Bungaroo Iron Ore Mine and Infrastructure Project
Level 2 Fauna Assessment

August 2015

Prepared for
Rio Tinto



Report Reference: 14263-15-BISR-4Rev1_160421

Bungaroo Iron Ore Mine and Infrastructure Project
Level 2 Fauna Assessment

Prepared for
Rio Tinto

Job Number: 14263-15

Reference: 14263-15-BISR-4Rev1_160421

Revision Status

Rev	Date	Description	Author(s)	Reviewer
A	11/11/2015	Draft Issued for Client Review	J. Oates	R. Archibald
B	12/01/2016	Draft Issued for Client Review	J. Oates	R. Archibald
0	04/03/2016	Final Issued for Information	J. Oates	R. Archibald
1	21/04/2016	Revised Final Issued for Information	J. Oates	R. Archibald

Approval

Rev	Date	Issued to	Authorised by	
			Name	**Signature**
A	13/11/2015	P. Royce	S. Pearse	
B	12/01/2016	P. Royce	S. Pearse	
0	04/03/2016	P. Royce	S. Pearse	
1	21/04/2016	P. Royce	S. Pearse	

© Copyright 2015 Astron Environmental Services Pty Ltd. All rights reserved.
This document and information contained in it has been prepared by Astron Environmental Services under the terms and conditions of its contract with its client. The report is for the clients use only and may not be used, exploited, copied, duplicated or reproduced in any form or medium whatsoever without the prior written permission of Astron Environmental Services or its client.

Abbreviations

Abbreviation	Definition
Bat Call WA	Bat Call WA Pty Ltd
Biota	Biota Environmental Sciences
BOM	Bureau of Meteorology
DEC	Department of Environment and Conservation (State)
DNA	Deoxyribonucleic acid
EN	Endangered
EPA	Environmental Protection Authority (State)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
ESA	Environmentally Sensitive Area
ha	Hectares
GDA	Geocentric Datum of Australia
GIS	Geographical Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometres
km^2	Kilometres squared
m	Metres
Mi	Migratory
mm	Millimetres
MNES	Matters of National Environmental Significance
P	Priority
PEC	Priority Ecological Community
Parks and Wildlife	Department of Parks and Wildlife (State)
S	Schedule
sp.	Species (singular)
spp.	Species (plural)
SRE	Short Range Endemic
TEC	Threatened Ecological Community
The 'survey area'	Bungaroo Development Envelope
VU	Vulnerable
WC Act	*Wildlife Conservation Act 1950* (State)
WAM	Western Australian Museum
°C	Degrees Celsius

Executive Summary

Astron was engaged to undertake a Level 2 vertebrate and short range endemic invertebrate fauna assessment for the Bungaroo Iron Ore Mine and Infrastructure Project. The proposed Bungaroo Development Envelope survey area is located approximately 17 kilometres south of Pannawonica, Western Australia and covers 9,795.4 hectares. The Phase 1 survey was conducted from 22 May to 2 June 2015 and Phase 2 survey from 3 to 15 August 2015. The surveys involved habitat assessments, trapping grids, avifauna censuses, foot traverses, targeted searches for both vertebrates and SRE invertebrates, and the use of motion sensitive cameras and SM2BAT ultrasonic bat detectors.

Vertebrate Fauna

Eight broad fauna habitat types were recorded in the survey area: Gorge, Breakaway, Rocky Hills, Low Hills/Slopes, Loamy/Stony Plain, Major Drainage Line, Minor Drainage Line and Non-cracking Clay Plain. Areas of disturbed habitat were also present, particularly in the northern portion within the survey area. Habitats varied in condition depending on the level of grazing and their fire history.

The majority of the survey area was mapped as low habitat suitability for the target Matters of National Environmental Significance species: 63.5%, 63.5% and 55.1% of the survey area for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python, respectively. Only 1.8%, 1.8% and 0.8% of the survey area was considered highly suitable habitat for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python, respectively. The Gorge and Breakaway habitats in the survey area were considered significant for fauna due to the abundance of significant microhabitats they provide such as caves and water pools, which were noted during the current surveys. A permanent spring site was located within the Gorge habitat, with Northern Quolls and potential short range endemic species being recorded from this site. Few caves were recorded during the surveys.

One hundred and fifty-one vertebrate fauna species comprising three amphibians, 50 reptiles, 70 birds and 28 mammals (including four introduced) were recorded within the survey area. This is similar to numbers of species recorded in previous surveys and the fauna species assemblage recorded during the current surveys is considered typical of the Hamersley Range subregion. Eight conservation significant species have been previously recorded within the survey area, all of which were also recorded in the current surveys.

A possible Pilbara Olive Python (S3; VU) scat was recorded from Breakaway habitat in close association with Minor Drainage Line habitat within the survey area. The Gorge and Breakaway habitats in close association with the permanent or semi-permanent pools are considered to be highly suitable habitat for the Pilbara Olive Python. These habitats predominantly occur on the northern and southern boundaries of the eastern portion of the survey area.

The survey area appears to support a small resident population of Northern Quolls, as it was one of the more commonly recorded mammal species within the survey area. Two individuals were captured within Rocky Hills habitat and individuals were also recorded from nine camera sites within Low Hills/Slopes, Minor Drainage Line, Gorge and Rocky Hills habitat. The Gorge and Breakaway habitats are considered suitable shelter habitat and the Minor Drainage Line habitats that are in close association with the Rocky Hills habitat are considered suitable foraging and dispersal habitats for the Northern Quoll.

Pilbara Leaf-nosed Bat (S3; VU) calls were recorded generally at low levels from a variety of habitats throughout the survey area, including Loamy/Stony Plains of the Bungaroo Creek valley, Gorge and Breakaway habitats. The Gorge habitat within the survey area was considered to be potential shelter

and foraging habitat for Pilbara Leaf-nosed Bats; however, the survey area appears to provide limited roosting habitat as few caves were recorded. The timing of calls from acoustic recordings suggests that the Pilbara Leaf-nosed Bats within the survey area originate from a roost outside the survey area. Major Drainage Line and Breakaway habitats and Minor Drainage Line habitat closely associated with the Rocky Hills habitat are considered to be highly suitable habitat for foraging, drinking and commuting purposes.

Other conservation significant species recorded from within the survey area were the Lined Soil-crevice Skink, *Anilios ganei*, Ghost Bat, Western Pebble-mound Mouse and Rainbow Bee-eater. The Rainbow Bee-eater (S5; Mi) is highly mobile and generally less reliant on specific habitats. The Ghost Bat (S3) was recorded at 12 localities within the survey area: four acoustic recording sites and four feeding roost locations. The low activity recorded from acoustic recordings and the presence of small scat piles indicates the caves are likely to be transient roosts and/or feeding sites used by small numbers of Ghost Bats. Twenty-seven inactive mounds from the Western Pebble-mound Mouse (P4) and two individuals were captured. Generally this species prefers gentle rocky slopes, hills and spurs; however, individuals were captured within Loamy/Stony Plain and Major Drainage Line habitats. The Lined Soil-crevice Skink (P4) has been recorded in reasonable numbers and is known to occur throughout the wider Robe Valley area. Two records of the blind snake *A. ganei* (P1) are known from the survey area, with one individual captured during the current surveys. Records of this species indicate it does not have a restricted distribution and is likely to be found throughout and adjacent to the survey area.

Short Range Endemic Invertebrate Fauna

Three habitats were found to be prospective for short range endemic fauna: Gorge habitat, Minor Drainage Line habitat, and the soak and drainage areas of the Major Drainage Line habitat. Minor Drainage Line and Gorge habitats often occur in close association and provide the most suitable habitat for short range endemic fauna. Breakaway and Low Hills/Slopes habitats were of lower importance to short range endemic fauna, though still somewhat prospective. Rocky Hills and Plains habitats were not considered prospective for short range endemic fauna.

A total of 226 specimens belonging to at least 30 invertebrate morphospecies were collected from the survey area. None of the species recorded within the survey area are listed as Threatened or Priority species under State and/or Federal legislation. Based on the survey results, 73% of the species were not considered to be, or are unlikely to be, short range endemics. No confirmed short range endemic species were collected but eight species were potential short range endemic species, principally in the slater (three species), pseudoscorpion (three species), scorpion (one species) and spider (one species) faunas. These species were recorded from the Bungaroo survey area for the first time. The potential short range endemic species recorded were:

- slaters - *Spherillo* sp. indet., *Buddelundia* '61' and Buddelundiinae sp. indet
- pseudoscorpions – *Euryolpium* sp. 'Bungaroo, *Ideoblothrus* sp. 'Bungaroo' and *Tyrannochthonius* sp. 'Bungaroo 2'
- scorpions – *Lychas* 'hairy-tail'-group
- spiders – *Karaops* sp. 'Bungaroo'.

Most of the potential short range endemic species have been collected from habitats that are widespread and well connected in the survey area, especially those from Major Drainage Line habitats, Rocky Slope habitats and Breakaway habitats. Most other species in short range endemic groups are also widespread in the survey area, including several slater species that may have a

similar biology to the potential short range endemic slater species recorded here. Only one habitat type, Gorges with associated minor drainage lines, may contain more tightly restricted species but this habitat type covers only 0.8% of the survey area.

Table of Contents

1 Introduction 1
1.1 Project Background 1
1.2 Scope and Objectives 1
2 Environmental Context 4
2.1 Physical Environment 4
2.1.1 Climate 4
2.1.2 Geology and Soils 4
2.1.3 Surface Water and Hydrology 5
2.2 Biological Environment 5
2.2.1 Interim Biogeographic Regionalisation of Australia 5
2.2.2 Land Systems 6
2.2.3 Pre-European Vegetation 6
2.3 State and Commonwealth Conservation Categories and Management 7
2.4 Land Use and Tenure 7
3 Methodology 9
3.1 Desktop Assessment 9
3.1.1 Database Searches 9
3.1.2 Literature Review 10
3.1.3 Habitat Characterisation 10
3.1.4 Conservation Assessment 10
3.2 Field Survey 12
3.2.1 Survey Timing and Personnel 12
3.2.2 Vertebrate Fauna 13
3.2.2.1 Habitat Assessment 13
3.2.2.2 Trapping Grids 13
3.2.2.3 Avifauna Surveys 14
3.2.2.4 Motion Sensitive Cameras 14
3.2.2.5 Acoustic Bat Surveys 14
3.2.2.6 Active Foraging 19
3.2.2.7 Targeted Searches 19

3.2.2.8 Nocturnal Spotlighting 19
3.2.3 Statistical Analyses 19
3.2.3.1 Sampling Effort 19
3.2.3.2 Site Classification 19
3.2.4 SRE Invertebrates 20
3.2.4.1 Habitat Assessment 20
3.2.4.2 Active Foraging 20
3.3 SRE Specimen Identification 20
3.4 Taxonomy and Nomenclature 21
3.5 Limitations 21
4 Results 24
4.1 Desktop Assessment 24
4.1.1 Environmentally Sensitive Areas 24
4.1.2 Vertebrate Fauna 24
4.1.3 SRE Invertebrates 25
4.1.3.1 Habitat Characterisation 25
4.1.3.2 Species 26
4.2 Field Survey 27
4.2.1 Vertebrate Fauna Habitat 27
4.2.1.1 Fauna Habitats 27
4.2.1.2 Significant Habitat Areas 32
4.2.1.3 Habitat Suitability for MNES Species 32
4.2.2 Vertebrate Fauna Species 33
4.2.2.1 Herpetofauna 33
4.2.2.2 Birds 35
4.2.2.3 Mammals 37
4.2.2.4 Conservation Significant Species Recorded 38
4.2.2.5 Conservation Significant Species Possibly Occurring 41
4.2.3 SRE Invertebrate Fauna Habitat 41
4.2.4 SRE Invertebrate Species 44
4.2.4.1 Slaters 45

4.2.4.2 Millipedes 46
4.2.4.3 Pseudoscorpions 46
4.2.4.4 Scorpions 48
4.2.4.5 Spiders 48
4.2.4.6 Non-marine Snails 49
5 Discussion 52
5.1 Vertebrate Fauna 52
5.1.1 Habitats 52
5.1.2 Species 52
5.1.2.1 General Assemblage 52
5.1.2.2 Conservation Significant Species 53
5.2 SRE Invertebrates 55
5.2.1 Habitats 55
5.2.2 Species 55
6 References 58

List of Figures

Figure 1: Survey area regional location. 3
Figure 2: Climate data for Pannawonica (Station 5069). 4
Figure 3: Previous surveys conducted over survey area. 11
Figure 4: Mean monthly (Pannawonica station; BOM 2015) and total rainfall (Bungaroo weather station; Rio Tinto supplied data), and mean monthly maximum temperatures (Pannawonica station; Bureau of Meteorology 2015) and daily maximum temperatures (Bungaroo weather station; Rio Tinto supplied data), in the 12 months preceding the survey. 12
Figure 5: Aerial view of systematic trapping grid layouts pitfall sites (above) and funnel sites (below). 15
Figure 6: Species accumulation curves for herpetofauna surveys. 34
Figure 7: Two-dimensional ordination of herpetofauna species assemblages of each site. 35
Figure 8: Species accumulation curves for bird surveys. 36
Figure 9: Two-dimensional ordination of bird species assemblages of each site. 36
Figure 10: Species accumulation curves for mammal surveys. 37
Figure 11: Two-dimensional ordination of mammal species assemblages of each site. 38

List of Plates

Plate 1: Loamy/Stony Plain habitat affected by recent fire. 28

Plate 2: Areas of habitat dominated by Buffel Grass. 28

Plate 3: 'High quality' condition Gorge habitat 28

Plate 4: Rocky Hills habitat affected by recent fire. 28

Plate 5: Examples of species in SRE groups collected within the survey area. A = the millipede A*ustrostrophus stictopygus*; B = pseudoscorpion *Oratemnus* sp. 'Bungaroo'; slaters C = Buddelundiinae sp. indet. and D = *Barrowdillo* '2'; and terrestrial snails E = *Eremopeas interioris* and F = *Rhagada* sp. 'Pannawonica'. 50

List of Tables

Table 1: Summary of survey scope. 2

Table 2: Geological units of the survey area. 5

Table 3: Distribution of land systems within the survey area and Pilbara bioregion (van Vreeswyk et al. 2004). 6

Table 4: Extent of pre-European vegetation in the survey area. 7

Table 5: Database searches requested. 9

Table 6: Trapping site locations and survey effort for the current survey. 17

Table 7: Statement of limitations for the Phase 1 and 2 fauna surveys. 22

Table 8: Summary of literature review results from surveys conducted within the vicinity of the survey area. 24

Table 9: Suitability of landforms for SRE fauna within the survey area. 26

Table 10: Vertebrate fauna habitat types recorded in the survey area. 29

Table 11: Number of vertebrate fauna species recorded during the survey. 33

Table 12: Total number of herpetofauna taxa sampled in comparison to estimates of the total species pool based on several models. 34

Table 13: Total number of bird taxa sampled in comparison to estimates of the total species pool based on several models 36

Table 14: Total number of mammal taxa sampled in comparison to estimates of the total species pool based on several models. 38

Table 15: Summary of the potential SRE species within the survey area 51

List of Appendices

Appendix A: Background Information Figures

Appendix B: Conservation and Introduced Fauna Categories, Habitat Condition Scales and Likelihood Criteria

Appendix C: Fauna Sampling Locations

Appendix D: Fauna Species Lists

Appendix E: Threatened and Priority Fauna Species Likelihood of Occurrence within the Survey Area

Appendix F: Fauna Habitat Mapping

Appendix G: Conservation Significant and SRE Fauna Locations

Appendix H: List of Specimens Lodged with Western Australian Museum

1 Introduction

1.1 Project Background

Rio Tinto engaged Astron to undertake a Level 2 vertebrate fauna and short range endemic (SRE) invertebrate fauna assessment for the Bungaroo Iron Ore Mine and Infrastructure Project (the Bungaroo project). The proposed Bungaroo Development Envelope, herein referred to as the 'survey area', is located approximately 17 kilometres (km) south of Pannawonica, Western Australia and covers 9,795.4 hectares (ha) (Figure 1).

1.2 Scope and Objectives

The objective of the assessment was to provide a two-phase Level 2 biological survey of vertebrate and SRE invertebrate fauna values through a desktop assessment and field survey. The resultant data was to be utilised to produce a report to support and inform the environmental assessment process for the Bungaroo project.

The scope of works was to undertake a:

- desktop assessment, including database searches and literature review of available contextual and project related resources
- two-phase vertebrate fauna field survey, including:
  - fauna sampling
  - targeted searches
  - fauna habitat mapping
- SRE field survey, including:
  - targeted survey and searches
  - SRE fauna habitat mapping.

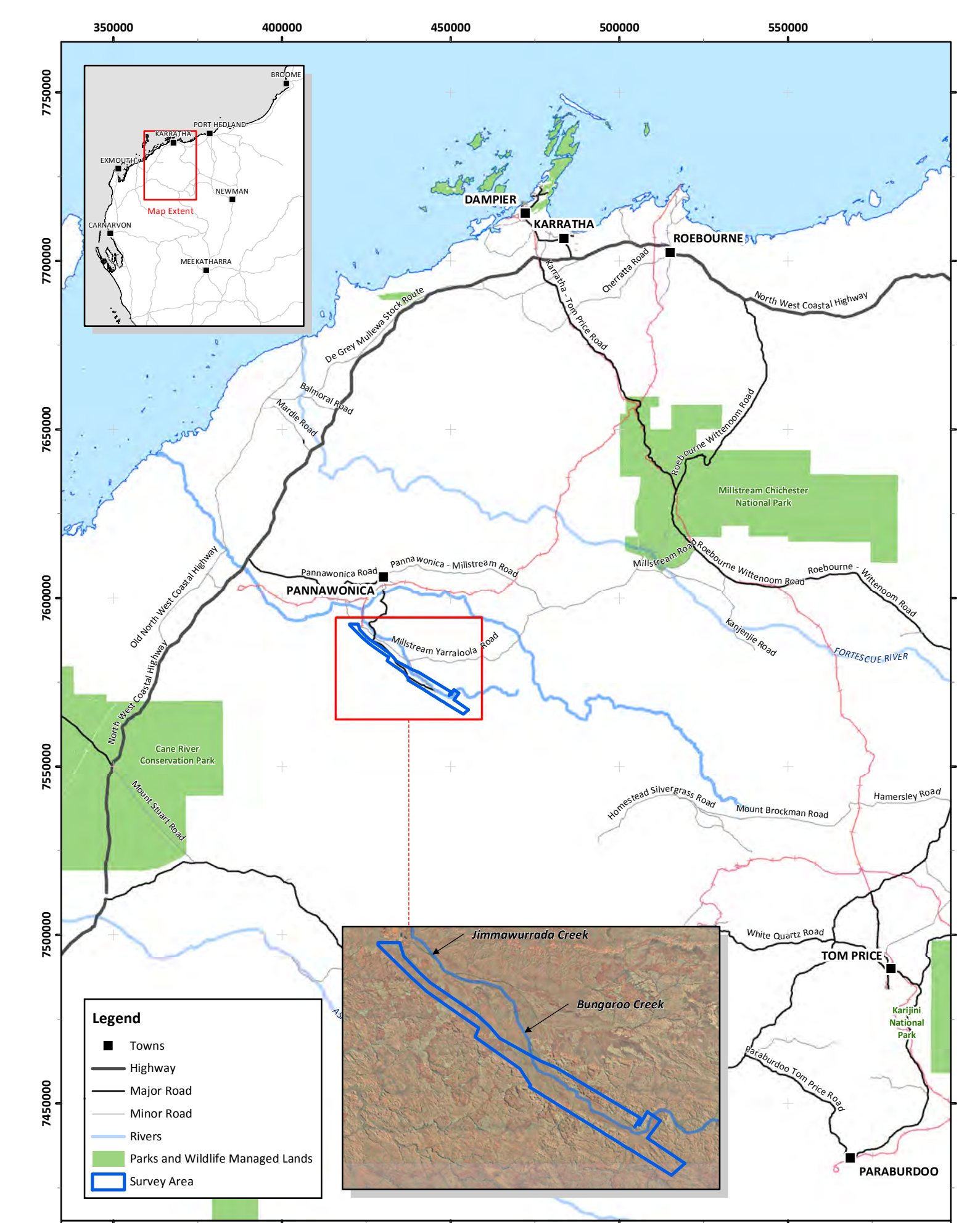
Astron conducted the fauna survey in accordance with the following:

- Position Statement No. 3 (Environmental Protection Authority 2002)
- Guidance Statement No. 56 (Environmental Protection Authority 2004)
- Guidance Statement No. 20 (Environmental Protection Authority 2009)
- Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (Environmental Protection Authority and Department of Environment and Conservation 2010)
- Rio Tinto data standards (Rio Tinto 2015a, 2015b, 2015c, 2015d, 2015e).

The scope and key limitations of the survey are outlined in Table 1. Section 3.5 of this report provides more detail on the limitations of the survey.

Table 1: Summary of survey scope.

Level of survey	Survey area size	Survey timing	Relevant regulatory guidance documents	Key survey limitations
Level 2 – two phase vertebrate fauna and SRE survey	9,795 ha	22 May – 2 June 2015 3 – 12 August 2015	• EPA Position Statement No. 3 (Environmental Protection Authority 2002) • EPA Guidance Statement No. 20 (Environmental Protection Authority 2009) • EPA Guidance Statement No. 56 (Environmental Protection Authority 2004) • EPA and DEC Technical Guide (Environmental Protection Authority and DEC 2010)	• Wet weather restricted the number of trapping grids that could be opened in Phase 1 and the number of nights they were opened for. Extra trapping grids were opened in Phase 2. • Not optimal time for SRE sampling. • Recent fire (covering ~29% of the survey area) and grazing by cattle had affected some areas of the survey area.



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure 1: Survey Area Regional Location

astron

Author: J. Oates	Date: 03-03-2016
Drawn: W. An	14263-15-BIDR-2Rev0_160303_Fig01_Location

Datum: GDA 1994 - Projection: MGA Zone 50

0 10 20 30 40 50 Km

N

2 Environmental Context

2.1 Physical Environment

2.1.1 Climate

The climate of the Pilbara region of Western Australia is classified as arid tropical with two distinct seasons: a hot, wet summer (October – April) and a mild, dry winter (May – September) (Bureau of Meteorology (BOM) 2015).

Based on long-term climatic data from the nearest BOM weather station at Pannawonica (Station 5069) (approximately 17 km north-east of the survey area) the mean annual rainfall since 1971 is 403.5 millimetres (mm) (Bureau of Meteorology 2015). The mean maximum daily temperatures range between 26.7 degrees Celsius (°C) and 41°C, and exceed 30°C for much of the year (Bureau of Meteorology 2015) (Figure 2).

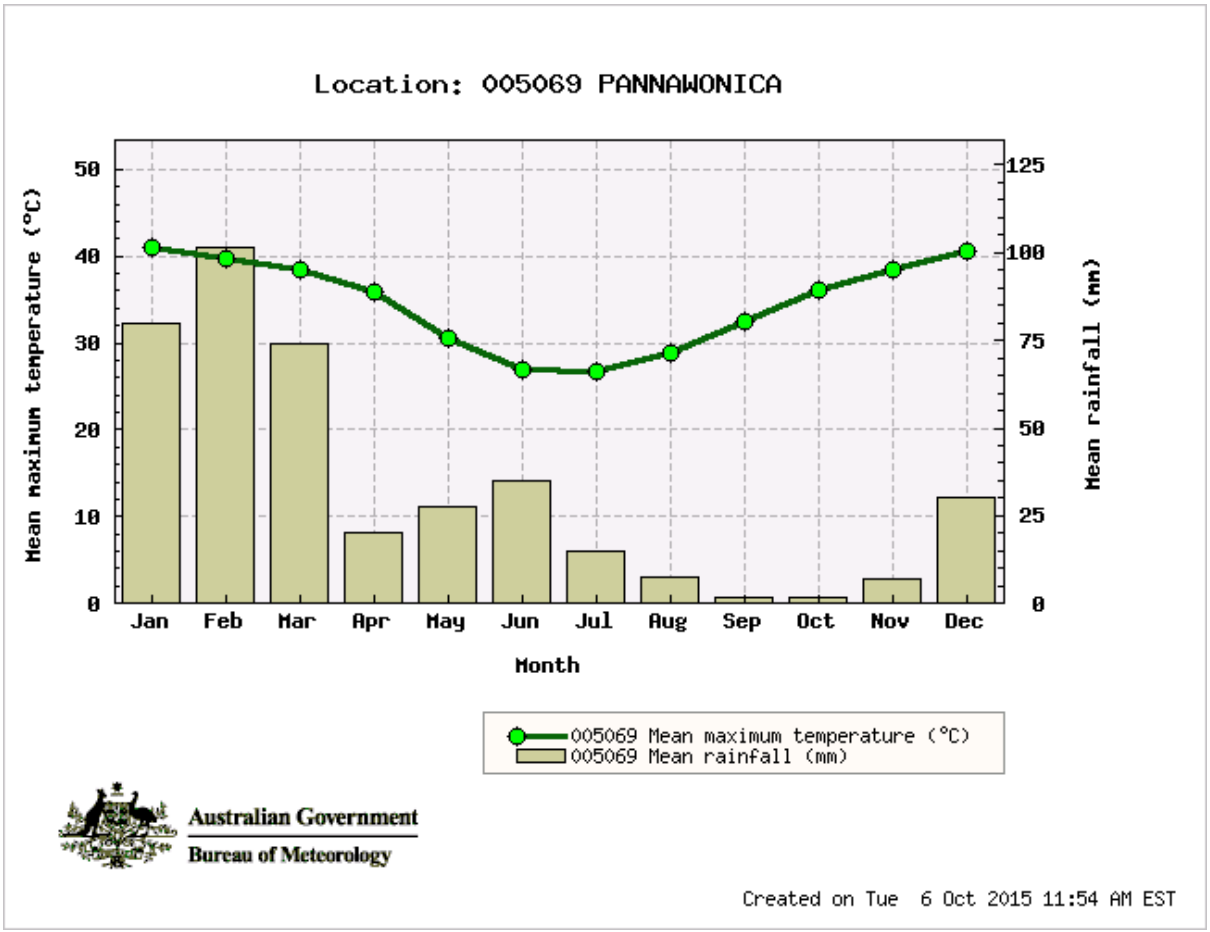


Figure 2: Climate data for Pannawonica (Station 5069).

2.1.2 Geology and Soils

The survey area occurs on the Hamersley Basin that overlies the older Archaean Pilbara Craton. The Hamersley Basin comprises mafic and felsic volcanics, shale, siltstone, sandstone and conglomerate, as well as dolomite and banded iron formation. The sequence is extensively deformed with the rocks being folded and faulted (Van Vreeswyk et al. 2004). The surface geology of the survey area is comprised of six units (Stewart et al. 2008) as presented in Table 2 and Figure A.1 (Appendix A) .

Table 2: Geological units of the survey area.

Geological name (Stewart et. al. 2008)	Label	Area within survey area (ha)
Marra Mamba Iron Formation: chert, ferruginous chert, jaspilite, banded iron formation, minor shale, siltstone, mudstone	Achm	318
Mount McRae Shale and Mount Sylvia Formation: interbedded shale, chert and banded ironstone	Ashm	1,247
Robe Pisolite: pisolitic, oolitic and massive limonite, goethite and hematite deposits containing fossil wood fragments; iron ore	Czlr	329
Brockman Iron Formation: banded iron formation, chert, mudstone and siltstone	Lchk	3,024
Alluvium 38485: channel and flood plain alluvium; gravel, sand, silt, clay, locally calcreted	Qa	1,820
Colluvium 38491: colluvial sediments	Qrc	3,057

The survey area is mapped as soil landscape zone 285 – Hamersley Plateaux of the Fortescue Province. This soil unit is described as hills and plateaux, with some stony plains and hardwash plains, on sedimentary and volcanic rocks of the Hamersley Basin. Stony soils with red shallow loams and some red brown non-cracking clays and red loamy earths predominate (Tille 2006).

2.1.3 Surface Water and Hydrology

The entire survey area occurs within the Bungaroo Creek valley with the southern portion intersected by approximately 15 km of Bungaroo Creek. This ephemeral creek flows in a north-westerly direction, forming a tributary of the Robe River. Other watercourses within the vicinity of the survey area include Jimmawurrada Creek, located approximately 2 km east of the survey area, and Kallawia Creek, which is approximately 8 km to the north-east at its nearest point. Each of these watercourses form part of the Robe River catchment zone. The Robe River, at its nearest point, lies approximately 4.5 km north of the survey area.

The survey area is within a Public Drinking Water Source Area: the Bungaroo Water Reserve (Department of Water 2008).

2.2 Biological Environment

2.2.1 Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation for Australia (IBRA version 7) divides the Australian continent into 89 bioregions and 419 subregions (Department of the Environment 2015a). The IBRA regions represent a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. The survey area occurs in the Pilbara Bioregion, of which 5% to 10% is represented in the national reserve system (Department of the Environment 2015b).

The biodiversity of the 53 subregions recognised in Western Australia was documented as part of a national audit to provide priorities for conservation action (Department of Conservation and Land Management 2002). The survey area occurs in the Hamersley subregion of the Pilbara region. The Hamersley subregion was described in the audit as:

- Hamersley PIL3 – dissected bold plateaux and ranges of flat lying or moderately folded sandstone and quartzite with vegetation described as Mulga low woodland over tussock

grasses occurring on fine textured soils in valley floors, with scattered Snappy Gum (*Eucalyptus leucophloia*) over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001).

2.2.2 Land Systems

Land systems of the Western Australian rangelands were mapped by the Department of Agriculture (now the Department of Agriculture and Food Western Australia) and providing comprehensive descriptions of biophysical resources, including soil and vegetation condition. The four land systems occurring in the survey area are described as:

- Boolgeeda – stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and Mulga shrublands
- Newman – rugged jaspilite plateaux, ridges and mountains with hard spinifex
- Robe – low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands
- Urandy – stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands (van Vreeswyk et al. 2004).

The total area of these land systems within the survey area and the Pilbara bioregion is presented in Table 3 and Figure A.2 (Appendix A).

Table 3: Distribution of land systems within the survey area and Pilbara bioregion (van Vreeswyk et al. 2004).

Land system	Total area within Pilbara bioregion (ha)	Total area within survey area (ha)	Proportion within survey area (%)
Boolgeeda	961,847	2,834	0.29
Newman	1,994,339	4,559	0.23
Robe	128,680	326	0.25
Urandy	132,039	2,076	1.57

2.2.3 Pre-European Vegetation

Pre-European vegetation was described and mapped across the Pilbara region at a scale of 1: 1,000,000 (Beard 1975). The survey area is located in the Hamersley Plateau physiographic unit of the Fortescue Botanical District. This physiographic unit is described as:

Hamersley: a compact unit defined by the outcropping of jaspilite and dolomite, with some shale, siltstone and volcanics. Vegetation is described as:

- ranges – tree steppe of *Eucalyptus brevifolia* (likely to represent *E. leucophloia*) over *Triodia wiseana* hummock grasslands
- valley plains – Mulga (*Acacia aneura* complex) low woodlands, or tussock grasslands on cracking clay soils
- basalt hills – mosaic of Mulga low woodland and *Acacia pyrifolia* and *Triodia* species shrub steppe.

Two vegetation units, 82 and 609 (Shepherd et al. 2002, Government of Western Australia 2014) are associated with the Bungaroo survey area (Table 4 and Figure A.3; Appendix A):

> 82: 'Hummock grasslands, low tree steppe; Snappy Gum over *Triodia wiseana*'
>
> 609: 'Mosaic: Hummock grasslands, open low tree steppe; Bloodwood with sparse Kanji shrubs over soft spinifex/Hummock grasslands, open low tree steppe; Snappy Gum over *Triodia wiseana*' on a lateritic crust.

Table 4: Extent of pre-European vegetation in the survey area.

Vegetation association	Mapping unit (Beard 1975)	Extent in survey area (ha)	Current extent in Pilbara bioregion (ha)	Pre-European extent (ha)	Proportion of pre-European extent remaining (%)
82	e16Lr t3Hi	3,898	2,550,898.98	2,563,583.23	99.51
609	e24Lr a2Sp t1Hi /e16Lr t3Hi	5,897	72,765.18	74,186.11	98.08

2.3 State and Commonwealth Conservation Categories and Management

Commonwealth and State regulatory authorities maintain databases of the locations and conservation status of significant flora, fauna and ecological communities in Western Australia.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage Matters of National Environmental Significance (MNES) including listed flora, fauna and ecological communities. These listed flora, fauna and ecological communities are allocated a conservation category, which are outlined in Table B.1-B.6 (Appendix B).

