected Matters Search Tool and the Queensland Government Wildlife Online database were utilised to determine species, communities and areas of conservation significance with potential relevance to the proposed action. Both searches included a buffer around a central co-ordinate within the study area (-21.6872° S, 139.2864° E), which comprises the entire study area as well as a large buffer incorporating similar habitat in the surrounding landscape. The Protected Matters search utilised a 25km buffer from the central co-ordinate, whereas the Wildlife Online search utilised a 100km buffer as smaller search areas produced very few records of threatened species known from the region.

The results of the database searches and their relevance to the proposed development are discussed in the Results section of this report. NRC has developed an approach for ranking threatened species and communities recorded from the desktop searches in terms of their likelihood of occurring within the study area. The approach is based on the presence of local records and the habitat requirements for each species, which are recommended criteria for desktop impact assessment in State published survey guideline documents, such as Eyre *et al.* (2014). Details of the criteria used to assess the likelihood of occurrence for threatened and near threatened species are provided in Table 1. The potential impacts to threatened species that may occur within the study area are discussed in the Impacts Assessment section of this report.

It is possible that some locally occurring near threatened or threatened species may not be recorded in the State and Commonwealth databases. The comprehensive field survey component of this assessment is therefore an important aspect of the impact assessment process to determine the presence of any threatened species that have not been previously recorded in the local area.

Table 1: Key assessment criteria for likelihood of occurrence of threatened and near threatened species

LIKELIHOOD OF OCCURRING	KEY CRITERIA	DEFINITION
Present	Present during survey or historical records in the study area	Species was recorded during field surveys or a historical record of the species was located in the study area
High	Known records (<100km) or within species known range AND Suitable habitat of high quality is present	Historical records of the species occur within a 100km radius of the study area or the study area is within the species known range Suitable habitat of high quality exists with the study area
Moderate	Known records (<100km) or within species known range AND Suitable habitat is present, but degraded	Historical records of the species occur within a 100km radius of the study area or the study area is within the species known range Suitable habitat is present but is significantly degraded or fragmented
Low	No records (<100km) and not within species known range OR Habitat present is unsuitable, absent, or highly degraded	No historical records of this species occur within a 100km radius of the study area and/or the study area is not within the known range for this species or: OR The habitat within the study area is not suitable and/or is in extremely poor condition, or is absent for the species

2.3 Mapping

The following mapping sources were reviewed as part of the desktop analysis:

- Flora Survey Trigger Map (EHP, 2017a).
- Referrable Wetlands Map (EHP, 2017c).
- Remnant 2015 Regional Ecosystems Map (Department of Science, Information Technology and Innovation [DSITI], 2017).
- Essential Habitat mapping in the Vegetation Management Report (DNRM, 2017).
- Geology map units as shown on the Geology of the Duchess-Urandangi Region, Map Sheet SF 54 05-06, 1983.
- Environmentally Sensitive Areas Map (EHP, 2017d).
- Queensland Globe online mapping service (DNRM, 2018b).

3. Nomenclature and taxonomy

With the exception of technical descriptions and tables, all flora and fauna species are referred to by their common names throughout this report, with their scientific names provided in brackets after the first reference. Scientific names for flora species within this report follow Bostock and Holland (2017). Where no common name is provided in reference texts, a search was conducted for other accepted common names and, if none were found, then the species name only was used. An asterisk is used to denote species that are not native to Australia.

The use of scientific and common names for fauna species is in accordance with the following texts:

- birds: Pizzey and Knight (2012)
- amphibians: Vanderduys (2012)
- reptiles: Wilson (2015)
- mammals (except bats): Van Dyck *et al.* (2013)
- bats: Reardon *et al.* (2015).

4. Flora survey methodology

4.1 Overall methodology

Techniques described in the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Neldner *et al.*, 2017) were used to collect sufficient data during the field vegetation assessments to verify the RE codes of the remnant vegetation in the study area. The key features recorded in the field relevant to this report are:

- Vegetation structure including height of each stratum and cover density.
- Key species within each stratum.
- Geology, landform and other landzone characteristics.

The species composition and structure for each community were compared to the technical descriptions provided in the Regional Ecosystem Description Database (REDD, Queensland Herbarium, 2018). The landzone characteristics of each site were compared to the descriptions provided in Wilson and Taylor (2012). This information provided the basis for determining the appropriate RE code for each community. The information in these documents was also used in conjunction with site observations to determine appropriate values for the factors relating to remnant status.

Vegetation surveys were conducted during the early dry season, between 31 May and 6 June 2017 and during the wet season, between 19 and 23 March 2018. The purpose of these surveys was to:

- Determine the appropriate RE code, extent and remnant status of vegetation communities throughout the study area.
- Ground-truth the extent of ESAs, where present.

- Perform targeted searches for threatened flora species identified during desktop analyses, including 'meander' searches in accordance with the Flora Survey Guidelines – Protected Plants (EHP, 2014).
- Compile a flora species inventory for the study area.

4.2 Vegetation assessment sites

Site selection

Ground-truthing of the remnant vegetation mapping involved assessments of the floristic structure and composition at various locations within the study area. Assessment sites were selected where they would provide representative data for the vegetation type that was the subject of the assessment.

The location of the assessment sites and the survey techniques employed were selected to achieve the following:

- Validate or support amendments to state published RE mapping.
- Accurately determine the extent of each vegetation type.
- Resolve heterogeneous polygons.
- Determine the remnant status of vegetation.
- Provide data on the vegetation community condition.
- Target threatened flora species identified during desktop assessments and their habitat.
- Compile a species inventory for each vegetation community and the entire study area.

A total of 27 RE type assessments and 40 quaternary assessments were conducted over the survey period, with the sites distributed over the study area to incorporate variations in community composition or structure (see Vegetation Survey map in Appendix A).

Survey techniques

RE assessments

A 50m × 10m vegetation assessment transect was established at each of the RE assessment sites within the study area. Within these transects a combination of quantitative and qualitative techniques was employed. A summary of vegetation survey techniques and measures is presented in Table 2.

Quantitative measurements such as canopy height and cover were used to describe the structural form of each community and determine the remnant status of the vegetation. Species composition and structure were used to determine the relevant RE code for each community and remnant status.

Quaternary assessment sites

Quaternary assessment sites were assessed to validate the vegetation community mapping and to capture any variability in the structure and composition of the community. Data collected at quaternary sites included species composition and structural information for the canopy layer. In

general, focus was given to the dominant species, crown cover and median height of the ecologically dominant layer, which is used to define each community and determine the appropriate RE code and remnant status.

Table 2: Vegetation attributes measured in secondary survey transects

SURVEY METHOD	ATTRIBUTES MEASURED
Survey plot 50m × 10m	Key species of each stratum Median height of each stratum Weed species and cover Complete species list Landzone characteristics Central coordinate
Transect 50m	Percentage cover of each stratum
Greater area encompassing the present vegetation community	Incidental species observed Additional relevant notes

4.3 Vegetation mapping

Mapping of vegetation communities was performed using a combination of vegetation traverses and aerial imagery. Using the information gained at each of the vegetation assessment sites, and observations made when traversing the study area, the boundaries of vegetation communities were recorded using a handheld GPS device. Some vegetation mapping was also refined using current, high-resolution aerial images.

4.4 Random meander technique

Various parts of the study area were traversed using the random meander technique documented by Cropper (1993). This technique was applied to supplement other survey techniques and to:

- Locate and record any flora species not identified in the vegetation assessment transects.
- Target threatened flora species.
- Validate vegetation community mapping.
- Determine the presence and extent of pest species.

The meander technique is the preferred approach to identify and locate protected plants (EVNT species) according to the Flora Survey Guidelines – Protected Plants (EHP, 2014). The study area is not located within a 'high risk area' on the Flora Survey Trigger Map, and therefore a flora survey in accordance with the guidelines is not mandatory. However, as a best-practice approach, NRC conducted random meanders as part of the study design to develop a flora species inventory and target locally occurring EVNT species identified during the desktop

assessment. All plant species observed during the meanders were either identified *in-situ* or collected and preserved for later identification.

5. Fauna survey methodology

5.1 Survey timing and environmental conditions

The fauna survey incorporated survey timing and effort recommendations outlined in the Terrestrial Vertebrate Survey Guidelines for Queensland (Eyre *et al.*, 2014). The first survey was conducted between 31 May and 6 June 2017 and the second survey was conducted between 19 and 23 March 2018. The first survey coincided with the timing for an 'early dry season' survey period (May–July). However, the second survey was undertaken just outside of the recommended time frame for an 'early wet season' survey (November–January) as the local area experienced approximately 130mm of rainfall between 3 and 4 of March after a prolonged dry period. Rainfall preceding the March 2018 survey instigated growth and activity in flora and fauna aiding the identification and detectability of species over the survey period.

Weather data relevant to the fauna survey period were obtained from the Bureau of Meteorology (BoM) 'The Monument Airport' station (037034) and a summary is provided in Table 3. Weather conditions before and during the 2017 survey period were characterised by warm days and cool nights, whereas conditions before and during the 2018 survey period were characterised by cool nights and hot, sunny days. Overall, weather conditions during the survey period were considered favourable for detecting most vertebrate fauna groups.

Table 3: Weather conditions relevant to the survey period

PERIOD	DATE	RAINFALL (MM)	TEMPERATURE (°C)	
			MINIMUM	MAXIMUM
Early dry season 2017: Pre-survey conditions	24/05/2017	0	15.0	32.5
	25/05/2017	0	14.2	31.1
	26/05/2017	0	9.4	28.0
	27/05/2017	0	8.2	30.0
	28/05/2017	0	11.0	30.6
	29/05/2017	0	11.6	21.6
	30/05/2017	0	6.1	NA
Early dry season 2017: Conditions during survey	31/05/2017	0	8.3	23.5
	01/06/2017	0	6.3	23.8
	02/06/2017	0	4.2	24.8
	03/06/2017	0	6.7	25.9

PERIOD	DATE	RAINFALL (MM)	TEMPERATURE (°C)	
			MINIMUM	MAXIMUM
	04/06/2017	0	6.4	26.4
	05/06/2017	0	4.7	26.0
	06/06/2017	0	5.7	24.9
Wet season March 2018: Pre-survey conditions	12/03/2018	0	18.7	33.6
	13/03/2018	0	18.8	35.3
	14/03/2018	0	19.7	35.7
	15/03/2018	0	20.2	35.8
	16/03/2018	0	21.7	36.4
	17/03/2018	0	21.1	37.1
	18/03/2018	0	22.8	37.6
Wet season March 2018: During survey conditions	19/03/2018	0	22.3	38.6
	20/03/2018	0	21.6	38.6
	21/03/2018	0	23.2	37.2
	22/03/2018	0	21.6	34.6
	23/03/2018	0	21.9	34.3

5.2 Systematic survey sites

Over the two survey periods, six systematic survey sites were established where an array of fauna trapping and survey techniques were employed. The systematic survey sites were positioned to provide an appropriate spatial distribution within the study area as well as encompassing the different habitat types. A description of the habitat present at each systematic survey site is provided in Table 4. The location of each systematic trapping site is depicted in the fauna survey map in Appendix A.

Table 4: Fauna site numbers and corresponding habitat conditions

SITE NUMBER AND LOCATION	HABITAT DESCRIPTION	PHOTOGRAPH OF HABITAT
1. Southern section of the project area on undulating terrain near southern resource zone	<i>Acacia cambagei</i> and <i>Atalaya hemiglauca</i> shrubland to low open woodland (RE 4.9.10b). Skeletal sedimentary soils with occasional small rocky areas. Very sparse vegetation with denser occurrences of <i>Acacia cambagei</i> in gullies	
2. Central section of the project area on major watercourse feature.	<i>Eucalyptus camaldulensis</i> fringing riparian woodland on Split Creek. Sandy creek bed with little ground cover and occasional debris piles. Banks/margins sparse but typically with dense grass cover of Buffel Grass (<i>Cenchrus pennisetiformis</i> *) and <i>Triodia</i> spp.	
3. Northern section of the study area in northern resource zone	Mixed open woodland with <i>Acacia cambagei</i> dominant in drainage lines and <i>Eucalyptus leucophloia</i> dominant on slopes. Trap site is located within <i>Triodia longiceps</i> hummocks, but open areas with bare soil and annual chenopods (<i>Sclerolaena</i> spp.) occur within the immediate surrounds.	
4. Eastern section of the study area along the margins of a major watercourse feature	<i>Eucalyptus camaldulensis</i> fringing riparian woodland on Split Creek. Sandy creek bed with little ground cover and occasional debris piles. Banks/margins typically dominated with dense grass cover of Buffel Grass and <i>Triodia</i> spp.	

SITE NUMBER AND LOCATION	HABITAT DESCRIPTION	PHOTOGRAPH OF HABITAT
5. Southern section of the study area within the disturbance footprint of the trial mining area (See maps in Appendix A)	Open woodland on flat terrain dominated by sparse to very sparse covering of <i>Acacia cambagei</i> . Trap site surrounded by drainage features historically impacted by exploration activities and cattle grazing. Groundcover very low in height and dominated by forbs responding to recent rainfall.	
6. Central section of the study area on minor watercourse feature	Low growing <i>Acacia cambagei</i> dominated woodland on a first order watercourse. Groundcover sparse to very sparse, but becoming denser on the immediate banks of the watercourse. Small rocky outcrop present to the east of the trap site.	

5.3 Survey techniques

The survey techniques employed at each systematic survey site are detailed in Table 5.

Table 5: Fauna survey methods employed at systematic survey sites

SURVEY METHOD	DESCRIPTION
Elliott traps	At each trapping site, type A Elliott style traps were placed on the ground approximately 5–10m apart in a straight line for three nights. Twenty traps were employed at each site. All traps were baited with a mixture of rolled oats, peanut butter and honey.
Pitfall and funnel traps	Drift fence lines incorporating pitfall and funnel traps were established for four to five nights at each of the systematic survey sites. Three pitfall traps (20 L buckets) were buried flush with the ground surface with the drift fence intersecting the centre of each bucket at each site. Six funnel traps were located along the drift fencing at each site. A shade cloth covering each funnel trap was deployed to protect trapped species from exposure.
Cage traps	Four cage traps were placed at each site and baited with a mixture of rolled oats and a variety of different meats.

SURVEY METHOD	DESCRIPTION
Bat call detectors	A bat call detector was deployed for one night at each site. Additionally, the bat call detector was placed at other habitat types/areas.
Active diurnal searches	Active diurnal searches were undertaken within each of the sites. This technique involved intensive investigation of ground layer habitat features (such as under logs, rocks and leaf litter) and low vegetation (under bark and tree stumps) for cryptic fauna, particularly reptiles. Searches were focussed during the parts of the day when reptile activity was likely to be at its peak.
Diurnal bird surveys	Birds were surveyed within each vegetation community for a total of at least one hour at multiple periods throughout the day, but with a particular focus during peak activity in the morning. Incidental observations made while conducting other survey techniques were also recorded. Birds were identified from either direct observation or by their calls.
Nocturnal surveys	High-powered spotlights were used to survey nocturnal mammals (flying, arboreal and terrestrial), birds (active nocturnal species, and roosting diurnal species), reptiles and frogs in each of the main trapping sites, as well as other locations throughout the study area.

5.4 Additional survey areas and techniques

During the fauna survey period, numerous survey techniques were employed within the systematic survey sites as well as in additional locations to identify fauna within the study area. Survey techniques utilised during the baseline study included a bat detector, active diurnal searches, diurnal bird surveys and nocturnal survey techniques. Some of these locations are depicted in the Fauna Survey map in Appendix A.

In addition to the techniques outlined previously, camera traps (motion-sensing infrared cameras) were utilised at multiple locations within the study area to target fauna that may be too large or 'shy' to be detected by other trapping techniques or that were utilising areas outside the main trapping sites. Camera traps were baited with the rolled oats mixture and a variety of meats.

Targeted nocturnal searches for arboreal mammals and nocturnal predatory birds were performed in areas considered higher quality habitat for such species.

Spotlighting surveys were also conducted while driving slowly over multiple parts of the study site and local area, where it was safe to do so.

Fauna species were continually observed throughout the survey period and records were frequently obtained outside of the systematic methodology of the survey. Any observations, tracks, scats or other signs of fauna were recorded with reference to the location and habitat type.

5.5 Targeted techniques

Targeted survey techniques for the Night Parrot (*Pezoporus occidentalis*) were incorporated into the survey programme in accordance with the methodology recommendations outlined by the

Night Parrot Recovery Team (NPRT, 2017). This methodology is also the recommended approach as outlined in the *Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act* (DEWHA, 2017). Because of the risks associated with disturbance, the recovery team has maintained a policy of minimal disturbance for research and surveys for the Night Parrot. The methods employed, as per the recommendations, were passive observation and listening. Areas of potentially suitable roosting habitat (*Triodia longiceps* patches near outcrops with low tree and shrub cover) were identified and two observers listened for calls during optimal periods (one hour after sunset and before dawn). Other habitats including potential drinking points and feeding habitats were also surveyed over the course of the fauna survey programme.

Targeted survey techniques for the Purple-necked Rock-wallaby were also incorporated into the fauna survey programme. Methodologies employed included those described by Rowland (2012b), including 'searching for signs', infra-red camera trapping and observation surveys. Focus was given to areas of preferred habitat such as rocky outcrops and slopes, and limestone cliffs and gorges.

5.6 Survey effort

The survey effort employed for each of the aforementioned techniques is outlined in Table 6, showing the effort employed at each systematic survey site and the total survey effort over the period (including effort outside the systematic surveys).

Table 6: Fauna survey effort for each technique

METHOD	EFFORT PER SITE – MAY 2017 SURVEY	EFFORT PER SITE – MARCH 2018 SURVEY	TOTAL SURVEY EFFORT
Pitfall trapping	12 – 15 trap nights Sites 1 and 2 – Array of three pits × five nights Site 3 – Array of three pits × four nights	12 trap nights (Array of three pits × four nights)	78 trap nights
Funnel trapping	30 trap nights (Array of six funnels × five nights)	24 trap nights (Array of six funnels × four nights)	162 trap nights
Diurnal active search	2 person hours (60 minute search × two people)	2 person hours (60 minute search × two people)	Approx. 22 person-hours (six × systematic surveys sites plus ten additional one person-hour survey sites)
Elliott trapping	100 trap nights (20 traps × five nights)	60 – 80 trap nights Site 4 – 15 traps × four nights Site 5 and 6 – 20 traps × four nights	520 trap nights

METHOD	EFFORT PER SITE – MAY 2017 SURVEY	EFFORT PER SITE – MARCH 2018 SURVEY	TOTAL SURVEY EFFORT
Cage trapping	20 trap nights (Array of four cages × five nights)	16 trap nights (Array of four cages × four nights)	108 trap nights
Diurnal bird survey	Four person-hours (Six × 20 minute surveys × two people)	Four person-hours (Six × 20 minute surveys × two people)	12 person-hours
Camera Trapping	Five trap nights (One camera × five nights)	Four trap nights (One camera × four nights)	27 trap nights
Spotlight/ nocturnal searches	Four person-hours (120 minute search × two people)	Four person-hours (120 minute search × two people)	24 person hours
Echolocation call detection	One detector night (One detector for one night at each site and one additional detector nights)	One detector night (One detector for one night at each site)	Seven detector nights

Desktop Analysis Results

1. Database searches

The EPBC Act Protected Matters Report (DEE, 2017a) and Wildlife Online Database extract (EHP, 2017b) are included in Appendix B and Appendix C, respectively. The Wildlife Online extract and Protected Matters Report identified two threatened flora species, thirteen threatened fauna species, and six migratory fauna species with potential relevance to the study area.

1.1 Threatened ecological communities (TEC)

No TEC were identified in the Protected Matters Report as potentially occurring within the study area or within a 25km radius.

1.2 Threatened and near threatened flora species

One near threatened and one threatened flora species were returned in the database searches. The EPBC Act Protected Matters Report did not identify any threatened plant species potentially occurring within a 25km radius of the study area (DEE, 2017a; see Appendix B). The Queensland Government Wildlife Online extract shows records of two near threatened or threatened plant species within a 100km radius of the study area (EHP, 2017b, see Appendix C). Table 7 shows all near threatened and threatened flora species recorded from the database searches and their status under State and Commonwealth legislation, as well as their likelihood of occurring within the study area.

Table D1 in Appendix D provides justification for the likelihood of occurrence determination for each species. Of the two flora species returned in the desktop analyses, only *Ptilotus maconochiei* was considered to have a moderate likelihood of occurring within the study area. The potential for *Ptilotus maconochiei* to occur within the study area and the likelihood of significant impacts to this species is discussed in further detail in the Impact Assessment and Management section of this report.

Mt Isa Mallee (*Eucalyptus nudicaulis*) was considered to have a low likelihood of occurring, as this species is only known from a localised area near Mt Isa, which is approximately 100km from the study area. Further details on the classification of a 'low' likelihood of occurrence is included in Appendix D.

The study area is not located within a 'high-risk area' on the protected plants flora survey trigger map.

1.3 Threatened fauna species

A total of 13 near threatened and threatened fauna species were returned from the database searches. These included nine from the Protected Matters Report (DEE, 2017a, see Appendix B) and four additional species from the Wildlife Online extract (EHP, 2017b, see Appendix C). The results of these searches have been combined in Table 8, which also provides an interpretation on the likelihood that each of these species would occur within the study area. Table D2 in Appendix D provides justification for how the likelihood of occurrence was determined for each species.

Eight species were considered to have a moderate or high likelihood of occurring within the study area; the remaining five species were considered to have a low likelihood of occurring. All species that were considered to have a moderate or high likelihood of occurring within the study area are discussed in further detail in the Impact Assessment and Management section of this report.

1.4 Migratory species

The EPBC Act Protected Matters Search Tool identified six migratory species with potential to occur within 25km of the study area. The results of this search are included in Table 9 along with interpretation on the likelihood that each of these species would occur within the study area. Table D3 in Appendix D provides a justification for how the likelihood of occurrence was determined for each species.

All of the six species were considered to have a low likelihood of occurring within the study area.

Table 7: Near threatened and threatened flora species identified from database searches

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	RECORDS	LIKELIHOOD OF OCCURRENCE
NCA	EPBC						
NT	–	Amaranthaceae	<i>Ptilotus maconochiei</i>	–	WO	1	Moderate
V	–	Myrtaceae	<i>Eucalyptus nudicaulis</i>	Mt Isa Mallee	WO	3	Low

1. Status: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered

2. WO = Wildlife Online Database (100km radius area for records), PM = EPBC Act Protected Matters Report (25km radius area for search)

Table 8: Near threatened and threatened fauna species identified from database searches

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	WO RECORDS	LIKELIHOOD OF OCCURRENCE
NCA	EPBC						
		BIRDS					
E	V	Accipitridae	<i>Erythrotriorchis radiatus</i>	Red Goshawk	PM	0	Moderate
V	–	Falconidae	<i>Falco hypoleucos</i>	Grey Falcon	WO	7	Moderate
V	V	Meliphagidae	<i>Grantiella picta</i>	Painted Honeyeater	PM/WO	2	Moderate
V	E, M	Rostratulidae	<i>Rostratula australis</i>	Australian Painted Snipe	PM	0	Low
LC	CE, M	Scolopacidae	<i>Calidris ferruginea</i>	Curlew Sandpiper	PM	0	Low
E	E	Psittacidae	<i>Pezoporus occidentalis</i>	Night Parrot	PM	0	Moderate
		MAMMALS					
LC	V	Dasyuridae	<i>Pseudantechinus mimulus</i>	Carpentarian Antechinus	PM	0	Moderate
NT	–	Macropodidae	<i>Petrogale purpureicollis</i>	Purple-necked Rock-wallaby	WO	10	Present
V	–	Hipposideridae	<i>Hipposideros stenotis</i>	Northern Leaf-nosed Bat	WO	1	Moderate
V	V	Megadermatidae	<i>Macroderma gigas</i>	Ghost Bat	PM	0	Low
E	V	Thylacomyidae	<i>Macrotis lagotis</i>	Greater Bilby	PM	0	Low
		Reptiles					
NT	–	Chelidae	<i>Emydura subglobosa worrelli</i>	Diamond Head Turtle	WO	4	Low
V	V	Elapidae	<i>Acanthophis hawkei</i>	Plains Death Adder	PM	0	Moderate

1. Status: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory

2. WO = Wildlife Online Database (100km search are for records), PM = EPBC Act Protected Matters Report

Table 9: EPBC Act listed migratory species from the Protected Matters Report

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	WO RECORDS	LIKELIHOOD OF OCCURRENCE
NCA	EPBC						
SLC	M	Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift	PM	0	Low
SLC	M	Motacillidae	<i>Motacilla cinerea</i>	Grey Wagtail	PM	0	Low
SLC	M	Motacillidae	<i>Motacilla flava</i>	Yellow Wagtail	PM	0	Low
SLC	CE, M	Scolopacidae	<i>Calidris ferruginea</i>	Curlew Sandpiper	PM	0	Low
SLC	M	Charadriidae	<i>Charadrius veredus</i>	Oriental Plover	PM	0	Low
SLC	M	Glareolidae	<i>Glareola maldivarum</i>	Oriental Pratincole	PM	0	Low

1. Status: SLC = Special Least Concern, LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, M = Migratory

2. WO = Wildlife Online Database (100k search area for records), PM = EPBC Act Protected Matters Report

2. RE mapping

The study area is located within a broad area that is not mapped in detail on the Vegetation Management Supporting Map (DNRM, 2017), which classifies remnant vegetation under the VM Act. The Vegetation Management Supporting Map (DNRM, 2017) shows the entire area as a 'Category B area containing remnant vegetation'. However, 'Remnant 2015 Regional Ecosystems Map' includes detailed vegetation community mapping for the study area (DSITI, 2017). This map shows a number of remnant REs within the study area and also represents the different categories of vegetation community according to the biodiversity status of that community, as assigned by the Queensland Herbarium.

Table 10 provides a summary of all the REs mapped throughout the study area including the short descriptions provided in the REDD (Queensland Herbarium, 2018).

