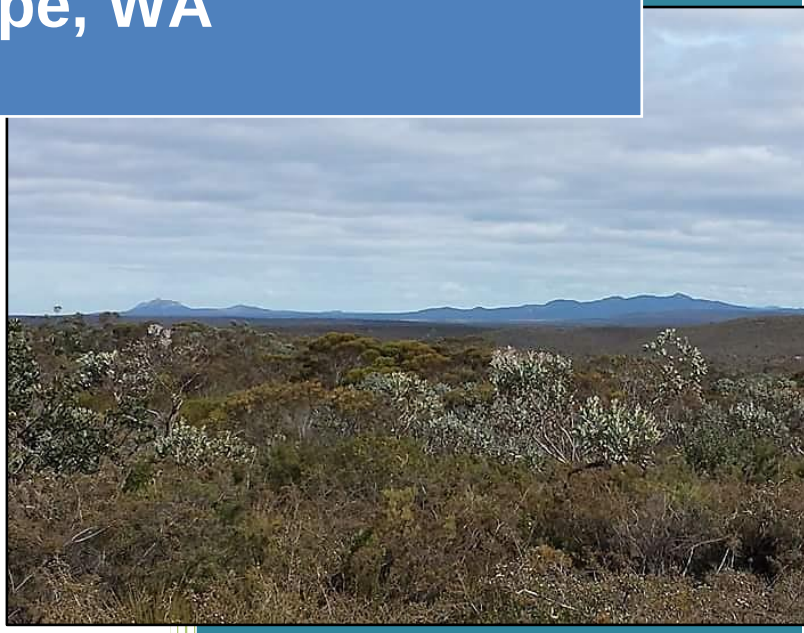
November 2018

RAVENSTHORPE GOLD PROJECT
Biological Survey

Ravensthorpe, WA



Prepared on behalf of ACH Minerals Pty Ltd by:

Animal Plant Mineral Pty Ltd

Kundip Mine Site:

M74/41, M74/51, M74/53, M74/135, M74/180, L74/34, L74/45

Completed by: Animal Plant Mineral Pty Ltd

ABN: 86 886 455 949

Tel: (08) 6296 5155

Fax: (08) 6296 5199

Address : 47 Caroline Retreat

Henley Brook, Western Australia 6055

Website: www.animalplantmineral.com.au

For further information on this report please contact:

Dr Mitchell Ladyman

Tel: 0437 307 008

Email: mitch@animalplantmineral.com.au

Disclaimer

In the preparation of this document, Animal Plant Mineral Pty Ltd (APM) has relied on data, plans and other information provided by ACH Minerals Pty Ltd. Except as otherwise stated in the Report, APM has not verified the accuracy or completeness of the information. APM will not be liable in relation to incorrect conclusions or recommendations should any data or information, be incorrect, misrepresented or otherwise not fully disclosed to APM. Within the limitations imposed by the commission, the assessment of the site and preparation of the report have been undertaken in accordance with generally accepted practices using a degree of care ordinarily exercised by professional Resource and Environmental Consultants. No other warranty expressed or implied is made.

EXECUTIVE SUMMARY

ACH Minerals Pty Ltd (ACH) proposes to develop the Ravensthorpe Gold Project (RGP) (the Project), located in the Fitzgerald subregion of the Esperance Interim Biogeographic region (IBRA) of Western Australia (WA), approximately 550 km southeast of Perth within the local government area of Ravensthorpe.

Animal Plant Mineral Pty Ltd (APM) was engaged by ACH to design and execute the requisite flora, vegetation, fauna and fauna habitat surveys of the Project area, to inform the referral of the RGP to the Office of the Environmental Protection Authority (**OEPA**), to enable the OEPA to determine if the Project requires formal assessment. Upon the determination that the RGP would be assessed as an Environmental Review Document, APM was commissioned to augment the survey work completed for the Referral. The guidance for the additional biological survey work came from comments received by the regulators on the Referral document.

This Biological Assessment Survey report is a synopsis of all biological survey work that has been undertaken for the RGP and for the same project area that was formerly known as the Phillips River Gold Project. Reporting on the flora and vegetation of the RGP focusses primarily on the work undertaken by APM with specific reference and comparison to the work of Craig *et al.* 2008 where appropriate locally, and reference to Markey *et al.* 2012 and Craig *et al*. 2008 where appropriate regionally. Reporting on the fauna and fauna habitat for the RGP is based on the consideration of all fauna data collected by Biota in 2003/4 and all fauna data collected by APM during 2016 and 2017.

Within the Kundip Mine Site there is longstanding legacy of mining practice stemming from the early 19th century to present day exploration projects. Subsequently, the vegetation within the 2016 and 2017 survey areas proposed to be impacted, reflects a mosaic of conditions from 'Completely Degraded' to 'Very Good' (Keighery 1994) or higher. One Weed of National Significance, the Bridal creeper **Asparagus asparagoides*, listed under the *Biosecurity and Agriculture Management Act 2007*, has been recorded within the Project area.

A total of 243 taxa (species, subspecies and varieties) belonging to 126 genera and 49 families were recorded within and adjacent to the 95 quadrats. The quadrats surveyed captured an average of 25, maximum of 48 and minimum of 4 species. The average richness recorded appears consistent with that detected by Markey *et al.* (2012). The compositional turnover (Whittaker's beta diversity; Whittaker 1965) was high at 0.83. The analysis of quadrats within vegetation units described by Craig *et al.* (2008) has allowed APM to update vegetation units within the Project area as Communities 1 through to 12.

Communities 2, 5, 7 and 9 (APM) were determined to be representative of the following conservation significant communities: 'Very Open Mallee over Melaleuca sp. Kundip Dense Heath' a Priority 1, Priority Ecological Community; and 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA' a Threatened Ecological Community (TEC/PEC). A small percentage of the vegetation consistent with the 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA' TEC will be cleared, and other parts lie adjacent to proposed disturbance areas. The proposed clearing is unlikely to have a significant residual impact on these communities, as any impacts will be temporary and reversible upon completion of mining.

The Department of Biodiversity Conservation and Attractions (DBCA) Threatened (Declared Rare) and Priority Flora Database, Threatened and Priority Flora List and the WA Herbarium Specimen Database found 11 Threatened flora and 63 Priority Flora species that could potentially occur within the Project area. PMST returned 11 botanical Matters of National Environmental Significance (MNES). Of these species 16 Priority flora have been previously recorded within the Project area according to the DBCA databases. APM's 2016 and 2017 surveys confirmed the presence of 7 Priority flora within the Project area including; *Calothamnus roseus, Hydrocotyle* sp. Decipiens, *Marianthus mollis, Melaleuca sophisma, Pultenaea craigiana, Stachystemon vinosus* and *Thysanotus parviflorus.* While some local populations will be directly impacted by the Project, the majority

of Priority flora populations occur outside of the proposed disturbance footprint. The RGP is unlikely to have a significant impact on the occurrence of these species in the Ravensthorpe Range.

Collectively, database searches indicate that a total of 297 fauna species are expected to occur within 10 km of the Project area: the total of 297 species comprise 133 birds, 27 mammals, 7 amphibians, 33 reptiles and 97 invertebrates. NatureMap lists records for 5 amphibians, 29 reptiles, 14 mammals and 69 birds. The Atlas of Living Australia lists records for 7 amphibians, 26 reptiles, 13 mammals, 77 birds and 94 invertebrates.

A search of the EPBC Act list of protected species and Threatened Ecological Communities considered to be MNES indicated 15 fauna species of conservation significance (comprising of 11 birds and 4 mammals) have the potential to occur in habitats that may be present within 10 km of the Project area. While the DBCA database search returned historical records of 34 Conservation Significant fauna (comprising of 20 birds, 11 mammals, 2 reptiles and 1 insect).

Three fauna habitats were identified as occurring within the Project area and include; 'Low Dense Forest / Forest', 'Damplands and Drainage Lines' and 'Low Woodland Mallee and Heath'. Fauna trapping and opportunistic collection recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians. Bat acoustic recordings undertaken in Biota (2004) and APM surveys returned acoustic signatures for 4 species.

Conservation significant fauna recorded during fauna surveys within the Project Area include the following:

- Birds – Carnaby's Black Cockatoo, Peregrine Falcon, Malleefowl, and Western Whipbird (Mallee).
- Mammals – Chuditch/Western Quoll, Quenda/Southern Brown Bandicoot and Western Brush Wallaby.
- Reptiles – Ravensthorpe Range Slider Skink.

It is unlikely that the RGP will have a significant impact on any of the above listed species, particularly given the occurrence of similar and undisturbed habitat immediately outside of the Project area and throughout the Ravensthorpe Range. Species such as the Peregrine Falcon and Carnaby's Cockatoo have a large foraging territory and APM has confirmed an absence of suitable natural breeding habitat within the Project area due to the lack of hollow-bearing trees and cliff recesses.

ACH are committed to supporting a Masters Research project for Chuditch and Malleefowl in conjunction with Edith Cowan University.

CONTENTS

APPENDICES

FIGURES

TABLES

PLATES

ABBREVIATIONS

Symbols and Units	Meaning
%	Percentage
*	Introduced plant species
DBH	Diameter at Base Height
°C	Degrees Celsius
ha	Hectare
km	Kilometre
m	Metre
mm	Millimetre

Abbreviation	Meaning
ACH	ACH Minerals Pty Ltd
ANZECC	Australian and New Zealand Environment Conservation Council
AoLA	Atlas of Living Australia
APM	Animal Plant Mineral Pty Ltd
BAM Act	*Biosecurity and Agriculture Management Act 2007* (WA)
Biota	Biota Environmental Sciences Pty Ltd
BoM	Bureau of Meteorology
CAMBA	China and Australian Migratory Bird Agreement 1986
Cth	Commonwealth
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DPaW	Department of Parks and Wildlife
DoE	Department of Environment
DoEE	Department of the Environment and Energy
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FRNP	Fitzgerald River National Park
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
JAMBA	Japan and Australian Migratory Bird Agreement 1974
L	Miscellaneous tenement
M	Mining tenement
MNES	Matters of National Environmental Significance
MS	Ministerial Statement
OEPA	Office of the Environmental Protection Authority
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
PRP	Phillips River Project
RGP	Ravensthorpe Gold Project
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement 2007
sp.	Species (Unspecified)
spp.	Multiple species (Unspecified)
subsp.	Sub-species
SRNP	Stirling Range National Park
TEC	Threatened Ecological Community
var.	Variety
WA	Western Australia

WC Act	*Wildlife Conservation Act 1950* (WA)
WONS	Weeds of National Significance

1 INTRODUCTION

1.1 PROJECT AND LOCATION

ACH Minerals Pty Ltd (**ACH**) proposes to develop the Ravensthorpe Gold Project (RGP) (the Project), located in the Fitzgerald subregion of the Esperance Interim Biogeographic region (IBRA) of Western Australia (WA), approximately 550 km southeast of Perth and 17 km southeast of the town of Ravensthorpe (Figure 1-1).

ACH purchased the Project from Silver Lake Resources Ltd (**Silver Lake**) on 15 July 2016, with settlement occurring in August 2016. Originally titled the Phillips River Project (**PRP**), the Project was referred to the Environmental Protection Authority of Western Australia (**EPA**) and the Commonwealth Department of Environment and Energy (**DoEE**) in 2005. The DoEE determined the PRP to be "Not a Controlled Action". The State Minister for the Environment approved the PRP in 2006 (by Ministerial Statement 716), with approval lapsing in 2011 after the proponents failed to make a substantive commencement on the Project and declined to request an extension to the approval. As a consequence, the Project was referred by new proponents ACH (the **Proponent**) to the EPA on 13 December 2016 for consideration.

The RGP will comprise the Kundip Mine Site (Figure 1-1). The site has a long history of mining, containing both native vegetation and historic mining legacies (see Plates 1 to 3). Both sites are accessible from the Hopetoun-Ravensthorpe Road.

Plate 1: The old Kundip battery

Plate 2: Unstable shafts in the Kundip mining area

Plate 3: Abandoned building in the Kundip mining area

170000 180000 190000 200000 210000 220000 230000 240000 250000 260000

6340000 6320000 6300000 6280000 6260000 6240000

Kununurra
Derby
Broome
Halls Creek
Fitzroy Crossing
Port Hedland
Marble Bar
Onslow
Exmouth
Tom Price
Newman
Paraburdoo
Carnarvon
Giles
Denham
Yulara
Meekatharra
Kalbarri
Leinster
Geraldton
Leonora
Morawa
Laverton
Moora
Kalgoorlie
Forrest
Merredin
Wanneroo
Perth
Madura
Eucla
Norseman
Caiguna
Border Village
Bunbury
Collie
Lake Grace
Esperance
Busselton
Augusta
Albany
Manjimup

Overshot Hill Nature Reserve

RAVENSTHORPE

Ravensthorpe Gold Project Area

Kundip Nature Reserve

Fitzgerald River National Park

HOPETOUN

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM2017GIS\ACH\02_GIS Maps\20180925_ACH026_ERD_RegionalLocation_Figure 2-2.mxd

Figure 1-1: Regional Location of the Ravensthorpe Gold Project

LEGEND

- Ravensthorpe Gold Project Area
- Nature Reserves
- Ravensthorpe Shire Boundary
- Major Roads

N

0 10 20

Kilometers

Date: 25/09/2018

Scale: 1:350,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

The expected life of mine (**LOM**) at Kundip is approximately 8 years and includes the following elements:

- Open pit mining of the Kaolin, Harbour View and Flag deposits and subsequent underground mining of the Harbour View and Flag deposits;
- Construction and operation of mineral processing facilities;
- Construction of a Tailings Storage Facility (**TSF**);
- Construction of water storage facilities and surface water diversion structures;
- Construction of two waste rock landforms (**WRL**) and a run of mine (**ROM**) pad;
- Construction of an access road from Hopetoun – Ravensthorpe Road to Kundip Mine Site and various internal roads within the site; and
- Construction of ancillary support infrastructure (e.g. offices, workshops, ablutionary facilities).

The Mine Site contains a Disturbance Footprint of 244.7 ha within a 428.4 ha Development Envelope (Table 1-1, Figure 1-2). Historic disturbance has led to the condition of 70.9 ha of vegetation in the site to be classified as 'Completely Degraded' (Keighery, 1994). There is 49.3 ha of existing disturbance in the Project area.

Table 1-1: Disturbance at the Ravensthorpe Gold Project

Mine Site	Proposed Development Envelope (ha)	Proposed Disturbance Footprint (ha)	Existing Disturbance (ha)
Kundip	428.4	244.7	49.3

The Project is a revision of the previously approved PRP. Since Ministerial Approval was received for the PRP in March 2006, a number of changes have occurred that directly and indirectly impact the Project resulting in key differences between the PRP and this proposal. Of most significance, the PRP contemplated trucking Kundip ore to the RAV8 Nickel Project (**RAV8**) for treatment in a pre-existing processing facility. RAV8 ceased production in 2007 and the site has largely been rehabilitated. In this revised proposal processing will be undertaken at the Kundip Mine Site, removing the requirement for a 17 km haul road to traverse a proposed Nature Reserve to the east and adjacent to the Project. As processing will occur on-site it will be a requirement to construct a TSF at the Kundip Mine Site. In all other respects, the basic elements of the Kundip Mine Site are unchanged from what was approved in 2006, being open pit and underground mines, WRLs and associated surface infrastructure.

Myamba Mine Site has been removed from the Project. This removes the requirement to truck ore between Myamba Mine Site and Kundip Mine Site for processing. No disturbance will occur at Myamba Mine Site, there will be no impacts to ground water and there will be no requirement to construct a power-water corridor within a road reserve immediately adjacent to the Kundip Nature Reserve. Myamba Mine Site was previously approved in 2006 as part of the PRP.

This document reports on the biological attributes of the Project area that may be influenced by the development of the RGP.

Mine Activity	Disturbance (ha)
Offices	3.2
Site Support	5.7
Magazine	0.7
Mine Pit (Kaolin)	40.3
Mine Pit (Harbour View)	11.1
Mine Pit (Flag East)	6.4
Mine Pit (Flag West)	8.9
Waste Rock Landform (North)	39.4
Waste Rock Landform (South)	46.7
Topsoil Stockpiles	19.5
Processing Plant Area	3.0
Run-of-Mine	4.1
Tailings Storage Facility	29.3
Site Access Roads	18.3
Water Storage Facility	7.0
Water Transfer Facility	1.2
TOTAL (ha)	**244.7**

239000 240000 241000 242000

6272000 6271000 6270000 6269000

P 74/374-S M 74/63 DBCA Fire Break E 74/311 E 74/486 M 74/53 M 74/180 M 74/41 M 74/135 E 74/382 L 74/34 M 74/51 E 74/605 L 74/45 E 74/391 E 74/413

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM Client\APM2017GIS\ACH\02_GIS Maps\20181012_ACH026_ERD_RGPLayout_Figure 2-3.mxd

Figure 1-2: Ravensthorpe Gold Project Disturbance Footprint

LEGEND

RGP Mine Activities
- Offices
- Site Support
- Magazine
- Mine Pit (Kaolin)
- Mine Pit (Harbour View)
- Mine Pit (Flag East)
- Mine Pit (Flag West)
- Waste Rock Landform (North)
- Waste Rock Landform (South)
- Topsoil Stockpile
- Topsoil Stockpile (DBCA Fire Break)
- Processing Plant Area
- Run-of-Mine
- Tailings Storage Facility
- Roads
- Water Storage Facility
- Water Transfer Facility
- RGP Development Envelope
- Ravensthorpe Gold Project Area
- Mining Tenements
- Major Roads

N

0 100 200 300 400 500

Meters

Date: 12/10/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

1.2 SCOPE OF WORK

Animal Plant Mineral Pty Ltd **(APM)** was engaged by ACH to design and execute the requisite flora, vegetation, fauna and fauna habitat surveys to inform the referral to the Office of the Environmental Protection Authority **(OEPA)** to enable the OEPA to determine if the Project requires formal assessment. The methodology for the biological survey was determined by an assessment of the proposed and current disturbance, the location of the site and the context of the proposed development relative to the surrounding land use, and the previous biological survey work that had been undertake as part of a previous environmental assessment process. The survey scope was then discussed in liaison with the OEPA and the Department of Biodiversity Conservation and Attractions **(DBCA).**

Upon the determination that the RGP would be assessed as an Environmental Review Document, APM was commissioned to augment the survey work completed for the Referral. The guidance for the additional biological survey work came from comments received by the regulators on the Referral document.

Generally, the scope included an on-ground assessment of the Kundip Mine Site and included the then power and water corridor adjacent to the Kundip Nature Reserve. It also included a reconnaissance and desktop assessment for the cleared pastoral land that was initially the proposed Myamba Mine Site, which has since been removed from the Project layout (Figure 1-2).

This Biological Assessment Survey report is a synopsis of all biological survey work that has been undertaken for the RGP and PRP, as relevant.

Reporting on the flora and vegetation of the RGP focusses primarily on the work undertaken by APM in 2016 through to 2018, with specific reference and comparison to the work of Craig *et al.* (2008) where appropriate locally and regionally, and reference to Markey *et al.* (2012) where appropriate regionally.

Reporting on the fauna and fauna habitat for the RGP is based on the consideration of all fauna data collected by Biota in 2003/4 and all fauna data collected by APM during 2016 and 2017.

1.2.1 Flora and Vegetation

1. APM undertook a Reconnaissance level survey in August 2016 within the Project Area. The survey was aimed at gathering broad information about the Project Area. To achieve this aim vegetation mapping (Craig *et al.* 2008) was ground-truthed, the extent of current disturbances quantified, a targeted flora survey was commenced, and opportunistic flora sampling conducted;
2. In May 2017, a targeted search for the Priority Ecological Community (PEC) '*Heath on Komatiite of the Ravensthorpe Range Area*' was undertaken. An initial desktop investigation of finer scale geological units (1:100 000) revealed that the 'komatiite' geology type did not occur in the RGP sites within the Project area. Nevertheless, an on-ground survey (21 person days active in the field) was undertaken where all possible geology types (and their associated vegetation) were searched for the presence of indicator species;
3. In July 2017 a flora and vegetation field survey comprising 21 person days active in the field was undertaken focussing on the collection of flora samples from quadrats representative of all vegetation types. The work was to enable the confirmation of the presence/absence of the Threatened Ecological Community (TEC) '*Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA*'. This survey also marked the commencement of broader vegetation sampling to refine the mapping boundaries of the existing vegetation map of the Ravensthorpe Range (Craig *et al.* 2008);

4. In October 2017, a spring flora and vegetation survey comprising 14 person days active in the field was undertaken comprising a grid search of the proposed Disturbance Footprint to determine the presence/absence of species of conservation significance that were difficult to detect at other times of the year. This survey also included the continuation of broader vegetation sampling to refine the mapping boundaries of the existing vegetation map of the Ravensthorpe Range (Craig *et al.* 2008). In addition, a targeted Priority flora search (2 person days active in the field) along the proposed drill lines at the Ard Patrick exploration lease just north of the Project Area was undertaken for a Vegetation Clearing Permit application **(VCP)**;
5. During all of the above-mentioned surveys, opportunistic observations of the patterns and identity of weed species occurring on the Project were collected;
6. In August 2018 a targeted survey for proteaceous and myrtaceous flora and the Priority *Hydrocotyle* sp. Decipiens was undertaken within the rehabilitated RAV8 site and the disturbed low-grade stockpiles at Kundip; and
7. In September 2018, a reconnaissance survey was undertaken (3 person days active in the field) to support a VCP application at the Welcome Stranger exploration lease.

This biological assessment survey report does not cover Phytophthora Dieback, which has been historically established through numerous surveys (Glevan, 2006, NRG Consultancy (2010) and Terratree, 2012) of the Project Area.

1.2.2 Terrestrial Fauna

A summary of the work undertaken to address specific impacts to terrestrial fauna is provided:

1. The 2016 Spring Fauna Surveys (August and September) targeted Conservation Significant fauna with a high likelihood of occurrence in the area based on the suitability of habitat present and previous historical species records (Biota 2004, 2005). The targeted survey utilised aluminium box traps, cage traps, pit traps, funnel traps, turtle traps and camera traps and acoustic recording devices. All opportunistic observations of other species were recorded.

2. In July 2017 a second targeted fauna survey (14 person days active in the field and more than 500 trapping nights) was undertaken to more confidently determine the presence/absence of the Heath Mouse (*Pseudomys shortridgei*), across the RGP following a possible record of one individual on the north-eastern boundary of the Project area. Other data collection that took place during this survey included:
   - 70 cage trapping nights targeting the Chuditch (*Dasyurus geoffroii*) following the recording of one individual on a motion sensitive camera during the fauna survey of 2016.
   - Call playback for the Western Whipbird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*) to augment records collected during the 2004 biological survey work for the PRP.

3. In October 2017 a third targeted survey, comprising 10 person days active in the field and more than 400 trapping nights was initiated to:
   - Resolve the absence of the Heath Mouse in the RGP;
   - Contribute to records of the Chuditch in the RGP; and
   - Detect the presence of Western Whip Bird (*Psophodes nigrogularis* subsp. *oberon*), the Western Bristlebird (*Dasyornis longirostris*) and Western Ground Parrot (*Pezoporus flaviventris*) comprising call play back and acoustic monitoring pre-dawn and post-dusk.

This survey comprised over 400 aluminium box trap nights, 40 cage trap nights, 8 predawn and 8 post-dusk, one-hour acoustic survey sessions.

During this survey further attempts were made to find trees suitable for Carnaby's Black-Cockatoo. 4 trees of suitable Diameter at Base Height (DBH) were identified, none of which contained hollows. GPS records and measurements of these trees were recorded (refer to section 3.3.3).

The mention of the Dibbler (EN) (*Parantechinus apicalis*) in the methodology section of the original biological survey led to it being included in the list of targeted fauna for additional work. However, this species was not recorded in the original survey (verified by Tony Start from DBCA), and therefore no further investigation of the Dibbler was undertaken.

2 BACKGROUND AND SUPPORTING INFORMATION

2.1 RELEVANT LEGISLATION

Species considered to be of National conservation significance are protected under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Under this Act, activities that may have a significant impact on a species of National conservation significance must be referred to the Department of Environment (DoE) for assessment. In WA, all native flora and fauna species are protected under the *Wildlife Conservation Act* 1950 (WC Act). Flora species that are considered likely to become Rare, Threatened with extinction or are presumed to be Extinct are specially protected by four schedules in the WC Act. Fauna are protected by seven schedules in the WC Act which accommodate all fauna species in need of special protection, that are rare (likely to become extinct) or that are presumed extinct, as well as birds subject to International Agreements relating to the protection of migratory birds. The Department of Biodiversity Conservation and Attractions (DBCA) classifies specially protected flora and fauna into eight categories as listed in Appendix 1. The lists also include potentially threatened species that do not meet survey criteria or are otherwise data deficient, these species are listed as Priority 1, 2 or 3. While species that are adequately known, are rare but not threatened, are listed as Priority 4.

Some species are protected under the *Australian and New Zealand Environment Conservation Council* (ANZECC, 1991) Convention (Cth). Migratory birds are further protected under the following agreements:

- 1974 Japan and Australian Migratory Bird Agreement (JAMBA) (Cth);
- 1975 RAMSAR Convention on Wetlands;
- 1983 Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention);
- 1986 China and Australian Migratory Bird Agreement (CAMBA) (Cth);
- 2004 Agreement on the Conservation of Albatrosses and Petrels (ACAP);
- 2007 Republic of Korea-Australian Migratory Bird Agreement (ROKAMBA); and
- 2006 East Asian - Australasian Flyway Partnership.

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as Matters of National Environmental Significance (MNES) under the EPBC Act.

2.2 LAND USE

The Project lies within the Shire of Ravensthorpe. Historical and current land use activities within the Shire of Ravensthorpe are pastoralism focused towards grazing and cereal crop cultivation. Some conservation areas are present along with unallocated crown land, crown reserves and forestry plantations (Comer *et al.,* 2003).

2.3 CLIMATE

The RGP is in the Goldfields-Esperance region of WA which experiences a Mediterranean-type climate characterised by mild summers and cool wet winters.

The nearest Bureau of Meteorology (BoM) weather station is at Ravensthorpe (BoM Site Number: 010633), less than 5 km north of the Kundip mine site. The Ravensthorpe station has been recording rainfall and

temperature since 1901. Average monthly and annual rainfall, temperature and evaporation is presented in Table 2-1.

Table 2-1: Rainfall and Temperature Averages for Ravensthorpe Weather Station (BoM, 2017a). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Mean Rainfall (mm)	24.8	26.5	32.8	32.8	44.1	43.6	47.3	45.1	42.3	38.0	30.5	24.1	427.2
Mean Max Temp (°C)	29.0	28.3	26.6	23.7	20.0	17.3	16.3	17.3	19.5	22.5	25.1	27.2	22.8
Mean Min Temp (°C)	14.1	14.6	13.6	11.8	9.6	7.9	6.7	6.7	7.4	9.1	11.1	12.8	10.5

Recorded data suggests that the Project area receives 427 mm of rain on an annual basis and experiences temperatures ranging between 2.2°C and 40.8°C (the lowest and highest monthly averages recorded) (BoM, 2017a). January is the hottest month with a mean maximum temperature of 29.0°C and mean minimum of 14.1°C. July is the coolest month with a mean maximum temperature of 16.3°C and mean minimum of 6.7°C (BoM, 2017a) (Table 2-1). Figure 2-1 illustrates the Project area is subject to climate typical of the region, with mild summers and wet winters. These observations are consistent with the description attributed to Ravensthorpe under the *Regional Development Commissions Act 1993* (see Mediterranean climate in Goldfields-Esperance region), IBRA regionalisation (see Mediterranean climate in the ESP01 subregion, DoE 2017).

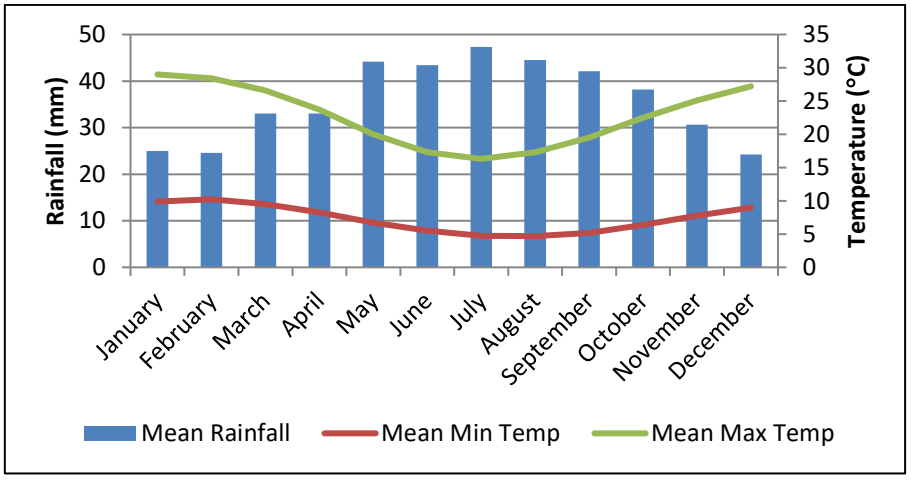


Figure 2-1: Ravensthorpe Weather Station Meteorological Data (BoM, 2017). Data is gained from BoM Site Number 010633, with rainfall data from 117 years and temperature data from 56 years.

2.4 BIOGEOGRAPHIC REGIONALISATION

The IBRA (version 7.1; DoE 2017) classifies the Australian continent into regions (bioregions) of similar geology, landform, vegetation, fauna and climate characteristics (Thackway and Cresswell, 1995). The mapping completed by Beard in 1975 provides the basis for the IBRA bioregions. IBRA mapping (Version 7.1; DoE 2017), places the Project within the Esperance Plains Bioregion.

The Esperance Plains Bioregion is characterised by a plain broken by quartzite ranges and granite domes/ outcrops. These inselbergs provide habitat diversity and unique microclimates compared to regional conditions, supporting a high species diversity and level of endemism (Hopper *et al.* 1997; Keppel *et al.* 2016). Dominant vegetation of the region is predominantly proteaceous scrub and mallee heaths on sandplain. Other vegetation types include herbfields and heaths, which are rich in endemics. Eucalypt woodlands also occur in gullies and foot-slopes (Thackway and Cresswell, 1995).

The Esperance Plains Bioregion is further subdivided into the Fitzgerald (ESP01) and Recherche (ESP02) sub-regions. The Project lies entirely within the Fitzgerald (ESP01) sub-region. Topography of the Fitzgerald subregion is variable, ranging from sandplains on the coast to granite and quartzite ranges on both the coastal plain and inland (Comer *et al.*, 2003). Soils are predominantly duplex, deep and yellow sands on the plains with shallow sandy soils on mountain ranges (Comer *et al.*, 2003). Herein, the vegetation is presumed diverse (species and endemic-rich), with *Eucalyptus* the most prevalent genera. The most prominent vegetation types include coastal dune woodlands, coastal shrublands and heathlands, mallee shrubland and heath. Herbfields and heaths can be found on granite tors, quartzite ranges and greenstone heath and shrublands (Comer *et al.*, 2003).

2.4.1 Land Systems

The land system approach to the management of rangelands results from the identification of recurring patterns of topography, soil and vegetation and involves their use in land use and catchment planning. The Project area falls into an area which has not been surveyed in the context of land systems. For this reason, information for this report is limited to IBRA and soil-landscape characterisation.

Soil-landscape mapping delineates repeating patterns of soils and landscapes across WA's rangelands and arid interior (Tille, 2006). Mapping completed by the Department of Agriculture places the Project within the Ravensthorpe Zone of the Stirling Province (Government of Western Australia, 2016). The Stirling Province is broadly described as a gently undulating plain in the northeast, occasionally broken by small valleys, low narrow rocky hills and ridges, and granitic tors and bosses. In the northwest a gently undulating plain occurs, dissected by short rivers. In the western half of the Stirling Province, hills and ranges are noticeable features (Tille, 2006).

Soils of the Ravensthorpe Range are mostly shallow gravels and red/brown non-cracking clays (Tille, 2006). Witt's (1997) 1: 100 000 geological series places the Project area between two major geological units, including; the Ravensthorpe Terrene spanning the northern section, and to the south the Mount Barren Group. For detailed breakdown of the corresponding geological formations see Table 2-2 and Appendix 2. The Ravensthorpe Zone itself is characterised as rolling low hills on greenstone (mafic and ultramafic). South-flowing rivers moderately dissect the zone and soils are red fine-textured (Government of Western Australia, 2016).

Vegetation in the Stirling Province is highly complex, however can be summarised broadly as a transitional vegetation type dominated by open mallee scrub and woodlands in the northeast, to mallee scrub and salmon gum-yate woodlands on the Ravensthorpe Range (Tille, 2006). Accompanying these Myrtaceous mosaics is a presumed rich and highly endemic 'kwonganoid' vegetation type characterised by proteiod scrub patches.

Table 2-2: Geological units intersecting with the Project area at a resolution of 1:100 000 (Witt 1997).

Geological code	Description
AAv	Mafic to intermediate tuff and agglomerate, and related epiclastic rocks (mainly andesite), subordinate dactite; metamorphosed.
ACc	Chert; metamorphosed
Czf	Ferruginous deposits—undifferentiated; mainly ferruginous quartz sand and granules, and angular rock fragments with ferruginous cement
Czi	Sand with limonitic pisoliths and gravel
Czl	Lateritic deposits—laterite, ferruginous duricrust, and ferricrete; massive
Czsr	Undulating sandplain, Reworked Czs; sandplain deposit—unconsolidated sand; remnants of peneplain.
PLBk	Kundip quartzite; quartzite, massive to coarsely bedded; minor peltic rocks.
PLBsc	Dolomite; metamorphosed; massive to finley bedded; locally ?stromatolitic.
PLBy	Pelitic schist and phyllite with minor psammitic layers
Qa	Quaternary alluvium
Qcb	Colluvium—rubble of boulders and sand derived from MOUNT BARREN GROUP; minor outcrops of MOUNT BARREN GROUP
TPp	White to yellow to brown siltstone, silty sandstone, and spongolite; mainly deeply weathered.

2.4.2 Surface Water

The Kundip mine site is characterised by moderate slopes of 5 - 10%. Landscape elevation is highest in the north-eastern corner of the site at 228 m Average Heights Datum (AHD), falling to 127 m AHD in the south-western corner. Surface drainage in the region trends north to south from the Ravensthorpe Range towards the Southern Ocean. The main drainage channels in the Kundip area are the Phillips River, Steere River and Jerdacuttup River. Stream channels within the Kundip mine site are moderately spaced forming an integrated network of convergent creeks. The divide between the Steere River sub-catchments and Jerdacuttup River catchment to the east varies in elevation from 232 at the divide to 80 m AHD at the river. The primary channel of the Steere River falls from 145 to 117 m AHD over a 2.75 km north-to-south stretch adjacent the western extent of the site.