Ecological communities may be subject to processes that threaten to destroy or significantly modify it across much of its range. These communities are identified as Threatened Ecological Communities (TECs) and are listed at both the Commonwealth level under the EPBC Act and the State level by the Western Australian Minister for Environment (Table B.1, Appendix B). The Department of Parks and Wildlife (Parks and Wildlife) maintains a list of Priority Ecological Communities (PECs), which may also be under threat and are assigned one of four Priority rankings according to the criteria outlined in Table B.2 (Appendix B).

Under Western Australian legislation, all native fauna is protected and it is an offence to 'take' protected fauna. The *Wildlife Conservation Act 1950* (WC Act) also provides for native fauna species to be specially protected when they are considered rare, threatened with extinction, or have a high conservation value (Table B.4, Appendix B). In addition, due to the diversity of Western Australia's fauna, many species are known from only a few collections or locations, but have not been adequately surveyed. Such fauna may be rare or threatened, but cannot be considered for declaration as Threatened fauna until adequate surveys have been undertaken. These fauna species are included on a supplementary conservation list managed by Parks and Wildlife called the *Priority Fauna List*. Priority fauna are categorised according to level of threat and other information and the conservation categories are described in Table B.5 (Appendix B).

2.4 Land Use and Tenure

The survey area is located within the Shire of Ashburton. Approximately one-third of the survey area is on the Yalleen Station pastoral lease, with the remainder on unallocated Crown land. The local area is used for pastoralism, mineral exploration and mining activity.

The Cane River Conservation Park is the nearest conservation reserve to the survey area, located approximately 44 km to the south-west (Figure 1). The Millstream-Chichester National Park and Karijini National Park is located approximately 74 km to the north-east and 150 km to the south-east of the survey area, respectively (Figure 1).

3 Methodology

3.1 Desktop Assessment

A desktop assessment was undertaken to assess whether any listed vertebrate and invertebrate species, SRE invertebrate species or communities, or PECs/TECs were likely to occur within the survey area. For vertebrate species, the review focused on key habitats for conservation significant fauna and species of MNES. For SRE invertebrates, the review focused on key habitats for SRE fauna and the eight invertebrate groups with a known high proportion of SRE species (the SRE groups): centipedes (Chilopoda), harvestmen (Opiliones), millipedes (Diplopoda), non-marine snails (Gastropoda), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), terrestrial slaters (Isopoda) and spiders (Araneae).

3.1.1 Database Searches

A search for Environmentally Sensitive Areas (ESAs) in the vicinity of the survey area was conducted using the Western Australian Atlas (Landgate 2015) and Register of the National Estate spatial database (Australian Government 2008). In addition, database searches were conducted for different fauna groups with search details summarised in Table 5. Conservation categories for fauna are provided in Tables B.1 – B.3 (Appendix B).

Table 5: Database searches requested.

Database name	Date search results received	Search focus	Search area (GDA94)
Protected Matters Search Tool (Department of the Environment 2015c)	16/09/2015	Fauna MNES	40 km radius from an approximate survey area centre point defined by the coordinates: -21.889172 S, 116.37722 E
Threatened and Priority Fauna Database (Department of Parks and Wildlife 2015a)	03/04/2015	Threatened and Priority fauna species	20 km radius surrounding survey area boundary
NatureMap (Department of Parks and Wildlife 2015b)	07/04/2015	Terrestrial fauna and fauna of conservation significance	40 km radius from a point defined by the coordinates: 21°53’21 S, 116°22’37 E
BirdLife Australia (Birdlife Australia 2015)	08/04/2015	Bird species	1 degree from a point defined by the coordinates: -21.7492 S and 116.32794 E (GDA94)
Western Australian Museum (WAM) Invertebrate Database (Western Australian Museum 2015a)	20/04/2015	Arachnids and myriapods	100 km buffer from survey area bounded by -21.772706, 116.225190 and -21.978406, 116.503473 (GDA94)
		Crustaceans	
		Molluscs	
Atlas of Living Australia (Atlas of Living Australia 2015)	20/04/2015	All fauna species	10 km radius from a point defined by the coordinates: 21°53’21 S, 116°22’37 E

3.1.2 Literature Review

Fauna surveys have previously been commissioned by Rio Tinto within the vicinity of the survey area and supplied to Astron for the desktop assessment. The previous survey area boundaries that overlap the current survey area are shown in Figure 3. The main reports reviewed as part of this assessment are:

- Biota Environmental Sciences (2006) 'Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo' unpublished report to Robe River Iron Associates
- Biota Environmental Sciences (2007) 'Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonica' unpublished report to Pilbara Iron Company
- Biota Environmental Sciences (2010) 'Greater Bungaroo Seasonal Fauna Survey', unpublished report to Rio Tinto
- ecologia Environment (2013) 'Middle Robe and East Deepdale Flora, Vegetation, Vertebrate and Invertebrate Fauna Survey', unpublished report to Rio Tinto
- Phoenix Environmental Sciences (2012) 'Terrestrial Fauna Surveys for the Buckland Project', unpublished report to Iron Ore Holdings Ltd
- Phoenix Environmental Sciences (2014) 'Terresterial Fauna Surveys for the Balla Balla Railway Project', unpublished report to Preston Consulting on behalf of Rutila Resources Ltd.

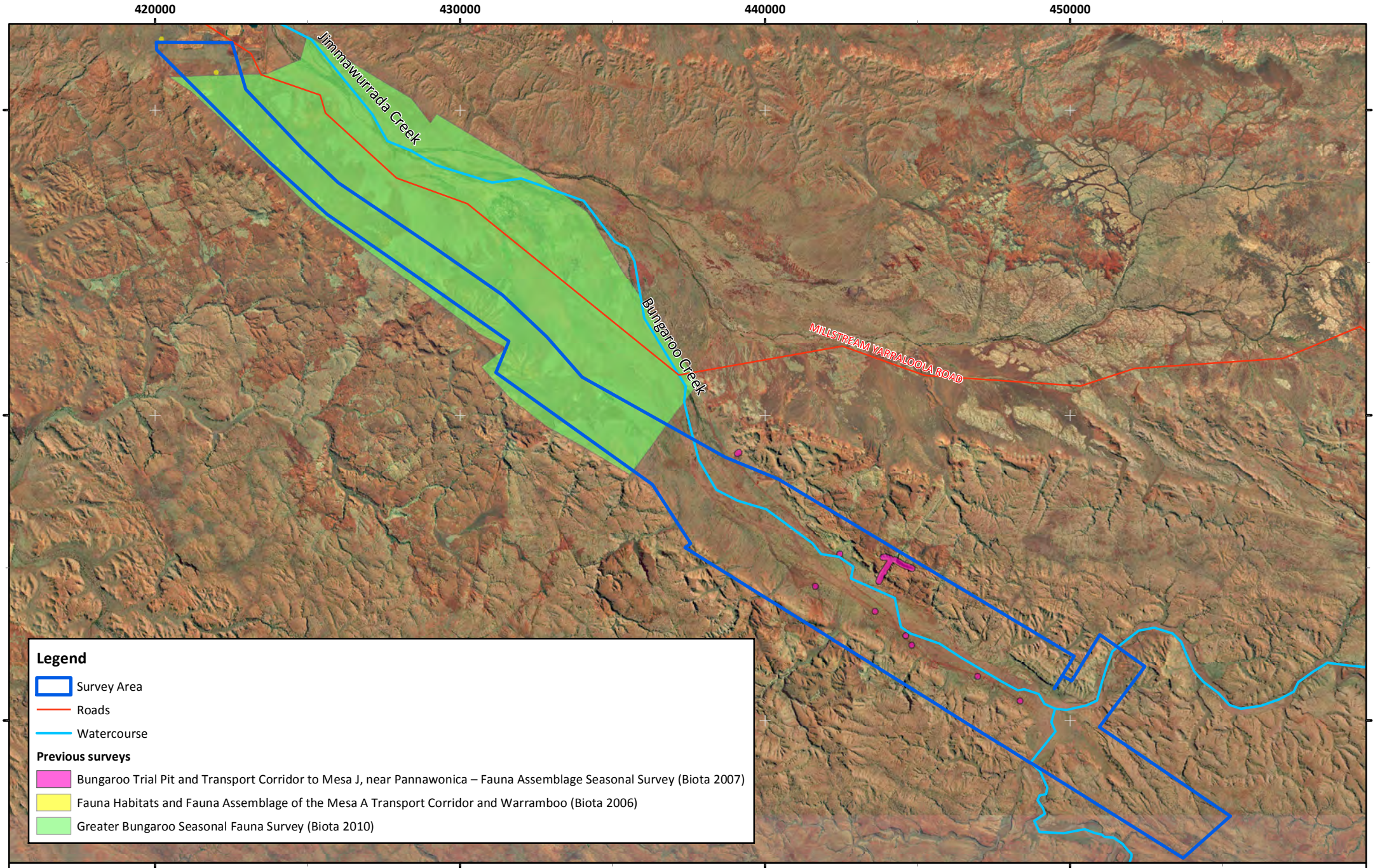
3.1.3 Habitat Characterisation

Using orthophotos provided by Rio Tinto and the available literature, the survey area was split into distinct landform types that were evaluated further for their likelihood of listed or SRE species occurrence. The assessment followed several criteria, such as the condition (according to Thompson and Thompson 2010), availability of moisture, extent of shade and shelter, soil, and vegetation types. Emphasis was given to landforms (and associated habitats) that may contain 'relict' species (sheltered and moist) and those that may support habitat specialists such as species restricted to rocky outcrops.

3.1.4 Conservation Assessment

Conservation significant vertebrate fauna species returned from the database searches were categorised for occurrence within the survey area prior to the field survey, according to the criteria listed in Table B.9 (Appendix B). Post survey, the likelihood table was re-assessed utilising the information obtained during the field survey using the additional criteria outlined in Table B.9 (Appendix B). The likelihood table was then updated to reflect a more improved understanding of species likelihood.

SRE invertebrates are species with distributions of less than 10,000 km^2 and their occurrence within their distribution is usually fragmented and highly localised (Harvey 2002; Ponder and Colgan 2002). However, it is often difficult to determine whether or not a species in one of the target SRE groups actually has a range <10,000 km^2. For the purpose of desktop review, SRE status was determined by the staff of the WAM through providing the results of SRE filtered searches of the WAM databases. This assessment was reviewed and supplemented with information contained in previous environmental reports, the published literature and online databases. For morphospecies collected during the Phase 1 survey, the criteria outlined in Table B.10 (Appendix B) were used to determine SRE status. The SRE categories of the WAM (confirmed SRE, potential SRE and widespread species) were used to assess the status of species.



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure 3: Previous surveys conducted over survey area

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_Fig03_Previous_surveys

3.2 Field Survey

3.2.1 Survey Timing and Personnel

The Phase 1 field survey was undertaken by Dr Jessica Oates, Matthew Johnston, Jeff Turpin and Frances Leng. The Phase 2 field survey was undertaken by Matthew Johnston and Ray Lloyd. All survey personnel have over five years of experience conducting Level 2 fauna surveys. The surveys were conducted under "Licence to Take Fauna for Scientific Purposes" Permit No. SF10306.

The Phase 1 and 2 field surveys were conducted from 22 May to 2 June 2015 and from 3 to 15 August 2015, respectively. Daily weather observations recorded from Bungaroo were used to describe local rainfall and temperatures preceding the survey (Figure 4). Prior to the surveys, recorded rainfall was 236 mm above the average between January and May 2015. Maximum daily temperatures were lower than the long-term mean during and preceding the Phase 1 survey (Figure 4). During the Phase 1 survey 47.3 mm rain was received and daily maximum temperatures ranged between 19.8°C and 28.3°C. Maximum daily temperatures were similar to the long-term mean during and preceding the Phase 2 survey (Figure 4). During the Phase 2 survey no rain was received and daily maximum temperatures ranged between 25.5°C and 30.2°C.

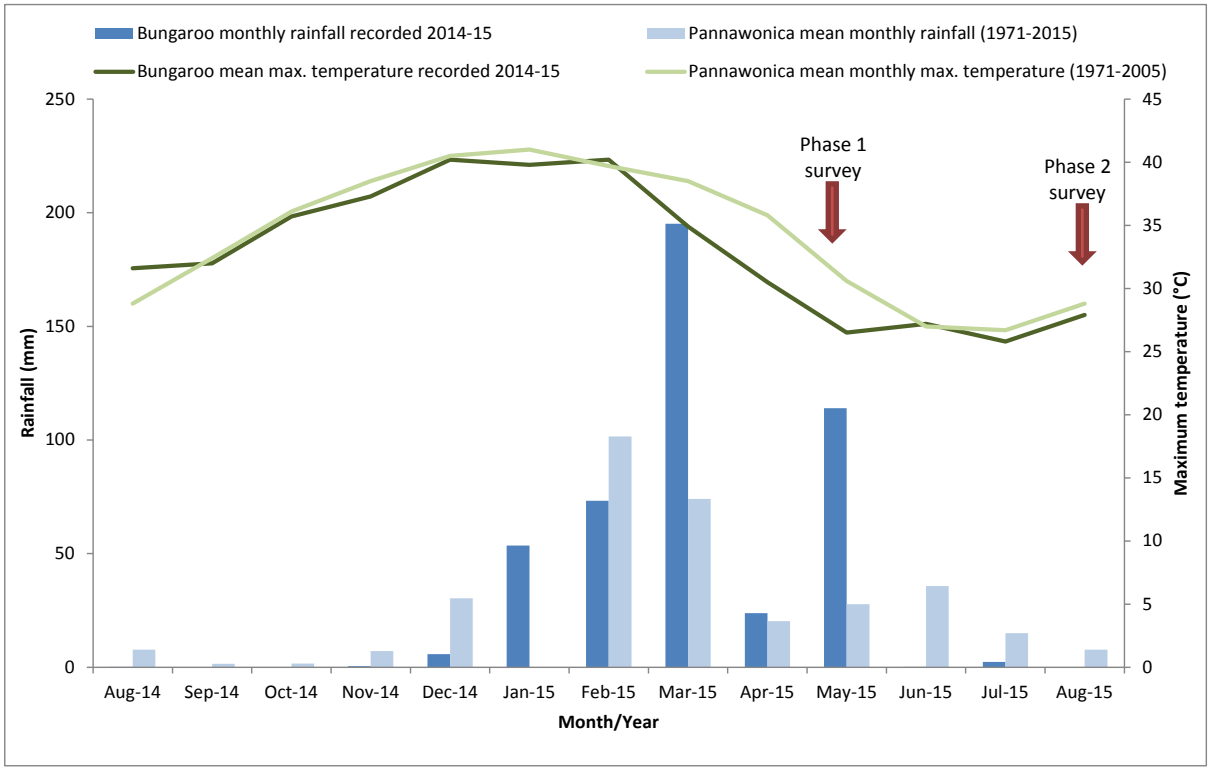


Figure 4: Mean monthly (Pannawonica station; BOM 2015) and total rainfall (Bungaroo weather station; Rio Tinto supplied data), and mean monthly maximum temperatures (Pannawonica station; Bureau of Meteorology 2015) and daily maximum temperatures (Bungaroo weather station; Rio Tinto supplied data), in the 12 months preceding the survey.

3.2.2 Vertebrate Fauna

3.2.2.1 Habitat Assessment

Fifty-eight fauna habitat assessments were conducted within the eight fauna habitat types present in the survey area (Table C.1, Appendix C). The locations are shown in Figure C.1 (Appendix C) and the following information was collected at each site:

- Location – coordinates measured using a handheld GPS (GDA94).
- Recorder and date – personnel involved in undertaking the fauna habitat assessment and the survey date.
- Habitat/landform – position in the landscape - major fauna habitat types were described based on the landform and vegetation.
- Vegetation type – a broad description of vegetation type and structure.
- Soils – a brief description of soil type.
- Microhabitat – presence of specific microhabitat features, e.g. leaf litter, logs, burrows, rocky outcrops, rock crevices, hollows, permanent or semi-permanent water.
- Condition – habitat condition was assessed based on the presence of anthropogenic (human-induced) disturbances, and using the condition ratings suggested by Thompson and Thompson (2010) (Table B.8, Appendix B).
- Disturbance – any disturbance such as clearing, fire, weeds, flooding, vehicular, machinery, tracks or grazing.
- Photographs – a representative photograph was taken of each habitat assessment site.

The information derived from the fauna habitat assessments was used to delineate fauna habitats throughout the survey area, which were then mapped accordingly. The potential for the mapped habitats to provide suitable habitat for MNES species, Pilbara Olive Python (VU, S3), Northern Quoll (EN, S2) and Pilbara Leaf-nosed Bat (VU, S3) were ranked according to the criteria listed in Table B.11 (Appendix B) and then mapped for each species.

3.2.2.2 Trapping Grids

Eight trap sites (four new and four previously established) were utilised in fauna habitats under-represented or not previously surveyed (Table 6). Sites were selected in areas of favourable micro-habitat to maximise the likelihood of fauna capture. The location of previous and current trap sites is shown in Figure C.1 (Appendix C).

Five of the trap sites consisted of 10 pitfall traps (20 litre bucket and PVC pipes), six funnel traps (fish-net style), 20 Elliot traps (aluminium box-trap) and four cage traps (wire mesh cage trap). The pitfall traps were used in conjunction with a 100 metre (m) drift fence running over the centre of the pit, directing animal movement into the pitfall trap. The remaining three trap sites in rocky habitats were established as funnel sites, with 16 funnel traps placed along a drift fence, plus 20 Elliott traps and four cage traps. Seven trap sites were open in Phase 1 and five trap sites in Phase 2. The trap sites remained open for six nights in Phase 1 and seven nights in Phase 2. Traps were cleared each morning within three hours after sunrise to minimise the potential of trap death. Trap arrangement is depicted in Figure 5.

3.2.2.3 Avifauna Surveys

Systematic avifauna (bird) censuses were undertaken at each trapping grid for 20 minutes each day on five occasions over both surveys, resulting in 100 minutes of surveys at each site and a total of 1,200 minutes (20 hours) over the survey area. All species were recorded through direct visuals and/or from species-specific bird calls. In addition, a targeted avifauna survey was conducted for 90 minutes at the soak during the Phase 1 survey. Opportunistic records of species across the survey area were also recorded and habitats that may support species of conservation significance were targeted.

3.2.2.4 Motion Sensitive Cameras

Thirty motion sensitive cameras were used during the survey (Moultrie, Bushnell Trophy Cam infra-red, and Reconyx HC600 HyperFire) in both surveys. Cameras were set at 48 locations for between two and six nights with a combined trapping effort of 247 camera trap nights over both surveys. The cameras were placed in prospective/suitable habitat such as cave entrances and water holes aimed at targeting MNES species. Camera locations are shown in Figure C.1 and detailed in Table C.2 (Appendix C).

3.2.2.5 Acoustic Bat Surveys

Acoustic ultrahigh frequency equipment was used to record the presence of bats, in particular the Pilbara Leaf-nosed Bat and Ghost Bat. Four (Song Meter 2) acoustic recording devices were positioned in 12 locations across both surveys to achieve a broad coverage of the survey area, but also distributed across the survey area to allow an analysis of flying direction and the potential locations of any roosts. The detectors were set for two to five nights, resulting in a total of 41 recording nights. The locations are depicted in Figure C.1 and detailed in Table C.3 (Appendix C).

The bat echolocation data collected on the SM2BAT+ detectors in the field was analysed by Robert Bullen (Bat Call WA 2015).

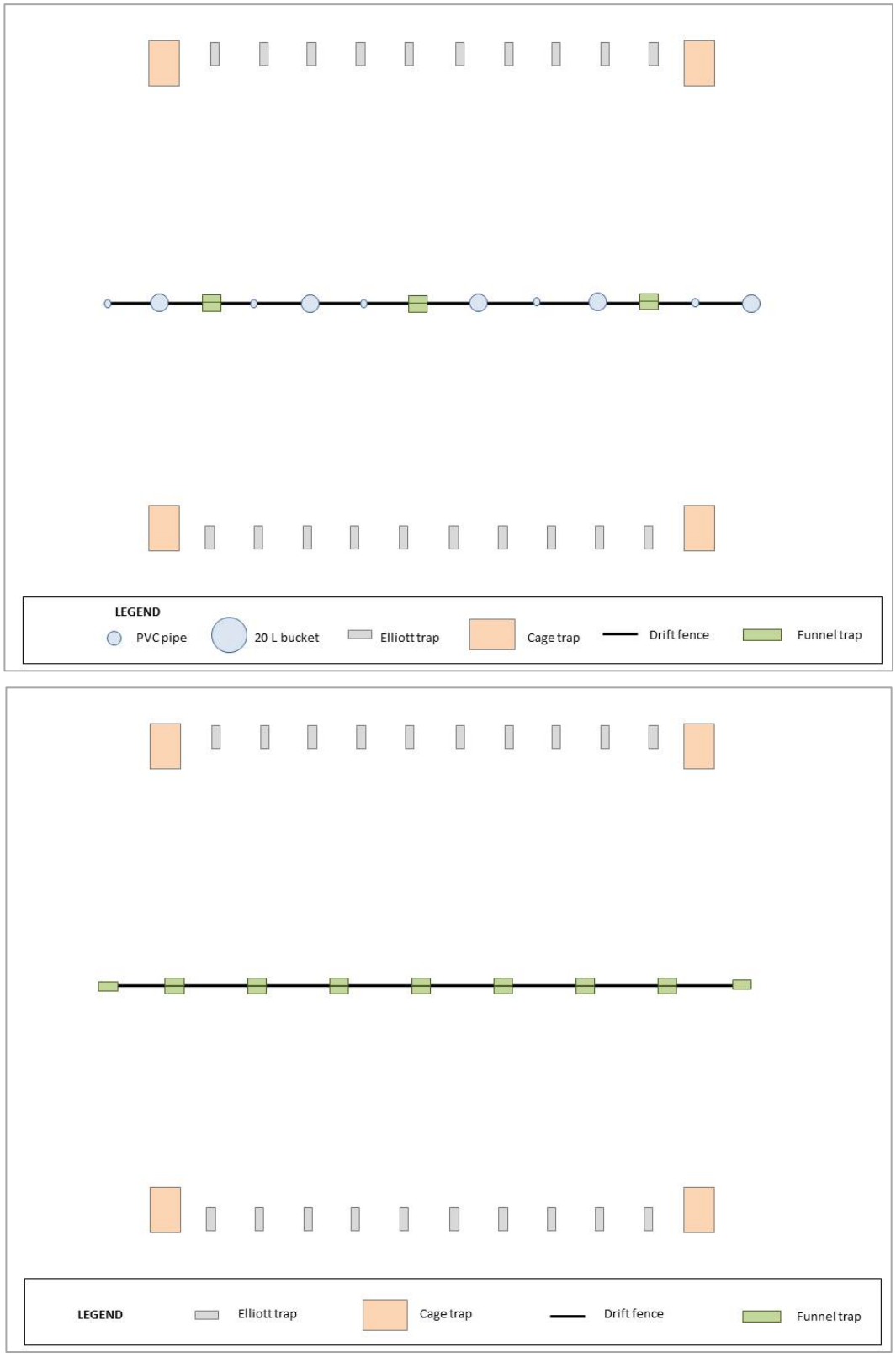


Figure 5: Aerial view of systematic trapping grid layouts pitfall sites (above) and funnel sites (below).

This page has been left blank intentionally.

Table 6: Trapping site locations and survey effort for the current survey.

Site	Easting (mE)	Northing (mN)	Habitat	Vegetation description	Habitat Condition	Date opened	Date closed	Trap nights	No. of traps	Total trap nights	Photos	
BTG1	448330	7570651	Loamy plain	*Corymbia hamersleyana* scattered low trees over *Grevillea pyramidalis* subsp. *leucadendron* scattered tall shrubs over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) scattered low shrubs over *Triodia epactia* hummock grassland on clay loamy soils.	0.8 (Very Good)	26/05/15	01/06/15	6	40	240		
BTG2	424172	7589212	Loamy plain	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over mixed scattered shrubs over *Triodia wiseana* open hummock grassland on clay loamy soils.	0.8 (Very Good)	04/08/15	11/08/15	7	40	280		
BTG3	446956	7571385	Loamy plain	*Corymbia hamersleyana* scattered low trees over *Grevillea pyramidalis* subsp. *leucadendron* scattered tall shrubs over *Tephrosia rosea* var. Fortescue creeks (M.I.H. Brooker 2186) scattered low shrubs over *Triodia epactia* hummock grassland on clay loamy soils on clay loamy soils.	0.8 (Very Good)	26/05/15	01/06/15	6	40	240		
BTG4	443829	7574519	Breakaway	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over mixed scattered shrubs over *Triodia wiseana* open hummock grassland on clay loamy soil (previously burnt) or rocky and loamy soils.	0.6 (Good)	26/05/15	01/06/15	6	40	240		
BTG5	448691	7569936	Rocky hills/ breakaway	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees to low open woodland over *Acacia inaequilatera* scattered tall shrubs to tall open shrubland over *Triodia wiseana* and *T.* sp. Robe River (M.E. Trudgen et al. MET 12367) hummock grassland on rocky soils. *Acacia pyrifolia* scattered tall shrubs over *Triodia epactia* hummock grassland and **Cenchrus setiger, *C. ciliaris* scattered tussock grasses at base of breakaway.	1.0 (Excellent)	26/05/15 04/08/15	01/06/15 11/08/15	6 7	40 40	240 280		

Site	Easting (mE)	Northing (mN)	Habitat	Vegetation description	Habitat Condition	Date opened	Date closed	Trap nights	No. of traps	Total trap nights	Photos
BTG6	441463	7576528	Rocky hills/ breakaway	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia inaequilatera, A. bivenosa* scattered tall shrubs over *Triodia wiseana* hummock grassland on rocky soils.	0.8 (Very Good)	26/05/15 04/08/15	01/06/15 11/08/15	6 7	40 40	240 280	 
BTG7	445248	7571716	Rocky hills/ breakaway	*Triodia wiseana* hummock grassland on rocky soils.	1.0 (Excellent)	26/05/15 04/08/15	01/06/15 11/08/15	6 7	40 40	240 280	 
BTG8	447130	7571716	Major drainage line	*Eucalyptus camaldulensis, E. victrix* closed forest over *Typha domingensis, Cyperus vaginatus* sedgeland on clay loamy soils.	0.6 (Good)	26/05/15 04/08/15	01/06/15 11/08/15	6 7	40 40	240 280	 
Total trap effort – Phase 1 **Total trap effort – Phase 2**										**1680** **1400**	

3.2.2.6 Active Foraging

There were 1,956 minutes (32 hours and 36 minutes) of actives searches undertaken across both surveys in microhabitats suitable for ground-dwelling reptiles and mammals (Table C.4, Appendix C). Active searches included the following:

- searching and recording scats, tracks and other traces
- turning over rock and logs and peeling off bark
- raking soil and leaf litter
- searching rocky habitats in cracks and caves, around water bodies and inside bore hole caps.

3.2.2.7 Targeted Searches

The aim of the targeted searches was to identify areas of potentially suitable habitat for conservation significant fauna, such as caves, and secondary signs including tracks, scats, diggings and burrows. Walked transects were undertaken throughout the survey area (Figure C.1, Appendix C). In addition, visual observation for conservation significant fauna habitat was ongoing whilst moving through the survey area. Track logs were recorded using a handheld GPS and are shown in Figure C.1 (Appendix C). Any opportunistic sightings of fauna species were recorded whilst traversing the survey area.

3.2.2.8 Nocturnal Spotlighting

Spotlighting at night was undertaken on foot and from vehicles to target fauna that are nocturnal or crepuscular, particularly conservation significant species. A total of 1,180 minutes (19 hours and 40 minutes) was undertaken in the survey area across both surveys.

3.2.3 Statistical Analyses

3.2.3.1 Sampling Effort

Sampling effort was assessed using species accumulation curves and modelled estimates of the total species pool. Species accumulation curves are created by randomly sampling an incremental number of sites while plotting the total number of species sampled. Species estimators are particular statistical models of species accumulation which estimate the total species pool available. Four species estimators were compared: Chao 2, Jackknife 1, Jacknife 2 and Bootstrap (Colwell and Coddington 1994). Species accumulation curves were created for each faunal group (mammals, birds and herpetofauna) and for the different monitoring programs (Astron Phase 1, Astron Phase 2, all Astron samples, and all samples including other consultant surveys). Species estimations were based on all Astron surveys. All analyses were performed in R 3.2.1 (R Development Core Team 2015) using the package “Vegan”.

3.2.3.2 Site Classification

The similarity of species assemblages amongst sites was assessed using two dimensional ordinations based on Sorensen’s index of similarity amongst sites. Significant groupings of sites by habitat type were identified using the ANOSIM function (Clarke et al. 2008) within the package “Vegan”. Ordinations and ANOSIM tests were performed for each faunal group.

3.2.4 SRE Invertebrates

3.2.4.1 Habitat Assessment

Fauna habitats within the survey area were mapped for their suitability to support SRE invertebrates as part of an initial desktop assessment (Section 3.1.3) and further refined following the field survey (Section 3.2.2.1).

3.2.4.2 Active Foraging

A total of 28 systematic sites were sampled for SRE fauna across the survey area (Figure C.1, Appendix C). All sites were sampled by active foraging and litter-soil samples. The sites were selected so that they represented the landforms and vegetation associations inferred as prospective in the desktop assessment; however, some sites also targeted the less prospective habitats (e.g. Plains) to confirm the results of the initial desktop assessment. Detailed site descriptions, including associated landforms and vegetation features, are provided in Table C.4 (Appendix C). The descriptions provide qualitative information about factors influencing the macroclimate (e.g. landform, vegetation type, dominant substrate, and indicative plant species) and microclimate (e.g. amount of organic matter or existing damage).

Foraging was focused under boulders, crevices in rocky outcrops, at the base of tree logs, under loose tree bark, in moist and dry leaf litter accumulations and in *Triodia* clumps, but occurred in all habitats. The search of mygalomorph spider burrows was by eye and using a leaf blower. Night-time searching for scorpions was also undertaken at the soak site. Leaf litter was sifted *in situ* with a 16 mm soil sieve, and potential SRE invertebrates preserved directly in 98% ethanol. Approximately 1,996 minutes (33 hours and 16 minutes) were spent searching the 28 SRE sites. Any potential SRE invertebrates observed in the dry pitfall or funnel traps at each of the seven trapping grids were also collected. Specimens were collected opportunistically from site JO-2 and from another site outside the survey area.

3.3 SRE Specimen Identification

The samples were separated and sorted to morphospecies level under a dissecting microscope. Morphological identifications to species level were attempted for all collected specimens. These identifications were done in-house and are based on the available taxonomic literature and keys, environmental reports and online databases. Compound microscopes were used to examine fine taxonomic characters not visible otherwise, e.g. trichobothria patterns in pseudoscorpions.

The identification of many invertebrates (e.g. millipedes and snails) was straightforward; however, all slaters were identified by Dr Simon Judd (Edith Cowan University) and expert advice was sought for some arachnid groups (scorpions: Dr Erich Volschenk; pseudoscorpions and spiders: Dr Danilo Harms). The identification of some snail species was based on dead-taken shells because no live specimens could be collected. There is a slight degree of uncertainty with this approach because the examination of internal morphological characters in live-taken specimens is sometimes necessary. Several pseudoscorpion species were compared with critical specimens from the WAM to assure species alignment whenever possible.

DNA analyses were performed on the single wall crab spider specimen (*Karaops* sp.) because it was juvenile and could not be identified based on morphology. A fraction of the CO1 'barcoding' gene was sequenced and compared with the Basic Local Alignment Search Tool against a set of 48 sequences of *Karaops* in the Pilbara (Phoenix Environmental Sciences, unpublished) and eight additional sequences that were generated as part of the recent Level 2 fauna survey at Middle Robe

(Astron Environmental Services 2015). Representative specimens of all species have been lodged with the WAM (Appendix H). The DNA sequence for *Karaops* has also been lodged with the WAM.

3.4 Taxonomy and Nomenclature

Nomenclature and sequence for invertebrates, amphibians, reptiles, birds and mammals within this report is as per the WAM (e.g. Western Australian Museum 2015b). Field guides and accepted scientific peer review references were also used for fauna identification.

For species identified in the desktop assessment, wherever there was doubt as to their true taxonomy (through subsequent name changes or taxonomic reviews) every effort was made to determine the current scientific name for each taxon. In addition, some taxon names may be followed by 'sp.', meaning that the species name was not given in the data source or the identification is in doubt. For named species in SRE groups, the taxonomy follows the published literature and WAM species codes were applied to unnamed species whenever possible (e.g. PSE codes for pseudoscorpions). Species not collected previously from the survey area, or those that cannot be identified further, are listed as 'sp. Bungaroo' to reference the area where they had been collected. Some of these are potential new species but detailed taxonomic work, which is beyond the scope of this assessment, is required to investigate this further.