Table 10: Regional ecosystem status and description for mapped remnant vegetation

RE CODE	VM ACT STATUS	BIODIVERSITY STATUS	REGIONAL ECOSYSTEM DATABASE SHORT DESCRIPTION
1.3.4a	Least Concern	No Concern at present	<i>Acacia cambagei</i> low open woodland to woodland on alluvium
1.3.7b	Least Concern	Endangered	<i>Eucalyptus camaldulensis</i> woodland on channels and levees (south)
1.3.13a	Least concern	No Concern at present	<i>Eucalyptus leucophylla</i> woodland on terraces and minor drainage lines
1.5.6c	Least concern	No Concern at present	<i>Atalaya hemiglauca</i> , <i>Ventilago viminalis</i> , <i>Grevillea striata</i> low open woodland on red earth plains
1.5.16	Least concern	No Concern at present	<i>Acacia cambagei</i> low woodlands on red soils
1.11.2a	Least concern	No Concern at present	<i>Eucalyptus leucophloia</i> low open woodland
1.11.10a	Least concern	No Concern at present	Mixed low open woodland on bare metamorphic plains
1.11.10b	Least concern	No Concern at present	Mixed low open woodland on bare metamorphic plains
1.11.11	Least concern	No Concern at present	<i>Triodia</i> spp. hummock grassland (south)
1.12.3b	Least Concern	No Concern at present	<i>Eucalyptus leucophylla</i> low open woodland on igneous rocks
2.3.18	Least concern	Of concern	<i>Atalaya hemiglauca</i> , <i>Grevillea striata</i> , <i>Vachellia sutherlandii</i> and <i>Eucalyptus microtheca</i> in mixed low woodlands on active Quaternary alluvial plains

RE CODE	VM ACT STATUS	BIODIVERSITY STATUS	REGIONAL ECOSYSTEM DATABASE SHORT DESCRIPTION
4.7.2x1b	Least Concern	No Concern at present	<i>Triodia</i> spp. hummock grassland. (Vegetation community description)
4.9.10b	Least Concern	No Concern at present	<i>Acacia georginae</i> (<i>Acacia cambagei</i> in the east) tall open shrubland on Cambrian limestone
4.9.12x4a	Least Concern	No Concern at present	<i>Corymbia terminalis</i> and/or <i>Eucalyptus leucophylla</i> low open woodland. (Vegetation community description)

3. ESAs

ESAs are described in the Environmental Protection Regulation (2008) and DES provides an online map tool to identify mapped ESAs relevant to resource activities. The ESA map for the study area (EHP, 2017d) shows multiple areas of Category B ESAs within the ML, in the form of endangered (biodiversity status) REs (see map in Appendix A). Review of the remnant REs mapping reveals the mapped Category B ESAs equate to the mapped extent of RE 1.3.7 (Table 11), which has an endangered biodiversity status in the REDD (Queensland Herbarium, 2018). The extent of Category B ESAs has significant bearing on the development of resource activities and therefore these areas were subject to a significant ground-truthing survey effort during the field survey programme.

NRC contacted the Queensland Herbarium to identify the criteria by which RE 1.3.7 has been assigned an endangered biodiversity status. The Queensland Herbarium has confirmed that less than 10% of the pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and, under this criterion, the community qualifies for an endangered biodiversity status. The degradation is defined as a greatly reduced floristic and/or faunal diversity that is unlikely to recover within the next 50 years even with the removal of threatening processes. The key threatening processes to the biodiversity values of this community are cattle grazing and exotic species invasion. These processes have substantially reduced the biodiversity of the understorey in this community.

Table 11: ESA description

RE CODE	BIODIVERSITY STATUS	ESA TYPE	VEGETATION COMMUNITY DESCRIPTION
1.3.7b	Endangered	Category B	<i>Eucalyptus camaldulensis</i> fringing woodland, usually with <i>Lophostemon grandiflorus</i> and <i>Melaleuca bracteata</i> and/or <i>M. dissitiflora</i> . Occurs on recent levees and channel deposits of medium and smaller tributaries which are dry for most of the year; alluvial soils. Riverine wetland or fringing riverine wetland.

4. Geology mapping

Geology mapping for the region was obtained from Geoscience Australia (Geology of the Duchess-Urandangi Region, Map Sheet SF 54 05-06, 1983). A number of geology units are shown within and surrounding the study area, as shown in Table 12. The relevant landzones as defined in Wilson and Taylor (2012) are also shown.

Table 12: Geology mapping units within the study area

MAP CODE	LITHOLOGY	ROCK TYPE	LANDZONE
Cz	Sand, silt, gravel	Alluvium/ colluvium	3/5
Cmb	Shaly siltstone	Sedimentary	9
Cme	Siltstone, chert, shale, phosphorite, phosphatic siltstone	Sedimentary	9
Cmt	Black and grey convoluted chert, nodular chert	Sedimentary	9
Cml	Sandstone, sandy dolomite, siltstone, mudstone, conglomerate, breccia	Sedimentary	9
Psg	Gneiss, amphibolite, quartzite	Metamorphic	11
Ps	Schist, quartzite, amphibolite, felsic metavolcanics, metabasalt	Metamorphic	11

5. Essential habitat

One section of the remnant vegetation within the study area is mapped as essential habitat on the DNRM essential habitat map (see fauna survey map in Appendix A). This essential habitat mapping is associated with two records of the Purple-necked Rock-wallaby (*Petrogale purpureicollis*), which is listed as vulnerable under the NC Act. All remnant vegetation within a 1km radius of this record is mapped as essential habitat and protected under the VM Act.

Essential habitat under the VM Act equates to protected wildlife habitat under the Queensland environmental offsets framework and is a MSES.

Flora Survey Results

1. Vegetation communities

1.1 EPBC Act TEC

The EPBC Act Protected Matters Search Tool did not identify any TEC likely to occur within 25km of the study area and the absence of any communities listed under the EPBC Act was confirmed through the field-based ground-truthing survey.

1.2 Remnant REs

The ground-truthing vegetation community surveys partially supported the Queensland Herbarium RE mapping; however, the spatial extent of some communities was ground-truthed in detail and some areas of heterogeneous polygons were resolved to single units. Ground-truthing identified a total of eight REs within the study area and the spatial extent of these ground-truthed communities is represented in the maps in Appendix A. Overall, some REs identified in the Queensland Herbarium RE mapping were not recorded as present during the ground-truthing survey effort. Notably, no distinct vegetation unit consistent with RE 2.3.18, which has an 'of concern' biodiversity status, was recorded during the field survey.

Table 13 provides a general description of each vegetation community type and their status under the Queensland vegetation management framework. The floristic composition and structure of these communities is also provided in the technical descriptions in Table 13, as well as a photograph representative of each community type.

Apart from RE 1.3.7b, all REs recorded and mapped within the study area have a 'least concern' status under the VM Act and a 'no concern at present' biodiversity status. RE 1.3.7b has a 'least concern' status under the VM Act but has an 'endangered' biodiversity status. REs with an endangered biodiversity status are classified as Category B ESAs under the EP Act and this community is discussed further below in that regard.

1.3 ESAs

The spatial extent of RE 1.3.7b (and therefore the extent of Category B ESAs) within the study area was ground-truthed in detail during both the May 2017 and March 2018 surveys. The extent of RE 1.3.7b was determined to be less than that represented in the state mapping within the ML; however, the state mapped distribution of RE 1.3.7b along Split Creek within the expanded study area closely aligned to the results of the ground-truthing surveys (see RE maps in Appendix A). The ground-truthing survey effort throughout the survey periods included numerous RE type assessments at regular intervals along the relevant drainage and water features throughout the study area. RE 1.3.7b is defined by the presence (and typically

dominance) of River Red Gum (*Eucalyptus camaldulensis*), with other species adapted to riparian environments potentially present. The ground-truthing surveys revealed that some areas shown as RE 1.3.7b on the state mapping did not support this defining species at all and were almost exclusively dominated by Gidgee (*Acacia cambagei*; see Figure 1A). Drainage features dominated by Gidgee are best represented as RE 1.3.4a, which has a biodiversity status of 'no concern at present' and does not equate to an ESA (see Figure 1A and maps in Appendix A).

All areas where River Red Gum forms a component of the canopy layer have been included in the ground-truthed and mapped extent of RE 1.3.7b. Within the study area, this species occurs almost exclusively within sandy alluvial beds and is therefore restricted to areas that are lower in the catchment and have a greater accumulation of alluvium. Most of the drainage features and watercourses in the study area have a very narrow bed of only 1–5m width and, therefore, River Red Gums are occasionally scattered along the beds of these features (Figure 1B and Figure 1C). In these circumstances, the margins of the watercourse feature rapidly transition to the Gidgee and Inland Bloodwood (*Corymbia terminalis*) communities of the surrounding non-riparian landscape (Figure 1C). Split Creek in the centre of the study area is a larger watercourse feature with a sandy bed of approximately 40m width that supports a much more substantial River Red Gum community and more distinct riparian habitat values (Figure 1D).

Significant disturbance from cattle grazing and pest plant species invasion is evident throughout all riparian areas (see Figure 1 and Figure 4A). Cattle grazing has greatly reduced the biodiversity of the ground layer through direct grazing and the introduction of pest plants. Buffel Grass is a desirable pasture species that occurs commonly throughout the region but can significantly reduce biodiversity values when introduced to an area. Buffel Grass has invaded all riparian areas within the study area and this competition with native species has greatly reduced the biodiversity values of riparian communities, particularly RE 1.3.7b (Figure 1). Mimosa bush (*Vachellia farnesiana**) is an invasive exotic species that is commonly present in the shrub layer on the margins of riparian areas. Overall, while the canopy of this community remains relatively intact, the biodiversity values of the understorey layers are severely degraded.

1.4 Regrowth vegetation

No areas of proposed Category C or Category R regrowth vegetation were identified within the study area on State mapping services (DNRM 2018b).

1.5 Non-remnant vegetation

The Queensland Herbarium RE mapping does not show any areas of non-remnant vegetation within the study area. Ground-truthing efforts showed that some small areas have been cleared and modified to create a stock water dam for cattle. Additionally, some small isolated areas of disturbance from prior disturbance and historical exploration activities are present within the vicinity of the trial mining area (Figure 2). The scale of this disturbance is such that the areas do not meet the criteria for remnant vegetation classification and, therefore, these areas have been excluded from the RE mapping (Appendix A).



Figure 1: Examples of vegetation communities relevant to the ESA ground-truthing surveys

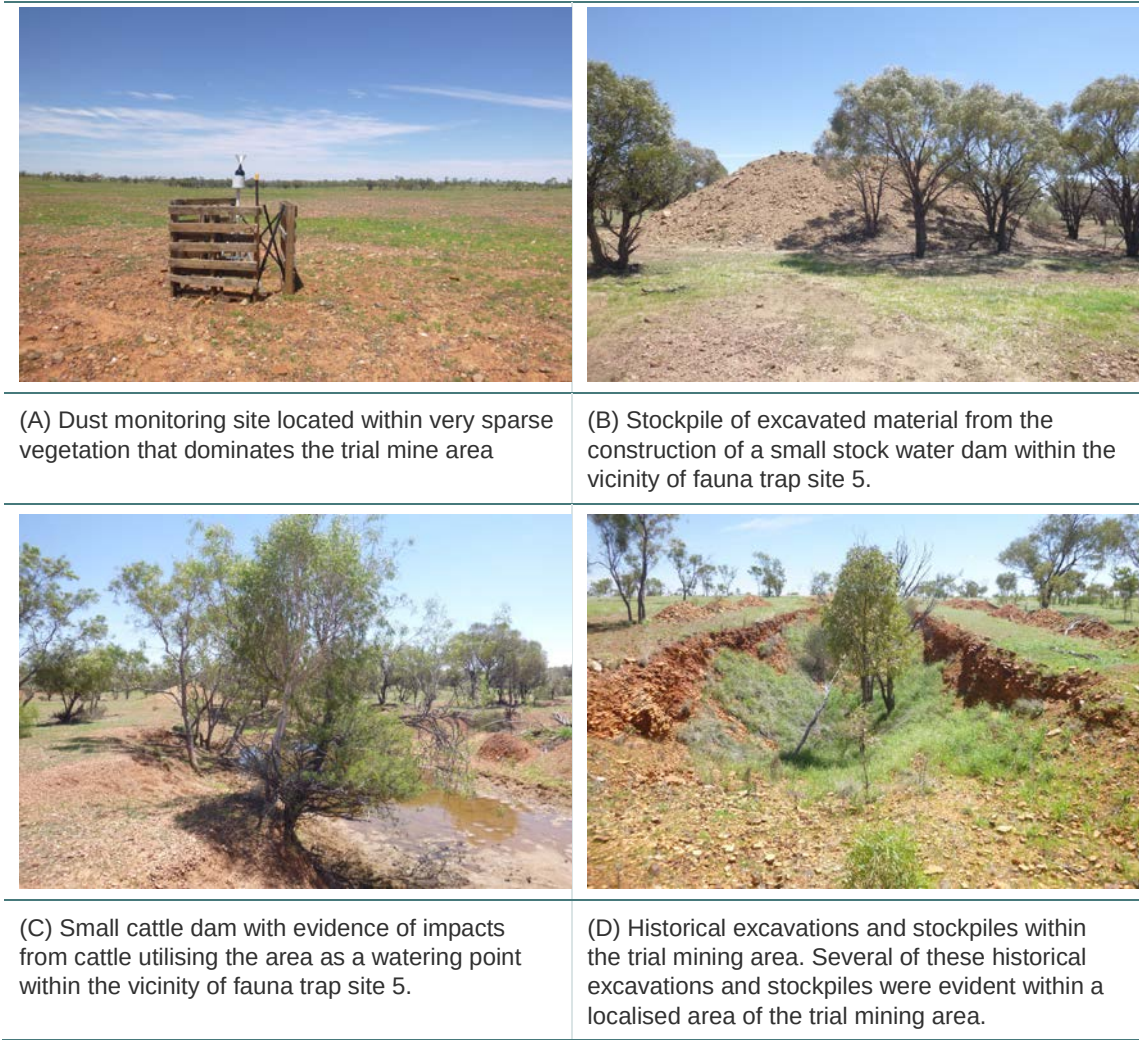


Figure 2: Examples of prior and historical disturbance to remnant vegetation communities within the trial mining area

2. Flora species

A total of 81 flora species from 31 families were recorded from the various vegetation survey techniques within the study area over the 2 survey periods. All flora species observed throughout the study area are common and widespread throughout the region in eucalypt woodland and grassland communities. Flora species diversity within each unit is generally low and the floristic composition is generally consistent throughout much of the study area, with some patchy disturbance from cattle grazing and exotic weeds evident. A full list of flora identified during the flora surveys is included in Appendix E.

2.1 Threatened flora species

No threatened or near threatened flora species (as listed under the EPBC Act or NC Act) were identified during the vegetation surveys, despite targeted surveys in suitable habitat. The potential for each threatened flora species identified in the desktop analysis to occur within the study area is discussed in Appendix D.

2.2 Pest species

Only two noteworthy invasive pest plant species were recorded within the project area during the survey programme. Mimosa Bush was recorded in a variety of habitats throughout the study area but was more prevalent on the margins of drainage features and watercourses and was occasionally relatively abundant in these habitats. Mimosa Bush is not a prohibited or restricted invasive plant in Queensland under the *Biosecurity Act 2014* nor is it a declared weed within the Cloncurry Shire. Cloncurry Buffel Grass is a desirable pasture species that is not native to Australia and competes with native species in a variety of habitats and impacts biodiversity. This species was recorded in almost all habitat types throughout the study area; however, it was particularly prevalent on the banks and levees of minor drainage features (typically RE 1.3.4a) and larger watercourses (typically RE 1.3.7b). Cloncurry Buffel Grass is not a prohibited or restricted invasive plant in Queensland under the *Biosecurity Act 2014*. A full flora species list, including pest species recorded during the survey is included in Appendix E.

Table 13: Floristic composition and structure of REs within the study area

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 1.3.4a</p> <p>Fringing low woodland of <i>Acacia cambagei</i> on minor drainage features between larger units. Also occurs as a minor component of other mapped vegetation communities.</p> <p>A sparse shrub layer is occasionally present and consists of <i>Acacia cambagei</i> and other species such as <i>Atalaya hemiglauca</i>, <i>Eremophila mitchellii</i>, <i>Carrissa lanceolata</i> and <i>Senna</i> spp.</p> <p>The ground layer varies depending on the position in the landscape and type of alluvium but is typically dominated by the invasive Buffel Grass on the margins of the drainage features. Other species occasionally present include <i>Triodia</i> spp. and <i>Aristida</i> spp., particularly <i>Triodia longiceps</i> in the upper reaches.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Sparse 4 – 8m (median 7m) <i>Acacia cambagei</i> (D) <i>Santalum lanceolatum</i> (A).</p> <p>S: Sparse 1 – 3m <i>Acacia cambagei</i> (D), <i>Atalaya hemiglauca</i> (SD), <i>Carissa lanceolata</i> (SD), <i>Eremophila mitchellii</i> (A), <i>Senna aretemisioides</i> ssp. (A), <i>Vachellia farnesiana</i>* (A), <i>Grevillea striata</i> (A), <i>Sesbania</i> spp. (A), <i>Pittosporum angustifolium</i> (A), <i>Eremophila longifolia</i> (A).</p> <p>G: Dense <i>Cenchrus pennisetiformis</i>* (D), <i>Triodia longiceps</i> (SD), <i>Aristida</i> spp. (A), <i>Sporobolus actinocladus</i> (A), <i>Salsola australis</i> (A), <i>Sclerolaena cuneata</i> (A), <i>Triodia</i> spp. (A), <i>Trichodesma zeylanicum</i> (A).</p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 1.3.7b</p> <p><i>Eucalyptus camaldulensis</i> fringing open woodland on recent alluvium in watercourses and margins.</p> <p>Generally restricted to the sandy beds of larger watercourse features within the study area.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: Endangered</p>	<p>T1: Sparse 7 – 14m <i>Eucalyptus camaldulensis</i> (D), <i>Corymbia terminalis</i> (A), <i>A. cambagei</i> (A), <i>Corymbia bella</i> (A).</p> <p>T2: Sparse 4 – 7m <i>Eucalyptus camaldulensis</i> (CD), <i>A. cambagei</i> (CD), <i>Atalaya hemiglauc</i>a (CD), <i>Eucalyptus normantonensis</i> (A), <i>Acacia excelsa</i> (A).</p> <p>S: Sparse 1 – 3m <i>Carissa lanceolata</i> (CD), <i>A. hemiglauc</i>a (CD), <i>A. cambagei</i> (CD), <i>Vachellia farnesiana</i>* (A-CD), <i>Acacia chisholmii</i> (A), <i>Sesbania javanica</i> (A), <i>Flueggea virosa</i> (A).</p> <p>G: Very sparse (bed) – Dense (banks) <i>Cenchrus pennisetiformis</i>* (D), <i>Triodia longiceps</i> (SD), <i>Themeda triandra</i> (A), <i>Chrysopogon fallax</i> (A), <i>Sporobolus actinocladus</i> (A), <i>Salsola australis</i> (A), <i>Triodia pungens</i> (A), <i>Eulalia aurea</i> (A).</p>	
<p>RE 1.5.6c</p> <p>Low very open woodland usually dominated by <i>Atalaya hemiglauc</i>a or <i>Acacia cambagei</i>, with <i>Corymbia terminalis</i> dominant in some areas.</p> <p>Ground layer typically dominated by annual grasses such as <i>Aristida contorta</i>, with some large areas dominated by <i>Sclerolaena cuneata</i>. Large bare patches also common.</p> <p>Occurs on flat to slightly undulating outwash plains.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Very sparse 3 – 8m <i>Acacia cambagei</i> (CD), <i>Atalaya hemiglauc</i>a (CD), <i>Corymbia terminalis</i> (SD), <i>Grevillea striata</i> (A),</p> <p>S: Very sparse – Dense 1 – 2m <i>Acacia cambagei</i> (CD), <i>Atalaya hemiglauc</i>a (CD), <i>Senna artemisiodes</i> (CD), <i>Carrissa lanceolata</i> (A)</p> <p>G: Variable Absent – mid-dense <i>Aristida contorta</i> (D), <i>Sclerolaena cuneata</i> (D), <i>Triodia longiceps</i> (A – SD), <i>Sclerolaena bicornis</i> (A – SD), <i>Enneapogon polyphyllus</i> (A – SD), <i>Salsola australis</i> (A), <i>Aristida spp.</i> (A), <i>Sporobolus actinocladus</i> (A), <i>Sclerolaena lanicuspis</i> (A), <i>Cenchrus pennisetiformis</i>* (A), <i>Sida spp.</i> (A).</p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 1.11.10a</p> <p>Very open woodland with varying canopy of species such as <i>Corymbia terminalis</i>, <i>Acacia cambagei</i>, <i>Atalaya hemiglauc</i>, <i>Grevillea striata</i> and <i>Hakea</i> spp. Treeless areas common.</p> <p>A very sparse shrub layer dominated by <i>Senna artemisioides</i> is occasionally present.</p> <p>The ground layer is patchy and typically dominated by annual grasses such as <i>Aristida contorta</i> with <i>Sclerolaena</i> spp. common in some areas. Occasionally broken by gullies with <i>Triodia longiceps</i> (usually with <i>A. cambagei</i> as tree layer). Large bare gravelly areas common.</p> <p>Occurs on gravelly plains and slightly undulating areas usually adjacent to rock outcrops.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Very sparse 4–8m <i>Corymbia terminalis</i> (CD), <i>Acacia cambagei</i> (CD), <i>Atalaya hemiglauc</i> (CD), <i>Acacia cambagei</i> (A - CD), <i>Grevillea striata</i> (A), <i>Eucalyptus leucophloia</i> (A), <i>Corymbia bella</i> (A), and <i>Hakea lorea</i> subsp. <i>lorea</i>, <i>Hakea chordophylla</i> (A).</p> <p>S: Very sparse 1 – 2m <i>Senna artemisioides</i> ssp. with occasional low canopy species.</p> <p>G: Sparse <i>Aristida contorta</i> (D), <i>Triodia longiceps</i> (A – D), <i>Enneapogon polyphyllus</i> (A – SD), <i>Sclerolaena cuneata</i> (A – SD), <i>Sclerolaena bicornis</i> (A – SD), <i>Aristida</i> spp. (A), <i>Salsola australis</i> (A), <i>Sclerolaena lanicuspis</i> (A), <i>Cenchrus pennisetiformis</i>* (A), <i>Sida</i> spp. (A).</p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 1.11.11</p> <p>Slopes and outcrops dominated by <i>Triodia longiceps</i> with occasional emergent <i>Eucalyptus leucophloia</i>.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Very sparse 7m <i>Eucalyptus leucophloia</i></p> <p>S: Absent – Very sparse 1m Occasional <i>Senna artemisioides</i> and <i>Acacia chisholmii</i></p> <p>G: Mid-dense – Dense <i>Triodia longiceps</i></p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 1.12.3b</p> <p>Similar to RE 1.11.10a, but with slightly different landzone characteristics.</p> <p>The tree layer is absent to very sparse and includes <i>Corymbia terminalis</i>, <i>Eucalyptus leucophloia</i>, <i>Atalaya hemiglauca</i>, <i>Grevillea striata</i> and <i>Hakea</i> spp.</p> <p>In the southern section of the study area treeless areas are more common and <i>Acacia chisholmii</i>, <i>Eremophila longifolia</i>, and <i>Sida</i> spp. are more prevalent in the lower strata.</p> <p>The ground layer is patchy, but typically dominated by <i>Triodia longiceps</i>.</p> <p>Occurs on undulating areas and low rises.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Very sparse 3 – 6m <i>Corymbia terminalis</i> (CD), <i>Atalaya hemiglauca</i> (CD), <i>Eucalyptus leucophloia</i> (A), <i>Grevillea striata</i> (A), <i>Hakea lorea</i> subsp. <i>lorea</i> (A), <i>Hakea chordophylla</i> (A)</p> <p>S: Sparse 0.5 – 2m <i>Acacia chisholmii</i> (D), <i>Eremophila longifolia</i> (A), <i>Sida fibulifera</i> (A)</p> <p>G: Very Sparse – Mid-dense <i>Triodia longiceps</i> (D), <i>Aristida contorta</i> (A–CD), <i>Enneapogon polyphyllus</i> (A – SD)</p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 4.9.10b</p> <p><i>Acacia cambagei</i> open shrubland on undulating sedimentary plains and low hills/gullies, often with skeletal soils. <i>Atalaya hemiglauc</i>a is dominant or co-dominant in some areas. <i>Corymbia terminalis</i> is occasionally present but is mapped as 4.9.12x4a where dominant.</p> <p><i>Acacia cambagei</i> becomes denser in gullies and larger gullies that are lower in the landscape often merge with RE 1.3.4a.</p> <p>A sparse low shrub layer dominated by <i>Senna</i> sp. is occasionally present.</p> <p>At the time of survey, the ground layer was generally dominated almost exclusively by <i>Enneapogon polyphyllus</i>, with <i>Cenchrus pennisetiformis</i>* sometimes present, and occasional patches of <i>Triodia longiceps</i>.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>S1/T1: Very sparse (occasionally mid-dense in gullies) 3–7m <i>Acacia cambagei</i> (D), <i>Atalaya hemiglauc</i>a (SD–D), <i>Corymbia terminalis</i> (A), <i>Grevillea striata</i> (A)</p> <p>S2: Very sparse 0.5 – 2m <i>Acacia cambagei</i> (D), <i>Senna artemistiod</i>es subsp. <i>oligophylla</i> (SD), <i>Senna artemistiod</i>es subsp. <i>helmsii</i> (A), <i>Eremophila longifolia</i> (A)</p> <p>G: Sparse <i>Enneapogon polyphyllus</i> (D), <i>Cenchrus pennisetiformis</i>* (A–SD), <i>Triodia longiceps</i> (A), <i>Aristida spp.</i> (A),</p>	

DESCRIPTION AND STATUS	FLORISTIC COMPOSITION AND STRUCTURE ¹	REPRESENTATIVE PHOTOGRAPH
<p>RE 4.9.12x4a</p> <p>Very sparse woodland of <i>Corymbia terminalis</i>, often with <i>Atalaya hemiglauc</i>a as co-dominant or dominant. Similar to, and often merging with, RE 4.9.10b – distinguished by dominance of <i>C. terminalis</i> rather than <i>Acacia cambagei</i>.</p> <p>VMA Status: Least concern</p> <p>Biodiversity Status: No concern at present</p>	<p>T1: Very sparse 4 – 9m <i>Corymbia terminalis</i> (D), <i>Atalaya hemiglauc</i>a (SD- D), <i>Acacia cambagei</i> (A-SD), <i>Grevillea striata</i> (A)</p> <p>S1: Very sparse 0.5 – 2m <i>Atalaya hemiglauc</i>a (D), <i>Acacia cambagei</i> (SD), <i>Senna artemistiod</i>es subsp. <i>oligophylla</i> (SD), <i>Senna artemistiod</i>es subsp. <i>helmsii</i> (A)</p> <p>G: Sparse – Mid-dense <i>Enneapogon polyphyllus</i> (D), <i>Cenchrus pennisetiformis</i>* (A–D), <i>Triodia longiceps</i> (A-D), <i>Aristida</i> spp. (A–SD)</p>	

¹ D = Dominant, CD = Co-dominant, SD = Sub-dominant, A = Associated, as defined in Neldner *et al.* (2017); * = Species not native to Australia

Fauna Survey Results

1. Fauna habitat

1.1 Habitat features

Habitat features varied across the study area and were primarily influenced by vegetation community type and landform characteristics. Overall, habitat values for most faunal groups were relatively low and sparsely distributed throughout most of the study area, with limited microhabitat features except in areas of rock outcrops and riparian communities. Rocky outcrop features primarily occurred on the eastern and western borders of the study area where areas of eroded limestone (western side; Figure 3A) or low outcropping hills (eastern side; Figure 3B) were present. Small areas of limestone outcrops (typically less than 0.1ha) occurred sporadically in the southern portion of the study area and provide some refugia for small reptiles in areas that were otherwise sparse and provided very limited fauna habitat (Figure 3C). There were some distinct habitat features associated with the major watercourses within the study area, particularly Split Creek, which traverses the centre of the study area from east to west. This feature had a large sandy bed, with mounds of woody debris collected in some areas and mature hollow-bearing River Red Gums (Figure 3D). The only permanent water sources were two stock water dams located in the north and south sections.