2.4.3 Wetlands

The Project Area does not include and is not near any wetlands listed as Ramsar sites (Landgate, 2016). Towards the western boundary of the Project there are patches of habitat dominated by myrtaceous species strongly associated with natural drainage lines.

2.4.4 Previous Surveys

The Phillips River Gold Project (PRP) was referred to the Federal Department of Environment (DoE) for assessment in 2005 where it was determined to be “Not a Controlled Action”.

The PRP was also assessed based on proponent information by the EPA in 2006. Following the recommendations of the EPA, the Minister for Environment approved the project (Ministerial Statement (MS) 0716). This approval is no longer valid due to the time that has elapsed without substantial commencement on the Project.

Survey work was done to underpin the environmental approvals at the time of assessment. The Kundip site specific vegetation survey work done by G.F Craig in 2004 and local vegetation mapping completed for the Ravensthorpe Ranges by the South Coast Natural Resource Management Group provides a wealth of background information to give context to the 2016 flora survey work. In 2004 a fauna survey consultant (Biota Environmental Sciences) executed a comprehensive baseline biological assessment over two seasons. The first survey was done at a sub-optimal time of the year, but the second survey was done in ideal conditions in spring (Biota 2004). This work provides a valuable baseline for the 2016 fauna survey work and the data are included herein as capture records for the Project.

A summary of biological surveys previously undertaken within the Project Area and regionally, are provided in Table 2-3 and these data have been used to guide 2016-2018 biological survey methodology.

Table 2-3: Existing Flora and Fauna Surveys and Investigations of the Ravensthorpe Gold Project and Surrounds

Report Title	Consultant	Year	Scale	Survey Type	Purpose
Flora and Vegetation					
Kundip Mining Leases M74/41, 51, 53, & 135 and P74/153 – Vegetation and Flora Survey.	G.F Craig	2004	Local	Declared Rare, Priority Flora and Vegetation Mapping Survey.	Kundip mining leases M74/41, 51, 53 & 135 and P74/153. Delineate vegetation community boundaries.
Kundip Mining Leases – Pultenaea and Melaleuca.	G.F Craig	2004	Local	Targeted Declared Rare Flora Survey.	Declared Rare and Priority Flora listed Pultenaea sp. Kundip and Melaleuca sp. Kundip. Estimation of population density confirming P1 status.
Kundip Haul Road – Declared Rare and Priority Flora Survey.	G.F Craig	2004	Local	Declared Rare and Priority Flora Survey.	Proposed haul road between Kundip and the RAV8 mine sites.
Kundip Mining Leases – Waste Dumps and Haul Road – Declared Rare and Priority Flora Surveys.	G.F Craig	2005	Local	Declared Rare and Priority Flora Survey.	Northern and Southern Waste Dumps and Haul Road. Add to known taxa records and estimate potential disturbance of mine design.
Kundip Mining Leases Monitoring Quadrat Survey	E. Hickman	2007	Local	Vegetation Mapping Survey.	Collect baseline data for the monitoring of potential impacts of mining activities on the vegetation communities within the mining leases at Kundip.
Vegetation of the Ravensthorpe Range: Mt Short to South Coast Highway.	Craig et al.	2007	Regional	Vegetation Mapping Survey.	Ravensthorpe Range between Mt Short and South Coast Highway. Pilot study, mapping the entirety of the Range's vegetation and delineate community boundaries undertaken for the Biodiversity Inventory Program of South Coast NRM.
Vegetation of the Ravensthorpe Range, Western Australia: Mt Short to Kundip, 1: 10,000 scale	Craig et al.	2008	Regional	Vegetation Mapping Survey.	Ravensthorpe Range between Mt Short and Kundip. Determining extent and occurrence of representative vegetation units to support conservation and land use planning.
Power and Water Easement, Trilogy to Kundip Mine Site. Declared Rare and Priority Flora Survey	E. Hickman	2008	Local	Declared Rare and Priority Flora Survey.	Clearing Permit and Permit to Take for construction of power and water easement between the Trilogy mine site and the Kundip mine site.
Floristic Survey of the Ravensthorpe Range 2007	Kern et al.	2008	Regional	Vegetation Mapping Survey.	Document conservation values and assess regional context in the Ravensthorpe Range for future proposed developments. Commissioned by Department of Environment and

Report Title	Consultant	Year	Scale	Survey Type	Purpose
					Conservation (DEC).
Kundip Mining Leases Additional Monitoring Quadrat Survey	E. Hickman	2009	Local	Declared Rare and Priority Flora Survey.	Additional survey areas from 2008 survey. Impact Assessment for the Kundip Mining Leases.
Targeted and Regional Survey for Melaleuca sp. Kundip and Melaleuca stramentosa.	N. McQuoid	2009	Regional	Targeted Priority Flora Survey.	Estimate distribution patterns and population estimates for Melaleuca sp. Kundip and Melaleuca stramentosa for revisal of conservation status.
Survey for Declared Rare and Priority Flora, and Exotic Weeds of Proposed Drill Grids at the Lonestar and the Gift Prospects, Kundip Mining Centre.	N. McQuoid	2009	Local	Declared Rare and Priority Flora survey and Weed Survey.	To meet approval for test drilling along grid lines within Lonestar and Gift prospects of the Kundip leases.
Survey for Dieback Disease caused by Phytophthora cinnamomi on Mining Leases within the Southern Ravensthorpe Range known as the Kundip Mining Centre Spring 2010 for Tectonic Resources N.L.	NRG Consultancy	2011	Local	Phytophthora Dieback Assessment.	Determine Dieback status (mapping areas of absense and those uninterpretable) in the Kundip Mining Centre and assessing potential impact from mining development.
Floristic communities of the Ravensthorpe Range, Western Australia.	Markey et al.	2012	Regional	Vegetation Mapping Survey.	Provide regional context with consistency and repeatability for proposed developments in the Ravensthorpe Range.
Kundip Mining Centre and Proposed Kundip – RAV8 Haul Road. Phytophthora Dieback Assessment.	Terratree Pty Ltd	2012	Local	Phytophthora Dieback Assessment.	Determine Dieback status (mapping areas of absense and those uninterpretable) Kundip Mining Centre and proposed Kundip to RAV8 haul road assessing potential impact from mining development.
Level 1 Flora Assessment of the Kundip Exploration Leases – Targeted Search of Tenements P74/352, 349, 350, 351, E74/537, E74/311, P74/290, E74/486, P74/259 and E74/392	MWH Global	2013	Local	Level 1 Flora Survey.	Assessing prospecting and exploration leases at the Kundip Mining Centre as part of approvals process.
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2016	Local	Vegetation Mapping and Declared Rare and Priority Flora Survey.	Reassess and remap (where required) the vegetation boundaries identified by the South Coast Natural Resource Management Group.

Report Title	Consultant	Year	Scale	Survey Type	Purpose
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2017	Local	Level 1 Targeted Threatened and Priority Flora Survey.	Declared Rare Flora and Priority Flora search across the Project Disturbance Footprint as part of approvals process.
Targeted Survey for Declared conservation significant Flora and Ecological Communities to Support Exploration Drilling within the Ravensthorpe Copper / Gold Project Area	APM	2017	Local	Targeted Threatened and Priority Flora and Ecological Communities.	Monitoring existing disturbance areas and searching in new disturbance areas.
Ravensthorpe Gold Project Biological Survey, Ravensthorpe, WA.	APM	2018	Local	Targeted Flora Survey.	Early August survey for *Hydrocotyle* sp. Decipiens and proteaceous and myrtaceous species within rehabilitated RAV8 and disturbed low-grade stockpiles at Kundip. September survey to support Welcome Stranger exploration lease and Vegetation Clearing Permit.
Fauna					
Fauna and Fauna Assemblages of the Kundip and Trilogy Study Sites.	Biota Environmental Sciences Pty Ltd	2004	Local	Level 2 Fauna Survey: Detailed Survey	Phase 1 of a two phase (two seasons) baseline survey as per EAG56 to assess the potential for impacts from the Phillips River Project.
Kundip Phase II Fauna Survey – Summary of Findings.	Biota Environmental Sciences Pty Ltd	2004	Local	Level 2 Fauna Survey: Detailed Survey	Phase II of the two phase (two season) baseline survey as per EAG56 to assess the potential for impacts from the Phillips River Project.
Subterranean fauna desktop risk assessment.	Outback Ecology	2010	Local	Level 1 Fauna Survey: Desktop Study	Desktop assessment of the risk to subterranean fauna from the Phillips River Project.
Gem Restored Flora and Fauna Reconnaissance Survey	Outback Ecology	2013	Local	Level 1 Fauna Survey: Reconnaissance Survey	Priority 1 "Gem Restored" survey to determine types of significant fauna and fauna habitat present in the area.
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2016 (August)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Spring survey targeting fauna of conservation significance previously recorded or highly likely to occur within the Project Area based on the baseline survey work undertaken by Biota in 2004 to assess presence and estimate likely impact.

Report Title	Consultant	Year	Scale	Survey Type	Purpose
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2016 (September)	Local	Level 2 Fauna Survey: Detailed Survey	Spring survey targeting fauna of conservation significance previously recorded or highly likely to occur within the Project Area based on the baseline survey work undertaken by Biota in 2004 to assess presence and estimate likely impact.
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2017 (June)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Targeted survey focussed primarily on assessing the presence/absence of Heath Mouse (*Pseudomys shortridgei*), Malleefowl (*Leipoa ocellata*), Chuditch (*Dasyurus geoffroii*), Western Whip Bird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*) and Western Bristlebird (*Dasyornis longirostris*).
Ravensthorpe Gold Project (Kundip and Myamba Mine Sites) Level 1 Biological Assessment.	APM	2017 (October)	Local	Level 1 Fauna Survey: Reconnaissance Survey	Targeted survey focussed primarily on assessing the presence/absence of Heath Mouse (*Pseudomys shortridgei*), Malleefowl (*Leipoa ocellata*), Chuditch (*Dasyurus geoffroii*), Western Whip Bird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*), Western Bristlebird (*Dasyornis longirostris*) and Western Ground Parrot (*Pezoporus flaviventris*). Site wide assessment to locate trees of a suitable diameter and/or containing hollows suitable for significant Black Cockatoo breeding.

3 METHODOLOGY

3.1 CONTRIBUTING AUTHORS

The Project survey scope was designed by APM Principal Biologist Dr Mitch Ladyman. The flora and vegetation survey was refined and executed by APM Botanist, James Tsakalos, with field assistance by environmental biologists Loren Kavanagh, Sarah Isbister and Crystal Heydenrych, Graduate Biologist Sarah Flemington and Taxonomist Shibi Ullas Chandran. The field fauna survey work was executed by Dr Mitch Ladyman and assisted by Sarah Flemington and Joshua Keen.

Data captured by Biota Environmental Sciences Pty Ltd (Biota) in May and November 2004 are incorporated into the results of this report. Those data are the property of ACH Minerals and can be utilised herein. Credit is given to Roy Teale and the team at Biota who undertook the field surveys and collected the data. The Biota reports are provided in Appendix 3 and Appendix 4.

3.2 DATABASE SEARCHES

A search of the EPBC listed protected species was undertaken using the Protected Matters Search Tool (PMST) (DoE, 2016) to identify Flora, Fauna and Threatened Ecological Communities considered to be Matters of National Environmental Significance. This search covered an area within 10 km of the centre of the Project Area (-33.67 S, 120.20 E). The results of the database search are presented in Appendix 5.

The NatureMap database (DPaW, 2016) was searched to produce a list of potentially occurring species within 10 km of the Project area using centre coordinates (-33.67° S, 120.20° E). This database has the most up to date species list based on flora and fauna licence returns from numerous surveys conducted in the area. The results of the database search are presented in Appendix 6.

A search of the Atlas of Living Australia (AoLA) (AoLA, 2016) was also undertaken to produce a list of fauna potentially occurring within a 10 km buffer of the Project Area using coordinates -33.67° S, 120.20° E. The results of the database search are presented in Appendix 7.

A request was made for a search of the DBCA databases for Threatened and Priority flora and fauna and the presence of Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). This search was conducted based on a single point approximately centrally located in the Project Area (-33.67° S, 120.20° E) and included a 10 km buffer for flora and Threatened/Priority communities and a 30 km buffer for fauna. The results of the DBCA flora database searches are presented Appendix 8, results of the fauna database search are presented in Appendix 9.

Additional searches for fauna focussing more intensively on the Kundip Mine Site and immediate area, including the Kundip Nature Reserve, were undertaken to enable a comparison of the results of an extensive field survey undertaken by Biota in 2004 (Biota, 2004a; Biota, 2005). The searches comprised the NatureMap search (Appendix 10) which included a 6 km buffer, AoLA search which included a predefined buffer of 5 km (Appendix 11) and the PMST, also a buffer of 5 km (Appendix 5).

3.3 FIELD SURVEY

3.3.1 Flora and Vegetation Survey Methodology

APM undertook a Targeted survey (EPA, 2016) in August 2016, a Detailed survey in May of 2016. In July 2017 a Detailed Survey was undertaken, followed by a Targeted survey in October 2017. Survey work was also undertaken more recently in early August and September 2018 within the Project Area and various exploration leases. Surveys were undertaken in accordance with:

- EPA (2016) Environmental Factor Guideline: *Flora and Vegetation*; and
- EPA (2016) Technical Guidance: *Flora and Vegetation Surveys for Environmental Impact Assessment.*

The 2016 survey was aimed at gathering broad information about the Project Area. To achieve this, Craig *et al.* 2004; Craig *et al.* 2008 vegetation mapping was ground-truthed, the extent of historic and recent disturbances quantified, a targeted flora survey commenced for conservation significant flora species most likely to occur in habitats within the Project Area and opportunistic flora sampling was conducted.

The data obtained from the 2016 survey was presented to the EPA in 'Biological Assessment of Ravensthorpe Gold Project, WA' (2016). Following the formal review of this document and insights gained from the survey, APM developed a strategy to augment the 2016 survey by undertaking both Targeted and Detailed surveys. The Targeted surveys were used to gather comprehensive information on conservation significant flora and vegetation within the Project Area, while the Detailed surveys were used to collect sufficient information to update the general flora and vegetation attributes of the Project Area, and to accurately assess the value of flora and vegetation in both a local and regional context. Surveys undertaken in 2017 were conducted during May and July (out-of-season) and August (in-season).

The Targeted survey(s) consisted of a gridded search bounded by the proposed Disturbance Footprint, as identified at the time of the survey, to determine the presence/absence of conservation significant species, TECs and PECs. Surveyors involved in the searches first familiarised themselves with the locally occurring records of conservation significant taxa and vegetation communities which were used to assist in the field identification. The gridded search was conducted by two botanists and one environmental scientist. Each person was spaced ~10 metres apart with the environmental scientist remaining along the central track. Both botanists were holding a global positioning system (GPS). Track logs were recorded on the GPS to ensure maximum coverage of the areas and minimum overlap of search effort. The locations of all potential conservation significant flora identified were recorded with the GPS unit. Plants with uncertain identities were recorded with the GPS, collected and later identified to species level. Identifications were conducted by; James Tsakalos, Shibi Chandran and Mike Hislop (contracted through the State Herbarium by APM). Opportunistic observations as well as plot-less surveys with the aim of capturing vegetation condition as well as the occurrence/identity of weed species was also conducted during the Targeted surveys. Additional opportunistic observations were made on transit to and from quadrats.

Vegetation condition was described using the Vegetation Condition Scale adapted from Keighery (1994) as presented in Appendix 12 from within the EPA *Technical Guidance for Flora and Vegetation Surveys* (2016). Condition mapping undertaken by Craig *et al.* 2004; 2008, as well as ground-truthing by APM enabled the confirmation of the condition of vegetation in all the areas that have historically received or will receive disturbance in the future, within the Kundip Mine Site from the proposed RGP. A condition of 'Completely Degraded' vegetation was denoted to those areas that have been historically mined in the Kundip Mine Site, including large infrastructural elements and access tracks and roads. Areas with both historical drill lines and historically cleared areas that have not been disturbed recently, as well as the areas targeted for controlled burning over several years by the DBCA, are denoted a 'Very Good' condition, as the vegetation structure has been altered through repeated or significant disturbance but has been able to regenerate or is in the process

of regeneration (Keighery, 1994). More recently disturbed areas such as the latest drill lines created, are considered to be areas of a mosaic of 'Good' to 'Degraded' condition, as vegetation has been recently removed and fragmented and has either retained some basic structure or requires intensive management and rehabilitation to bring it back to 'Good' condition (Keighery, 1994). Vegetation condition is only an estimation and each area has not been denoted a specific condition due to physical limitations, priorities and time limitations in the field. Only a general description can therefore be provided. It has been estimated that the Kundip Mine Site contains a mosaic of conditions (Keighery, 1994) that range across the entirety of the Condition Scale. Areas that have not been mapped and represented in figures, are being assumed (based on Craig *et al.* mapping and APM field observation and survey for vegetation communities) that they are of 'Very good' condition or higher on the Condition Scale.

The Detailed survey(s) were designed to capture the vegetation and environmental heterogeneity (of the mature vegetation) in the Project area. Fire scar mapping (spanning back to 2007) was created and utilised to ensure that the placement of the quadrats was in vegetation considered mature (See EPA 2016). To create the fire scar mapping, Landsat 7 imagery (spanning 10 years, accessed from USGS earth explorer) was collected and raster bands 7, 4 and 1 used to emphasise the extent of potentially burnt areas. These areas were manually digitised into a polygon shape file using QGIS software. The reasons for the selection of matured vegetation over recovering / recently disturbed are manyfold (Bond & van Wilgen 1996, Bowman *et al.* 2009), however in terms of community assembly and disassembly, the primary factors are likely the regeneration of nutrient pools and reconstruction of ecological niches. The age selected here (9 years), we consider conservative, since in putatively similar mediterranean-type fire prone shrublands, the recovery of species composition appears to range from 2 (Van der Merwe & Rooyen 2011) to 8 years (Herath *et al.* 2009). Nonetheless, the Project area appears largely uninfluenced by fire with records along the eastern and southern boundaries occurring during 2007 and 2008 (representing 9 and 10-year-old regeneration, respectively). See Appendix 12 and Appendix 13 to query the spatial extent of the fire scar mapping near the Project Area.

Vegetation and environmental data collection and collation

Ninety-five permanent quadrats, each sized 10 m x 10 m were established within the Project Area between August 2016 and October 2017 (Figure 3-1). The sampling grain (i.e. 100 m^2) is consistent with that recommended as optimal by Bennett's (1987) species area curve analysis within the Ravensthorpe Range. To capture the habitat heterogeneity of the Project area a minimum of three quadrats were placed in each of the vegetation types (presumed to intersect with potential impacts) mapped by Craig *et al.* (2004). Within each of these quadrats the projected cover (%) and height (m) of all plants was recorded. Additionally, a 5 m buffer was added to the perimeter of the quadrat and all additional species encountered were recorded. The inclusion of buffer species is consistent with survey methods applied by Kern *et al.* (2008) and Markey *et al.* (2012) within the Ravensthorpe Range. The nomenclature of the plant taxa follows FloraBase (WA Herbarium, 2017).

At each of the ninety-five permanent quadrats we collected 52 soil and 3 topographical data variables. Soil data was sourced from CSIRO Terrestrial Ecosystem Research Network (TERN) and the 1:100 000 geological map of Ravensthorpe (2930). Soil data from TERN included modelled; Total Nitrogen, Total Phosphorus, Bulk Density, Clay, Sand, Silt, Organic Carbon, pH, $CaCl_2$, Plant Available Water (PAW), and Effective Cation Exchange Capacity (CEC). Soil data from the geological map included qualitative spatial descriptions of the underlying surface geology. Topographic data included slope, aspect and elevation determined using Earth Explorer's non-void-filled satellite radar topographic mission series (SRTM) captured at 1 arc second resolution (Farr *et al.* 2007). Climate data was not included because the spatial distribution of the quadrats was small, hence we would not expect to see any major changes as a product of modelled climatic variation. Fire data was not included because all surveyed areas were from matured vegetation (> 9-years-old).

Figure 3-1: APM (2018) Permanent Flora Quadrats within the Ravensthorpe Gold Project Area

LEGEND

- APM Quadrats
- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500

Meters

Date: 25/09/2018

Scale: 1:14,500

ACHMINERALS

WGS 1984 Web Mercator Auxiliary Sphere

Author: sarah@animalplantmineral.com.au

3.3.2 Flora and Vegetation Data Analyses

Classification and post-classification procedures

OptimClass 1 (Tichy *et al.* 2010) was used to evaluate the performance of commonly applied data-analytical combinations representing resemblance measures and clustering algorithm used for classifications. Specifically, we evaluated space-conserving and space-dilating resemblance measures (see Strauss & Maltitz 2017 for review) of unweighted pair group method with arithmetic mean (UPGMA) (Sokal & Michener 1958) and Ward's method (Ward 1963) respectively. These clustering algorithms were paired with Bray-Curtis and relative Euclidean distances respectively. The OptimClass 1 method has been used extensively (e.g. Tichý *et al.* 2010; Wiser *et al.* 2011; Eliáš *et al.* 2013; Lötter *et al.* 2013; Vymazalová *et al.* 2016) to evaluate the ability of classifications to translate dendrograms (hierarchical classification patterns) into non-hierarchical vegetation classification systems. OptimClass 1 identifies the classification that yields the highest number of faithful species across the classes (clusters, communities) as 'optimal'. The number of faithful species for each cluster is determined using Fisher's Exact Test (Chytrý *et al.* 2002). According to the peaks in the 'faithful species to cluster number' trend line from OptimClass 1, the different nested hierarchical levels (i.e. communities, community groups and major community groups) were determined. JUICE version 7.0.187 (Tichý 2002) was used to carry out the OptimClass 1 procedure (Tichý *et al.* 2010).

Post-classification analyses involved extraction of 'diagnostic community profiles' and synoptic table of association. The diagnostic community profiles were comprised of; Diagnostic, Constant, and Dominant taxa. JUICE offers identification of diagnostic species based, in this case we used the phi coefficient > 30. Constant species were those which occur across 50% of the quadrats within a community. Dominant species were those with projected cover values greater than 20%. Diagnostic community profiles are included as Appendix 15. The synoptic table was populated by the species constancy (%) values and was sorted according to the JUICE routine based on fidelity (a sorting of the species according to Fisher's exact test scores).

Comparison between Markey et al. 2012 and new APM classification

Despite the substantial number of quantitative methods available for direct formal comparison between classification systems (for example; non-metric multidimensional scaling of fused constancy (%) tables) we were only able to provide qualitative comparisons. The reason for qualitative over quantitative comparison emanate from our inability to attain or reproduce their complete synoptic table for comparison purposes. Specifically, Markey *et al.* (2012) provided only a redacted (with species which frequencies were > 20%) synoptic table, and the source data published online (DPaW, 2012) was missing 64 quadrats and there was not any attribute data which could potentially serve to link between Markey *et al.*'s (2012) communities and the published quadrat data. Since the original classification was conducted on qualitative data (1/0), purportedly high in beta diversity (Markey *et al.* 2012) species combinations would have driven the community patterns. These combinations, through omission of species with frequencies < 20% are missing in the redacted synoptic table.

Identification of environmental drivers

We used distance-based redundancy analysis (db-RDA) (Legendre & Anderson 1998; ter Braak & Šmilauer 2012), as offered by *vegan* (Oksanen *et al.* 2017) in the R Statistical Environment (R Core Team, 2017), to identify the potential drivers of compositional patterns. This method allows flexible selection of any resemblance function to be used to analyse the relationship between environmental and community composition data (Legendre & Anderson 1999; Legendre & Gallaher 2001). The number of explanatory variables was reduced through formation of a consensus derived according to two techniques; (1) the 'ordistep' function from *vegan* (Oksanen *et al.* 2017) where variables are included if their inclusion into the model leads to a significant increase of explained variance, and if the AIC of the new model is lower than the

AIC of the simpler model, and (3) by removing variables if they introduced linear dependencies determined using 'vif.cca' from *vegan* (Oksanen *et al.* 2017).

3.3.3 Terrestrial Vertebrate Fauna Survey Methodology

The field fauna surveys were executed by Dr Mitch Ladyman (Principal Biologist), assisted by Sarah Flemington and Joshua Keen. The surveys were designed in accordance with:

- EPA (2016) Environmental Factor Guideline: *Terrestrial Fauna;*
- EPA (2016) Technical Guidance*: Terrestrial Fauna Surveys;*
- EPA (2016) Technical Guidance: *Sampling Methods for Terrestrial Vertebrate Fauna;* and
- EPA (2002) Position Statement 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection.*

Project specific liaison was undertaken with the DBCA to further tailor the survey design.

The 2016 spring fauna survey, undertaken from 20 - 26 September, targeted conservation significant fauna with a high likelihood of occurrence in the area based on the habitat present and previous historical records (Biota 2004, 2005). The targeted survey utilised aluminium box traps, cage traps, pit traps, funnel traps, turtle traps and camera traps and acoustic recording devices. All opportunistic observations of other species were recorded.

The 2017 surveys were undertaken from 14 - 19 July and 12 – 27 October. In July 2017 a second targeted fauna survey (14 person days active in the field and more than 500 trapping nights) was undertaken to more confidently determine the presence / absence of the Heath Mouse across the RGP following a possible record of one individual on the north-eastern boundary of the Project area. Other data collection that took place during this survey included:

- 70 cage trapping nights targeting the Chuditch following the recording of one individual on a motion sensitive camera during the fauna survey of 2016.
- Call playback for the Western Whipbird (Mallee) to augment records collected during the 2004 biological survey work for the PRP.

In October 2017 a third targeted survey, comprising 10 person days active in the field and more than 400 trapping nights was initiated to:

- Resolve the absence of the Heath Mouse in the RGP;
- Contribute to records of the Chuditch in the RGP; and
- Detect the presence of the Western Whip Bird, the Western Bristlebird and the Western Ground Parrot, comprising call play back and acoustic monitoring pre-dawn and post-dusk.

The October 2017 survey comprised over 400 aluminium box trap nights, 40 cage trap nights, eight (8) predawn and eight (8) post-dusk one-hour acoustic survey sessions. During this survey further attempts were made to find hollow-bearing trees suitable for Carnaby's nesting, however none were found. GPS records and measurements of a number of large trees, 4 of which were suitably sized to facilitate hollows, as stipulated in the habitat assessment guidelines (EPBC, 2012), however, none of these trees contained any hollows as outlined in Table 3-1.

Table 3-1: Black Cockatoo Nesting Tree Assessment

Tree ID	Diameter Breast Height (mm)	Height (m)	Hollows	Fire (Years since)
1	570	18	None	>10
2	510	16	None	>10
3	490	16	None	>10
4	720	15	None	>10

Table 3-2 outlines the target fauna species and the method of trapping employed to determine presence / absence. The location of trap lines is illustrated in Figure 3-2.

Table 3-2: Target Conservation Significant Fauna Species and Method of Trapping

Fauna Species	Transect Observation	Funnel and Pit Trapping	Call Play-back	Thermal Trigger Fauna Cameras	Aluminium Box Traps	Cage traps	Opportunistic Hand Searching
Calyptorhynchus latirostris (Carnaby's Cockatoo (short-billed black-cockatoo))	×		×				
Dasyornis longirostris (Western Bristlebird)	×		×				
Dasyurus geoffroii (Chuditch, Western Quoll)				×		×	
Falco peregrinus (Peregrine Falcon)	×		×				
Hydromys chrysogaster (Water-rat, Rakali)	×			×	×	×	
Isoodon fusciventer (Quenda, Southern Brown Bandicoot)	×			×	×	×	
Leipoa ocellata (Malleefowl)	×			×			
Lerista viduata (Ravensthorpe Range Slider skink)		×					×
Notamacropus eugenii derbianus (Tammar Wallaby (WA subsp))	×			×			
Notamacropus irma (Western Brush Wallaby)	×			×			
Merops ornatus (Rainbow Bee-eater)	×						
Myrmecobius fasciatus (Numbat Walpurti)	×			×	×	×	
Parantechinus apicalis (Dibbler)	×			×	×		
Phascogale calura (Red-tailed Phascogale, Kenngoor)	×			×	×		
Pseudomys occidentalis (Western Mouse)	×			×	×		
Pseudomys shortridgei (Heath Mouse, Dayang)	×			×	×		
Psophodes nigrogularis oberon (Western Whipbird (Mallee))	×		×				

239000 000000
240000 000000
241000 000000
242000 000000
6272000 000000
6271000 000000
6270000 000000
6269000 000000
6268000 000000

M 74/63
E 74/486
E 74/311
E 74/392
M 74/53
M 74/180
M 74/41
M 74/135
E 74/382
L 74/34
M 74/51
E 74/605
L 74/45
E 74/391
E 74/413

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM2017GIS\ACH\02_GIS Maps\20180927_ACH026_ERD_APM_FaunaCollectionSites_Figure 4-12.mxd

Figure 3-2: APM Fauna Data Collection Points at the Ravensthorpe Gold Project Area

LEGEND

- Fauna Trap Lines
- Thermal Trigger Camera Sites
- Ravensthorpe Gold Project Area
- Mining Tenements

Acoustic Monitoring Sites

- Bat
- Frog

Bird Monitoring

- Bird Monitoring Site
- Opportunistic Record - Western Whipbird

N

0 100 200 300 400 500
Meters

Date: 27/09/2018
Scale: 1:13,000
GDA 1994 MGA Zone 51
Author: sarah@animalplantmineral.com.au

ACHMINERALS

3.3.3.1 Transect Observation

Transect observations were made in many ways with each increasing the likelihood of an encounter with a particular species or suite of species.

Nocturnal Transects

Nocturnal searching comprised vehicle-based searches of all roads and tracks throughout the Project area. Searches commenced after sunset (approximately 7 pm) and typically lasted for more than one hour. On all occasions hand held spotlights were used to detect arboreal or volant nocturnal fauna, including possums and owls, and vehicle headlights and spotlights were used to detect ground dwelling reptiles and amphibians and hawking nocturnal birds that are often found roosting on the track.

Diurnal Transects

As a function of the botanical survey protocol, biologists were able to actively search for Malleefowl nests during grid searches for Priority flora species. Over the course of the botanical survey five persons walked a total of more than 35 km searching a ~10 metre swath width for Malleefowl mounds.

Movement between traps and sites on foot increases the likelihood of detection of scats and secondary evidence of fauna. All evidence observed during daily systematic trap clearing was recorded.

3.3.3.2 Funnel and Pit Trapping

A total of 40 funnel traps were set up in two different habitats. The first site comprised sandy gentle slopes in vegetation Community 6 '*Taxandria spathulata - Melaleuca rigidifolia*' (APM 2017). The object was to sample for the Ravensthorpe Slider and funnel traps were augmented by small cup pit traps with four funnel traps and four cups set up per 10 m drift fence.

The second site was in a small patch of vegetation mapped as Community 10 '*Melaleuca stramentosa - Taxandria spathulata*' (APM 2017), to sample species that had persisted in this remnant patch of vegetation between Western Gem, Two Boys and Kaolin Pit and the Tailings Storage Facility. Funnel traps were set up in conjunction with deep 20 L bucket pit traps with three-way traversing wire drift fences (Table 3-3 and Table 3-4).

Table 3-3: Funnel Trap Survey Effort

Trap Location	No. of Traps	No. of Trap Nights	Total
F29	20	4	80
F30	20	4	80
Total	**40**	**4**	**160**

Table 3-4: Pit Trap Survey Effort

Trap Location	No. of Traps	No. of Trap Nights	Total
P30	5	5	25
Total	**5**	**5**	**25**

3.3.3.3 Call Play-back

A Marantz acoustic recorder was set up over many nights adjacent to a small permanent water body at the foot of an historic heap leach pit at the point of out flow (Table 3-5).

The objective here was to establish a list of common frog species that give an indication of overall water quality and environmental health.

Table 3-5: Frog Acoustic Monitoring Survey Effort

Trap Location	No. of Traps	No. of Trap Nights	Total
ACHS8Ac Outflow	1	1	1
ACHS8Ac Heap leach dam	1	1	1
ACHS8Ac Two boys	1	1	1
Total	**3**	**3**	**3**

3.3.3.4 Acoustic Monitoring

A total of four full spectrum lossless WAC0 format with Wildlife Acoustics SM2BAT bat detectors (sampling rate 384 kHz, trigger 6 dB above background; 48 dB gain) were set to record the acoustic signatures of the microbats across the Project area. Detectors were set up in strategic locations where the likelihood of detecting bats was significantly increased near water bodies and mine shafts. Detectors were set to turn on automatically at sunset and off at sunrise (Table 3-6).

Table 3-6: Bat Acoustic Monitoring Survey Effort

Trap Location	No. of Traps	No. of Trap Nights	Total
A23 - 7014	1	5	5
A24 - 8066	1	5	5
A31 - 6066	1	4	4
A33 - 8048	1	3	3
Total	**4**	**17**	**17**

3.3.3.5 Bird Monitoring

Bird monitoring was undertaken at the sites indicated in Figure 3-2. Each site was monitored by 1 person for 1 hour in the morning and evening, with monitoring commencing 15 minutes prior to sunrise and 15 minutes prior to sunset. A schedule of monitoring undertaken is present in Table 3-7.

Table 3-7: Bird Monitoring Survey Effort

Date	Time of Day	No. people	Sites Monitored	Person Hours (total)
20/10/2017	Evening	2	1 & 2	2
21/10/2017	Morning	2	1 & 2	2
21/10/2017	Evening	2	3 & 4	2
22/10/2017	Morning	2	3 & 4	2
22/10/2017	Evening	2	5 & 6	2
23/10/2017	Morning	2	5 & 6	2
			Total:	**16**

3.3.3.6 Thermal Trigger Fauna Cameras

Scout Guard SG560K-14mHD white light and Reconyx HC500 HyperFire™ Semi-Covert IR were set up at several locations across the Project area (Table 3-8). The principal focus was on mine shafts set at angles that would encourage occupation by both native and introduced fauna of assorted sizes from small dasyurids and rodents to larger animals including; foxes, cats and the Chuditch.