The biology of many SRE species is not well known and the precise distribution and life history are poorly, if at all, documented (Harvey 2002, Harvey et al. 2011). Very often, species identification is difficult because very few specimens have been collected, reference collections are unavailable, the specimens have the wrong sex or life stage for identification, or they are morphologically cryptic and require DNA analyses. Taxonomic resolution can also be poor, either because there are no published taxonomic revisions for a group in question (i.e. terrestrial isopods in Western Australia), or because there is no expert actively working on one of the SRE groups.

3.5 Limitations

To identify how complete the fauna survey was, it was assessed against the potential limitations suggested in Guidance Statement 56 for fauna surveys (Environmental Protection Authority 2004) and Guidance Statement 20 for SRE assessments and sampling protocols (Environmental Protection Authority 2009). Table 7 identifies potential constraints of the fauna survey against the limitations criteria presented in Guidance Statement 56 and Guidance Statement 20 (Environmental Protection Authority 2004, 2009).

The Phase 1 survey was intended to be a wet season survey and given the above average rainfall received during the three months preceding the survey this was considered adequate; however, conditions were also cool during most of Phase 1. The Phase 2 survey was intended to be a dry season survey and given little rainfall was received during the two months preceding the survey this was considered adequate. Warmer and drier conditions experienced during Phase 2 resulted in an additional 10 reptile species being recorded.

Most SRE species rely on moisture and are most active following periods of elevated rainfall and comparably low temperatures (Harvey 2002). Weather conditions in the first half of the Phase 1 survey were relatively cool and moist. Extensive rainfall at Bungaroo occurred before and during the survey and the leaf litter was wet or damp, but not moist, which is the preference for most 'relict' SRE invertebrates. Scorpions were mostly inactive and could not be detected at the entrance of their burrows at night, presumably because it was too cold and wet. The second half of the Phase 1 survey was slightly drier and warmer, though rainfall had occurred before and several species that were collected during the first phase were re-collected during Phase 2 and obviously active. Several

invertebrate species were collected only during the second phase (e.g. pseudoscorpions in the genera *Beierolpium* and *Euryolpium*), which indicates some seasonality in the SRE group fauna.

It is also noted that prospective SRE habitat identified in the desktop survey was often degraded, or disturbed, as it had been grazed and trampled by cattle. Parts of the survey area (approximately 29% of the survey area) were affected by recent fire, which further diminished prospective habitat for conservation significant invertebrate fauna. Suitable microhabitats for SREs such as leaf litter accumulations were rare across the survey area. Weeds that created a rather uniform matrix with very little suitable microhabitats also dominated large sections of the survey area, particularly the Bungaroo Creek valley floor. Studies on woodlands and grasslands have shown that grazing impacts on abundance and diversity in many invertebrate lineages, primarily through reducing microhabitat diversity (e.g. Debano 2006, Lindsay and Cunningham 2009), and this is likely also the case in arid systems.

The Environmental Protection Authority (EPA) 2009 recommends that assessments of SRE fauna in the Pilbara should be undertaken between November and April when there is enhanced activity of cryptic groups and adult males are most active; however, recent studies on millipedes and mygalomorph spiders suggest that adult specimens are frequently collected much later in the year between May and October and that SREs are not only active during the cyclone season (Car and Harvey 2013, Harvey et al. 2012, Miglio et al. 2014). The timing of the surveys falls within the activity period for the target SRE groups, e.g. all specimens of the recently described trapdoor spider *Missulena langlandsi* from the Pilbara have been collected in June (Harms and Framenau 2013).

Table 7: Statement of limitations for the Phase 1 and 2 fauna surveys.

Potential limitation	Statement regarding potential limitations
(i) Competency/experience	The ecologists responsible for conducting the survey have extensive experience in conducting Level 2 vertebrate and SRE fauna surveys in the Pilbara.
(ii) Scope What faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions.	The survey scope was able to be completed. Access to the very northern section was restricted during Phase 1 due to track conditions; however, this has been covered in previous surveys (Biota Environmental Sciences 2007) and was also surveyed during Phase 2. Please also see (v) below for tasks achieved. The fauna observed and identified is likely to represent a portion of the suite of species that utilise the survey area.
(iii) Proportion of fauna identified, recorded and/or collected	The fauna observed and identified is likely to represent a portion of the suite of species that utilise the survey area. Fauna habitats were able to be adequately described and a list of species likely to be present was prepared based on this assessment. Species accumulation curves generally did not reach an asymptote, but when taking into account previous Biota records as well as species recorded from methods other than trapping, then a large portion of the predicted assemblage was recorded. It is not possible to determine bat species abundance from echolocation records; bat activity levels provide a relative measure of the abundance of each species within the survey area.
(iv) Sources of information Previously available information (whether historic or recent) as distinct from new data.	Adequate information was available from database searches and previous studies in the survey area and region.

Potential limitation	Statement regarding potential limitations
(v) Proportion of task achieved. Further work which might be needed?	Wet weather experienced during Phase 1 survey resulted in some tasks not being fully achieved during this phase of survey: • only seven out of eight trapping sites were opened due to water on tracks preventing access • six instead of seven nights of trapping were undertaken in Phase 1 due to weather. The additional trapping site was opened and surveyed during Phase 2.
(vi) Timing/weather/season/ cycle	The Phase 1 survey was intended to be a wet season survey and given the above average rainfall received during the three months preceding the survey this was considered adequate. Conditions were wet and cool during the first half of the Phase 1 survey which would have resulted in fewer species being recorded, including the Pilbara Olive Python as they would have been less active. However, species groups such as frogs, geckos and pythons were recorded. Conditions became drier and warmer during the second half of the survey, with an increase in captures of skinks, dragons and varanids. The mix of conditions experienced during the survey probably resulted in the high diversity but low captures recorded. The wet weather and subsequent high abundance of insects also affected some of the acoustic recording results. Conditions were mostly favourable for invertebrates, but scorpions were mostly inactive and could not be detected at the entrance of their burrows at night, presumably because it was too wet. The Phase 2 survey was intended to be a dry season survey and given little rainfall was received in the two months before the survey this was considered adequate. Conditions were drier and warmer resulting in additional reptile species being recorded.
(vii) Disturbances e.g. fire, flood, accidental human intervention which affected results of survey	Approximately 29% of the survey area had been affected by a recent fire within the last two years.
(viii) Intensity In retrospect, was the intensity adequate?	The intensity of the surveys was considered adequate for a Level 2 assessment.
(xi) Completeness Was the relevant area fully surveyed?	All main habitats in the survey area were surveyed and coverage of habitat assessments and targeted surveys is considered adequate.
(x) Resources Degree of expertise available in animal identification to taxon level.	Adequate resources were available to identify fauna species. All personnel involved in identification have extensive experience in conducting Level 2 vertebrate and SRE fauna surveys in the Pilbara.
(xi) Remoteness and/or access problems	There were no access problems with all of the survey area able to be accessed by vehicle or on foot. Due to safety and heritage related constraints, internal inspections of caves are not permitted. The characteristics of Pilbara Leaf-nosed Bat and Ghost Bat roost caves are variable and therefore it is not possible to determine the potential for a cave to be a roost by external visual observation. The cave assessments provide an indication only as to whether Pilbara Leaf-nosed Bats or Ghost Bats may utilise the caves as habitat.
(xii) Availability of contextual information e.g. biogeographic information on the region.	Database searches and previous fauna surveys in the survey area provided by Rio Tinto provided contextual information.

4 Results

4.1 Desktop Assessment

4.1.1 Environmentally Sensitive Areas

There are no ESAs located within, or adjacent to the survey area (Australian Government 2008).

4.1.2 Vertebrate Fauna

The database searches and literature review results indicate that 307 vertebrate fauna have been previously recorded within 40 km of the survey area, including five amphibian species, 101 reptile species, 152 bird species (including one introduced bird species) and 49 mammal species (including eight introduced mammal species) (Tables D.1-D.4, Appendix D). Of these, 31 species are of conservation significance, including four reptile species, 18 bird species and nine mammal species (Table E.1, Appendix E). Of these, 10 species were considered to have a 'high' likelihood (inclusive of those previously recorded within the survey area), three species were considered to have a 'moderate' likelihood and 18 were considered to have a 'low' likelihood of occurrence (Table E.1, Appendix E). This is based on their respective ecology, habitats considered likely to be present and any previous records from historic survey and database records.

Previous surveys undertaken for Rio Tinto in the vicinity of the survey area recorded six conservation significant vertebrate fauna species: Northern Quoll (*Dasyurus hallucatus),* Western Pebble-mound Mouse (*Pseudomys chapmani*), Ghost Bat (*Macroderma gigas*), Rainbow Bee-eater (*Merops ornatus*), Wood Sandpiper (*Tringa glareola*) and Lined Soil-crevice Skink (*Notoscincus butleri*) (Biota Environmental Sciences 2006, 2007, 2010) (Table 8).

Table 8: Summary of literature review results from surveys conducted within the vicinity of the survey area.

Survey parameters	Biota Environmental Sciences (2006)	Biota Environmental Sciences (2007)	Biota Environmental Sciences (2010)
Survey area	Mesa A Transport Corridor and Warramboo	Bungaroo Trial Pit and Transport Corridor to Mesa J	Greater Bungaroo
Survey area size (ha)	7,045.22	1,047.98	8,765
Survey focus	Two season Level 2 survey	Two season Level 2 and targeted survey	Two season Level 2 and targeted survey
Survey timing	March, April/May and August 2005	March 20015 and June 2006	August 2009 and March 2010
Survey effort	2,931 trap nights 4,200-min of avifauna census Harp netting at 4 sites Fish sampling at 2 pools	1,498 trap nights 1,755-min of avifauna census Harp netting at 3 sites Non-systematic sampling	2,449 trap nights 1,900-min of avifauna census Harp netting and call recordings at 5 sites Non-systematic sampling
Total fauna habitats mapped	3	4	4
Total vertebrate species recorded	181	147	147

Survey parameters	Biota Environmental Sciences (2006)	Biota Environmental Sciences (2007)	Biota Environmental Sciences (2010)
Conservation significant vertebrate species recorded	*Notoscincus butleri* (Lined Soil-crevice Skink) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Macroderma gigas* (Ghost Bat)	*Notoscincus butleri* (Lined Soil-crevice Skink) *Tringa glareola* (Wood Sandpiper) *Pseudomys chapmani* (Western Pebble-mound Mouse) *Dasyurus hallucatus* (Northern Quoll)	*Notoscincus butleri* (Lined Soil-crevice Skink) *Merops ornatus* (Rainbow Bee-eater)

4.1.3 SRE Invertebrates

4.1.3.1 Habitat Characterisation

The emphasis was on landforms likely to support a suitable microclimate and geology for SRE fauna, such as shallow and deep creek lines, sheltered gorges, south-facing slopes and areas with high vegetation cover.

There are seven landforms in the survey area; Breakaway, Clay/Loam/Stony Plains, Gorge, Low Hills/Slopes, Minor Drainage Line, Major Drainage Line and Rocky Hills. Sections of the survey area (218.4 ha) that have been cleared are unsuitable for SRE fauna, and are not assessed further.

Clay/Loam/Stony Plains were the most common landform, followed by Rocky Hills, Low Hills/Slopes and Major Drainage Lines. Minor Drainage Lines, Breakaways and Gorge were less common (Table 9).

Two of the most common landforms, Plains and Major Drainage Lines, were inferred as unlikely to support significant SRE communities because they are exposed, have generally low moisture holding capacity, lack topographic relief, and generally have uniform vegetation (primarily introduced Buffel Grass and *Triodia* steppe). The riverbeds are also not ideal habitat due to the flooding and washouts which occur. Low Hills/Slopes may support some SRE species but lack significant topographic relief and shelter, thus are not a prospective landform for SRE fauna either.

The Gorge, Breakaway, Minor Drainage Lines and Rocky Hills landforms may provide suitable habitat for relictual SRE species owing to their capacity to provide sheltered microhabitats (such as between rock boulders, at the base of outcrops or south-facing gullies), the accumulation of organic matter such as leaf litter, and permanent moisture required for many SREs (Harvey 2002). The Breakaway and Rocky Hills landforms are also likely to support specialist SRE species, such as *Synsphyronus* pseudoscorpions and selenopid spiders that live under rocks (e.g. Crews and Harvey 2011, Crews 2013, Harvey 2010). Of the prospective SRE landforms, Rocky Hills were more common than Breakaway. The Breakaway and Rocky Hills landforms also appear to be mostly well connected across the survey area, forming a continuous area along both sides of the Bungaroo Creek valley and extending well beyond the survey area.

Table 9: Suitability of landforms for SRE fauna within the survey area.

Landform	Total area (ha)	Total area (%)	Suitability for SRE fauna
Breakaway	98.8	1.0	High
Clay, Loam and Stony Plains	3,877.7	39.6	Low
Gorge	76.6	0.8	High
Low Hills/Slopes	1,304.4	13.3	Moderate
Minor Drainage Line	543.5	5.5	High
Major Drainage Line	821.8	8.4	Low
Rocky Hills	2,854.3	29.1	High

The review also identified a variety of vegetation features in the survey area that roughly corresponded to the identified landforms and the underlying geology. These ranged from heavily grazed *Triodia*/Buffel grassland in the plains to moderately dense *Eucalyptus/Corymbia* woodlands and *Acacia* shrublands associated with the gorges, drainage lines and breakaway. The *Triodia* grasslands represent a uniform vegetation type that is widespread in the survey area. These grasslands may support scorpion species in the genera *Lychas* and *Urodacus* but given the widespread nature of their habitat, these species should also be widespread. The woodlands and shrublands may support SRE communities because they hold moisture and have sufficient ground cover.

4.1.3.2 Species

Eleven arachnids, 17 crustaceans, four millipedes and one polychaete species from the Pilbara are currently listed as (State) Schedule fauna species. These species are either subterranean and not part of the current assessment, or do not occur in the vicinity of the survey area. Seven Priority species are listed, comprising three species of insect (the dragonflies *Antipodogomphus hodgkini* and *Nososticta pilbara* and the cockroach *Nocticola flabella*), one arachnid (*Draculoides vinei*), one terrestrial snail (*Dupucharopa millestriata*) and two crustaceans (*Nedsia chevronia* and *Stygiocaris stylifera*). These species are either subterranean species or do not occur in the vicinity of the survey area. No other listed invertebrate species occur in the Pilbara. There are no PECs or TECs in the vicinity of the survey area on the basis of terrestrial SRE taxa.

The available grey and published literature revealed diverse communities of species in SRE groups. However, there is considerable uncertainty about the ranges of most species, either because they are known from only a few specimens or because there is a lack of taxonomic resolution. The collation of data, including results from the WAM databases, revealed at least 77 potential or confirmed SRE species belonging to eight SRE groups have been collected in the search area (Table D.5, Appendix D). These comprised mygalomorph spiders (13 species), araneomorph spiders (five), harvestmen (one), pseudoscorpions (seven), scorpions (five), millipedes (nine), centipedes (three), slaters (25) and non-marine snails (nine). The proportion of confirmed SRE species was rather low with 19 species comprising millipedes (nine species), spiders (five), snails (four) and pseudoscorpions (one). Most species were potential SREs with deficient data, reflecting uncertainties caused by insufficient taxonomic resolution and/or the lack of reference collections. For example, recent taxonomic revisions are available for some spiders (Baehr and Harvey 2013) and millipedes (Car and Harvey 2013) which explicitly infer SRE status, whereas almost nothing is known about the slater fauna and current species concepts (including range estimates) are tentative.

The likelihood of SRE species groups occurring within the survey area is detailed in Table E.2 (Appendix E). A seasonal survey in 2010 collected 10 species in SRE groups: two mygalomorph spider species, a selenopid spider, three pseudoscorpion species, two terrestrial and two aquatic snail

species (Biota Environmental Sciences 2010). All species were locally widespread and recorded from both within and outside the survey area. A previous survey had collected four millipede species, one mygalomorph spider, one terrestrial and two aquatic snail species, which were also locally widespread (Biota Environmental Sciences 2007). Another survey at the Buckland Project, located immediately south of the survey area, identified seven potential SRE species: one terrestrial snail species in the family Camaenidae, four slater species, one selenopid spider species, and one centipede species in the family Cryptopidae. All but one slater species were also found outside the survey area (Phoenix Environmental Sciences 2012).

Additional assessments for the Balla Balla Railway Project, located north-east of the Bungaroo survey area, collected 13 potential SRE invertebrates, comprising three arachnids, two centipedes, seven isopods and one terrestrial snail (Phoenix Environmental Sciences 2014). All but two slater species occurred more widely in the area. Additional surveys at the Mesa A Transport Corridor (Biota Environmental Sciences 2006) and Middle Robe (ecologia Environment 2013) also collected millipedes, mygalomorph spiders and snail species, all more widespread in the area.

Overall, no confirmed SRE species have been collected at Bungaroo and its vicinity. Several potential SRE species have been collected and these are primarily isopods, mygalomorph spiders, pseudoscorpions, and terrestrial snails. Potential SRE millipedes, centipedes and harvestmen also occur but have been collected less frequently. At least six scorpion species are known from Middle Robe and East Deepdale near the survey area but only one species is a potential SRE (ecologia Environment 2013).

Based on the desktop assessment, all SRE groups are likely to be present in the survey area and its vicinity with representations by multiple species. Although no confirmed SRE species have been recorded from the survey area, potential SRE species are likely present, most likely belonging to the slater, spider, snail and pseudoscorpion groups. However, potential SRE species are likely to be more widespread locally with total ranges of at least several square kilometres (e.g. Biota Environmental Sciences 2007, Phoenix Environmental Sciences 2012).

4.2 Field Survey

4.2.1 Vertebrate Fauna Habitat

4.2.1.1 Fauna Habitats

Eight broad fauna habitat types were recorded in the survey area: Gorge, Breakaway, Rocky Hills, Low Hills/Slopes, Loamy/Stony Plain, Major Drainage Line, Minor Drainage Line and Non-cracking Clay Plain. Areas of disturbed habitat were also present within the survey area, particularly in the north. The habitats are described in Table 10 and mapping is presented in Figure F.1 (Appendix F). Habitat assessments undertaken during the survey are detailed in Table C.1 (Appendix C).

Approximately 29% of the survey has been burnt within the last two years, resulting in reduced ratings of habitat condition (Plate 1). The majority of Loamy/Stony Plain and both Major and Minor Drainage Line habitats were generally in ‘disturbed’ to ‘very good’ condition. Some areas were heavily affected by grazing and Buffel Grass (Plate 2). All other habitats were generally in ‘good’ to ‘high quality’ condition depending on the level of grazing and fire history. The Rocky Hills and Gorge habitats were generally ‘high quality’ condition (Plate 3), however, some of the Rocky Hills habitat had been affected by recent fires (Plate 4) and Breakaway habitats often had a Buffel Grass understorey at their base.



Plate 1: Loamy/Stony Plain habitat affected by recent fire.



Plate 2: Areas of habitat dominated by Buffel Grass.



Plate 3: 'High quality' condition Gorge habitat.



Plate 4: Rocky Hills habitat affected by recent fire.

Table 10: Vertebrate fauna habitat types recorded in the survey area.

Habitat type	Extent in survey area ha (%)	Broad habitat description	Broad vegetation description	Microhabitats	Sites	Habitat condition	Value (particularly for MNES species)	Representative photos	
Rocky Hills (hills crests and slopes)	2,854.3 (29.1%)	Stony hills on high ranges with dissected valleys and gorges	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* trees over *Triodia wiseana* hummock grassland	Termite mounds, tree hollows, crevices	JO-HAB-6, JO7, MJ20A, MJ23, MJ35, MJ36 M14b, M15b, M17b	Disturbed to High Quality	Moderate value for target MNES species as they are likely to traverse and forage within these habitats.		
Breakaway	98.8 (1%)	Breakaway or ridge line, falling away to steep scree slope or drainage line	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* trees over/or *Acacia bivenosa* or *Acacia inequilatera* scattered low shrubs over *Triodia wiseana, T. epactia* or *T.* sp. Robe River (M.E. Trudgen et al. MET12367) hummock grassland or *Eriachne mucronata*, *Themeda triandra, Cymbopogon ambiguus* tussock grassland	Overhangs, crevices, caves	CAM12, JO1, JO6, JO14, JO-BAT-1, JO-BAT-2, JO-HAB-4, JT Cam 2, MJ1, MJ4, MJ7, MJ9, MJ11, MJ31, MJ32, MJ38, MJ41 Cam09a, Cam10, Cam12a, Cam19aSRE01b, SRE02b, SRE03b, SRE08bSM7634a	Good to High Quality	Moderate value habitat for foraging Pilbara Leaf-nosed Bat and Pilbara Olive Python due to few caves and water pools, respectively. High value habitat for Northern Quoll as contains crevices and overhangs.		
Gorge	76.6 (0.8%)	Deep often rocky gorges, sometimes with ephemeral, semi-permanent or permanent pools	Scattered *Eucalyptus leucophloia* subsp. *leucophloia* trees over *Triodia wiseana* hummock grassland	Overhangs, crevices, caves, tree hollows, ephemeral, semi-permanent and permanent water	JO-2, JO3, JO5, JO13, JO13A, JT Cam, JT Cam 1, JT Cam 2A, JT Cam 3, JT Cam 4, JT Walk 1, JT Walk 2, MJ2, MJ3, MJ5, MJ6, MJ8, MJ12, MJ13, MJ15, MJ16, MJ18, MJ19, MJ21, MJ22, MJ30, MJ37, SRE3 Cam04a, Cam15a, Cam17a, Cam20a, Cam21a, Cam24a, Cam27a, Cam35a, Cam36a, M03, M08, SM11040a, SM7566a, SRE04b, SRE05b, SRE06b, SRE07b	Disturbed to High Quality	Primary high value habitat for target MNES species as well as Ghost Bats. Provides significant refugia/shelter sites and greater diversity of prey species.		
Low Hills/Slopes	1,304.4 (13.3%)	Low rolling stony hills	*Corymbia hamersleyana* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over mixed scattered shrubs over *Triodia wiseana* open hummock grassland	Termite mounds	JO-HAB-3, JO4, JO12, JT Walk 2 28/5, JT Walk 3, MJ29 M17	Disturbed to High Quality	Low value to target MNES species, as they do not provide significant refugia or shelter.		

Habitat type	Extent in survey area ha (%)	Broad habitat description	Broad vegetation description	Microhabitats	Sites	Habitat condition	Value (particularly for MNES species)	Representative photos	
Loamy/ Stony Plain	3,786.8 (38.7%)	Low-lying undulating loamy to stony plain within Bungaroo valley floor	Scattered to open *Corymbia hamersleyana* woodland over mixed *Acacia ancistrocarpa, A. inaequilatera, A. bivenosa, A. coleu* var. *ileocarpa, Grevillea pyramidalis* subsp. *leucadendron* shrubland over *Triodia wiseana* or *T. epactia* hummock grassland or **Cenchrus ciliaris* and **C. setiger* grassland	Termite mounds	JO10, JO-HAB-1, JO-HAB-2, JO-HAB-5, MJ17, MJ27, MJ28 Cam01a, Cam03a,Cam13a, Cam29a, M01, M10, M13, M14, M15, SM8027a	Highly Degraded to High Quality	Low value to target MNES species as they do not provide significant refugia or shelter.		
Minor Drainage Line	543.5 (5.5%)	Minor channels within the broad Bungaroo valley floor or valleys of the Rocky Hill habitat	*Corymbia hamersleyana* scattered low trees to low open woodland over *Acacia tumida* var. *pilbarensis*., *Gossypium robinsonii, Grevillea* spp., *Petalostylis labicheoides, Stylobasium spathulatum* tall shrubland over *Triodia epactia* and *Triodia wiseana* hummock grassland	Termite mounds, crevices, overhangs, ephemeral pools	JO8A, JT Hab 2, JT Walk 30/5, MCL02, MJ25, MJ26	Good to High Quality	Moderate value to the target MNES species, as generally do not provide semi-permanent water. However, they are often in association with breakaway habitat and those that contain semi-permanent pools would be of high value.		
Major Drainage Line	821.8 (8.4%)	The major drainage channel running through the Bungaroo valley floor	*Eucalyptus victrix* scattered low trees over *Acacia pyrifolia, A. trachycarpa* open shrubland over *Triodia epactia* open hummock grassland	Tree hollows	JO8, JO8B, JO9, MJ39, MCL01, SRE4, SRE13, SRE20 Cam06a, Cam08a, Cam11a, Cam14a, Cam18a, Cam25a, Cam26a, Cam28a, M04, SRE09b	Good to Very Good	Moderate value for the MNES species Pilbara Leaf-nosed Bat as they are likely to be utilised for foraging. However, considered low value for the other MNES species, Northern Quoll and Pilbara Olive Python due to lack of vegetation cover through majority of this habitat type.		
Non-cracking Clay Plain	90.9 (0.9%)	Low-lying non-cracking clay areas of the Bungaroo valley floor	*Corymbia hamersleyana* scattered low trees over *A. tumida* var. *pilbarensis* closed heath over *T. epactia* hummock grassland	None	JO11	Disturbed	Low value to target MNES species, as they do not provide significant refugia or shelter. However, is likely to support a unique faunal assemblage.		
Disturbed	218.4 (2.2%)	Cleared areas including roads, tracks and other infrastructure, e.g. camps, bores, etc	N/A	None	N/A	Highly Degraded	Little value as fauna habitat.	No photo	No photo

Rocky Hills habitat comprised 29.1% of the survey area and is considered to generally have low vegetation complexity and low diversity of microhabitats. Extensive areas of Rocky Hills habitat are common and widespread throughout the Pilbara; however, MNES species (such as the Northern Quoll) are likely to traverse and forage within these habitats. Other conservation significant species such as the Western Pebble-mound Mouse, *Anilios ganei* and Long-tailed Dunnart may also utilise this habitat. Therefore this habitat is considered of moderate value for fauna.

Breakaway habitat comprised 1% of the survey area. It is a common feature of the Pilbara but as they tend to be narrow linear features they represent a small proportion of the total land area, as is the case within the survey area. Breakaway habitat contained microhabitats such as crevices, overhangs and caves that provide shelter opportunities for the MNES species, Northern Quoll. A small number of caves that may be used as temporary roost/feeding caves for the Ghost Bat and Pilbara Leaf-nosed Bat were also recorded within this habitat type. Therefore this habitat is considered of high value overall for fauna.

Gorge habitat only comprised 0.8% of the survey area and is also a common feature of the Pilbara; however, as they tend to be narrow, linear features, represent a small proportion of the total land area. In addition, they represent important shelter or roosting habitat for a number of MNES species, including the Pilbara Olive Python, Pilbara Leaf-nosed Bat and Northern Quoll, as well as the Ghost Bat. They may also support Priority listed species such as *A. ganei*. Caves and rock pools (including a permanent spring) were recorded in this habitat type. Both these habitat features also act as refugia for fauna during harsher drier seasonal conditions. This habitat is considered of high value as it presents a complexity of habitats and it contains permanent and semi-permanent water.

Low Hills/Slopes habitat was common within the survey area (13.3%). It is widespread and common throughout the Pilbara region and although a few species of conservation significance may utilise this habitat, they are unlikely to be restricted to it, with the possible exception of the Western Pebble-mound Mouse. Large areas of this habitat were also affected by recent fire within the survey area. It generally has low vegetation complexity and low diversity of microhabitats and therefore it is considered to be of low value for fauna.

Loamy/Stony Plain habitat was the most common habitat within the survey area (38.7%). It is also widespread and common throughout the Pilbara region and although there are a few species of conservation significance that may utilise it, they are not restricted to this habitat type. Conservation significant fauna likely to occur in this habitat type include the Western Pebble-mound Mouse and Rainbow Bee-Eater. This habitat generally had low vegetation complexity and microhabitat diversity as well as areas that were heavily affected by grazing and Buffel Grass; therefore, it is considered to be of low value for fauna.

Minor Drainage Line habitat comprised 5.5% of the survey area. It is considered to be of moderate value as it generally exhibits a moderate diversity of microhabitats, with some tree hollows and woody debris (logs and leaf litter) and therefore the ability to support a wide suite of species. Within the survey area this habitat was often associated with breakaways. Species of conservation significance, including the Rainbow Bee-eater and Lined Soil-crevice Skink may occur in this habitat. This habitat is considered common in the Pilbara region.

Major Drainage Line habitat comprised 8.4% of the survey area. This habitat tends to be relatively narrow and linear, therefore only accounting for a small proportion of the total land area. The vegetation adjacent to the main channel(s) is usually denser, taller and more diverse than adjacent terrain; however, within the survey area large areas of this habitat were devoid of vegetation within the channel. The soak was located within this habitat, although it no longer had surface water present as had been previously observed by Biota, that listed it as a permanent water source (Biota

Environmental Sciences 2007). The soak is likely to be seasonally inundated during large rainfall events and the soil was very moist during the current survey. The only other sources of permanent and semi-permanent water found were rock pools within the rockier habitat of the survey area. This habitat potentially supports conservation significant fauna species such as the Rainbow Bee-eater and foraging sites for Ghost Bats and Pilbara Leaf-nosed Bats. Therefore, this habitat is considered to be of high importance to fauna.

Non-cracking Clay Plain habitat comprised only 0.9% of the survey area. It is considered to have low value for fauna, particularly for MNES species. However, it is likely to support a relatively unique and diverse faunal assemblage, with some species largely restricted to this habitat type, such as the Short-tailed Mouse. The area of this habitat within the survey area is also very small. It is generally a common, but patchy habitat throughout the Pilbara, especially within the Hamersley subregion.

4.2.1.2 Significant Habitat Areas

Several significant habitat features were recorded throughout the survey area (Figure F.1, Appendix F). This comprised a permanent spring within Gorge habitat on the eastern side of the valley (Figure F.1, Appendix F). Fourteen semi-permanent pools were recorded within the survey area and were mainly comprised of rock pools within Gorge habitat (Figure F.1 and Table F.1, Appendix F). A soak was also present in the northern portion of the survey area; however, although the soil was moist, no surface water was present. Biota Environmental Sciences (2007) considered the soak to have permanent water; however, it appears to be semi-permanent and likely to be inundated after significant rainfall only (Table F.1, Appendix F).

Eleven potentially suitable caves for Pilbara Leaf-nosed Bats and Ghost Bats were recorded within the survey area (Figure F.1 and Table F.1, Appendix F). Of these, Ghost Bat scats were present in six caves (MJ19, JT GB Cave 1, M14, M17, M14b, M14c (Table F.1, Appendix F)). Two appeared to be shallow feed caves or overhangs (MJ30 and M08s) with Ghost Bat scats and feeding debris present (Table F.1, Appendix F). A SM2 bat detector placed at another cave with two entrances (JO-BAT-2 and M02) recorded Pilbara Leaf-nosed Bat and Ghost Bat calls (Table F.1, Appendix F). Two cave sites (JO-BAT-2 and M02) are different entrances to the same cave.

None of the fauna habitats were considered to be synonymous with any TECs or PECs relating to terrestrial fauna listed in the Pilbara region (Department of Parks and Wildlife 2015c). It should be noted however, that two PECs relating to subterranean invertebrates overlap the survey area - '*Subterranean invertebrate communities of mesas in the Robe valley*' (P1) and '*Stygofaunal Community of the Bungaroo Aquifer'* (P1). These have not been addressed in this report as they relate to subterranean habitats.

4.2.1.3 Habitat Suitability for MNES Species

Northern Quoll

Approximately 1754.4 ha (1.8%) of the survey area, comprising Gorge and Breakaway habitats, was considered highly suitable habitat for the Northern Quoll (Figure F.2, Appendix F). Approximately 3,397.7 ha (34.7%) of the survey area was considered moderately suitable habitat, which consisted of Minor Drainage Line and Rocky Hills habitats, particularly where these habitats were in close association as they provided crevices and cracks for shelter (Figure F.2, Appendix F). The remaining 6,222.3 ha (63.5%) of the survey area was considered to provide limited foraging and dispersal habitat, consisting of Major Drainage Line, Loamy/Stony Plain, Low Hills/Slopes and Non-cracking Clay Plain habitats (Figure F.2, Appendix F). The Major Drainage Line habitat within the survey area contained limited large tree hollows for refugia or shelter.