Disturbance from cattle grazing is evident throughout much of the study area but is particularly evident in close proximity to the two water points, where grazing pressure is clearly much higher. Vegetative cover is much lower in these areas and, as they occur in flat areas in the landscape, these areas are virtually devoid of microhabitat features for fauna species (Figure 4). These areas support relatively low biodiversity values. In this context, it is important to note that the two water points occur in areas where phosphate rock is known to occur and therefore the main resource areas correlate strongly with areas of significant existing disturbance.

The presence of highly mobile fauna species is likely to be influenced by seasonal characteristics such as rainfall, with these species (such as birds and bats) foraging when suitable trees are flowering or fruiting. Because of this, habitat suitability may vary seasonally causing species diversity to fluctuate as species immigrate and emigrate to exploit available resources.

1.2 Connectivity

The study area is located within a broad area of remnant vegetation with intact connectivity values. In general, the habitat within the study area does not form a critical link between habitats, but rather forms part of a relatively homogenous mix of communities within the broader region. Some higher connectivity values are associated with the watercourse features, where woody vegetation becomes denser and forms linear corridors at different scales depending on the size of the watercourse feature. Most watercourse and drainage features are not large

enough to provide corridor connectivity values. Split Creek is the only feature on the site that is large enough to provide corridor values at the local scale.

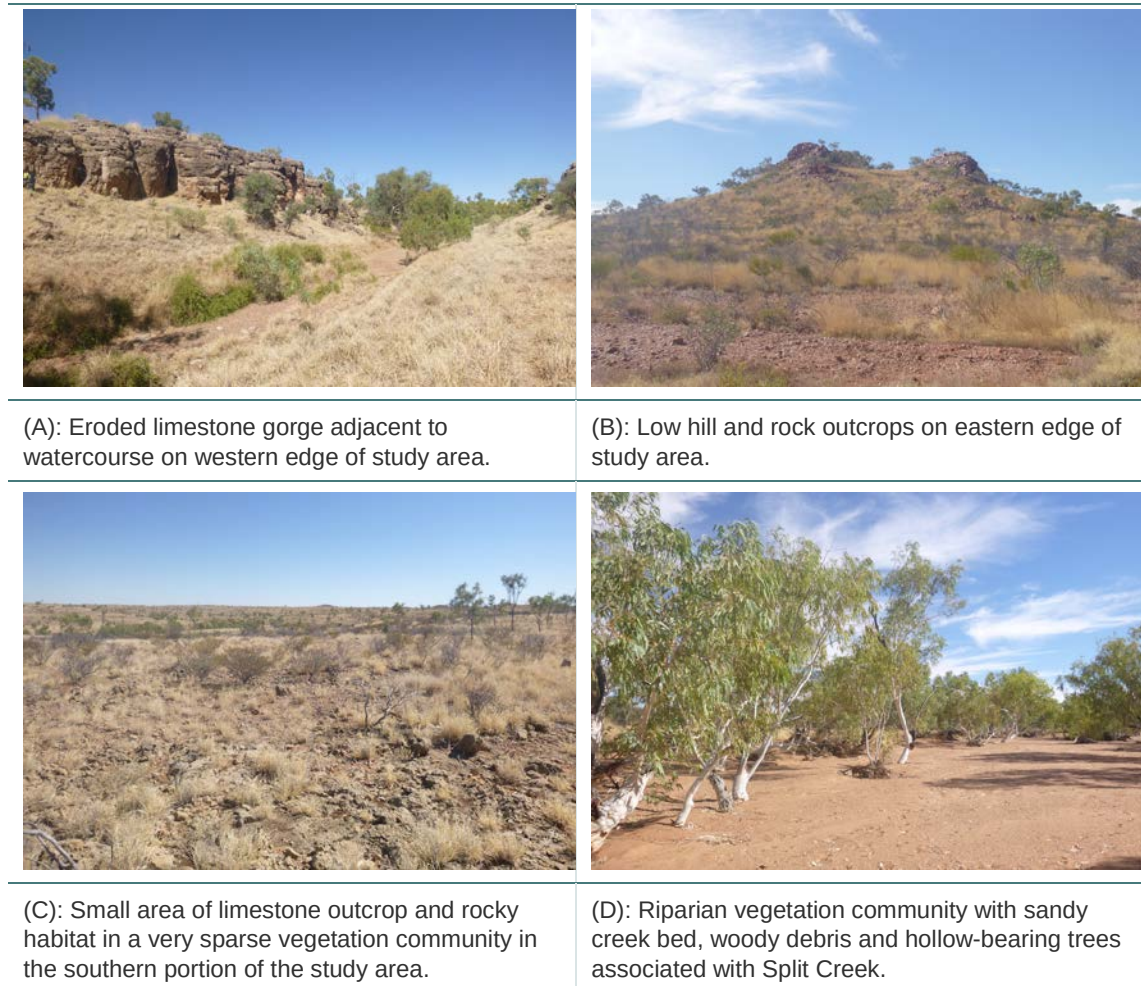


Figure 3: Examples of habitat features within the study area

1.3 Watercourse and wetland habitat

There are no wetland protection areas or wetlands of high ecological significance shown on the map of referable wetlands (EHP, 2017c). There are no wetlands of international significance that are relevant to the study area. The two stock water dams located at the northern and southern ends of the study area are the only permanent water sources within the study area.

There are a number of ephemeral drainage features and watercourses throughout the study area, most of which are tributaries of Split Creek. Split Creek is the main watercourse feature present within the study area and supports a broad sandy bed of approximately 40m in width and a distinct riparian community. This riparian community provides some additional habitat

values to the surrounding landscape in the form of hollow-bearing River Red Gums and some connectivity values. Most of the tributaries are relatively minor and have similar biodiversity values to the surrounding non-riparian communities.

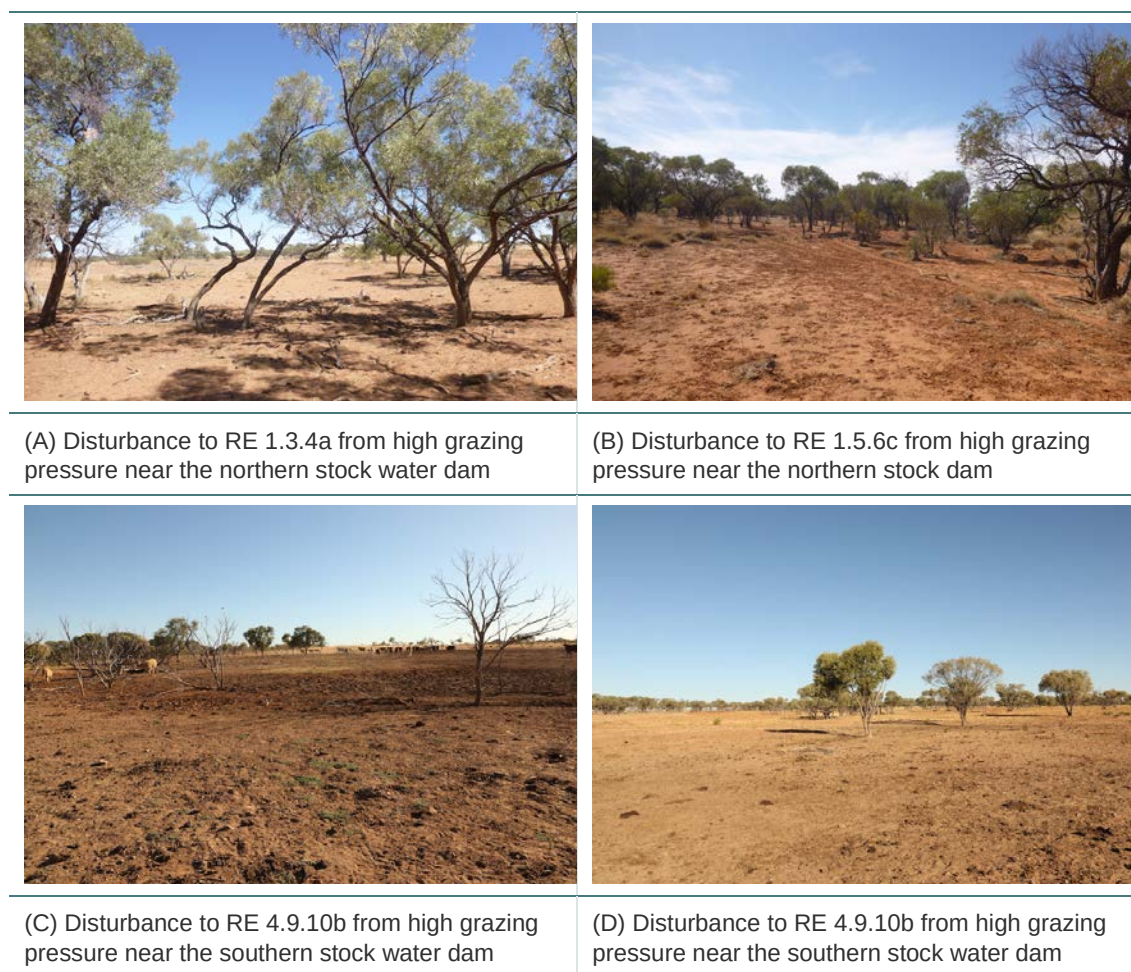


Figure 4: Disturbance from cattle grazing near stock water dams

2. Fauna species

An array of fauna was identified within the study area over the survey period using a variety of different observation and trapping techniques. A combined list of all species identified during the survey period is included in Appendix F. The following sections provide a brief discussion of the species observed for each taxonomic group. Potential impacts to fauna are discussed in the latter sections of this report, with a focus on conservation significant species.

2.1 Mammals

Twenty species of mammals from ten different families were recorded within the study area over the May 2017 and March 2018 survey periods (Appendix F). Small mammal diversity was highest at site 3 during the May 2017 survey, which was located in the ecotone of different habitat types and had significant cover of Grey Spinifex (*Spinifex longiceps*) in the ground layer. One individual native rodent, the Common Rock Rat (*Zyomys argurus*), was captured at site 2 during the May 2017 survey in the riparian habitat adjacent to Split Creek. While this habitat is somewhat atypical for this species, there are multiple areas of rock outcrops in close proximity to the creek and the trapping site. Survey site 5 contained the highest mammal richness during the March 2018 survey period, with 12 species recorded, the majority of which were microbats.

At least seven and as many as ten bat species were recorded using the echolocation recording device over the May 2017 and March 2018 surveys. Seven species were positively identified from the call data collected, with some calls only able to be attributed to a genus. The *Microbat Call Interpretation Report* from the fauna surveys are included in Appendix G. While some calls could not be clearly distinguished between several species, none of these species are listed as threatened or near threatened under the NC Act or the EPBC Act.

One threatened mammal species, the Purple-necked Rock-wallaby, was recorded within the study area. This species is listed as vulnerable under the NC Act, but is not listed under the EPBC Act. Several individuals of this species were recorded at a single location on the western edge of the ML during the May 2017 and March 2018 baseline surveys. Individuals were recorded in an area of outcropping limestone associated with a watercourse (see example photographs in Figure 5, and location in Appendix A). The occurrence of this species and potential impacts of development within the ML are detailed in the Impact Assessment and Management section of this report.

No evidence of any other mammals listed as near threatened or threatened was observed within the study area.

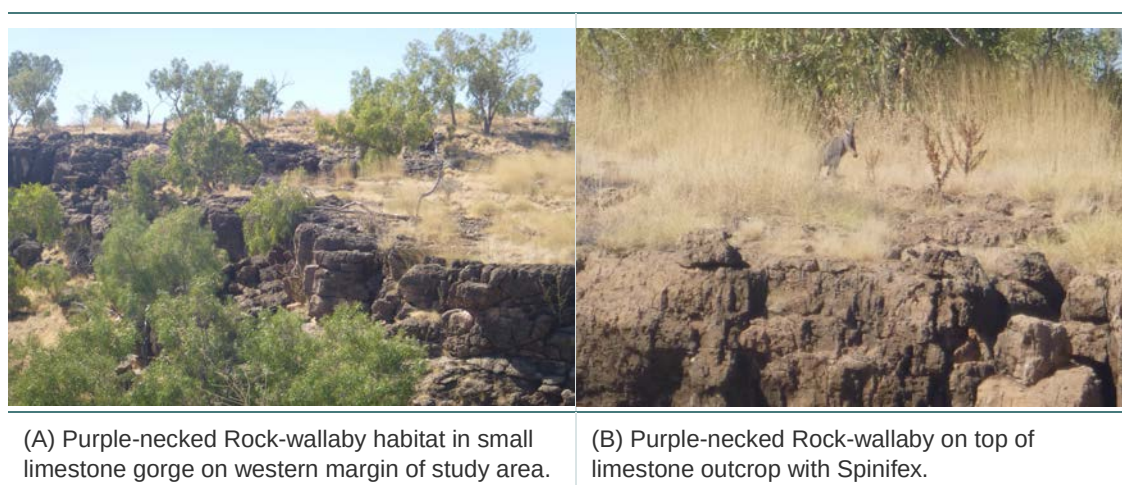


Figure 5: Purple-necked Rock-wallaby habitat in the western portion of the study area

2.2 Reptiles

A total of 23 reptile species from 8 different families were observed within the study area over the May 2017 and March 2018 survey periods (see Appendix F). All of these species are common and widespread throughout similar habitats within the broader region.

No evidence of any reptiles listed as near threatened or threatened was observed within the study area.

2.3 Amphibians

No amphibian species were recorded during the May 2017 survey period and this is likely due to the dry and cool conditions at the time of the survey. However, three amphibian species from two different families were recorded within the study area over the March 2018 survey. These species were predominantly observed to occur around areas of pooled water and were notably absent from dryer areas within the study area. Additionally, tadpoles were observed within isolated areas of pooled water throughout the study area during the March 2018 survey, particularly within the vicinity of trap sites 4 and 5. All three of these species are common and widespread throughout similar habitats within the broader region.

There are no amphibians listed as near threatened or threatened known to occur in the local area or broader region.

2.4 Birds

A total of 64 bird species were observed within the study area over the May 2017 and March 2018 survey periods. This species assemblage includes a number of sedentary and nomadic species. All species observed are common in eucalypt/acacia habitats throughout the region.

No birds listed as near threatened or threatened were observed during the survey period. The likelihood of impacts to threatened bird species with potential to occur within the study area are discussed in the Impact Assessment and Management section of this report.

2.5 Pest species

The House Mouse (*Mus musculus**) and Feral Pig were the only pest fauna species recorded within the study area. Both of these species commonly occur in a variety of habitats throughout Queensland; however, Feral Pigs are a restricted invasive animal under the *Biosecurity Act 2014* and are a declared pest within the Cloncurry Shire Council. Impacts and management strategies for the Feral Pig are detailed in the Impact Assessment and Management section of this report.

Impact Assessment and Management

1. MSES

The following sections detail the presence of MSES, as identified in the Environmental Offsets Regulation 2014 (Qld). The potential for impacts to these matters is discussed with reference to the Queensland Environmental Offsets Policy – Significant Residual Impact Guideline. Habitat for endangered or vulnerable species ('protected wildlife') is discussed in section 1.4; however, further details regarding the potential occurrence of conservation significant species is provided in sections 3 and 4.

1.1 Regulated vegetation

REs

All of the remnant vegetation communities recorded within the study area have a 'least concern' status under the VM Act, which is consistent with the State-published Remnant Regional Ecosystems Map. None of the vegetation communities recorded within the study equate to a MSES under the Queensland environmental offsets framework. RE 2.3.18, which has an 'of concern' biodiversity status, is shown on the Queensland Herbarium RE mapping; however, no distinct vegetation unit consistent with this community was recorded during the field survey. The vegetation communities recorded within the study area are common throughout the region and are broadly represented at the local and landscape scale. Consequently, it is unlikely these communities would be significantly impacted at any scale by development within the ML. However, see further details below on restrictions pertaining to RE 1.3.7b.

ESAs

The ground-truthing vegetation surveys confirmed the presence of RE 1.3.7b within the study area, although the spatial extent was less than represented in the state mapping. Areas of RE 1.3.7b were notably absent from minor drainage features within the trial mining area, however were present within the extended study area along Split Creek. RE 1.3.7 has an 'endangered' biodiversity status, as identified in the REDD (Queensland Herbarium, 2018), and is therefore a Category B ESA under the EP Act. The 'standard conditions' for ML and exploration activities include restrictions on environmentally relevant activities with respect to Category B ESAs:

- For ML activities: *The holder of the environmental authority must not carry out activities in, or within 1 km of, a category B environmentally sensitive area.*

- For exploration and mineral development projects: *The holder of the environmental authority must not carry out activities in a category B environmentally sensitive area. Activities involving machinery must not be carried out within 500m of category B environmentally sensitive area.*

As previously discussed, the relevant criterion for the endangered biodiversity status for RE 1.3.7b is the severe degradation to this community at the regional scale. The biodiversity values of this community have been severely degraded through agricultural land uses and invasion of exotic plant species. These impacts are evident throughout all riparian areas within the study area, with high grazing pressure in areas close to stock water dams and Buffel Grass dominating the ground layer.

The ground-truthed extent of the ESA was found to be restricted to the bed and banks of the main watercourse features within the study area. While the biodiversity values of riparian areas are severely degraded, there is a distinct community present, particularly in association with larger features such as Split Creek. However, the biodiversity values associated with this community are largely restricted to the bed and banks of the watercourses. Beyond the banks of the watercourses, the vegetation rapidly transitions to the open woodland/shrubland communities that are characteristic of the broader landscape. Biodiversity values beyond the banks and immediate margins of the drainage and watercourse features, despite being within the prescribed buffer zones, are of low relevance to the endangered biodiversity status RE 1.3.7b community.

An EA amendment to the standard conditions to allow disturbance up to 100m of the Category B ESA was submitted and approved within the ML in early 2018. The endangered biodiversity values for this community are those present in the understorey layers. The existing degradation of these understorey layers is such that exploration and/or development works within the surrounding buffer zones are unlikely to result in an increased risk to these biodiversity values. Weed hygiene and management practices should be implemented to avoid the spread of non-native species; however, it should be noted that in many areas the ground layer is already invariably dominated by the invasive Buffel Grass to an extent that it is unlikely exploration or development works pose an increased risk of exotic species invasion. Overall, it is therefore unlikely the biodiversity values associated with the Category B ESA would be significantly impacted by indirect disturbance within the buffer zones of this community.

Remnant vegetation associated with a watercourse

Remnant vegetation associated with a watercourse or drainage feature shown on the *vegetation management watercourse and drainage feature map* (as certified under the VM Act) is classified as a MSES under the Queensland environmental offsets framework. There are several watercourse and drainage features within the study area that are represented on the *vegetation management watercourse and drainage feature map* (see maps in Appendix A). The extent to which the remnant vegetation associated with the watercourse is considered a protected matter is determined by the bioregional context and the stream order of the watercourse or drainage feature.

All of the vegetation communities located within the study area are classified as remnant vegetation, and therefore the extent of vegetation communities within the defined distance of the

banks of the state-mapped watercourse or drainage features is a MSES (see RE maps in Appendix A for locations of watercourses and drainage features as represented on the relevant state mapping layer). The study area is located within a non-coastal bioregion and the relevant defining distances for REs associated with a watercourse are shown in Table 14.

Table 14: Defined distance for REs associated with a watercourse (non-coastal bioregions) as shown in the Queensland Environmental Offsets Policy V1.2

WATERCOURSE STREAM ORDER	DISTANCE FROM DEFINING BANK (M)
1 or 2 (all tributaries of Split Creek within the study area)	25
3 or 4 (Split Creek)	50

Clearing of vegetation within the defined distance of the mapped watercourse and drainage features should be avoided where possible. Where impacts are unavoidable, the following criteria are used to determine whether the impacts are *significant*, and therefore trigger environmental offset liability:

- Clearing occurs within 5m of the defining bank of the feature, AND
- The following area thresholds are exceeded¹:
 - Greater than 20m wide for linear infrastructure
 - Greater than 2 hectares for non-linear infrastructure.

Any clearing of remnant vegetation within 5m of the defining banks of the mapped watercourse and drainage features that is also in excess of these thresholds may be classified as a significant residual impact. The provision of an environmental offset may be required under the Queensland environmental offsets framework.

1.2 Connectivity areas

The study area is located within a broad scale area of remnant vegetation and remnant vegetation communities within the study area are broadly represented throughout the surrounding region. However, watercourse vegetation and related habitat associated with Split Creek likely provides some connectivity value to fauna within the local area, particularly during times of flow. Therefore, any habitat modification or other impacts to watercourse vegetation associated with Split Creek may result in minor impacts to connectivity at a local scale. Overall, habitats within the ML are unlikely to be fragmented or isolated as a result of mining activities and it is therefore unlikely there will be a significant impact to connectivity in the local or broader area. Movement of fauna and other factors affecting biodiversity values associated with

¹ Clearing area and width thresholds are dependant on the structural category of the regional ecosystem as defined in the REDD. All relevant REs mapped and ground-truthed within the study area have a 'sparse' or 'very sparse' structural category and therefore only the relevant thresholds for these communities are presented here.

connectivity in the area are unlikely to be impacted and the existing level of ecosystem function will likely be maintained.

1.3 Watercourse habitat and wetlands

The study area does not contain any wetland protection areas or wetlands of high ecological significance as shown on the map of referrable wetlands (EHP, 2017c). The watercourses present within the study are not 'high ecological value waters' as identified under the Environmental Protection (Water) Policy 2009. Disturbance to watercourse features present within the study area, particularly within Split Creek, should be avoided where possible to minimise impacts to local environmental values.

1.4 Protected wildlife habitat

Desktop studies identified one area of mapped essential habitat for the Purple-necked Rock-wallaby within the northeast portion of the study area. Subsequent field studies also identified the presence of Purple-necked Rock-wallabies within a small limestone gorge in the southwest portion of the study area. Both of these areas equate to the protected wildlife habitat MSES under the Queensland environmental offsets framework and disturbance within these areas should be avoided wherever possible. Additionally, evidence of the Short-beaked Echidna (*Tachyglossus aculeatus*), listed as 'special least concern' wildlife under the NC Act, was detected during field studies. Habitat for the Short-beaked Echidna is classified as a MSES and impacts to the habitat of this species are discussed further below.

No other threatened flora or fauna species were detected within the study area during the survey period and the proposed disturbance area does not represent known critical habitat for any threatened flora or fauna species.

The proposed disturbance area is not located within an area shown on the flora survey trigger map as a 'high-risk' area.

State mapped Purple-necked Rock-wallaby essential habitat

State mapped essential habitat for the Purple-necked Rock-wallaby is localised around an area of hilly terrain towards the northeast portion of the study area and two records (1976–1985) of this species occur within this habitat approximately 400m to the east of the ML boundary (Atlas of Living Australia, 2018). Multiple records on Atlas of Living Australia (2018) area also present in the vicinity of Split Creek. The records are from the 70's and the sensitivity of the records only provides accuracy up to 2km. It is thought these records are likely to be from the large rocky hills to the west of the ML, which Split Creek flows through. During the March 2018 baseline flora and fauna survey, NRC investigated a 400m stretch of road as well as broad scale surrounding habitat values within the eastern boundary of the ML along the Diamantina Developmental Road (See maps in Appendix A). The purpose of this investigation was to ground-truth the presence of essential habitat factors for the Purple-necked Rock-wallaby within the State mapped area of essential habitat. This ground-truthing exercise confirmed a lack of essential habitat factors described in the Essential Habitat Database for this species, under the

category of 'vegetation community'. The relevant essential habitat factors in the regard are 'boulder-strewn ridges of rocky ranges/gorges/rock outcrops'. These habitat features and their relevance to the Purple-necked Rock-wallaby are described further by Rowland (2012b) and identified as shelter habitat. Purple-necked Rock-wallaby shelter habitat (as defined by Rowland, 2012b) including boulder piles, rocky slopes, cliffs and gorges in limestone areas was not present within the ML; however, rocky outcrops were present outside of the ML to the east and south. Habitat outside the ML contained notable rocky outcrops and boulder fields that likely support shelter and breeding habitat for Purple-necked Rock-wallabies. Despite a lack of shelter habitat within the ML, the mapped essential habitat does contain Spinifex grasslands in association with the adjacent rocky habitats that may be utilised by Purple-necked Rock-wallabies for foraging (Rowland, 2012b) (Figure 6). Spinifex habitats are described as part of the 'vegetation community' essential habitat factor within the Essential Habitat Database.