Table 3-8: Thermal Trigger Camera Survey Effort

Trap Location	No. of traps	No. of trap nights	Total
ACHS3TC004	1	3	**3**
ACHS5TC003	1	3	**3**
ACHS5TC004	1	3	**3**
ACHS6 - Camera 005 & 006	2	3	**6**
ACHS7TC001	1	3	**3**
ACHS7TC002	1	3	**3**
C25 - Camera 25	1	4	**4**
E34 - Camera 29	1	4	**4**
E35 - Camera 30	1	4	**4**
DpaW10 - bridge	1	4	**4**
DPaW21 - NW hill	1	4	**4**
DPaW24 - NW creek	1	4	**4**
DPaW25	1	4	**4**
DPaW25	1	4	**4**
DPaW26	1	4	**4**
DPaW27	1	4	**4**
DPaW35	1	4	**4**
TC003	1	3	**3**
TC005	1	3	**3**
TC006	1	2	**2**
Total	**21**	**70**	**73**

3.3.3.7 Aluminium Box Traps

A total of 80 aluminium box traps were set up along linear transects in close proximity to each other to concentrate trapping in limited habitats (Table 3-9). Trap spacing was at least 10 m, with the average spacing around 20 m. Many of the box traps were set in habitats likely to support the Conservation Significant mammalian fauna of the Project area. Many grids were established along drainage lines starting at or perpendicular to artificially constructed dam walls. Saturation trapping of 20 traps around one shaft was employed after it the detection of a Dibbler on a remote sensing camera was speculated, but later discounted as a capture (refer to section 5.2.9.1).

Table 3-9: Aluminium Box Trap Survey Effort

Trap Location	No. of traps	No. of trap nights	Total
ACHS1	12	3	36
ACHS2	8	3	24
ACHS3	20	3	60
ACHS4	20	3	60
C25	20	5	100
E22	22	10	220
E26	20	4	80
E28	8	4	32
E32	40	3	120
E21	20	9	180
E36	20	8	160
E35	29	11	319
E34	19	9	114
E19	20	3	60
E20	10	3	30
E25	20	8	160
E18	5	3	15
E16	10	3	30
E15	10	3	30
E23	20	10	200
E30	10	5	50
E33	10	5	50
E29	10	5	50
E24	10	5	50
Total	**393**	**128**	**2230**

3.3.3.8 Cage Traps

Twelve cage traps were established in sets of four in association with the aluminium box traps (Table 3-10). The primary focus was on habitat likely to support Chuditch or Rakali/Water Rats (*Hydromys chrysogaster*). Though the Water Rat may be captured in the larger aluminium box traps used in this survey, cage traps have a higher capture success rate. Cage traps are the only traps of a sufficient size to catch Chuditch.

Table 3-10: Cage Trap Survey Effort

Trap Location	No. of traps	No. of trap nights	Total
ACHS1	4	3	12
ACHS2	4	3	12
ACHS3	4	3	12
C20	5	5	25
C27	5	4	20
C36	3	8	24
C21	2	5	10
C24	1	8	8
C25	2	5	10
C15	1	3	3
C22	1	5	5
C23	1	5	5
C24	1	5	5
C25	1	5	5
C26	1	5	5
C28	1	5	5
Total	**37**	**77**	**166**

3.3.3.9 Turtle traps

Seven turtle traps were set along the banks of more established rehabilitated water bodies (Table 3-11).

Table 3-11: Turtle Trap Survey Effort

Trap Location	No. of Traps	No. of Trap Nights	Total
T21	7	4	28
Total	**7**	**4**	**28**

3.3.3.10 Opportunistic Hand Searching

Historic mine workings, processing areas and settlement sites provided an array of material including; tin sheets, concrete slabs, and timber which serve as fauna habitat and have the potential to preserve fossorial remains. In addition, roadside vegetation spoil heaps were searched, and micro-refuges in standing and fallen timber were investigated. More than 30-person hours were invested in opportunistic searching across the site, the majority of which was undertaken by Principal Biologist Dr Mitch Ladyman.

4 FLORA AND VEGETATION RESULTS

4.1 DESKTOP SURVEY

4.1.1.1 Climate

Leading up to the 2017 surveys, monthly total rainfall was above average for February, August and September (Figure 4-1), particularly in February when the average was exceeded by 222.7 mm (BoM 2017a; BoM 2017b).

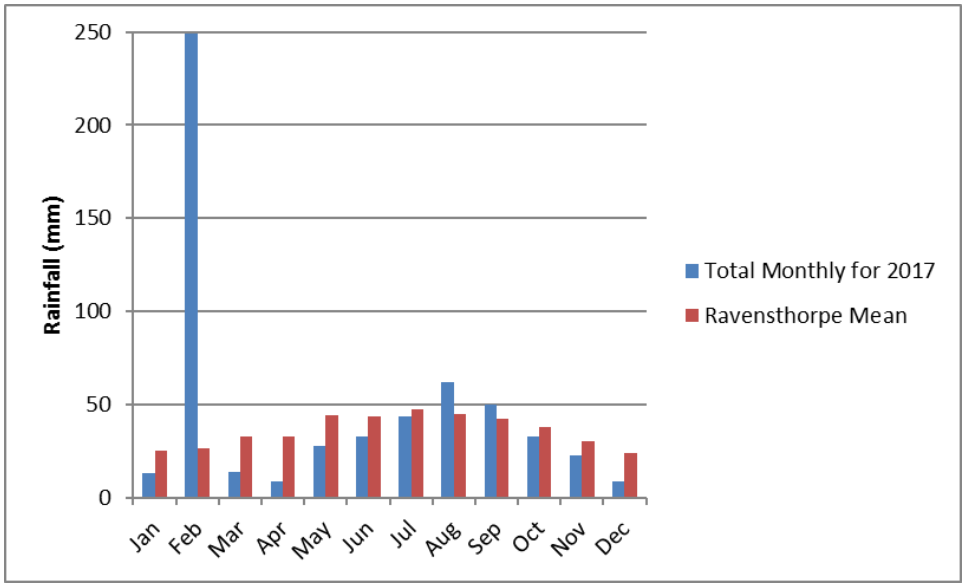


Figure 4-1: Monthly rainfall for Ravensthorpe in 2017. BoM Site Number 010633.

4.1.1.2 Previous Surveys

The Ravensthorpe Range is situated within the Esperance Plains Bioregion (Department of Environment and Water Resources, 2007). The vegetation was first described by Beard (1972, 1973) and this is where the Ravensthorpe-, Oldfield- and Esperance-vegetation systems were formalised. Additional vegetation surveys within the Project Area have been undertaken by Craig *et al.* (2008; 2004) where qualitative assessment of vegetation enabled the creation of digitally available mapping units; Kern *et al.* (2008) who established 200 permanent quadrats; and Markey *et al.* (2012) who revisited as well as established an additional 66 quadrats during 2008-09. Combined, only nine of the 266 quadrats established by Kern *et al.* (2008) and Markey *et al.* (2012) across the Ravensthorpe Range were positioned in the Project area. The study of Markey *et al.* (2012) focused on quantitatively defining the vegetation patterns as well as comparing these newly defined patterns to those described and mapped by Craig *et al.* (2008).

According to the Craig *et al.* (2008) mapping a total of 25 vegetation units fall within the Project area, many of which (63%) have been described as dominated by obligate re-seeding taxa. In general, Craig *et al.* (2008; 2004) found that the vegetation was in 'Excellent' condition, with weed invasion minimal. This holds true for those areas away from historical and recent disturbance. Unfortunately, for practical purposes it is not possible to determine from the Markey *et al.* (2012) analyses how many of the newly derived vegetation units fall within the Project area. There are multiple reasons for this; (1) there was a mismatch between Craig's described vegetation units and the newly derived classification; and (2) spatial information provided to the TERN network lacked reference on how the 266 established quadrats were assigned to floristic communities.

Combined, we have found that the vegetation mapping of the Ravensthorpe Range in general, is requiring an update with the newest system of vegetation units.

4.1.1.3 Conservation Significant Flora

The DBCA Threatened (Declared Rare) and Priority Flora Database, Threatened and Priority Flora List and the WA Herbarium Specimen Database identified 11 Threatened and 63 Priority flora species which have the potential to occur within the Project Area. The PMST returned 11 botanical Matters of National Environmental Significance (MNES). Of these, 16 conservation significant flora have been recorded as occurring within the Project Area. These are:

- *Acacia argutifolia* (P4) (3 individuals);
- *Acacia* sp. Ravensthorpe Range (P1) (1 individual);
- *Calothamnus roseus* (P1) (8 individuals);
- *Dampiera* sp. Ravensthorpe (G. F. Craig 8277) (P3) (1 individual);
- *Eucalyptus desmondensis* (P4) (2 individuals);
- *Eucalyptus stoatei* (P4) (2 individuals);
- *Grevillea fulgens* (P3) (1 individual);
- *Hydrocotyle* sp. *decipiens* (G.J. Keighery 463) (P2) (3 individuals);
- *Lepidosperma* sp. Elverdton (R. Jasper *et al.* LCH 16844) (P1) (1 individual);
- *Lepidosperma* sp. Mt Short (S. Kern *et al.* LCH 17510) (P1) (1 individual);
- *Marianthus mollis* (P4) (7 individuals);
- *Melaleuca sophisma* (P1) (6 individuals);
- *Pultanaea brachyphylla* (P2) (1 individual);
- *Pultanaea calycina* subsp. *proxena* (P4) (1 individual);
- *Pultanaea craigiana* (P3) (12 individuals); and
- *Thomasia* sp. Hopetoun (K.R. Newbey 4896) (P2) (1 individual).

Priority Flora within the Project Area identified by APM (2018) during surveys (not recorded by DBCA) include:

APM 2016

- *Stachystemon vinosus* (P4) (1 individual).

APM 2017

- *Thysanotus parviflorus* (P4) (4 individuals).

Priority Flora identified by APM during surveys outside of the Project Area, additional to existing DBCA records, include:

APM 2017 (Ard Patrick Exploration Survey) (Appendix 14)

- *Hibbertia hamata* (P3) (2 individuals);
- *Hydrocotyle* sp. Decipiens (P2) (35 individuals); and
- *Melaleuca sophisma* (P1) (2 individuals).

APM 2018 (Welcome Stranger Exploration Survey)

- *Eucalyptus desmondensis* (P4) (average cover of 8.5% over seventeen quadrats containing the species).

All flora identified by the database searches, and augmented by APM and other consultant's survey work have been assimilated into Table 4-1 below to provide a comprehensive list flora that have the potential to occur and those that are known to occur within the Project Area. The results of the DBCA flora search are presented in Figure 4-2.

Table 4-1: Conservation Significant Flora Potentially Occurring in the Ravensthorpe Gold Project Area

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Acacia argutifolia	Low spreading shrub. Shallow sand over quartzite, rocky hills & ridges	High, flowering in spring		Recorded in 1985 & 2010 (DBCA & WA Herbarium records)			P4
Acacia besleyi	Resinous shrub with stringy and fibrous bark.	High, flowering in spring					P1
Acacia bifaria	Prostrate or semi-prostrate shrub. Rocky loam, sandy soils. Plains, roadsides, low lying areas	High, flowering in spring					P3
Acacia dictyoneura	Shrub. Loamy soils, River banks, gentle slopes.	High, flowering in spring					P4
Acacia disticha	Spreading shrub. Sand, rocky loam, limestone soils. Watercourses within rocks.	High, flowering in spring	Craig 2004a, 2005		P2		Not Threatened
Acacia durabilis	Slender, open spinescent shrub. Rocky or lateritic clay, sandy clay. Stony ridges and hills.	High, flowering in spring	Craig 2004a, 2005; Hickman 2007		P3		Not Threatened
Acacia errabunda	Dense, bushy, spreading shrub. Clay loam, gravelly loam, sand. Plans, clay flats.	High, flowering in spring		Recorded in 2002 (DBCA & WA Herbarium records)			P3
Acacia grisea	Spreading or compact shrub. Lateritic gravelly loamy soils. Plains & slopes.	Medium, flowering in winter		Recorded in 1992 and 2007 (DBCA & WA Herbarium records)			P4
Acacia improcera	Spreading, spiny shrub. Sand, loamy clay, clay. Undulating plaints, flats	High, flowering in spring	K. Newbey 4.8 km SE of Ravensthorpe				P3
Acacia laricina var.[1] *crassifolia*	Domed, dense, spreading shrub. Loamy stony shallow sand, lateritic soils. Ridges.	High, flowering in spring	Craig 2004a, 2004b, 2005; Hickman 2007; APM 2017		P2		Not Threatened
Acacia nitidula	Spreading shrub. Granitic sandy gravelly soils. Amongst granite boulders.	Low, few, if any granite protruding granite boulders.		Naturemap WA, Herbarium record 40 km east of Site.			P3
Acacia ophiolithica	Dense, bushy & rounded shrub. Clay loam, loam. Rocky areas, river banks.	High, flowering in spring	Craig 2004b		P3		Not Threatened

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Acacia papulosa	Bushy shrub. Spongolitic loam.	High, flowering in spring		Recorded 2003 and 2010 (DBCA & WA Herbarium records)			P2
Acacia pinguiculosa	Shrub. Gravelly or loamy sand, loam, clay, laterite, granite, outcrops, risen plains.	High, flowering in spring	Craig 2004a; APM 2017		P4		Not Threatened
Acacia rhamphophylla	Low spreading shrub. Rocky or sandy clay. Upper sloped of low ranges.	High, flowering in spring		Recorded 2006, 2008, 2009, 1992 and 1995 (DBCA & WA Herbarium records)		EN	T
Acacia sp. Ravensthorpe Range (B.R. Maslin 5463)	Low spreading shrub. Rocky clay, clayey loam.	High, flowering in spring		Recorded in 1975, 1980, 83, 2001 and 2003 (WA Herbarium record)			P1
Acrotriche parviflora	Erect, spreading/compact shrub. Rocky grey loam, white-grey sandy or clay loam.	High, flowering in spring	Hickman 2009; APM 2017		P4		Not Threatened
Allocasuarina hystricosa	Dioecious tree. Orange, red or brown loam with limestone or granite outcropping. Plains, lower slopes, hilltops.	Medium, flowering in summer	MWH 2013	Recorded 2004-05, 2007 (DBCA & WA Herbarium	P4		P4
Allocasuarina scleroclada	Dioecious straggling shrub. Granitic/lateritic soils. Rocky hillsides and limestone pavements.	Medium, flowering in winter	Craig 2004b		T		Not Threatened
Anigozanthos bicolor subsp. minor	Rhizomatous, perennial herb. Sand. Well-watered sites.	High, flowering in spring		Naturemap WA, Recorded 1987, 2004 (WA Herbarium record)		EN	T
Anticoryne ovalifolia	Shrub. Quartzite rocky slopes & granite.	High, flowering in spring		Recorded 1983 (DBCA & WA Herbarium)			P2
Banksia corvijuga	Dense, rounded shrub. Gravelly lateritic soils. Hillslopes.	High, flowering in spring	MWH 2013	Recorded 1960, 1979, 1993, 2004 & 2007 (DBCA & WA Herbarium)	T		P3
Banksia corvijuga x heliantha	Dense, rounded shrub. Gravelly lateritic soils. Hillslopes.	High, flowering in spring		Recorded DBCA & WA Herbarium [Unknown			P3

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
				year]			
Banksia foliosissima	Dense erect, non-lignotuberous shrub. Gravelly sand or sandy clay over laterite. Hill top & upper slopes.	High, summer flowerer with distinctive perennial morphology.		Recorded 1960-64, 1993,98 (DBCA & WA Herbarium)			P4
Banksia laevigata subsp. laevigata	Shrub. Rocky soils. Hill, top of breakaways.	High, flowering in spring	MWH 2013	Recorded 1925,1959, 1962-63, 1978, 2005-2009 (DBCA & WA Herbarium)	P4		P4
Beyeria sulcata var. truncata	Straggly shrub.			Recorded 2004 (DBCA & WA Herbarium)			P3
Beyeria villosa (Previously *Beyeria* sp. A Ravensthorpe)	Upright spreading perennial shrub.	Medium, flowering in winter	Craig 2004b	Recorded 1987, 2004, 2007 (DBCA & WA Herbarium)	P1		P4
Boronia oxyantha var. *brevicalyx*	Spreading shrub. Gravel, clay, loam. Ironstone slopes.	High, flowering in spring	Craig 2004a, 2005; APM 2017		P3		Not Threatened
Calothamnus roseus	Dense shrub. Sandy loam, quartzite soil. Upper-slopes and hilltops.	High, flowering in spring	APM 2017	Recorded in 2004, 2007-2010 (WA Herbarium record)	P1		P1
Conostylis lepidospermoides	Rhizomatous, tufted perennial, grass-like or herb. Grey or yellow-brown sand over laterite.	High, flowering in spring		Naturemap WA, Recorded in 1968 (WA Herbarium)		EN	T
Cryptandra craigiae	Erect to spreading shrub. Sand. Low-lying sand dunes, low rises between or adjacent to swampy areas, gutter on disturbed road verge.	Medium, flowering in winter		Recorded in 2005 (DBCA & WA Herbarium)			P1
Dampiera deltoidea	Erect perennial herb. Sand, sandy clay, loam. Sandplains around quartzite rocks	High, flowering in spring	MWH 2013	Recorded in 1963, 1998, 2004, 2005 (DBCA & WA Herbarium)	P4		P4

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Dampiera sp. Ravensthorpe (G.F. Craig 8277)	Erect perennial herb. Orange loam, rocky outcrops & hillcrest.	High, flowering in spring		Recorded in 2009,2010 (WA Herbarium record)			P3
Darwinia oxylepis	Upright, dense shrub. Occurs on stony, peaty sand and rocky gullies.	High, flowering in spring		Naturemap record (WA Herbarium) ~140 km SW of site.		EN	T
Daviesia megacalyx	Erect shrub. Gravelly laterite. Ridges. Hillslopes.	High, flowering in spring	MWH 2013	Recorded 1995, 2004-2007 (DBCA & WA Herbarium)	T	EN	T
Daviesia newbeyi	Bushy, multi-stemmed, broom-like shrub. Sand or sandy clay over granite. Rocky slopes.	High, flowering in spring		Recorded 2010 and 2005 (DBCA & WA Herbarium)			P3
Dodonaea trifida	Shrub. Sandy/gravelly soils. Coastal areas.	High, flowering in spring	Craig, 2004a; Craig, 2005; Hickman, 2007; APM 2017		P3		Not Threatened
Eremophila chamaephila	Low, dome-shaped shrub. White sand, clay. Sandplains, disturbed road verges.	High, flowering in spring		Naturemap record in 2005 (WA Herbarium) 40 km SW of site.			P3
Eremophila denticulata subsp. denticulata	Erect, open shrub. Alluvium, sand, sandy clay loam. River beds & plains, laterite breakaways.	High, flowering in spring		Naturemap record in 2015 (WA Herbarium) 20km SW of site.		VU	T
Eucalyptus desmondensis	Mallee. Stony loam or sand, clay, granitic soils. Rocky hillsides, sandplains.	High, flowering in spring	MWH 2013; APM 2018	Recorded in 1950-1980, 2002, 2005-2007 (WA Herbarium record)	P4		P4
Eucalyptus famelica	Mallee. White / grey sand. Wet areas, sometimes slightly brackish.	High, flowering in winter - long lived perennial structures can be used for identification		Recorded in 1989 (WA Herbarium record)			P3
Eucalyptus proxima	Mallee. Smooth bark, grey over coppery stems, strippy. Gravelly loam, red brown, red-yellow sand, sandy clays, ironstone.	Medium, flowering in summer	Hickman 2009; APM 2017		P4		Not Threatened
Eucalyptus purpurata	Tree (mallette). White powdery loam, magnesite.	High, flowering in spring		Recorded in 1970 (WA Herbarium).			T

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Eucalyptus stoatei	Slender tree. Gravelly sand or clay, sandy loam. Flats, rises.	High, flowering in spring		Recorded in 1981 (WA Herbarium record)			P4
Eucalyptus x bennettiae	Mallee. Red quartzite rubble, red loam. Slopes.	High, flowering in spring		Recorded in 1979, 1981, 1991, 2000-01 (DBCA & WA Herbarium)			P4
Goodenia phillipsiae	Low shrub. Sandy soils.	High, flowering in spring		Recorded in 2002-08 (DBCA & WA Herbarium)			P4
Goodenia stenophylla	Erect shrub. Rocky soils. Granite or quartzite rocks. Steep slopes.	High, flowering in spring		Recorded in 1987-88, 2007 and 2010 (WA Herbarium)			P4
Grevillea fastigiata	Shrub. Red clay, granite.	High, flowering in summer - long lived perennial structures can be used for identification.		Recorded in 1990,91,99 and 2006 and 2007 (WA Herbarium)			P4
Grevillea fulgens	Spreading to straggling, shrub. Gravel over laterite. Hillsides.	High, flowering in spring	MWH 2013	Recorded in 1960-1990, 2004-2007 (DBCA & WA Herbarium)	P3		P3
Grevillea punctata	Shrub. Stony red loam, red clay.	High, flowering in spring	MWH 2013	Recorded in 1991-98 and 2000, 2007 and 2010 (WA Herbarium)	P3		P3
Grevillea sulcata	Spreading shrub. Loam.	Medium, flowering in winter	MWH 2013		P1		P1
Guichenotia apetala	Compact, much branched shrub. Gravel, laterite.	High, flowering in spring	MWH 2013	Recorded in 2002-2007 (DBCA & WA Herbarium)	P1		P1
Gyrostemon sessilis (Previously *Gyrostemon* sp. Ravensthorpe)	Slender shrub. Sand, loam. Sandplains.	Medium, flowering in winter		Recorded in 2008 (WA Herbarium record)	P1		Not Threatened

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Hakea acuminata	Shrub. Deep white sand, grey sand over granite, loam. Undulating plain.	Medium, flowering in winter		Recorded in 2003 (DBCA & WA Herbarium record)			P2
Hibbertia hamata	Erect shrub. Granite. Inland outcrops.	High, flowering in spring	APM 2017		P3		P3
Hydrocotyle sp. Decipiens (G.J. Keighery 463)	Prostrate annual herb. Clay / loam soils. Riverbeds & banks.	Medium, flowering in spring	APM 2017	Recorded in 2005 (DBCA & WA Herbarium)	P2		P2
Lasiopetalum sp. Desmond (N. McQuoid 653)	Shrub. Brown laterite. Ridges.	High, flowering in spring		Recorded in 2008 (WA Herbarium)			P1
Lepidosperma sp. Archer Drive (S. Kern & R. Jasper LCH 18300)	Sedge. Grey clayey sand. Outcrops.			Recorded in 2007 (WA Herbarium)			P1
Lepidosperma sp. Elverdton (R. Jasper *et al.* LCH 16844)	Sedge. Sandy loam, red-brown clay. Tonalite on surface.	Underlying geology matches the site		Recorded in 2007 (WA Herbarium record)			P1
Lepidosperma sp. Hopetoun Road (S. Kern *et al.* LCH 16552)	Sedge. Grey clayey-sand. Lateritic outcrop.			Recorded in 2007 (WA Herbarium record)			P1
Lepidosperma sp. Maydon (S. Kern, R. Jasper, H. Hughes LCH 17844)	Sedge. Clayey sand. Tonalite on surface.			Recorded in 2007 (WA Herbarium record)			P1
Lepidosperma sp. Mt Chester (S. Kern *et al.* LCH 16596)	Sedge. Sandy loam. Tonalite on surface.			Recorded in 2007 (WA Herbarium record)			P1
Lepidosperma sp. Mt Short (S. Kern *et al.* LCH 17510)	Sedge. Clayey sand. Tonalite on surface.	Underlying geology matches the site		Recorded in 2007 (WA Herbarium record)			P1
Lepidosperma sp. Shoemaker *Levy* (L. Ang & O. Davies 10815)				Recorded in 2005 (WA Herbarium record)			P3

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
Lepidosperma sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764)	Sedge. Sandy loam.			Recorded in 2007 (WA Herbarium record)			P1
Marianthus mollis	Low branching, spreading, silky hairy shrub. Laterite soils. Hills and ridges.	High, flowering in spring	Hickman, 2007; MWH, 2013; APM 2016	Recorded in 2003-2010 (WA Herbarium record)	T; P4		P4
Marianthus tenuis (Previously *M. villosus).*	Slender twining shrub. Red-brown sandy clay or loam. Slopes, rock outcrops, valleys.	High, flowering in spring	Craig, 2004a; Craig, 2004b; 2005		T		Not Threatened.
Melaleuca penicula	Spreading shrub. Red, brown loamy sand or red sandy clay. Granite outcrops, valley slopes.	Medium, perennial summer flowerer. Some structures would be intact for identification.	MWH, 2013-	Recorded in 2007, 2008. (WA Herbarium record)	P4		P4
Melaleuca similis	Shrub. Grey sand. Margins of saline drainage lines.	High, flowering in spring.		Naturemap record in 2003 (Threatened Flora Seed Centre Collections) 25 km E, NE of site.			P1
Melaleuca stramentosa	Compact shrub. Yellow sand, lateritic gravel. Plains, heath and thicket.	High, flowering in spring.	Craig 2004a, 2004b, 2005; Hickman 2007; APM 2016, 2017.		P1		Not Threatened
Melaleuca sophisma	Short, dense/compact shrub.	High, flowering in spring	APM 2016	Recorded in 2003-2005 (DBCA & WA Herbarium record)			P1
Micromyrtus navicularis	Spindly, erect shrub. Sand with gravel, laterite, granite. Hill slopes.	High, flowering all year	MWH 2013	Recorded in 2007 (WA Herbarium record)	P3		P3
Pultenaea brachyphylla	Erect shrub. Pale brown sandy loam, sandy clay, gravel, granite, quartz, laterite.	High, flowering in spring		Recorded in 2008 (WA Herbarium record)			P2
Pultenaea calycina subsp. proxena	Many-branched, compact shrub. Sand, clay, sandy clay or loam with gravel, over magnesite. Moderate	High, flowering in spring	Craig 2004b	Recorded in 2002-2010 (WA Herbarium record)	P1		P4

Species	Description & Habitat	Likelihood of Detection if Present	Survey Records on Site	DBCA Records on Site	Conservation Status when Taxa was Recorded	Current Conservation Status	
						Cth	State
	slopes, adjacent to creek beds.						
Pultenaea craigiana (Previously *Pultenaea* sp. Kundip)	Branching, erect shrub.	High, flowering in spring	Craig 2004a; Hickman 2007, 2009; APM 2017.	Recorded in 2003 - 2010 (DBCA & WA Herbarium record)	P1		P3
Pultenaea vestita	Erect or procumbent shrub. Sandy soils. Coastal cliffs, granite.	High, flowering in spring		Recorded in 1951 (WA Herbarium) and in 1999 Naturemap (Salinity Action Plan Flora Survey Data)			P3
Ricinocarpos trichophorus	Erect, openly branching shrub. Occurs on sandy clay and loam on breakaways and among sandstone rocks	High, flowering in spring		Naturemap record in 2014 (DBCA TPFL) 30 km E of site.		EN	T
Siegfriedia darwinioides	Much-branched, spreading shrub. Gravelly loam or sandy soils, clay.	High, flowering in spring	Craig 2004a, 2005; Hickman 2007; APM 2016		P4		Not Threatened
Spyridium glaucum	Erect or spreading shrub. Clay.	High, flowering in spring	Craig 2004a, 2004b; Hickman 2007		P3; P4		Not Threatened
Stachystemon vinosus	Compact shrub. Fine loamy sand, stony soils. Sandplains, rock crevices on breakaways.	High, flowering in spring	Hickman 2007; APM 2016	Recorded in 2005 & 2010 (Wa Herbarium record)	T		P4
Thomasia sp. Hopetoun (K.R. Newbey 4896)	Erect slender shrub	High, flowering in spring	MWH 2013	Recorded in 1969, 74,98 (WA Herbarium record)	P2		P2
Thysanotus parviflorus	Perennial herb. Grey sand	High, flowering in spring	APM 2017	Recorded in 1987 (WA Herbarium record)			P4
Xanthoparmelia subimitatrix	Lichen. Granite. Sheltered/exposed outcrops.	High, flowering in spring		Recorded in 2004 (WA Herbarium record)			P3
Xanthoparmelia xanthomelanoides	Lichen. Granite. Sheltered/exposed outcrops.	High, flowering in spring		Recorded in 2007 (WA Herbarium record)			P2

[redacted]

4.1.1.4 Threatened and Priority Ecological Communities

Two Threatened Ecological Communities (**TEC**) listed under the EPBC Act were identified as potentially occurring in the Project Area through a search of the Protected Matters Search Tool:

- Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA; and
- *Banksia laevigata – Banksia lemanniana* proteaceous thicket.

Three Priority Ecological Communities (**PEC**) listed under the WC Act were also identified as potentially occurring in the Project Area by searches of the DBCA databases:

- Very open Mallee over Melaleuca sp. Kundip dense heath (P1);
- Heath on Komatiite of the Ravensthorpe area (P3); and
- Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA (P3).

Descriptions for these communities are provided in Table 4-2 and their representative distributions (by DBCA as of 2016) shown in Figure 4-3.

Table 4-2: Priority and Threatened Ecological Communities of the Ravensthorpe Gold Project Region

Community	Description	Conservation Status
Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA	Consists of predominantly obligate seeding proteaceous shrubland and heath (Kwongkan) and Mallee heath on sandplain, duplex sand/clay and gravels overlying Eocene sediments, quartzite, schist, Yilgarn and Albany Fraser granite and greenstone ranges. Its flora is characterised by high species diversity and a high degree of endemism, particularly in the Stirling Range, Fitzgerald River National Park, Ravensthorpe Range and Russell Ranges. Due to the high levels of endemism, there are few species that exist across the entire range of the dense, obligate seeding Proteaceae dominated shrublands and Kwongkan of the Esperance Sandplains, however particular species have been identified as common dominant species in each of its ecodistricts.	TEC, EPBC Act; PEC (Priority 3), WC Act
Banksia laevigata – Banksia lemanniana proteaceous thicket	This community occurs on laterised ridges and breakaways. Associated species generally include *Eucalyptus pleurocarpa*, *Adenanthos oreophilus*, *Leptospermum maxwellii*, *Beaufortia orbifolia, Taxandria spathulata* and *Stylidium albomontis*.	TEC, EPBC Act
Very open Mallee over *Melaleuca* sp. Kundip dense heath	Very open Mallee over Melaleuca sp. Kundip (Collection number GF Craig 6020) dense heath. Open Mallee over dense shrub heath (1.0-1.5) dominated by *Melaleuca sophisma* on pale grey loamy sand with quartz rubble, occupies hill slopes. Associated species include *Melaleuca sophisma* (prev. *Melaleuca* sp. Kundip (GF Craig 6020) (P1) (dominant), *M. haplantha, M. stramentosa*, *M rigidifolia, M. bracteosa, Melaleuca ulicoides* (prev. *Melaleuca* sp. Gorse), *Pultenaea craigiana* (prev. *Pultenaea* sp. Kundip (GF Craig 6008)) (P3), *Eucalyptus cernua, E. phaenophylla, E. pileata, Dodonaea trifida*, *Acacia durabilis*, *Leucopogon infuscatus* and *Hibbertia psilocarpa* ms. On its eastern boundary, the community abuts *Eucalyptus astringens* open low woodland and in this area, there is an intergrade community.	PEC (Priority 1), WC Act
Heath on Komatiite of the Ravensthorpe area	Dense heath on alkaline red clay over komatiite (ultra-mafic rock) and associated carbonates. Note: very open tree Mallee over heath B in Hale Bopp orebody area. Dominant species: *Beyeria cockertonii* (T), *Acacia ophiolithica, Hakea verrucosa, Grevillea fastigiata* (P4), *Melaleuca ulicoides , Allocasuarina hystricosa* (P4), *Verticordia oxylepis, Grevillea oligantha, Hybanthus floribundus, Pomaderris brevifolia*, *Pultenaea* Xwudjariensis (P1), *Melaleuca pomphostoma, Nematolepis phebalioides, Philotheca gardneri* subsp. *gardneri, Gyrostemon sessilis, Calothamnus quadrifidus, Calytrix tetragona, Halgania anagalloides, Coleanthera myrtoides, Beyeria cockertonii* (T), *Pultenaea* Xwudjariensis, *Grevillea fastigiata* (P4) and *Gyrostemon sessilis* are narrow range endemics.	PEC (Priority 3), WC Act

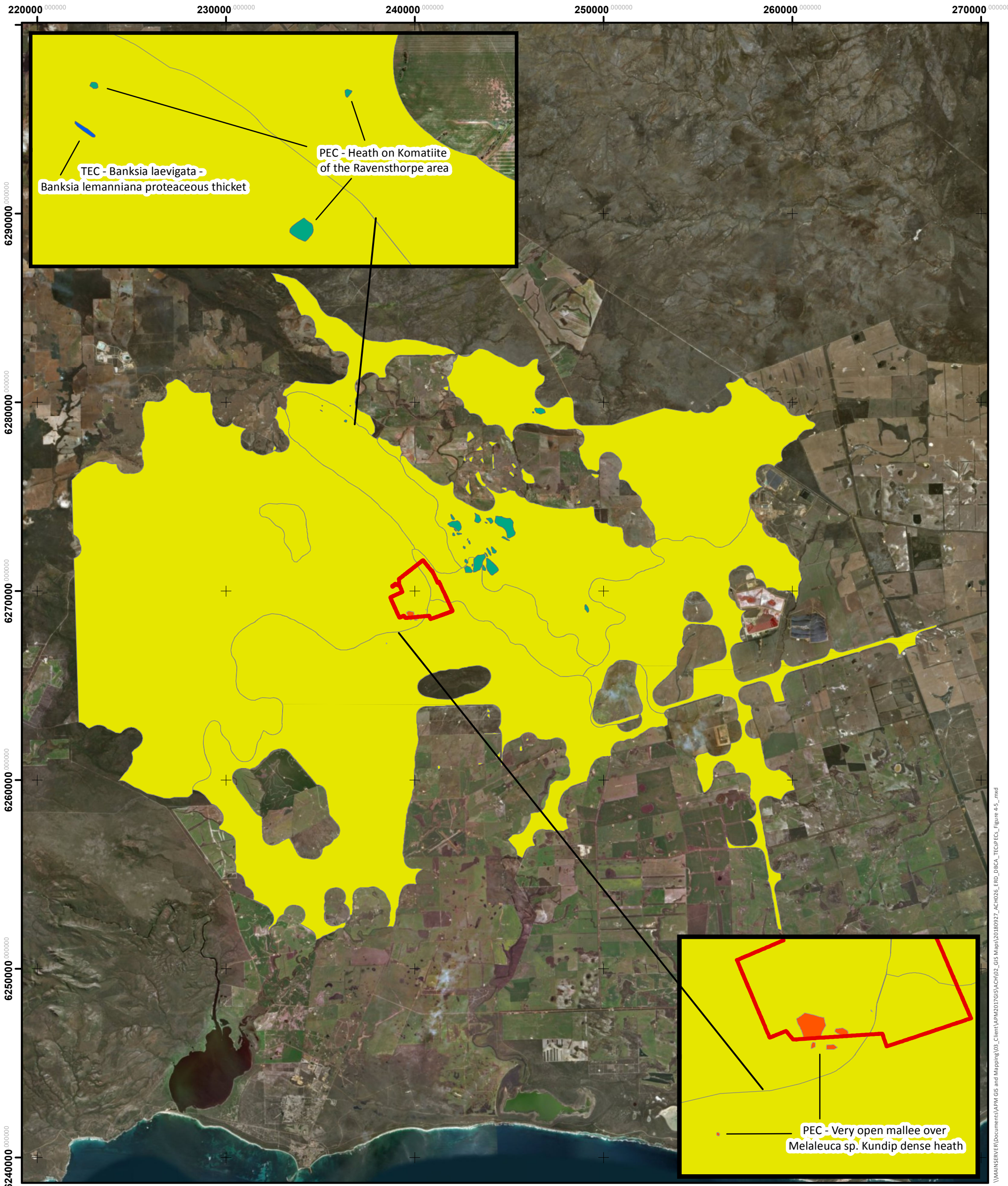


Figure 4-3: Department of Biodiversity Conservation and Attractions Threatened and Priority Ecological Communities of the Ravensthorpe Range

LEGEND

- Ravensthorpe Gold Project Area
- PEC - Heath on Komatiite of the Ravensthorpe area.
- TEC - Banksia laevigata - Banksia lemanniana proteaceous thicket.
- PEC - Very open mallee over Melaleuca sp. Kundip dense heath.
- TEC/PEC - Proteaceae dominated kwongkan shrublands of the southeast coastal floristic province of WA.