Pilbara Leaf-nosed Bat

Approximately 76.6 ha (0.8%) of the survey area was categorised as habitat with high suitability for Pilbara Leaf-nosed Bats (Figure F.3, Appendix F), due to the presence of either caves that may provide potential roosting habitat or due to the presence of water pools within gorge habitats that provide high value foraging habitat. Forty-four per cent (4,318.40 ha) of the survey area was considered suitable foraging and dispersal habitat (Figure F.3, Appendix F). The remaining 5,400.5 ha (55.1%) of the survey area, comprising Loamy/Stony Plain, Low Hills/Slopes and Non-cracking Clay Plain habitats, was considered to provide limited foraging and dispersal opportunities (Figure F.3, Appendix F).

Pilbara Olive Python

Approximately 175.4 ha (1.8%) of the survey area was considered highly suitable habitat for the Pilbara Olive Python (Figure F.4, Appendix F). This habitat was mapped as Gorge and Breakaway habitat, in particular those sites associated with permanent or semi-permanent water pools. Approximately 3,397.7 ha (34.7%) of the survey area was considered moderately suitable habitat, which consisted of Minor Drainage Line and Rocky Hills habitats (Figure F.4, Appendix F). The remaining 6,222.3 ha (63.5%) of the survey area was considered to provide limited foraging and dispersal habitat, consisting of Major Drainage Line, Loamy/Stony Plain, Low Hills/Slopes and Non-cracking Clay Plain habitats (Figure F.4, Appendix F). The Major Drainage Line habitat within the survey area contained few large tree hollows and no permanent water for Pilbara Olive Pythons.

4.2.2 Vertebrate Fauna Species

One hundred and fifty-one vertebrate fauna species were recorded within the survey area during the survey (Table 11). A complete list of recorded species is provided in Tables D.6 to D.10 (Appendix D). The following sections provide detailed results for each major taxonomic group sampled.

Table 11: Number of vertebrate fauna species recorded during the survey.

Fauna taxonomic group	No. of native species recorded	No. of conservation significant species recorded	No. of introduced species recorded
Amphibians	3	0	0
Reptiles	50	3*	0
Birds	70	1	0
Mammals	28	4	4
Total	**151**	**8**	**4**

*One species is unconfirmed.

4.2.2.1 Herpetofauna

Three amphibian species were recorded during the survey: *Litoria rubella, Uperoleia saxatilis* and *Pseudophryne douglasi* (Table D.6, Appendix D). Frogs were either caught in pitfall traps and sighted, or heard calling during targeted searches. No conservation significant species were recorded.

Fifty reptile species were recorded during the survey (Table D.7, Appendix D). The most abundant group encountered were the skinks (32 records, 42%), which was also the most speciose family with 11 species, and the geckos (20 records, 26%) with 10 species. The most commonly recorded species were *Ctenotus grandis titan* (11 records) and *Ctenotus pantherinus* (10 records). The most speciose

site was BTG5 (Rocky Hills/Breakaway) and BTG 6 (Rocky Hills/Breakaway) with 10 species. The established trapping site that was poorest in species was BTG3 (Loamy/Stony Plain) with only three species recorded. Sixteen of the 50 reptile species (32%) were not captured at trapping grids, but were recorded from targeted and opportunistic records.

Three conservation significant species were recorded during the survey. Two individual *Notoscincus butleri* (P4) were caught at BTG5 (Rocky Hills/Breakaway) and BTG8 (Major Drainage Line). An individual *Anilios ganei* (P1) was also captured at site BTG5 (Rocky Hills/Breakaway). A scat, likely to be from a Pilbara Olive Python (S3; VU), was recorded.

Species accumulation curves did not reach an asymptote during the current surveys (Figure 6), and based on estimates of total species richness, Astron sampled between 54% and 68% of the total species pool (Table 12). This was expected, as an additional 18 species (34% of all species) were recorded using methods other than trapping. However, the species accumulation curve was reaching an asymptote when all surveys were considered (Figure 6).

Table 12: Total number of herpetofauna taxa sampled in comparison to estimates of the total species pool based on several models.

	Observed	Estimated			
		Chao2	Jacknife 1	Jackknife 2	Bootstrap
Number of species	23	36.6	38.6	42.4	33.6
Estimated % sampled		62.8	59.6	54.2	68.5

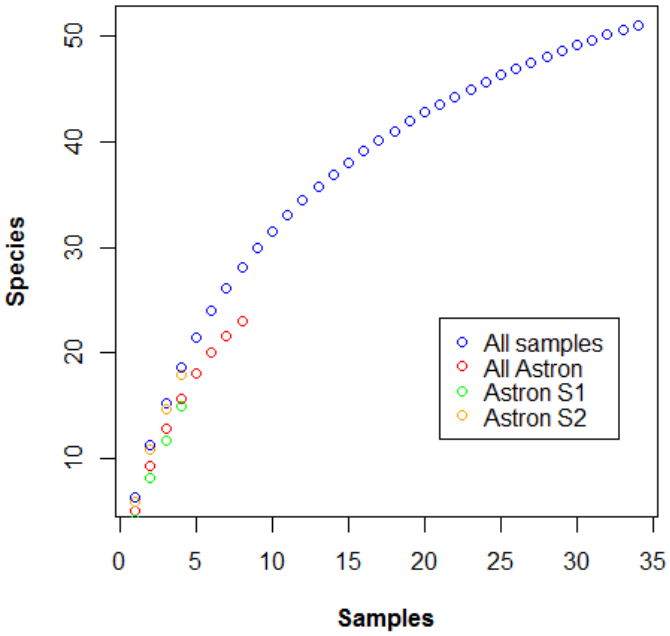


Figure 6: Species accumulation curves for herpetofauna surveys.

There was a significant difference in species composition between habitat types (ANOSIM R = 0.295, P=0.017), with the Rocky Hills habitat being most distinct from the other habitats (Figure 7).

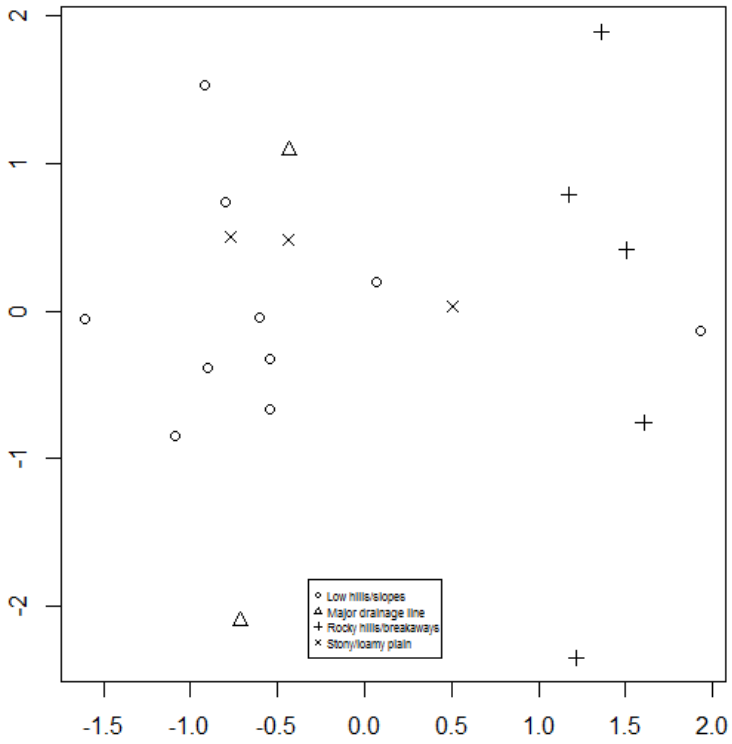


Figure 7: Two-dimensional ordination of herpetofauna species assemblages of each site.

4.2.2.2 Birds

Seventy bird species were recorded during the survey (Table D.8, Appendix D). The most commonly recorded species was the Budgerigar *Melopsittacus undulatus,* with a total of 165 records and the Zebra Finch *Emblema pictum* with 73 records. The most abundant group of birds was the Psittacidae, with 190 records accounting for 22% of all records. The most speciose families observed were the Meliphagidae and Columbidae, which comprised eight and five species, respectively. The most speciose sites were BTG6 (Rocky Hills) with 32 species and BTG2 (Loamy/Stony Plain) with 29 species. An additional 15 species were recorded from targeted and opportunistic records only.

One species of conservation significance was recorded during the survey. The Rainbow Bee-eater (S5; Mi) was recorded on numerous occasions throughout the survey area in a variety of habitats including Loamy/Stony Plains, Major and Minor Drainage Lines and Breakaways.

Species accumulation curves did not quite reach an asymptote during the current surveys (Figure 8), and based on estimates of total species richness, Astron sampled between 59% and 76% of the total species pool (Table 13). This was expected, as an additional 15 bird species (21%) were recorded opportunistically. However, the species accumulation curve was approaching an asymptote when all surveys were considered (Figure 8).

There was no significant difference in species composition between habitat types (ANOSIM R = -0.059, P=0.614; Figure 9).

Table 13: Total number of bird taxa sampled in comparison to estimates of the total species pool based on several models.

	Observed	Estimated			
		Chao2	Jacknife 1	Jackknife 2	Bootstrap
Number of species	42	67.7	63.0	71.1	55.3
Estimated % sampled		62.1	66.7	59.0	76.0

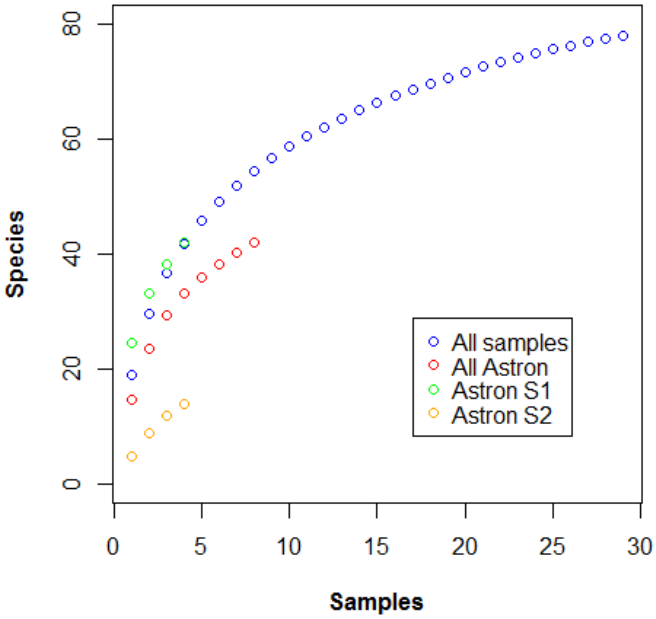


Figure 8: Species accumulation curves for bird surveys.

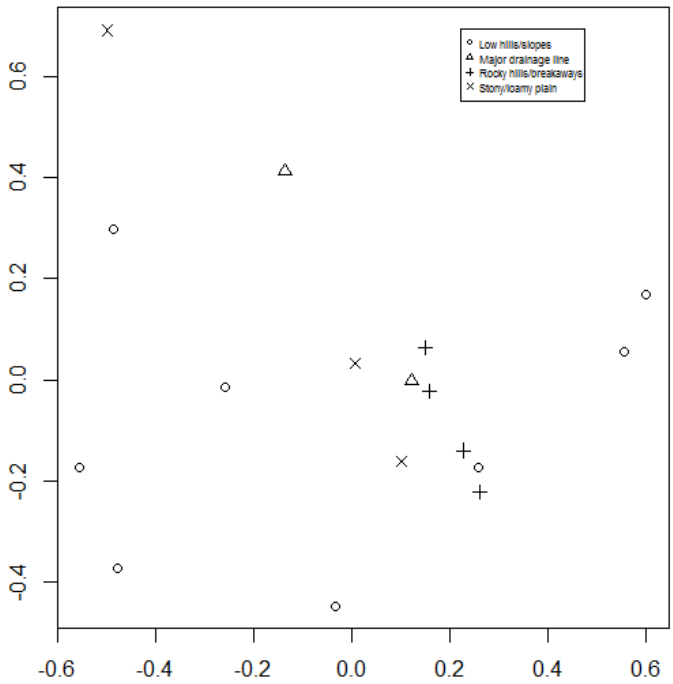


Figure 9: Two-dimensional ordination of bird species assemblages of each site.

4.2.2.3 Mammals

Twenty-eight species of mammal were recorded during the survey, including four introduced species: Cat (**Felis catus*), Dog (**Canis familiaris*), European Cattle (**Bos taurus*) and House Mouse (**Mus musculus*) (Table D.9, Appendix D). The most commonly trapped species was the rodent *Pseudomys hermannsburgensis* with 21 captures (30% of trap records). Also commonly encountered was *Ningaui timealeyi* with 10 captures and *Pseudomys desertor*, with eight captures. The most speciose trapping sites were BTG8 (Major Drainage Line) with seven species and BTG3 (Loamy Plain) and BTG4 (Breakaway) with four species each. The most commonly recorded species including targeted and opportunistic records was the European Cattle, **Bos taurus*, followed by the Western Pebble-mound Mouse *Pseudomys chapmani* and Euro *Osphranter robustus erubescens.* The Northern Quoll *Dasyurus hallucatus* was also commonly recorded, with one individual captured and images from nine camera sites. Ten bat species were recorded from the acoustic recording sites (Table D.10, Appendix D).

Four species of conservation significance were recorded during the survey: Northern Quoll (S2; EN), Pilbara Leaf-nosed Bat (S3; VU), Ghost Bat (S3) and Western Pebble-mound Mouse (P4).

Species accumulation curves did not reach an asymptote during the current surveys (Figure 10), and based on estimates of total species richness, Astron sampled between 48% and 57% of the total species pool (Table 14). Even when all surveys were considered, the species accumulation curve did not reach an asymptote (Figure 10). This was expected, as the data only includes trapping data and does not include any bat species, which make up 36% of the mammal species, as well as an additional four species that were recorded opportunistically.

There was no significant difference in species composition between habitat types (ANOSIM R = 0.190, P=0.084; Figure 11).

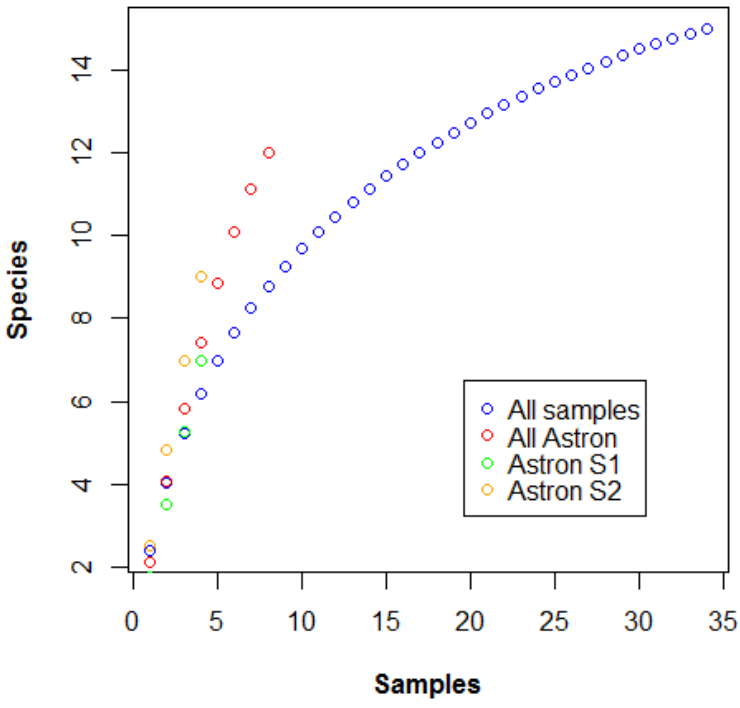


Figure 10: Species accumulation curves for mammal surveys.

Table 14: Total number of mammal taxa sampled in comparison to estimates of the total species pool based on several models.

	Observed	Estimated			
		Chao2	Jacknife 1	Jackknife 2	Bootstrap
Number of species	12	25.0	25.0	28.4	21.1
Estimated % sampled		48.0	48.0	42.3	56.9

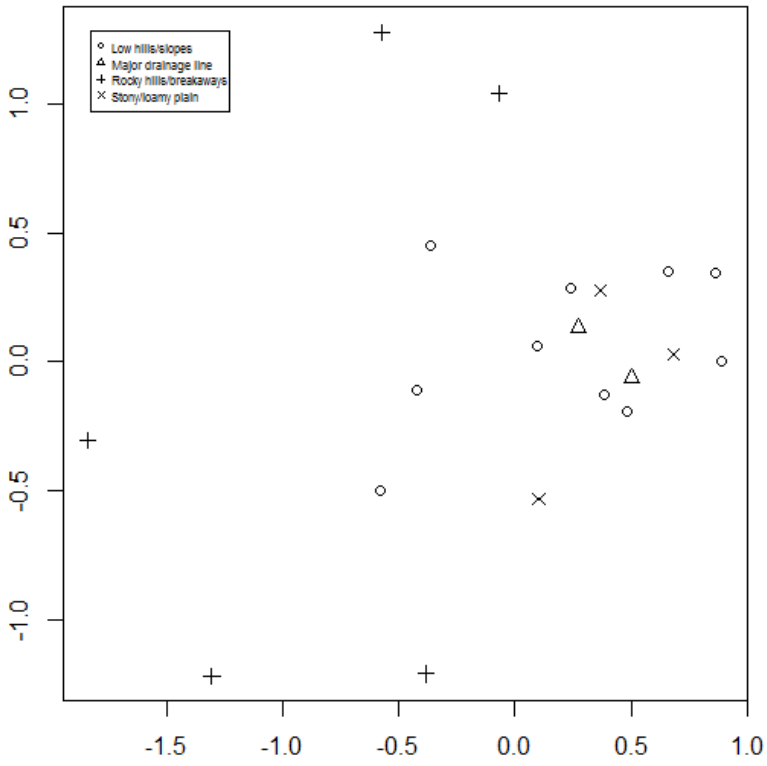


Figure 11: Two-dimensional ordination of mammal species assemblages of each site.

4.2.2.4 Conservation Significant Species Recorded

Eight vertebrate species of conservation significance have been recorded within the survey area. The locations of these species records from the current survey, as well as previously recorded species, are shown in Figure G.1 and detailed in Table G.1 (Appendix G).

Northern Quoll (*Dasyurus hallucatus*) (S2; EN)

The Northern Quoll occurs in a variety of habitats (Oakwood 2008) but is commonly found in open lowland savannah forest and rocky escarpments. Rocky areas are particularly important for quolls in the Pilbara as these areas retain water and provide a diversity of microhabitats. These areas also tend to have greater floristic diversity and productivity resulting in greater prey density compared to non-rocky areas. Rocky areas also provide refuge from feral cats, fire and livestock (Hill and Ward 2010) and provide breeding potential (Department of the Environment 2013).

The Northern Quoll was recorded from two trapped individuals within Rocky Hill/Breakaway habitat (BTG6) and numerous recordings on motion sensitive cameras (Figure G.1, Appendix G). Previously only recorded from scats in the main gorge system of the survey area (Biota Environmental Sciences

2007), it appears to be relatively common and widespread over the ranges on either side of the Bungaroo Creek valley (Figure G.1, Appendix G).

Ghost Bat (*Macroderma gigas*) (S3)

The preferred habitat of Ghost Bats is considered to be rocky gorges and breakaways that support caves and crevices used as maternity roosts. The Ghost Bat uses different natural formations for various purposes and for groups to persist they generally require habitats that provide:

- a selection of roosting opportunities with night roosts or feeding sites, day roosts and at least one deep cave with characteristics of a maternity roost
- nearby gullies and gorges with vegetation of vertical complexity (diverse vegetation heights and density) and presence of water that would attract prey species
- a productive foraging area within a 5 km to 10 km radius, usually including a good quality riparian line.

Transient roosts and feeding sites are used by small numbers of Ghost Bats, whereas maternity roosts are used by larger colonies (Armstrong and Anstee 2000). Night feeding roosts are typically shallow caves and shelters/overhangs high in the strata and poorly insulated from the elements (Armstrong and Anstee 2000). Transient day roosts are deeper and more complex, have more insulation providing a more stable temperature and typically have one or more large chambers high enough to avoid predators. Maternity roosts provide additional features to support a reproducing population including high temperature (27°C to 33°C) and humidity (>85%) (Armstrong and Anstee 2000). The Ghost Bat is known to range great distances on an annual cycle from these locations depending upon seasonal weather conditions and availability of suitable day roosts.

Ghost Bats were recorded in low activity levels from four acoustic recording sites, as well as scats/feeding debris recorded at eight caves, all within Gorge and Breakaway habitats (Figure G.1, Appendix G). Biota Environmental Sciences (2010) recorded Ghost Bats from a cave within the survey area and stated that the shallow nature of the cave indicates that it is likely that their records represent itinerant individuals. Larger caves suitable for maternity roosts appeared to be absent from the survey area.

Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* Pilbara form) (S3; VU)

Pilbara Leaf-nosed Bats are known to require deep caves characterised by high levels of humidity and stable temperatures (Churchill 2008). This is a result of their limited ability to conserve heat and water (Armstrong 2001, Churchill 1991). Caves deep enough to create this environment are relatively uncommon in the Pilbara, with only 20 to 25 roost sites being known (R. Bullen, pers. comm. 20 Oct 2014). Foraging habitat for the Pilbara Leaf-nosed Bat is diverse and includes riparian vegetation, hummock grassland, and sparse tree and shrub savannah (Duncan et al. 1999). It has also been recorded flying over small watercourses amongst granite boulder terrain, over pools and low shrubs in ironstone gorges and above low shrubs and around pools in gravelly watercourses with *Melaleuca leucadendron*, such as in Barlee Range Nature Reserve (Armstrong 2001). In the Pilbara it has been observed in *Triodia* hummock grasslands covering low rolling hills and shallow gullies, with scattered *Eucalyptus camaldulensis* along the creeks (Armstrong 2001, Churchill 1991).

In 2010, this species was recorded from the soak riverine habitat just north of the survey area boundary (Biota Environmental Sciences 2010). During the current survey, the Pilbara Leaf-nosed Bat was recorded from eight acoustic recording sites within Loamy/Stony Plain, Gorge and Breakaway habitats. One site had high (MJ1) activity (115 calls) and the remaining had low activity

levels (JO-BAT-2, MJ5, MJ21, SM7566a, SM7634a, SM8027a, SM11040a; Figure G.1, Appendix G). The earliest and latest detections at MJ1 were at 19:07 and 04:35 on 25 May and at SN7566a at 18:55 and 04:53 (Bat Call WA 2015). The time differential between detection and Civil Twilight times (between 52 mins and 106 min) are consistent with the Pilbara Leaf-nosed Bats originating from a roost in the ranges adjacent to the survey area (Bat Call WA 2015).

Pilbara Olive Python (*Liasis olivaceus barroni*) (S3; VU)

The Pilbara Olive Python prefers escarpments, deep gorges, water holes and rock piles associated with permanent pools in rocky areas in the ranges of the Pilbara region (Pearson 1993, Wilson and Swan 2010). Microhabitat preferences of the Pilbara Olive Python are under rock piles, on top of rocks or under spinifex (Tutt et al. 2004). Individuals spend the cooler winter months within caves and rock crevices away from water sources. In the warmer summer months the pythons are found to move around widely, usually in close proximity to water and rock outcrops (Wilson and Swan 2010). A population is known to exist along the Robe River near Pannawonica (Biota Environmental Sciences 2007).

A possible Pilbara Olive Python scat was recorded from within Minor Drainage Line habitat in close association with a breakaway (Figure G.1, Appendix G). The scat may also be from a Black-head Python; however this species feeds primarily on amphibians and reptiles as they lack the characteristic heat sensing pits of pythons to detect mammals (Bush and Maryan 2011). Based on the fur within the scat it is considered likely to be Pilbara Olive Python. An anecdotal record of this species has also been reported to the north of the survey area within a drainage line (E. Carroll, pers. comm., 26 October 2015). This species is likely to be found within the Gorge habitat of the survey area, particularly in those that contain semi-permanent and permanent water.

Rainbow Bee-eater (*Merops ornatus*) (S5; Mi)

The Rainbow Bee-eater is one of the most common and widespread birds in Australia and was a commonly recorded species during bioregional surveys in the Pilbara (Burbidge et al. 2010). The species winters from the Gascoyne north to Indonesia, moving south mainly in late September and early October and north from February to April (Johnstone and Storr 1998). Rainbow Bee-eaters tend to prefer lightly wooded, preferably sandy country near water (Johnstone and Storr 1998).

The Rainbow Bee-eater was recorded on numerous occasions throughout the survey area during the current and previous surveys in a variety of habitats including Loamy/Stony Plains, Major and Minor Drainage Lines and Breakaways (Figure G.1, Appendix G).

Unnamed Blind Snake (*Anilios ganei*) (P1)

The blind snake *Anilios ganei* is poorly collected, but is known from Pannawonica. This species has been associated with moist gorges and gullies (Wilson and Swan 2010) but potentially occurs over a wide range of other stony habitats. Given its cryptic fossorial habit, this species is rarely encountered. Little is known of this species' ecology but like most other blind snakes, it is insectivorous, feeding on termites and their eggs, and larvae and pupae of ants (Wilson and Swan 2010).

One previous record from 2005 exists from within a minor gorge in the survey area according to the Department of Parks and Wildlife (2015b) search results (Figure G.1, Appendix G). One individual was captured from Rocky Hills/Breakaway habitat (BTG5) within the survey area and is likely to be present within other suitable habitats (including Gorge and Low Hills/Slopes) of the survey area.

Lined Soil-crevice Skink (*Notoscinus butleri*) (P4)

Notoscincus butleri (P4) is endemic to Western Australia and restricted to the arid north-west of the Pilbara bioregion (Storr et al. 1999). This species has been associated with spinifex-dominated areas near creek and river margins (Wilson and Swan 2010).

This species was recorded on 14 occasions within the survey area during a previous survey (Biota Environmental Sciences 2007) (Figure G.1, Appendix G). It was also captured during the current survey from Rocky Hills/Breakaway (BTG5) and Major Drainage Line (BTG8) habitats.

Western Pebble-mound Mouse (*Pseudomys chapmani*) (P4)

Although suitable habitat is patchy, extant Western Pebble-mound Mouse (P4) populations are widespread in the extensive ranges of the central and southern Pilbara region (Start 2008). The persistence of abandoned mounds in the Gascoyne and Murchison regions and small, isolated, coastal ranges in the Pilbara indicates considerable recent decline in the range of this species (Start 2008). Colonies occur on the gentler slopes of rocky ranges where the ground is covered by stony mulch and vegetated by hard spinifex, often with a sparse overstorey of eucalypts and scattered shrubs, typically *Senna, Acacia* and *Ptilotus* (Start 2008), while some mounds are also sited close to narrow ribbons of *Acacia* dominated scrub along incised drainage lines (Start 2008).

Previous surveys recorded one captured individual and two inactive mounds within stony plain and low rise habitat (Biota Environmental Sciences 2007). During the current survey the Western Pebble-mound Mouse was recorded from two trapped individuals at sites BTG3 (Loamy/Stony Plain) and BTG8 (Major Drainage Line) and 27 inactive mounds within Loamy/Stony Plain and Low Hills/Slopes habitats of the survey area (Figure G.1, Appendix G). The inactive mounds were generally found in areas that had been recently burnt. Despite individuals being captured, no active mounds were observed.

4.2.2.5 Conservation Significant Species Possibly Occurring

An additional species, the Long-tailed Dunnart (P4), was considered to have a high likelihood of occurring within the survey area (Table E.1, Appendix E). The Long-tailed Dunnart is patchily distributed but at times can be locally common (Burbidge et al. 2008). It is found in rocky scree and plateau areas, generally with little vegetation or spinifex hummock grassland, shrubs and open woodland (Burbidge et al. 2008). This species has been recorded within 3 km of the survey area and is considered likely to utilise the Rocky Hills and Low Hills/Slopes habitats of the survey area.

Three species, Fork-tailed Swift (S5; Mi), Cattle Egret (S5; Mi) and Eastern Great Egret (S5; Mi) were considered to have a moderate likelihood of occurrence (Table E.1, Appendix E). Suitable habitat is present within the survey area; however, they are non-cryptic species that were not detected despite adequate survey effort. The Cattle Egret and Eastern Great Egret are likely to utilise the survey area on a seasonal basis after rains when areas are inundated.

An additional 19 species were considered to have a low likelihood of occurrence due to lack of suitable habitats within the survey area (Table E.1, Appendix E).

4.2.3 SRE Invertebrate Fauna Habitat

Seven SRE habitat types were identified in the desktop assessment, each of which differs with regards to their prospectivity for SRE fauna (Figure F.5, Appendix F). The most prospective habitats were Gorge, Minor Drainage Line and Rocky Hills habitats. Plains and Major Drainage Line habitats

were inferred as having a low prospectivity for SRE fauna. This section reviews the findings of the desktop assessment using the field survey results.

Breakaway habitat describes accumulations of rock boulders and scree between the Rocky Hills/Slopes habitat and the drainage lines. It differs from the geologically similar Low Hills/Slopes habitat in that the rock strata are not compacted and without a weathered zone (hardcapping) near the surface. Four breakaway habitats were sampled as sites JO8, MCL02, MJ31, MJ32 and three additional sites (BTG4, BTG5 and BTG6) included breakaway sections. This landform supported three slater species: the widespread *Buddelundia* '30' and *Buddelundia* '14hr', and the potential SRE species *Buddelundia* '61'. The latter species was collected from a Breakaway site (MJ32) and also from Rocky Hills and Slope habitat (site BTG07). Breakaway habitat has some potential for SRE fauna to be present, although potential SRE species collected here may also occur in the adjacent Rocky Hills/Slopes habitat.

Clay/Loam/Stony Plains (dry plains) habitat occupies virtually the entire survey area; a more or less continuous landform that extends beyond the survey area and poses no obvious limits to the dispersal of invertebrate fauna. Some of these plains are flooded periodically and the predominant vegetation type (Buffel Grass and *Triodia* steppe) is also widespread and not prospective SRE habitat. Sample sites that represented this landform were BTG1, BTG3, and JO10. Species in SRE groups recorded from this landform were the isopods *Buddelundia* '10bf', *Buddelundia* '14hr', *Buddelundia* '36', and the scorpion *Lychas bituberculatus*; all were more widespread in the survey area and not SRE species. These results confirm the findings of the desktop assessment that this is not prospective SRE habitat.

Gorges habitat is embedded into the Rocky Hills or Breakaway habitats, where deeply carved rock incisions and minor drainage lines provide shade and diverse microhabitats. Minor creek lines and water run-off, if present, lead to high moisture availability compared to the surrounding areas and may isolate SRE fauna present. Gorge habitats have relatively low connectivity and are isolated from one another, though there is some potential for fauna dispersal along creek lines. Due to its high potential for SRE fauna, sampling for SRE fauna was undertaken at seven sites: JO2, JO3, JO6, JO13, SRE3, SRE14 and SRE20. Gorge habitat supported many widespread species in six SRE groups such as the snail *Rhagada* sp. 'Pannawonica', slater *Buddelundia* '14hr', millipede *Austrostrophus stictopygus,* and the pseudoscorpions *Indohya* 'PSE002' and *Tyrannochthonius aridus*. Two potential SRE species were also collected: *Tyrannochthonius* sp. 'Bungaroo 2', *Buddelundia* '61' and *Lychas* 'hairy-tail'-group. The Gorge habitat supports a diverse community of species in SRE groups, with most species more widespread and not restricted to a single gorge. There are also some potential SRE species however, that may have smaller ranges. Gorge habitat is therefore considered to be prospective habitat for SRE fauna, in particular if minor drainage lines are present (e.g. site SRE20).

Low Hills/Slopes habitat links the high-topography feature, rocky hills, with the flat plains of the Bungaroo Creek valley. It is a widespread and more or less continuous habitat type, though some isolated hills are present in the north-western and south-eastern sections of the survey area. Low Hills/Slopes habitat is more common than Breakaway habitat that is geologically similar but consists predominantly of scree without solid hardcapping. It supports some slater species such as the potential SRE species *Buddelundia* '61'. The relatively high connectivity with other habitat types (e.g. Gorges and Rocky Hills habitat) and the lack of isolating features may lead to wider ranges amongst the SRE fauna present. The available data for *Buddelundia* '61' support this hypothesis as the species was also collected from Gorge and Drainage Line, habitats also prospective for SRE fauna, and is not restricted to the Low Hills/Slopes habitat. The field survey results suggest that this is not prospective SRE habitat.

Minor Drainage Line habitat indicates tributaries of the Bungaroo Creek that are embedded into a more or less continuous matrix of Rocky Hills, Gorges, and Low Hills/Slopes habitats, primarily in the south-eastern survey area. Three sample sites targeted Minor Drainage Line habitat outside gorges: JO8, JO14 and MCL01. Two additional sample sites targeted Minor Drainage Line habitat within gorges (SRE4 and SRE20). The Minor Drainage Line habitat outside the gorges appears generally well connected across the survey area as they lead into the major drainages of the Bungaroo Creek valley. Drainage lines in gorges have a higher prospect of harbouring isolated fauna.