Primary data on foraging behaviour for the Purple-necked Rock-wallaby is limited; however, general constraints and impacts to this species can likely be correlated from other similar Rock-wallaby species. Therefore, the foraging distance from shelter sites likely varies depending on the local extent and intensity of impacts from predators and competition from other herbivores, as well as the abundance and distribution of palatable flora species (Tuft *et al.*, 2011).

The portion of the State mapped essential habitat for within the ML may support some foraging for the Purple-necked Rock-wallaby but favoured shelter and breeding habitat occur outside the ML. A species-specific management plan for the Ardmere Phosphate Project incorporating the potential haul road within State mapped essential habitat incorporating the hierarchy of controls (avoid, mitigate, offset) should be developed. Where a significant residual impact cannot be avoided, provision of an environmental offset under the Queensland environmental offsets framework may be required.

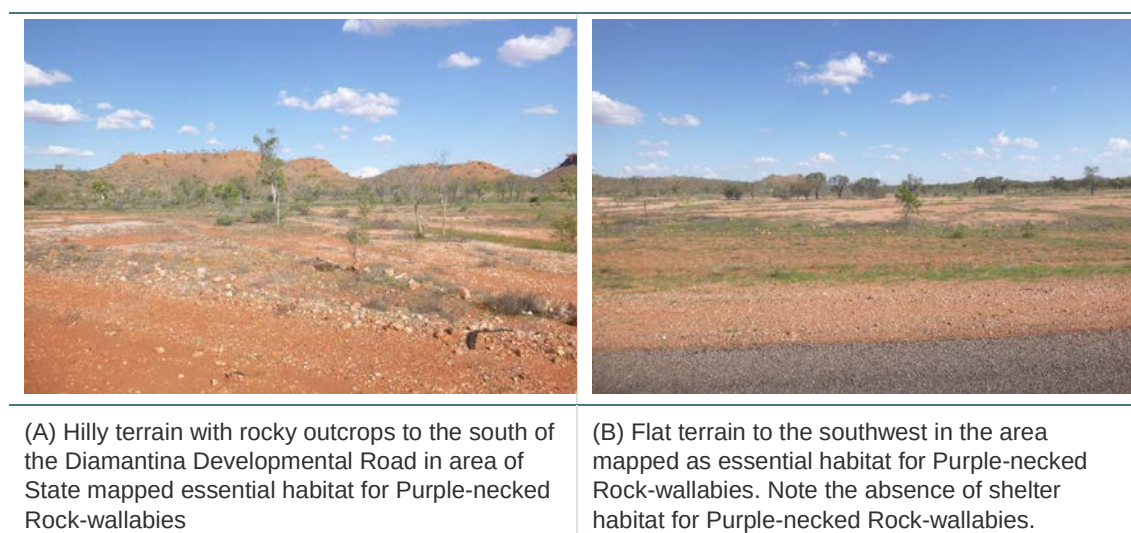


Figure 6: Habitat associated with area of State mapped essential habitat for Purple-necked Rock-wallabies within the northeast portion of the ML

Observations of Purple-necked Rock-wallabies

Multiple observations of Purple-necked Rock-wallabies were recorded within a small limestone gorge in the southwest portion of the study area during both the May 2017 and March 2018 surveys. Limestone outcrop habitats and associated Spinifex grasslands in this area are the main habitat features relevant to this species and disturbance to these habitats should be avoided throughout the study area where possible. Spinifex habitat occurs in an area of approximately 200m radius from the location where this species was recorded in the southwest of the study area. It is therefore recommended that a 200m disturbance exclusion buffer from this location be implemented to avoid impacts to habitat relevant to this species. Disturbance within areas of mapped essential habitat, or where this species has been recorded during the baseline survey, may trigger the requirement for an environmental offset under the Queensland environmental offsets framework.

The Purple-necked Rock-wallaby is unlikely to be relying on the other habitat types that are surrounding the preferred rocky outcrop areas, and it is unlikely that disturbance outside the preferred rocky outcrop areas will result in significant impacts to this species. It is important to note that the known resource areas are located in relatively low-lying and flat areas of the ML that do not support any significant habitat features for the Purple-necked Rock-wallaby. As such, areas of important habitat for this species may be readily avoided by design. Preparation of a Species Management Plan for the Purple-necked Rock-wallaby will be required for the project, including the geographical boundary, an animal breeding place survey report and an impact management plan.

Short-beaked Echidna

The Short-beaked Echidna is listed as 'special least concern' wildlife under the NC Act and habitat for this species is also a MSES. Traces (scats) of this species were recorded in the far southwest corner of the study area during the survey period. Any action involving significant impacts to special least concern wildlife habitat may require the provision of an environmental offset under this framework.

While the study area supports a variety of habitats that are potentially suitable for the Short-beaked Echidna, it represents a small area within a vast expanse of similar habitat. There are no habitat features unique to the study area on which this species would be relying and the area does not represent a link between other habitat areas. It is unlikely that any disturbance within the study area would result in:

- A long-term decrease in the size of the local population.
- A reduced extent of occurrence of the species.
- Fragmentation of the existing population.
- The formation of genetically distinct populations as a result of habitat isolation.
- Disruption to ecologically significant locations for the species.

It is therefore unlikely there would be any significant impacts to the Short-beaked Echidna as a result of the proposed development.

1.5 Protected areas

There are no protected areas relevant to the study area.

2. MNES

The following sections detail the presence of MNES and potential impacts to these matters as assessed with reference to the Matters of National Environmental Significance - Significant Impact Guidelines 1.1 (DEE, 2013). Listed threatened species and ecological communities are discussed in Section 2.1; however, further details regarding the potential occurrence of conservation significant species is provided in Sections 3 and 4.

2.1 Listed threatened species and ecological communities

No flora or fauna species listed as threatened under the EPBC Act were detected within the study area during the May 2017 and March 2018 surveys.

There are no TEC mapped or ground-truthed within the study area.

2.2 Listed migratory species

Six migratory species were identified as potentially relevant to the study area during the desktop analysis. However, all were determined to have a low likelihood of occurrence and none of these species were recorded during the baseline survey. The study area does not support any critical habitat for any of these species. All habitats within the study area are common throughout the broader region with similar habitat values occurring throughout. It is unlikely development within the ML would have a significant impact on individuals or populations of any of these migratory species. Table D3 in Appendix D includes a list of all migratory species that have the potential to occur within the study area and their likelihood of occurrence.

2.3 Wetlands of international importance

No wetlands of international importance (Ramsar wetlands) are located within the study area or the region in general.

3. Conservation significant flora species

No threatened or near threatened flora species were found within the study area, despite the use of targeted threatened flora survey methods. Two conservation significant flora species with relevance to the study area were identified in the desktop analyses and the likelihood of their occurrence within the study area was assessed using key criteria such as local records and habitat suitability/quality. One of these species was considered to have a moderate likelihood of occurring within the study area and is discussed below. Appendix D provides further details of

the likelihood of occurrence assessment for the conservation significant species identified in the desktop assessment.

One record of *Ptilotus maconochiei* was returned from the database searches, and further searches revealed there is a record of this species approximately 100km northeast of the study area and several additional records around the Mt Isa township. While there are no records in close proximity to the study area, this species was considered to have a moderate likelihood of occurrence due to its scattered distribution in rocky habitats throughout western Queensland. Suitable habitat for this species is mostly restricted to the scattered rocky habitats along the eastern margin of the study area. Targeted searches were conducted in areas of potentially suitable habitat; however, this species was not detected during the baseline field survey. The main resource areas within the ML are not located in areas of suitable habitat for this species. Given the lack of local records, the absence of suitable habitat in the main resources areas and the fact this species was not observed during the field surveys, it is unlikely this species would be significantly impacted by development within the ML.

4. Conservation significant fauna species

One threatened fauna species, the Purple-necked Rock-Wallaby, was observed within the study area during the field survey programme. Additionally, traces of one special least concern species, the Short-beaked Echidna, were observed during the field survey programme. Seven other conservation significant fauna species with relevance to the study area were identified in the desktop analyses and the likelihood of their occurrence within the study area was assessed using key criteria such as local records and habitat suitability/quality. The likelihood of occurrence and potential for impacts to these species are discussed below. The remaining five species identified in the desktop analyses were considered to have a low likelihood of occurring within the study area and are not discussed further in this section. However, Appendix D provides further details of the likelihood of occurrence assessment for all conservation significant species identified in the desktop assessment.

4.1 Red Goshawk

The Red Goshawk (*Erythrotriorchis radiatus*) is listed as vulnerable under the EPBC Act and endangered under the NC Act. This species is very sparsely distributed from the western Kimberly area in Western Australia to north eastern New South Wales (Marchant & Higgins, 1993). It typically occurs in coastal and sub coastal areas in wooded and forested lands of tropical and warm temperate Australia (Marchant & Higgins, 1993). It nests in large trees, typically less than 1km from a permanent water source (Aumann & Baker-Gabb, 1991).

There are no records of the Red Goshawk in the local area. The nearest record in the Atlas of Living Australia is over 100km north of the study area around Mt Isa. The home range for this species is very large, between 50 and 220km² (Debus & Czechura, 1988) and the study area is within the known distribution of this species.

No evidence of this species was detected during the fauna surveys. Given that this species is sparsely distributed and occupies large ranges, it is possible that this species may fly over the study area or use the area as part of a much larger home range. However, the study area does

not contain any unique habitat features for the Red Goshawk. Rather, the vegetation communities within the study area are characteristic of the broader landscape. It is unlikely the relatively minor loss of vegetation associated with development of the ML would significantly impact this species.

4.2 Grey Falcon

This species is not listed under the EPBC Act but is listed as vulnerable under the NC Act. The Grey Falcon (*Falco hypoleucos*) is found in low densities throughout much of arid and semi-arid Australia. In Queensland, the majority of records occur in the west, but there are scattered records throughout much of the state. This species inhabits arid and semi-arid areas that are lightly timbered and also occurs in lowland plains where rainfall is typically below 500mm a year (Birdlife International, 2016 and references therein).

The study area is within the known range of this species and the desktop analyses returned seven records within a 100km radius. This species was not observed within the study area during the fauna survey programme. This species is uncommon across a very broad distribution within Australia. While it is possible that this species may occur within the study area or broader locality, the study area does not contain any significant habitat for this species. It is unlikely this species would be significantly impacted by the relatively minor loss of potential habitat associated with development within the ML.

4.3 Painted Honeyeater

The Painted Honeyeater (*Grantiella picta*) is listed as vulnerable under the EPBC Act and the NC Act. This highly nomadic species occurs in low densities mainly west of the Great Dividing Range in Queensland; however, vagrant non-breeding individuals have been recorded occasionally from coastal areas (Rowland, 2012a).

The greatest concentrations and almost all records of breeding come from south of 26° S, on inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland (Higgins *et al.*, 2001). The species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe, with which its breeding season is closely matched (Rowland, 2012a). Many birds move to semi-arid regions after breeding such as north-eastern South Australia, central and western Queensland, and central Northern Territory (Garnett *et al.*, 2011).

The Queensland Department of Science, Information Technology and Innovation (DSITI) targeted species survey guidelines for the Painted Honeyeater identify the breeding season as the optimal survey timing for this species (Rowland, 2012a). However, as the study area is located in the northwest of the species' range, in an area where the species occurs (nomadically) during post-breeding migration periods, the timing of the May 2017 (early dry season) baseline fauna survey programme is considered optimal for detecting this species in the study area. However, this species was not detected within the study area during the May 2017 or March 2018 survey programmes, despite targeted surveys in areas of potentially suitable habitat.

The Painted Honeyeater mostly occurs in woodland habitats that have an abundance of mistletoe. These woodlands are usually dominated by *Acacia* spp. (e.g. *Acacia harpophylla*, *Acacia pendula* and *Acacia aneura*), Belah (*Casuarina cristata*) and Bull-oak (*Allocasuarina luehmannii*). Riparian eucalypt woodlands (e.g. River Red Gum) are also utilised, particularly those affiliated with acacia shrubs (Rowland, 2012a).

The study area supports potentially suitable foraging habitat for the post-breeding season migration period. The River Red Gum habitat associated with Split Creek likely represents the most suitable habitat for this species. However, the habitat in the study area is broadly represented throughout the region and forms part of a very large area of potential non-breeding habitat for this species. The key threat to the Painted Honeyeater is the loss and degradation of breeding habitat. Given the study area is located outside the breeding range for this species, the migratory/dispersive habitats of this species and the prevalence of similar habitat throughout the region, it is unlikely this species would be significantly impacted by development within the ML.

4.4 Night Parrot

The Night Parrot (*Pezoporus occidentalis*) is listed as endangered under the EPBC Act and the NC Act. The current distribution of the Night Parrot is not known and there are few substantiated records since 1935; however, there are accepted historical records from remote arid and semi-arid inland regions of Western Australia, Northern Territory, South Australia and Queensland (Higgins, 1999). It is possible that the Night Parrot may continue to occur throughout much of this range; however, there have been only two areas (western Queensland and the Pilbara in Western Australia) where reliable records indicate that populations may persist (Threatened Species Scientific Committee, 2016 and references therein). Sometime prior to 2013, a population was located in southwestern Queensland by naturalist John Young and this population is thought to be part of a larger regional-scale extant population (Threatened Species Scientific Committee, 2016). The specific location of this area has not been identified in order to protect the species; however, the population is centred on the Diamantina National Park – Pullen Pullen Reserve area in western Queensland.

Habitat information published by the NPRT (2017) for the recently discovered Queensland population includes:

- Night Parrots are known to use areas that have a mix of *Triodia* (Spinifex), alluvial and stony pavement (sometimes called gibber) habitats. All recent Night Parrot records have been associated with *Triodia longiceps* but other *Triodia* species might also be important. *Triodia longiceps* growing near escarpments and without high densities of trees or shrubs might be favoured, although some Night Parrots have been found living in *Triodia* areas a long way from escarpments. The actual spatial extent of *Triodia* patches does not necessarily need to be large.
- *Triodia* habitats are used for roosting, breeding and feeding, while alluvia and stony habitats are used mainly for feeding. Night Parrots are known to drink at dams and raised earthen stock tanks (often called turkey nests). They are also likely to drink at other free-standing water bodies within 10–15km of roosting habitats.

Potentially suitable roosting, breeding and feeding habitat for the Night Parrot is present within the study area. *Triodia* habitats occur in areas mapped as RE 1.11.11 on the ground-truthed RE

map (Appendix A). Areas mapped as REs 1.11.10a, 1.5.6c and 1.12.3b surrounding these *Triodia* habitats represent potential gravelly/chenopod feeding habitat.

The fauna survey programme included targeted surveys for this species in accordance with the recommendations published by the NPRT (2017). These targeted surveys focussed on *Triodia* habitats, but also included areas of potential feeding habitats (gravelly/chenopod plains) and drinking points. No evidence of Night Parrots was detected anywhere within the study area during the 2017 and 2018 baseline fauna survey programmes.

It is important to note that the main areas of phosphate rock within the study area occur in close proximity to two stock water dams, and grazing pressure is very high in these areas. The extent of disturbance in these locations is such that the habitat quality is substantially degraded. The phosphate rock resource areas are not located in potential roosting and breeding *Triodia* habitats. The phosphate rock areas provide only very degraded potential feeding habitat areas and it is likely that higher quality feeding habitat is prevalent in the surrounding landscape.

The Night Parrot is a highly cryptic species and, given the presence of habitats that are consistent with preferred habitat described by the NPRT (2017), it is possible this species could occur within the study area, despite a lack of evidence from the field survey programme. However, the majority of the habitat within the study area is marginal or heavily degraded. Higher quality *Triodia* habitats are associated with hills and rock outcrops on the eastern boundary of the ML, but these habitats likely do not correlate with the phosphate rock resource. On this basis, it is unlikely any potential local population of the Night Parrot would be significantly impacted by development within the ML.

4.5 Carpentarian Antechinus

The Carpentarian Antechinus (*Pseudantechinus mimulus*) is listed as vulnerable under the EPBC Act and least concern under the NC Act. In Queensland, this species has been recorded along the Selwyn Range south of Cloncurry (Biodiversity Assessment and Management Pty Ltd, 2011; Lloyd *et al.*, 2013) and on a number of ridges around Mt Isa (DEE, 2017b). There are no records of this species within 100km of the study area in the Wildlife Online database; however, the study area is located within the potential range of this species.

The DEE Species Profile and Threats Database (DEE, 2017b and references therein) identifies the following habitats in which this species has been recorded:

- Near Mt Isa: woodland of Snappy Gum (*Eucalyptus leucophloia*), Inland Bloodwood (*Corymbia terminalis*), Normanton Box (*Eucalyptus normantonensis*), Whitewood (*Atalaya hemiglauc*) and *Acacia* spp. with *Triodia* spp. ground cover.
- South-east of Mt Isa: on a rocky ridge and hill-slope of igneous rock with a tree layer dominated by Snappy Gum, *Eucalyptus leucophylla* and *Terminalia aridicola*. Sparse shrub layer dominated by *Acacia* spp. Grass layer dominated by *Triodia* spp., with *Enneapogon oblongus* (RE 1.12.1/1.12.1x1).
- East of Mt Isa: on a midslope of rocky hillside with abundant boulder piles of igneous or metamorphic rock. Very sparse tree layer dominated by Snappy Gum and *Eucalyptus leucophylla*. Shrub layer dominated by *Terminalia aridicola* and *Acacia* spp. Grass layer dominated by *Triodia* spp. (RE 1.11.2a/1.11.2x4/1.12.1)

- East of Mt Isa: on a rocky ridge and hill-slope of metamorphic or igneous rock with tree layer dominated by Snappy Gum and Whitewood. Mid-dense shrub layer. Grass layer dominated by *Triodia* spp., with *Enneapogon oblongus* and patchy invasion by Buffel Grass (RE 1.11.2a/1.11.2x1/1.12.1x1).
- On Selwyn Range: on a cliff base and slope of deeply weathered granite mesa with numerous boulders. Sparse tree layer dominated by Snappy Gum, *Eucalyptus leucophylla* and Lancewood (*Acacia shirleyii*). Shrub layer dominated by Chisholm's Wattle (*Acacia chisholmii*). Diverse native grass layer dominated by *Triodia* spp., with *Aristida* spp., *Enneapogon* spp. and *Themeda triandra* (RE 1.7.1/1.12.1).

Based on these habitat descriptions, areas mapped as RE 1.11.11 on the ground-truthed RE map (Appendix A) represent potentially suitable habitat for this species. This habitat was incorporated into the trapping programme; however, the Carpentarian Antechinus was not captured during the baseline fauna surveys. The majority of the study area is dominated by REs 4.9.10b, 4.9.12x4a and 1.5.6c, all of which do not represent suitable habitat for this species. The phosphate rock resource areas are also strongly correlated with these parts of these REs and therefore exploration and/or mining activities are unlikely to interact with potential habitat for this species. Given the lack of local records, the lack of evidence of this species during the field survey programme and the lack of suitable habitat in known phosphate rock resource areas, it is unlikely this species would be significantly impacted by development within the ML.

4.6 Purple-necked Rock-wallaby

The Purple-necked Rock-wallaby is listed as vulnerable under the NC Act; however, it is not listed under the EPBC Act. As identified previously, this species was recorded within limestone habitat in the southwest portion of the study area. Suitable habitat for this species is present in the form of rock outcrops and associated Spinifex habitats in various parts of the study area, particularly on the eastern and western margins of the lease. These potential habitat areas are reflected on the ground-truthed RE map as RE 1.11.11 (Appendix A). There are also two records of this species immediately to the northeast of the study area, as represented by the DNRM essential habitat mapping, within the vicinity of a proposed haul road development site. This species could occur in the various scattered outcrops and associated Spinifex habitats throughout the study area, but the location where this species was recorded during the baseline survey programme supports greater microhabitat features and has higher connectivity with other similar limestone outcrop habitats further to the northwest outside the study area.

The phosphate rock resources areas are of low relevance to the larger rock outcrop areas, such as the limestone gorge habitat on the western boundary. Consequently, mining of this resource can potentially avoid significant interaction with Purple-necked Rock-wallaby habitat. A 200m habitat buffer from the location where this species was recorded during the baseline fauna survey programme has been included in the fauna survey map (Appendix A). An area of essential habitat, as shown on the State mapping layer, is also represented on the fauna survey map. Preparation of a Species Management Plan for the Purple-necked Rock-wallaby will be required as part of the environmental approvals process for the project, including the geographical boundary, an animal breeding place survey report and an impact management plan. Provision of an environmental offset may be required for significant residual impacts to habitat for this species (see section on 'Protected wildlife habitat' above).

4.7 Northern Leaf-nosed Bat

The Northern Leaf-nosed Bat (*Hipposideros stenotis*) is not listed under the EPBC Act but is listed as vulnerable under the NC Act. In Queensland, the only records of this species occur in the Mt Isa region (Hourigan, 2011), which may be an outlying population as all other records are from the Northern Territory and the Kimberly region in Western Australia. This species roosts in sandstone and limestone caves, boulder piles and disused mines (Hourigan, 2011).

The Northern Leaf-nosed Bat has been recorded in monsoon thickets, tall open forest, open eucalypt woodland, floodplains, open grassland and Spinifex hills, and is closely associated with steep hills, rocky outcrops and escarpments (Churchill, 2008; Duncan *et al.*, 1999; Milne & Hall, 2008; Milne *et al.*, 2006).

The study area supports potentially suitable foraging habitat for this species and some rocky outcrop areas may support potentially suitable roosting overhangs and boulder piles. The calls of this species are easily distinguished from all other microbats occurring within its range (Hourigan, 2011). However, this species was not detected as part of the acoustic detection surveys during the fauna survey programme. Given the lack of local records, absence of echolocation data for this species during the field survey programme and absence of records outside Mt Isa in Queensland, it is unlikely this species would be significantly impacted by development in the ML.

4.8 Plains Death Adder

The Plains Death Adder (*Acanthophis hawkei*) is listed as vulnerable under the EPBC Act and the NC Act. The exact distribution of this species is poorly known, but fragmented populations of the Plains Death Adder are known to occur in the Mitchell Grass Downs of western Queensland, the Barkly Tableland on the Northern Territory/Queensland border and east of Darwin in the Northern Territory. Suitable habitat for this species consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000). The majority of the study area consists of shallow/skeletal soils on limestone and other sedimentary rocks. The study area does not support significant areas of preferred cracking-clay soils. Therefore, while the study area occurs within the potential distribution of this species, given the lack of suitable habitat it is unlikely this species would be impacted by development within the ML.

4.9 Short-beaked Echidna

The Short-beaked Echidna (*Tachyglossus aculeatus*) is listed as 'Special Least Concern' wildlife under the NC Act. Traces (scats) of this species were incidentally observed in a rock outcrop area in the southwest section of the study area during the survey period.

This well-known species occurs throughout Australia in almost all terrestrial habitats except intensively managed farmland (Menkhorst & Knight, 2011). It is a mostly solitary species, occupying large home ranges and feeding on soil invertebrates.

Special least concern wildlife habitat is a MSES under the Queensland environmental offsets framework. Any action involving significant impacts to special least concern wildlife habitat may require the provision of an environmental offset under this framework.

While the habitat within the study area contains habitat that is suitable for the Short-beaked Echidna, it represents a small area within a vast expanse of similar habitat. There are no habitat features unique to the study area on which this species would be relying and the area does not represent a link between other habitat areas. It is unlikely that any disturbance within the study area would result in:

- A long-term decrease in the size of the local population.
- A reduced extent of occurrence of the species.
- Fragmentation of the existing population.
- The formation of genetically distinct populations as a result of habitat isolation.
- Disruption to ecologically significant locations for the species.

It is therefore unlikely there would be any significant impacts to the Short-beaked Echidna as a result of development within the ML.

5. Pest species

The two notable non-native plant species recorded in the study area, Buffel Grass and Mimosa Bush, were particularly prevalent within riparian areas.

Buffel Grass is a desirable pasture species that occurs in grazing country throughout much of Queensland. This species occurs in almost all habitat types within the study area but is very abundant in riparian areas where it dominates the ground layer and reduces biodiversity. Given the existing high abundance of this species in riparian areas, it is unlikely that development within the ML would increase the risk this species represents to local biodiversity values.

Mimosa Bush is an invasive shrub species that forms thickets along watercourses, reducing biodiversity and potentially impacting stock movement. This species currently occurs as a sparsely scattered shrub along the margins of watercourse features in flatter terrain with a relatively higher accumulation on alluvium and is absent in more rocky areas. The movement of seed spreads this species and development within the ML should include measures to prevent the increased spread of this species and decrease the existing population.

The House Mouse was observed at the majority of systematic survey sites, whereas observations of the Feral Pig within the study area was restricted to riparian habitat within the vicinity of systematic survey site 4. Both of these species are common in a variety of habitat types throughout Queensland; however, the Feral Pig is listed as a declared pest by the Cloncurry Shire Council and is a restricted invasive species under the *Biosecurity Act 2014*. No pest management plan is currently available for the Cloncurry Shire Council; therefore, preferred management strategies for the Feral Pig within the local area are not identified. However, development and ongoing activities within the ML should include measures to record and report Feral Pig observations to the Cloncurry Shire Council to aid in joint approach management of this species within the local area.

Besides the Feral Pig none of the pest plant or animal species recorded are a prohibited or restricted invasive species in Queensland under the *Biosecurity Act 2014*. In accordance with the Act, the Feral Pig must not be moved, fed, given away, sold or released into the environment without a permit. In addition to this, the Act requires all reasonable and practical steps to be taken to minimise the risks associated with this species under a general biosecurity

obligation. Despite the presence of a restricted invasive species within the study area, development is unlikely to modify the landscape in a way that would increase the occurrence of pest flora and fauna species or the threat they represent to local biodiversity values.

Recommendations

1. Clearing and vegetation management

During construction activities, the following measures should be implemented to minimise disturbance impacts and the potential harm to habitat values and flora and fauna present within the area:

- The boundary of areas to be cleared should be clearly marked, to ensure the disturbance footprint is minimised.
- Clearing should occur in a sequential manner to allow any fauna present in the area to escape to areas away from construction activities.