N

0 10

Kilometers

Date: 27/09/2018

Scale: 1:188,937

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

4.1.1.5 Introduced Flora

Three invasive plant taxa listed as MNES were identified as likely to occur near the Project area; *Asparagus asparagoides*, *Lycium ferocissimum* and *Tamarix aphylla*. Interestingly, Florabase occurrence records indicate that *Tamarix aphylla*, unlike *Asparagus asparagoides* and *Lycium ferocissimum,* does not occur within the same IBRA region as the Project, and is therefore unlikely to occur.

Bridal creeper *Asparagus asparagoides* is classified as a Weed of National Significance **(WONS)** and a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) characterised as 'no control' (Department of Primary Industries and Regional Development, 2017) and will require active management.

African Boxthorn *Lycium ferocissimum* is broadly distributed over the Eremaean Province and South-West Botanical Provinces. Often introduced on islands and near-coastal areas as a wind break this species is highly invasive and, once established, is difficult to control. Broken stem and root pieces can remain alive for several months before flowering, fruiting or taking root. Disturbance results in mass seed germination within one year. Over the life of the Project the spread of this species must be curtailed and provisions for active removal should be put in place.

Athel Pine *Tamarix aphylla* is a WONS. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. This species, if detected, will require active management.

4.2 FIELD SURVEY

4.2.1 Summary of the quadrat data

A total of 243 taxa (species, subspecies and varieties) belonging to 126 genera and 49 families were recorded within and adjacent to the 95 quadrats (Appendix 16). The 95 quadrats surveyed captured an average of 25, maximum of 48 and minimum of 4 species. The average richness recorded appears consistent with that detected by Markey *et al.* (2012). The compositional turnover (Whittaker's beta diversity; Whittaker 1965) was high, at 0.83.

4.2.2 Flora and Vegetation Associations

The Craig (2008) vegetation communities were ground-truthed with a focus on structural changes during the survey conducted in Spring 2016. During this time disturbed areas were updated. Only very minor changes were made to the boundaries of these vegetation units. After the establishment and analyses of the 95 quadrats within these vegetation units, the vegetation units have been updated. A description of each vegetation community as described by Craig *et al.* (2008) are presented in Table 4-3 and Figure 4-4 shows where those vegetation communities occur within the Project Area.

Relative Euclidean distance combined with Ward's clustering was identified by OptimClass as the optimal classification. This is not surprising given that normalisation of the data is known to decrease unbalanced species distribution across relevés, as is the case with APM data (See section 4.2.1). According to peaks in the number of diagnostic species to cluster number, we identified 12 floristic communities belonging to two major groups (MG). Detailed descriptions of the Communities were summarised in the form of community profiles and their position established along gradients of variables from the environmental data in Appendix 15. A low (%) of the compositional variance (at quadrat level) was explained by the environmental variables with a total of 13.57 along the first two db-RDA axis. With exception of Community 12 (*Eucalyptus asperatilis – Eucalyptus*

cernua) which occurs primarily on shallow regolith with higher Total Nitrogen and Organic Carbon, the remainder of the Communities appear to have overlapping environmental niches.

Table 4-3: Relationship between Craig *et al.*'s (2008) and APM (2017) New Floristic Communities in the Ravensthorpe Gold Project Area (with exception of Completely Degraded areas).

New Community Number	Craig *et al.*'s (2008) Code	APM Community Name	Total Occurrence in the RGP (ha)
1	Efal/Eple	*Taxandria spathulata - Banksia heliantha*	10.7
2	Ecli; Mx; East; Efal/Eple/ Mallee/Mspp	*Eucalpytus clivicola - Eucalyptus astringens*	18.1
3	Ecli;	*Eucalyptus flocktoniae subsp. flocktoniae*	0.6
4	Efal/Eple; Eole/Mpau	*Eucalyptus flocktoniae - Calothamnus quadrifidus*	6.7
5	Eflo/Espp; Eple/Bmed; Mallee/Mspp	*Eucalyptus leptocalyx - Tetrapora verrucosa*	56.6
6	Dcir; Efal/Eple; Eflo/Espp; Mallee/Mspp	*Taxandria spathulata - Melaleuca rigidifolia*	134.5
7	Ecli; Efal; Efal/Eple; Eflo/Mbra; Mstr	*Banksia cirsioides - Eucalyptus pleurocarpa*	20.0
8	Efal/Eple; Eflo/Mgor; Mallee/mspp; Mstr	*Melaleuca glaberrima - Melaleuca rigidifolia*	46.0
9	East; Eflo/Espp; Eflo/Esug; Eflo/Mgor; Mcau	*Melaleuca stramentosa - Eucalyptus flocktoniae*	64.5
10	Epil; Epla; Epro/Mspp; Espo; Mstr	*Melaleuca stramentosa - Taxandria spathulata*	44.1
11	Eflo/Mcuc; Eflo/Mgor; Eocc; Epro/Mspp; Espo	*Melaleuca cucullata - Melaleuca acuminata*	90.5
12	Mosaic Ecer and Ecli	*Eucalyptus aspratilis - Eucalyptus cernua*	43.7
n/a[1]	Elep/Mrig	*Eucalyptus leptocalyx - Melaleuca rigidifolia*	9.5
		TOTAL:	**545.4**

[1] Not surveyed as the mapped extent of this community does not intersect with the proposed RGP layout.

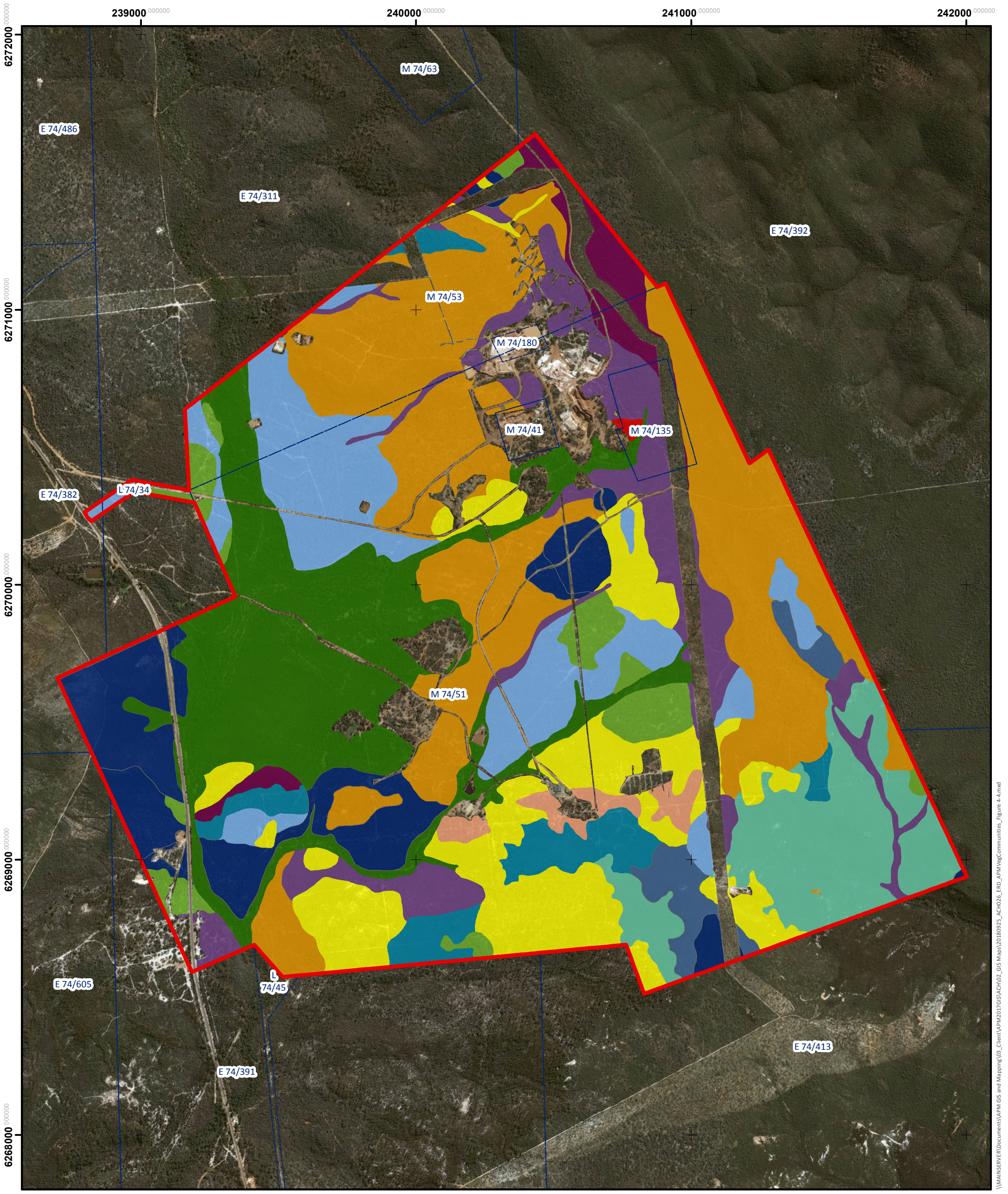


Figure 4-4: APM (2018) Vegetation Communities of the Ravensthorpe Gold Project Area

LEGEND

APM Vegetation Communities

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- Elep/Mrig (Craig 2008 Mapping)

- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500

Meters

Date: 27/09/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

4.2.3 Threatened and Priority Ecological Communities

During the ground-truthing of Craig's mapping (Craig *et al.* 2008) each community was assessed to determine whether it was representative of any one of the TECs or PECs that have the potential to occur in the Project area based on the databases search (Table 4-2). To achieve this goal; (1) the descriptions of the TECs/PECs were compared with those from Craig *et al.* (2008) mapped vegetation units, (2) detailed field observations were made during the on-ground surveys, and (3) formal comparison (especially regarding proteaceous species) was made during the surveys.

Initial desktop survey has identified four of Craig *et al.* (2008) communities as potentially representing one or more of the TECs or PECs. The full description of these communities by Craig *et al.* (2008) is presented in Table 4-4. The status of these communities as belonging to one of the TECs was then further assessed on a per case basis which involved use of quadrat data, the communities produced from the new numerical Classification as well as from field observations.

Table 4-4: Full Description of the Craig *et al.* (2008) Vegetation Communities that Could be Representative of Local TECs and PECs

Craig *et al.* (2008) Vegetation Unit Code	Craig *et al.* (2008) Vegetation Unit Name	Geology	Vegetation description
Dcir	*Banksia cirsioides*: Proteaceous mallee-heaths	Colluvium of deeply eroded surfaces - Qrg (228.8 ha); Sandplain - Czs (101.9 ha), Cemented ironstone gravel and laterite - Czl (67.6 ha); Gravel plain - Czg (64.1 ha); Colluvium and minor alluvium - Qrt (21.5 ha); Ultramafic rock, altered - Ae (6.9 ha); Pelitic metasediments - Alp (3.5 ha)	**Mallees:** *Eucalyptus pleurocarpa, Eucalyptus incrassata, Eucalyptus tetraptera, Eucalyptus uncinata* **Tall shrubs**: *Allocasuarina acutivalvis subsp. acutivalvis, Banksia lemanniana, Hakea pandanicarpa subsp. crassifolia, Melaleuca hamata* **Mid shrubs:** *Banksia cirsioides, Banksia pallida, Gastrolobium parviflorum forma 'broad', Petrophile seminude, Taxandria spathulata* **Low shrubs:** *Allocasuarina humilis, Beaufortia schaueri, Beaufortia micrantha var. micrantha, Melaleuca rigidifolia, Melaleuca subtrigona, Petrophile glauca* **Dwarf shrubs**: *Hibbertia pungens, Leucopogon conostephioides* **Sedges:** *Gahnia ancistrophylla, Mesomelaena stygia subsp. stygia* **Landform:** Lower and simple slopes and flat
Efal/Eple	*Eucalyptus falcata / E. pleurocarpa*: Proteaceous mallee-heath	Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (1135.6 ha); Cemented ironstone gravel and laterite - Czl (779.2 ha); Metamorphosed sedimentary rock - As (405.1 ha); Fine-grained mafic rock - Ab (144.1 ha); Serpentinite - Au (81.3 ha), Pelitic metasediments - Alp (79.7 ha); Colluvium and minor alluvium - Qrt (78.0 ha); Gravel plain - Czg (52.2 ha)	**Mallees**: *Eucalyptus pleurocarpa, Eucalyptus falcata subsp. falcata, Eucalyptus uncinata, Eucalyptus* *incrassata, Eucalyptus phaenophylla* **Tall shrubs:** *Banksia lemanniana, Banksia laevigata subsp. laevigata, Beaufortia orbifolia, Banksia quercifolia, Grevillea coccinea subsp. coccinea, Melaleuca hamata* **Mid shrubs:** *Acacia fragilis, Acacia heterochroa subsp. heterochroa, Allocasuarina humilis, Beyeria brevifolia var. brevifolia, Calothamnus quadrifidus, Banksia cirsioides, Banksia pallida, Gastrolobium parviflorum forma 'broad', Hakea lissocarpha, Hakea obtusa, Hakea verrucosa, Isopogon polycephalus, Jacksonia viscosa, Kunzea cincinnata, Leptospermum spinescens, Melaleuca rigidifolia, Melaleuca subtrigona, Petrophile seminuda, Taxandria spathulata* **Low shrubs:** *Beaufortia schaueri, Hibbertia mucronata, Lasiopetalum compactum, Leucopogon cuneifolius,* *Petrophile glauca, Petrophile fastigiata, Philotheca gardneri subsp. Ravensthorpe (G.F. Craig 6902)* **Dwarf shrubs:** *Hibbertia pungens, Leucopogon conostephioides, Rinzia communis* **Sedges:** *Gahnia ancistrophylla, Lepidosperma sp. Mt Benson (RL Barrett 3553), Lepidosperma sp. Cordingup* *(GF Craig 6138), Mesomelaena stygia subsp. stygia* **Landform:** Crest, upper to lower slope, flat, and open depression

Craig *et al.* (2008) Vegetation Unit Code	Craig *et al.* (2008) Vegetation Unit Name	Geology	Vegetation description
Eple/Bmed	*Eucalyptus pleurocarpa / Banksia media*	Sandplain - mostly loam/ clay, with ironstone pebbles and limonite nodules - Czc (95.9 ha); Sandplain - Czs (61.9 ha); Drainage/ Alluvium of mature drainage - Qpv (59.2 ha); Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (59.2 ha); Colluvium and minor alluvium - Qrt (57.8 ha); Fine-grained mafic rock - Ab (18.8 ha); Felsic extrusives, mainly dacite - Al (11.0 ha)	**Mallees**: *Eucalyptus falcata subsp. falcata, Eucalyptus flocktoniae subsp. flocktoniae, Eucalyptus incrassata, Eucalyptus pleurocarpa, Eucalyptus phaenophylla, Eucalyptus proxima, Eucalyptus suggrandis subsp. suggrandis, Eucalyptus uncinata* **Tall shrubs:** *Banksia media, Melaleuca hamata, Hakea laurina, Hakea pandanicarpa subsp. crassifolia, Hakea pandanicarpa subsp. pandanicarpa* **Mid shrubs:** *Allocasuarina humilis, Calothamnus gibbosus, Calothamnus gracilis, Banksia cirsioides, Grevillea oligantha, Hakea corymbosa, Melaleuca bracteosa, Melaleuca glaberrima, Melaleuca rigidifolia, Melaleuca lateriflora subsp. lateriflora, Melaleuca subfalcata, Melaleuca subtrigona, Taxandria spathulata* **Low shrubs:** *Acacia gonophylla, Baeckea corynophylla, Beaufortia micrantha var. micrantha, Beaufortia schaueri, Boronia inornata, Hakea marginata, Isopogon sp. Fitzgerald River (DB Foreman 813), Leucopogon fimbriatus, Lysinema ciliatum, Petrophile squamata subsp. northern (J Monks 40)* **Dwarf shrubs:** *Acacia ingrata, Hibbertia pungens, Rinzia communis* **Sedges:** *Gahnia ancistrophylla* **Landform:** Simple lower slopes and flats
Mx	Mx	Colluvium of deeply eroded surfaces; contains rock fragments and minor outcrops - Qrg (10.6 ha)	**Mallets:** *Eucalyptus cernua* **Mallees:** *Eucalyptus flocktoniae subsp. flocktoniae, Eucalyptus phaenophylla* **Mid shrubs:** *Baeckea corynophylla, Melaleuca bracteosa, Melaleuca haplantha, Melaleuca sp. Kundip (GF Craig 6020), Melaleuca stramentosa* **Low shrubs:** *Pultenaea craigiana* **Dwarf shrubs:** *Andersonia parvifolia, Coopernookia polygalacea, Hibbertia psilocarpa, Leucopogon infuscatus* **Sedges:** *Gahnia aristata* **Landform**: Gently undulating, lower slopes

Dcir

The *Banksia cirsioides*: Proteaceous mallee-heaths are a vegetation community representative of the Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA TEC/PEC. *Banksia cirsioides* and *Hakea pandanicarpa* are species known to occur in the TEC and have been detected within the Dcir vegetation community described by Craig *et al.* (2008). In support of Craig *et al.*'s (2008) description both species have been detected during our field survey with *B. cirsioides* (Projected cover (%); $\bar{x}$ = 30) and *H. pandanicarpa* (Projected cover (%); $\bar{x}$ = 1). Further, since *B. cirsioides* occurs with cover ≥ 30% the vegetation triggers one of the criteria for referral under the EPBC Act (EPA 1999a). Additionally, pursuant to the new vegetation classification Community 7, consisting of 7 quadrats and named *Banksia cirsioides – Eucalyptus pleurocarpa* is considered as the TEC/PEC. Table 4-5 provides a complete list of species recorded in a single quadrat intersecting with the initial mapping of the Dcir community (Craig *et al.* 2008).

Throughout the Ravensthorpe Range this vegetation community is present as 37 discrete units (Craig *et al.* 2008). Following the new mapping within the Project area, Community 7 occurs within a total of 11 polygons (7 within the Kundip area and 4 along the vegetation corridor) covering a total area of 21.6 ha. Based on the current Disturbance Footprint approximately 3.2 ha (15%) of Community 7 will be directly impacted.

Table 4-5: Species Recorded in 1 Quadrat Intersecting with Craig *et al.*'s (2008) Dcir (*Dryandra cirsioides*) Polygon (bold and shaded taxa are those identified as characteristic floristic elements of the Kwongan TEC).

Species	Number of Observations	Average Projected Cover (%)
Banksia cirsioides	**1**	**30.00**
Allocasuarina thuyoides	1	5.00
Beaufortia micrantha	1	3.00
Lepidosperma diurnum	1	3.00
Leucopogon sp. Newdegate (M. Hislop 3585)	1	3.00
Conostylis bealiana	1	2.00
Melaleuca rigidifolia	1	2.00
Amphipogon turbinatus	1	1.50
Billardiera venusta	1	1.00
Chorizema glycinifolium	1	1.00
Eucalyptus goniocarpa	1	1.00
Eucalyptus pleurocarpa	1	1.00
Gompholobium knightianum	1	1.00
Hakea pandanicarpa* subsp. *pandanicarpa	**1**	**1.00**
Hibbertia gracilipes	1	1.00
Lepidosperma gahnioides	1	1.00
Leptospermum sp. Bandalup Hill (G. Cockerton 11001)	1	1.00
Lysinema pentapetalum	1	1.00
Mesomelaena stygia subsp. *stygia*	1	1.00
Neurachne alopecuroidea	1	1.00
Petrophile squamata subsp. *northern* (J. Monks 40)	1	1.00
Schoenus pleiostemoneus	1	1.00
Stylidium piliferum	1	1.00
Tetrapora verrucosa	1	1.00
Xanthorrhoea platyphylla	1	1.00

Efal/Eple

Eucalyptus falcata / E. pleurocarpa: Proteaceous mallee-heath vegetation community has elements of TECs; (1) Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA and (2) *Banksia laevigata - Banksia lemanniana* proteaceous thicket.

The floristic element reported by Craig *et al.* (2008) within Efal/Eple and belonging to 'Proteaceae Dominated Kwongkan Shrublands TEC' is *B. cirsioides*.

The floristic elements reported by Craig *et al.* (2008) within Efal/Eple and belonging to '*Banksia laevigata - Banksia lemanniana* proteaceous thicket TEC' are; *B. laevigata* subsp. *laevigata*, *B. lemanniana*, *Adenanthos oreophilus*, *Leptospermum maxwellii*, *Beaufortia orbifolia*, *Taxandria spathulata* and *Stylidium albomontis*.

Based on filed observations (Table 4-6), within the Efal/Eple vegetation units (mapped by Craig *et al.*, 2008), occurring within the Project area, the main floristic elements of this vegetation was highly variable, and included; Myrtoid, Ericoid and Restiod dominating taxa (in terms of projected cover as well as high incidence records); with only two records of *B. cirsioides* (Projected cover (%); $\bar{x}$ = 6, Sd ± 5.6), 7 records of *B. lemanniana* (Projected cover (%); $\bar{x}$ = 5.7, Sd ± 4.2), 8 records of *T. spathulata* (Projected cover (%); $\bar{x}$ = 26.1, Sd ± 26.5) and 4 records of *S. albomontis* (Projected cover (%); $\bar{x}$ = 1, Sd ± 0). At no point was *B.* laevigata detected.

The Efal/Eple community is represented within 99 discrete units in the Ravensthorpe Range area. The Efal/Eple vegetation as described by Craig *et al.* (2008) should not be considered as the '*Banksia laevigata - Banksia lemanniana* proteaceous thicket' and only marginal sections have the potential for consideration for referral under the EPBC Act for EPBC as 'Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province'.

Our reasons are manyfold and include; (1) field data (Table 4-6) indicate that the dominant strata are not Proteacous species (instead co-dominating myrtaceous, ericoid, restiod and proteoid only at low strata levels): *sensu stricto* to be considered for listing the vegetation patches must have Proteaceous projected cover values of > 30% across all layers where the shrubs occur (EPA 1999a), and (2) as was the case here, and likely throughout the extent of Efal/Eple across the Ravensthorpe range, fine scale survey effort (capturing the large variability contained within the unit) has/will elucidate patches of vegetation (new Community 7 which is considered a TEC/PEC) contained within Efal/Eple. This re-assignment is not surprising considering that the study of Markey *et al.* (2012) also found that the Efal/Eple community was highly variable.

The vegetation type Efal/Eple (as mapped by Craig *et al.* 2008), represents 151 ha the Project Area, of which 3.3 ha of its original extent falls into the newly delineated Community 7, a small portion of which will be directly impacted based on the current Disturbance Footprint.

Table 4-6: Species Recorded in 12 quadrats Intersecting with Craig *et al.*'s (2008) Efal/Eple Polygons (bold and shaded taxa are those identified as characteristic floristic elements - singleton species were removed unless determined as a characteristic floristic element).

Species	Number of observations	Average projected cover (%)
Eucalyptus pleurocarpa	11	7.82
Petrophile squamata subsp. northern (J. Monks 40)	11	6.91
Hibbertia gracilipes	9	1.11
Taxandria spathulata	**8**	**26.13**
Eucalyptus falcata	8	8.63
Leucopogon sp. Newdegate (M. Hislop 3585)	8	4.75
Melaleuca rigidifolia	8	2.44
Banksia lemanniana	**7**	**5.71**
Lepidosperma gahnioides	7	3.36
Hakea lissocarpha	7	2.57
Lepidosperma carphoides	7	1.50
Mesomelaena stygia subsp. *stygia*	7	1.29
Tetrapora verrucosa	6	6.83
Beaufortia micrantha	6	3.00
Neurachne alopecuroidea	6	1.67
Lepidosperma viscidum	5	2.40
Lepidosperma diurnum	5	1.80
Isopogon sp. Fitzgerald River (D.B. Foreman 813)	5	1.70
Cassytha melantha	5	1.00
Eucalyptus flocktoniae subsp. *flocktoniae*	4	13.00
Eucalyptus incrassata	4	3.00
Allocasuarina humilis	4	2.25
Calothamnus pinifolius	4	2.25
Chorizema glycinifolium	4	1.63
Lepidosperma tuberculatum	4	1.25
Amphipogon turbinatus	4	1.00
Hibbertia exasperata	4	1.00
Lomandra mucronata	4	1.00
Stylidium albomontis	**4**	**1.00**
Hakea laurina	3	10.33
Banksia heliantha	3	6.67
Eucalyptus leptocalyx	3	5.00
Grevillea patentiloba subsp. *patentiloba*	3	3.00
Melaleuca hamata	3	2.67
Eucalyptus uncinata	3	2.33
Eutaxia cuneata	3	1.33
Acacia gonophylla	3	1.00
Acacia subcaerulea	3	1.00
Dampiera lavandulacea	3	1.00
Leptospermum sp. Bandalup Hill (G. Cockerton 11001)	3	1.00
Pterostylis sanguinea	3	1.00

Species	Number of observations	Average projected cover (%)
Pultenaea indira subsp. *indira*	3	1.00
Stylidium piliferum	3	1.00
Verticordia acerosa var. *preissii*	3	1.00
Acacia heterochroa subsp. *heterochroa*	2	15.50
Beaufortia schaueri	2	9.50
Acacia pinguiculosa subsp. *pinguiculosa*	2	8.00
Jacksonia viscosa	2	7.00
Banksia cirsioides	**2**	**6.00**
Hibbertia mucronata	2	6.00
Leucopogon carinatus	2	3.50
Grevillea oligantha	2	3.00
Boronia crassifolia	2	2.00
Leucopogon fimbriatus	2	1.50
Lysinema ciliatum	2	1.50
Acacia crispula	2	1.00
Allocasuarina microstachya	2	1.00
Calothamnus roseus	2	1.00
Cassytha glabella	2	1.00
Cassytha racemosa	2	1.00
Conostylis bealiana	2	1.00
Coopernookia strophiolata	2	1.00
Daviesia anceps	2	1.00
Desmocladus lateriflorus	2	1.00
Dodonaea pinifolia	2	1.00
Gastrolobium venulosum	2	1.00
Gompholobium knightianum	2	1.00
Lasiopetalum rosmarinifolium	2	1.00
Leucopogon opponens	2	1.00
Olearia imbricata	2	1.00
Schoenus racemosus	2	1.00
Thelymitra graminea	2	1.00
Xanthorrhoea platyphylla	2	1.00

Eple/Bmed

The floristic elements reported by Craig *et al.* (2008) within the *Eucalyptus pleurocarpa* / *Banksia media* vegetation suggests that it is representative of the Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA TEC. Characteristic of the Kwongkan TEC are many subordinate (constant) obligate re-seeding species (another characteristic of the TEC) including; *Banksia media, B. cirsioides, Hakea corymbosa* and *H. pandanicarpa*.

Our field data (Table 4-7), partially support Craig *et al.*'s (2008) vegetation descriptions with the detection of *B. media* (Projected cover (%); $\bar{x}$ = 6.7, Sd ± 9.0), *H. corymbosa* (Projected cover (%); $\bar{x}$ = 2, Sd ± 2) and *H. pandanicarpa* (Projected cover (%); $\bar{x}$ = 2, Sd ± 2). Further, we also identified; *Petrophile squamata* subsp. *northern* (J. Monks 40) and *B. lemanniana*—additional diagnostic species of the Kwongkan TEC—occurring

within the Eple/Bmed unit mapped by Craig *et al.* (2008). Of these, *B. media* was distributed amongst four quadrats and *B. lemanniana* over two quadrats.

The *Eucalyptus pleurocarpa* / *Banksia media* vegetation is represented within 31 discrete units within the Ravensthorpe Range (Craig *et al.* 2008). Following the new classification, the unit was re-assigned to Community 5 (*Eucalyptus leptocalyx – Tetraphora verrucosa*) consisting of 14 polygons, which we consider as the Kwongkan TEC. The new area covers 56.6 ha within the Project area of which 22.7 ha will be directly impacted based on the current disturbance footprint.

Table 4-7: Species recorded in 5 quadrats intersecting with Craig *et al.*'s (2008) Eple/Bmed polygons. Bold and shaded taxa are those identified as characteristic floristic elements. Singleton species were removed unless determined as a characteristic floristic element.

Species	Number of observations	Average projected cover (%)
Lepidosperma gahnioides	5	3.40
Lepidosperma fairallianum	5	3.20
Cassytha glabella	5	1.10
Eucalyptus flocktoniae subsp. *flocktoniae*	4	11.25
Melaleuca rigidifolia	4	9.00
Banksia media	**4**	**6.75**
***Petrophile squamata* subsp. Northern (J. Monks 40)**	**4**	**6.25**
Amphipogon turbinatus	4	6.00
Schoenus racemosus	3	14.33
Eucalyptus leptocalyx	3	11.00
Tetrapora verrucosa	3	9.33
Leucopogon sp. Newdegate (M. Hislop 3585)	3	3.00
Hakea laurina	3	2.67
Mesomelaena stygia subsp. *stygia*	3	2.33
Melaleuca stramentosa	3	2.00
Acacia gonophylla	3	1.33
Acacia ingrata	3	1.33
Calytrix leschenaultii	3	1.33
Hibbertia gracilipes	3	1.33
Neurachne alopecuroidea	3	0.70
Banksia lemanniana	**2**	**21.00**
Hakea lissocarpha	2	2.50
Daviesia teretifolia	2	2.00
Grevillea oligantha	2	2.00
Stachystemon virgatus	2	2.00
Leptospermum sp. Bandalup Hill (G. Cockerton 11001)	2	1.50
Conostylis bealiana	2	1.00
Coopernookia polygalacea	2	1.00
Isopogon sp. Fitzgerald River (D.B. Foreman 813)	2	1.00
Hakea corymbosa	**1**	**2.00**
Hakea pandanicarpa* subsp. *pandanicarpa	**1**	**2.00**

Mx

The floristic elements reported by Craig *et al.* (2008) within the *Melaleuca sp. Kundip* vegetation (Mx) suggests that it is representative of the PEC 'Very open mallee over Melaleuca sp. Kundip dense heath (P1)'. Characteristic species recorded by Craig *et al.* (2008) include; *Acacia durabilis, Dodonaea trifida, Eucalyptus cernua, Eucalyptus phaenophylla, Eucalyptus pileata, Leucopogon infuscatus, Hibbertia psilocarpa, Melaleuca bracteosa, Melaleuca* sp. Kundip (*Melaleuca sophisma*), *Melaleuca haplantha, Melaleuca rigidifolia, Melaleuca stramentosa, Melaleuca ulicoides*. Additionally, the vegetation community occurs on pale loamy sand with quartz rubble – also matching formal description of the PEC.

Mx is found within three discrete units in the Ravensthorpe Range, all of which are within the Project area. During the field survey within the quadrat falling within Mx we detected; *E. cernua* (Projected cover (%); $\bar{x}$ = 15)*, E. phaenophylla* (Projected cover (%); $\bar{x}$ = 5)*, M. bracteosa* (Projected cover (%); $\bar{x}$ = 10) and *M. sophisma* (Projected cover (%); $\bar{x}$ = 30) (Table 4-8). Following classification procedures these quadrats were assigned to Community 2 (*Eucalyptus clivicola – Eucalyptus astringens*) which is described as having two main physiognomic facies: one dominated by *M. sophisma* and the other by *M. haplantha*.

Community 2 consists of 13 polygons and as whole is distributed across 17.5 ha within the Project area. Importantly, only one of these polygons is dominated by *M. sophissima* and covers 1.0 ha. In a precautionary fashion we also incorporated a buffer around database records as well as field opportunistic observations of *M. sophissima* to delineate the full extent (34.2 ha), subsequently this PEC area now incorporates Community 7 & 9 as well. Additionally, DPAW (2016) noted that the PEC abuts *Eucalyptus astringens* low woodland – an observation which is consistent with our new classification (i.e. Community 2, is named *Eucalyptus clivicola – Eucalyptus astringens* after its two most dominant taxa). As a result, the new buffer also includes this area as described by DPAW (2016) as marginal. We remain confident that this new buffer captures the extent of this PEC and captures the majority of the ecological substrate (pale loamy sand with quartz rubble) representing the niche of this PEC community as well as that of the Priority 4 species, *M. sophissima*. As a point, this surface geology (Qrg; Table 4-4) which exhibits the loamy sand with quartz rubble appears and extends south from the southern extent of the Project area. Approximately 2 ha (6%) of this PEC will be directly impacted based on the current disturbance footprint.

Table 4-8: Species Recorded in 1 Quadrat Intersecting with Craig *et al.*'s (2008) Mx polygon (bold and shaded taxa are those identified as characteristic floristic elements).