The Minor Drainage Line habitat outside the gorges supported a diverse fauna of species in SRE groups, in particular snails (four species in three families), but all species were widespread. This is prospective habitat for invertebrates but no confirmed or potential SRE species were collected. However, Minor Drainage Line habitat associated with gorges differed in fauna composition and several pseudoscorpion species were collected, including the potential SRE species *Tyrannochthonius* sp. 'Bungaroo 2'. The collections suggest that Minor Drainage Line habitat is prospective for SRE fauna if it is associated with gorges because these habitats have topographic complexity, are shaded, and diverse microhabitats are present. SRE species may occur in Minor Drainage Line habitat that is not associated with gorges but most species should be widespread, with distributions that mirror the degree of connectivity with the associated habitat type (e.g. Major Drainage Line habitat of the Bungaroo Creek valley).

Major Drainage Line habitat (and river beds) comprising Bungaroo Creek and its major catchments, is found as continuous across the entire survey area and was sampled as sites JO9, MJ42, SRE13 and BTG08. The desktop assessment identified this habitat as having little prospectivity for SRE fauna as these sites are seasonally flooded, very exposed during dry periods, and organic matter is either alluvial or washed away periodically. The collections from sites MCL01 and SRE13 supported this conclusion, given that most of the species collected (one millipede, one pseudoscorpion, three slaters and three snail species) are widespread and found elsewhere in the western Pilbara. However, the two soak and drainage areas MJ42 and BTG8 supported several widespread species but also three potential SREs: the slater species *Spherillo* sp. indet. and Buddelundiinae sp. indet. and the pseudoscorpion *Ideoblothrus* sp. 'Bungaroo'.

It is possible that these potential SREs remain undetected elsewhere in the survey area and have been washed into the soaks during one of the periodic floods just to persist in the allochthonous organic matter, such as leaf litter. The better known distribution of the more frequently collected invertebrate species (e.g. the snail *Rhagada* sp. 'Pannawonica and the millipede *Austrostrophus stictopygus*) support the hypothesis of habitat connectivity along the major creek lines and it appears plausible that the three potential SREs are found along the entire drainage line, having a linear range greater than 20 km, but remain undetected elsewhere. Nevertheless, the range of these species is difficult to establish at present and it is suggested that the drainage and soak areas embedded into the Major Drainage Line habitat have potential to harbour SRE fauna.

Rocky Hills habitat denotes the high-elevation features that form a continuous and more or less uniform stretch either side of the Bungaroo Creek valley across the survey area. This habitat type is strongly associated with Breakaway and Low Hills/Slopes habitats and is deeply incised by Major and Minor Drainage Lines habitats. Sampling was undertaken at four sites: BTG4, BTG5, BTG6 and MJ36. This habitat supported the widespread snail species *Rhagada* sp. 'Pannawonica' (site MJ36) and *Buddelundia* '30'. These results contradict the desktop assessment that this is prospective SRE habitat. Although some species in the SRE groups were collected, none were confirmed or considered potential SRE species.

Overall, three habitat types are classified here as having a higher prospect of SRE fauna occurrence than others: i) Gorge habitat, ii) Minor Drainage Line habitat and iii) soaks and drainage areas of the

Major Drainage Line habitat. Minor Drainage Line and Gorge habitats occur in close association and provide the most suitable habitat for SRE fauna. Together, these three habitat types comprise the majority of the potential SRE species collected in this survey. The currently available data suggest that Breakaway and Low Hills/Slopes habitats are of much lower importance to SRE fauna, though are still somewhat prospective. Rocky Hills and Plain habitats are classified as not prospective for SRE fauna.

4.2.4 SRE Invertebrate Species

Sorting and identification of all invertebrate samples to family level was done in-house (slaters: Dr Simon Judd, scorpions: Dr Erich Volschenk, pseudoscorpions and spiders: Dr Danilo Harms) using available keys, online databases and published literature. WAM lodgement details for representative vouchers are given in Appendix H.

A total of 226 specimens belonging to 30 invertebrate morphospecies were collected from the survey area (Table D.11, Appendix D). Slaters were the most diverse group with nine species and 101 specimens collected, followed by non-marine snails (six species; 81 specimens) and pseudoscorpions (10 species; 29 specimens). The remaining groups were far less common: scorpions were less diverse with three species and araneomorph spiders and millipedes were recorded with one species each. No mygalomorph spiders, harvestmen or centipedes were collected. No listed invertebrate species were collected during the survey.

Based on these results, 22 of the species (73.3%) were not considered to be, or unlikely to be, SREs. No confirmed SRE species were collected; however, eight species (26.7%) were potential SRE species, principally in the slater (three species), pseudoscorpion (three species), scorpion (one species) and spider (one species) faunas (Figure G.2 to G.3 and Table G.2, Appendix G). These species are:

- Slaters – *Spherillo* sp. indet., *Buddelundia* '61' and Buddelundiinae sp. indet.
- Pseudoscorpions – *Euryolpium* sp. 'Bungaroo', *Ideoblothrus* sp. 'Bungaroo' and *Tyrannochthonius* sp. 'Bungaroo 2'
- Scorpions – *Lychas* 'hairy tail'-group
- Spiders – *Karaops* sp. 'Bungaroo'

Of these potential SRE species, three are known only from singletons (pseudoscorpions *Euryolpium* sp. 'Bungaroo' (SRE5b), *Tyrannochthonius* sp. 'Bungaroo 2' (SRE20) and spider *Karaops* sp. 'Bungaroo' (SRE7b)) and four are known only from a single site in the survey area (pseudoscorpions *Euryolpium* sp. 'Bungaroo' (SRE5b), *Ideoblothrus* sp. 'Bungaroo' (MJ42) and *Tyrannochthonius* sp. 'Bungaroo 2' (SRE20); and spider *Karaops* sp. 'Bungaroo' (SRE7b)). Only four potential SRE species (scorpion *Lychas* 'hairy tail'-group and slaters *Spherillo* sp. indet., *Buddelundia* '61' and Buddelundiinae sp. indet.) were collected from multiple sites though never in large numbers (less than eight specimens each). *Spherillo* sp. indet. and Buddelundiinae sp. indet. are also known from outside the survey area.

Overall, only a relatively small number of potential SRE species were collected in the survey area. The analysis of habitat types and microhabitats for these species has shown that they are found primarily in Major Drainage Line and Gorge habitats that are widespread in the survey area. All potential SRE species are currently under-sampled and are likely to be more widespread because of the wider occurrence of the habitats they occupy. There are no habitats unique to the survey area and the habitat forms that may contain relict SRE species (Gorge, Minor Drainage Line and the soaks associated with Major Drainage Line habitat) are more widespread outside the survey area.

Many species known from the desktop assessment to potentially occur within the survey area were not collected. For example, no mygalomorph spider species could be detected despite extensive searches and previous survey results that recorded species of *Aname* (family Nemesiidae), *Missulena* (Actonopodidae) and *Synothele* (Barychelidae) (Biota Environmental Sciences 2007, 2010), indicating they are likely to be absent from the survey area. Most species identified in the desktop assessment occur in the wider search area and outside the Bungaroo Creek valley. They may be absent locally, or have ranges that do not coincide with the survey area.

The apparent absence of some species collected previously in the survey area may be caused by the recent fire that reduced the amount of suitable habitat (e.g. leaf litter) in large parts of the survey area or had a direct impact on the populations of SRE species (e.g. increased mortality in moisture-dependent species). For example, it has been shown that fire has a significant impact on spider communities in arid land systems and many spider species have a significant preference for, or were restricted to, particular post fire ages. Changes in species richness, evenness and composition have been documented with increasing post-fire age and that may explain the absence of some groups (e.g. Langlands et al. 2011a, Langlands et al. 2011b). Other factors including climatic factors and/or seasonality and the presence of weeds and habitat disturbance by cattle grazing/trampling in many of the collection sites is also likely to have had an impact in the SRE fauna. The impact of these factors is discussed in more detail in Section 3.5.

Importantly, sampling for SRE invertebrates is principally opportunistic because most SREs have patchy distributions and can be very difficult to sample, especially when habitat preferences of particular species are unknown, they occur at low abundance, or sampling is outside their narrow activity period.

A summary of the SRE groups recorded and the eight potential SRE species identified is provided below.

4.2.4.1 Slaters

Nine slater species (and 101 specimens) were collected in this survey (Table D.11, Appendix DTable 15 and Figure G.2, Appendix G). The nine species belong to four genera: *Barrowdillo* (one species), *Buddelundia* (six), *Spherillo* (one) and a currently undescribed genus in the subfamily Buddelundiinae (one). Three of these species were considered potential SRE species: *Spherillo* sp. indet., *Buddelundia* '61' and Buddelundiinae sp. indet. (Table 15).

Two of these species (Buddelundiinae sp. indet., and *Spherillo* sp. indet.) were only collected in leaf litter from soak sites associated with Major Drainage Line habitat that generally offers little topographic diversity and vegetation cover. Microhabitats in this landform are ephemeral because there is periodical flooding and leaf litter accumulations are unlikely to be permanent because they would be washed away. The dominant vegetation type in these habitats was generally *Corymbia hamersleyana* scattered trees or woodland over mixed *Acacia* spp. shrublands over *Triodia wiseana* and/or *T. epactia* hummock grassland and these flora associations are not unique to the Major Drainage Line habitats. The Major Drainage Line habitat is also well connected as it is part of the main Bungaroo Creek channel that runs through the survey area and there are no habitat isolates that could reduce the dispersal capacity of SRE fauna present. Habitat surrogates are frequently available in the survey area and it is almost certain that the potential SRE species from the Major Drainage Line habitat are more widespread in the Bungaroo Creek valley area.

The remaining potential SRE slater species, *Buddelundia* '61', has been collected from at least two habitat types, with a linear range of at least 3.5 km. This slater species showed no clear habitat

association and was collected from Breakaway, Gorge and Drainage Line habitats. It may have a range <10,000 km^2 but is widespread locally.

***Buddelundia* '61'**

This species was collected from eight sites (BTG7, MJ32, SRE3b, SRE5b, SRE7b, SRE8b, SRE13 and SRE14) in the survey area. It is currently known only from the Bungaroo Creek valley area and is therefore a potential SRE species. However, it is fairly widespread locally and has been sampled from several microhabitats, including gorges/drainage lines and rocky breakaway. It is also noted that the areas west and north of the survey area have not been surveyed for slaters and the lack of records outside the Bungaroo Creek valley may just reflect a lack of sampling. The species may also be conspecific with another morphospecies from the area, *Buddelundia* '62', which may extend the range of this complex further but additional work is needed and it is likely that a reliable identification will require adult males (S. Judd pers. comm., 26 June 2015).

Buddelundiinae sp. indet.

A single female specimen was collected from Creekline/Major Drainage Line habitat at BTG8 (Plate 5C). It belongs to a currently undescribed genus that is taxonomically poorly resolved and rarely collected in the Pilbara. The species is considered a potential SRE species in accordance with the precautionary principle (S. Judd, pers. comm., 26 June 2015). Additional juvenile specimens of this genus was collected from JO10 within the survey area and Major Drainage Line habitat at site SRE9b, which is located outside the survey area, and thought to represent the same species (S. Judd pers. comm., 26 June 2015). Buddelundiinae sp. indet. may be a SRE species but is unlikely to be threatened by the current proposal because populations occur outside the area of the proposed development and all records are from Drainage Line habitat, which is generally well connected and widespread outside the survey area.

***Spherillo* sp. indet.**

Five specimens of a single *Spherillo* morphospecies were collected from a soak at site MJ42 and Major Drainage Line habitat at site SRE9b. *Spherillo* is a widespread genus in moist habitats across eastern and south-eastern Australia where six species are currently recognised; however, it is rarely collected and poorly known in Western Australia, including the Pilbara region. The taxonomy of *Spherillo* is poorly resolved and little is known about species ranges. The samples from Bungaroo are treated as a potential SRE species, owing to the high moisture dependence and poor dispersal abilities of the known species in this genus (Lee et al. 2014). However, the known populations are from both within (MJ42) and outside (SRE9b) the survey area and known from two habitat types, of which one (Major Drainage Line habitat) is widespread beyond the survey area.

4.2.4.2 Millipedes

Seven specimens of millipede were collected from four sites (SRE7b, SRE13, SRE14 and MCL01) in the survey area and they all belong to a single species of fire millipede (family Pachybolidae) (Table D.11, Appendix D and Figure G.3, Appendix G). *Austrostrophus stictopygus* is widespread across the Pilbara and has been recorded from a variety of locations between Karratha and Newman (Plate 5A). The linear range is more than 450 km (Harvey et al. 2011) and this is not a SRE species.

4.2.4.3 Pseudoscorpions

A total of 29 specimens representing 10 pseudoscorpion species in five families were collected during this survey: Atemnidae (*Oratemnus*: one species), Chthoniidae (*Austrochthonius*: one;

Tyrannochthonius: two), Hyidae (*Indohya*: one), Olpiidae (*Beierolpium*: one; *Euryolpium*: one; *Indolpium*: two) and Syarinidae (*Ideoblothrus*: one) (Table D.11, Appendix D and Figure G.3, Appendix G).

Little can be said about the ranges of the three potential SRE pseudoscorpions *Euryolpium* sp. 'Bungaroo', *Ideoblothrus* sp. 'Bungaroo' and *Tyrannochthonius* sp. 'Bungaroo 2' (Table 15) because they are known only from singletons or two specimens, have been collected from single sites and are currently undescribed.

***Tyrannochthonius* sp. 'Bungaroo 2'**

A single male specimen was collected from leaf litter in a gorge. This species differs from the only other named chthoniid pseudoscorpion from surface habitats in the Pilbara, *Tyrannochthonius aridus*, in several morphological characters such as longer fingers of the chela, the shape and number of chelal teeth, and the shape of the epistome. The only other species of *Tyrannochthonius* (and the closely related *Lagynochthonius*) in the wider survey area are from subterranean habitats and are troglomorphic. These were on loan to the University of Adelaide when this survey was conducted (K. Abrams, WAM, pers. comm., 25 June 2015) hence their examination was not possible.

Considering the moisture dependence of many chthoniid species and the extensive short-range endemism documented in the subterranean fauna of *Tyrannochthonius* and *Lagynochthonius* (Edward and Harvey 2008, Harrison et al. 2014), this is a potential SRE species.

The pseudoscorpion '*Tyrannochthonius* sp. 'Bungaroo 2' may have a smaller range because it was sampled from leaf litter in a single Gorge habitat, a generally more isolated habitat type. It is possible that this pseudoscorpion is restricted to gorges and the associated deep gullies that provide permanent shade and moisture for relict SRE fauna. Considering the extent of this gorge, this species should have a range of at least 7 km but it is most likely more widespread as habitat surrogates are available elsewhere in the survey area.

***Euryolpium* sp. 'Bungaroo'**

A single female belonging to the olpiid genus *Euryolpium* was collected in Gorge habitat at Site SRE5b. *Euryolpium* species are generally widespread in arid Australia but at least some potential SRE species have been recorded recently as part of environmental impact assessments (Biologic Environmental Survey 2014, Outback Ecology 2013). No additional *Euryolpium* species are currently known from the survey area (WAM data) and *Euryolpium* sp. 'Bungaroo' may be a new species.

The pseudoscorpion *Euryolpium* sp. 'Bungaroo' is known only from Gorge habitat but the data available are not sufficient to infer whether it actually has a small range or is simply undersampled. Most environmental assessments have considered *Euryolpium* species to be widespread but there is recent evidence that at least some species have restricted ranges (Biologic Environmental Survey 2012, Outback Ecology 2013); this assessment is precautionary but also preliminary. *Euryolpium* samples collected at Bungaroo South were not considered SREs (Phoenix Environmental Sciences 2012) and there is considerable uncertainty about the SRE status of *Euryolpium* sp. 'Bungaroo'. *Euyolpium* sp. 'Bungaroo' is classified here as a potential SRE species with deficient data, meaning that there is a lack of taxonomic and geographic information to determine SRE status.

***Ideoblothrus* sp. 'Bungaroo'**

The genus *Ideoblothrus* is diverse in both surface and subterranean habitats throughout the north-western Pilbara with numerous described and undescribed species (Harvey and Edward 2007,

Harvey and Leng 2008). The two specimens collected from moist leaf litter at Site MJ42 differ from the eight recognised Australian species in body measurements and the morphology of the pedipalps. All described species in this genus are known to have highly localised distributions and are SRE species (Harvey and Edward 2007). Although the range of *Ideoblothrus* sp. 'Bungaroo' is likely to extend further than is currently known, it is categorised here as a potential SRE species.

4.2.4.4 Scorpions

Seven scorpion specimens were collected from four sites and represent three species in the genus *Lychas* (family Buthidae) (Table D.11, Appendix D and Figure G.3, Appendix G).

***Lychas* 'hairy tail'-group**

Two specimens were collected from Gorge habitat at Site SRE14 and Breakaway habitat at Site SRE3b (Table 15). This is a species complex that comprises several cryptic species in the Midwest, Kimberley and Pilbara regions of Western Australia. Members of this complex were previously classified as widespread but recent molecular studies at the WAM have shown that at least some of the species have short ranges. The three collected specimens are therefore classified as potential SRE species in accordance with the precautionary principle (E. Volschenk, pers. comm.).

The scorpion in the *Lychas* 'hairy tail' group is also a SRE with deficient data because there is no taxonomic framework, and there is no geographic information with regards to the distribution of putative cryptic species in this complex. All specimens were collected from Gorge habitat but should be more widespread because scorpions generally have greater dispersal capacities, are arid-adapted, and morphologically very similar specimens have been collected elsewhere in the Pilbara. Morphologically similar specimens have also been collected in the Robe Valley (ecologia Environment 2013) and wider occurrence across temporarily moist habitats is likely.

4.2.4.5 Spiders

One selenopid spider specimen was collected from one site, SRE 7b (Table 15 and Figure G.3, Appendix G).

***Karaops* sp. 'Bungaroo'**

A single juvenile specimen was collected from Gorge habitat at Site SRE7b (**Error! Reference source not found.** and Figure G.3, Appendix G) but could not be identified based on morphology because adult specimens would be required. DNA barcoding was subsequently performed on this specimen and a 450 bp fragment of the CO1 'barcoding' gene amplified. The amplification of longer fragments was not possible and all subsequent analyses were performed on 450 bp fragments. The obtained CO1 sequence checked against 56 reference sequences, including several undescribed species from the Pilbara that are range-restricted and *Karaops martamarta* that is widespread in the central Pilbara. An additional selenopid specimen was collected from Bungaroo during a previous survey (Biota Environmental Sciences 2010) but was not suitable for genetic analyses because it was dead-taken.

A genetic distance table derived for all samples indicated that the closest match was with a currently undescribed species that was collected in the recent Level 2 fauna survey at Middle Robe more than 40 km north-west of the survey area: *Karaops* sp. 'Middle Robe 1' (Astron Environmental Services 2015). Pairwise genetic divergences between the Bungaroo sample and *Karaops* sp. 'Middle Robe 1' (represented by six sequences) ranged between 8.8% and 9.1% and divergences to all other sequences were higher (> 9.2 %). There is no barcoding threshold for selenopids but 8% has been

proposed as a general threshold for species delineation in arthropods (Hebert et al. 2003) and 9.5% have recently been proposed for mygalomorph spiders in the Pilbara (Castalanelli et al. 2013). Based on these thresholds, the Bungaroo sample falls into a 'grey area' where species cannot be delineated with certainty because divergences are not high enough to suggest the presence of two genetic species, but also not low enough to rule out the possibility of a single species.

In accordance with the precautionary principle, the *Karaops* sample from Bungaroo should be treated as a putative genetic species with an unknown distribution range. *Karaops* sp. 'Bungaroo' is a potential SRE based on research and expertise because many described species have small ranges (Crews and Harvey 2011, Crews 2013). The selenopid spider *Karaops* sp. 'Bungaroo', also collected from Gorge habitat, should also be more widespread in the Bungaroo Creek valley; most likely in Gorges and associated Breakaway habitats. This species may also be conspecific with *Karaops* sp. 'Middle Robe 1', pending detailed taxonomic and molecular analyses, which would result in a linear range of at least 40 km. Additional juvenile specimens of *Karaops* have also been collected at Bungaroo South (Phoenix Environmental Sciences 2012) and previously at Bungaroo (Biota Environmental Sciences 2010) which demonstrates wider occurrence of the genus *Karaops* in the area.

4.2.4.6 Non-marine Snails

Eighty-one snail specimens representing at least six species in five families were collected: Camaenidae (one species), Lymnaeidae (one), Planorbidae (one), Pupillidae (two) and Subulinidae (one) (Table D.11, Appendix D**Error! Reference source not found.** and Figure G.4, Appendix G). The pupillid snails were by far the most abundant with a total of 46 specimens collected.

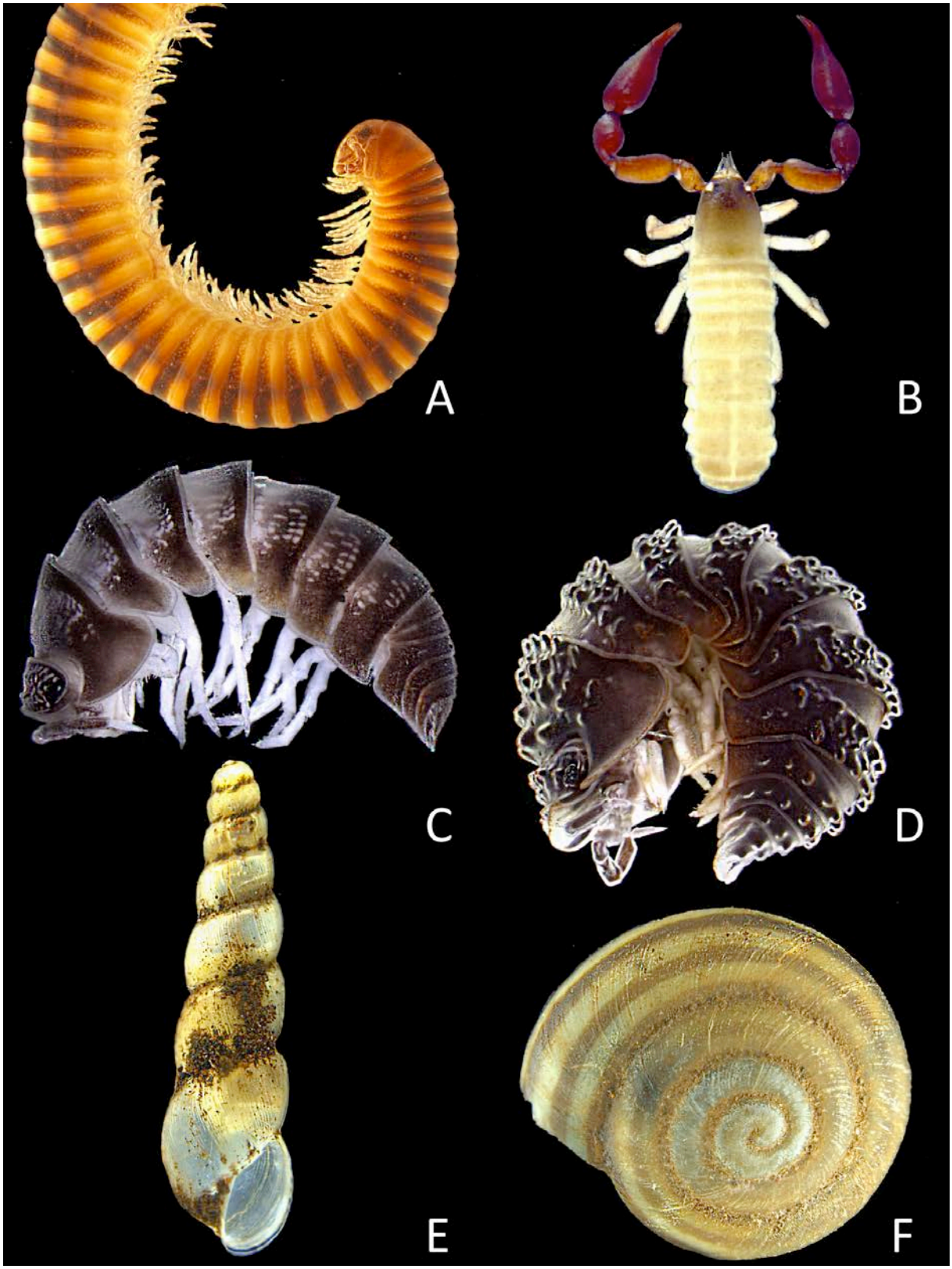


Plate 5: Examples of species in SRE groups collected within the survey area. A = the millipede A*ustrostrophus stictopygus*; B = pseudoscorpion *Oratemnus* sp. 'Bungaroo'; slaters C = Buddelundiinae sp. indet. and D = *Barrowdillo* '2'; and terrestrial snails E = *Eremopeas interioris* and F = *Rhagada* sp. 'Pannawonica'.

Table 15: Summary of the potential SRE species within the survey area.

Species	No. of specimens	Site(s)	Landform	Linear range	Suspected range in survey area (based on habitat)	Habitat surrogates
Pseudoscorpiones						
Ideoblothrus sp. 'Bungaroo'	2	MJ42	Major Drainage Line	Unknown	21 km	Available
Tyrannochthonius sp. 'Bungaroo 2'	1	SRE20	Gorge	Unknown	7 km	Available
Euryolpium sp. 'Bungaroo'	1	SRE5b	Gorge	Unknown	4 km	Available
Scorpiones						
Lychas 'hairy-tail'-group	2	SRE14, SRE3b	Gorge, Breakaway	Unknown	1 km	Available
Spiders						
Karaops sp. 'Bungaroo'	1	SRE7b	Gorge	Unknown	5 km	Available
Isopoda						
Buddelundia '61'	16	BTG7, MJ32, SRE13, SRE14, SRE3b, SRE5b, SRE7b, SRE8b	Breakaways, Gorge, Major Drainage Line	3.5 km	21 km	Available
Buddelundiinae sp. indet.	3	BTG8, JO10, SRE9b	Drainage Line	14 km	21 km	Available
Spherillo sp. indet.	5	MJ42, SRE9b	Major Drainage Line	500 m	21 km	Available

5 Discussion

5.1 Vertebrate Fauna

5.1.1 Habitats

Habitats within the Bungaroo survey area are not restricted at the local, sub-regional or regional scale and no restricted or uncommon geological units or land systems occur within the survey area. The Gorge and Breakaway habitats in the survey area are considered significant for fauna. Deeply incised gorges are characteristic of the Hamersley subregion, generally have high levels of species endemism and diversity, and are considered important as refugia in a local context (Kendrick 2001). This is due to the significant microhabitats they provide such as caves and water pools, which were recorded during the current survey. Gorge and Breakaway habitats are considered suitable for several MNES species including the Pilbara Olive Python, Northern Quoll and Pilbara Leaf-nosed Bat (for foraging) that were all recorded during this survey. A permanent spring (where Northern Quolls and potential SRE species were recorded) was also identified within the Gorge habitat. Although Gorge and Breakaway habitats were considered suitable foraging habitat for Pilbara Leaf-nosed Bats, the survey area has limited potential as roosting habitat with few caves recorded. In a regional context, the Gorge and Breakaway habitats in the Pilbara are restricted to the Chichester and Hamersley Ranges but they are well represented in these areas.

The gullies and valleys of the Rocky Hills habitat type also contain caves and rock crevices and are likely to be utilised by a range of species, including those of conservation significance. This habitat type had a distinct herpetofauna assemblage due to the presence of a number of rocky habitat specialists, including *Varanus acanthurus, Ctenophorus caudicinctus, Ctenotus rubicundus* and *A. ganei* being recorded within this habitat only. However, Rocky Hills habitat is widespread and common throughout the Pilbara bioregion and is not restricted to the Chichester and Hamersley Ranges.

The Drainage Line habitats within the survey area are mainly the broad valley of Bungaroo Creek or minor ephemeral drainage lines that are not likely to provide significant refugia for species. The Minor Drainage Line habitat that is in close association with the Rocky Hills habitat (and particularly those that had semi-permanent pools) is likely to provide refugia for species, including MNES species. Drainage Line habitats, although not necessarily large in terms of area, are common habitats within the Pilbara region and immediate surrounds, e.g. the Robe River, which contains permanent and semi-permanent water unlike Bungaroo Creek is located just to the north of the survey area.

The Low Hills/Slopes and Plains in the survey area provide fewer microhabitat opportunities for terrestrial fauna and are also more widespread in the immediate vicinity as well as the Hamersley subregion and wider Pilbara bioregion.

5.1.2 Species

5.1.2.1 General Assemblage

One hundred and fifty-one vertebrate fauna species, comprising three amphibians, 50 reptiles, 70 birds and 28 mammals (including four introduced) were recorded within the survey area during the current surveys. This compares to 148 and 147 species recorded from the wider Bungaroo area by Biota Environmental Sciences (2007, 2010), respectively. The fauna species assemblage recorded during the current survey is considered typical of the Hamersley Range subregion extending from near Pannawonica to Mt Brockman as well as a subset of typical fauna assemblages across the Pilbara bioregion.

Fewer species of reptile and amphibian (53 species) were recorded than were expected. By comparison, 82 species of amphibians and reptiles combined have been recorded in the wider Robe Valley (Biota Environmental Sciences 2007). The lower number of amphibian/reptile species recorded during the current survey are likely to be due to cooler conditions experienced during Phase 1 of the current surveys compared with temperatures during the Biota Environmental Sciences (2007) survey, which ranged between 39.2°C and 42.9°C. At least 88 bird species have been recorded in the Robe Valley (Biota Environmental Sciences 2007), and the lower number of birds recorded during the current surveys (70 birds) is likely due to an absence of any large pools of water along the Bungaroo Creek, meaning that a number of waterbirds recorded elsewhere (i.e. along the Robe River) were not recorded within the survey area. The current surveys (Phase 1 and 2) recorded a higher number of mammal species (28 species) compared to 16 recorded by Biota Environmental Sciences (2007). This was mainly due to the number of bat species recorded because of methods used; 10 species were recorded in the current survey using acoustic recordings, whereas only two bat species were recorded by Biota Environmental Sciences (2007) using harp nets. Even so, species such as *Sminthopsis* spp., *Notomys alexis* and *Leggadina lakedownensis* that are generally typical of Pilbara assemblages were absent. This is likely due to the habitats present, as these species generally occur in more sandy or clay habitats, which were rare within the survey area.

5.1.2.2 Conservation Significant Species

Of the 31 conservation significant species identified in the literature review, eight species have been previously recorded or were recorded during the current surveys. An additional single species was considered to have a 'high' likelihood of occurrence (Long-tailed Dunnart), three species to have a 'moderate' likelihood and 18 species to have a 'low' likelihood. The large number of 'low' likelihood species is a reflection of the absence of permanent and semi-permanent pools of water along Bungaroo Creek at the time of the survey.

Target MNES Species

The Gorge and Breakaway habitats within the survey area were considered suitable for the target MNES species: Pilbara Olive Python, Pilbara Leaf-nosed Bat and Northern Quoll. The current survey included a targeted search for these species. The majority of the survey area was mapped as low habitat suitability for the target MNES species, 63.5%, 63.5% and 55.1% of the survey area for the Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python, respectively. Low potential habitat for all three species generally comprised Loamy/Stony Plain, Non-cracking Clay Plain and Low Hills/Slopes habitats. These habitats contained no significant refugia or shelter, or semi-permanent or permanent water.

A possible indication of the presence of the Pilbara Olive Python was found during the survey. A possible Pilbara Olive Python scat was recorded from Breakaway habitat in close association with Minor Drainage Line habitat and an anecdotal record has been reported from a drainage line to the north of the survey area. It is considered likely that this species is still present within the highly suitable Gorge and Breakway habitats, particularly those in close association with permanent and semi-permanent pools within the survey area. The Rocky Hills and Minor Drainage Line habitats (particularly those that contain permanent or semi-permanent pools) are considered suitable foraging and dispersal habitat for the Pilbara Olive Python. The assessment of suitability of habitats was based on species records, and the presence of semi-permanent or permanent water pools adjacent to rocky habitats, which has been defined as their preferred habitat (Pearson 1993). These habitats predominantly occur on the northern and southern boundaries of the eastern portion of the survey area. All other habitats were considered to provide limited foraging and dispersal habitat for the Pilbara Olive Python.