Vegetation stockpiles will provide habitat for small ground dwelling mammals and reptiles during the construction phase. It is important to locate these stockpiles away from high traffic areas and ensure they are not isolated from contiguous vegetation at the edge of the site. This will reduce the likelihood of fauna travelling across the site.

Cleared vegetation should be managed according to the following best practice principles:

- Where possible, logs and large branches with hollows should be reserved and stockpiled separately (at the edge of the site) for rehabilitation purposes.
- Any mulching should occur as near as possible to the time of clearing to prevent the establishment of stockpiles as fauna habitat.

2. Soil management

During construction, soil stockpiles should be managed to maximise suitability for future use in rehabilitation processes. Topsoil should be stockpiled separately from sub-soils and stockpiled to a maximum height of 2m. This will improve the likelihood of retention of a seed bank within the topsoil, which will increase the effectiveness of its use for rehabilitation in the future. Stockpiles should also be managed to allow passage for fauna by leaving a sufficient gap between stockpiles.

3. Pest management

3.1 Pest flora

Soil disturbance is a major contributor to weed establishment and invasion. A number of pest plant species were identified in the flora surveys; however, there were no restricted invasive plants observed within the study area.

The following recommendations are relevant to the construction phase as well as ongoing monitoring and management post-construction:

- Wherever possible, construction activities should work from areas with fewer weed species and smaller infestations towards areas where there is a greater abundance of weeds.
- Vehicles and machinery brought on site should be clean and free of weeds, dirt and other material that may contain weed seeds and cause exotic species to become established within the works areas.
- Weed spread should attempt to be minimised by implementing some control measures within the proposed works areas prior to construction.
- Regular observation of disturbance sites and stockpiles for incidence of weed species.
- Where any weed establishment is identified, appropriate control measures should be implemented to minimise the impacts of weeds on native habitat.

3.2 Pest fauna

It is recommended to record pest fauna species when encountered on site and collaborate with the local council to determine effective ways to reduce populations of pest fauna species. Several control strategies for the Feral Pig are outlined and further detailed within the Biosecurity Queensland Feral Pig factsheet (DAF, 2016). These control strategies include fencing, trapping, shooting and poisoning and it is recommended that an integrated, collaborative approach to Feral Pig management with relevant stakeholders be incorporated to effectively manage populations.

4. Dust management

Excavation and vehicle movements produce increased levels of dust, which can have a cumulative impact on plant function. While it is unlikely that dust produced over a short period of time will significantly impact plant function, advisable dust suppression techniques include:

- application of water on trafficable surfaces
- limiting activities during high wind conditions
- application of water/binding agent to construction sites during construction.

5. Flora management

5.1 Category B ESAs

Direct disturbance to the ESA areas themselves should be avoided and appropriate buffer areas maintained around any mapped Category B ESA. Specific approval will need to be obtained from DES for any disturbance within any Category B ESA or associated buffers. A weed management and hygiene plan should also be implemented for all works near Category B ESAs to minimise the spread of non-native species and reduce current population sizes of invasive species that are already established.

6. Fauna management

6.1 General managements strategies

Excavated areas can pose a risk to native fauna through entrapment and exposure. Excavated areas should be checked regularly for trapped fauna, with inspection occurring at least twice daily. These areas should be checked early in the morning for fauna that has become trapped overnight and again in the late afternoon for fauna that has become trapped over the course of the day.

Safe egress points should be included to allow fauna to escape of their own accord. Any fauna that cannot escape of its own accord should be removed in a manner that is safe for both the animal and the person handling the animal. Only a suitably qualified and experienced person should handle dangerous fauna species such as snakes. The use of a fauna spotter-catcher during the vegetation-clearing and construction period is recommended to minimise the chances of injury to native fauna. The fauna spotter-catcher should have a current rehabilitation permit and should be present during clearing activities. The role of the spotter-catcher would be to advise on appropriate clearing methods to ensure animal escape paths are maintained and relocate fauna located within the disturbance area accordingly.

6.2 Threatened species

The only threatened fauna species recorded within the study area was the Purple-necked Rock-wallaby. This species was recorded from a limestone outcrop/gorge area on the western boundary of the ML that is not associated with known phosphate rock deposits. The fauna survey map in Appendix A includes a habitat buffer for the location where Purple-necked Rock-wallabies were observed, as well as the state mapped essential habitat layer. Disturbance within these areas should be avoided to minimise potential impacts to this species. Preparation of a Species Management Plan for the Purple-necked Rock-wallaby will be required as part of the environmental approvals process for the project, including the geographical boundary, an animal breeding place survey report and an impact management plan. Provision of an environmental offset may be required for significant residual impacts to habitat for this species.

References

- Atlas of Living Australia. (2018). Online data for Purple-necked Rock-wallaby. Retrieved from <http://spatial.ala.org.au/?q=lsid:urn:lsid:biodiversity.org.au:afd.taxon:21101ff9-a33f-4e94-b26b-e11364741bd2>.
- Aumann, T., & Baker-Gabb, D. (1991). RAOU Report 75. A Management plan for the Red Goshawk. RAOU. Melbourne: Royal Australasian Ornithologists Union.
- Biodiversity Assessment and Management Pty Ltd. (2011). CopperString Project SEIS – Terrestrial ecology assessment report. Report prepared for CopperString Pty Ltd. (Cited in DEE, 2017b).
- Birdlife International. (2016). *Falco hypoleucos*. The IUCN Red List of Threatened Species 2016. Retrieved from <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22696479A93566768.en>
- Bostock, P. D., & Holland, A. E. (eds) (2017). Census of the Queensland flora 2017. Brisbane: Queensland Department of Science, Information Technology and Innovation. Retrieved from <https://data.qld.gov.au/dataset/census-of-the-queensland-flora-2017>.
- Churchill, S. K. (2008). *Australian bats*. Sydney: Allen and Unwin.
- Cogger, H. G. (2000). *Reptiles and amphibians of Australia: 6th edition*. Melbourne: Reed Books.
- Cropper, S. C. (1993). *Management of endangered plants*. East Melbourne: CSIRO Publications.
- Debus, S., & Czechura, G. (1988). The Red Goshawk *Erythrorchis radiatus*: A review. *Australian Bird Watcher* 12: 175-199.
- Department of Agriculture and Fisheries (DAF). (2016). Feral Pig restricted invasive animal factsheet.
- Department of Environment and Heritage Protection (EHP). (2014). Flora survey guidelines- Protected plants. State of Queensland, 2014.
- Department of Environment and Heritage Protection (EHP). (2017a). Protected plants flora survey trigger map. Downloaded 04/04/17.
- Department of Environment and Heritage Protection (EHP). (2017b). Queensland Government wildlife online. Extract Date 26/05/17.
- Department of Environment and Heritage Protection (EHP). (2017c). Map of referable wetlands. Downloaded 28/06/17.
- Department of Environment and Heritage Protection (EHP). (2017d). Environmentally sensitive areas map. Department of Environment and Heritage Protection, Brisbane. Retrieved from http://www.ehp.qld.gov.au/licences-permits/maps_of_environmentally_sensitive_areas.php.

- Department of the Environment, Water, Heritage and the Arts (DEWHA). (2017). Survey Guidelines for Australia's threatened birds. Guidelines for detecting birds listed as threatened under the EPBC Act 1999. Updated April 2017.
- Department of Natural Resources and Mines (DNRM). (2017). Vegetation management report. The State of Queensland. Retrieved from <https://www.dnrm.qld.gov.au/qld/environment/land/vegetation/vegetation-map-request-form>
- Department of Natural Resources and Mines (DNRM). (2018). Managing Category C regrowth vegetation.
- Department of Natural Resources and Mines (DNRM). (2018b). Queensland Globe. Accessed at: <https://qldglobe.information.qld.gov.au>
- Department of the Environment and Energy (DEE). (2013). Matter of national environmental significance. Significant impact guidelines 1.1. Commonwealth of Australia.
- Department of Science, Information Technology and Innovation (DSITI). (2017). Copy of the Remnant regional ecosystem map–Version 10.0. Online RE Map, The Department of Science, Information Technology and Innovation, Brisbane. Retrieved from <https://environment.ehp.qld.gov.au/map-request/re-broad-veg-group/>.
- Department of Science, Information Technology, Innovation and the Arts. (2012). WildNet Records. Department of Science, Information Technology, Innovation and the Arts, Queensland Government: Brisbane. Accessed June 2011. Cited in Hourigan (2011).
- Department of the Environment and Energy (DEE). (2017a). EPBC Act protected matters report. Report created: 04/04/17 at 14:32:06.
- Department of the Environment and Energy (DEE) (2017b). Species profile and threats database, Department of the Environment and Energy, Canberra. Retrieved from <http://www.environment.gov.au/sprat>.
- Duncan, A., Baker, G. B., & Montgomery, N. (1999). *The action plan for Australian bats*. Canberra: Environment Australia.
- Eyre, T. J., Ferguson, D. J., Hourigan, C. L., Smith, G. C., Mathieson, M. T., Kelly, A. L., Venz, M. F. & Hogan, L. D. (2014). *Terrestrial vertebrate fauna survey assessment guidelines for Queensland*. Brisbane: Department of Science, Information Technology, Innovation and the Arts, Queensland Government.
- Garnett, S., Szabo, J., & Dutson, G. (2011). *The action plan for Australian birds 2010*. CSIRO Publishing.
- Higgins, PJ (Ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird. Oxford University Press, Melbourne.
- Higgins, PJ (Ed.) and Davies, S. (1996). Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons. Oxford University Press, Melbourne.
- Higgins, P. J., Peter, J. M., & Steele, W. K. (eds.). (2001). *Handbook of Australian, New Zealand and Antarctic birds, Volume 5: Tyrant-flycatchers to Chats*. Melbourne: Oxford University Press.

- Hourigan, C. (2011). *Northern leaf-nosed bat, Hipposideros stenotis. Targeted species survey guidelines*. Brisbane: Queensland Herbarium, Department of Science, Information Technology and Innovation.
- Marchant, S., & P. J. Higgins (eds) (1993). *Handbook of Australian, New Zealand and Antarctic birds. Volume 2: Raptors to Lapwings*. Melbourne: Oxford University Press.
- Menkhorst, P., & Knight, F. (2011). *A field guide to the mammals of Australia - Third Edition*. Oxford University Press.
- Milne, D. J., and Hall, L. S. (2008). Northern leaf-nosed bat, *Hipposideros stenotis*. In: 'The Mammals of Australia. Third Edition' (Eds. S. Van Dyck and R. Strahan) pp. 467-468. Reed New Holland: Sydney. Cited in Hourigan (2011).
- Milne, D. J., Fisher, A., and Pavey, C. R. (2006). Models of the habitat associations and distributions of insectivorous bats of the Top End of the Northern Territory, Australia. *Biological Conservation* 130, 370-385. Cited in Hourigan (2011).
- Neldner, V. J., Wilson, B. A., Dillewaard, H. A., Ryan, T. S., & Butler, D. W. (2017). *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 4.0*. Updated May 2017. Brisbane: Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts.
- Night Parrot Recovery Team (NPRT). (2017). Looking and listening for Night Parrots. Retrieved from <https://nightparrot.com.au/index.php/advice/>
- Pizzey, G., & Knight, F. (2012). *Field guide to the birds of Australia. Ninth Edition*. Sydney: Harper Collins.
- Queensland Herbarium. (2018). Regional ecosystem description database (REDD). Version 10.1 (March, 2018). Brisbane: Queensland Department of Science, Information Technology, Innovation and the Arts.
- Reardon, T. B., Armstrong, K. N., & Jackson, S. M. (2015). A current taxonomic list of Australian Chiroptera. Australasian Bat Society. Retrieved from <http://ausbats.org.au/taxonomic-list/4589345107>.
- Rowland, J. (2012a). *Painted honeyeater, Grantiella picta. Targeted species survey guidelines*. Brisbane: Queensland Herbarium, Department of Science, Information Technology and Innovation.
- Rowland, J. (2012b). *Purple-necked Rock-wallaby, Petrogale purpureicollis. Targeted species survey guidelines*. Brisbane: Queensland Herbarium, Department of Science, Information Technology and Innovation.
- Threatened Species Scientific Committee. (2016). Approved conservation advice for *Pezoporus occidentalis* (night parrot). Canberra: Department of the Environment. Retrieved from <http://www.environment.gov.au/biodiversity/threatened/species/pubs/59350-conservation-advice-15072016.pdf>. In effect under the EPBC Act from 15-Jul-2016.
- Tuft, K. D., Crowther, M. S., Connell, K., Muller, S., & McArthur, C. (2011). Predation risk and competitive interactions affect foraging of an endangered refuge-dependent herbivore. *Animal Conservation* 14(4): 447-457.

Van Dyck, S., Gynther, I., & Baker, A. (2013). *Field companion to the mammals of Australia*. Sydney, Australia: New Holland Publishers.

Vanerduys, E. (2012). *Field guide to the frogs of Queensland*. Collingwood, Victoria, Australia: CSIRO Publishing.

Wilson, S. (2015). *Field guide to the reptiles of Queensland*. Sydney, Australia: New Holland Publishers.

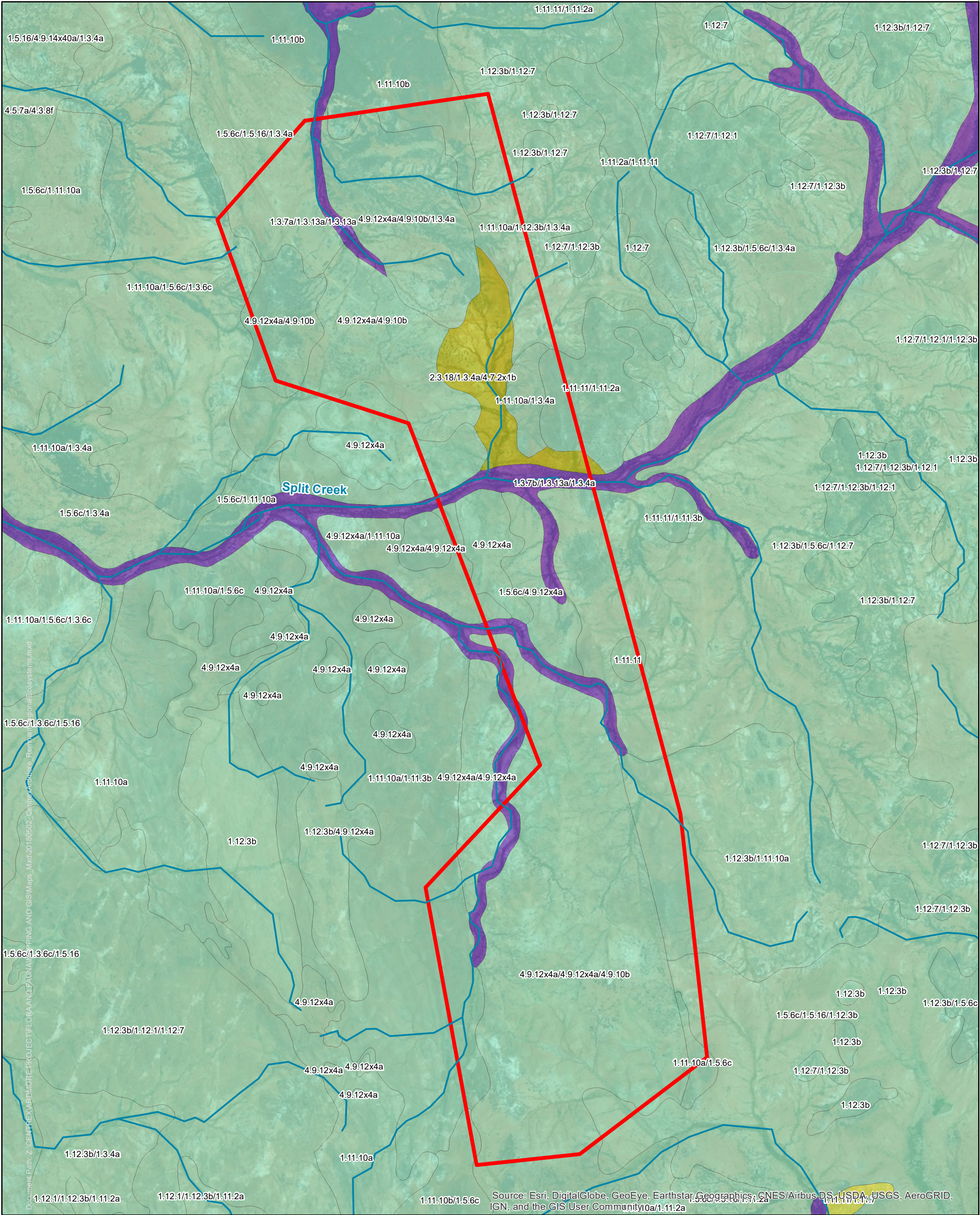
Wilson, P. R., & Taylor, P. M. (2012). *Land zones of Queensland*. Brisbane: Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts.

Appendix summary

Appendix A	Mapping
Appendix B	EPBC Act Protected Matters Report
Appendix C	Wildlife Online Database Extract
Appendix D	Potential Occurrence of EVNT Species
Appendix E	Flora Species List
Appendix F	Fauna Species List
Appendix G	Microbat Call Interpretation Report

Appendix A

Mapping



CENTREX - ARDMORE PHOSPHATE PROJECT

STATE-MAPPED REMNANT REGIONAL ECOSYSTEMS

Legend

Vegetation Management

Watercourse/Drainage Feature

Mining Lease

Remnant Regional Ecosystems (Biodiversity Status)

Endangered - Dominant vegetation

Of Concern - Dominant

Of Concern - Sub-dominant

No concern at present

Credits:

Mine Lease boundary

Watercourse

© State of Queensland (Department of Natural Resources and Mines) 2016.

Remnant Regional Ecosystems

© State of Queensland Queensland Herbarium (2016)

Regional Ecosystem Description Database (REDD).

Version 10.0 (December 2016)

(Queensland Department of Science, Information Technology)

Coordinate System: GDA 1994 MGA Zone 54

Projection: Transverse Mercator

Datum: GDA 1994

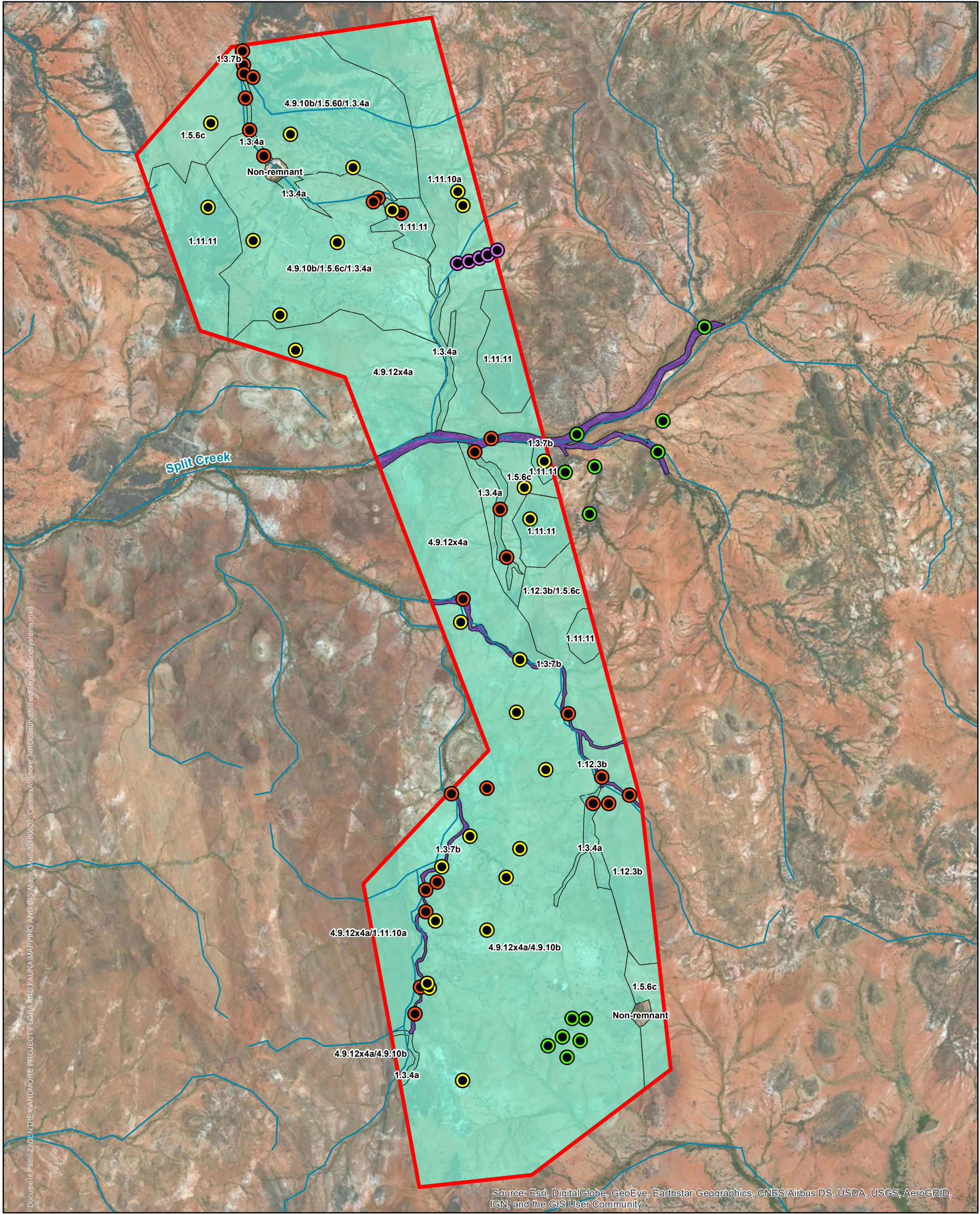
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Metres

Scale: 1:35,000 at A3

Northern Resource CONSULTANTS



CENTREX - ARDMORE PHOSPHATE PROJECT

NRC GROUNDTRUTHED REGIONAL ECOSYSTEMS

Legend

- Essential Habitat Assessment 2018
- Quarternary Assessments 2018
- Quarternary Assessments 2017

- Regional Ecosystem Assessment 2017
- Mining Lease

- Vegetation Management Watercourse/Drainage Feature

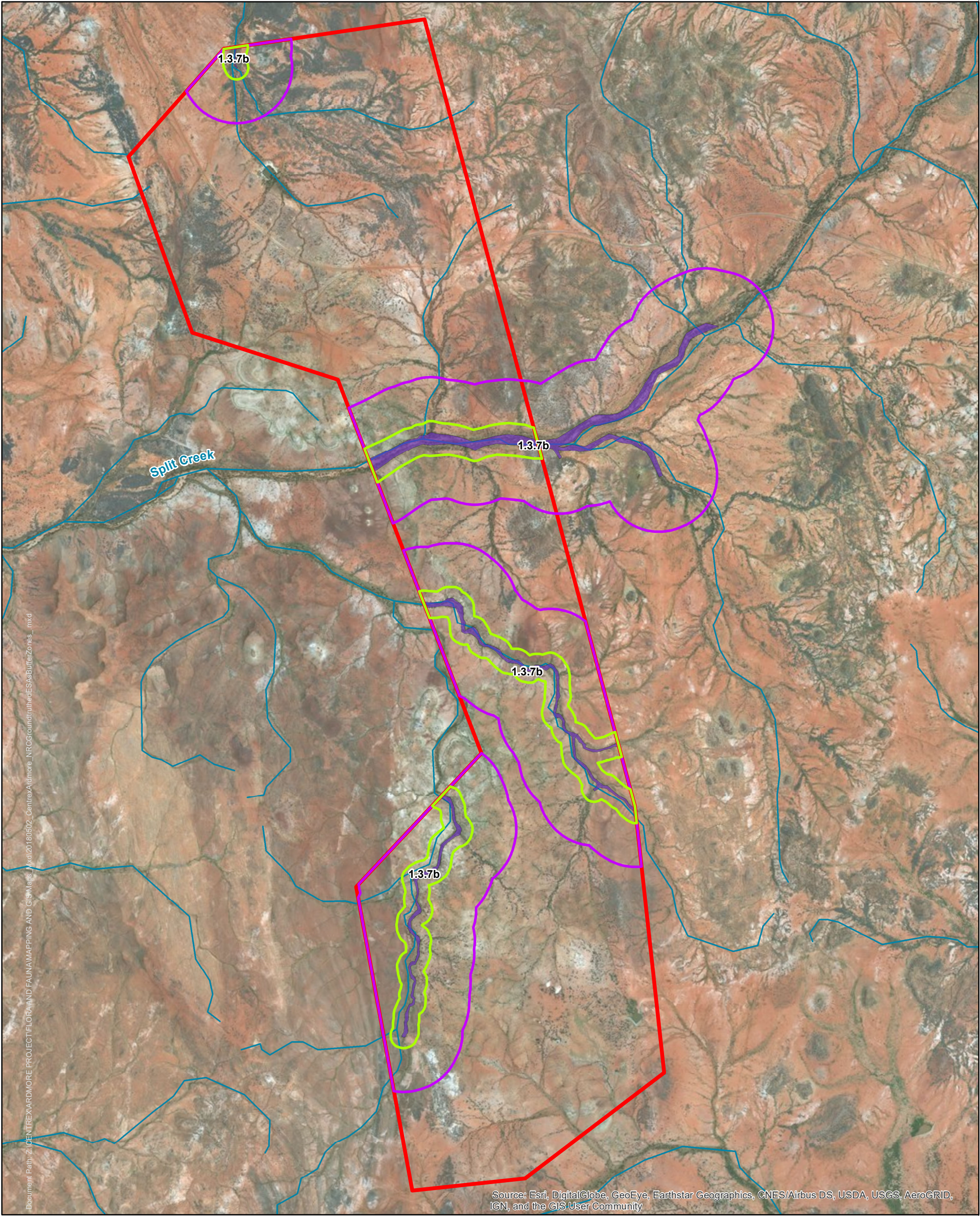
- Remnant Regional Ecosystem (Biodiversity Status)
- No concern at present
- Endangered - Dominant vegetation

Credits:
Mine Lease boundary, Watercourses
© State of Queensland (Department of Natural Resources and Mines) 2018.