Species	Number of observations	Average projected cover (%)
Melaleuca sophisma	**1**	**30**
Eucalyptus cernua	**1**	**15**
Melaleuca bracteosa	**1**	**10**
Melaleuca torquata	1	10
Eucalyptus phaenophylla	**1**	**5**
Melaleuca cucullata	1	5
Acacia ingrata	1	1
Gahnia sp. South West (K.L. Wilson & K. Frank KLW 9266)	1	1
Lepidosperma sp.	1	1
Melaleuca lateriflora	1	1

Table 4-9 provides a summary of estimated impacts to vegetation communities, which based on the above assessment, potentially represent TECs/PECs listed in Table 4-2. Potential impacts have been considered at a local scale (i.e. within the Project Area) and at a regional scale (i.e. within the context of the wider Ravensthorpe Range). Figure 4-5 shows the distribution of these communities within the Project Area.

Table 4-9: Threatened and Priority Ecological Community Impacts

TEC/PEC Representation	Vegetation Community	Community occurrence in the Project area (ha)[1]	Community Directly Impacted (ha)	Disturbance to TEC/PEC within the Project area (%)	Disturbance to TEC/PEC in the Occurring within a 30 km Radius of the Project Area (%)[2]
Priority 1 PEC – Very open Mallee over Melaeuca sp. Kundip dense heath.	Community 2 Community 7 Community 9	34.2[3]	1.2	3.5	8.8
TEC/PEC – Proteacea Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA	Community 5 Community 7	76.7[4]	38.4	50.1	< 0.1

[1] 8.9 ha of vegetation community 7 meets the criteria for both and therefore must be subtracted from the total. The total area of these communities within the Project area is therefore 101.9 ha (not 110.8 ha).

[2] Calculated using shapefiles provided by DBCA on 16 June 2016. For the purpose of estimating the total area of each TEC/ PEC the 500 m buffers were removed from each polygon.

[3] The area provided represents specific portions of Communities 2, 7 and 9 considered as PEC 'Very open Mallee over *Melaleuca* sp. Kundip dense heath', and isolated towards the south within the Kundip Mine Site.

[4] Validation for the estimated extent of this TEC/PEC along the access corridor from the Hopetoun-Ravensthorpe Road can be made, as, brief survey work in early August (2018) comprised of quadrat and species collections that were found to reflect Community 5 (TEC/PEC).

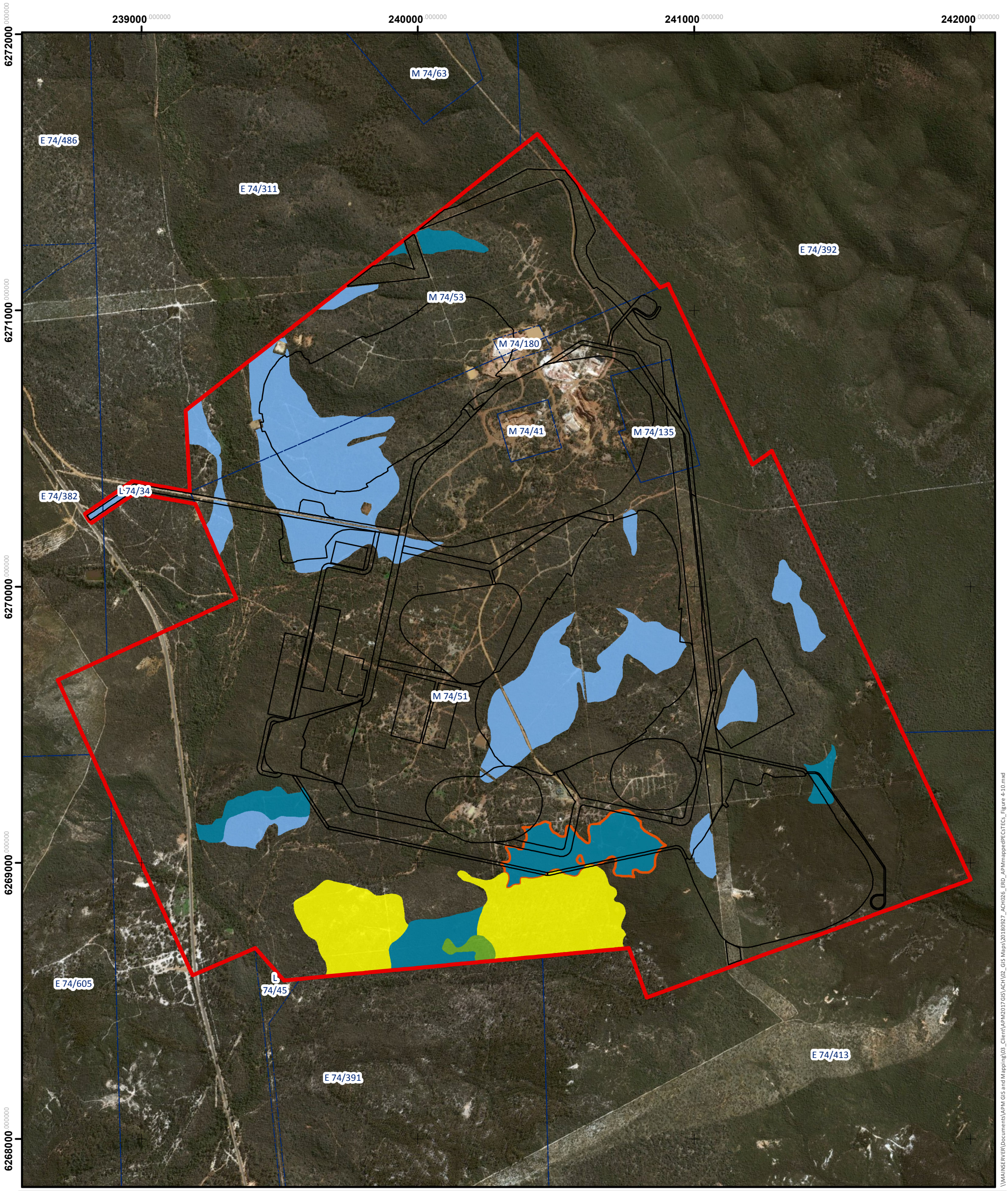


Figure 4-5: Vegetation Representative of Priority and Threatened Ecological Communities at the Ravensthorpe Gold Project Area

LEGEND

TECs and PECs of the RGP (APM 2018)

- Community 2 - PEC - Melaleuca sp. Kundip dense heath
- Community 5 - TEC/PEC Kwongkan Shrublands
- Community 7 - TEC/PEC Kwongkan Shrublands
- Community 7 - TEC/PEC Kwongkan and PEC Melaleuca sp. Kundip
- Community 9 - PEC - Melaleuca sp. Kundip dense heath

- RGP Disturbance Footprint
- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500

Meters

Date: 27/09/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

4.2.4 Vegetation Condition

There is a longstanding legacy of mining practice within the Kundip Mine Site stemming from the early 19th century to present day exploration projects. As such, vegetation within the Project Area consequently reflects a mosaic of conditions (Keighery, 1994). Areas containing established access roads and all historically disturbed areas such as open pits, underground workings, WRL, heap leach pad and old hardstand areas are of 'Completely Degraded' condition (Keighery, 1994). Recent exploration works (drill lines at 25 – 50 m resolution) are areas of both 'Good' and 'Degraded' condition vegetation (Keighery, 1994), given that some areas of disturbance have had more time to regenerate. Areas containing historic exploration lines, historic access tracks and some historically cleared areas are of 'Very Good' condition (Keighery, 1994). All areas that have not been mapped to a specific condition are considered of 'Very Good' condition (Keighery, 1994) or better (i.e. up to 'Excellent' and 'Pristine' (Keighery, 1994).

In total, there is 70.9 ha of 'Completely Degraded' vegetation within the Project Area. Condition mapping for vegetation within the Kundip Mine Site is shown in Figure 4-6.

239000 000000
240000 000000
241000 000000
242000 000000
6272000 000000
6271000 000000
6270000 000000
6269000 000000
6268000 000000

M 74/63
E 74/486
E 74/311
E 74/392
M 74/53
M 74/180
M 74/41
M 74/135
E 74/382
L 74/34
M 74/51
E 74/605
L 74/45
E 74/391
E 74/413

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM2017GIS\ACH\02_GIS Maps\20180927_ACH026_ERD_VegCondition_Figure 4-8.mxd

Figure 4-6: Vegetation Condition at the Ravensthorpe Gold Project Area

LEGEND

Vegetation Condition

- Completely Degraded
- Good to Degraded
- Very Good

- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500

Meters

Date: 27/09/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

4.2.5 Conservation Significant Flora

The 2016 - 2018 APM biological surveys identified a total of 7 flora species of conservation significance as occurring within the overall Project Area (Table 4-10). The location of recorded individuals is shown in Figure 4-7, with actual or estimated (~) population sizes provided in Table 4-10. The recorded distribution of each species in a local and regional context is discussed below.

Table 4-10: Flora of Conservation Significance Recorded within the Ravensthorpe Gold Project Area

Species	Conservation Status	Recorded in APM Quadrat(s)	Recorded in APM Targeted Search(es)	No. of Individuals Recorded
Calothamnus roseus	P1	*		≈753+
Dampiera sp. Ravensthorpe	P3			1
Hydrocotyle sp. Decipiens	P2	*	*	4
Lepidosperma sp. Elverdton	P1			1
Marianthus mollis	P4		*	≈1569+
Melaleuca sophisma	P1	*	*	3
Pultenaea craigiana	P3	*	*	8
Stachystemon vinosus	P4	*		1
Thysanotus parviflorus	P4	*		4

APM have been unable to confirm the status of phrase name sedges of the Genus *Lepidosperma* within the Project area, despite making collections near previous records and submitting these to the paid ID at the State Herbarium. The WA Herbarium has stated:

"The genus Lepidosperma is large and taxonomically complex. It is currently in the early stages of revision by Russell Barrett, formerly of Kings Park but who is now based in Canberra and not working on Lepidosperma. Russell has so far adopted very narrow species concepts and in addition to the published taxa and formally recognised phrase names there are many other waiting in the wings. This has left users with the problem of how to distinguish previously described species from the numerous formal and informal phrase names that Russell recognises, in the absence of documentation of the character differences that his is using. This basically means that the W.A. Herbarium is now in the unsatisfactory position of frequently being unable to provide authoritative identifications in the genus." Michael Hislop (2017).

It cannot therefore be confirmed whether any of these sedges would represent conservation significant flora based on the WA Herbarium response. The following conservation significant *Lepidiosperma* sedge species that could potentially occur within the Project Area include:

- *Lepidosperma* sp. Archer Drive (S. Kern & R. Jasper LCH 18300) (P1);
- *Lepidosperma* sp. Elverdton (R. Jasper *et al.* LCH 16844) (P1);
- *Lepidosperma* sp. Maydon (S. Kern, R. Jasper, H. Hughes LCH 17844) (P1);
- *Lepidosperma* sp. Mt Chester (S. Kern *et al.* LCH 16596) (P1);
- *Lepidosperma* sp. Mt Short (S. Kern *et al.* LCH 17510) (P1);
- *Lepidosperma* sp. Shoemaker Levy (L. Ang & O. Davies 10815) (P3); and
- *Lepidosperma* sp. Steere River (S. Kern, R. Jasper, H. Hughes LCH 17764) (P1).

Of these species *Lepidiosperma* sp. Mt Short and *Lepidosperma* sp. Elverdton have previously been recorded by the DBCA databases as occurring within the Project Area.

4.2.6 Introduced Flora

APM identified 17 weed species within the RGP, including **Aloe brevifolia*, **Aloe maculata*, **Arctotheca calendula*, **Asparagus asparagoides*, **Atriplex prostrata*, **Carpobrotus aequilaterus*, **Cersium vulgate*, **Cotula coronopifolia*, **Conyza bonariensis*, **Hypochaeris glabra*, **Lolium rigidum*, **Oxalis pes-caprae*, **Pelargonium capitatum*, **Pentameris airoides* subsp. *airoides*, **Sanchus oleraceus*, **Trifolium* spp. and **Ursinia anthemoides*. Of these, only one, **Asparagus asparagoides*, is classified as a Weed of National Significance (WONS) by the DoEE (2012) and is also a Declared Pest by the DPIRD *Biosecurity and Agriculture Management Act 2007* (BAM Act) and is categorised as C3 (Management) (DAFWA, 2016). The locality of this species is isolated to areas of high disturbance and is associated with annual weed species (Plate 4).

The location of *A. asparagoides* and other annual weeds recorded within the Project Area during APM surveys is indicated in Figure 4-8.

Plate 4: *Asparagus asparagoides* Weed Patch (APM, 2016)

239000 000000
240000 000000
241000 000000
242000 000000
6271000 000000
6270000 000000
6269000 000000
6268000 000000

M 74/63
E 74/486
E 74/311
E 74/392
M 74/53
M 74/180
M 74/41
M 74/135
E 74/382
L 74/34
M 74/51
E 74/605
L 74/45
E 74/413
E 74/391

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM Client\APM2017GIS\ACH\02_GIS Maps\20180927_ACH026_ERD_Weeds_Figure 4-9.mxd

Figure 4-8: Location of **Asparagus asparagoides* and other Annual Weeds (Buffer Zone) and Eradication Zone at the Ravensthorpe Gold Project Area

LEGEND

- Buffer Zone - *Asparagus asparagoides* and Other Annual Weeds
- Eradication Zone - *Asparagus asparagoides* and Other Annual Weeds
- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500
Meters

Date: 27/09/2018
Scale: 1:13,000
GDA 1994 MGA Zone 51
Author: sarah@animalplantmineral.com.au

ACHMINERALS

5 TERRESTRIAL VERTEBRATE FAUNA RESULTS

5.1 DESKTOP SURVEY

Collectively, database searches indicate that a total of 297 fauna species are expected to occur within 10 km of the Project area: the total of 297 species comprise 133 birds, 27 mammals, 7 amphibians, 33 reptiles and 97 invertebrates. NatureMap lists records for 5 amphibians, 29 reptiles, 14 mammals and 69 birds. The AoLA lists records for 7 amphibians, 26 reptiles, 13 mammals, 77 birds and 94 invertebrates.

Baseline fauna surveys have recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians. The assimilated survey records represent collections of approximately 50% of the expected fauna species likely to be present in the Project area. Some of the common fauna elements of the Project have been discussed in the context of the fauna habitat types within which they occur.

Database searches of Conservation Significant fauna indicate that a total of 46 fauna species are expected to occur within 10km of the Project area. This comprises 28 birds, 15 mammals, 2 reptiles and 1 invertebrate. The EPBC Protected Matters Search Tools lists records for 15 fauna species of Conservation Significance (comprising 11 birds and 4 mammals). The DBCA database search lists 34 Conservation Significant fauna (comprising of 20 birds, 11 mammals, two reptiles and one insect).

Conservation significant fauna identified by the database searches and the likelihood they occur in the Project Area are discussed in Table 5-1.

Fauna surveys carried out in January and November of 2004 by Biota Environmental Sciences Pty Ltd (Biota) recorded five fauna taxa of Conservation Significance. These included Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Malleefowl (*Leipoa ocellata*), Ravensthorpe Range Slider (*Lerista viduata*), Western Whipbird (Mallee) (*Psophodes nigrogularis* subsp. *oberon*) and the Western Brush Wallaby (*Macropus* Irma). The Biota surveys also recorded two species of mygalomorph spiders, *Aname mainae* and *Chenistonia tepperi,* in the Project area.

Table 5-1: Conservation Significant Fauna Potentially Occurring and those Recorded During the Surveys in the Ravensthorpe Gold Project Area

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Birds							
Apus pacificus	Fork-tailed Swift	IA	IA	The Fork-tailed Swift occurs on coastal plains and sometimes foothills (DoEE, 2018b). They are mostly found over dry or open habitats including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh. This species is almost exclusively aerial (DoEE, 2018b).	Moderate	Yes	This species is almost exclusively aerial and therefore will not be dependent upon habitats within the RGP.
Ardea ibis	Cattle Egret	IA		The heaviest distribution of this species in WA is in the north east, and into the Northern Territory. In the non-breeding season, it can be found throughout most of Australia (DoEE, 2018b).	Low	No	There is no suitable habitat in the RGP.
Ardea modesta	Eastern Great Egret	IA		The Great Egret occupies a wide variety of wet habitats including freshwater wetlands, dams, flooded pastures, estuarine mudflats, mangroves and reefs (Morcombe, 2004). The species is also known to visit shallows of rivers, sewage ponds and irrigation areas (Pizzey & Knight, 2012).	Moderate	Yes	If this species did occur, it would only be as a transitory visitor foraging over the site.
Botaurus poiciloptilus	Australasian Bittern	EN	EN	In Western Australia the species was formerly widespread in the south west however is now thought to only occur on the western coastal plain, southern coastal region and inland to some wetlands in the	Low	No	There is no suitable habitat in the RGP.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
				Jarrah forests (DoEE, 2018b).			
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	EN	Carnaby's Cockatoo is a postnuptial nomad and typically moves west soon after breeding. The species nests in hollows of smooth-barked eucalypts, particularly Salmon Gum (*Eucalyptus salmonophloia)* and Wandoo (*E. Wandoo)* but is not limited to these eucalypts. Diet consists of an array of Proteaceous and Myrtaceous species. Foraging habitat, including *Banksia* woodlands, is habitat critical to the survival of the species (DPaW, 2013).	Recorded	Yes	The majority of vegetation remaining at the Project Area represents potential feeding habitat for this species. While the Project is located on the edge of the breeding range for Carnaby's Cockatoo (DoEE 2018b), no hollow-bearing trees have been identified within the Project area (APM 2016; 2017). The record made by Biota in 2004 was of individuals flying over and perching on site on two occasions, by which the species was sighted a total of 6 times. APM also recorded individuals flying over the site in 2016.
Dasyornis longirostris	Western Bristlebird	EN	VU	The Western Bristlebird inhabits floristically diverse low dense coastal heathland. It occurs in three distinct locations: Fitzgerald River National Park, Hassell (Cheynes) Beach/Waychinicup National Park/Two Peoples Nature Reserve, and a translocated population near Walpole, though this last population may no longer occur there. There is also a record of two Western Bristlebirds at Kundip Nature Reserve from December 2003. However, it is unknown if this record represents a permanent subpopulation or was a record of vagrant or dispersing birds (DoEE, 2018b).	Low	No	The Project is not in the preferred range for this species. The Western Bristlebird occurs mostly in the deep south west of the State occupying dense thickets and heath. A record of two birds have been made on the Jerdacuttup Road immediately south of the Project Area however, these are isolated occurrences, when compared to the 1000+ records made within and adjacent the Fitzgerald National Park.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Falco peregrinus	Peregrine Falcon	-	OS	A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2012). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests.	Recorded	Yes	Individuals would forage over the site as part of a broader foraging territory. However, nesting is unlikely due to lack of suitable natural habitat. One individual was recorded during the APM 2016 survey flying over heavily disturbed areas around Two Boys pit adjacent the 'Low Woodland Mallee and Heath' vegetation of the Kundip Mine Site.
Leipoa ocellata	Malleefowl	VU	VU	Malleefowl habitat requirements are quite specific. The species requires unburnt Mallee and woodland with low scrub and abundant litter to use in nesting mounds (Morcombe, 2004).	Recorded	Yes	One historically inactive mound has been located within the Kundip Mine Site in the 'Low Woodland Mallee and Heath habitat' and individuals were recorded during the APM 2016 survey foraging in the 'Low Woodland and Mallee Heath' habitat around the Kundip Battery and running across the Hopetoun-Ravensthorpe Road adjacent to the Kundip Mine Site entrance. In 2017 APM sighted one individual dashing across the main road further towards the town of Ravensthorpe, outside of the Project Area. Despite extensive ground searches, no active or recently inactive mounds have been located.
Merops ornatus	Rainbow Bee-eater	M	-	The Rainbow Bee-eater is a common species which occupies numerous habitats including open woodlands with sandy loamy soil, sand ridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests. The Rainbow Bee-eater avoids heavy forest that would hinder the pursuit of its insect prey (Morcombe, 2004).	High	Yes	This species is ubiquitous across much of the south west and nests in loosened soil in spoil heaps and topsoil dumps. Therefore, the Project Area potentially provides habitat of value to this species.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Motacilla cinerea	Grey Wagtail	IA	IA	The Grey Wagtail prefers the banks and rocks of fast-running fresh water habitats. It occurs in open and forested areas but can be found anywhere during migration (Johnstone and Storr, 2004).	Low	No	There is no fast-running fresh water habitat available in the Project Area. Though the species may move past during migration, it is not likely to be recorded within the site.
Pandion cristatus	Eastern Osprey	IA	IA	The Osprey is found in coastal areas (Johnstone and Storr, 1998).	Low	No	The Project Area is not adjacent to the coast.
Pezoporus occidentalis	Night Parrot	EN	CR	The Night Parrot requires treeless or sparsely wooded spinifex grasslands near water (Johnstone and Storr, 1998).	Low	No	There is no habitat suitable for this species in the Project Area.
Psophodes nigrogularis oberon	Western Whipbird (Mallee)	-	P4	The Western Whipbird species is restricted to four races in small fragmented populations including Two Peoples Bay, Kangaroo Island, and 'Murray Mallee' (Pizzey & Knight, 2012). This species prefers dense long unburnt thickets of healthy shrubs, low Eucalypts and Mallee trees (Pizzey & Knight, 2012).	Recorded	Yes	There is little evidence of recent fire in the Kundip Mine Site and much of the habitat is suitable for this species particularly along the north and eastern edges of the tenement. This species was previously recorded by Biota (2004) and again during the APM (2017) survey. On all occasions the species was recorded in the 'Low Woodland Mallee and Heath' and one record location was the same for the Biota and APM surveys in the centre of the Development Envelope.
Pezoporus flaviventris	Western Ground Parrot	CR	CR	Heathland dominated by *Banksia* and *Hakea* and in low open Mallee in swampy areas. The species prefers vegetation that has been unburnt for at least six years.	High	Yes	The primary population of Western Ground Parrot occurs within the Fitzgerald River National Park, with smaller populations to the west in the Cheyne Beach/Waychinicup area and to the east in Cape Arid National Park and Nuytsland Nature Reserve. This species has not been recorded in the Kundip

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
							Mine Site by Biota (2004), or APM (2016 and 2017).
Reptiles							
Lerista viduata	Ravensthorpe Range Slider skink	-	P1	As with other species from the *Lerista* genus, the Ravensthorpe Range Slider is found in loose soil or sand beneath stones, logs, termite mounds etc. This species has only been recorded in the Ravensthorpe Range (Cogger, 2014).	Recorded	Yes	This species was recorded by Biota in 2004 in the 'Low Woodland Mallee and Heath' where open Mallee and very dense proteaceous thicket of *Banksia lemanniana* is typical and soils were skeletal pale grey to orange loamy sands with lateritic gravel.
Mammals							
Dasyurus geoffroii	Chuditch, Western Quoll	VU	VU	Following European settlement, the range of this species contracted dramatically, from much of the continent to a small area in the south west. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and Mallee shrubland (Van Dyck & Strahan, 2008). Most of the records are found in the contiguous Jarrah forests of the south west of Western Australia (DoEE, 2018b). Recent records exist within the Gnangara pine forest and Walyunga National Park.	Recorded	Yes	The 'Low Dense Forest/Forest' habitat of the Kundip Mine Site provides suitable habitat and individuals were recorded on camera during the APM 2016 and 2017 surveys in the same location. In the area within which this species was recorded was a number of mine shafts and a significant amount of building debris from the old Kundip Battery.
Hydromys chrysogaster	Water Rat/Rakali	-	P4	The Water Rat is found in a range of habitats including subalpine streams, slow inland rivers, lakes, farm dams and sheltered marine waters (Menkhorst and Knight 2001).	Moderate	Yes	This species may occur at the dams within the Kundip Mine Site, however, this would be sub optimal habitat due to the lack of waterside vegetation.

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Isoodon fusciventer	Quenda, Southern Brown Bandicoot	-	P4	The Quenda or Southern Brown Bandicoot exists only in a fragmented distribution to its former range in southern south western and eastern Australia. It is found in forest, woodland, heath and shrub communities in these regions. Preferred habitat usually consists of a combination of sandy soils and dense heathy vegetation (Van Dyck & Strahan, 2008).	Recorded	Yes	The 'Low Dense Forest / Forest' habitat of the Kundip Mine Site provides suitable habitat particularly in areas where sedges and grasses form a dense understory. Diggings consistent with this species' form were identified in all 3 fauna habitat types during the APM (2016) survey.
Notamacropus eugenii derbianus	Tammar Wallaby	-	P4	The Tammar Wallaby is thought to have persisted in disjunct mainland populations for up to 10,000 years however given the large scale vegetation clearing since the arrival of Europeans, the range of this species has contracted. In the south west of Western Australia, this species occurs in several reserves in the wheatbelt and national parks in the Great Southern Region (Van Dyck & Strahan, 2008).	High	Yes	This species has the potential to be cosmopolitan across the Project Area when foraging, retreating to thicker heath and scrub for refuge during the day.
Notamacropus irma	Western Brush Wallaby	-	P4	The Western Brush-wallaby occurs in the southwest of Western Australia. Its preferred habitat consists of open sclerophyll forest or woodland and favours open flats over scrub thickets. It is also found in larger areas of Mallee and heathland in the wheatbelt and is uncommon in wet sclerophyll forest (Van Dyck & Strahan, 2008).	Recorded	Yes	The preferred habitat of this species is open forests and woodlands, but it also occurs in scrubby thickets, Mallee and heath. All of these habitat types occur within the Kundip Mine Site. The species was recorded as roadkill at the entrance of the Kundip Mine Site by Biota (2004) and more recently south of the Project Area on the Hopetoun-Ravensthorpe Road (2017).

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
Myrmecobius fasciatus	Numbat, Walpurti	EN	EN	Originally widespread, the Numbat now only persists in two remnant populations at Dryandra and Perup in Western Australia with several reintroduced populations in the Western Australian Wheatbelt (DoEE, 2018b).	Low	No	This species would no longer be present in the region.
Parantechinus apicalis	Dibbler	EN	EN	The Dibbler appears to be able to occupy a range of habitats. They seem to prefer vegetation with a dense canopy greater than 1 m high, unburnt for at least 10 years. In some areas, the presence of Proteaceous and Myrtaceous flowering shrubs may also be important (DoEE, 2018b).	Moderate	Yes	Areas of vegetation within the Kundip Mine Site have both a dense canopy and a composition dominated by proteaceous shrubs. Therefore, suitable habitat does occur.
Phascogale calura	Red-tailed Phascogale, Kenngoor	VU	CD	The Red-tailed Phascogale is found in the branches of Rock Sheoak (*Allocasuarina huegeliana*) with a tail the same colour as the exposed wood from this plant. It is restricted to areas that receive an annual rainfall of 300-600 mm in isolated patches of forest. Its preferred habitat is the denser and taller communities with Wandoo and Rock Sheoak with hollows in Wandoo providing nesting sites (Van Dyck & Strahan, 2008).	Low	No	There is no habitat suitable for this species in the Project Area.
Pseudomys occidentalis	Western Mouse	-	P4	The Western Mouse is a nocturnal species that live in burrows during the day (20-30 cm deep) consisting of a single vertical entrance shaft connected to a horizontal	High	Yes	Habitat for this species is described as shrublands that have not been burnt for 15-30 years on clay loams, usually with a laterite component (Lee, 1995). This habitat is present within the Kundip

Species	Common Name	Cons. Code		Habitat	Likelihood of Occurrence	Habitat Requirements Met	Comments
		Cth	State				
				loop 2-3 metres in diameter. The nesting chamber is directly opposite the entrance. The entrance shaft is commonly located in dense leaf litter. Capture sites of the Western Mouse have long unburnt vegetation (30-50 years) with layers of extremely dense vegetation at 0.5-2.5 metres high. Dominant upper storey includes *Eucalyptus*, *Isopogon, Acacia, Casuarina* and *Melaleuca* (Van Dyck & Strahan, 2008).			Mine Site.
Pseudomys shortridgei	Heath Mouse, Dayang	EN	VU	The Heath Mouse is found in lowland heath, woodlands and sclerophyll forests (Atlas of Living Australia 2016). Largely confined to habitats with a Mallee overstory on variable soils including loamy-sands and sandy-loams with a laterite component, stony clays and sandy light clay on greenstone (Cooper *et al*., 2003).	Moderate	Yes	The initial survey (APM, 2016) was thought to have recorded *Psudomys shortridgei* (Heath Mouse) based on a field identification. The specimen was not vouchered to the WA Museum at the time of collection. Intensive trapping on two further surveys failed to reveal further evidence of this species. It is suspected that the original recording was a Bush Rat rather than the Heath Mouse.

5.2 FIELD SURVEY

5.2.1 Previous Survey Work

Previous fauna surveys undertaken within the Project area are listed in Table 2-3.

5.2.2 Avifauna Records

Meliphagidae (honeyeaters and wattlebirds) were the most abundant avifauna group recorded during the survey. This is likely a function of the structure of the vegetation, with low mallee woodlands and heaths dominant, as well as abundant Myrtaceae & subordinate Proteaceae species. A total of 301 New Holland Honeyeaters were recorded during Biota's systematic bird censuses. The full records of the avifauna census works are presented in Table 5-2.

5.2.3 Fauna Trapping

Baseline fauna surveys have recorded a total of 101 terrestrial vertebrate fauna species in the Project area, including 54 bird species, 12 mammals (9 native and 3 introduced), 29 reptiles and 6 amphibians (Table 5-3).

The number of small mammals captured during the surveys provides some indication of the quality of fauna habitat in the area. A total of 56 Pygmy Possums (*Cercartetus concinnus*) and 87 Honey Possums (*Tarsipes rostratus*) were captured in pit traps around the Project area.

Despite their apparent fragility these two species are often trapped in high numbers and may be considered a good indicator of environmental health. Pygmy possums feed on pollen and nectar, so an abundant population indicates an abundant array of Proteaceae species. Honey Possum are also a good indicator of the biomass of Proteaceae and Myrtaceae and are often most abundant in climax communities that have remained unburnt for many years (Bradshaw pers. Comm.) which matches habitat age (>100 years) estimated by Craig (2008).

The 87 individuals captured during the Biota survey of 2004 equates to a capture rate of almost 20%. This is four times higher than the average capture rate of a long-term survey in the Scott River National Park (Figure 5-1).