The Northern Quoll was one of the more commonly recorded mammals within the survey area. Two individuals were captured at BTG6 within Rocky Hills habitat and they were recorded on numerous occasions from nine camera sites within Low Hills/Slopes, Minor Drainage Line, Gorge and Rocky Hills habitat. The Gorge and Breakaway habitats are considered potential shelter and foraging habitat for the Northern Quoll. Minor Drainage Line habitats that are in close association with the Rocky Hills habitat are considered suitable foraging and dispersal habitats for the Northern Quoll. Similar to the Pilbara Olive Python, these habitats predominantly occur on the northern and southern boundaries of the eastern portion of the survey area. Northern Quolls were not recorded from the Major Drainage Line habitat, and although Riverine areas are considered critical habitat for this species (Department of Sustainability Environment Water Population and Communities 2011), this habitat within the survey area does not appear to support the structurally diverse woodlands that are required for this species. The survey area appears to support a small resident population of Northern Quolls of at least five individuals based on the location and timing of observations from motion-sensitive cameras.

Pilbara Leaf-nosed Bat calls were recorded infrequently from a variety of habitats throughout the survey area, including Loamy/Stony Plains of the Bungaroo Creek valley, Gorge and Breakaway habitats. The Gorge habitat within the survey area was considered to be potential shelter and foraging habitat for Pilbara Leaf-nosed Bats; however, the survey area appears to provide limited roosting habitat as few caves were recorded. The timing of calls from acoustic recordings suggests that the Pilbara Leaf-nosed Bats within the survey area originate from a roost outside the survey area. The occurrence of Pilbara Leaf-nosed Bats within the survey area is likely to be influenced by the presence of water pools (typically persisting within deeply incised, shaded gorges) and major drainage lines with dense vegetation (Specialised Zoological 2010). Therefore Major Drainage Line and Breakaway habitats, and Minor Drainage Line habitat closely associated with the Rocky Hills habitat are considered to be suitable habitat for foraging, drinking and commuting purposes.

Other Conservation Significant Species

Other conservation significant species recorded from within the survey area include the Ghost Bat, Western Pebble-mound Mouse, Rainbow Bee-eater, Lined Soil-crevice Skink, and the blind snake *A. ganei*.

The Ghost Bat (S3) was recorded at 12 localities within the survey area: four acoustic recording sites and eight scat/feeding evidence (two shallow caves/overhangs and six caves). The low activity recorded from acoustic recordings and the presence of small scat piles indicates the caves are likely to be transient roosts and/or feeding sites are used by small numbers of Ghost Bats. Larger caves suitable for maternity roosts appeared to be absent from the survey area. The preferred foraging habitat of Ghost Bats for the survey area is likely to be the Major and Minor Drainage Lines of the Bungaroo Creek valley and the rocky Gorge and Breakaway habitats that support semi-permanent pools.

Twenty-seven inactive mounds from the Western Pebble-mound Mouse (P4) and two individuals were recorded during the current survey. Generally this species prefer gentle rocky slopes, hills and spurs; however, individuals were captured within Loamy/Stony Plain and Major Drainage Line habitats. These habitats, along the Low Hills/Slopes and Rocky Hills habitats of the survey area are likely to support this species. These habitats suitable for the Western Pebble-mound Mouse are also widespread and common adjacent to the survey area.

The Rainbow Bee-eater (S5; Mi) was recorded on numerous occasions throughout the survey area in a variety of habitats including Loamy/Stony Plains, Major and Minor Drainage Lines and Breakaways. This species is highly mobile and generally less reliant on specific habitats.

The Lined Soil-crevice Skink (P4) was recorded during the current survey, previously in reasonable numbers (Biota Environmental Sciences 2007) and is known to occur throughout the wider Robe Valley area. The species was recorded from Drainage Line and Rocky Hills/Breakaway habitats within the survey area. Suitable habitats also exist adjacent to the survey area and are common within the wider region.

Two records of the blind snake *A. ganei* (P1) are now known from the survey area (one record from this survey and one from the Department of Parks and Wildlife (2015a) database). This species is commonly associated with gorges and gullies and was recorded during the current survey from Rock Hills/Breakaway habitat. Records of this species suggest that it does not have a restricted distribution and is likely to be found throughout the survey area as well as suitable habitat adjacent to the survey area.

5.2 SRE Invertebrates

5.2.1 Habitats

Prospective SRE habitats within the survey area are not restricted at the local, sub-regional or regional scale. Gorge habitats are islands of high moisture retention in the rather arid landscape and may act as refugia for moisture-dependent SRE fauna, with some potential for dispersal-restriction in species potentially present. Some areas were heavily impacted from grazing and weed infestation (Buffel Grass), and other areas had been impacted by recent fires.

Three habitats were found to be prospective for SRE fauna: Gorge habitat, Minor Drainage Line habitat, and the soak and drainage areas of the Major Drainage Line habitat. Minor Drainage Line and Gorge habitats often occur in close association and provide the most suitable habitat for SRE fauna. Together, these three habitat types contributed the majority of the potential SRE species collected in this survey. Breakaway and Low Hills/Slopes habitats were of lower importance to SRE fauna, though still somewhat prospective. Rocky Hills and Plains habitats were not considered prospective for SRE fauna.

The three most prospective habitat types for SRE fauna together comprised 1,442 ha (14.7%) of the survey area whereas the least prospective habitats, Plains and Rocky Hills, together comprised 6,732 ha (68.7%) of the area. This means that there is limited prospective SRE habitat in the survey area. Most habitats are also well connected along the Bungaroo Creek valley area and there are very few habitat isolates that could reduce the dispersal of fauna. Sheltered habitats and microhabitats appear to be restricted to Gorge habitat and to a lesser degree drainage lines and these are most prospective for SRE fauna, although the survey data indicated that these are not particularly abundant with potential SRE fauna either. Overall, the habitat assessment indicates that potential SRE species in the survey area should be more widespread due to the wider occurrence of the habitats they occupy within the Hamersley subregion and wider Pilbara bioregion. There are no habitats unique to the survey area and the habitat forms that contain SRE species; Gorge and Minor Drainage Line habitats as well as the soak area associated with Major Drainage Line habitat, are more widespread both within and outside the survey area.

5.2.2 Species

A total of 226 specimens belonging to at least 30 invertebrate morphospecies were collected from the survey area, with eight potential SRE species identified. Slaters were the most diverse group with nine species and 101 specimens collected, followed by non-marine snails (six species; 81 specimens) and pseudoscorpions (10 species; 29 specimens). This is lower than the 19 potential SRE species collected during previous assessments at Bungaroo South (19 species) (Phoenix Environmental

Sciences 2014) and the 10 potential SRE species collected in the Bungaroo area (Biota Environmental Sciences 2010). This may reflect increased sampling effort, differences in survey design, but could also indicate increased knowledge on the species or difference in timing (the Biota surveys were carried out in August and March respectively).

None of the species recorded within the survey area are listed as Threatened or Priority species under State and Federal legislation. Based on the survey results, the vast majority of the species were not considered to be, or are unlikely to be, SREs. No confirmed SRE species were collected but eight species were considered potential SRE species:

- slaters: *Spherillo* sp. indet., *Buddelundia* '61' and Buddelundiinae sp. indet.
- pseudoscorpions: *Euryolpium* sp. 'Bungaroo', *Ideoblothrus* sp. 'Bungaroo' and *Tyrannochthonius* sp. 'Bungaroo 2'.
- scorpions: *Lychas* 'hairy tail'-group
- spiders: *Karaops* sp. 'Bungaroo'.

Three of the potential SRE species (*Euryolpium* sp. 'Bungaroo', *Karaops* sp. 'Bungaroo' and *Lychas* hairy tail'-group) identified during the current surveys have the possibility to be conspecific with those reported from Bungaroo South (Phoenix Environmental Sciences 2012, 2014), the wider Bungaroo area (Biota Environmental Sciences 2010) and Middle Robe (Astron Environmental Services 2015) but their alignment requires a comprehensive genetic approach that is beyond the scope of the present study.

The slater *Buddelundia* '61 was collected from at least two habitat types and is clearly not a habitat specialist. It is likely to be more widespread but remains poorly documented and under sampled. Two other slater species, *Spherillo* sp. indet. and Buddelundiinae sp. indet., have been collected both within and outside the survey area and are potential SREs with deficient data, meaning that their SRE status cannot be confirmed as there is no taxonomic framework and a lack of contextual geographic information. These two species were collected from a soak in Major Drainage Line habitat and their distribution likely follows the drainages that are well connected and not restricted at the local, sub-regional or regional scale.

The two pseudoscorpion species *Ideoblothrus* sp. 'Bungaroo' and *Tyrannochthonius* sp. 'Bungaroo 2' are deemed SRE species based on quantitative research and expert opinion. They belong to groups that are moderately well studied taxonomically, and have a high proportion of SRE species. The species *Ideoblothrus* sp. 'Bungaroo' was sampled from leaf litter in Major Drainage Line habitat and is likely more widespread but remains undetected elsewhere. Most species of *Ideoblothrus* in the western Pilbara and Kimberley regions of Western Australia have been described from subterranean habitat and are thought to have very tight ranges (Harvey and Edward 2007). However, the new species *Ideoblothrus* sp. 'Bungaroo' is morphologically a surface species and was sampled from leaf litter in a habitat type that is ubiquitous. The second species, *Tyrannochthonius* sp. 'Bungaroo 2' is known from Gorge habitat and may have a relatively small linear range (at least 6 km following the gorge) but it should also be noted that it is known from a single specimen only and obviously under sampled. It is also noted that the only other species of *Tyrannochthonius* from surface habitats in the Pilbara, *T. aridus*, is very widespread and known from Barrow Island, Pannawonica and Weeli Wolli Creek (Edward and Harvey 2008).

The scorpion species in the *Lychas* 'hairy tail'-group is classified as a potential SRE with deficient data because there is no taxonomic framework and it is impossible to estimate the total range. SRE status cannot be determined and the classification as a potential SRE is according to the precautionary

principle. It is noted though that morphologically very similar specimens are known from elsewhere in the Pilbara, such as the Robe Valley (ecologia Environment 2013) and it is likely that that the species in the survey area is more widely distributed in the Pilbara. The pseudoscorpion *Euryolpium* sp. 'Bungaroo' is also a potential SRE with deficient data and belongs to a poorly studied group without a taxonomic framework. Most environmental assessment have considered species of this genus to be widespread and the classification of *Euryolpium* sp. 'Bungaroo' as a potential SRE is precautionary and based on recent surveys that suggest range restriction in at least some *Euryolpium* species.

The selenopid spider *Karaops* sp. 'Bungaroo' is deemed a potential species based on quantitative research and expert opinion. It belongs to a group that is moderately well studied taxonomically, and has a high proportion of SRE species. The species is known from Gorge habitat and known from a singleton only, so is under sampled. It may be conspecific with *Karaops* sp. 'Middle Robe 1' from the Robe Valley, pending detailed taxonomic and multi-locus genetic analyses, which would result in a linear range of at least 40 km. Additional juvenile specimens of *Karaops* have also been collected at Bungaroo South (Phoenix Environmental Sciences 2012) and previously at Bungaroo (Biota Environmental Sciences 2010) which demonstrates wider occurrence of the genus *Karaops* in the area.

Overall, the survey data indicated a moderately diverse fauna of SRE group species within the survey area but species richness was not overly high. Most of the potential SRE species, with the exception of the four species from Gorge habitat (two pseudoscorpions, a scorpion and a spider species), have been collected from habitats that are widespread and well connected in the survey area, especially those from Major Drainage Line habitats, Rocky Slope habitats and Breakaway habitats. Most other species in SRE groups are also widespread in the survey area, including several slater species that may have a similar biology to the potential SRE slater species recorded here. Only one habitat type, Gorges with associated minor drainage lines, may contain more tightly restricted species but this habitat type covers only 0.8% of the survey area.

6 References

Armstrong, K 2001, 'The roost habitat and distribution of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia', *Wildlife research*, vol. 28, pp. 95-104.

Armstrong, KN & Anstee, SD 2000, 'The ghost bat in the Pilbara: 100 years on', *Australian Mammalogy*, vol. 22, pp. 93-101.

Astron Environmental Services 2015, *Middle Robe and East Deepdale Level 2 Fauna Assessment, Phase 1*, unpublished report to Rio Tinto.

Atlas of Living Australia 2015, *The Atlas of Living Australia*, 2015, <http://www.ala.org.au/>.

Australian Government 2008, *Register of the National Estate - Spatial Database (RNESDB)*, viewed 14 November 2014, <http://www.environment.gov.au/metadataexplorer/explorer.jsp>.

Baehr, BC & Harvey, MS 2013, 'The goblin spider genus *Opopaea* in Australia and the Pacific islands (Araneae: Oonopidae)', *Memoirs of the Queensland Museum | Nature*, vol. 58, pp. 107-338.

Bat Call WA 2015, *Bungaroo Creek survey, Pilbara WA, May 2015 Echolocation Survey of Bat Activity, Draft A*, unpublished report to Astron Environmental Services, issued 6 June 2015.

Beard, JS 1975, *Vegetation survey of Western Australia, Pilbara. 1:1 000 000 Vegetation Series Explanatory Notes to Sheet 5*, University of Western Australia Press, Nedlands, Western Australia.

Biologic Environmental Survey 2012, *Christmas Creek SRE Invertertebrate Survey Report: Fortescue Marsh Samphire Report*, Prepared for Fortescue Metals Group, North Perth.

Biologic Environmental Survey 2014, *Orebody 31 Targeted Survey and Environmental Impact Assessment of Short-Range Endemic Fauna*, unpublished report prepared for BHP Billiton Iron Ore Pty Ltd.

Biota Environmental Sciences 2006, *Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo*, unpublished report to Robe River Iron Associates.

Biota Environmental Sciences 2007, *Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonica: Fauna Assemblage Seasonal Survey*, unpublished report to Pilbara Iron Company.

Biota Environmental Sciences 2009, *Mesa G Baseline Fauna Survey*, unpublished report to Rio Tinto Iron Ore.

Biota Environmental Sciences 2010, *Greater Bungaroo Seasonal Fauna Survey*, unpublished report to Rio Tinto.

Birdlife Australia 2015, *Birdata*, 2015, <http://www.birdata.com.au/homecontent.do>.

Burbidge, AA, McKenzie, NL & Fuller, PJ 2008, 'Long-tailed Dunnart, *Sminthopsis longicaudata* (Spencer, 1909)', in S Van Dyck and R Strahan (eds), *The Mammals of Australia 3rd Edition*, New Reed Holland, Sydney, pp. 148-50.

Burbidge, AH, Johnstone, RE & Pearson, DJ 2010, 'Birds in a vast arid upland: avian biogeographical patterns in the Pilbara region of Western Australia', *Records of the Western Australian Museum, Supplement 78*, pp. 247-70.

Bureau of Meteorology 2015, *Climate Data Online*, <http://www.bom.gov.au/climate/data/index.shtml>.

Bush, B & Maryan, B 2011, *Field Guide to Snakes of the Pilbara*, Western Australian Museum, Welshpool.

Car, CA & Harvey, MS 2013, 'A review of the Western Australian keeled millipede genus *Boreohesperus* (Diplopoda, Polydesmida, Paradoxosomatidae)', *ZooKeys*, vol. 290, pp. 1-19.

Castalanelli, MA, Teale, RJ, Rix, MG, Kennington, WJ & Harvey, MS 2013, 'Barcoding of mygalomorph spiders (Araneae : Mygalomorphae) in the Pilbara bioregion of Western Australia reveals a highly diverse biota', *Invertebrate Systematics*, vol. 28, pp. 375-85.

Churchill, S 1991, 'Distribution, abundance and roost selection of the Orange Horseshoe-bat, *Rhinonycteris aurantius*, a tropical cave dweller', *Wildlife research*, vol. 18, pp. 343-53.

Churchill, S 2008, *Australian Bats*, 2 edn., Allen and Unwin, Crows Nest, New South Whales.

Clarke, KR, Somerfield, PJ & Gorley, RN 2008, 'Testing of null hypotheses in exploratory community analyses: similarity profiles and biota-environment linkage', *Journal of Experimental Marine Biology and Ecology*, vol. 366, no. 1–2, pp. 56-69.

Colwell, RK & Coddington, JA 1994, 'Estimating terrestrial biodiversity through extrapolation', *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, vol. 345, no. 1311, pp. 101-18.

Crews, S & Harvey, MS 2011, 'The spider family Selenopidae (Arachnida, Araneae) in Australia and Asia', *ZooKeys*, vol. 99, pp. 1-103.

Crews, SC 2013, 'Thirteen new species of the spider genus *Karaops* (Araneae: Selenopidae) from Western Australia', *Zootaxa*, vol. 3647, pp. 443-69.

Debano, S 2006, 'Effects of livestock grazing on aboveground insect communities in semi-arid grasslands of southeastern Arizona', *Biodiversity and Conservation*, vol. 15, pp. 2547-64.

Department of Conservation and Land Management 2002, *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia*, Department of Conservation and Land Management, Western Australia.

Department of Parks and Wildlife 2015a, *Threatened and Priority Fauna database*, Kensington.

Department of Parks and Wildlife 2015b, *NatureMap database search*, 2015, <http://naturemap.dpaw.wa.gov.au/>.

Department of Parks and Wildlife 2015c, *Threatened and Priority Ecological Communities database*, Parks and Wildlife, Kensington.

Department of Sustainability Environment Water Population and Communities 2011, *Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the endangered northern quoll, Dasyurus hallucatus*, EPBC Act Policy Statement 3.25, Commonwealth of Australia, Canberra.

Department of the Environment 2013, *Dasyurus hallucatus- Northern Quoll, in Species Profile and Threats Database*, Canberra, viewed 17 November 2014, <http://www.environment.gov.au/sprat>.

Department of the Environment 2015a, *Interim Biogeographic Regionalisation for Australia (IBRA), Version 7*, Department of the Environment, viewed 2015, <http://www.environment.gov.au/land/nrs/science/ibra>.

Department of the Environment 2015b, *National Reserve System*, <http://www.environment.gov.au/topics/land/national-reserve-system>.

Department of the Environment 2015c, *Protected Matters Search Tool*, 2015, <www.environment.gov.au/epbc/pmst/index.html>.

Department of Water 2008, *Public Drinking Water Source Areas of Western Australia: A register of drinking water catchments within each local government*, Department of Water, Water Source Management Division, Perth.

Duncan, A, Baker, GB & Montgomery, N 1999, *The Action Plan for Australian Bats*, Environment Australia, Canberra.

ecologia Environment 2013, *Middle Robe and East Deepdale Flora, Vegetation, Vertebrate and Invertebrate Fauna Survey*, unpublished report to Rio Tinto.

Edward, KL & Harvey, MS 2008, 'Short-range endemism in hypogean environments: the pseudoscorpion genera *Tyrannochthonius* and *Lagynochthonius* (Pseudoscorpiones: Chthoniidae) in the semiarid zone of Western Australia', *Invertebrate Systematics*, vol. 22, pp. 259-93.

Environmental Protection Authority 2002, *Terrestrial Biological Surveys as an Element of Biodiversity Protection, Position Statement 3*, Environmental Protection Authority, Perth.

Environmental Protection Authority 2004, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, Guidance Statement 56*, Environmental Protection Authority, Perth.

Environmental Protection Authority 2009, *Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact in Western Australia, Guidance Statement 20*, Perth.

Environmental Protection Authority & Department of Environment and Conservation 2010, *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*, ed. B.M. Hyder, J. Dell and M.A. Cowan, Perth, Western Australia.

Government of Western Australia 2014, *2014 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)*, Parks and Wildlife, Perth.

Harms, D & Framenau, VW 2013, 'New species of Mouse Spiders (Araneae: Mygalomorphae: Actinopodidae: Missulena) from the Pilbara region, Western Australia', *Zootaxa*, vol. 3637, pp. 521-40.

Harrison, SE, Guzik, MT, Harvey, MS & Austin, AD 2014, 'Molecular phylogenetic analysis of Western Australian troglobitic chthoniid pseudoscorpions (Pseudoscorpiones : Chthoniidae) points to multiple independent subterranean clades', *Invertebrate Systematics*, vol. 28, pp. 386-400.

Harvey, FSB, Framenau, VW, Wojcieszek, JM, Rix, MG & Harvey, MS 2012, 'Molecular and morphological characterisation of new species in the trapdoor spider genus *Aname* (Araneae: Mygalomorphae: Nemesiidae) from the Pilbara bioregion of Western Australia', *Zootaxa*, vol. 3383, pp. 15-38.

Harvey, MS 2002, 'Short-range endemism amongst the Australian fauna: some examples from non-marine environments', *Invertebrate Systematics*, vol. 16, pp. 555-70.

Harvey, MS 2010, 'Two new species of *Synsphyronus* (Pseudoscorpiones: Garypidae) from southern Western Australian granite landforms', *Records of the Western Australian Museum*, vol. 26, pp. 11-22.

Harvey, MS & Edward, KL 2007, 'A review of the pseudoscorpion genus *Ideoblothrus* (Pseudoscorpiones, Syarinidae) from western and northern Australia', *Journal of Natural History*, vol. 41, pp. 445-72.

Harvey, MS & Leng, MC 2008, 'Further observations on *Ideoblothrus* (Pseudoscorpiones: Syarinidae) from subterranean environments in Australia', *Records of the Western Australian Museum*, vol. 24, pp. 379-86.

Harvey, MS, Rix, MG, Framenau, VW, Hamilton, ZR, Johnson, MS, Teale, RJ, Humphreys, G & Humphreys, WF 2011, 'Protecting the innocent: studying short-range endemic taxa enhances conservation outcomes', *Invertebrate Systematics*, vol. 25, pp. 1-10.

Hebert, P, Ratnasingham, S & de Waard, J 2003, 'Barcoding animal life: Cyctochrome c oxidase subunit 1 divergences among closely related species', *Proceedings of the Royal Society London B*, vol. 270, no. Supplement 1, pp. 96-9.

Hill, B & Ward, S 2010, *National Recovery Plan for the Northern Quoll Dasyurus hallucatus*, Northern Territory, <http://www.environment.gov.au/biodiversity/threatened/publications/recovery/pubs/northern-quoll.pdf>.

Johnstone, RE & Storr, GM 1998, *Handbook of Western Australian Birds Volume 1 - Non-passerines (Emu to Dollarbird)*, Western Australian Museum, Perth.

Kendrick, P 2001, *Pilbara 3 (PIL3 - Hamersley subregion)*, (M. Cowan, chairman), *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002*, Department of Conservation and Land Management, Western Australia, Perth.

Landgate 2015, *WA Atlas*, <https://www2.landgate.wa.gov.au/bmvf/app/waatlas/>.

Langlands, P, Brennan, K, Framenau, V & Main, B 2011a, 'Predicting the post-fire responses of animal assemblages: testing a trait-based approach using spiders', *Journal of Animal Ecology*, vol. 80, pp. 558-68.

Langlands, P, Brennan, K & Ward, B 2011b, 'Is the reassembly of an arid spider assemblage following fire deterministic?', *Austral Ecology*, vol. 37`, pp. 429-39.

Lee, TRC, Ho, SYW, Wilson, GDF & Lo, N 2014, 'Phylogeography and diversity of the terrestrial isopod *Spherillo grossus* (Oniscidea: Armadillidae) on the Australian East Coast', *Zoological Journal of the Linnean Society*, vol. 170, pp. 297-309.

Lindsay, E & Cunningham, S 2009, 'Livestock grazing exclusion and microhabitat variation affect invertebrates and litter decomposition rates in woodland remnants', *Forest Ecology and Management*, vol. 258, pp. 178-87.

Miglio, LT, Harms, D, Framenau, VW & Harvey, MS 2014, 'Four new Mouse Spider species (Araneae, Mygalomorphae, Actinopodidae, *Missulena*) from Western Australia', *ZooKeys*, vol. 410, pp. 121-48.

Oakwood, M 2008, 'Northern Quoll', in S. Van Dyck and R. Strahan (eds), *The Mammals of Australia 3rd Edition*, Reed New Holland, Sydney.

Outback Ecology 2013, *Browns Range Project: Terrestrial Short-Range Endemic Invertebrate Fauna Baseline Survey*, final report to Northern Minerals Limited.

Pearson, D 1993, 'Distribution, status and conservation status of pythons in Western Australia', in D Lunney and D Ayers (eds), *Herpetology in Australia: A Diverse Discipline*, Royal Zoological Society of NSW, Sydney, pp. 383-95.

Phoenix Environmental Sciences 2012, *Terrestrial fauna surveys for the Buckland Project*, final report to Iron Ore Holdings Ltd, Balcatta, Western Australia.

Phoenix Environmental Sciences 2014, *Terresterial fauna surveys for the Balla Balla Railway Project*, final report to Preston Consulting on behalf of Rutila Resources Ltd., Balcatta, Western Australia.

Ponder, WF & Colgan, DJ 2002, 'What makes a narrow-range taxon? Insights from Australian freshwater snails', *Invertebrate Systematics*, vol. 16, pp. 571-82.

R Development Core Team 2015, 'R: A language and environment for statistical computing', R Foundation for Statistical Computing, Vienna.

Rio Tinto 2015a, 'Data Standard: Fauna Habitat, Version 1, RTIO-HSE-0177900'.

Rio Tinto 2015b, 'Data Standard: Fauna, Version 1, RTIO-PDE-0064550'.

Rio Tinto 2015c, 'Data Standard: Field Sites, Version 1, RTIO-HSE-0113107'.

Rio Tinto 2015d, 'Data Standard: Significant Areas, Version 1, RTIO-HSE-0064549'.

Rio Tinto 2015e, 'Data Standard: Tracklog, Version 1, RTIO-HSE-0251323'.

Shepherd, DP, Beeston, GR & Hopkins, AJM 2002, 'Native vegetation in Western Australia: Extent, type and status', *Resource Management Technical Report 249*, Department of Agriculture, Western Australia.

Specialised Zoological 2010, *A summary of occurrence of the Pilbara Leaf-nosed Bat at Eastern Ranges and surrounds literature review*, unpublished report to Rio Tinto.

Start, AN 2008, 'Western Pebble-mouse *Pseudomys chapmani* (Kitchener, 1980)', in S Van Dyck and R Strahan (eds), *The Mammals of Australia 3rd Edition*, New Reed Holland, Sydney, pp. 621-2.

Stewart, A, Sweet, I, Needham, R, Raymond, O, Whitaker, A, Liu, S, Phillips, D, Retter, A, Connolly, D & Stewart, G 2008, 'Surface Geology of Australia 1:1,000,000 Scale, Western Australia', Geoscience Australia, Canberra.

Storr, GM, Smith, LA and Johnstone, RE, 1999, *Lizards of Western Australia. I. Skinks*, 2 edn., Western Australian Museum, Perth.

Thompson, SA & Thompson, GG 2010, *Terrestrial Vertebrate Fauna Assessments for Ecological Impact Assessment*, Terrestrial Ecosystems, Mt Claremont.

Tille, P 2006, *Soil-landscapes of Western Australia's Rangelands and Arid Interior*, Department of Agriculture and Food, Perth.

Tutt, M, Fekete, S, Mitchell, P, Brace, P & Pearson, D 2004, 'Unravelling the mysteries of the Pilbara Olive Python ecology', *Threatened Species Network Community Grants Final Report – Project WA11/101*, Nickol Bay Naturalists' Club and CALM, Karratha.

Van Vreeswyk, A, Payne, A, Leighton, K & Hennig, P 2004, *An inventory and condition survey of the Pilbara region, Western Australia* Technical Bulletin No. 92, Department of Agriculture, Western Australia, Perth.

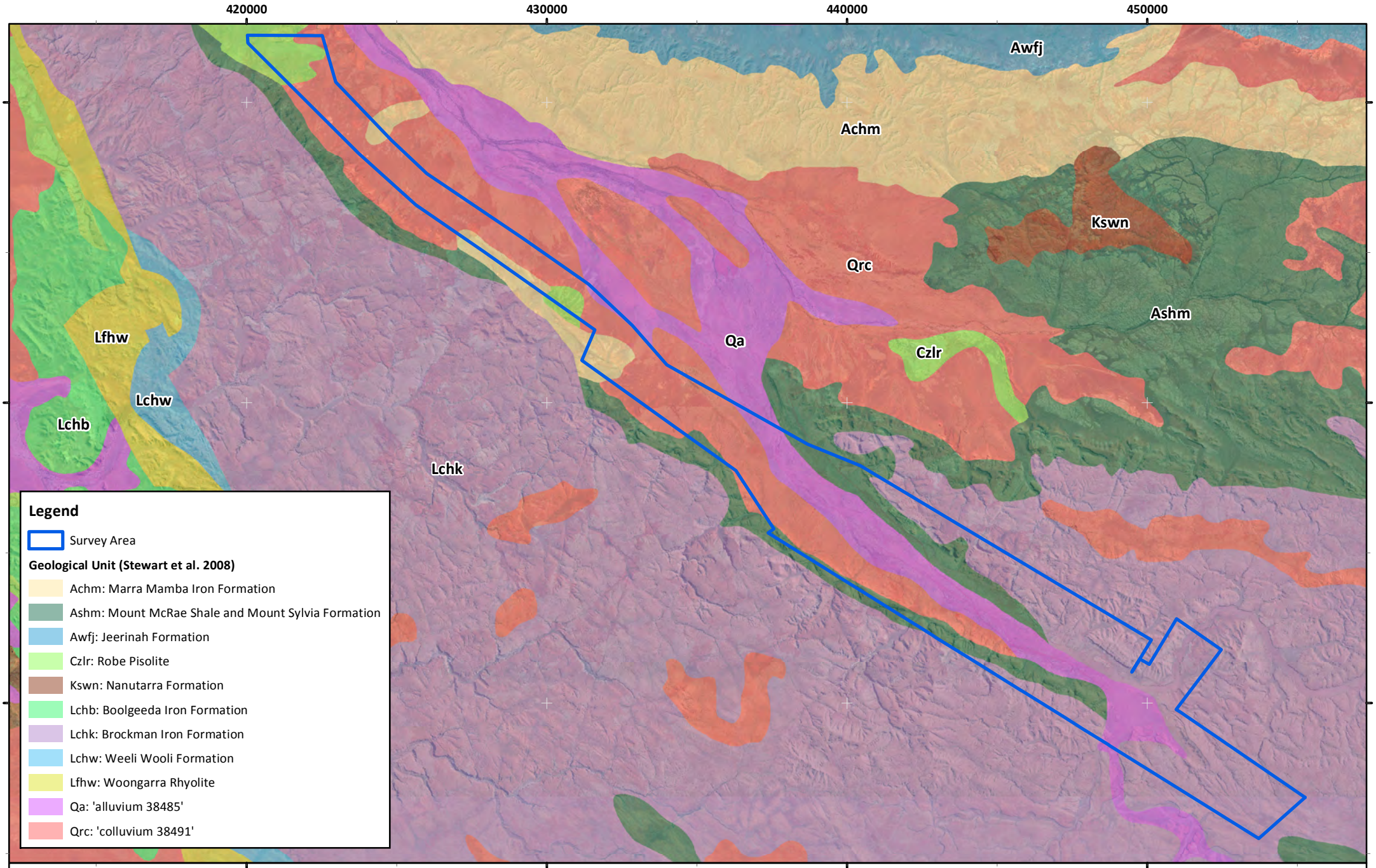
Western Australian Museum 2015a, *Western Australian Museum Taxonomic Service invertebrates database*, Welshpool.

Western Australian Museum 2015b, *Western Australian Museum Checklist of the Vertebrates of Western Australia*, updated April 2015, <http://museum.wa.gov.au/research/departments/terrestrial-zoology/checklist-terrestrialvertebrate-fauna-western-australia>.

Wilson, S & Swan, G 2010, *A Complete Guide to Reptiles of Australia*, New Holland Publishers, Sydney.

Appendix A: Background Information Figures

This page has been left blank intentionally.