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
Date: 03-May-18

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Metres
Scale: 1:32,000 at A3





Document Path: Z:\CENTREXARDMORE PROJECT\FLORA AND FAUNA\MAPPING AND GIS\Maps_N\rd120180502_CentrexArdmore_NROGroundtruthedESAsBufferZones_.mxd

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

CENTREX - ARDMORE PHOSPHATE PROJECT

Legend

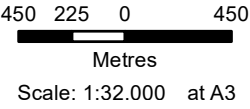
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- Ground-truthed ESAs (500m buffer)
- Mining Lease

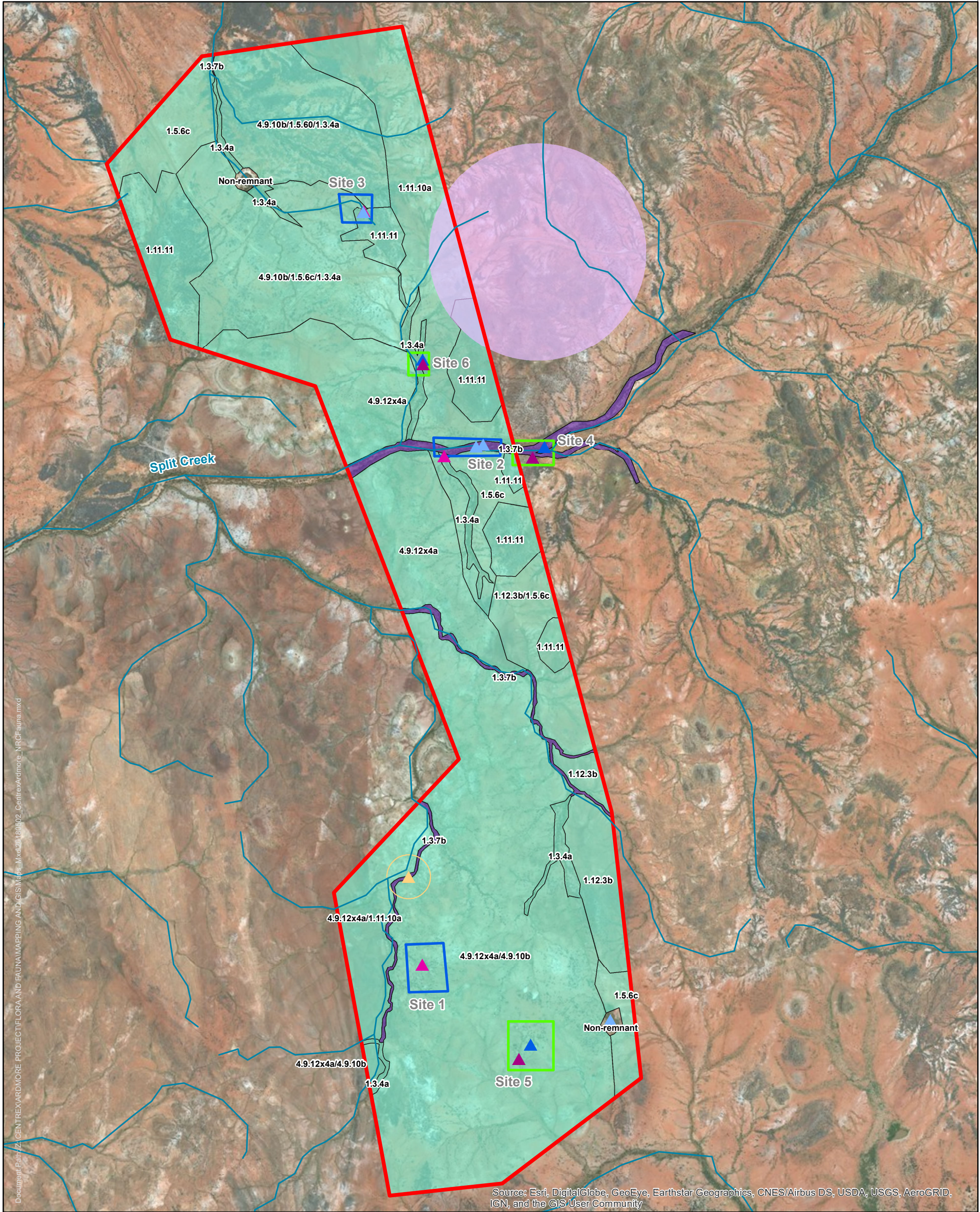
- Remnant Regional Ecosystem (Biodiversity Status)
- Endangered - Dominant vegetation
 - Vegetation Management Watercourse/Drainage Feature

GROUND-TRUTHED ESAS AND PROPOSED ESA BUFFER

Credits:
Mine Lease boundary
Watercourse
© State of Queensland (Department of Natural Resources and Mines) 2018.
Remnant Regional Ecosystems
© State of Queensland Queensland Herbarium (2016)
Regional Ecosystem Description Database (REDD).
Version 10.0 (December 2016)
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Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
Date: 03-May-18





CENTREX - ARDMORE PHOSPHATE PROJECT

FAUNA SURVEY SITES

Legend

- Purple-necked Rock-wallaby observation - 2017 and 2018
- 2017 Fauna Survey**
- Bat Detector

- 2018 Fauna Survey**
- IR Camera Trap
 - IR Camera Trap
 - Bat Detector
 - 2017 Survey Sites

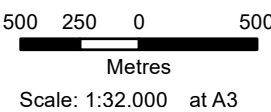
- 2018 Survey Sites**
- Purple-necked Rock-wallaby habitat buffer**
- 200m Buffer (2017 and 2018 Sighting)
 - Mining Lease

- Vegetation Management**
- Watercourse/Drainage Feature
 - DNRM Essential Habitat

- Remnant Regional Ecosystem (Biodiversity Status)**
- No concern at present
 - Endangered - Dominant vegetation

Credits:
Mine Lease boundary,
Watercourses,
DNRM Essential Habitat
© State of Queensland
(Department of Natural
Resources and Mines) 2018.

Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
Date: 03-May-18



Appendix B

EPBC Act Protected Matters Report



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 04/04/17 14:32:06

[Summary](#)

[Details](#)

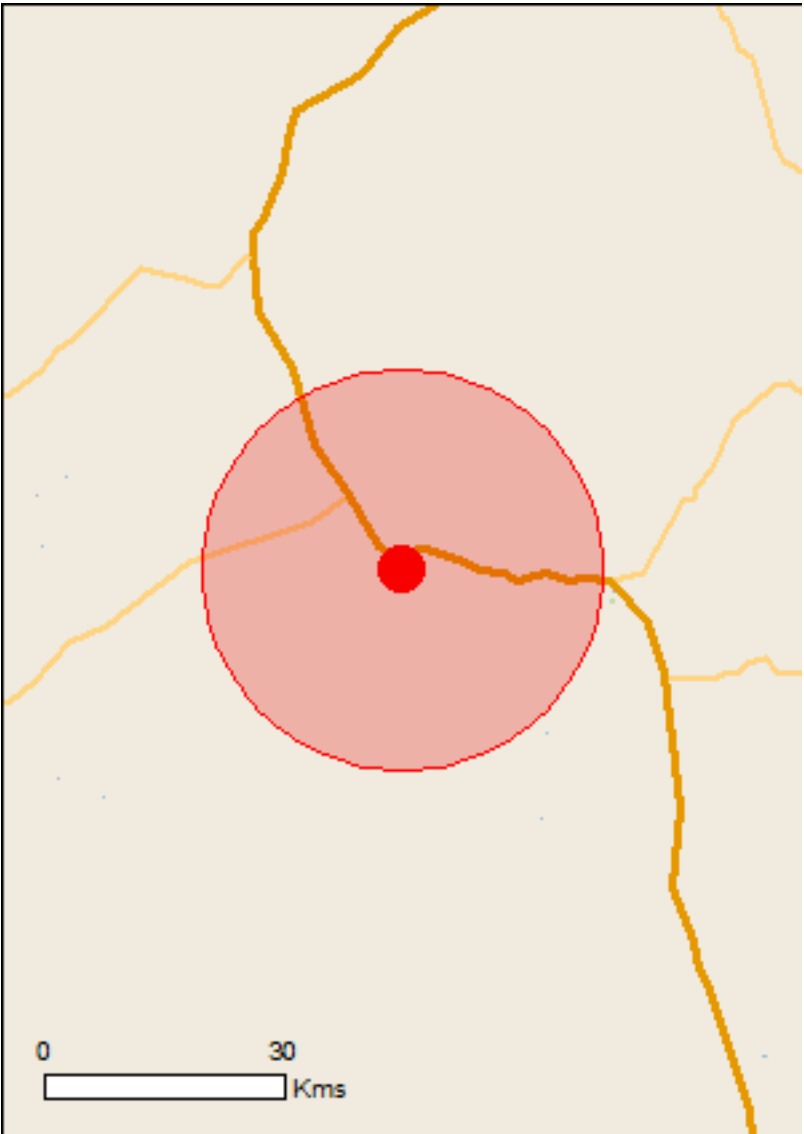
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

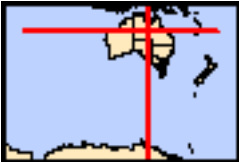
[Acknowledgements](#)



This map may contain data which are
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[Coordinates](#)

[Buffer: 25.0Km](#)



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	9
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	10
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	15
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythroriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Pseudantechinus mimulus Carpentarian Antechinus [59283]	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Acanthophis hawkei Plains Death Adder [83821]	Vulnerable	Species or species habitat known to occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		

Name	Threatened	Type of Presence
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species	[Resource Information]	
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species

[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur

Name	Status	Type of Presence within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-21.6872 139.2864

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

Appendix C

Wildlife Online Database Extract



Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point

Species: All

Type: Native

Status: Rare and threatened species

Records: All

Date: Since 1980

Latitude: -21.6872

Longitude: 139.2864

Distance: 100

Email: scott@northres.com.au

Date submitted: Friday 26 May 2017 12:11:09

Date extracted: Friday 26 May 2017 12:20:09

The number of records retrieved = 7

Disclaimer

As the DSITIA is still in a process of collating and vetting data, it is possible the information given is not complete. The information provided should only be used for the project for which it was requested and it should be appropriately acknowledged as being derived from Wildlife Online when it is used.

The State of Queensland does not invite reliance upon, nor accept responsibility for this information. Persons should satisfy themselves through independent means as to the accuracy and completeness of this information.

No statements, representations or warranties are made about the accuracy or completeness of this information. The State of Queensland disclaims all responsibility for this information and all liability (including without limitation, liability in negligence) for all expenses, losses, damages and costs you may incur as a result of the information being inaccurate or incomplete in any way for any reason.

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Falconidae	<i>Falco hypoleucos</i>	grey falcon		V		7
animals	birds	Meliphagidae	<i>Grantiella picta</i>	painted honeyeater		V	V	2
animals	mammals	Hipposideridae	<i>Hipposideros stenotis</i>	northern leaf-nosed bat		V		1
animals	mammals	Macropodidae	<i>Petrogale purpureicollis</i>	purple-necked rock-wallaby		V		10/2
animals	reptiles	Chelidae	<i>Emydura subglobosa worrelli</i>	diamond head turtle		NT		4
plants	higher dicots	Amaranthaceae	<i>Ptilotus maconochiei</i>			NT		1/1
plants	higher dicots	Myrtaceae	<i>Eucalyptus nudicaulis</i>			V		3/3

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992*. The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ().

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999*. The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).

This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.

This number is output as 999 if it equals or exceeds this value.

Appendix D

Potential Occurrence of EVNT Species

Table D1: Potential for near threatened and threatened flora to occur within the study area

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	WO ² RECORDS	POTENTIAL TO OCCUR IN THE STUDY AREA
NCA	EPBC					
NT	-	Amaranthaceae	<i>Ptilotus maconochiei</i>	-	1	Moderate The majority of records of this species are from the Mt Isa area where it has been collected from a variety of rocky habitats (AVH, 2017). Records for this species indicate a scattered distribution across northwest and western Queensland. Given this scattered distribution and apparent range of rocky outcrop habitats, this species was considered to have moderate likelihood of occurrence within the study area
V	-	Myrtaceae	<i>Eucalyptus nudicaulis</i>	Mt Isa Mallee	3	Low This species is a mallee form eucalypt endemic to the Mt Isa – Cloncurry area approximately 100km north of the study area. It is restricted to quartzite rocky gullies and steep hillsides in this area (Brooker and Kleinig, 2004). This species was considered to have a low likelihood of occurrence within the study area due to a lack of local records and a lack of suitable habitat within the study area.

1. Status: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered.

2. WO = Queensland Government Wildlife Online Database Extract (100km radius search area).

References

Australia's Virtual Herbarium (AVH). (2017). Queensland Herbarium Records. Specimen label data. Accessed online 20 June 2017.

Brooker, M. I. H. & Kleinig, D. A. (2004). *Field guide to eucalypts. Volume 3. Northern Australia. Second Edition*. Melbourne: Bloomings Books.

Table D2: Potential for near threatened and threatened fauna to occur within the study area

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	WO RECORDS	POTENTIAL TO OCCUR IN THE STUDY AREA
NCA	EPBC						
		BIRDS					
E	V	Accipitridae	<i>Erythroriorchis radiatus</i>	Red Goshawk	PM	0	Moderate – There are no records of the Red Goshawk within 100km, but the study area is located within the distribution of this species. This species prefers forest and woodland with a mosaic of vegetation types, particularly near riverine systems and permanent water, where there is an abundance of prey species (DEE, 2017, and references therein). The home range in northern Australia has been reported as up to 200km ² ; with indications it may be even larger (Aumann & Baker-Gabb, 1991). Given the large home range of this species and the distribution of this species encompassing the study area, this species has a moderate likelihood of occurrence.
V	-	Falconidae	<i>Falco hypoleucos</i>	Grey Falcon	WO	7	Moderate – There are multiple records of this species within 50km of the study area and seven records within 100km. This species is distributed across a large area of Australia, however is considered rare or nomadic across much of its distribution. It has been recorded to prefer lightly timbered country, especially stony plains and lightly timbered acacia scrublands (Morcombe, 2003). Due to the large distribution of this species and scattered records occurring around the study area this species has a moderate likelihood of occurrence.
V	V	Meliphagidae	<i>Grantiella picta</i>	Painted Honeyeater	PM/WO	2	Moderate – This species is sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. The greatest concentrations and almost all records of breeding come from inland slopes of the Great Dividing Range between the Grampians, Victoria and Roma, Queensland. This species exhibits seasonal north-south movements governed principally by the fruiting of mistletoe. Many birds move after breeding to semi-arid regions such as north-eastern South Australia, central and western Queensland, and central Northern Territory (DEE, 2017). This species has moderate potential to occur within the study area during post-breeding-season northward migrational period.
V	E, M	Rostratulidae	<i>Rostratula australis</i>	Australian Painted Snipe	PM	0	Low – This species has been recorded at wetland sites throughout much of Australia but is most common in the eastern States. The Australian Painted Snipe is a distinct species, but its cryptic and crepuscular behaviour can make it difficult to detect. This species typically occurs in shallow freshwater wetlands and other permanently or temporarily inundated areas, particularly where rank tussocks of grasses, sedges, rushes or reeds are present (DEE, 2017; Morcombe, 2003). Given the lack of suitable foraging habitat and absence of local records, this species has a low likelihood of occurrence within the study area.
LC	CE, M	Scolopacidae	<i>Calidris ferruginea</i>	Curlew Sandpiper	PM	0	Low - This species typically inhabits intertidal mudflats in sheltered coastal areas, however have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains as well as around floodplains (Higgins & Davies, 1996). There are no records of this species within 100km of the study area. It is considered that this species is unlikely to occur within the study area, as there is limited suitable habitat present for this species.
E	E	Psittacidae	<i>Pezoporus occidentalis</i>	Night Parrot	PM	0	Moderate – The distribution of this species is poorly known, but the study area supports potentially suitable breeding, roosting and foraging habitat for this species. The species has been assigned a moderate likelihood of occurrence as a conservative approach given there are so few reliable records of this species and its distribution is poorly known.
		MAMMALS					
LC	V	Dasyuridae	<i>Pseudantechinus mimulus</i>	Carpentarian Antechinus	PM	0	Moderate - In Queensland, this species has been recorded along the Selwyn Range south of Cloncurry and on a number of ridges around Mt Isa. There are no records of this species within 100km of the study area in the Wildlife Online database, but the study area is located within the potential range of this species. The study area supports potentially suitable habitat and consequently this species has been assigned a moderate likelihood of occurrence.
NT	-	Macropodidae	<i>Petrogale purpureicollis</i>	Purple-necked Rock-wallaby	WO	10	Present – There is one record of this species immediately adjacent to the northeast boundary of the study area, as represented by the DNRM essential habitat mapping. This species was also recorded as part of the field survey programme at a limestone outcrop/gorge located near the southwest boundary of the study area. Suitable habitat for this species is present within the study area in the form of rock outcrops and associated Spinifex habitats.

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	WO RECORDS	POTENTIAL TO OCCUR IN THE STUDY AREA
NCA	EPBC						
V	-	Hipposideridae	<i>Hipposideros stenotis</i>	Northern leaf-nosed Bat	WO	1	Moderate - In Queensland, the only records of this species occur in the Mt Isa region, which may be an outlying population as all other records are from the Northern Territory and the Kimberly region in Western Australia. This species roosts in sandstone and limestone caves, boulder piles, and disused mines. The northern leaf-nosed bat has been recorded in monsoon thickets, tall open forest, open eucalypt woodland, floodplains, open grassland, and Spinifex hills, and is closely associated with steep hills, rocky outcrops and escarpments. The study area supports potentially suitable foraging habitat for this species and some rocky outcrop areas may support potentially suitable roosting overhangs and boulder piles. This species has a moderate likelihood of occurrence given the records from Mt Isa region and the presence of potentially suitable habitat.
V	V	Megadermatidae	<i>Macroderma gigas</i>	Ghost Bat	PM	0	Low - This species has a patchy distribution through rainforest, deciduous vine thicket, open woodland, Spinifex, black soil and grasslands. It has been recorded to roost in caves, boulder piles, shallow escarpments and mines (Van Dyck <i>et al.</i> , 2013). Due to the absence of any records within 100km of the study area, it is considered unlikely that this species occurs within the study area.
E	V	Thylacomyidae	<i>Macrotis lagotis</i>	Greater Bilby	PM	0	Low – There are no records of the Greater Bilby within 100km of the study area. The study area is located outside the currently accepted distribution of this species. On this basis, it has a low likelihood of occurrence within the study area.
		REPTILES					
NT	-	Chelidae	<i>Emydura subglobosa worrelli</i>	Diamond Head Turtle	WO	4	Low – This species is known from coastal-draining catchments in northern Australia. It is not known from the Georgina or Burke River catchments within which the study area is located. This species has a low likelihood of occurrence due to a lack of records in the relevant river systems and a lack of suitable habitat.
V	V	Elapidae	<i>Acanthophis hawkei</i>	Plains Death Adder	PM	0	Moderate - The exact distribution of this species is poorly known, but fragmented populations of the plains death adder are known to occur in the Mitchell Grass Downs of western Queensland, the Barkly Tableland on the Northern Territory/Queensland border and east of Darwin in the Northern Territory. Suitable habitat for this species consists of flat, treeless, cracking-soil riverine floodplains (Cogger, 2000). The majority of the study area consists of shallow/skeletal soils on limestone and other sedimentary rocks. The study area does not support significant areas of preferred cracking-clay soils. There a now local records of this species and the habitat present within the study are is marginal but given the study area occurs within the potential distribution of this species, it has been assigned a moderate likelihood of occurrence.

1. Status: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory.
2. WO = Queensland Government Wildlife Online Database Extract (100km radius search area), PM = EPBC Act Protected Matters Report.

References

Aumann, T. & Baker-Gabb. D. (1991). RAOU Report 75. *A management plan for the Red Goshawk*. Melbourne: Royal Australasian Ornithologists Union.

Cogger, H.G. (2000). *Reptiles and amphibians of Australia: 6th edition*. Melbourne: Reed Books.

Department of the Environment and Energy (DEE). (2017). Species profile and threats database, Department of the Environment and Energy, Canberra. Retrieved from <http://www.environment.gov.au/sprat>.

Morcombe, M. (2003). *Field guide to Australian birds*. Steve Parish Publishing Pty Ltd.

Van Dyck, S., Gynther, I., & Baker, A. (2013). *Field companion to the mammals of Australia*. Sydney, Australia: New Holland Publishers.

Table D3: Potential for terrestrial migratory fauna identified in Protected Matters Search Tool to occur within the study area

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	SOURCE ²	WO RECORDS	POTENTIAL TO OCCUR IN THE STUDY AREA
NCA	EPBC						
		BIRDS					
SLC	M	Apodidae	<i>Apus pacificus</i>	Fork-tailed Swift	PM	0	Low – The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (Higgins, 1999). While commonly recorded in various parts of sub-coastal Queensland, they are rarely found as far west as the study area. Given the lack of local records, it is considered unlikely this species would occur within the study area. However, it is possible this species would fly over the study area in seasonal migration periods.
SLC	M	Motacillidae	<i>Motacilla cinerea</i>	Grey Wagtail	PM	0	Low – This species is a rare non-breeding summer visitor to northern Australia. There are no records anywhere relevant to the study area and it is therefore unlikely to occur.
SLC	M	Motacillidae	<i>Motacilla flava</i>	Yellow Wagtail	PM	0	Low – This species is a rare but regular migrant to coastal areas within Australia. It typically inhabits open habitats, often near water, and occasionally on drier inland plains (Morcombe, 2003). Due to the lack of preferred habitat and absence of local records for this species, it is unlikely to occur.
SLC	CE, M	Scolopacidae	<i>Calidris ferruginea</i>	Curlew Sandpiper	PM	0	Low - This species typically inhabits intertidal mudflats in sheltered coastal areas, however have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains as well as around floodplains (Higgins & Davies, 1996). There are no records of this species within 100km of the study area. It is considered that this species is unlikely to occur within the study area, as there is limited suitable habitat present for this species.
SLC	M	Charadriidae	<i>Charadrius veredus</i>	Oriental Plover	PM	0	Low – This species is a regular summer migrant that has been recorded across all mainland states but is most regularly recorded across coast areas and the northern inland (Pizzey & Knight, 2012). While it is possible this species may visit the locality over summer migration periods, given the lack of any local records this species has been assigned a low likelihood of occurrence.
SLC	M	Glareolidae	<i>Glareola maldivarum</i>	Oriental Pratincole	PM	0	Low – Within Australia the Oriental Pratincole is widespread in northern areas, especially along the coasts of the Pilbara Region and the Kimberley Division in Western Australia, the Top End of the Northern Territory, and parts of the Gulf of Carpentaria. It is also widespread but scattered inland, mostly north of 20° S (DEE, 2017). While it is possible this species may visit the locality over summer migration periods, given the lack of any local records this species has been assigned a low likelihood of occurrence.

1. Status: LC = Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, CE = Critically Endangered, M = Migratory.
2. WO = Queensland Government Wildlife Online Database Extract (100km radius search area), PM = EPBC Act Protected Matters Report.

References

Department of the Environment and Energy (DEE). (2017). Species profile and threats database, Department of the Environment and Energy, Canberra. Retrieved from <http://www.environment.gov.au/sprat>.

Higgins, P.J. (ed.). (1999). *Handbook of Australian, New Zealand and Antarctic birds. Volume Four - Parrots to Dollarbird*. Melbourne: Oxford University Press.

Higgins, P.J., & Davies S.J.J.F., (ed.). (1996). *Handbook of Australian, New Zealand and Antarctic birds. Volume Three - Snipe to Pigeons*. Melbourne, Victoria: Oxford University Press.

Morcombe, M. (2003). *Field guide to Australian birds*. Steve Parish Publishing Pty Ltd.

Pizzey, G., & Knight, F. (2012). *Field guide to the birds of Australia. Ninth Edition*. Sydney: Harper Collins.