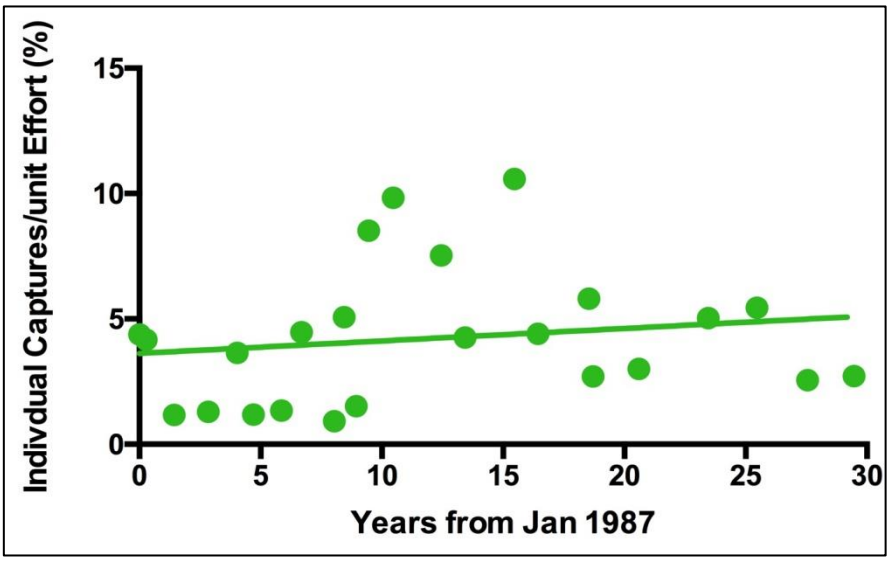


Figure 5-1: **Capture Rates for Honey Possum in the Scott River National Park (Bradshaw in prep.)**

Table 5-2: Avifauna Census Data

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
CASUARIIFORMES										
	Casuariidae									
		Dromaius novaehollandiae	Latham, 1790	Emu	6	x	x			2
GALLIFORMES										
	Megapodiidae									
		Leipoa ocellata	Gould, 1840	Malleefowl	3		x		x	1
	Phasianidae									
		Coturnix ypsilophora	Bosc, 1792	Brown Quail	8		x			1
COLUMBIFORMES										
	Columbidae									
		Phaps chalcoptera	Latham, 1790	Common Bronzewing	1		x			1
		Phaps elegans	Temminck, 1809	Brush Bronzewing	1				x	1
CAPRIMULGIFORMES										
	Podargidae									
		Podargus strigoides	Latham, 1802	Tawny Frogmouth	1				x	1
	Eurostopodidae									
		Eurostopodus argus	Hartert, 1892	Spotted Nightjar	1		x			1
ACCIPITRIFORMES										
	Accipitridae									
		Lophoictinia isura	Gould, 1838	Square-tailed Kite	3	x	x			2
		Accipiter fasciatus	Vigors and Horsfield, 1827	Brown Goshawk	1		x			1
CHARADRIIFORMES										
	Turnicidae									
		Turnix varius	Latham, 1802	Painted Button-	1		x			1

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
				quail						
PSITTACIFORMES										
	Cacatuidae									
		Calyptorhynchus latirostris	Carnaby, 1948	Carnaby's Black-Cockatoo	13		x			1
	Psittacidae									
		Glossopsitta porphyrocephala	Dietrichsen, 1837	Purple-crowned Lorikeet	192	x	x			2
		Barnardius zonarius	Shaw, 1805	Australian Ringneck	22	x	x			2
		Purpureicephalus spurius	Kuhl, 1820	Red-capped Parrot	3		x			1
CUCULIFORMES										
	Cuculidae									
		Chalcites lucidus	J.F. Gmelin, 1788	Shining Bronze-Cuckoo	5		x			1
		Cacomantis flabelliformis	Latham, 1802	Fan-tailed Cuckoo	1		x			1
STRIGIFORMES										
	Strigidae									
		Ninox novaeseelandiae	J.F. Gmelin, 1788	Southern Boobook	1				x	1
	Tytonidae									
		Tyto javanica	J.F. Gmelin, 1788	Eastern Barn Owl	1		x			1
PASSERIFORMES										
	Maluridae									
		Malurus pulcherrimus	Gould, 1844	Blue-breasted Fairy-wren	10		x			1
	Acanthizidae									
		Sericornis frontalis	Vigors and Horsfield, 1827	White-browed Scrubwren	23	x	x			2
		Hylacola cauta	Gould, 1843	Shy Heathwren	11		x			1

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
		Smicrornis brevirostris	Gould, 1838	Weebill	71	x	x			2
		Gerygone fusca	Gould, 1838	Western Gerygone	1	x				1
		Acanthiza apicalis	Gould, 1847	Inland Thornbill	9	x	x			2
	Pardalotidae									
		Pardalotus punctatus	Shaw, 1792	Spotted Pardalote	26	x	x			2
		Pardalotus striatus	J.F. Gmelin, 1789	Striated Pardalote	19	x	x			2
	Meliphagidae									
		Lichenostomus leucotis	Latham, 1802	White-eared Honeyeater	3		x			1
		Lichenostomus cratitius	Gould, 1841	Purple-gaped Honeyeater	9		x			1
		Anthochaera lunulata	Gould, 1838	Western Wattlebird	25		x			1
		Anthochaera carunculata	Shaw, 1790	Red Wattlebird	36	x	x			2
		Anthochaera paradoxa	Daudin, 1800	Yellow Wattlebird						
		Glyciphila melanops	Latham, 1802	Tawny-crowned Honeyeater	49		x			1
		Lichmera indistincta	Vigors and Horsfield, 1827	Brown Honeyeater	47	x	x			2
		Phylidonyris novaehollandiae	Latham, 1790	New Holland Honeyeater	301	x	x			2
		Melithreptus brevirostris	Vigors and Horsfield, 1827	Brown-headed Honeyeater	2		x			1
		Melithreptus chloropsis	Gould, 1848	Western White-naped Honeyeater	16	x	x			2
	Pomatostomidae									
		Pomatostomus superciliosus	Vigors and Horsfield, 1827	White-browed Babbler	2		x			1
		Psophodes nigrogularis	Gould, 1844	Western Whipbird	9		x		x	1

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
	Campephagidae									
		Coracina novaehollandiae	J.F. Gmelin, 1789	Black-faced Cuckoo-shrike	3	x	x			2
	Pachycephalidae									
		Pachycephala pectoralis	Latham, 1802	Golden Whistler	9		x			1
		Colluricincla harmonica	Latham, 1802	Grey Shrike-thrush	4	x	x			2
		Oreoica gutturalis	Vigors and Horsfield, 1827	Crested Bellbird	9		x			1
	Artamidae									
		Artamus cyanopterus	Latham, 1802	Dusky Woodswallow	9	x	x			2
		Cracticus torquatus	Latham, 1802	Grey Butcherbird	2		x			1
		Cracticus tibicen	Latham, 1802	Australian Magpie	1		x			1
		Strepera versicolor	Latham, 1802	Grey Currawong	28		x			1
	Rhipiduridae									
		Rhipidura leucophrys	Latham, 1802	Willie Wagtail	4		x			1
	Corvidae									
		Corvus coronoides	Vigors and Horsfield, 1827	Australian Raven	10	x	x			2
	Monarchidae									
		Myiagra inquieta	Latham, 1802	Restless Flycatcher	1		x			1
	Petroicidae									
		Eopsaltria griseogularis	Gould, 1838	Western Yellow Robin	2		x			1
		Drymodes brunneopygia	Gould, 1841	Southern Scrub-robin	27	x	x			2
	Timaliidae									
		Zosterops lateralis	Latham, 1802	Silvereye	61		x			1
	Hirundinidae									

Order	Family	Species	Nomenc.x	Common Name	No. Recorded	Forest/Low Forest	Mallee and Shrubland	Dampland and Drainage	Opportunistic	No of Habitats
		Hirundo neoxena	Gould, 1842	Welcome Swallow	35		x			1
		Petrochelidon nigricans	Vieillot, 1817	Tree Martin	23		x			1
Species richness:		**54**				**19**	**49**	**0**	**5**	**-**
Total number of individuals:					**1161**					

Table 5-3: Fauna Captured or Recorded in the Ravensthorpe Gold Project Area

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
AMPHIBIANS							
Hylidae							
Litoria moorei	Motorbike Frog	1			x		1
Litoria cyclorhyncha		8		x			1
Myobatrachidae							
Crinia pseudinsignifera		2		x			1
Lymnodynastes dorsalis	Western Banjo Frog	1		x	x		2
Myobatrachus gouldii	Turtle Frog	1		x			1
Neobatrachus kunapalari		1		x			1
REPTILES							
Agamidae							
Caimanops amphibularoides		1		x			1
Amphibolourus norrissi		2		x			1
Ctenophorus maculatus griseus		4		x			1
Pogona minor minor	Western Bearded Dragon	1				x	
Carphodactylidae							
Underwoodisaurus milii	Barking gecko	25	x	x			2
Diplodactylidae							
Crenodactylus ocellatus	Clawless gecko	17	x	x			2
Gekkonidae							
Christinus marmoratus	Marbled gecko	16	x	x			2
Diplodactylus granariensis granariensis		19	x	x			2
Pygopidae							
Pygopus lepidodopus	Common scaly-foot	1		x			1
Delma australis		3		x			1
Delma fraseri fraseri		2		x			1
Aprasia repens		1		x			1

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
Scincidae							
Egernia kingii	King's skink	1		x			1
Tiliqua rugosa	Bobtail lizard	7	x	x	x		3
Acritoscincus trilineatus	South west cool skink	1		x			1
Hemiergis peronii	Four-toed earless skink	31	x	x			2
Morethia obscura	Shrubland morethia skink	15		x			1
Cryptoblepharus virgatus clarus		28	x	x			2
Hemiergis initialis		24	x	x			2
Menetia greyii		21	x	x			2
Lerista distinguenda		8	x	x			2
Ctenotus impar		3		x			1
Lerista viduata		1		x			1
Ctenotus labillardieri		1		x			1
Varanidae							
Varanus rosenbergii	Rosenberg's monitor	10	x	x			2
Boidae							
Morelia spilota imbricata	Carpet python	2					
Elapidae							
Elapognathus coronatus	Crown snake	4		x			1
Parasuta gouldii	Gould's hooded snake	1		x			1
Pseudonaja affinis affinis	Dugite	2	x	x			2
MAMMALS							
Muridae							
Rattus fuscipes	Bush rat	68	x	x	x		3
Mus musculus	House mouse	47		x	x		2
Peramelidae							
Isoodon fusciventer	Southern Brown Bandicoot (Quenda)					x	3

Species	Common Name	No. Recorded	Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage	Opportunistic	No of Habitats
Dasyuridae							
Dasyurus geoffroii	Chuditch	2	x			x	1
Sminthopsis crassicaudata	Fat-tailed Dunnart	1		x			1
Sminthopsis griseoventer	Grey-bellied Dunnart	9	x	x			2
Tarsipedidae							
Tarsipes rostratus	Honey possum	87	x	x			2
Macropodidae							
Macropus fulginosus	Western Grey Kangaroo	3	x	x			1
Notamacropus irma	Western Brush Wallaby	1		x		x	1
Burramyidae							
Cercartetus concinnus	Pygmy Possum	56	x	x			2
Canidae							
Vulpes vulpes	Red Fox			x			1
Felidae							
Felis catus	Feral Cat	1				x	
Tachyglossidae							
Tachyglossus aculeatus	Echidna	1	x	x			2
Species richness		**46**	**19**	**42**	**5**	**5**	
Total number of individuals		**542**					

5.2.4 Bat Acoustic Recording

The database searches for a 10 km radius revealed that only two species of bat had been recorded previously. This provides some indication of the lack of survey work completed in the area. This became particularly apparent the Biota and the APM surveys both returned acoustic signatures for the same four species of bat (Table 5-4).

Table 5-4: Bat Species Recorded in the Ravensthorpe Gold Project Area

		Low Dense Forest/Forest	Low Woodland Mallee and Heath	Damplands and Drainage
Vespertilionidae				
Chalinolobus gouldii	Gould's Wattle Bat		x	x
Chalinolobus morio		x	x	x
Vespadelus regulus		x	x	x
Molossidae				
Austronomus australis	White-striped Mastiff Bat		x	x

5.2.5 Fauna Habitats

Low Dense Forest/Forest

Dense low forest occurred on areas of sheet wash on a low gradient slope. Residual, quartzofeldspathic sand overlies granite rock. The highest vegetation includes mallets of *Eucalyptus astringens*, *E. cernua*, *E. clivicola*, *E. platypus* and mallees of *E. pileata* and *E. flocktoniae* subsp. *flocktoniae*, with tall *Melaleuca cucullata* shrubs over *Daviesia nematophylla*, *Exocarpus aphyllus*, *Melaleuca* sp. Gorse (A.S. George 7224) mid shrubs and low *Grevillea huegelii*. In some areas there are colluvium of deeply eroded surfaces with associated minor outcrops of sandstone and conglomerate or Cemented ironstone gravel and laterite and in areas of poor drainage the ground story can comprise almost entirely of sedges such as *Gahnia aristata.*

These landforms support a complex array of fauna. All of the four species of gecko collected during the surveys, Barking Gecko, Clawless Gecko, Marbled Gecko and the Wheatbelt Stone Gecko, were collected in this habitat, as was a suite of fossorial skinks including the *Hemiergis peronei*, *Hemiergis initialis initialis* and *Lerista distinguenda*. Chuditch were recorded on motion-sensing cameras (APM 2016; 2017) around the Kundip battery in the lower south western section of the Project area containing patches of 'Low Dense Forest/Forest' within the broader vegetation complex, 'Low Woodland Mallee and Heath' habitat.

Dense and structurally diverse vegetation and floristics also provided abundant suitable habitat for the smaller ground-dwelling Grey-bellied Dunnart and the arboreal Honey Possum and Pygmy Possum. Evidence of a diverse and abundant small fauna assemblage was further supported by the presence of larger predatory fauna species such as Rosenberg's Monitor and the Dugite.

The Low Dense Forest/Forest habitat was not particularly well represented within the Project area (52.76 ha), which is comprised mainly of undulating landforms (Figure 5-2). In total, 17.21 ha of this habitat will be cleared within the extent of the Kundip Mine Site, representing 32.62% of the Low Dense Forest/Forest available in the project area. This habitat type was not present within the extent of the corridor.

Damplands and Drainage Lines

The Damplands and Drainage lines contain common eucalypt species such as *E. platypus* subsp. *platypus* and the mallees *E. suggrandis* subsp. *suggrandis*. Tall shrubs are dominated by *Melaleuca* spp. differing from the low dense forest/forest. In Damplands and Drainage lines, more than six species are dominant in the upper strata including *M. cucullata, M. bromelioides*, *M. haplantha*, *M. pauperiflora* subsp. *pauperiflora*, *M. bracteosa*, *M.* sp. Kundip (GF Craig 6020), *M. stramentosa*, *M. acuminata* subsp. *acuminata* and *M. cuticularis*. Acacias are also present in the mid to upper storey. Sedges (*Gahnia trifida, G. ancistrophylla, Mesomelaena stygia* subsp. *stygia, Lepidosperma* sp. *Cordingup* (GF Craig 6138)), grasses (*Spartochloa scirpoidea*) and Herbs (**Asparagus asparagoides, Cassytha melantha*) are common ground story component.

Few species were captured in this habitat type, which is possibly an artefact of the poor conditions during the survey, with a delayed onset of spring and little warm weather during the survey. Surveys in drainage lines during the Biota surveys in January would also not have been particularly productive due to lack of water. Only the Spotted-thighed Frog, Western Banjo Frog, Bobtail Lizard, Bush Rat and House Mouse were recorded.
This habitat has intrinsic value as a connective corridor, currently limiting any fragmentation between all 3 of the broad habitats identified within the Project area.

In total, 27.8 ha of the Damplands and Drainage habitat will be disturbed by the Kundip Mine Site and Corridor, representing 32.0 % of this habitat type within the Project area (Figure 5-2).

Low Woodland Mallee and Heath

The dry Low Woodlands Mallee contain a broad variety of eucalypt species including *E. falcata* subsp. *falcata*, *E. flocktoniae* subsp. *flocktoniae*, *E. incrassata*, *E. pleurocarpa*, *E. phaenophylla*, *E. proxima*, *E. suggrandis* subsp. *suggrandis*, and *E. uncinata*. The primary difference between this habitat and the Dampland and Drainage Lines is the location (this habitat type exists on rises and hills), and the presence of a more diverse array of species preferring dry or better drained substrates. Banksia (*B. media*) and Hakea (*Hakea laurina*, *H. pandanicarpa* subsp. *crassifolia*, *H. pandanicarpa* subsp. *pandanicarpa*) species were prevalent and the mid-shub layer was diverse, including *Allocasuarina humilis*, *Calothamnus gibbosus*, *C. gracilis*, *B. cirsioides*, *Grevillea oligantha* and *H. corymbosa*. Low shrubs were also diverse and dense, including *Acacia gonophylla*, *Baeckea corynophylla*, *Beaufortia micrantha* var. *micrantha*, *Beaufortia schaueri*, *Boronia inornata*, *Hakea m.*, *Isopogon* sp. Fitzgerald River (DB Foreman 813), *Leucopogon fimbriatus*, *Lysinema ciliatum*, *P. squamata* subsp. northern (J Monks 40).

Of the 47 non-volant species recorded throughout the project area, 43 were recorded within this fauna habitat. The records illustrate both the dominance of this vegetation type in the area and the associated sampling bias that is unavoidable in impact assessment. In addition, this habitat is present across the majority of areas likely to be impacted. This bias is not a shortcoming of the survey design, as such intensive sampling achieves a better understanding of the fauna habitat most likely to be impacted by the development.

Within this habitat type, all four of the *Pygopid* (true legless lizards) were collected. Large skinks, the Bobtail Lizard, and the King Skink, were recorded, with the latter collected under building refuge near the historic heap leach facility.

This habitat was the most common habitat type from which the Bush Rat was collected. It is also the habitat within which the Ravensthorpe Range Slider was recorded by Biota (2004). Chuditch were recorded on motion-sensing cameras around the historic Kundip Battery in the lower south western section of the Project area and Malleefowl observed foraging in the same location. A historically inactive Malleefowl mound resides in this habitat type in the lower south-east of the Kundip disturbance footprint near the proposed TSF. In addition to the Dugite, the two small elapids, Crown snake and Gould's hooded snake, were collected under building material in this habitat. Figure 5-2 illustrates the location of this habitat type in the Project area.

Of the 440.9 ha of Low Woodland Mallee and Heath present within the project area, 24.1% (106.4 ha) will be disturbed by the Kundip Mine site, and Corridor.

239000.000000 240000.000000 241000.000000 242000.000000

6271000.000000
6270000.000000
6269000.000000
6268000.000000

M 74/63
E 74/486
E 74/311
E 74/392
M 74/53
M 74/180
M 74/41
M 74/135
E 74/382
L 74/34
M 74/51
E 74/605
L 74/45
E 74/391
E 74/413

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM2017GIS\ACH\02_GIS Maps\20181102_ACH026_ERD_FaunaHabitat_ConsigFigure 4-13.mxd

Figure 5-2: Fauna Habitats and Conservation Significant Fauna Records within the Ravensthorpe Gold Project Area

LEGEND

- Ravensthorpe Gold Project Area
- Mining Tenements

Fauna Habitats

- Damplands and Drainage Habitat
- Low Dense Forest / Forest Habitat
- Low Woodland Mallee and Heath Habitat

Conservation Significant Fauna

- Aname mainae
- Carnaby's Cockatoo
- Chuditch
- Lycosidae sp., Aname mainae
- Malleefowl
- Peregrine
- Quenda
- Western Whipbird
- Western Whipbird, Aname mainae

N

0 100 200 300 400 500

Meters

Date: 02/11/2018

Scale: 1:12,500

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

5.2.6 Conservation Significant Fauna

Fauna surveys carried out in January and November of 2004 by Biota Environmental Sciences Pty Ltd (Biota) recorded five fauna taxa of Conservation Significance. These included:

- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) (Endangered, EPBC Act; Schedule 2 / Division 2 WC Act);
- Malleefowl (*Leipoa ocellata*) (Endangered, EPBC Act; Schedule 3 / Division 2 WC Act);
- Ravensthorpe Range Slider (*Lerista viduata*) (Priority 1, WC Act);
- Western Whipbird (Mallee) (*Psophodes nigrogularis oberon*) (Priority 4, WC Act); and
- Western Brush Wallaby (*Notamacropus irma*) (Priority 4, WC Act).

The APM 2016 and 2017 field surveys identified six conservation significant fauna species listed under the EPBC Act and WC Act. These included:

- Chuditch (*Dasyurus geoffroii*) (Vulnerable, EPBC Act; Schedule 3 / Division 1 WC Act);
- Peregrine Falcon (*Falco peregrinus*) (Other Specially Protected Schedule 7 / Division 2 WC Act);
- Quenda (*Isoodon fusciventer*) (Priority 4, WC Act)
- Malleefowl (*Leipoa ocellata*) (Vulnerable, EPBC Act; Schedule 3 / Division 2 WC Act);
- Western Brush Wallaby (*Notamacropus irma*) (Priority 4, WC Act).
- Western Whipbird (Mallee) (*Psophodes nigrogularis oberon*) (Priority 4, WC Act).

In total, eight terrestrial vertebrate fauna species of Conservation Significance have been recorded during surveys of the RGP. Table 5-5 outlines the conservation significant fauna recorded during the Biota and APM surveys.

Table 5-5: Conservation Significant fauna expected or recorded in the Ravensthorpe Gold Project area

Fauna Species	Common Name	Conservation Status		Database		Biological Surveys			
		Cwlth	State	NatureMap (6 km)	AoLA (5 km)	Biota 2004 Summer	Biota 2004 Spring	APM 2016	APM 2017
Birds									
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	EN	S2	X		X			
Falco peregrinus	Peregrine Falcon	-	S4					X	
Leipoa ocellata	Malleefowl	VU	S3	X	X	X		X	X
Psophodes nigrogularis oberon	Western Whipbird (Mallee)	-	P4	X		X	X		X
Mammals									
Dasyurus geoffroii	Chuditch, Western Quoll	VU	S3	X				X	X
Isoodon fusciventer	Quenda, Southern Brown Bandicoot	-	P4	X				X	
Notamacropus eugenii derbianus	Tammar Wallaby (WA subsp.)	-	P4	X	X				
Notamacropus irma	Western Brush Wallaby	-	P4	X		X			X
Reptiles									
Lerista viduata	Ravensthorpe Range Slider Skink	-	P1	X	X	X			

5.2.7 Conservation Significant Fauna Known to Occur in the RGP

5.2.7.1 Carnaby's Cockatoo – Calyptorhynchus latirostris

Carnaby's Cockatoo is endemic to, and widespread in, the south west of WA. It occurs in uncleared or remnant native Eucalypt woodlands, especially those that contain Salmon Gum and Wandoo, and in shrubland or Kwongkan heathland dominated by *Hakea*, *Banksia* and *Grevillea* species. It also occurs in remnant patches of native vegetation on land otherwise cleared for agriculture (DoEE, 2018b; Saunders 1974, 1979, 1980, 1982, 1986).

Breeding habitat encompasses areas which contain suitably sized nest trees that contain hollows and adjacent foraging habitat. Breeding activity is restricted to Eucalypt woodlands mainly in the semi-arid and sub-humid interior in the wheatbelt. The species nests in large hollows in tall, living or dead Eucalypts. It nests most commonly in smooth-barked Wandoo and Salmon Gum but has also been noted breeding in other vegetation types and is likely to nest in any species of Eucalypt with a suitable hollow (DoEE, 2018b).

During the breeding season, Carnaby's Cockatoo forages in native vegetation surrounding their breeding site. The species are opportunistic feeders and will utilise introduced food sources (e.g. pine plantations). Research indicates that foraging habitat within 12 km of a breeding site is one of the key factors in ensuring successful breeding (DoEE, 2018b; Cale, 2003). Maintaining foraging habitat close to breeding areas and providing corridors of vegetation linking breeding areas to patches of foraging habitat is essential to allow birds to move between isolated patches, and for Black Cockatoo chick survival (DoEE, 2018b; Saunders, 1977, 1990).

To date, Carnaby's Cockatoo has been recorded perching and foraging on six occasions by Biota in 2004, whilst only having been recorded by APM flying over the Kundip site (2016). On two of the occasions in 2004, the birds were sighted in *Melaleuca cucullata – Melaleuca acuminata subsp. acuminata* (APM Community 11), one sighting within *Taxandria spathulata – Melaleuca rigidifolia* (APM Community 6) and three sightings within the mapped Kwongkan Shrublands TEC/PEC north west of the Project Area. It should also be noted that, some natural regrowth of vegetation within the low-grade stockpiles at Kundip (as surveyed in August 2018) is forming APM Community 6. In addition to this, the vegetation within the rehabilitation site at RAV8 is reforming as APM Community 11. Both Community 6 and 11 are communities that support species of feeding value to the Carnaby's Cockatoo. Food species that have naturally recruited and become established on the low-grade stockpiles have been estimated to have grown to maturity (seed bearing) in less than 30 years.

5.2.7.2 Chuditch – Dasyurus geoffroii

Chuditch formerly ranged across nearly 70% of the continent, occurring in every mainland State and Territory (DEC, 2012b). Free-ranging populations of Chuditch are now restricted to WA within an estimated 5% of their former range. The major portion of the remaining natural populations occur in varying densities in Jarrah (*Eucalyptus marginata*) forests and woodlands in the south west coast of WA, and in woodlands, Mallee shrublands and heaths along the south coast, east to the Ravensthorpe area (DEC, 2012b).

Chuditch use a range of habitats including forest, Mallee shrublands, woodland and desert. The most dense populations have been found in riparian Jarrah forest. Chuditch require adequate numbers of suitable den and refuge sites (horizontal logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to persist locally (DEC, 2012b). They are capable of travelling long distances, have large home ranges, and even at their most abundant, Chuditch are generally present in low numbers. Chuditch are predated by foxes and feral cats. For this reason, Chuditch require contiguous suitable habitat as they are more susceptible to predation in fragmented and open habitats.

Chuditch are solitary animals for most of their life. In the absence of foxes, they occupy relatively large home ranges; males ranging over 15 km^2 and females 3 – 4 km^2 (DEC, 2012b; Serena & Soderquist, 1989). While

home ranges may overlap, there tends to be a smaller non-overlapping 'core' area defined by den locations. Core areas are approximately 4 km^2 and 0.9 km^2 for males and females, respectively (Serena & Soderquist, 1989). Females tend to be territorial, although some areas may be shared by a mother and her adult daughter (Serena & Soderquist, 1989). Male core areas are much larger and overlap broadly with other males as well as females. Both sexes occur at similar densities in the Jarrah forest. Home range size may be smaller in areas where foxes are effectively controlled, and where Chuditch population densities are higher (DEC, 2012b; Mathew, 1996).

Chuditch are opportunistic feeders, foraging primarily on the ground at night. In the forest, insects and other large invertebrates comprise the bulk of their diet, though some mammals, birds and lizards are also included (DEC, 2012b; Serena *et al.*, 1991).

The Chuditch is primarily a nocturnal species, they may be diurnally active during the breeding season (April to July) or when cold, wet weather restricts nocturnal foraging (DEC, 2012b). The average life span of an established adult is two years, and wild Chuditch generally don't live past four years (Soderquist, 1988). Factors contributing to Chuditch mortality include:

- Motor vehicle strike (Chuditch commonly forage along dirt roads and tracks making them more susceptible to this);
- Illegal shooting near roads;
- Predation by foxes, raptors and feral cats;
- Injury in rabbit traps; and
- Natural accidents and disease.

The Chuditch has been recorded on camera within the Project Area during the two fauna surveys conducted by APM in 2016 and 2017.

5.2.7.3 Malleefowl – Leipoa ocellata

Malleefowl have been sighted frequently around the Project Area over recent years. Despite the recording of a number of Malleefowl (two individuals sighted during the 2016 APM survey and a further individual sighted dashing across the main road towards the town of Ravensthorpe, outside the Project Area, on the 2017 survey) and the intensive ground search (Figure 5-3), no active or recently inactive Malleefowl mounds have been located. The high level of individual activity on site provides strong evidence that the nests are local. Some of the vegetation is so thick, however, that detectability of mounds may have been reduced. Management of individuals and mounds will be incorporated into the Fauna Management Plan, and this will include more intensive searches for mounds and activity prior to ground clearing and during construction and operation.

Much of the preferred habitat of the Malleefowl has been cleared or modified across its original range, largely by grazing, to which this species is highly sensitive. The degree of fragmentation of remaining Malleefowl habitat is of particular concern and is a major limiting factor in the prevention and reversal of decline of this species (Benshemesh, 2007). Malleefowl appear to preferentially use densely vegetated for movement through the landscape and building their sheltered mounds, highlighting the importance of corridors within thick vegetation in otherwise cleared areas, such as agricultural land.

Malleefowl are also threatened by a range of introduced vertebrate fauna, through predation (e.g. by foxes) or competition for resources (e.g. rabbits and goats) (Benshemesh, 2007). Predation by foxes is thought to be limiting Malleefowl abundance and in many areas may be a major cause of its decline. The impact of fire on

Malleefowl is severe, and breeding in burnt areas is usually reduced or limited for at least 30 years. Deleterious impacts of fire may be mitigated, however, if fires burn patchily (Benshemesh, 2007).

Malleefowl have are generally monogamous and most likely pair for life (Benshemesh, 2007; Frith, 1959). During breeding season, male home-ranges are considerably contracted as they spend the majority of their time in the vicinity of their nests. Malleefowl generally build their nests over several months from autumn to spring. Egg laying usually begins in September and an egg is laid every 5 – 7 days until mid to late summer. Malleefowl chicks typically begin hatching and emerging from mounds in November, and although hatching may continue until March in some seasons, most chicks usually emerge from mounds before January (Benshemesh, 2007; Frith, 1959). Chicks receive no parental care and disperse upon eviction from the nest. As a result, mortality during the first month is high (Benshemesh, 1992).

While breeding birds tend to be sedentary, nesting in the same general area year after year (Benshemesh, 2007, 1992; Frith, 1959), a pair sometimes moves several kilometres between nesting seasons for no discernible reason (Benshemesh, 2007; Frith, 1959). Malleefowl have large home ranges up to several square kilometres which do not appear to be defended. The nest itself, however is vigorously defended by the (Benshemesh, 2007; Frith, 1959).

The proposed Project Area at the Kundip Mine Site has been extensively searched for Malleefowl and Malleefowl mounds. One historic inactive mound occurs in the 'Low Woodland Mallee and Heath' habitat southeast of the Kundip Mine Site on the hill slope adjacent the proposed TSF; however, no active or recently inactive Malleefowl mounds have been recorded within the Project Area. Despite this, Malleefowl individuals were recorded within the Project Area, suggesting that the Project Area may form part of a home range territory for a pair, or multiple pairs, of Malleefowl.

239000 000000
240000 000000
241000 000000
242000 000000
6272000 000000
6271000 000000
6270000 000000
6269000 000000
6268000 000000

M 74/63
E 74/486
E 74/311
E 74/392
M 74/53
M 74/180
M 74/41
M 74/135
E 74/382
L 74/34
M 74/51
E 74/605
L 74/45
E 74/391
E 74/413

\\MAINSERVER\Documents\APM GIS and Mapping\03_Client\APM2017GIS\ACH\02_GIS Maps\20180816_ACH026_ERD_APMSurveyTracks_Figure 4-3.mxd

Figure 5-3: APM (2018) Survey Tracks within the Ravensthorpe Gold Project Area

LEGEND

- APM Survey Tracks (2016 - 2018)
- Ravensthorpe Gold Project Area
- Mining Tenements

N

0 100 200 300 400 500

Meters

Date: 25/09/2018

Scale: 1:13,000

GDA 1994 MGA Zone 51

Author: sarah@animalplantmineral.com.au

ACHMINERALS

5.2.7.4 Peregrine Falcon – *Falco peregrinus*

The Peregrine Falcon inhabits a vast array of environments in Australia, and throughout the world (Pizzey & Knight, 2012). It is likely that individuals of this species would forage within the Kundip Mine Site as part of a broader foraging territory. Peregrine Falcons generally nest on cliffs, and sometimes in tree hollows therefore, there is no suitable natural habitat within the Project Area for nesting. However, abandoned pit walls can provide excellent artificial nesting habitat for this species. It is therefore speculated that the existing Two Boys pit could potentially provide nesting habitat.

This species has only been recorded once within the Project Area by APM in 2016. The individual was sighted opportunistically in 'Low Woodland Mallee and Heath' habitat within the Kundip Mine Site. Despite 12 sessions of bird monitoring at 6 locations within Kundip Mine Site in 2017, and intensive search efforts across the Project Area in 2016 and 2017 surveys, no further records have been made.

5.2.7.5 Ravensthorpe Range Slider Skink – *Lerista veduata*

The Ravensthorpe Range Slider Skink is a small (45 mm snout-vent) skink, endemic to the RRA (Cogger, 2014). Members of the genus *Lerista* share a high degree of commonality in their habits and ecology. Most *Lerista* sp. are burrowing species, in loose soil or sand, where they feed on ants and termites, and other small insects (Cogger, 2014). Other than generic information on the entire genus, there appears to be very little information known regarding this species, apart from the fact that it is only known from the RRA on the south coast of WA. The species has been previously recorded in Eucalypt woodlands on the south facing slopes of the Ravensthorpe Range (G. Harold pers. comm. 2004). Closer to the RGP the species has been recorded just to the west of the old Kundip townsite (G. Harold pers. comm.).

5.2.7.6 Quenda – Isoodon fusciventer

Quenda are widely distributed throughout the southwest of WA. The species is known to inhabit scrubby and swampy vegetation, with dense cover of up to 1 m high. Quenda often feed in adjacent forest and woodland that is frequently burnt, and in areas of pasture and cropland adjacent to dense vegetation. Populations inhabiting Jarrah and Wandoo forests are usually associated with watercourses (DEC, 2012c). Quenda will thrive in more open habitat subject to introduced predator control.

Evidence of the presence of Quenda (diggings) was ubiquitous in all areas where understorey vegetation included sedges or dense low thickets. APM (2016) recorded Quenda diggings in all 3 fauna habitats identified in the Project Area.

5.2.7.7 Western Brush Wallaby – *Notamacropus irma*

The Western Brush Wallaby is endemic to the southwest of WA. This species prefers habitat of open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open, scrubby thickets (Van Dyck & Strahan, 2008). It is found in some larger areas of Mallee and heathland in the wheatbelt, but is uncommon in wet sclerophyll forest and absent from Karri (*Eucalyptus diversicolor*) forest where there is a dense understorey. They are primarily grazers, but little is known of food preferences. Unlike the Western Grey Kangaroo and Tammar Wallaby, it does not readily venture into open pasture adjacent to its bushland refuges (Van Dyck & Strahan, 2008).

Clearing for agriculture has fragmented the population and reduced the availability of habitat, while predation by foxes has reduced the species abundance. However, there are no specified current threats (Woinarski & Burbidge, 2016). Over the past 10 years, the Western Brush Wallaby population has increased in areas where foxes have been controlled (Woinarski & Burbidge, 2016).

One Western Brush Wallaby individual was recorded by APM south of the Project Area, nearby the Hopetoun-Ravensthope Road. Biota (2004a) also recorded this species as roadkill at the entrance to the Kundip site. The species was sighted by APM exiting the 'Low Woodland Mallee and Heath' habitat. It is considered likely that Western Brush Wallabies are present in this community, as well as the 'Damplands and Drainage' habitat within the Project Area.

5.2.7.8 Western Whipbird (Mallee) – *Psophodes nigrogularis oberon*

The Western Whipbird inhabits Mallee heath shrubbery with a dense understorey of up to 1.5 m (McNee, 1986). The presence of this species is dependent on the dense structure of the vegetation more than floristic composition (Smith, 1991). In the FRNP, the Western Whipbird is almost always recorded in long unburnt Mallee (>15 years). The species is predominantly sedentary (McNee, 1986), and builds nests close to the ground (<1 m high) in 'prickly' vegetation, predominantly in *Banksia caleyi*.

The Western Whipbird was opportunistically recorded within the Kundip Mine Site by Biota (2004). Following recommendations by the EPA to undertaken further survey work on this species, monitoring for Western Whipbird was undertaken by APM in 2017 and 3 sightings were opportunistically recorded. Both the Biota (2004) and APM (2017) surveys recorded this species in 'Low Woodland Mallee and Heath' habitat. APM also recorded this species in 'Low Dense Forest/ Forest' habitat which adjoins the aforementioned Mallee community.

APM and Biota records indicate the Western Whipbird prefers elevated open Mallee habitat on the upper hilltops and hill slopes across the eastern half of the Kundip Mine Site. Based on this species' suspected small home range, and behaviour of reusing previous nests (Smith, 1991), it is likely that Kundip Mine Site contains suitable breeding and foraging habitat for the Whipbird. However, the habitats in which this species have been recorded are broadly distributed across the Ravensthorpe Range.

5.2.8 Conservation Significant Fauna Highly or Moderately Likely to Occur but Not Recorded

5.2.8.1 Rainbow Bee-eater – *Merops ornatus*

The Rainbow Bee-eater is a widespread, highly mobile species found throughout mainland Australia, except in desert areas. The species breeds throughout most of its range, nesting in loosened soil in spoil heaps and topsoil dumps. The Kundip Mine Site would therefore contain significant areas of habitat for the Rainbow Bee-eater, most of which would be provided through artificial sources associated with previous mining.

5.2.8.2 Tammar Wallaby – Notamacropus eugenii derbianus

Tammar Wallaby have been recorded from road kill on the Ravensthorpe – Hopetoun Road (2 DBCA records) adjacent to the Project. No individuals have been sighted by APM during field surveys despite intensive on-ground searches across the Project Area. Remote sensing cameras recorded a number of macropods, and some photos may potentially be of Tammar Wallabies. However, the poor quality of nocturnal images precluded the positive identification of these captures. As a result, it is not possible to confirm presence of this species within the Project Area.

Tammar Wallabies if present would likely utilise the 'Low Woodland Mallee and Heath' and 'Low Dense Forest/ Forest' habitat types, as they require dense low undergrowth for daytime shelter, and open grassy areas for grazing (Van Dyck & Strahan, 2008). The Tammar Wallaby has suffered a recent decline in abundance and distribution, probably as a result of predation by the introduced red fox (Kinnear *et al.*, 2002).

5.2.8.3 Water Rat/ Rakali – *Hydromys chysogaster*

The Water Rat is a distinctive rodent specialised for an aquatic existence. The species generally occurs in permanent fresh or brackish water, from inland waterways to lakes, swamps and farm dams, and it can also be found in marine environments (Menkhorst and Knight, 2004). The Water Rat prefers habitats of dense, low-lying vegetation, with low density canopy cover, and shallow, narrow water bodies (Speldewinde *et al.*, 2013).