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure A.1: Geological units of the Bungaroo survey area

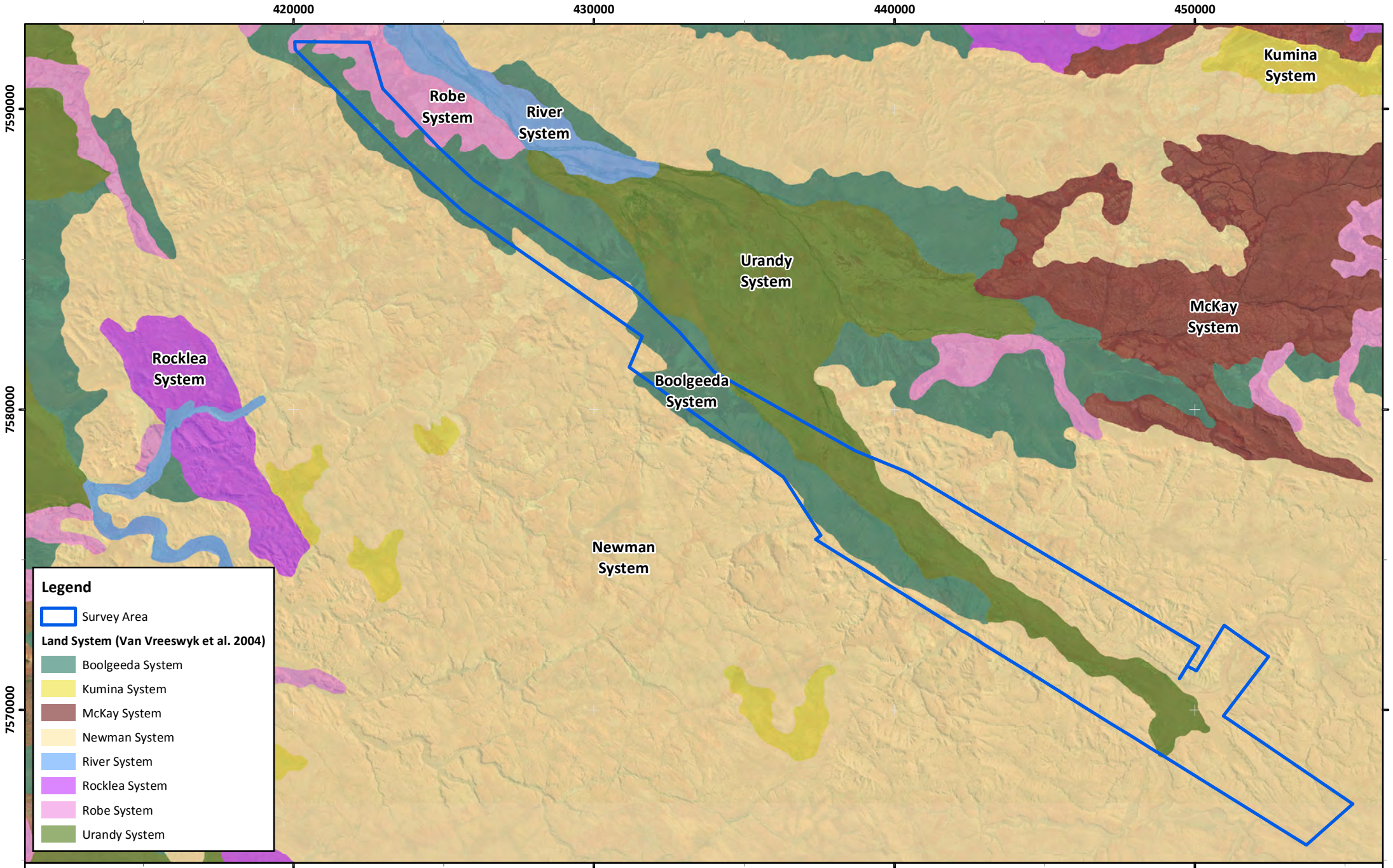
Datum: GDA 1994 - Projection: MGA Zone 50

0 5 10 Kilometres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigA1_Geology

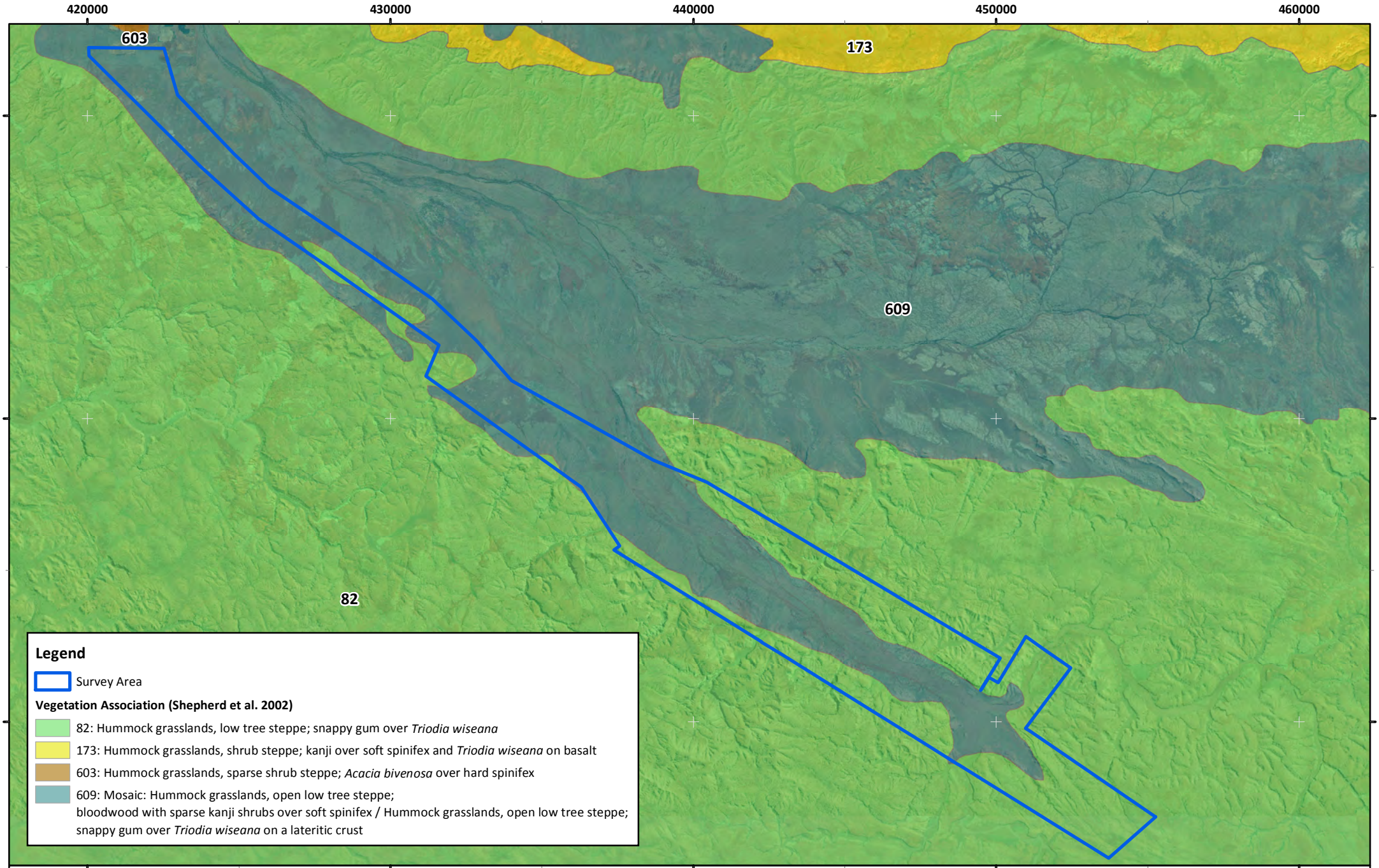


Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure A.2: Land Systems of the Bungaroo survey area

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigA2_LandSystems



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure A.3: Pre-European Vegetation of the Bungaroo survey area

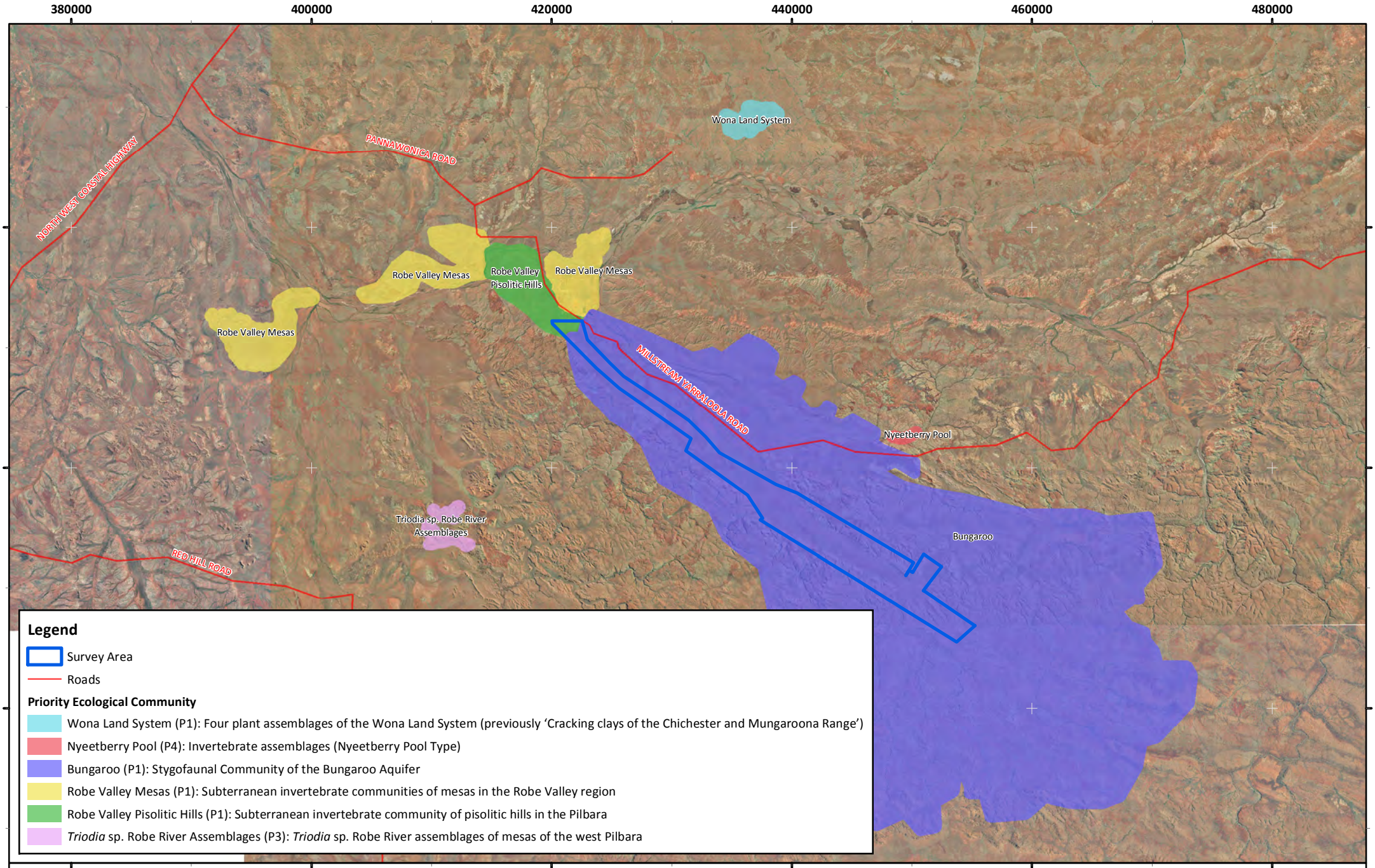
Datum: GDA 1994 - Projection: MGA Zone 50

0 5 10 Kilometres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigA3_PreEuro



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure A.4: Priority Ecological Communities of the Bungaroo Survey Area

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigA4_PECs

Appendix B: Conservation and Introduced Fauna Categories, Habitat Condition Scales and Likelihood Criteria

This page has been left blank intentionally.

Table B.1: Categories of Threatened Ecological Communities (Parks and Wildlife 2015a).

PD: Presumed Destroyed
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or** B) All occurrences recorded within the last 50 years have since been destroyed.
CR : Critically Endangered
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more of** the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

En: Endangered

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

VU: Vulnerable

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Table B.2: Definitions and criteria for Priority Ecological Communities (Parks and Wildlife 2015a).

Possible Threatened Ecological Communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

P1: Priority One – Poorly-known ecological communities
Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two – Poorly-known ecological communities
Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three – Poorly-known ecological communities
(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4: Priority Four
Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5: Priority Five – Conservation dependent ecological communities
Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table B.3: Definitions and criteria for Threatened Ecological Communities (DoE 2015d).

Three categories exist for listing Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). An ecological community may be categorised as:

Categories of ecological communities	
Critically endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Table B.4: Conservation codes for Western Australian fauna (Western Australian Government 2015).

Code	Conservation category	Definition
S1	Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that is rare or likely to become extinct, as critically endangered fauna.
S2	Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that is rare or likely to become extinct, as endangered fauna.
S3	Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that is rare or likely to become extinct, as vulnerable fauna.
S4	Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that is presumed to be extinct.
S5	Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Birds that are subject to international agreements relating to the protection of migratory birds.
S6	Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Fauna that are of special conservation need being species dependent on ongoing conservation intervention.
S7	Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice under the Wildlife Conservation Act 1950.	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned.

Table B.5: Priority species under Western Australian Wildlife Conservation Act 1950.

Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna. Taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These taxa require regular monitoring. Conservation Dependent species are placed in Priority 5.

P1: Priority One – Poorly known taxa
Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2: Priority Two – Poorly known taxa
Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3: Priority Three – Poorly known taxa
Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4: Priority Four: Rare, near threatened and other taxa in need of monitoring
(a) Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. (b) Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5: Priority Five: Conservation dependent taxa
Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

Table B.6: Categories and definitions for EPBC Act listed fauna species (DoE 2014c).

Conservation category	Definition
Extinct	Taxa with no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa known to survive only in cultivation, in captivity or as a naturalized population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriated seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (E)	Taxa are not critically endangered; and are facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (V)	Taxa are not critically endangered or endangered; and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent (CD)	Taxa are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or the following subparagraphs are satisfied: i) the taxa is a species of fish; ii) the taxa is the focus of a management plan that provides management actions necessary to stop the decline of, and support the recovery of, the taxa so that its chances of long term survival in nature are maximized; iii) the management plan is in force under a law of the Commonwealth or of a State or Territory; iv) Cessation of the management plan would adversely affect the conservation status of the taxa Fish includes all taxa of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals/reptiles.

Table B.7: Declared pests categories as gazetted under the *Biosecurity and Agriculture Management Act 2007* (Department of Agriculture and Food 2014).

The management of introduced flora species in Western Australia is now regulated through the Biosecurity and Agriculture Management Act 2007 (BAM Act). A list of declared pests, including 'pest' plants is provided under the BAM Act, which has been updated to incorporate a number of other Acts that are administered by DAFWA (2014). Declared pests can fall into two categories: one that relates to the prevention of introducing the species or eradicating it; and the other relates to managing the species and whether it can be kept (i.e. for scientific purposes, education or other purpose).

The threat and risk posed to site-specific biodiversity values, influences to rehabilitation success, primary production, infrastructure assets or human health will differ depending on the unique characteristics of each site and the associated land management practice or operation. Therefore site or project specific weed assessments and priorities should be reviewed for each project.

As per introduced flora species, the BAM Act seeks to establish a modern biosecurity regulatory scheme to prevent serious animal pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State. Declared animal pests fall into three categories as Gazetted under the BAM Act (DAFWA 2014).

Category	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table B.8: Fauna habitat condition scale (Thompson and Thompson 2010).

Habitat condition	Condition description
High Quality Fauna Habitat (1.0)	These areas closely approximate the vegetation mix and quality that would have been in the area prior to any human induced disturbance. The habitat has connectivity with other habitats and is likely to support the most natural vertebrate fauna assemblage.
Very Good Fauna Habitat (0.8)	These areas show minimal signs of human induced disturbance (e.g. grazing, clearing, fragmentation, weeds) and retain almost all of the characteristics of the habitat had it not been disturbed. The habitat has connectivity with other habitats, and fauna assemblages in these areas are likely to be minimally effected by disturbance.
Good Fauna Habitat (0.6)	These areas show signs of human induced disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat had it not been disturbed. The habitat still retains some connectivity with other habitats but fauna assemblages in these areas are likely to be affected by disturbance. Fauna assemblages in these areas are likely to be similar to what might be expected in this habitat.
Disturbed Fauna Habitat (0.4)	These areas show signs of human induced significant disturbance (e.g. mining, clearing, tracks and roads). Many of the trees, shrubs and undergrowth have died or have been cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, contain an abundance of weeds or have been damaged by vehicles or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.
Highly Degraded Fauna Habitat (<0.2)	These areas often have a significant human induced loss of vegetation, and / or a large number of vehicle tracks and / or have been completely cleared, and / or areas have been heavily grazed or farmed. There is limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to differ significantly from what existed prior to the disturbance, and are often depleted compared to what existed prior to the disturbance.

Table B.9: Criteria used to define likelihood occurrence of conservation significant fauna species.

Likelihood of occurrence	Pre-survey	Post-survey
Recorded	N/A	Species or evidence of species recorded during survey.
High	Species has been recorded within the survey area or within 20 km of the survey area and preferred habitat appears to be present.	Core or preferred habitats present in the survey area which are abundant and/or high quality condition. OR Species is known to be cryptic and may not have been detected despite adequate survey effort and suitable habitat present within the survey area. OR Species or evidence of species recorded within the survey area however doubt remains over the taxonomic identification, validity of record.
Moderate	Species has not been recorded from within the survey area, however species has been recorded within 20 km of the survey area and suitable habitat appears to be present.	Core or highly suitable habitats present in the survey area, however, non-cryptic species that was not detected despite adequate survey effort. OR Core or preferred habitats present in the survey area are mainly in poor or modified condition.
Low	Species recorded within 20 km of the survey area but suitable habitat does not appear to be present.	Species has not been recorded in the survey area despite adequate survey effort. OR Species dependent on specific habitats that do not occur in the survey area. OR Species considered locally extinct.

Table B.10: Criteria used to determine SRE status of invertebrates.

Status	Criteria
Confirmed	This species has a high probability of being an SRE based on expert opinion, reference databases or the scientific literature. Usually, this species belongs to a group that is well known taxonomically and contains a high proportion of SRE species. Example: Millipedes belonging to the genus *Boreohesperus* (Car and Harvey 2013).
Potential	This species has a moderate probability of being an SRE because it belongs to a group with a high proportion of SRE species, has specific biological and/or ecological attributes that may indicate range restriction, or has been collected from a single microhabitat type. Usually, this species will belong to a group with a poorly or moderately resolved taxonomy. Example: Many trapdoor spiders in the infraorder Mygalomorphae (Castalanelli *et al.* 2014). The WAM recognises the uncertainty involved with this category and lists five sub-categories that may help elucidating this status: i) data deficient because there is insufficient information; ii) habitat indicators that are associated with potential SRE status; iii) morphological indicators; iv) molecular evidence; and v) research and expert knowledge held within the WAM (WAMTS staff 2013). These sub-categories are implicitly addressed as part of the species assessments.

Table B.11: Suitability/significance of habitat ranking criteria for the three target Matters of National Environmental Significance (MNES) species.

Species	Potential shelter and foraging habitat (a)	Suitable foraging and dispersal habitat (b)	Limited foraging and dispersal habitat (c)
Pilbara Olive Python (*Liasis olivaceus barroni*)	Rocky habitat such as gorges, escarpments and Breakaways along with Drainage lines including or in close proximity to permanent or semi-permanent water holes.	Drainage lines with dense vegetation enabling transitory behaviours and/or providing foraging potential. Rocky habitats that are not in close proximity to water.	Habitat that has limited sheltering and foraging capacity with no permanent or semi-permanent water.
Northern Quoll *(Dasyurus hallucatus)*	Rocky habitats such as ranges, escarpments, mesas, ranges, gorges, Breakaways and boulder fields. Also major Drainage lines or tree-lined drainage systems that are structurally diverse and contain large diameter trees, termite mounds or hollow logs.	Habitat important for foraging, dispersal and buffering of the species including moderate to small sized Drainage lines and native vegetation in close proximity (within 2 km) denning or shelter habitat.	Habitat that has limited sheltering and foraging capacity and not connected to potential denning/shelter and foraging habitat.
Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*)	Rocky habitat that contains caves suitable as diurnal or maternity roosts sites, or potentially contains these caves and has not adequately surveyed; OR Areas highly suitable for foraging that are likely to be used on a regular basis.	Habitat important for foraging including diverse rocky terrain, moderately sized Drainage lines and dense complex vegetation stands.	Habitat that has limited ecological value but may provide capacity for transitory movement across the landscape and/or limited foraging potential.

This page has been left blank intentionally.

Appendix C: Fauna Sampling Locations

This page has been left blank intentionally.

418000 420000 422000 424000 426000 428000 430000 432000 434000

7594000 7592000 7590000 7588000 7586000 7584000 7582000

Jonnawurrada Creek

Bungaroo Creek

MILLSTREAM YARRALOOLA ROAD

BTG2

Map Extent

Legend

- Roads
- Watercourse
- Tracklogs
- Survey Area
- Previous Fauna Sampling Locations (Biota 2006, 2007, 2009, 2010)

Current sampling locations

- Acoustic recording
- Active foraging (SRE)
- Active foraging (Vertebrate)
- Avifauna census
- Camera (active)
- Habitat assessment
- Trapping grid/avifauna census

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure C.1A: Previous and Current Sampling Locations and Targeted Search Effort

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigC1A_SampLoc

This page has been left blank intentionally.

424000 426000 428000 430000 432000 434000 436000 438000 440000 442000

7586000 7584000 7582000 7580000 7578000 7576000

MILLSTREAM YARRALOOLA ROAD

Bungaroo Creek

BTG6

Map Extent

Legend

- Roads
- Watercourse
- Tracklogs
- Survey Area
- Previous Fauna Sampling Locations (Biota 2006, 2007, 2009, 2010)

Current sampling locations

- Acoustic recording
- Active foraging (SRE)
- Active foraging (Vertebrate)
- Avifauna census
- Camera (active)
- Habitat assessment
- Trapping grid/avifauna census

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure C.1B: Previous and Current Sampling Locations and Targeted Search Effort

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigC1B_SampLoc

This page has been left blank intentionally.

442000 444000 446000 448000 450000 452000 454000 456000

7574000 7572000 7570000 7568000 7566000

BTG4 BTG7 BTG3 BTG8 BTG1 BTG5

Bungaroo Creek

BTG4

Map Extent

Legend

- Roads
- Watercourse
- Tracklogs
- Survey Area
- Previous Fauna Sampling Locations (Biota 2006, 2007, 2009, 2010)

Current sampling locations

- Acoustic recording
- Active foraging (SRE)
- Active foraging (Vertebrate)
- Avifauna census
- Camera (active)
- Habitat assessment
- Trapping grid/avifauna census

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure C.1C: Previous and Current Sampling Locations and Targeted Search Effort

Datum: GDA 1994
Projection: MGA Zone 50

0 500 1,000 1,500 2,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigC1C_SampLoc

This page has been left blank intentionally.

Table C.1: Locations of fauna habitat assessment sites.

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO1	445356	7571726	Habitat assessment	26/05/2015	Breakaway	1; none	*Ficus* trees over *Acacia* shrubland over *Triodia* grassland on clay loam soils	Breakaway	Overhangs	
JO3	447649	7571087	Habitat assessment	28/05/2015	Gorge, semi-permanent pools	1; none	*Ficus* and *Eucalyptus* trees over *Triodia* and tussock grassland on clay loam soils	Gorge	Crevices, overhangs, semi-permanent pools	
JO4	447121	7572269	Habitat assessment	29/05/2015	Hillslope	0.8; grazing, drill lines	Scattered *Eucalyptus* trees over *Acacia* and *Hakea* shrubland over *Triodia* grassland on sandy clay loam soils	Hillslope	Termite mounds	
JO5	447402	7572423	Habitat assessment	29/05/2015	Gorge; semi-permanent pools	1; none	*Ficus* and *Eucalyptus* trees over *Acacia* shrubland over *Triodia* and tussock grassland on clay loam soils	Gorge	Semi-permanent pool	
JO7	447650	7572527	Habitat assessment	29/05/2015	Hillcrest	1; none	*Eucalyptus* and *Corymbia* trees over *Acacia* and *Hakea* shrubland over *Triodia* grassland on clay loam soils	Hillcrest	Tree hollows, termite mounds	
JO8	448742	7571660	Habitat assessment	29/05/2015	Minor drainage line; ephemeral pool	0.8; grazing, drill lines, weeds	*Eucalyptus* trees over *Acacia* shrubland over *Themeda*, buffel and other grasses on clay soils	Breakaway on drainage line	Overhangs, shelters, crevices, ephemeral pool	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO8A	448214	7571459	Habitat assessment	29/05/2015	Minor drainage line	0.6; grazing, tracks, drill lines, weeds	*Corymbia hamersleyana* trees over *Acacia inaequilatera* shrubland over buffel grassland on clay loam soils	Minor drainage line	None	
JO8B	448187	7571431	Habitat assessment	29/05/2015	Major drainage line	0.8; tracks, weeds	Low heath over buffel grassland on clay loam soils	Major drainage line	None	
JO9	443446	7573342	Habitat assessment	29/05/2015	Major drainage line	0.6; grazing, drill lines, weeds	*Corymbia* and *Eucalyptus* woodland over *Acacia* shrubland over *Themeda* sp. and *Triodia* grassland on clay loam	Major drainage line	None	
JO10	442070	7574040	Habitat assessment	29/05/2015	Drainage, sandy loam plain	0.8; grazing, weeds	*Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland on sandy clay loam soils	Loamy plain	None	
JO11	436614	7578393	Habitat assessment	29/05/2015	Non-cracking clay plain	0.2; grazing, tracks, weeds, burnt	*Corymbia hamersleyana* trees over *Acacia* and *Hakea* shrubland over buffel grassland and herbs on clay soils	Non-cracking clay plain	None	
JO12	442595	7575501	Habitat assessment	30/05/2015	Hillslope	1; none	*Eucalyptus* trees over *Acacia inaequilatera* shrubland over *Triodia* grassland on clay loam soils	Hillslope	Termite mounds	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO13	443084	7575735	Habitat assessment	30/05/2015	Gorge	1; none	*Eucalyptus leucophloia* trees over *Acacia* shrubland over *Triodia* and tussock grassland on clay loam soils	Gorge	Crevices	
JO-BAT-2	448687	7569055	Habitat assessment	28/05/2015	Cave at breakaway	1; none	*Ficus* trees over *Triodia* and tussock grassland	Breakaway	Cave	
JO-HAB-1	440996	7576283	Habitat assessment	27/05/2015	Stony plain	0.8; grazing, weeds	*Corymbia hamersleyana* trees over *Acacia* shrubland over *Triodia* and buffel grassland on clay loam soils	Stony plain	None	
JO-HAB-2	431701	7583155	Habitat assessment	27/05/2015	Stony plain	0.6; drill lines, burnt	*Acacia* woodland over *Triodia* grassland and herbland on clay loam soils	Stony plain	None	
JO-HAB-3	431211	7583220	Habitat assessment	27/05/2015	Hillslope	0.6; burnt	*Triodia* grassland on clay loam soils	Hillslope	None	
JO-HAB-4	431695	7581922	Habitat assessment	27/05/2015	Breakaway	0.6; burnt	*Acacia* shrubland over *Triodia* grassland on clay loam soils	Breakaway	Crevices	

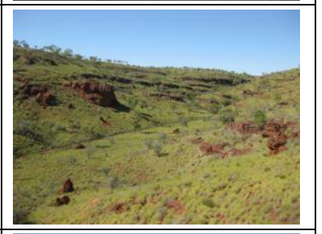
Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO-HAB-5	447369	7570836	Habitat assessment	28/05/2015	Stony plain	0.8; grazing, drill lines, weeds	*Corymbia hamersleyana* trees over *Acacia* shrubland over *Triodia* and buffel grassland on clay loam soils	Stony plain	None	
JO-HAB-6	447242	7570657	Habitat assessment	28/05/2015	Hillslope	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on clay loam soils	Hillslope	Termite mounds	
JT Hab 2	427502	7586015	Habitat assessment	27/05/2015	Minor drainage line	0.8; grazing	*Acacia* and *Grevillea wickhamii* shrubland over *Triodia* grassland on clay loam soils	Minor drainage line	Termite mounds	
JT Walk 1	444592	7571285	Habitat assessment	26/05/2015	Gorge	1; none	*Eucalyptus camaldulensis* trees over *Triodia* grassland on clay loam soils	Gorge	Crevices	
JT Walk 2	445508	7570791	Habitat assessment	26/05/2015	Gorge	1; none	*Corymbia ferreticola* and *Ficus* trees over *Acacia* shrubland over *Triodia* grassland on clay loam soils	Gorge	Crevices, tree hollows	
JT Walk 3	427588	7585639	Habitat assessment	27/05/2015	Hillcrest	0.2; burnt	*Eucalyptus leucophloia* trees over *Acacia* shrubland over *Triodia* grassland on clay loam soils	Hillcrest	Crevices, termite mounds	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JT Walk 30/5	451538	7572341	Habitat assessment	30/05/2015	Minor drainage line	0.6; grazing, tracks, weeds	*Ficus* trees and *Eucalyptus* woodland over *Triodia* and buffel grassland on clay loam soils	Minor drainage line	Caves, crevices	
JT Walk 2 28/5	446058	7573229	Habitat assessment	28/05/2015	Hillslope	1; none	*Eucalyptus leucophloia* trees over *Acacia* shrubland over *Triodia* grassland on clay loam soils	Hillslope	Termite mounds	
MJ12	444406	7572788	Habitat assessment	25/05/2015	Gorge; ephemeral pool	0.8; drill lines	*Eucalyptus leucophloia* trees over *Triodia* grassland on clay loam soils	Gorge	Crevices	
MJ17	442459	7573293	Habitat assessment	26/05/2015	Stony plain	0.6; grazing, drill lines, weeds	*Cleome viscosa* and buffel grassland on clay loam soils	Stony plain	None	
MJ18	441898	7572939	Habitat assessment	26/05/2015	Gorge	0.8; drill lines	*Acacia* woodland over *Triodia* grassland on clay loam soils	Gorge	Crevices, overhangs, caves.	
MJ20	434651	7580912	Habitat assessment	27/05/2015	Soak; moist soil but no surface water	0.8; grazing, weeds	*Eucalyptus camaldulensis* woodland over *Triodia* and buffel grassland and sedgeland on sandy clay loam soils	Major drainage line	Tree hollows	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
MJ20A	443137	7572216	Habitat assessment	28/05/2015	Hillcrest	0.6; burnt	*Eucalyptus* woodland over *Triodia* grassland on sandy clay soils	Hillcrest	None	
MJ22	448164	7569863	Habitat assessment	28/05/2015	Gorge; semi-permanent water	1; none	*Ficus* and *Eucalyptus* trees over tussock grassland on clay loam soils	Gorge	Semi-permanent pool	
MJ23	447348	7569707	Habitat assessment	28/05/2015	Hillcrest	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on sandy clay soils	Hillcrest	None	
MJ25	446641	7571514	Habitat assessment	28/05/2015	Minor drainage line	0.6; tracks, weeds	*Corymbia hamersleyana* and *Eucalyptus victrix* trees over *Acacia* shrubland over *Triodia* and buffel grassland on clay loam soils	Minor drainage line	None	
MJ26	440260	7574800	Habitat assessment	28/05/2015	Minor drainage line	1; none	*Corymbia hamersleyana* trees over *Acacia* and *Hakea* shrubland over *Triodia* grassland on clay loam soils	Minor drainage line	None	
MJ28	442699	7576951	Habitat assessment	28/05/2015	Stony plain	1; none	*Acacia inaequilatera* trees over *Acacia ancistrocarpa* shrubland over *Triodia* grassland on clay loam soils	Stony plain	None	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
MJ29	446865	7572210	Habitat assessment	29/05/2015	Hillslope	0.6; drill lines, burnt	*Corymbia* trees over *Triodia* grassland on sandy clay soils	Hillslope	None	
MJ30	447125	7572647	Habitat assessment	29/05/2015	Gorge	0.4; burnt	*Eucalyptus leucophloia* trees over *Triodia* grassland on sandy clay soils	Gorge	Caves, overhangs	
MJ33	434610	7580845	Habitat assessment	29/05/2015	Soak; most soil but no surface water	0.6; grazing, weeds	*Eucalyptus* woodland over buffel grassland on clay loam soils	Major drainage line	Tree hollows	
MJ35	442489	7575858	Habitat assessment	30/05/2015	Hillslope	0.8; grazing, weeds	*Eucalyptus leucophloia* trees over *Triodia* grassland on sandy clay soils	Hillslope	None	
MJ36	442106	7576793	Habitat assessment	30/05/2015	Hillslope	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on sandy clay soils	Hillslope	None	
MJ37	441269	7577068	Habitat assessment	30/05/2015	Gorge	0.4; burnt	*Eucalyptus* woodland over mixed herbland on clay loam soils	Gorge	None	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
MJ38	440688	7577531	Habitat assessment	30/05/2015	Breakaway	0.6; burnt	*Triodia* grassland on sandy clay soils	Breakaway	Crevices	
MJ39	440273	7577774	Habitat assessment	30/05/2015	Major drainage line	0.6; grazing, weeds	*Ficus* and *Eucalyptus* woodland over *Acacia* shrubland over buffel grassland on sandy clay soils	Major drainage line	None	
MJ41	444242	7574545	Habitat assessment	31/05/2015	Breakaway	0.6; burnt	*Eucalyptus* trees over mixed tussock grassland on sandy clay soils	Breakaway	Crevices, overhangs	
SRE13	447972	7572389	Habitat assessment	29/05/2015	Minor drainage line	0.8; grazing	*Eucalyptus leucophloia* and *Ficus* sp. trees over *Triodia* grassland on clay loam soils	Breakaway on drainage line	Crevices, overhangs	
SRE14	445621	7574306	Habitat assessment	28/05/2015	Spring; permanent water	0.8; grazing, weeds	*Ficus* and *Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland and sedgeland on clay soils	Spring at gorge	Crevices, overhangs, tree hollows	
M01	440219	7577074	Habitat assessment	4/08/2015	Stony plain	0.4; grazing, weeds	*Eucalyptus victrix* and *Corymbia hamerslyana* woodland over *Triodia wiseana* and **Cenchrus ciliaris* grassland on clay loam soils	Stony plain	Permanent water at well	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
M03	447989	7570610	Habitat assessment	5/08/2015	Gully	1; none	*Ficus* sp. over isolated grasses on sandy clay soils	Gully	Crevices, semi-permanent water	
M04	450914	7571651	Habitat assessment	5/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	
M08	449703	7568370	Habitat assessment	6/08/2015	Gully	1; none	Scattered *Eucalyptus leucophloia* over *Triodia wiseana* grassland on sandy clay soils	Gully	Large spinifex hummocks	
M12	454543	7566724	Habitat assessment	7/08/2015	Gully	1; none	*Eucalyptus leucophloia* and *Corymbia hamerslyana* woodland over *Triodia wiseana* grassland on sandy clay soils	Low Hills and Slopes	None	
M13	433242	7581964	Habitat assessment	7/08/2015	Stony plain	0.6; rehab	Mixed herbs and shrubs over *Triodia* sp. grassland on sandy clay soils	Stony plain	None	
M14	450564	7569475	Habitat assessment	8/08/2015	Sandy plain	0.8; grazing, weeds	Mixed *Acacia* spp. shrubland over *Triodia* sp. grassland on clay loam soils	Stony plain	None	

Site ID	Easting	Northing	Sampling method	Date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
M14b	443690	7572830	Habitat assessment	8/08/2015	Rocky hills/breakaway	1; none	*Triodia wiseana* grassland on loamy sand	Rocky hills	Caves	
M15	441304	7574654	Habitat assessment	8/08/2015	Sandy plain	0.6; grazing, weeds	*Corymbia hamerslyana* open woodland over mixed *Acacia* spp. over *Triodia* sp. grassland on silty clay soils	Stony plain	None	
M17	422484	7590565	Habitat assessment	9/08/2015	Stony plain	1; none	*Acacia ancistrocarpa* shrubland over *Triodia wiseana* grassland on sandy clay soils	Rocky hills	None	
M17b	439147	7575601	Habitat assessment	9/08/2015	Hillslope	1; none	*Triodia wiseana* grassland on sandy clay soils	Rocky hills	None	

Vegetation condition rating:

1.0 (Excellent)
0.8 (Very Good)
0.6 (Good)
0.4 (Poor)
0.2 (Very Poor)
0.0 (Completely Degraded)

Table C.2: Locations of motion sensitive camera sites.