Appendix E

Flora Species List

Table E1: Flora species recorded within the study area

STATUS ^{1, 2}		FAMILY	SCIENTIFIC NAME	COMMON NAME
NCA	EPBC			
LC	-	Adiantaceae	<i>Cheilanthes sp.</i>	Lip Fern
LC	-	Amaryllidaceae	<i>Crinum flaccidum</i>	Darling Lilly
LC	-	Apocynaceae	<i>Carissa lanceolata</i>	Current Bush
LC	-	Apocynaceae	<i>Cynanchum brevipedicellatum</i>	Caustic Vine
LC	-	Asteraceae	<i>Pterocaulon serrulatum var. velutinum</i>	Rag Weed
LC	-	Boraginaceae	<i>Trichodesma zeylanicum</i>	Camel Bush
LC	-	Caesalpiniaceae	<i>Senna artemisioides subsp. helmsii</i>	Blunt-leaf Cassia
LC	-	Caesalpiniaceae	<i>Senna artemisioides subsp. oligophylla</i>	Limestone Cassia
LC	-	Caesalpiniaceae	<i>Senna glutinosa subsp. pruinosa</i>	White Cassia
LC	-	Capparaceae	<i>Capparis lasiantha</i>	Nipan
LC	-	Chenopodiaceae	<i>Einadia nutans</i>	Climbing Saltbush
LC	-	Chenopodiaceae	<i>Salsola australis</i>	Roly-poly
LC	-	Chenopodiaceae	<i>Sclerolaena bicornis</i>	Goathead Burr
LC	-	Chenopodiaceae	<i>Sclerolaena calcarata</i>	Red Copperburr
LC	-	Chenopodiaceae	<i>Sclerolaena cuneata</i>	Tangled Copperburr
LC	-	Chenopodiaceae	<i>Sclerolaena lanicuspis</i>	Woolly Copperburr
LC	-	Cleomaceae	<i>Cleome viscosa</i>	Tick Weed
LC	-	Fabaceae	<i>Crotalaria dissitiflora</i>	Grey Rattlepod
LC	-	Fabaceae	<i>Crotalaria medicaginea</i>	Trefoil Rattlepod
LC	-	Fabaceae	<i>Crotalaria novae-hollandiae</i>	New Holland Rattlepod
LC	-	Fabaceae	<i>Rhynchosia minima</i>	Rhyncho
LC	-	Fabaceae	<i>Sesbania benthamiana</i>	Tall Sesbania Pea
LC	-	Fabaceae	<i>Tephrosia brachyodon</i>	Red Pea-bush
LC	-	Fabaceae	<i>Tephrosia supina</i>	Short Tephrosia
LC	-	Lamiaceae	<i>Clerodendrum floribundum</i>	Lolly Bush
LC	-	Lamiaceae	<i>Ocimum tenuiflorum</i>	Holly Basil
LC	-	Loranthaceae	<i>Lysiana subfalcata</i>	Northern Mistletoe
LC	-	Malvaceae	<i>Abutilon otocarpum</i>	Mallow
LC	-	Malvaceae	<i>Malvastrum americanum</i>	Spiked Malvastrum
LC	-	Malvaceae	<i>Sida fibulifera</i>	Pin Sida

STATUS ^{1, 2}		FAMILY	SCIENTIFIC NAME	COMMON NAME
NCA	EPBC			
LC	-	Marsileaceae	<i>Marsilea drummondii</i>	Nardoo
LC	-	Meliaceae	<i>Owenia acidula</i>	Emu Apple
LC	-	Mimosaceae	<i>Acacia cambagei</i>	Gidgee
LC	-	Mimosaceae	<i>Acacia chisholmii</i>	Chisholm's Wattle
LC	-	Mimosaceae	<i>Acacia excelsa</i>	Ironwood
LC	-	Mimosaceae	<i>Acacia victoriae subsp. victoriae</i>	Gundabluie
*	-	Mimosaceae	<i>Vachellia farnesiana</i>	Mimosa bush
LC	-	Myrtaceae	<i>Corymbia bella</i>	North-west Ghost Gum
LC	-	Myrtaceae	<i>Corymbia terminalis</i>	Inland Bloodwood
LC	-	Myrtaceae	<i>Eucalyptus camaldulensis</i>	River Red Gum
LC	-	Myrtaceae	<i>Eucalyptus leucophloia</i>	Snappy Gum
LC	-	Myrtaceae	<i>Eucalyptus normantonensis</i>	Normanton Box
LC	-	Myrtaceae	<i>Melaleuca bracteata</i>	Black Tea-tree
LC	-	Nyctaginaceae	<i>Boerhavia pubescens</i>	Tar Vine
LC	-	Nyctaginaceae	<i>Boerhavia schomburgkiana</i>	Tar Vine
LC	-	Phyllanthaceae	<i>Flueggea virosa</i>	White Currant Bush
LC	-	Pittosporaceae	<i>Pittosporum angustifolium</i>	Cattle Bush
LC	-	Poaceae	<i>Aristida contorta</i>	Bunched Kerosene Grass
*	-	Poaceae	<i>Cenchrus pennisetiformis</i>	Cloncurry Buffel Grass
LC	-	Poaceae	<i>Cymbopogon bombycinus</i>	Silky Oil Grass
LC	-	Poaceae	<i>Dactyloctenium radulans</i>	Button Grass
LC	-	Poaceae	<i>Enneapogon lindleyanus</i>	Lindley Nineawn
LC	-	Poaceae	<i>Enneapogon polyphyllus</i>	Limestone Bottlewashers
LC	-	Poaceae	<i>Eriachne mucronata</i>	Mountain Wanderrie Grass
LC	-	Poaceae	<i>Eulalia aurea</i>	Silky Browntop
LC	-	Poaceae	<i>Oxychloris scariosa</i>	Winged Chloris
LC	-	Poaceae	<i>Panicum decompositum</i>	Native Millet
LC	-	Poaceae	<i>Sporobolus actinocladius</i>	Katoora
LC	-	Poaceae	<i>Themeda triandra</i>	Kangaroo Grass
LC	-	Poaceae	<i>Triodia basedowii</i>	Hard Spinifex
LC	-	Poaceae	<i>Triodia longiceps</i>	Grey Spinifex
LC	-	Poaceae	<i>Triodia pungens</i>	Soft Spinifex

STATUS ^{1, 2}		FAMILY	SCIENTIFIC NAME	COMMON NAME
NCA	EPBC			
LC	-	Portulacaceae	<i>Portulaca filifolia</i>	Slender Pigweed
*	-	Portulacaceae	<i>Portulaca oleracea</i>	Pigweed
LC	-	Proteaceae	<i>Grevillea striata</i>	Beefwood
LC	-	Proteaceae	<i>Hakea chordophylla</i>	Bootlace Oak
LC	-	Proteaceae	<i>Hakea lorea subsp. lorea</i>	Bootlace Oak
LC	-	Rhamnaceae	<i>Ventilago viminalis</i>	Vine Tree
LC	-	Santalaceae	<i>Santalum lanceolatum</i>	Sandalwood
LC	-	Sapindaceae	<i>Atalaya hemiglauca</i>	Whitewood
LC	-	Scrophulariaceae	<i>Eremophila longifolia</i>	Berrigan
LC	-	Scrophulariaceae	<i>Eremophila maculata</i>	Spotted Emu Bush
LC	-	Scrophulariaceae	<i>Eremophila mitchellii</i>	False Sandalwood
LC	-	Scrophulariaceae	<i>Eremophila obovata</i>	Emu Bush
LC	-	Solanaceae	<i>Solanum esuriale</i>	Quena
LC	-	Solanaceae	<i>Solanum quadiloculatum</i>	Bush Tomato
LC	-	Solanaceae	<i>Solanum sp.</i>	
LC	-	Ulmaceae	<i>Trema tomentosa</i>	Poison Peach
LC	-	Violaceae	<i>Hybanthus aurantiacus</i>	Orange Spade Flower
LC	-	Zygophyllaceae	<i>Tribulopsis sp.</i>	
LC	-	Zygophyllaceae	<i>Tribulus terrestris</i>	Goat's Head

1. Status: LC = Least Concern, * = Species not native to, or naturalised within, Australia.

2. NCA = *Nature Conservation Act 1992*, EPBC = *Environment Protection and Biodiversity Conservation Act 1999*.

Appendix F

Fauna Species List

Table F1: Fauna species recorded within the study area

STATUS ¹		FAMILY	SCIENTIFIC NAME	COMMON NAME	S1	S2	S3	S4	S5	S6	INCEDENTAL
NCA	EPBC										
BIRDS											
LC	-	Dromaiidae	<i>Dromaius novaehollandiae</i>	Emu		X		X	X		X
LC	-	Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail				X			
LC	-	Anatidae	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck							X
LC	-	Anatidae	<i>Anas gracilis</i>	Grey Teal							X
LC	-	Anatidae	<i>Aythya australis</i>	Hardhead							X
LC	-	Podocipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe							X
LC	-	Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing							X
LC	-	Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon	X	X	X				X
LC	-	Columbidae	<i>Geopelia cuneata</i>	Diamond Dove				X	X		X
LC	-	Columbidae	<i>Geophaps plumifera</i>	Spinifex Pigeon					X		X
LC	-	Aegothelidae	<i>Aegotheles cristatus</i>	Owlet Nightjar							X
LC	-	Anhingidae	<i>Anhinga novaehollandiae</i>	Australasian Darter							X
LC	-	Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant							X
LC	-	Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite							X
LC	-	Accipitridae	<i>Milvus migrans</i>	Black Kite							X
LC	-	Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk		X					

LC	-	Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle				X			X
LC	-	Accipitridae	<i>Circus approximans</i>	Swamp Harrier							X
LC	-	Falconidae	<i>Falco berigora</i>	Brown Falcon					X	X	X
LC	-	Falconidae	<i>Falco cenchroides</i>	Nankeen Kestrel					X		X
LC	-	Falconidae	<i>Falco longipennis</i>	Australian Hobby							X
LC	-	Falconidae	<i>Falco subniger</i>	Black Falcon	X						
LC	-	Otididae	<i>Ardeotis australis</i>	Australian Bustard							X
LC	-	Burhinidae	<i>Burhinus grallarius</i>	Bush Stone-curlew				X			
LC	-	Charadriidae	<i>Vanellus tricolor</i>	Banded Lapwing							X
LC	-	Charadriidae	<i>Vanellus miles</i>	Masked Lapwing							X
LC	-	Turnicidae	<i>Turnix velox</i>	Little Button-quail							X
LC	-	Psittaculidae	<i>Eolophus roseicapilla</i>	Galah			X		X		X
LC	-	Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella					X		X
LC	-	Cacatuidae	<i>Nymphicus hollandicus</i>	Cockatiel					X		
LC	-	Psittaculidae	<i>Barnardius zonarius macgillivrayi</i>	Cloncurry Ringneck		X				X	X
LC	-	Psittaculidae	<i>Melopsittacus undulatus</i>	Budgerigar				X			X
LC	-	Halcyonidae	<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher							X
LC	Ma	Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater				X			
LC	-	Ptilonorhynchidae	<i>Chlamydera nuchalis</i>	Great Bowerbird							X
LC	-	Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren				X			
LC	-	Acanthizidae	<i>Smicrornis brevirostris</i>	Weebill		X	X	X			X
LC	-	Acanthizidae	<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				X	X	X	X

LC	-	Meliphagidae	<i>Gavicalis virescens</i>	Singing Honeyeater	X		X		X		X
LC	-	Meliphagidae	<i>Ptilotula penicillata</i>	White-plumed Honeyeater		X					X
LC	-	Meliphagidae	<i>Manorina flavigula</i>	Yellow-throated Miner	X	X					X
LC	-	Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner				X			
LC	-	Meliphagidae	<i>Lichmera indistincta</i>	Brown Honeyeater				X			X
LC	-	Meliphagidae	<i>Epthianura tricolor</i>	Crimson Chat							X
LC	-	Pomatostomidae	<i>Pomatostomus temporalis</i>	Grey-crowned Babbler		X			X		X
LC	-	Campephagidae	<i>Coracina maxima</i>	Ground Cuckoo-shrike							X
LC	-	Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				X			
LC	-	Campephagidae	<i>Lalage tricolor</i>	White-winged Triller							X
LC	-	Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	X			X	X		X
LC	-	Oreoicidae	<i>Oreoica gutturalis</i>	Crested Bellbird				X	X		X
LC	-	Artamidae	<i>Artamus cyanopterus</i>	Dusky Woodswallow							X
LC	-	Artamidae	<i>Artamus cinereus</i>	Black-faced Woodswallow	X	X	X		X	X	X
LC	-	Artamidae	<i>Artamus minor</i>	Little Woodswallow				X			
LC	-	Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird						X	X
LC	-	Artamidae	<i>Cracticus tibicen</i>	Australian Magpie							X
LC	-	Rhipiduridae	<i>Rhipidura leucophrys</i>	Willy Wagtail	X				X	X	X
LC	-	Corvidae	<i>Corvus coronoides</i>	Australian Raven				X	X		X
LC	-	Corvidae	<i>Corvus orru</i>	Torresian Crow	X		X				X
LC	-	Monarchidae	<i>Grallina cyanoleuca</i>	Magpie Lark					X		X
LC	-	Petroicidae	<i>Melanodryas cucullata</i>	Hooded Robin					X	X	X

LC	-	Megaluridae	<i>Cincloramphus mathewsi</i>	Rufous Songlark				X			
LC	-	Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird		X					
LC	-	Estrildidae	<i>Taeniopygia guttata</i>	Zebra Finch	X	X	X	X	X	X	X
LC	-	Motacillidae	<i>Anthus novaeseelandiae</i>	Australasian Pipit						X	X
MAMMALS											
*	-	Bovidae	<i>Bos taurus*</i>	Domestic Cattle	X	X	X	X		X	X
LC	-	Canidae	<i>Canis lupus</i>	Dingo				X			X
LC	-	Dasyuridae	<i>Sminthopsis macroura</i>	Stripe-faced Dunnart					X		
LC	-	Emballonuridae	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat				X	X	X	
LC	-	Macropodidae	<i>Macropus robustus</i>	Common Wallaroo							X
LC	-	Macropodidae	<i>Macropus rufus</i>	Red Kangaroo	X				X		X
V	-	Macropodidae	<i>Petrogale purpureicollis</i>	Purple-necked Rock-Wallaby							X
LC	-	Molossidae	<i>Chaerephon jobensis</i>	Greater Northern Freetail Bat	X	X	X	X	X	X	
LC	-	Molossidae	<i>Ozimops</i> sp.	Free-tailed Bats	P	P	P		P		
LC	-	Molossidae	<i>Setirostris eleryi</i>	Hairy-nosed Freetail Bat				P	P	P	
LC	-	Muridae	<i>Leggadina forresti</i>	Forrest's Mouse			X				
*	-	Muridae	<i>Mus musculus*</i>	House Mouse	X	X	X				
LC	-	Muridae	<i>Pseudomys desertor</i>	Desert Mouse			X				
LC	-	Muridae	<i>Zyzomys argurus</i>	Common Rock Rat		X					
*	-	Suidae	<i>Sus scrofa*</i>	Feral Pig				X			
SLC	-	Tachyglossidae	<i>Tachyglossus aculeatus</i>	Echidna							X
LC	-	Vespertilionidae	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	X	X	X	X	X	X	

LC	-	Vespertilionidae	<i>Chalinolobus nigrogriseus</i>	Hoary Wattled Bat	P	P	P		P		
LC	-	Vespertilionidae	<i>Nyctophilus</i> sp.	Long-eared Bats	X	X	X				
LC	-	Vespertilionidae	<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat	X	X		X	X	X	
LC	-	Vespertilionidae	<i>Scotorepens greyii</i>	Little Broad-nosed Bat	P	P	P	X	P	X	
LC	-	Vespertilionidae	<i>Vespadelus baverstocki</i>	Inland Forest Bat					X	X	
LC	-	Vespertilionidae	<i>Vespadelus finlaysoni</i>	Finlayson's Cave Bat	X	X	X	X	X	X	
REPTILES											
LC	-	Agamidae	<i>Amphibolurus gilberti</i>	Gilbert's Dragon		X		X		X	X
LC	-	Agamidae	<i>Ctenophorus nuchalis</i>	Central Netted Dragon				X			X
LC	-	Agamidae	<i>Gowidon temporalis</i>	Swamplands Lashtail					X		
LC	-	Agamidae	<i>Pogona vitticeps</i>	Central Bearded Dragon							X
LC	-	Diplodactylidae	<i>Strophurus krisalys</i>	Kristin's Spiny-tailed Gecko	X						X
LC	-	Elapidae	<i>Brachyurops incinctus</i>	Unbanded Shovel-nosed Snake				X			
LC	-	Elapidae	<i>Furina ornata</i>	Orange-naped Snake			X				
LC	-	Elapidae	<i>Pseudonaja nuchalis</i>	Northern Brown Snake				X			
LC	-	Gekkonidae	<i>Gehyra dubia</i>	Dubious Dtella			X				
LC	-	Gekkonidae	<i>Gehyra robusta</i>	Robust Dtella						X	X
LC	-	Gekkonidae	<i>Gehyra versicolor</i>	Variable Dtella		X	X	X	X	X	
LC	-	Gekkonidae	<i>Heteronotia binoei</i>	Bynoe's Gecko			X	X		X	X
LC	-	Pythonidae	<i>Antaresia stimsoni</i>	Stimson's Python					X		X
LC	-	Pythonidae	<i>Aspidites melanocephalus</i>	Black-headed Python							X
LC	-	Scincidae	<i>Ctenotus lateralis</i>	Gravelly-soil Ctenotus		X	X				

LC	-	Scincidae	<i>Ctenotus pantherinus</i>	Leopard Ctenotus	X	X		X		X	
LC	-	Scincidae	<i>Ctenotus spaldingii</i>	Straight-browed Ctenotus							X
LC	-	Scincidae	<i>Egernia hosmeri</i>	Hosmer's Skink						X	
LC	-	Scincidae	<i>Proablepharus tenuis</i>	Slender Snake-eyed Skink				X			
LC	-	Typhlopidae	<i>Anilius diversus</i>	Northern Blind Snake				X			
LC	-	Varanidae	<i>Varanus acanthurus</i>	Ridge-tailed Monitor	X			X			X
LC	-	Varanidae	<i>Varanus tristis</i>	Black-headed Monitor			X				
LC	-	Varanidae	<i>Varanus panoptes</i>	Yellow-spotted Monitor		X		X		X	X
AMPHIBIANS											
LC	-	Hylidae	<i>Cyclorana novaehollandiae</i>	Eastern Snapping Frog					X		X
LC	-	Hylidae	<i>Litoria cearulea</i>	Green Tree Frog					X		
LC	-	Limnodynastidae	<i>Platyplectrum ornatum</i>	Ornate Burrowing Frog				X			

1. Status: LC = Least Concern, SLC = Special Least Concern, NT = Near Threatened, V = Vulnerable, E = Endangered, Ma = Marine, * = Species not native to Australia.

2. P = Possible record from bat call analysis – unable to be confirmed from call data

Appendix G

Microbat Call Interpretation Report



Microbat Call Interpretation Report

Prepared for ("Client"):	Northern Resource Consultants
Survey location/project name:	Mount Isa area
Survey dates:	1-5 June 2017
Client project reference:	
Job no.:	NRC-1705
Report date:	21 June 2017

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Methods

Survey summary

Balance! Environmental received 714 full-spectrum (WAV format) audio files, recorded over four consecutive nights (1st – 4th June 2017), using a Song Meter SM4 detector (Wildlife Acoustics, USA).

Post-processing

All WAV files were converted to zero-crossing analysis file format (ZC files), using Wildlife Acoustics' *Kaleidoscope* (Version 4.0.3) with the "Advanced signal processing" feature enabled. These ZC files formed the basis of the identification data set; however, the original WAV files for some calls were also used to verify identification.

Call analysis and identification

All ZC sequence files were analysed using *AnaLookW* (Corben 2015). A subset of files representing all call types recorded on each night was selected for call identification. Species identification was achieved manually by comparing the ZC spectrograms of the selected calls with those of reference calls from northern and central-western Queensland and/or with published call descriptions (e.g. Reinhold et al. 2001; Milne 2002; Pennay et al. 2004). Full-spectrum copies of some calls were also viewed using the *Kaleidoscope Viewer* to confirm identities assigned to the ZC files.

Consideration was also given to the probability of occurrence based on published distribution information (e.g. Churchill 2008; van Dyck et al. 2013) and on-line database records (e.g. <http://www.ala.org.au>).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003), available on-line at <http://www.ausbats.org.au/>.

Species nomenclature follows Reardon et al. (2015).

Results & Discussion

The *Kaleidoscope* WAV-ZC conversion process produced 710 ZC sequence files, 113 of which were selected for species identification.

At least six and potentially eight or nine species were recorded during the Mount Isa survey. Four call types were reliably identified to single species, while another four types were allocated to groups of species that share many call characteristics (Table 1). These groups included:

- *Nyctophilus* species
 - o Steep, almost-linear FM pulses terminating around 40 kHz
 - o readily distinguished from other bat calls but the species in the genus cannot be reliably differentiated
 - o *N. geoffroyii* is the primary candidate for these calls, but up to three other species occur in the greater Mount Isa region, including *N. bifax*, *N. arnhemensis* and *N. walkeri* (the latter two mainly in areas around Lawn Hill)

- *Scotorepens greyii* or *Chalinolobus nigrogriseus*
 - o Steep, curvilinear pulses with curved to hooked pulse-bodies and characteristic frequency (Fc) around 36-40 kHz
 - o Almost impossible to differentiate these two species using call data and both probably occur in the study area
- *Chalinolobus gouldii* / *Scotorepens balstoni*
 - o Steep, curvilinear pulses with curved pulse-bodies and Fc=28-34 kHz
 - o Both species reliably identified for all nights on the basis of distinctly alternating pulse frequency (*C. gouldii*) versus consistent frequency (*S. balstoni*)
 - o A number of files with calls from multiple individuals and/or inconsistent alternation pattern could have been from either species
- *C. gouldii* / *Mormopterus* species
 - o Curvilinear calls with short (or sometimes lacking) initial frequency sweep and variable Fc in the range 31-33 kHz (but no obvious frequency alternation)
 - o Could be aberrant *C. gouldii* calls, or that species flying in open airspace
 - o *Mormopterus* species that call within the frequency range, and which potentially occur in the study area, include *M. coburgianus* and *M. halli*

No threatened species were recorded.

Sample spectrograms of each recorded call type are shown at Appendix 1.

Table 1 Microbat species recorded during the Mount Isa survey, 1-5 June 2017.

Detection date:	1-Jun	2-Jun	3-Jun	4-Jun
Total ZC sequence files:	12	592	76	30
Number of calls identified:	11	55	28	19
Species positively identified				
<i>Chalinolobus gouldii</i>	✓	✓	✓	✓
<i>Scotorepens balstoni</i>		✓	✓	
<i>Vespadelus finlaysoni</i>		✓	✓	✓
<i>Chaerephon jobensis</i>	✓	✓	✓	✓
Calls not positively identified				
<i>Nyctophilus</i> species	✓	✓	✓	✓
<i>Scotorepens greyii</i> or <i>Chalinolobus nigrogriseus</i>		✓	✓	✓
<i>C. gouldii</i> / <i>S. balstoni</i>		✓		
<i>C. gouldii</i> / <i>Mormopterus</i> species		✓	✓	✓

References

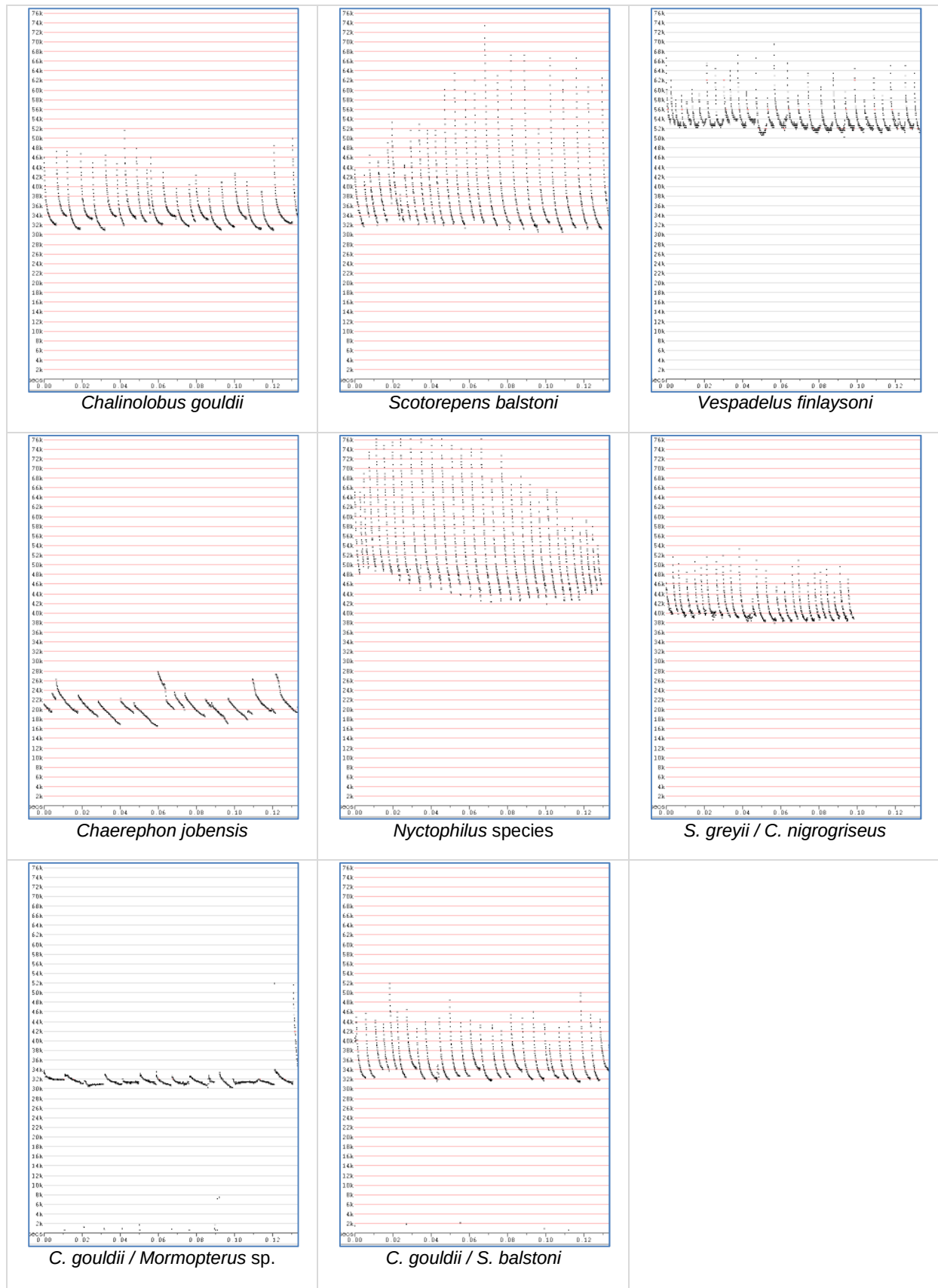
- Churchill, S. (2008). Australian Bats. Jacana Books, Allen & Unwin; Sydney.
- Corben, C. (2015). AnalookW for bat call analysis using ZCA. Version 4.1z, 20 September 2015.
- Milne, D.J. (2002). Key to the bat calls of the Top End of the Northern Territory. Technical Report No. 71; Parks and Wildlife Commission of the Northern Territory, Darwin.
- Pennay, M., Law, B. and Reinhold, L. (2004). Bat Calls of New South Wales. Department of Environment and Conservation, Hurstville.
- Reardon, T. (2003). Standards in bat detector based surveys. Australasian Bat Society Newsletter 20, 41-43.
- Reardon, T.B., Armstrong, K.N. and Jackson, S.M. (2015). A current taxonomic list of Australian Chiroptera. Australasian Bat Society. Version 2015-05-15. URL: <http://ausbats.org.au/taxonomic-list/4589345107>
- Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). Key to the bat calls of south-east Queensland and north-east New South Wales. Department of Natural Resources and Mines, Brisbane.
- van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). Field Companion to the Mammals of Australia. New Holland; Sydney.

Glossary

Technical terms used in this report are described in the following table.