The species is largely carnivorous, consuming predominantly crustaceans, aquatic insects and fish. Among insects, water beetles (Family Dysticidae) and water bugs (Order Hemiptera) are of primary importance, and nymphs of damselflies and dragonflies (Order Odonata) can be seasonally important items. Birds, mammals, frogs, reptiles, mussels, spiders and plants are also occasionally eaten (Woollard *et al*., 1978; Harris, 1978).

Water Rats are a generalist species and have good dispersal capabilities. This species often forages on land and may move considerable distances when doing so. Water rats undertake regular movements along shorelines and follow regular routes when crossing bodies of water (Harris, 1978). While it is predominantly nocturnal, the Water Rat is often active for part of the day, in contrast with most Australian rodents. It is most active in the hours following sunset but may also be found swimming or foraging during daylight hours in the early morning or early evening (Bettink, 2016).

5.2.8.4 Western Mouse – Pseudomys occidentalis

The Western Mouse has been previously collected from 11 semi-isolated Conservation Reserves within the southern wheatbelt and south coast. Most capture sites have long unburnt vegetation, ranging from 15 to 50 years unburnt (Van Dyck & Strahan, 2008; Morris *et al*., 2008), which contain layers of extremely dense vegetation at 0.5 – 2.5 m high. Dominant overstorey taxa include *Eucalyptus* sp., *Isopogon* sp., *Acacia* sp., *Casuarina* sp. and *Melaleuca* sp. Various sedge species are also essential habitat features.

The Western Mouse is nocturnal, sheltering during the day in a burrow (20 – 30 cm deep). The species is communal with 10 animals having been collected from one burrow system. Individuals have been recorded travelling 600 m overnight from a trap-site to a burrow (Van Dyck & Strahan, 2008).

5.2.9 Conservation Significant Fauna Identified as a Factor by DBCA

5.2.9.1 Dibbler – Parantechnius apicalis

Dibblers have been recorded over an extensive area and it is likely that they can occupy a diverse range of habitats. Dibblers may prefer vegetation with a dense canopy of greater than 1 m high which has been unburnt for at least 10 years (Baczocha and Start, 1996). In some locations, the presence of Proteaceous and Myrtaceous flowering shrubs may also be important (Maxwell *et al*., 1996).

It was recognised that the Dibbler has the potential to occur within the Project Area based on a known population of Dibblers on the eastern side of the FRNP. In addition, the Project Area contains suitable habitat, appearing to be long unburnt, resulting in a thick understorey. A more intensive trapping program specifically targeting the Dibbler was undertaken by APM in 2017. This included trapping in a mosaic of post-fire heath sites within the Project Area and immediate surrounds, as the abundance of Dibblers is strongly correlated with time since fire. However, no Dibblers have been recorded within the Project Area during any of the fauna surveys.

5.2.9.2 Heath Mouse – Pseudomys shortridgei

The Heath Mouse was initially reported as a capture during the 2016 survey. The record was attributed following field identification based on diagrams of the posthallucal pad which differs slightly from the more common Bush Rat. The identification was made after direct comparison of the foot structure in the field where both the Bush Rat and the presumed Heath Mouse were available for comparison. The two specimen captures were not vouchered to the Western Australian Museum (**WAM**) for confirmation.

In 2017, an intensive trapping program was implemented for the Heath Mouse on two occasions (winter and spring) with aluminium box traps set at a high density in several different habitats across the Project Area. The trapping effort totalled almost 1000 trap nights. No records of the Heath Mouse were made despite abundant captures of the Bush Rat.

The lack of captures, the revisiting of data and photos from the 2016 survey work, and further liaison with an expert on this species (Damian Cancilla, PhD Candidate) has led to the conclusion that the Heath Mouse records from 2016 were mis-identified and were both Bush Rats with a less obvious elongated posthallucal pad.

While possible, it is unlikely the Heath Mouse occurs within the Kundip Mine Site. However, if it does, it will likely occur within the long-unburnt patches of 'Low Woodland Mallee and Heath' habitat, particularly in portions that contain *Banksia cirsioides*, which the species is known to utilise the dense and protective cover of this *Banksia* sp. to form their shallow nesting burrows (Damian Cancilla, PhD Candidate).

5.2.9.3 Western Bristlebird – Dasyornis longirostris

The Western Bristlebird is known from three locations including the Fitzgerald River National Park, Hassell (Cheynes) Beach/Waychinicup National Park/Two Peoples Nature Reserve and a translocated population near Walpole (though unknown if the population remains here). A record of two Bristlebirds at Kundip Nature Reserve (December 2003) was identified. It is unknown if the record represents permanent subpopulations or vagrant visitors across the reserve.

The Project is not in the preferred range for this species, which occurs mostly in the deep south west occupying the dense thickets and heath provided there. Although a record of two birds exist on the Jerdacuttup Road immediately south of the Project Area, APM has not identified the Bristlebird within Kundip despite transect survey work over three years (2016-2018) and targeted Bristlebird call play back monitoring over 16 acoustic survey sessions in October 2017 (8 predawn and 8 post-dusk 1 hour sessions). Furthermore, these records are isolated occurrences when they are compared to the 1000+ records made within, and adjacent to, the Fitzgerald National Park.

Based on the primary records in reserves containing bays and river systems, it is likely that the Bristlebird prefers open heaths near refuge clumps of dense watercourse thickets or taller dense shrubbery, though it is known to inhabit dense, low, closed heaths as well. The species builds low-lying nests in Sword Grass sedges. The Project Area may provide some suitable habitat, though it is not likely that birds would establish permanent populations, given the lack of permanent and large flowing water courses within the Project Area.

As exhibited by the records in the Kundip Nature Reserve, it is far more likely the species would inhabit surrounding undisturbed and unfragmented areas of native vegetation in the upper catchment of the Jerdacuttup river within the Kundip Nature Reserve. The river flows southeast along the Ravensthorpe Range where it reaches the Jerdacattup Lakes only a few kms from the ocean into the Jerdacuttup Lakes Nature Reserve. The portion of the river that extends 8 km from the Jerdacuttup Lakes retains water all year round, even when the Jerdacuttup Lakes dry out (DoE, 2004). This would be likely be a far more desirable area of suitable habitat for the Bristlebird and other birds, where a permanent source of water is provided all year round, especially for nesting.

5.2.9.4 Western Ground Parrot – *Pezoporus flaviventris*

The Western Ground Parrot is known to occur in heathland dominated by *Banksia* and *Hakea* and in low open Mallee in swampy areas. The species prefers vegetation that has been unburnt for at least six years (Cale and Burbidge, 1993). The species typically calls before dawn and after dusk and being difficult to see the species is easily missed during standard diurnal bird surveys.

The primary Western Ground Parrot population occurs within FRNP, with smaller populations to the west in the Cheyne Brach/ Waychinicup area and to the east in Cape Arid National Park and Nuytsland Nature Reserve. While these populations occur nearby the Project, and the Kundip Mine Site supports suitable vegetation, the Western Ground Parrot has not been recorded at the site during the Biota 2004 surveys or the APM 2016 and 2017 surveys.

6 DISCUSSION AND CONCLUSION

6.1 IMPACTS TO FLORA OF CONSERVATION SIGNIFICANCE

Calothamnus roseus is a species that has only been previously identified from the Ravensthorpe region. DBCA records of this species within the Project area occur in Communities 7 and 8 on the western side of Hopetoun - Ravensthorpe Road and Community 11. APM also identified populations of this species in Communities 1, 2, 5 and 9. Individuals were found to be particularly concentrated along a ridge within Community 1 and Community 7, indicating preferred habitat for this species. The number of individuals was not counted as the population did not occur within the proposed Project area at the time. Following small variations in the Project layout, a minor internal road now intersects the far eastern extent of the population polygon for this species. The majority of the population will not be impacted by the Project directly or indirectly. Overall impacts to this species are therefore expected to be low.

Dampiera sp. Ravensthorpe has been identified within the Ravensthorpe Range, though very little records have been made available in databases. The species is known to occur on weathered lateritic (gossen) rock of red to brown clayey-loam soils within hillcrests (in the rock cracks) and on hillslopes containing quartz. It is associated with regeneration after fire, and regeneration after disturbance (a DBCA record indicates 2 records found within an old drill pad). The species is associated with communities that contain re-seeder Eucalypt species found within the Ravensthorpe range, such as *Eucalyptus clivicola* mallee woodland, and occurs within shrublands of *Melaleuca hamata* and *Acacia durabilis* and *A. subcaerulea*. Craig *et al.* (2008) recorded this species 9 times across 204 sites across the entire Ravensthorpe Range (not a population estimate or number of individuals) and 3 records exist in the Range according to DBCA. The Project will impact 1 individual adjacent the firebreak, however given its response to fire, and the recent burning of the firebreak, (and continued monitoring and management of it by DBCA and ACH), it is possible the species will re-establish itself.

Hydrocotyle sp. Decipiens is a species that has been identified from the Ravensthorpe and Esperance regions. The species is known to occur in habitats such as riverbeds, banks and low-lying/ephemeral creek edges in black clay-loam soils, associated with fire disturbance (appearing after recent (<1 year) burns)). Although the Project would only result in the loss of up to four individuals from the Project area, APM (2018) extended the local population by 35 individuals with a survey in 2012 within an exploration tenement (Ard Patrick) outside and to the north of the Project area (E74/311). In light of this recent population extension, the loss of up to four individuals within the Project area will not constitute a significant impact.

Large populations of *Marianthus mollis* have been recorded multiple times in the north and east of the Project Area. This species is known to thrive in habitats consisting of hill tops with loose stones and lateritic soils and is associated with fire disturbance. This is particularly evident for the east population (the population to be impacted) where individuals were found to be highly concentrated in a strip of vegetation subject to a controlled burn by DBCA in 2008. The regenerative evidence of this species following disturbance in 2008 indicates that this species should recruit following disturbance associated with mining, and significant source populations of these species will still occur locally following the proposed amendment; the proposed impact to this species therefore will not constitute a significant impact.

Melaleuca sophisma is a species that has only been previously identified from the Ravensthorpe Region. DBCA records of this species have previously identified one population in Community 7, a second population in Community 9 and a third population in Community 2. The population in Community 7 was validated during APM surveys, a second population was identified nearby and a third population was recorded in Community 9. It is considered likely that these three communities represent preferred habitat for the species. It was identified that there may have been potential habitat for this species in the south eastern extent of the site;

however, a visual inspection of this area did not identify *Melaleuca sophisma*. None of the recorded populations will be directly impacted.

Pultenaea craigiana is a species that has only been previously identified from the Ravensthorpe Region. APM surveys recorded five individuals within Community 12 in the south-east of the Kundip Mine Site and a single individual in Community 6 towards the middle of the site. Three of the six individuals recorded by APM will be directly impacted by the Project. DBCA records have previously identified this species in seven other areas, and in multiple locations outside of the Project area, therefore there are undisturbed populations in areas surrounding the Project that will not be impacted.

Stachystemon vinosus has been recorded outside, to the south of the Project area according to the DBCA database. One population of the species was recorded during the 2017 APM field survey in the north-east of the Kundip Mine Site within Community 10. Despite extensive on-ground searches across the Project area, no other populations have been recorded. Based on DBCA records of this species, it appears to be fairly widespread within the Ravensthorpe and Esperance region. Disturbance of one population within the Project area is unlikely to impact representation of this species in the region.

Thysanotus parviflorus has been recorded outside, to the east of the Project area according to the DBCA database. APM surveys recorded three populations of this species within the Project area. Three populations occur within Communities 7 and 10 in the north of the Kundip Mine Site. These populations will not be directly impacted based on the current project layout.

6.2 IMPACTS TO VEGETATION OF CONSERVATION SIGNIFICANCE

6.2.1 PEC – Very Open Mallee over Melaleuca sp. Kundip Dense Heath

The total amount of this PEC as mapped by APM (2017) within the Project Area (34.2 ha) is more than the DBCA total mapped area in the Ravensthorpe Range (14 ha), indicating that this PEC is more widespread than indicated by the DBCA mapping based on more systematic mapping by APM (2017). A total of 1.2 ha (3.5%) out of the mapped 34.2 ha of this PEC will be impacted (Table 4-9). This amount of clearing is unlikely to impact the conservation status of the PEC, and surface water management along the road will further reduce any impacts to the community.

6.2.2 TEC/PEC – Proteaceae Dominated Kwongkan Shrublands of the Southeast Coastal Floristic Province of WA.

A total of 38.4 ha out of the mapped 76.6 ha of this TEC/ PEC present within the Project Area is proposed to be impacted by the Project footprint (Table 4-9). Given that DBCA has mapped up to approximately 67,032 ha of this TEC/ PEC, impacts to the TEC/ PEC on a regional scale are expected to be very low and equate to around 0.1% of the overall TEC.

6.3 IMPACTS TO FAUNA OF CONSERVATION SIGNIFICANCE

The RGP is located at the southern end of the Ravensthorpe-Kundip copper-gold belt. This belt stretches 20 km in a north-south orientation, from just north of Ravensthorpe to south of the historic town of Kundip. Within the Kundip Mine Site there is significant historical disturbance legacy from small operations that commenced in the early 1900s. The number of mine shafts around the Kundip Mine Site is beyond count and of concern, having been left open without safety exclusion fencing by the previous tenement holders.

In the early 1900s much of the original vegetation at the Kundip Mine Site was cleared, with larger trees being felled and used for bracing mine shafts and the construction of gantries. Tall hollow bearing Eucalypt and Corymbia species, which would have provided essential nesting and roosting habitat for a number of arboreal and semi arboreal non-volant (non-flying) species and a number of predatory volant species, are all but absent. The current over-story vegetation does not accurately reflect the vegetation that would have been present had these small-scale mining operations not proliferated. There is little doubt that this major shift in vegetation attributes would have had a major impact on the faunal assemblages of the area. In addition to the changes in vegetation structure, the small-scale mines of the early and mid-1900s and the subsequent larger scale activities in more recent times have resulted in the clearing of approximately 30 ha within the Kundip Mine Site.

Nevertheless, the area still has intrinsic value in both vegetation and its associated fauna assemblages and contains a significant area of remnant vegetation. It was reflected in the surveys, that the small patch (<1 ha) of remnant vegetation between Kaolin Pit, Western Gem Pit and the Tailings Storage Facility continues to support a diverse array of mammals and reptiles. The innumerable mine shafts distributed across the site provide refuge for species such as the Chuditch and small Microchiropteran bats which would, under normal circumstances, take refuge in standing and fallen hollow limbs (or refugia offered by granite inselbergs).

Refugia are priority habitats for biodiversity conservation, due to their unique ecological and biological attributes (Keppel *et al.* 2012). They have led to the development of unique evolutionary units, they function to preserve habitats and potentially provide protection to biota under periods of stress, to survive, and to radiate under more benign conditions (Keppel *et al.* 2012). It is recommended that, whilst these sites do not occur in disturbance areas, refugial vegetation types surrounding the Project area are identified and surveyed over the life of the mine for both flora and fauna. These provide good research and preservation units under long term mining activities.

6.3.1 Current local and regional environmental values

The RGP occurs on the periphery of the Fitzgerald Biosphere, which is one of 15 biodiversity hotspots. The most valuable ecological attributes within this biosphere are protected within the Fitzgerald River National Park (FRNP). Radiating out from the FRNP, the peripheral areas of the biosphere are now regarded as buffer zones as of June 2017. They were previously known as ‘zones of co-operation’, where development can take place in an ecologically sustainable manner. The intent of the buffer zone is that development does not constrain or inhibit the radiation or movement of local fauna species, many of which have become threatened by fragmentation, land clearing, increased feral predation and competition from non-native species.

The Kundip Mine Site is situated in the foothills of the Ravensthorpe Range approximately 0.4 - 1 km north of the Kundip Nature Reserve (Reserve No. 31128). There is little capacity for the Kundip Mine Site to impact on local and regional flora and fauna values beyond the direct impacts of clearing for construction and operation. The activities forecast for Kundip are unlikely to constrain or inhibit the movement or radiation of species around the Project area, where they are free to radiate in large tracts of undisturbed vegetation.

The RGP Project will not degrade the local and regional fauna conservation values.

6.3.2 Future local environmental values

The RGP is not likely to have significant impact on site specific flora, vegetation and fauna values. Rather, the proposal to recommence mining presents a unique opportunity to improve conservation and land management through the implementation of mining and mine site related environmental management practices, such as introduced fauna, fire and weed management.

To date, very limited resources have been invested locally in fauna conservation by government and non-government entities, as evidenced by the number of key threatened species known to occur but not recently recorded and reported. For instance, records of the Chuditch are sporadic across the region and most are more than two decades old, however, the species is known to occur at Kundip and was recorded during the 2017 fauna survey of the Project area.

Local environmental values will be further improved through collaboration between ACH Minerals and Edith Cowan University. ACH Minerals has already instigated a process to increase the amount of zoological research at the site by providing some financial and a large amount of in-kind support to two Masters students with studies focussed on the habitat requirements of the Chuditch and the Malleefowl, which would be ideal, given the evidence found by APM of these species occurring, and occurrence of suitable habitat in and around the Kundip Mine Site.

The level of site specific localised impact from clearing and construction has the potential to be rapidly offset by the longer-term net positive impacts of proactive mine site environmental management.

6.3.3 Conservation Significant Fauna Impact Assessment

6.3.3.1 Carnaby's Cockatoo – Calyptorhynchus latirostris

Kundip Mine Site was assessed for the presence of suitable nesting habitat. Trees suitable for nesting typically must have a Diameter at Breast Height **(DBH)** of at least 500 mm. Across the Project Area only three trees were found that had the potential to host nesting hollows (and one other close to the minimum DBH) as outlined in Table 6-1. None of these trees were found to contain hollows. The potential nesting habitat present in the Project area is therefore not well represented for this species. Any disturbances associated with the construction and operation of the RGP will not have an impact on available breeding habitat for the Carnaby's Cockatoo given that no hollow-bearing trees have been identified.

Table 6-1: Black Cockatoo Nesting Tree Assessment

Tree ID	Diameter Breast Height (mm)	Height (m)	Hollows	Fire (Years since)
1	570	18	None	>10
2	510	16	None	>10
3	490	16	None	>10
4	720	15	None	>10

Carnaby's Cockatoo are likely to forage over several TECs including the 'Proteaceae Dominated Kwongkan Shrublands of the southwest coastal floristic province of WA' TEC (DoEE, 2018b). Vegetation communities have been identified within the Project area that are representative of this TEC and, therefore, it is evident that foraging habitat is present for this species within the Project area.

Carnaby's Cockatoo feed on a range of *Banksia* sp. *Hakea* sp., *Eucalyptus* sp. and *Corymbia* sp. and are therefore most likely to feed in the 'Low Woodland Mallee and Heath' habitat type. This habitat type is spread across 408.8 ha in the Project area, and 36.8 % (150.3 ha) will be cleared.

Development of the Project will therefore temporarily reduce the overall foraging habitat for the Carnaby's, but the impact of this in the Fitzgerald region is likely to be low given the amount of 'Excellent' condition vegetation in the surrounding area outside of the Disturbance Footprint (Craig, 2004; Craig *et al*., 2008) and included in the protected Kundip Nature Reserve (31128) to the south of the Kundip Mine Site.

Moreover, the Carnaby's Cockatoo has been observed feeding on revegetated foraging habitat at rehabilitated mine pits in the Jarrah Forest within eight years of establishment. Newly revegetated foraging habitat may be more productive for Carnaby's Cockatoo because of a lack of canopy (Valentine *et al*., 2014). Therefore, the impact associated with the clearing of vegetation will not be permanent as rehabilitated habitat will increase in value following mine closure and during the course of regeneration.

Based on regional vegetation mapping (DBCA, 2018; Craig, 2004;Craig *et al*., 2008) it is estimated that there is approximately 67,032 ha of Proteaceae dominated Kwongkan shrublands of the Southeast Coastal Floristic Province of WA in the Project region. The proposed Project clearing will therefore impact 0.1 % of this total area of potential foraging habitat. DoEE Species Profile and Threats Database mapping indicates that this vegetation type extends along the south coast from Albany, west of the Project Area, to Cape Arid National Park in the east (approximately 500 km).

Altered fire regimes that reduce the flowering and fruiting potential of species within vegetation types that are used for foraging have the potential to reduce local available food supply, which could compound the effect of the loss of foraging habitat from clearing. Fire management and mitigation actions in place on site, will reduce the potential impacts of intense fire on this species.

Carnaby's Cockatoos regularly use open artificial water (e.g. water troughs and ponds), late in the afternoon, prior to roosting for the night. While very unlikely to become entrapped, birds drinking from the TSF will be exposed to Cyanide. Maintaining a Cyanide concentration in tailings water below 50 mg/L, the level considered safe for wildlife, this risk will be mitigated.

Noise, vibration, lighting, entrapment and fragmentation are not likely to significantly impact this species.

6.3.3.2 Chuditch – Dasyurus geoffroii

The Chuditch has been recorded by APM in both 2016 and 2017 foraging on the periphery of the 'Low Woodland Mallee and Heath' habitat, likely utilising the patches of 'Low Dense Forest/ Forest' surrounding this habitat. As this species is an opportunistic feeder, its overlapping occurrence within both habitats is not unusual (Morris & Orell, 1993). Within the Project Area, 32.7% (17.2 ha) of this habitat type will be cleared. In the area within which this species was recorded was a number of mine shafts and a significant amount of building debris from the old Kundip Battery.

Records of conservation significant fauna were as expected in this region as the formal database records often do not reflect what is known locally and recorded anecdotally. For example, the last formal record of Chuditch was in the mid-1990s. However, mine site personnel have observed individuals in the area over recent years. Therefore, the capture of Chuditch on remote sensing cameras was anticipated.

Based on the solitary nature of this species and its large home ranges (DEC, 2012b; Serena and Soderquist, 1989), it is probable that numbers of Chuditch in this area would be very low. Given that this species was found within the same approximate area within the past two surveys, it is likely that 'Low Dense Forest/Forest' represents significant fauna habitat for the Chuditch present in that area. It is also possible that other areas

within the Kundip Mine Site that contain similar vegetation, might also provide significant foraging habitat for the Chuditch, given that the individual/s recorded have continued to use the site.

Clearing for construction of the mine site will impact foraging opportunities and home range of Chuditch found during the surveys (APM, 2018). However, significant tracts of similar habitat are likely to occur within the 10,369 ha of undisturbed vegetation mapped in the Ravensthorpe Range mapped by Craig *et al.* (2008) and nearby in the Kundip Nature Reserve.

The contraction of home ranges due to habitat fragmentation associated with mine infrastructure within Kundip may increase territoriality between Chuditch individuals (males). This has the potential to result in an increase of intraspecific competition for a mate (Belcher & Darrant, 2004) and a rise in the associated impacts of this (injury or potential death of male Chuditch). Female territoriality of den sites may also increase if female Chuditch home-ranges begin to overlap (Glen & Dickman, 2005), however this impact is minimised given the lack of suitable natural breeding habitat and lack of active/inactive nest recordings within the Project Area. The cost of territorial defence for females and mate competition in males (energy expenditure, risk of injury, competition for food resources) is likely to push individuals to occupy an exclusive territory instead, *i.e.* to move into undisturbed habitat outside of the Development Envelope (Belcher & Darrant, 2004; Glen & Dickman, 2005). This will likely mitigate the effects of home-range contraction due to habitat fragmentation within the Kundip Mine Site. The sufficient amount of suitable breeding and foraging habitat present outside of the Project Area is likely to normalise the home-range sizes and territories of Chuditch individuals occupying the Kundip-Ravensthorpe area and allow for a number of non-overlapping female ranges, which is integral to maintaining high population densities (Glen & Dickman, 2005).

Vehicle strike have a limited potential to influence local numbers of Chuditch. Vehicle speeds around the mine site would be too slow to present a threat to this elusive and agile species. Nevertheless, personnel will need to be vigilant driving around the site at night when it is possible that Chuditch may be immobilised by vehicle headlights/ spotlights, increasing the likelihood of vehicle strike. The overall risk from this can be mitigated through the application of speed limits and awareness, removal of road-kill at least 10 m from roads (as Chuditch will feed on road kill), inductions for discussions, and recording of sightings (including road-kills, if it were to occur).

The construction of Kundip Mine Site will likely attract a number of invertebrate species and small rodents through the creation of food wastes, potential shelter/ habitat for nests in buildings/ waste materials, and lighting (which would attract a number of invertebrate species including moths). It is therefore probable that the higher concentration such prey items would also attract the Chuditch. There is commonly an inverse relationship between the size of an animal's home range and density of its food resources, as increased resource availability can reduce competition and energy expenditure (Smith, 1968; Litvaitis *et al*., 1986). As a result, increased resource availability may inflate the carrying capacity of fauna habitat, and Chuditch that persist in the area post-construction may derive some benefit from the constructed mine site that provides abundant food resources and a more complex array of refuge. Physical structures created by humans can also increase and improve habitat heterogeneity. Shine and Fitzgerald (1996) were able to show that large pythons were prepared to use artificial shelters if they offered the same characteristics (e.g. thermal stability) as natural shelters. Research on Koolan Island of the Northern Quoll (PhD student; Jai Thomas, Murdoch University) has provided validation for the concept that post-mining landforms can provide suitably heterogeneous habitats for burrow, crevice or den dependent species, such as the Chuditch. These artificial habitats could result in an increased abundance and overall fitness of the local population after initial land clearing. Additionally, the potential increase in prey resources from the Mine Site may increase the amount of female Chuditch using the area in the future to derive their nutritional requirements for rearing young (Belcher & Darrant, 2004) and may consequently increase the likelihood of mothers using the mine shafts as nesting habitat.

ACH are committed to supporting a Masters Research project for this species in conjunction with Edith Cowan University. The outcomes of this research will be specifically aimed at better managing the local population. The focus of the research will be on the value of artificial habitats for sustaining populations during mining and continued management and monitoring of the population following closure.

Feral cats and introduced predators such as foxes, also predate heavily on Chuditch and an increase in these predator populations is perhaps the greatest potential threat for local Chuditch. This will be managed with proactive introduced animal control to mitigate this threat.

Increased frequency or severity of fire associated with mining is not likely to influence denning opportunities for Chuditch as there are no hollow-bearing fallen logs in the Project Area. However, altered fire regimes have the potential to greatly reduce ground and mid-storey cover in fragmented vegetation and increase exposure of foraging Chuditch to foxes and cats.

6.3.3.3 Dibbler – Parantechnius apicalis

'Low Woodland Mallee and Heath' is the habitat type most likely to be occupied by the Dibbler and is present across the majority of Project Area (408.8 ha). Based on the current Disturbance Footprint, 36.8% (150.3 ha) of this habitat type will be cleared.

The 'Proteaceae dominated Kwongkan shrublands', which extends over 76.6 ha in the Project Area, is recognised as valuable habitat for the Dibbler. It is estimated that there is approximately 67,032 ha of Proteaceae dominated Kwongkan shrublands in the Project region. DoEE Species Profile and Threats Database mapping indicates that this vegetation type extends along the south coast from Albany, west of the Project Area and to Cape Arid National Park in the east (approximately 500 km). Therefore, the proposed clearing of 38.4 ha for the RGP will impact < 0.1% of this vegetation type.

The mainland habitat of the Dibbler is characterised by the presence of long unburnt heathland, typified by sandy substrates and occasionally lateritic soils (Baczocha & Start, 1996). The Dibbler's requirement for long-unburnt vegetation may be related to high invertebrate density in thick leaf litter accumulations or to the cover afforded by dense vegetation which protects against predators, including birds of prey, foxes, and cats (Friend, 2003). In the absence of foxes, the Dibbler may occupy vegetation at an earlier stage of recovery after fire (Friend, 2003). Dibblers occupy distinct but overlapping home ranges and are thought to have relatively high site fidelity (Friend, 2003).

While this species is unlikely prone to vehicle strike, its persistence in the area would be intrinsically linked to the extent of habitat fragmentation arising from the construction of roads and infrastructure around the Project Area. Fragmentation is known to constrain an individual's ability to derive sufficient resources within its home range and can often lead to a decline in the local population to vulnerable levels in remnant vegetation. As a result, a loss of individuals and populations in all remnants across a site can occur. The constraint on resources can also cause individuals to cross barriers (roads) between habitats, which increases their exposure and subsequently elevates their risk of predation. Increased frequency of fire can also significantly increase the vulnerability of foraging individuals to predation in open areas.

If the Dibbler were present in the Project Area, all secondary impacts of light, noise, vibration and entrapment would have a deleterious impact on this species. It is possible that construction of the mine infrastructure and artificial lighting may increase the availability of invertebrate prey for this species. However, other impacts are likely to assert a greater deterrent for this species.

6.3.3.4 Heath Mouse – Pseudomys shortridgei

In 1987 this species was rediscovered in southwest WA in the FRNP, after being known only from scattered records in WA since 1906. The Heath Mouse has since been found at three other sites in the southern wheatbelt (Van Dyck & Strahan, 2008). Western Australian populations of the species are mainly associated with species-rich heath, with records from mixed scrub and Mallee. Within WA, Heath Mice have not been found in heath vegetation left unburnt for any less than 10 years, and as the vegetation matures they can eventually attain high densities in 30-year-old unburnt heath (Van Dyck & Strahan, 2008).

Though possible, it is unlikely the Heath Mouse occurs within the Project Area. If this species does occur, the habitat it would most likely occur within would be the long unburnt patches of 'Low Woodland Mallee and Heath', the most widely distributed habitat type within the Project Area. 36.8 % (150.3 ha) of the 'Low Woodland Mallee and Heath' habitat present in Project Area will be cleared.

The Heath Mouse, though functionally different to the Dibbler, will suffer the same impacts from the Project.

6.3.3.5 Malleefowl – Leipoa ocellata

The Kundip Mine Site has been extensively searched for Malleefowl and Malleefowl mounds. Given that the proposed Disturbance Footprint does not contain any active or recently inactive Malleefowl mounds, it is unlikely to represent significant breeding habitat for the species. Only one historic inactive mound is known to exist within the Project Area. The lack of suitability for nesting may be a function of the fire history. In areas where Malleefowl have been sighted during the field survey work, the vegetation and detritus layer is so thick and lacks any corridors or partially open areas, that the construction of mounds does not seem viable when compared to vegetation in other Project areas where mounds are common (M. Ladyman pers obs).

Despite there not being any mounds identified, Malleefowl individuals were recorded within and outside of the Project Area, suggesting that the Project Area may form part of a home range territory for a pair, or multiple pairs, of Malleefowl. The value of the foraging habitat depends specifically on the proximity of active mounds to the Project Area, but these mounds have simply not been located.

Within the Project Area, Malleefowl are most likely to occur within the 'Low Woodland Mallee and Heath' habitat, which is the most common habitat type, encompassing 408.8 ha. Of this, 36.8% (150.3 ha) of this habitat type will be cleared.

The clearing of vegetation within the Project Area is unlikely to significantly reduce the regional availability of suitable habitat, as the surrounding areas, outside the Development Envelope are of 'Excellent' condition (Craig, 2004; Craig *et al*., 2008). These adjacent areas likely provide a plentiful food resource and include significant tracts of relatively undisturbed vegetation for Malleefowl to move through without increasing their exposure to predators. Further, Malleefowl have large home ranges averaging 4 km^2 (Booth, 1987), and do not display territoriality (beyond defence of the nest site during breeding), meaning small changes to range areas, as a result of development of the Project are unlikely to significantly impact individuals.

ACH are committed to supporting a Masters Research project of this species in conjunction with Edith Cowan University. The focus of the research will be determining how clearing and topsoil stockpile creations can be modified to benefit nesting Malleefowl. The outcomes of this research will be specifically aimed at better managing the local population.

The greatest potential for impact to Malleefowl will come from vehicle strike and increased predation. Malleefowl are commonly observed on roadsides at dawn. They forage along the edges of roads where they can move easily between groves of vegetation where food is abundant. It is during this period where they are most susceptible to vehicle strike. When the sun is low, Malleefowl are very difficult to detect even at 40 kilometres per hour (**km/h**) and individuals are commonly observed dashing across roads out from under thick cover giving drivers limited time to avoid collisions.

Internal roads will have low vehicle speeds of 40 kph or less. It is therefore unlikely that individuals will be observed on the major connective roads. They are more likely to be observed on the peripheral roads.

One of the risks in clearing for the construction of the mine site is the increased potential for introduced fauna to predate Malleefowl individuals. Adult Malleefowl are extremely vulnerable to predation by foxes, while chicks are vulnerable to both foxes and cats. Increasing the road network around the mine site is very likely to increase the mobility of both these predators, and thereby increase predation opportunities. Therefore, ACH has committed to proactively manage introduced predators to reduce the potential for this secondary impact.

Altered fire regimes are not likely to significantly impact Malleefowl as much of the habitat that would typically be used for mound construction appears to be unsuitable due to the dense accumulation of vegetation and detritus in excessively long unburnt areas, which is potentially inhibiting nest construction. Though increased fire is not a preference for the Project, it would not be detrimental to this species locally within the Kundip site.

Incandescent lighting, noise, vibration and entrapment are not potential impacts for this species. As Malleefowl are not nocturnal and do or can forage on invertebrates, it would therefore be reasonable to expect Malleefowl to forage around the mine site area if construction of infrastructure is presenting resource opportunities. Moreover, individuals frequently nest and forage in roadside vegetation in the wheatbelt where larger tracts of remnant vegetation are not available. In these cases, vehicles create incessant noise in the day and night which has not been observed to inhibit nesting individuals or nest selection sites (i.e. the Malleefowl are not avoiding these high noise areas).

6.3.3.6 Peregrine Falcon – *Falco peregrinus*

The Peregrine Falcon inhabits a broad array of environments in Australia and throughout the world (Pizzey & Knight, 2012). This species nests in recesses of cliff faces, tree hollows or large abandoned nests. The record of the Peregrine Falcon at the Kundip site was expected for this species as it was observed in close association with a disused mine pit nearby the 'Low Woodland Mallee and Heath'. This species uses steep cliffs of exposed rock as nesting sites and old mine pits can provide excellent artificial nesting habitat. It is possible that the sighting of the Falcon near the disused mine pit, could reflect the presence of a nest, however no survey effort has been employed to confirm the presence/ absence of a nest in the area.

During the commencement of the Project, blasting within the existing Two Boys pit should be considered to take place outside of the nesting season for this species, as once a nest has been disturbed, local individuals will find another nest site and not return. The lack of access to the potential nest through blasting for the Falcon, will prevent an accurate assessment of the species presence/ absence in the area.

With regard to foraging, Peregrine Falcons would forage broadly over the sites and would not be specifically dependent on any one vegetation type. Whilst an opportunistic sighting within the 'Low Woodland Mallee and Heath habitat' was recorded, this species is not limited to this foraging habitat. Based on the current Disturbance Footprint, 36.8% (150.3 ha) of 'Low Woodland Mallee and Heath' in the Project Area will be cleared.

No other impacts associated with mining are likely to disturb the Peregrine Falcon.

6.3.3.7 Quenda – Isoodon fusciventer

Suitable habitat for the Quenda exists within the Disturbance Footprint and Quenda diggings have been recorded within the Project Area by APM in 2016. The Project is likely to impact individuals of this species through the reduction of habitat availability. Further, individuals may be killed if animals are trapped in burrows (Quenda can use old rabbit burrows to nest) or nests during clearing operations, though unlikely given

the noise disturbance generated for this process. The Quenda is one of the most urban adapted species of mammal in the southwest and populations will very likely rebound once clearing and construction is complete. The construction of mine infrastructure will provide an abundance of refuge for this species and invertebrates attracted by lighting and the creation of unique microhabitats for invertebrates and small reptiles will likely provide an additional food source for this species.

Evidence of the Quenda was ubiquitous in all areas where ground storey vegetation comprised sedges or dense low thickets. Quenda diggings were present mainly in the 'Damplands and Drainage Line' habitats, however the recent abundant rainfall may have caused individuals to radiate out of this habitat, resulting in the evidence of foraging being found within a number of sites. In total, 33.2 % (28.0 ha) of the 'Damplands and Drainage Line' habitat in the Project Area will be cleared based on the current Disturbance Footprint.

Quenda are vulnerable to vehicle strike where they occur in suitable habitat adjacent to roads that carry high traffic loads, but the reduction of vehicle speeds around the mine site would result in few deaths as Quenda are quite agile. Altered fire regimes could have mixed effects on this species. As Quenda are omnivorous, fires can promote new growth in the form of underground tubers, bulbs and corms, which have increased nutritional value. However, fire can also remove the valuable detrital layer that supports many of the invertebrate species Quenda consume. Fire can also increases the risk of predation. Where fire is occurring patchily, and refuge remains available, Quenda could prosper providing introduced fauna numbers are low.

Incandescent lighting, noise and vibration may initially impact the activity of local Quenda that persist beyond the clearing stage. However, there are innumerable examples where artificial light and noise fail to deter Quenda from foraging in a peri-urban environment (M. Ladyman, pers. obs).

6.3.3.8 Rainbow Bee-eater – *Merops ornatus*

The Rainbow Bee-eater is a widespread, highly mobile species found throughout mainland Australia, except in desert areas. The species breeds throughout most of its range, nesting in loosened soil in spoil heaps and topsoil dumps. The Kundip Mine Site would therefore contain significant areas of habitat for the Rainbow Bee-eater, most of which would be provided through artificial sources associated with previous mining.

Given this species is widespread, highly mobile and has a large breeding range throughout Australia the development of the Project is not expected to significantly impact the species. Future disturbance is also likely to provide greater nesting opportunities at the site.

6.3.3.9 Ravensthorpe Range Slider Skink – *Lerista veduata*

One Ravensthorpe Range Slider Skink was captured in a pit trap during the Biota (2004a) survey. The pit trap was located within the PEC 'Very open Mallee over *Melaleuca* sp. Kundip dense heath' which contains proteaceous thickets. The soils of this vegetation community were described as skeletal pale grey to orange loamy sands with lateritic gravel.

Whilst impacts to individuals of this species are possible, the number of individuals likely to be impacted is expected to be small as the species is likely not abundant in the area. Survey efforts by APM in 2016 and 2017, and intense raking through soil by Biota (2004b) specifically where an individual was collected, have failed to yield additional individuals.

The location of the individual collected was in the 'Low Woodland Mallee and Heath' habitat type in the higher topography of the Project Area (the north east corner) by Biota (2004). This area will be disturbed for the inclusion of WRL north, which will include the clearing of 37.1 ha of native vegetation. However, in total, only 150.3 ha (36.8 %) of the Low Woodland Mallee and Heath habitat of the 408.8 ha present in the Project area, will be cleared.

Altered fire regimes, specifically an increase in burn frequency or intensity, may threaten this species at a local scale. Being fossorial this species is likely vulnerable to intense wildfires that burn hotter in the dense heath, rather than more open areas with lower fuel loads. In addition, there is some possibility for entrapment in drill holes that are excavated below the surface and left uncapped. However, these are not likely to be present following rehabilitation of drill collars in the Project Area.

6.3.3.10 Tammar Wallaby – Notamacropus eugenii derbianus

The Tammar Wallaby inhabits coastal scrub, heath, dry sclerophyll forest and thickets in Mallee and woodland (Van Dyck & Strahan, 2008). This species is nocturnal, sheltering in dense, low vegetation during the day, and grazing in open grassy areas at night. Tammar Wallabies do not require any specialised habitat for breeding. Individuals have defined home ranges that overlap with those of other individuals. While several wallabies are often observed feeding in the same area, this species is solitary, and no social grouping has been observed except between females and their young at foot (Van Dyck & Strahan, 2008).

While Tammar Wallabies have not previously been recorded within the Project Area, it is considered to potentially occur due to the presence of suitable habitat and two sightings of road kill along the Hopetoun – Ravensthorpe Road. In total, 32.7% (17.2 ha) of the 'Low Dense Forest/ Forest' habitat, and 36.8% (150.3 ha) of the 'Low Woodland Mallee and Heath' habitat present in Project Area will be cleared. The availability of 'Excellent' condition (Craig, 2004; Craig *et al.*, 2008) low and dense vegetation throughout the areas surrounding the Project Area is expected to be utilised for daytime shelter and suggests that impacts to this species will be minimal.

The Project is unlikely to impact the survival of the population within the vicinity of the Project Area, particularly if introduced animal control is undertaken, as it is introduced fauna predation that is the greatest threat to this species following the impact of land clearing.

Vehicle strikes are a potential impact associated with the Project. Reduction of vehicle speeds to 40 kph or less would greatly reduce the likelihood of vehicle strikes when driving through site. Increased traffic on the Hopetoun Ravensthorpe Road, as a function of the mining operation, will increase the likelihood of fauna deaths between Kundip and Ravensthorpe. The likelihood can be decreased if traffic in periods of low or no daylight is reduced.

6.3.3.11 Water Rat – Hydromys chrysogaster

The Water Rat has not previously been recorded within the Project Area. It has the potential to occur, as there are permanent water sources within historical excavation areas and surrounding areas. It may also occur within the nearby Steere River and associated tributaries when they flow following rainfall, particularly within any pools that may temporarily form during winter and spring (Jun – Oct). The species prefers shallow, narrow waterways with dense, low surrounding vegetation (Speldewinde *et al.*, 2013).

Based on the habitat preference of the Water Rat, there is unlikely to be suitable sites for this species within the Project Area. Following construction of the mine, this species could occasionally appear in permanent mine ponds or dams; however, these are unlikely to provide food or shelter, and if this species were to enter the Project Area and use partial suitable habitat, it would likely only be temporary. If present, this species would be expected to be confined to the 'Damplands and Drainage' habitat within the Project Area, 33.2% (28.0 ha) of which will be cleared.

There are unlikely to be significant impacts to this species as a result of the mine development.

6.3.3.12 Western Brush Wallaby – *Notamacropus irma*

The Western Brush Wallaby was recorded both during the Biota (2004a) survey as roadkill, and the APM 2017 survey as an opportunistic sighting. Both records of the Western Brush Wallaby have been made on the Hopetoun - Ravensthorpe road near 'Low Woodland Mallee and Heath'. In total, 36.8% (150.3 ha) of the 'Low Woodland Mallee and Heath' habitat present in the Project area will be cleared. This species prefers open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open, scrubby thickets (Van Dyck & Strahan, 2008). Vegetation within the Project area, however, consists primarily of dense undergrowth (perhaps a result of the suspected long unburnt vegetation), which is not favoured by the species.

It is possible that the species utilises the area due to the mosiac of dense undergrowth with disturbed areas and the development of the Project may push the species into surrounding areas. Given the availability of 'Excellent' condition (Craig, 2004; Craig *et al.*, 2008) vegetation in these areas, however, this is unlikely to impact the survival of the population within the vicinity of the Project Area, particularly if introduced fauna control is undertaken. It is likely that a mosaic of burnt and unburnt vegetation exists in the surrounding areas which could be beneficial for this species.

Vehicle strikes are a potential impact associated with the Project. Reduction of vehicle speeds below 50 km per hour would greatly reduce the likelihood of vehicle strikes. Increased traffic on Hopetoun - Ravensthorpe Road, as a function of the mining operation, will increase the likelihood of fauna strike. The likelihood can be decreased if traffic in periods of low or no daylight is reduced.

6.3.3.13 Western Bristlebird – Dasyornis longirostris

The Western Bristlebird has not been recorded by APM during any of the transect survey work over three years (2016-2018) or the 16 targeted call play back monitoring sessions undertaken in October 2017 (APM, 2018). The species has previously been recorded in 2003 along the Jerdacuttup Road south of the Project Area in the Kundip Nature Reserve.

If this species is present in the Project Area, it is likely to only be transitory. The Western Bristlebird is likely to inhabit the areas of the Damplands and Drainage Lines habitat, adjacent to Low Woodland Mallee and Heath , in the west of the Project Area where the Damplands habitat is most represented. A total of 33.2% (28.0 ha) of the 'Damplands and Drainage' habitat and 36.8% (150.3 ha) of the 'Low Woodland Mallee and Heath' habitat present in the Project Area will be cleared. This will not constitute a significant impact to this species as these habitat types are represented extensively over the entire Ravensthorpe Range and south west.

If this species is a transitory visitor along the Hopetoun-Ravensthorpe Road, the potential impacts to this species could include vehicle strike. However, this species is known to be shy and difficult to sight, often remaining hidden in the dense heath (Morcombe, 2011), and this behaviour may mitigate some of the risk of vehicle strike . Indirect impacts include loss of Project Area and surrounding undisturbed vegetation due to high intensity burns caused by mine-related actions. However, this is expected to be a very low likelihood based on the management in place for accidental fires on site, and the protection of the firebreak within the site, preventing the rapid spread of fire into adjacent vegetation.

6.3.3.14 Western Ground Parrot – *Pezoporus flaviventris*

The largest population of Western Ground Parrot occurs within the FRNP, with smaller populations to the west in the Cheyne Brach/ Waychinicup area and to the east in Cape Arid National Park and Nuytsland Nature Reserve. While the Project Area occurs nearby these populations and supports suitable vegetation, the Western Ground Parrot has not been recorded within the site during the Biota 2004 surveys or the APM 2016 and 2017 surveys.

The Biota 2004 search effort comprised 17 hours of census observation within discrete habitat types and a further 23 hours attributed to walking transects. The APM 2017 search effort comprised 16 hours of call playback pre-dawn and post-dawn and no individuals of the Western Ground Parrot were identified. Though this species may forage within the vegetation assemblages of the Project Area, it would not be specifically dependent upon them and the extent of proposed disturbance is not likely to influence local or regional populations.

Altered fire regimes have the potential to adversely impact this species that is dependent on a particular suite of vegetation for feeding. Loss of significant tracts of vegetation to wildfire would result in individuals foraging elsewhere. Patchy mosaic burns can benefit the species, however, by increasing food diversity. Fire Management has the potential to reduce impacts to this species, should individuals use the Kundip site.

The Western Ground Parrot is very susceptible to predation as it spends the majority of its activity feeding, resting and nesting on the ground in low, dense heathlands. In the context of an active mine site and increased vehicle presence there is some potential for vehicle strikes as this species flies with rapid speed, but very low over the low heath vegetation. Movements are typically limited to one hour prior to sunrise and one hour after sunset which can be a period of high vehicle activity with personnel shift changes. The unusual movement times also mean that this species may be deterred from using habitats around the site if area is constantly illuminated.

This species is also likely to be deterred from occupying habitats around the mine site due to noise and vibration.

6.3.3.15 Western Mouse – Pseudomys occidentalis

The Western Mouse occurs in dry shrubland, Mallee, and woodland that is long unburnt (15-50 years) and contains patches of dense understorey (Lee, 1995). This species has likely been in decline since before European settlement in Australia, which may have been accelerated by the loss of habitat due to land clearing, altered fire regimes, and predation by foxes and cats (Morris *et al*., 2008). Remaining populations are now restricted to small fragments (i.e. nature reserves of less than 1,000 ha), increasing their vulnerability (Morris *et al*., 2008).

The Western Mouse has not been recorded within the Project Area during surveys. Potential habitat may exist in the future, dependent on fire regimes. Within the Project Area, Western Mouse is likely to be located within long-unburnt patches of 'Low Dense Forest/Forest', 32.7% (17.2 ha) of which will be cleared. Much of the Project Area has not been burnt for >10 years. Despite this, the development of the Project Area would be unlikely to significantly impact this species due to the large amount of 'Excellent' or higher condition vegetation surrounding the Project Area, including the nearby Kundip Nature Reserve. Persistence of local populations of this species is more likely as ACH will actively manage introduced fauna on site.

6.3.3.16 Western Whipbird (Mallee) – *Psophodes nigrogularis oberon*

The Western Whipbird (Mallee) is confined to coastal or near coastal regions of southwest WA. The species inhabits Mallee heath shrubbery with dense understorey of up to 1.5 m (Cale and Burbidge, 1993; McNee, 1986). The Western Whipbird relies on dense stands of vegetation that is long unburnt (>15 years) (McNee, 1986).

Western Whipbird (Mallee) (*P. nigrogularis oberon*) was delisted from the EPBC Act in 2009 as land clearing was no longer considered a key threat to the species, given the remaining populations occur predominantly within reserves. Populations of the species that occur in the Stirling Range National Park and the FRNP have been identified as the two largest populations across the subspecies geographic distributions (TSSC, 2009).

Clearing of habitat outside reserves may be a threat to the subspecies, but the Committee judged that clearing will not cause a substantial reduction in numbers of the species in the immediate future.

The Western Whipbird has been recorded within the Kundip Mine Site by Biota in 2004 and APM in 2017. These recent records, coupled with the high site fidelity, suggest the Kundip Mine Site contains suitable breeding and foraging habitat for this species.

Records indicate that this species prefers elevated open Mallee habitat on the upper hilltops and hill slopes, which occurs in the eastern half of the Kundip Mine Site. Similar habitat is broadly distributed across the Ravensthorpe Range, meaning that the proposed extent of disturbance is unlikely to have a significant impact on local or regional populations. Of the two habitats within which the Whipbird has been recorded, 36.8% (150.3 ha) of 'Low Woodland Mallee and Heath' habitat and 32.7% (17.2 ha) of the 'Low Dense Forest/Forest' habitat, will be cleared.

Given the species has an affinity for reusing nests/ nest sites, an increased frequency of fire is likely to have a significant impact on nesting success of local individuals. Any increase in the presence of feral cats may also impact this species because nest construction occurs in relatively low strata vegetation. The management of fire and introduced fauna by ACH will contribute significantly to the security of individuals of this species that persist following clearing and construction.

It is unlikely that the Western Whipbird (Mallee) will respond favourably to increases in noise and vibration. It is more likely that nesting pairs will move away from the Development Envelope, though they may continue to forage in the vicinity.

While the RGP will have a localised impact on habitat within the Project area that may potentially support fauna of Conservation Significance, the extent of 'Excellent' or higher quality vegetation in adjacent areas and throughout the region will provide a suitable refuge and source of foraging for fauna relocating from the Project area.

7 REFERENCES

Atlas of Living Australia. (2016). Available: http://www.ala.org.au/. (Accessed June 2016).

Baczocha, N. and Start, A.N. (1996). Status and ecology of the dibbler (*Parantechinus apicalis*) in Western Australia. Half-yearly report, August 1996. Report to Australian Nature Conservation Agency. Department of Conservation and Land Management, Perth.

Beard JS (1972) Vegetation Survey of Western Australia. 1:250 000 Series. The Vegetation of the Bremer Bay and Newdegate Area. Map and Explanatory Memoir. Vegmap Publications, Applecross.

Beard JS (1973) Vegetation Survey of Western Australia. 1:250 000 Series. The Vegetation of the Ravensthorpe Area. Map and Explanatory Memoir. Vegmap Publications, Applecross.

Belcher, C. A., & Darrant, J. P. (2004). Home range and spatial organization of the marsupial carnivore,Dasyurus maculatus maculatus (Marsupialia: Dasyuridae) insouth-eastern Australia. The Zoological Scociety of London, 262. 271-280.

Benntt, E.M. (1987). Ecological Relationships in the Vegetation Near Mt Desmond, Ravensthorpe Range, Western Australia. PhD Thesis, University of Western Australia, Perth

Benshemesh, J. (1992). The conservation ecology of Malleefowl, with particular regard to fire. PhD Thesis, Monash University, Clayton.

Benshemesh, J. (2007). National Recovery Plan for Malleefowl. Department for Environment and Heritage, South Australia.

Bettink, K.A., (2016). Shedding light on rakali: Genetic and morphological differentiation in the Australo-Papuan golden-bellied water rat (*Hydromys chrysogaster*), with notes on the Barrow Island population. PhD Thesis, University of Western Australia, Perth

Biota Environmental Sciences Pty Ltd. (2004). Fauna and Fauna Assemblages of the Kundip and Trilogy Study Sites. Unpublished report for Tectonic Resources NL.

Biota Environmental Sciences Pty Ltd. (2005). Letter to Kim Bennett, Tectonic Resources NL. Kundip Phase II Fauna Survey – Summary of Findings.

Bond, J.W. & van Wilgen, B.W. (1996). Fire and Plants. Chapman and Hall, London, UK.

Booth, D.T., (1987). Home Range and Hatching Success of Malleefowl*, Leipoa ocellata* Gould (Megapodiidae), in Murray Mallee Near Renmark, SA. Wildlife Research, 14(1), pp.95-104.

Bowman, D.M.J.S., Blach, J.K., Artaxo, O., Bond, W.J., Carlson, J.M., Cochrane, M.A., D'Antonio, C.M., Defries, R.S., Doyle, J.C. & Payne, S.(2009). Fire in the Earth System. Science 324: 481-484.

Bureau of Meteorology (2017a) Climate Data Online. Available: http://www.bom.gov.au/climate/averages/tables/cw_010633.shtml (Accessed June 2016).

Bureau of Meteorology (2017b) Daily Rainfall, Ravensthorpe. Available: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=010633 (Accessed October 2016).

Cale, P.G. & A.H. Burbidge (1993). Research plan for the Western Ground Parrot, Western Whipbird and Western Bristlebird. Australian National Parks & Wildlife Service.

Chytrý, M., Tichý, L., Holt, J. & Botta-Dukát, Z. (2002). Determination of diagnostic species with statistical fidelity measures. Journal of Vegetation Science 13: 79–90.

Cockburn, A. (1978) The distribution of *Pseudomys shortridgei* (Muridae: Rodentia) and its relevance to that of other heathland *Pseudomys*. Australian Wildlife Research 5: 213 – 219.

Cogger, H. G. (2014). Reptiles and Amphibians of Australia. CISRO Publishing, Victoria, pp. 629.

Comer, S., Gilfillan, S., Grant, M., Barrett, S. and Anderson, L. (2003). A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002. Esperance 1 (ESP1 – Fitzgerald subregion). Available: https://www.dpaw.wa.gov.au/about-us/science-and-research/biological-surveys/117-a-biodiversity-audit-of-wa. (Accessed June 2016).

Cooper, N. K., Bertozzi, T., Baynes, A., & Teale, R. J. (2003). The relationship between eastern and western populations of the heath rat, *Pseudomys shortridgei* (Rodentia: Muridae). Records of the Western Australian Museum 21, 367-370.

Craig, G.F., (2004). Kundip Mining Leases M74/41, 51, 53 & 135 and P74/153; Vegetation & Flora Survey, unpublished report prepared for Tectonic Resources NL

Craig, G.F., Hickman, E.J., Newell, J. McQuoid, N., Rick, A.M. and Sandiford, E.M. (2008). Vegetation of the Ravensthorpe Range, Western Australia: Mt Short to Kundip, 1:10,000 scale. Department of Environment and Conservation and South Coast Natural Resource Management Inc, Albany, Western Australia.

Department of Environment and Conservation (DEC) (2012a). Chuditch *(Dasyurus geoffroii*) Recovery Plan. Wildlife Management Program No. 54. Department of Environment and Conservation, Perth

Department of Environment and Conservation (DEC) (2012b) Quenda *Isoodon obesulus* (Shaw, 1797), Fauna profiles.

Department of Parks and Wildlife (DPaW) (2013). Carnaby's cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. Department of Parks and Wildlife, Perth

Department of Parks and Wildlife (DPaW) (2016). *NatureMap*. Available https://naturemap.dpaw.wa.gov.au/ (Accessed June 2016).

Department of Parks and Wildlife (DPaW) (2017). Numbat (*Myrmecobius fasciatus*) Recovery Plan. Wildlife Management Program No. 60. Prepared by J.A. Friend and M.J. Page, Department of Parks and Wildlife, Perth

Department of the Environment and Energy (DoEE). (2017). Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Subregions). Available: https://data.gov.au/dataset/interim-biogeographic-regionalisation-for-australia-ibra-version-7-subregions (Accessed January 2018). Australian Government, Canberra, AU.

Department of the Environment and Energy (DoEE). (2018). Species Profile and Threats Database. Available: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. (Last accessed March 2018)

Department of the Environment (DoE) (2016). Protected Matters Search Tool. Available: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf (Accessed June 2016).

Diaz, S., Kattage, J., Cornelissen, JHC., Wright, I., Lavorel, S. et at. (2016). The global spectrum of plant form and function. Nature. 529. 161-174.

Eliáš Jr, P., Sopotlieva, D., Dítě, D., Hájková, P., Apostolova, I., Senko, D., Melečková, Z. & Hájek, M. (2013). Vegetation diversity of salt-rich grasslands in Southeast Europe. Applied Vegetation Science 16: 521–537.

Environmental Protection Authority (EPA). (1999a). Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (s266B) Approved Conservation Advice for Proteaceae Dominated Kwongkan Shrublands of the southeast coastal floristic province of Western Australia.

Environmental Protection Authority (EPA). (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3. Perth, Western Australia.

Environmental Protection Authority (EPA). (2004a). Guidance for the Assessment of Environmental Factors. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, No. 51. Environmental Protection Authority, Western Australia.

Environmental Protection Authority (EPA). (2004b). Guidance for the Assessment of Environmental Factors. Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56. Perth, Western Australia.

Environmental Projection Authority (EPA). (2016). Technical Guidance. Flora and Vegetation Surveys for Environmental Impact Assessment. Perth, Western Australia.

Farr, T.G., Rosen, P.A., Caro, E., Crippen, R., Duren, R., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Alsdorf, D.E. (2007). The shuttle radar topography mission. Reviews of Geophysics 45: 1–33.

Friend, J.A., (2003). Dibbler (*Parantechinus apicalis*) Recovery Plan, Department of Conservation and Lands Management, Perth

Frith, H.J., (1959). Breeding of the mallee-fowl, *Leipoa ocellata* Gould (Megapodiidae). CSIRO Wildlife Research, 4(1), pp.31-60.

Glen, A. S., & Dickman, C. R. (2005). Home range, denning behaviour and microhabitat use of the carnivorous marsupial *Dasyurus maculatus* in eastern Australia. Journal of Zoology, 268. 347-354. doi: 10.1111/j.1469-7998.2006.00064.x

Glevan Consulting Pty Ltd (2006) Dieback Assessment of Kundip, Trilogy and RAV8 Sites

Government of Western Australia. (2016). National Map - Department of Agriculture and Food Western Australia Soil Landscape Zones. Available: http://catalogue.beta.data.wa.gov.au/dataset/soil-landscape-zones/resource/e7f5ded9-a8c6-3193-aaed-6034303bffce?inner_span=True (Accessed October 2016).

Harris, W. F. (1978). An ecological study of the Australian Water-rat (*Hydromys chrysogaster*: Geoffroy) in southeast Queensland. MSc thesis. University of Queensland, Brisbane.

Herath, D. N., Lamont, B.B., Enright, N.J. & Miller, B.P. (2009). Impact of fire on plant -species persistence in post-mine restored and natural shrubland communities in southwestern Australia. Biological Conservation 142: 2175-2180.

Hickman., E.J. (2007). Kundip Mining Leases – Monitoring Quadrat Survey. Unpublished report for Tectonic Resources NL.

Hopper, SD., Browns, AP., Marchant, NG. (1997). Plants of Western Australian granite outcrops. Journal of the Royal Society of Western Australia 80: 141-158.

JDA. (2005).Phillips River Gold Project. Kundip Notice of Intent: Surface Hydrology Assessment. Unpublished report prepared for Tectonic Resources N.L.

Johnstone, R.E. & Storr, G.M. (1998). Handbook of Western Australian Birds. Volume 1: Non-passerines (Emu to Dollarbird). Western Australian Museum, Perth.

Johnstone, R.E. & Storr, G.M. (2004). Handbook of Western Australian Birds. Volume 2: Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Keighery. (1994). Bushland plant survey. A guide to plant community survey for the community. Wildflower Society of WA (Inc.). Nedlands, Western Australia.

Keppel, G., Mokany, K., Wardel-Johnson, GW. *et al.* (2016). The capacity of refugia for conservation planning under climate change. Frontiers in Ecology and the Environment.

Kern, S., Jasper, R., and True, D., (2008) Floristic survey of the Ravensthorpe Range. Report prepared for Department of Environment and Conservation, Woodvale by Western Botanical, Bassendean

Kinnear, J.E., Sumner, N.R. and Onus, M.L., (2002). The red fox in Australia—an exotic predator turned biocontrol agent. Biological Conservation, 108(3), pp.335-359.

Landgate. (2016). WA Atlas. Available: https://www2.landgate.wa.gov.au/web/guest/wa-atlas (Accessed October 2016).

Lee, A. K. (1995). The action plan for Australian rodents. Australian Nature Conservation Agency, Endangered Species Program Project Number 130.

Lee, J., Finn, H. and Calver, M. (2013) Feeding activity of threatened black cockatoos in mine-site rehabilitation in the jarrah forest of south-western Australia. Australian Journal of Zoology, 61 (2). pp. 119-131.

Legendre, P. & Anderson, M.J. (1999). Distance-based redundancy analysis: Testing multispecies responses in multifactorial ecological experiments. Ecological Monographs 69: 1–24.

Legendre, P. & Gallagher, E.D. 2001. Ecologically meaningful transformations for ordination of species data. Oecologia 129: 271–280.

Litvaitis, J.A., Sherburne, J.A. and Bissonette, J.A., (1986). Bobcat habitat use and home range size in relation to prey density. The Journal of Wildlife Management, pp.110-117.

Lötter, M.C., Mucina, L. & Witkowski, T.F. (2013). The classification conundrum: species fidelity as leading criterion in search of a rigorous method to classify a complex forest data set. Community Ecology 14: 121–132.

Markey, A.S., Kern, S. and Gibson, N., (2012). Floristic communities of the Ravensthorpe Range, Western Australia. Conservation Science Western Australia, 8, pp.187-239.

Mathew, H. (1996). An investigation into the effect of management strategies on the home range of chuditch (*Dasyurus geoffroii*). B.Sc.(Honours) Thesis, University of Western Australia, Perth

Maxwell, S., Burbidge, A.A. and Morris, K.D. (Eds.) (1996). The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia, Endangered Species Project Number 500. Environment Australia, Canberra.

McNee, S. (1986). Surveys of the Western Whipbird and Western Bristlebird in Western Australia, 1985. Royal Australasian Ornithological Union. Report Series. 18.

Menkhorst, P. and Knight, F., (2004). Field guide to the mammals of Australia. Oxford University Press.

Morcombe, M. (2003). Field Guide to Australian Birds. Steve Parish Publishing. Archerfield, Queensland.

Morris, K., Burbidge, A. and Friend, T. (2008). *Pseudomys occidentalis*. The IUCN Red List of Threatened Species 2008: eT18553A8429880. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T18553A8429880.en. Downloaded on 12 December 2017.

MWH Global. (2013). Level 1 Flora Assessment of the Kundip Exploration Leases – Targeted Search of Tenements P74/352, 349, 350, 351, E74/537, E74/311, P74/290, E74/486, P74/259 and E74/392. Unpublished report prepared for Silverlake Resources.

Oksanen, J., Blanchet, F.G., Friendly, M., Kindt, R., Legendre, P., McGlinn, D., Minchin, P.R., O'Hara, R.B., Simpson, G.l., Wagner, H. (2017). Vegan: Community ecology package. R package version 2.4-4.

Pizzey, G., and Knight, F. (2012). The Field Guide to the Birds of Australia. Harper Collins Publishers, Sydney.

Quinlan, K., Moro, D., & Lund, M. (2004). Improved trapping success for rare species by targeting habitat types using remotely sensed data: case study of the heath mouse *(Pseudomys shortridgei)* in Western Australia. Wildlife Research. 31:219-227.

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, http://www.R-project.org/

Rayner, K., Chambers, B., Johnson, B., Morris, K.D. and Mills, H.R., (2012). Spatial and dietary requirements of the chuditch (*Dasyurus geoffroii*) in a semiarid climatic zone. Australian mammalogy, 34(1), pp.59-67.

Saunders, D.A. (1982). The breeding behaviour and biology of the short-billed form of the White-tailed Black Cockatoo *Calyptorhynchus funereus*. Ibis. 124: 422-455.

Saunders, D.A. (1990). Problems of survival in an extensively cultivated landscape: the case of Carnaby's cockatoo *Calyptorhynchus funereus latirostris*. Biological Conservation. 54: 277-290.

Saunders, D.A. and Ingram, J.A. (1998). Twenty-eight years of monitoring a breeding population of Carnaby's cockatoo. Pacific Conservation Biology. 4: 261-270.

Serena, M., Soderquist, T. R., and Morris, K. (1991). 'The Chuditch (*Dasyurus geoffroii*).' Department of Conservation and Land Management, Perth

Serena, M., and Soderquist, T.R., (1989). Spatial organization of a riparian population of the carnivorous marsupial *Dasyurus geoffroii*. Journal of Zoology, 219(3), pp.373-383.

Shine, R. and Fitzgerald, M. (1996), *Large snakes in a mosaic rural landscape: The ecology of carpet pythons Morelia spilota (serpentes: Pythonidae) in coastal eastern Australia*. *Biological Conservation*. 76(2); pp. 113-122

Smith, C.C., (1968). The adaptive nature of social organization in the genus of three squirrels Tamiasciurus. Ecological Monographs, 38(1), pp.31-64.

Smith, G.T., (1991). Ecology of the western whipbird *Psophodes nigrogularis* in Western Australia. Emu-Austral Ornithology, 91(3), pp.145-157.

Soderquist, T., 1988. The Ecology of Chuditch, *Dasyurus geoffroii*, in the Jarrah Forest: A Summary of Facts Relevant to Management. Department of Conservation & Land Management.

Sokal R and Michener C (1958). "A statistical method for evaluating systematic relationships". University of Kansas Science Bulletin. 38: 1409–1438.

Speldewinde, P.C., Close, P., Weybury, M. and Comer, S., (2013). Habitat preference of the Australian water rat (*Hydromys chrysogaster*) in a coastal wetland and stream, Two Peoples Bay, south-western Australia. Australian Mammalogy, 35(2), pp.188-194.

Strauss T, von Maltitz MJ (2017) Generalising Ward's Method for Use with Manhattan Distances. PLoS ONE 12(1)

ter Braak, C.J.F. & Šmilauer, P. (2012). Canoco reference manual and user's guide: Software for ordination (version 5.0). Microcomputer Power, Ithaca, NY, US.

Terratree Pty Ltd (2012) Kundip Mining Centre and Proposed Kundip-Rav 8 Haul Road *Phytophthora* Dieback Assessment, Unpublished Report for Silverlake Resources.

Thackway, R. And Creswell, I.D., (1995) An interim Biogeographic Regionalisation for Australia: A framework for establishing the national system of reserves: Version 4. Canberra, Australian Nature Conservation Agency.

Tichý, L. (2002). JUICE, software for vegetation classification. Journal of Vegetation Science 13: 451–453.

Tichý, L., Chytrý, M., Hájek, M., Talbot, S.S. & Botta-Dukát, Z. (2010). OptimClass: Using species-to-cluster fidelity to determine the optimal partition in classification of ecological communities. Journal of Vegetation Science 21: 287–299.

Tille, P. (2006). Soil-landscape of Western Australia's Rangelands and Arid Interior. Department of Agriculture and Food, Western Australia.

Valentine, L.E., Fisher, R., Wilson, B.A., Sonneman, T., Stock, W.D., Fleming, P.A. and Hobbs, R.J., (2014). Time since fire influences food resources for an endangered species, Carnaby's cockatoo, in a fire-prone landscape. Biological Conservation, 175, pp.1-9.

Van der Merwe, H., & van Rooyen, M.W. (2011). Vegetation trends following fire in the Roggeveld, Mountain Renosterveld, South Africa. South African Journal of Botany 77:127-136.

Van Dyck, S. and Strahan, R. (2008) The Mammals of Australia: 3rd Edition. New Holland, Sydney.

Vymazalová, M., Tichý, L. & Axmanová, I. (2016). The role of vernal species in vegetation classification: a case study on deciduous forests and dry grasslands of Central Europe. Phytocoenologia 46: 9–20.

Ward, J. H., Jr. (1963). Hierarchical Grouping to Optimize an Objective Function, Journal of the American Statistical Association, 58, 236–244.

Western Australian Herbarium, (2017). Retrieved from https://florabase.dpaw.wa.gov.au/

Whittaker, R.H. (1965). Dominance and diversity in land plant communities. Science 147: 250–260.

Wiser, S.K., Hurst, J.M., Wright, E.F. & Allen, R.B. (2011). New Zealand's forest and shrubland communities: a quantitative classification based on a nationally representative plot network. Applied Vegetation Science 14: 506–523.

Witt, W.K. (1997). Geology of the Ravensthorpe and Cocanarup 1:100 000 Sheets: Western Australia Geological Survey, 1:100 000. Geological Series Explanatory Notes, 1:26.

Woinarski, J. & Burbidge, A.A. (2016). *Macropus irma*. The IUCN Red List of Threatened Species 2016: e.T12626A21953231. http://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T12626A21953231.en. Downloaded on 05 February 2018.

Woollard, P., Vestjens, W. J. M., and L. Maclean. (1978). The ecology of the Eastern Water Rat *Hydromys chrysogaster* at Griffith, NSW: food and feeding habits. Australian Wildlife Research 5:59-73.