Approach phase	The part of a bat <i>call</i> emitted as the bat starts to home in on a detected prey item; a transitional series of <i>pulses</i> between the <i>search phase</i> and <i>feeding buzz</i> , that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound <i>pulses</i> in one or more <i>phases</i> (<i>search, approach, feeding buzz</i>).
CF (=Constant Frequency)	A type of <i>pulse</i> in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with <i>shape</i> appearing flat on the sonogram. Often also contains a brief <i>FM</i> component at the beginning and/or end of the CF component (<i>viz.</i> FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a <i>pulse</i> ; usually the lowest frequency reached in the <i>qCF</i> component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a <i>pulse</i> to the end of the pulse.
Feeding buzz	The terminal part of a <i>call</i> , following the <i>approach phase</i> , emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of <i>pulse</i> in which there is substantial change in frequency from beginning to end; <i>shape</i> ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the <i>characteristic frequency</i> section of <i>pulses</i> within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a <i>pulse</i> sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a <i>pulse</i> between the initial (usually steeper) frequency sweep and the <i>characteristic frequency</i> section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat <i>call</i> ; the <i>shape, duration</i> and <i>characteristic frequency</i> of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the <i>pulse</i> between the <i>knee</i> and <i>tail</i> and containing the <i>characteristic frequency</i> section.
Pulse shape	The general appearance of a <i>pulse</i> on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also <i>CF, qCF</i> and <i>FM</i> .
qCF (=quasi Constant Frequency)	A type of <i>pulse</i> in which there is very little change in frequency from beginning to end; <i>shape</i> appears to be almost flat. Some pulses also contain an <i>FM</i> component at the beginning and/or end of the qCF component (<i>viz.</i> FM-qCF).
Search phase	The part of a bat <i>call</i> generally required for reliable species diagnosis. A consistent series of <i>pulses</i> emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than <i>approach phase</i> and <i>feeding buzz</i> pulses.
Sequence	Literally, a sequence of <i>pulses</i> that may be from one or more bats; but generally refers to a <i>call</i> or part (e.g. <i>phase</i>) of a call.
Tail	The final component of a <i>pulse</i> , following the <i>characteristic frequency</i> section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

Appendix 1 Representative call sequences from the Mount Isa survey, 1-5 June 2017.





Microbat Call Identification Report

Prepared for ("Client"):	Northern Resource Consultants
Survey location/project name:	Duchess-Dajarra area, NW Qld
Survey dates:	18-22 March 2018
Client project reference:	
Job no.:	NRC-1802
Report date:	19 April 2018

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Methods

Survey summary & data received

Bat calls were recorded using a Song Meter SM4 detector (Wildlife Acoustics, Maynard MA, USA). Call data were saved in full-spectrum (WAV) format, with 2643 WAV files recorded over five consecutive nights (18-22 March 2018).

Post-processing and call identification

Wildlife Acoustics' *Kaleidoscope* (Version 4.5.1) was used to convert the WAV files to Anabat-type zero-crossing analysis sequence files (ZC files), which were then analysed in *AnalookW* (Corben 2017). ZC files containing only background noise and/or fewer than three clear, unfragmented bat-call pulses were excluded from the analysis.

Species identification was achieved manually by comparing the ZC file spectrograms with those of reference calls from northern and central Queensland and with reference to published call descriptions (e.g. Reinhold *et al.* 2001; Milne 2002; Pennay *et al.* 2004). Full-spectrum copies of some calls were analysed in the *Kaleidoscope Viewer* to confirm or improve the reliability of identification for some species.

Species' identification was also guided by considering the probability of a species' occurrence based on published distributions (Churchill 2008; van Dyck *et al.* 2013) and/or on-line database records (e.g. <http://www.ala.org.au>).

Reporting standard

The format and content of this report follows Australasian Bat Society standards for the interpretation and reporting of bat call data (Reardon 2003). Species nomenclature follows Jackson & Groves (2015). Note that this treatment of Australian mammal taxonomy elevates the sub-genus names proposed by Reardon *et al.* (2008, 2014) for the *Mormopterus* free-tailed bats to genus level; hence *Ozimops* (*O. lumsdenae*, *O. petersi*) and *Setirostris eleryi* are used herein.

Results & Discussion

Data quality/quantity

The WAV-ZC conversion yielded 2525 ZC sequence files, from which, a subset of 344 files were selected for call identification. This relatively low proportion of files required for identification is reflective of a high proportion of files attributable to just a few species.

Species recorded

At least ten and up to twelve species were recorded during this survey (see Table 1). Nine call types were identified positively to single species, and one call type was reliably attributable to the *Tapozous* genus, two species of which may occur in the study area (*T. georgianus* & *T. troughtoni*). Several unresolved call types may have represented two additional species, or may simply have been atypical variants of positively identified species. These are discussed further below.

Table 1. Microbat species recorded during the Duchess survey, 18-22 March 2018.

- ◆ = 'definite' at least one call from the site/session was attributed unequivocally to the species
 □ = 'probable' calls like those of the species were recorded, but could not be reliably identified

Date:	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar
Total WAV files:	1861	293	190	207	92
Total ZC sequence files:	1828	252	175	194	76
Number of calls identified:	140	51	49	52	52
<i>Chalinolobus gouldii</i>	◆	◆	◆	◆	◆
<i>Chalinolobus nigrogriseus</i>	□			□	
<i>Scotorepens balstoni</i>	◆	◆	◆	◆	◆
<i>Scotorepens greyii</i>	◆	◆	◆	□	◆
<i>Vespadelus baverstocki</i>	◆			◆	◆
<i>Vespadelus finlaysoni</i>	◆	◆	◆	◆	◆
<i>Chaerephon jobensis</i>	◆	◆	◆	◆	◆
<i>Ozimops lumsdenae</i>	◆	◆			
<i>Ozimops</i> species	□	□		□	
<i>Setirostris eleryi</i>	◆	◆	□	□	□
<i>Saccolaimus flaviventris</i>	◆	◆	◆	◆	◆
<i>Taphozous georgianus</i> / <i>T. troughtoni</i>	◆	◆			

Unresolved calls were allocated to the following groups:

- *Chalinolobus gouldii* / *Ozimops* species
 - o Narrow-band, flat to curvilinear (qCF) pulse shape, with characteristic frequency (Fc) in the range 31-35 kHz)
 - o *C. gouldii* reliably identified from calls with broader band-width including steep initial frequency sweep (FM-qCF pulses) and Fc alternating between successive pulses
 - o These unresolved calls could just be *C. gouldii* calling in very open space, but *Ozimops* species also typically produce flatter qCF-type pulses
 - o No *Ozimops* species have been recorded in the study area, but it is possible that the area lies within an overlap zone between three species for which distributional limits are not well known (*O. coburgianus*, *O. halli*, *O. petersi*)
- *Scotorepens greyii* / *Setirostris eleryi*
 - o Steep, curvilinear (FM-qCF), short-duration pulses with Fc in the range 36-40 kHz, often with hooked pulse-bodies
 - o Difficult to differentiate unless approach-phase and feeding-buzz transitions are evident in the calls
 - o Corben (2010) described distinctive approach and feeding buzz characteristics that may be used to differentiate between molossid and vespertilionid bats
 - o A few calls were differentiated using these characteristics; however, most lacked those diagnostic features and were allocated only to the species pair

- *Scotorepens greyii* / *Chalinolobus nigrogriseus*
 - o Pulse shape and Fc similar to above, but *C. nigrogriseus* calls typically have longer-duration pulses with flatter bodies and no tail or down-swept tail
 - o A few calls with characteristics intermediate between those of *C. nigrogriseus* and *S. greyii* were thought to most likely be from *S. greyii* foraging in open space, but the potential presence of *C. nigrogriseus*, although very unlikely, cannot be discounted

Technical terms used in the above call descriptions are explained in the Glossary. Sample spectrograms of each species /group are shown at Appendix 1.

References

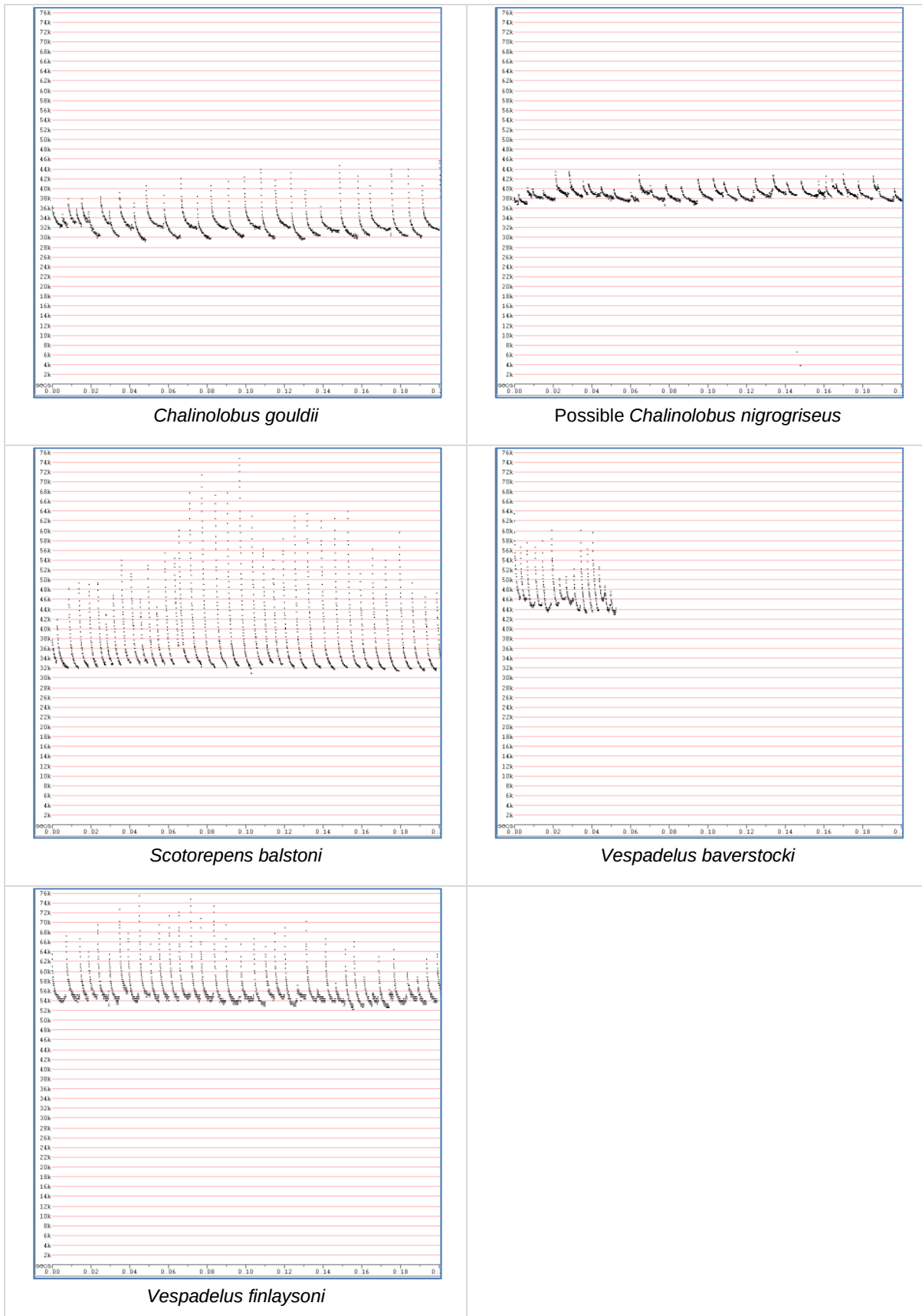
- Churchill, S. (2008). *Australian Bats*. Jacana Books, Allen & Unwin; Sydney.
- Corben, C. (2010). Feeding Buzzes. *Australasian Bat Society Newsletter* **35**, 40-44.
- Corben, C. (2017). *AnaLookW for bat call analysis using ZCA. Version 4.2n*, 16 March 2017.
- Milne, D.J. (2002). *Key to the Bat Calls of the Top End of the Northern Territory*. Technical Report No. 71, Parks and Wildlife Commission of the Northern Territory, Darwin.
- Jackson, S. and Groves, C. (2015). *Taxonomy of Australian Mammals*. CSIRO Publishing, Melbourne.
- Pennay, M., Law, B. and Reinhold, L. (2004). *Bat Calls of New South Wales*. Department of Environment and Conservation, Hurstville.
- Reardon, T. (2003). Standards in bat detector based surveys. *Australasian Bat Society Newsletter* **20**, 41-43.
- Reardon, T., Adams, M., McKenzie, N. and Jenkins, P. (2008). A new species of Australian freetail bat *Mormopterus eleryi* sp. nov. (Chiroptera: Molossidae) and a taxonomic reappraisal of *M. norfolkensis* (Gray). *Zootaxa* 1875: 1-31.
- Reardon, T. B., McKenzie, N. L., Cooper, S. J. B., Appleton, B., Carthew, S. and Adams, M. (2014). A molecular and morphological investigation of species boundaries and phylogenetic relationships in Australian free-tailed bats *Mormopterus* (Chiroptera: Molossidae). *Aust. J. Zool.* **62**, 109–136.
- Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Department of Natural Resources and Mines, Brisbane.
- van Dyck, S., Gynther, I. and Baker, A. (ed.) (2013). *Field Companion to the Mammals of Australia*. New Holland; Sydney.

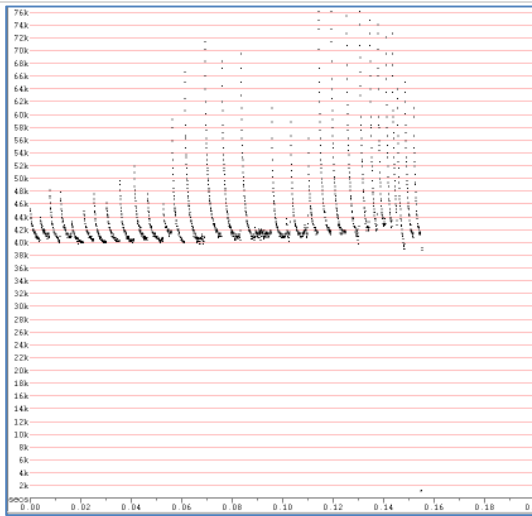
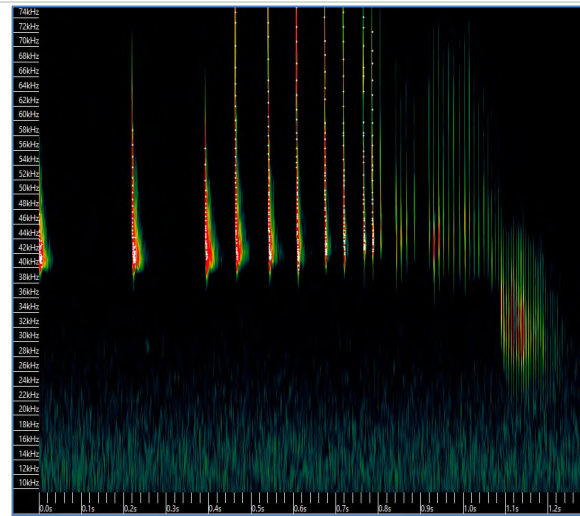
Glossary

Technical terms used in this report are described in the following table.

Approach phase	The part of a bat <i>call</i> emitted as the bat starts to home in on a detected prey item; a transitional series of <i>pulses</i> between the <i>search phase</i> and <i>feeding buzz</i> , that become progressively steeper and shorter in duration.
Call	Refers to a single bat call, made up of a series of individual sound <i>pulses</i> in one or more <i>phases</i> (<i>search, approach, feeding buzz</i>).
CF (=Constant Frequency)	A type of <i>pulse</i> in which the dominant component consists of a more-or-less 'pure tone' of sound at a Constant Frequency; with <i>shape</i> appearing flat on the sonogram. Often also contains a brief <i>FM</i> component at the beginning and/or end of the CF component (<i>viz.</i> FM-CF-FM).
Characteristic frequency (Fc)	The frequency of the flattest part of a <i>pulse</i> ; usually the lowest frequency reached in the <i>qCF</i> component of a pulse. This is often the primary diagnostic feature for species identification.
Duration	The time period from the beginning of a <i>pulse</i> to the end of the pulse.
Feeding buzz	The terminal part of a <i>call</i> , following the <i>approach phase</i> , emitted as the bat catches a prey item; a distinctive, rapid series of very steep, very short-duration pulses.
FM (=Frequency Modulated)	A type of <i>pulse</i> in which there is substantial change in frequency from beginning to end; <i>shape</i> ranges from almost vertical and linear through varying degrees of curvature.
FC range	Refers to the range of frequencies occupied by the <i>characteristic frequency</i> section of <i>pulses</i> within a call or set of calls.
Frequency sweep or "band-width"	The range of frequencies through which a <i>pulse</i> sweeps from beginning to end; Maximum frequency (Fmax) – minimum frequency (Fmin).
Knee	The transitional part of a <i>pulse</i> between the initial (usually steeper) frequency sweep and the <i>characteristic frequency</i> section (usually flatter); time to knee (Tk) and frequency of knee (Fk) can be diagnostic for some species.
Pulse	An individual pulse of sound within a bat <i>call</i> ; the <i>shape, duration</i> and <i>characteristic frequency</i> of a pulse are the key diagnostic features used to differentiate species.
Pulse body	The part of the <i>pulse</i> between the <i>knee</i> and <i>tail</i> and containing the <i>characteristic frequency</i> section.
Pulse shape	The general appearance of a <i>pulse</i> on the sonogram, described using relative terms related to features such as slope and degree of curvature. See also <i>CF, qCF</i> and <i>FM</i> .
qCF (=quasi Constant Frequency)	A type of <i>pulse</i> in which there is very little change in frequency from beginning to end; <i>shape</i> appears to be almost flat. Some pulses also contain an <i>FM</i> component at the beginning and/or end of the qCF component (<i>viz.</i> FM-qCF or qCF-FM, respectively).
Search phase	The part of a bat <i>call</i> generally required for reliable species diagnosis. A consistent series of <i>pulses</i> emitted by a bat that is searching for prey or and/or navigating through its habitat. Search phase pulses generally have longer duration, flatter slope and more consistent shape than <i>approach phase</i> and <i>feeding buzz</i> pulses.
Sequence	Literally, a sequence of <i>pulses</i> that may be from one or more bats; but generally refers to a <i>call</i> or part (e.g. <i>phase</i>) of a call.
Tail	The final component of a <i>pulse</i> , following the <i>characteristic frequency</i> section; may consist of a short or long sweep of frequencies either upward or downward from the Fc; or may be absent.

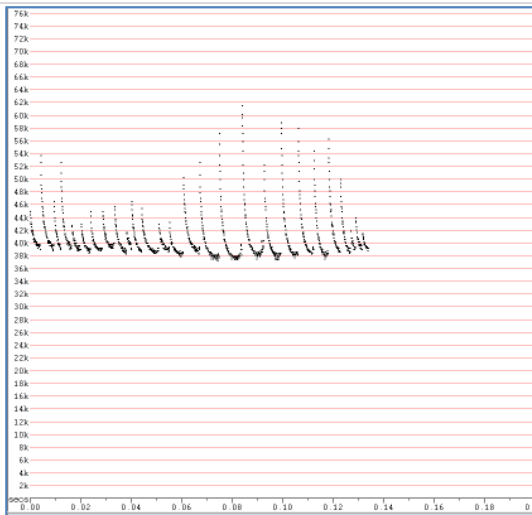
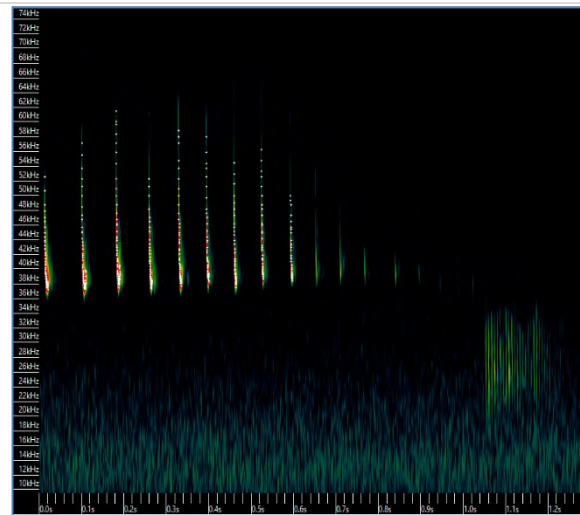
Appendix 1 Representative call sequences from the Duchess survey, 18-22 March 2018.
Scale: 10msec per tick; time between pulses removed (*AnalookW* F7 compressed mode)





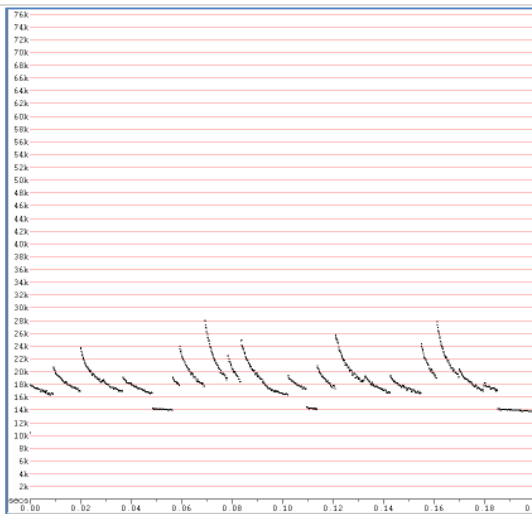
Scotorepens greyii

ZC and full-spectrum versions of same call, with 'typical' vesperilionid feeding buzz clear on FS spectrogram

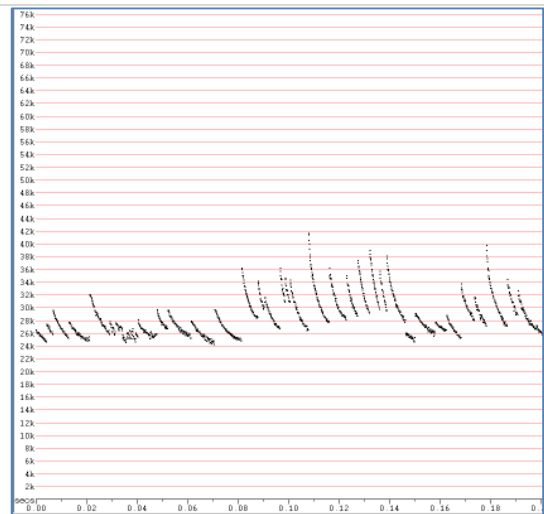


Setiostrois eleryi

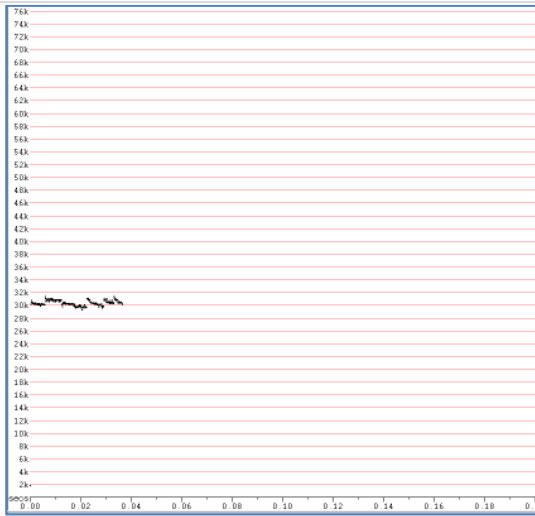
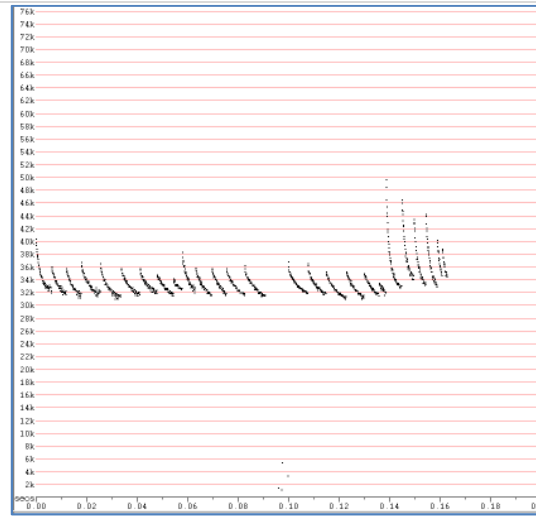
ZC and full-spectrum versions of same call, with 'typical' molossid feeding buzz clear on FS spectrogram



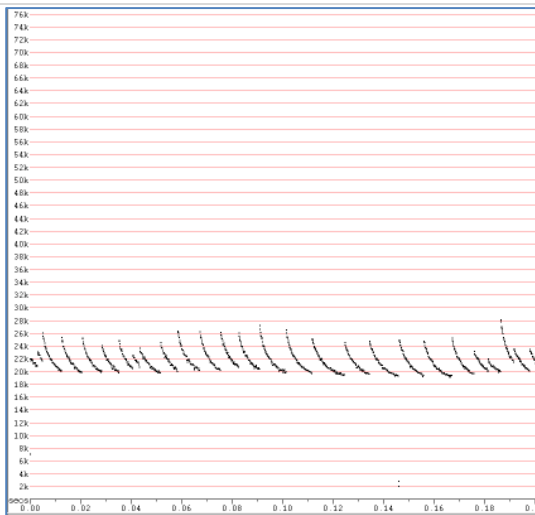
Chaerephon jobensis



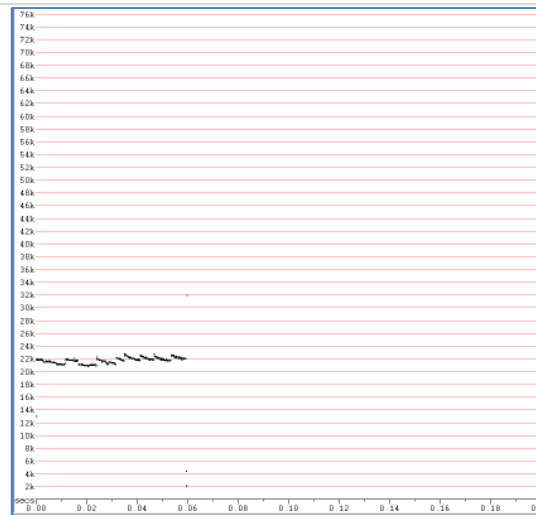
Ozimops lumsdenae



Possible *Ozimops petersi* / *O. halli* / *O. coburgianus*



Saccolaimus flaviventris



Taphozous georgianus / *T. troughtoni*