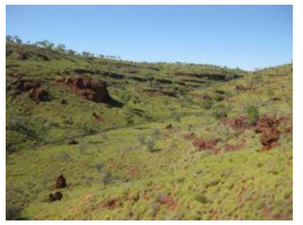
Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
CAM12	448642	7569055	Camera (active)	28/05/2015	1/06/2015	Breakaway	1; none	*Ficus* trees over *Triodia* grassland on clay loam soils	Breakaway	Overhangs	Moultrie 12	No photo
JO-BAT-2	448687	7569055	Camera (active)	28/05/2015	1/06/2015	Cave at breakaway	1; none	*Ficus* trees over *Triodia* and tussock grassland	Breakaway	Cave	Moultrie 22	
	448687	7569055	Camera (active)	28/05/2015	1/06/2015						Moultrie 28	
JT Cam	444524	7571280	Camera (active)	26/05/2015	1/06/2015	Gorge	1; none	*Eucalyptus* trees over *Triodia* grassland on clay loam soils	Gorge	Overhangs, crevices	Bushnell 8	
JT Cam 1	444356	7575463	Camera (active)	25/05/2015	31/05/2015	Gorge	0.6; burnt	*Eucalyptus leucophloia* over *Acacia, Hakea* and *Grevillea* shrubland over *Triodia* grassland on clay loam soils	Gorge	Boulders	Moultrie 30	
JT Cam 2	439648	7578203	Camera (active)	25/05/2015	31/05/2015	Breakaway	1; none	*Acacia* shrubland over *Triodia* grassland on clay loam soils	Breakaway	Cave	Moultrie 27	
JT Cam 2A	444560	7571522	Camera (active)	26/05/2015	1/06/2015	Gorge	1; none	*Corymbia* trees over *Acacia* shrubland over *Triodia* grassland on clay loam soils	Gorge	Crevices, overhangs	Moultrie 14	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
JT Cam 3	444734	7571974	Camera (active)	26/05/2015	1/06/2015	Gorge	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on clay loam soils	Gorge	Crevices, overhangs	Moultrie 23	
JT Cam 4	445508	7570791	Camera (active)	26/05/2015	31/05/2015	Gorge	1; none	*Ficus* and *Corymbia* trees over *Triodia* grassland on clay loam soils	Gorge	Crevices	Bushnell 4	
MJ2	441348	7576597	Camera (active)	25/05/2015	30/05/2015	Gorge	0.8; burnt	*Triodia* grassland on clay loam soils	Gorge	Crevices	Reconyx 36	
MJ3	442015	7575929	Camera (active)	25/05/2015	30/05/2015	Gorge	0.8; burnt	*Triodia* grassland over herbland on clay loam soils	Gorge	Crevices, small caves	Bushnell 5	
MJ4	442085	7575821	Camera (active)	25/05/2015	30/05/2015	Breakaway	0.8; burnt	*Triodia* grassland over herbland on clay loam soils	Gorge	Crevices, small caves	Bushnell 3	
MJ6	444405	7575145	Camera (active)	25/05/2015	31/05/2015	Gorge	1; none	*Eucalyptus leucophloia* trees over tussock grassland on clay loam soils	Gorge	Crevices	Moultrie 11	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
MJ7	444408	7575155	Camera (active)	25/05/2015	31/05/2015	Breakaway	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on clay loam soils	Breakaway	Overhangs	Moultrie 26	
MJ8	444094	7575263	Camera (active)	25/05/2015	31/05/2015	Gorge	1; none	*Grevillea wickhamii* shrubland over *Triodia* grassland on clay loam soils	Gorge	Crevices	Moultrie 20	
MJ9	443821	7574538	Camera (active)	25/05/2015	31/05/2015	Breakaway	0.6; drill lines	*Triodia* grassland on sandy clay soils	Breakaway	Caves	Bushnell 9	
MJ11	439735	7578230	Camera (active)	25/05/2015	31/05/2015	Breakaway	0.6; burnt	*Triodia* grassland on sandy clay soils	Breakaway	Caves	Bushnell 6	No photo
MJ13	443554	7572155	Camera (active)	26/05/2015	28/05/2015	Gorge	1; none	*Eucalyptus leucophloia* trees over *Acacia* shrubland over tussock grassland on sandy clay soils	Gorge	Overhangs, ephemeral pool	Moultrie 19	
MJ15	443488	7571983	Camera (active)	26/05/2015	28/05/2015	Gorge	1; none	*Ficus* and *Eucalyptus* trees over tussock grassland on sandy clay soils	Gorge	Crevices, semi-permanent pool	Reconyx 35	
MJ16	443483	7571908	Camera (active)	26/05/2015	28/05/2015	Gorge	1; none	*Ficus* and *Eucalyptus* trees over tussock grassland on sandy clay soils	Gorge	Crevices, semi-permanent pool	Bushnell 7	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
MJ19	441898	7572939	Camera (active)	26/05/2015	1/06/2015	Gorge	1; none	*Triodia* grassland on clay loam soils	Gorge	Caves	Moultrie 15	
	441898	7572939	Camera (active)	26/05/2015	1/06/2015						Moultrie 25	
	441772	7573032	Camera (active)	26/05/2015	1/06/2015						Bushnell 1	
MJ20	434651	7580912	Camera (active)	27/05/2015	31/05/2015	Soak; most soil but no surface water	0.8; grazing, weeds	*Eucalyptus* woodland over buffel grassland on clay loam soils	Major drainage line	Tree hollows	Moultrie 13	
	434577	7581053	Camera (active)	27/05/2015	31/05/2015						Moultrie 17	
	434488	7581087	Camera (active)	27/05/2015	31/05/2015						Moultrie 24	
MJ27	436453	7578786	Camera (active)	28/05/2015	31/05/2015	Stony plain	0.8; grazing, tracks, weeds, burnt	*Corymbia hamersleyana* trees over *Acacia* shrubland over *Triodia* grassland and herbland on clay loam soils	Stony plain	None	Moultrie 21	
	436432	7578814	Camera (active)	28/05/2015	31/05/2015						Moultrie 19	
	436399	7578829	Camera (active)	28/05/2015	31/05/2015						Reconyx 35	
	436374	7578844	Camera (active)	28/05/2015	31/05/2015						Bushnell 7	
SRE14	445621	7574306	Camera (active)	28/05/2015	1/06/2015	Spring; permanent water	0.8; grazing, weeds	*Ficus* and *Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland and sedgeland on clay soils	Gorge	Crevices, permanent water	Moultrie 18	
	445606	7574299	Camera (active)	28/05/2015	1/06/2015						Moultrie 29	
	445526	7574200	Camera (active)	28/05/2015	1/06/2015						Bushnells 10	
Cam01a	440219	7577055	Camera (active)	4/08/2015	10/08/2015	Stony plain	0.4; grazing; weeds	*Eucalyptus victrix* and *Corymbia hamerslyana* woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on clay loam soils	Stony plain	Permanent water at well	Bushnell 1	
Cam03a	440240	7577074	Camera (active)	4/08/2015	10/08/2015	Stony plain	0.4; grazing; weeds	*Eucalyptus victrix* and *Corymbia hamerslyana* woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on clay loam soils	Stony plain	Permanent water at well	Bushnell 3	
Cam04a	449279	7568681	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Eucalyptus leucophloia* over *Triodia wiseana* grassland on sandy clay soils	Gorge	Large spinifex hummocks	Bushnell 4	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
Cam06a	450914	7571651	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Bushnell 6	
Cam08a	451170	7571514	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Bushnell 8	
Cam09a	443640	7572830	Camera (active)	8/08/2015	10/08/2015	Breakaway	0.6; weeds	*Triodia wiseana* grassland on loamy sand soils	Hillcrest	Caves	Bushnell 9	
Cam10a	449400	7568840	Camera (active)	7/08/2015	10/08/2015	Breakaway	1; none	Scattered *Ficus* sp. over isolated grasses on sandy clay soils	Breakaway	Crevices	Moultrie 10	
Cam11a	451031	7570482	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Moultrie 11	
Cam12a	449351	7568775	Camera (active)	7/08/2015	10/08/2015	Breakaway	1; none	Scattered *Ficus* sp. over isolated grasses on sandy clay soils	Breakaway	Crevices	Moultrie 12	
Cam13a	438750	7576649	Camera (active)	8/08/2015	10/08/2015	Sandy plain	0.8; grazing, weeds	Mixed *Acacia* spp. shrubland over *Triodia* sp. grassland on sandy clay soils	Sandy plain	None	Moultrie 13	
Cam14a	451026	7570531	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland	Major drainage line	Tree hollows	Moultrie 14	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
Cam15a	454543	7566724	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. and *Eucalyptus* sp. over isolated grasses on sandy loam soils	Hillslope	None	Moultrie 15	
Cam17a	447989	7570610	Camera (active)	5/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. over isolated grasses on sandy clay soils	Gorge	Crevices	Moultrie 17	
Cam18a	450383	7570567	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy clay soils	Major drainage line	Tree hollows	Moultrie 18	
Cam19a	443690	7572830	Camera (active)	8/08/2015	10/08/2015	Breakaway	1; none	*Triodia wiseana* grassland on loamy sand soils	Hillcrest	Caves	Moultrie 19	
Cam20a	449200	7568624	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Eucalyptus leucophloia* over *Triodia wiseana* grassland on sandy clay soils	Gorge	Large spinifex hummocks	Moultrie 20	
Cam21a	449196	7568564	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Eucalyptus leucophloia* over *Triodia wiseana* grassland on sandy clay soils	Gorge	Large spinifex hummocks	Moultrie 21	
Cam24a	448015	7570580	Camera (active)	5/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. over isolated grasses on sandy clay soils	Gorge	Crevices	Moultrie 24	
Cam25a	451077	7570457	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Moultrie 25	
Cam26a	450106	7570592	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Moultrie 26	

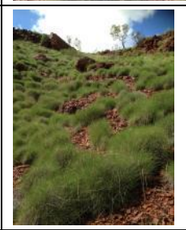
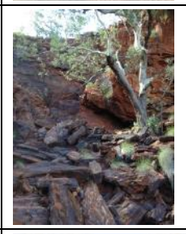
Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
Cam27a	447985	7570585	Camera (active)	5/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. over isolated grasses on sandy clay soils	Gorge	Crevices	Moultrie 27	
Cam28a	450455	7570584	Camera (active)	5/08/2015	10/08/2015	Major drainage line	0.6; weeds	*Eucalyptus victrix* and *Ficus* sp. woodland over *Triodia* sp. and **Cenchrus ciliaris* grassland on sandy loam soils	Major drainage line	Tree hollows	Moultrie 28	
Cam29a	438732	7576669	Camera (active)	8/08/2015	10/08/2015	Sandy plain	0.8; grazing, weeds	Mixed *Acacia* spp. shrubland over *Triodia* sp. grassland on sandy clay soils	Sandy plain	None	Moultrie 29	
Cam35a	453979	7565914	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. and *Eucalyptus* sp. over isolated grasses on sandy clay soils	Hillslope	Caves, crevices	Reconyx 35	
Cam36a	453962	7565896	Camera (active)	7/08/2015	10/08/2015	Gully	1; none	Scattered *Ficus* sp. and *Eucalyptus* sp. over isolated grasses on sandy clay soils	Hillslope	Caves	Reconyx 36	

Table C.3: Locations of acoustic recording sites.

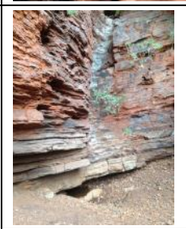
Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
JO-BAT-1	434492	7580984	Acoustic recording	25/05/2015	27/05/2015	Soak; most soil but no surface water	0.8; grazing, weeds	*Eucalyptus* woodland over buffel grassland on clay loam soils	Major drainage line	Tree hollows	SN7634	
JO-BAT-2	448687	7569055	Acoustic recording	28/05/2015	1/06/2015	Cave at breakaway	1; none	*Ficus* trees over *Triodia* and tussock grassland	Breakaway	Cave	SN7566	
MJ1	439648	7578203	Acoustic recording	25/05/2015	27/05/2015	Breakaway	1; none	*Triodia* grassland on clay loam soils	Breakaway	Crevices, caves	SN11793	
MJ13	443554	7572155	Acoustic recording	26/05/2015	28/05/2015	Gorge	1; none	*Eucalyptus leucophloia* trees over *Acacia* shrubland over tussock grassland	Gorge	Overhangs, ephemeral pool	SN8027	
MJ21	441772	7573035	Acoustic recording	28/05/2015	1/06/2015	Gorge	1; none	*Triodia* grassland on clay loam soils	Gorge	Caves	SN8027	
MJ27	436453	7578786	Acoustic recording	28/05/2015	31/05/2015	Stony plain	0.8; grazing, tracks, weeds, burnt	*Corymbia hamersleyana* trees over *Acacia* shrubland over *Triodia* grassland and herbland on clay loam soils	Stony plain	None	SN11793	

Site ID	Easting	Northing	Sampling method	Start date	End date	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Notes	Photo
MJ5	444217	7575288	Acoustic recording	25/05/2015	27/05/2015	Gorge	1; none	*Eucalyptus* woodland over *Triodia* grassland on clay loam soils	Gorge	None	SN7566	
SRE14	445634	7574303	Acoustic recording	28/05/2015	1/06/2015	Spring; permanent water	0.8; grazing, weeds	*Ficus* and *Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland and sedgeland on clay soils	Gorge	Crevices, permanent water	SN7634	
SM11040a	448005	7570584	Acoustic recording	5/08/2015	10/08/2015	Gully	1; none	*Ficus* trees over isolated grasses on sandy clay soils	Gorge	Crevices, semi-permanent pool	SN11040a	
SM7566a	453982	7565918	Acoustic recording	7/08/2015	10/08/2015	Gully	1; none	*Ficus* and *Eucalyptus* scattered trees over isolated grasses on sandy clay soils	Gorge	Caves, crevices	SN7566a	
SM7634a	448668	7569079	Acoustic recording	4/08/2015	10/08/2015	Cave at breakaway	0.8; grazing, weeds	*Ficus* trees over *Triodia* and tussock grassland on loamy sandy soils	Rocky Hills/Breakaway	Caves	SN7634a	
SM8027a	440219	7577074	Acoustic recording	4/08/2015	10/08/2015	Well	0.4; grazing, weeds	*Eucalyptus victrix* and *Corymbia hamerslyana* woodland over *Triodia wiseana* and **Cenchrus ciliaris* grassland on clay loam soils	Stony Plain	Permanent water at well	SN8027a	

Table C.4: Locations of active foraging sites.

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO2	442595	7575501	Opportunistic site (SRE)	27/05/2015	N/A	N/A	N/A	Gorge	1; none	*Ficus* and *Eucalyptus* trees over *Triodia* and tussock grassland on clay loam soils	Gorge	Crevices, overhangs	No photo
JO3	447010	7570477	Active foraging (SRE)	28/05/2015	12:08	28/05/2015	12:38	Gorge, semi-permanent pools	1; none	*Ficus* and *Eucalyptus* trees over *Triodia* and tussock grassland on clay loam soils	Gorge	Crevices, overhangs, semi-permanent pools	
JO4	447121	7572269	Active foraging (Vertebrate)	29/05/2015	10:15	29/05/2015	12:10	Hillslope	0.8; grazing, drill lines	Scattered *Eucalyptus* trees over *Acacia* and *Hakea* shrubland over *Triodia* grassland on sandy clay loam soils	Hillslope	Termite mounds	
JO6	447820	7572874	Active foraging (SRE)	29/05/2015	10:42	29/05/2015	11:12	Breakaway	1; none	*Ficus* and *Grevillea wickhamii* shrubland over *Triodia* grassland on clay loam soils	Rocky hills	Crevices	
JO8	446989	7571962	Active foraging (SRE) Active foraging (Vertebrate)	29/05/2015	11:30	29/05/2015	12:00	Minor drainage line; ephemeral pool	0.8; grazing, drill lines, weeds	*Eucalyptus* trees over *Acacia* shrubland over *Themeda*, buffel and other grasses on clay soils	Breakaway on drainage line	Crevices, overhangs, ephemeral pool	
JO9	443446	7573342	Active foraging (SRE) Active foraging (Vertebrate)	29/05/2015	15:03	29/05/2015	15:23	Major drainage line	0.6; grazing, drill lines, weeds	*Corymbia* and *Eucalyptus* woodland over *Acacia* shrubland over *Themeda* sp. and *Triodia* grassland on clay loam	Major drainage line	None	

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
JO10	442070	7574040	Active foraging (SRE) Active foraging (Vertebrate)	29/05/2015	15:30	29/05/2015	16:00	Drainage, sandy loam plain	0.8; grazing, weeds	*Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland on sandy clay loam soils	Loamy plain	None	
JO11	436614	7578393	Active foraging (SRE) Active foraging (Vertebrate)	29/05/2015	16:11	29/05/2015	16:22	Non-cracking clay plain	0.2; grazing, tracks, weeds, burnt	*Corymbia hamersleyana* trees over *Acacia* and *Hakea* shrubland over buffel grassland and herbs on clay soils	Non-cracking clay plain	None	
JO13A	442922	7575716	Active foraging (SRE)	30/05/2015	11:38	30/05/2015	12:08	Gorge	1; none	*Eucalyptus* trees over *Acacia* shrubland over tussock grassland	Gorge	Crevices	
JO14	440225	7577715	Active foraging (SRE)	30/05/2015	13:51	30/05/2015	15:25	Breakaway; no permanent water but moist soil	0.6; grazing, weeds, burnt	*Ficus* sp. and *Eucalyptus leucophloia* trees over buffel grassland and herbs on clay loam soil	Breakaway on drainage line	Crevices, caves, leaf litter	
MCL01	440290	7577780	Active foraging (SRE)	30/05/2015	14:00	30/05/2015	15:00	Major drainage line; no permanent water but moist soil	0.6; grazing, weeds, burnt	*Ficus* and *Eucalyptus* tress over buffel grassland on clay loam soils	Breakaway on drainage line	Crevices, caves	
MCL02	444338	7575428	Active foraging (SRE)	31/05/2015	11:45	31/05/2015	12:30	Gorge; no permanent water	1.0; none	*Eucalyptus leucophloia* trees over *Grevillea wickhamii* shrubland over tussock grassland	Breakaway on drainage line	Crevices	

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
MJ31	447437	7573339	Active foraging (SRE)	29/05/2015	11:30	29/05/2015	11:50	Breakaway	1; none	*Eucalyptus leucophloia* woodland over *Triodia* grassland on sandy clay soils	Breakaway	Crevices	
MJ32	447442	7573351	Active foraging (SRE)	29/05/2015	12:00	29/05/2015	12:20	Breakaway	1; none	*Ficus* and *Eucalyptus* trees over *Triodia* grassland on sandy clay soils	Breakaway	Crevices, overhangs, caves	
MJ36	442106	7576793	Active foraging (SRE) Active foraging (Vertebrate)	30/05/2015	10:20	30/05/2015	10:40	Hillslope	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on sandy clay soils	Hillslope	None	
MJ42	434524	7580396	Active foraging (SRE) Active foraging (Vertebrate)	31/05/2015	13:30	31/05/2015	15:09	Soak; moist soil but no surface water	0.6; grazing, weeds	*Eucalyptus xerothermica* woodland over *Acacia* shrubland over buffel grassland on sandy clay loam soils	Soak/major drainage line	Leaf litter	
SRE3	443554	7572155	Active foraging (SRE)	26/05/2015	10:20	26/05/2015	11:00	Gorge; ephemeral pool	1; none	*Eucalyptus leucophloia* trees over *Triodia* grassland on clay loam soils	Gorge	Overhangs, ephemeral pool	
SRE4	444611	7571509	Active foraging (SRE)	26/05/2015	11:00	26/05/2015	12:30	Gorge; no permanent water	1; none	*Eucalyptus* trees over *Acacia* shrubland over *Triodia* grassland and sedgeland on clay loam soils	Minor drainage line in gorge	Leaf litter	

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
SRE13	447972	7572389	Active foraging (SRE) Active foraging (Vertebrate)	29/05/2015	10:30	29/05/2015	14:00	Minor drainage line	0.8; grazing	*Eucalyptus leucophloia* and *Ficus* sp. trees over *Triodia* grassland on clay loam soils	Breakaway on drainage line	Crevices, overhangs	
SRE14	445621	7574306	Active foraging (SRE) Active foraging (Vertebrate)	28/05/2015	10:00	28/05/2015	14:00	Spring; permanent water	0.8; grazing, weeds	*Ficus* and *Corymbia* woodland over *Acacia* shrubland over *Triodia* grassland and sedgeland on clay soils	Gorge	Crevices, permanent water	
SRE20	441739	7573041	Active foraging (SRE)	26/05/2015	13:12	26/05/2015	13:42	Gorge	0.8; weeds, burnt	*Ficus* and *Corymbia* woodland over herbland on clay loam soils	Minor drainage line in gorge	Crevices, overhangs	
M13	433242	7581964	Active foraging (Vertebrate)	7/08/2015	16:00	7/08/2015	16:30	Stony plain	0.6; rehab	Mixed herbs and shrubs over *Triodia* sp grassland on sandy clay soils	Stony plain	None	
M15	441304	7574654	Active foraging (Vertebrate)	8/08/2015	12:40	8/08/2015	14:40	Stony plain	0.6; grazing, weeds	*Corymbia hamerslyana* open woodland over mixed *Acacia* spp. shrubland over *Triodia wiseana* grassland on silty clay soils	Stony plain	None	
SRE01b	451438	7572335	Active foraging (SRE)	5/08/2015	15:00	5/08/2015	15:30	Breakaway	0.8; grazing, weeds	Scattered *Eucalyptus victrix* over mixed herbs and grasses on sandy clay loam soils	Breakaway	Crevices, leaf litter, breakaway	

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
SRE02b	450490	7570588	Active foraging (SRE)	5/08/2015	15:30	5/08/2015	16:30	Breakaway	0.6; grazing, weeds	*Ficus* sp. over isolated grasses on loamy sand	Breakaway	Crevices, leaf litter	
SRE03b	449272	7568684	Active foraging (SRE)	6/08/2015	9:45	6/08/2015	10:35	Breakaway	0.8; grazing, weeds	*Ficus* sp. over isolated grasses on sandy clay soils	Breakaway	Crevices, leaf litter	
SRE04b	449948	7568204	Active foraging (SRE)	6/08/2015	11:00	6/08/2015	11:30	Gully	1; none	*Eucalyptus victrix* scattered trees over mixed herbs and grasses on sandy clay loam soils	Gully	Rocks	
SRE05b	451488	7567670	Active foraging (SRE)	6/08/2015	13:00	6/08/2015	13:30	Gorge	1; none	*Eucalyptus victrix* scattered trees over mixed herbs and grasses on loamy sand soils	Gorge	Crevices, shade	
SRE06b	453951	7565903	Active foraging (SRE)	7/08/2015	11:00	7/08/2015	11:45	Gully	1; none	*Ficus* sp. and *Eucalyptus* sp. open woodland over isolated grasses on loamy sand soils	Gully	Cave, semi-permanent pool	
SRE07b	454155	7567375	Active foraging (SRE)	7/08/2015	12:52	7/08/2015	13:30	Gorge	1; none	*Ficus* sp. and *Eucalyptus* sp. open woodland over isolated grasses on sandy clay loam soils	Gorge	None	

Site ID	Easting	Northing	Sampling method	Start date	Start time	End date	End time	Habitat	Condition; disturbance	Vegetation description	Landform	Microhabitats	Photo
SRE08b	429958	7583955	Active foraging (SRE)	9/08/2015	13:45	9/08/2015	14:15	Breakaway	1; none	Scattered *Ficus* sp. on clay loam soils	Breakaway	Rocks and leaf litter	
SRE09b	434603	7581101	Active foraging (SRE)	10/08/2015	10:00	10/08/2015	10:30	Moist soil but no surface water	0.6; grazing, weeds	*Eucalyptus xerothermica* woodland over *Acacia* shrubland over buffel grassland on sandy clay loam soils	Soak/major drainage line	Leaf litter	No photo (outside survey area)

This page has been left blank intentionally.

Appendix D: Fauna Species Lists

This page has been left blank intentionally.

Table D.1: Amphibian species list – results of database searches, literature reviews and survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
HYLIDAE										
Cyclorana maini	Sheep Frog					x			x	
Litoria rubella	Little Red Tree Frog					x			x	x
MYOBATRACHIDAE										
Pseudophryne douglasi	Gorge Toadlet									x
Uperoleia russelli	Northwest Toadlet					x			x	
Uperoleia saxatilis	Pilbara Toadlet					x				x

Table D.2: Reptile species list – results of database searches, literature reviews and survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous Surveys	Current Survey
			EPBC Act	WC Act	Parks and Wildlife					
AGAMIDAE										
Amphibolurus longirostris	Long-Nosed Dragon					x			x	x
Ctenophorus caudicinctus	Ring-tailed Rock Dragon					x			x	x
Ctenophorus isolepis isolepis	Military Sand Dragon					x			x	x
Ctenophorus nuchalis	Central Netted Dragon					x			x	
Ctenophorus reticulatus	Western Netted Dragon					x				
Pogona minor minor	Bearded Dragon					x			x	x
DIPLODACTYLIDAE										
Crenadactylus ocellatus	Clawless Gecko					x			x	x
Diplodactylus bilybara	Western Fat-tailed Gecko					x			x	x
Diplodactylus galaxias						x				
Diplodactylus mitchelli						x				
Diplodactylus savagei						x			x	
Lucasium stenodactylum	Pale-snouted Ground Gecko					x			x	x
Lucasium wombeyi						x			x	x
Oedura marmorata	Marbled Velvet Gecko					x			x	x
Rhynchoedura ornata	Beaked Gecko					x			x	
Strophurus ciliaris						x				
Strophurus elderi	Jewelled Gecko					x			x	x
Strophurus wellingtonae						x				
CARPHODACTYLIDAE										
Nephrurus levis pilbarensis									x	
Nephrurus wheeleri cinctus	Banded Knob-tailed Gecko					x			x	
Nephrurus wheeleri wheeleri	Banded Knob-tailed Gecko					x			x	x
GEKKONIDAE										
Gehyra pilbara						x			x	x
Gehyra punctata	Spotted Rock Dtella					x			x	x
Gehyra variegata	Variegated Tree Dtella					x			x	x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous Surveys	Current Survey
			EPBC Act	WC Act	Parks and Wildlife					
Hemidactylus frenatus	Asian House Gecko	*				x				
Heteronotia binoei	Bynoe's Gecko					x			x	x
Heteronotia spelea	Pilbara Cave Gecko					x			x	x
PYGOPODIDAE										
Delma concinna concinna	Javelin Legless Lizard					x				
Delma concinna major	Javelin Legless Lizard				P1	x	x			
Delma elegans						x			x	
Delma nasuta						x			x	
Delma pax						x			x	x
Delma tincta						x			x	
Lialis burtonis	Burrton's Legless Lizard					x			x	x
Pygopus nigiceps						x			x	
EUGONGYLIDAE										
Carlia munda						x			x	x
Carlia triacantha						x				
Cryptoblepharus plagiocephalus									x	
Cryptoblepharus buchananii						x				
Cryptoblepharus ustulatus						x				x
AGAMIDAE										
Ctenotus brooksi						x				
Ctenotus calurus						x				
Ctenotus duricola						x			x	
Ctenotus grandis titan						x			x	x
Ctenotus hanloni						x			x	
Ctenotus helenae						x			x	
Ctenotus pantherinus	Leopard Ctenotus					x			x	x
Ctenotus rubicundus						x			x	x
Ctenotus quattuordecimlineatus						x				

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous Surveys	Current Survey
			EPBC Act	WC Act	Parks and Wildlife					
Ctenotus saxatilis	Rock Ctenotus					x			x	x
Ctenotus schomburgkii						x			x	
Ctenotus serventyi						x				
EGERNIIDAE										
Cyclodomorphus melanops	Slender Blue-tongue					x			x	x
Egernia cygnitos						x				
Ergenia depressa						x				
Ergenia formosa						x			x	x
Ergenia pilbarensis	Pilbara Skink					x			x	
Eremiascincus isolepis						x			x	
Tiliqua multifasciata	Central Blue-tongue					x			x	
SPHENOMORPHIDAE										
Lerista bipes						x			x	
Lerista flammicauda						x			x	x
Lerista ips						x				
Lerista muelleri						x				x
Lerista verhmens						x				
Notoscincus butleri	Lined Soil-crevice Skink				P4	x	x		x	x
Notoscincus ornatus ornatus						x			x	x
EUGONGYLIDAE										
Menetia greyii						x			x	x
Menetia surda						x			x	x
Morethia ruficauda exquisita	Fire-tailed Skink					x			x	x
VARANIDAE										
Varanus acanthurus	Spiny-tailed Monitor					x			x	x
Varanus brevicauda	Short-tailed Pygmy Monitor					x			x	
Varanus bushi	Pilbara Mulga Monitor					x			x	x
Varanus caudolineatus						x				
Varanus eremius	Pygmy Desert Monitor					x			x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous Surveys	Current Survey
			EPBC Act	WC Act	Parks and Wildlife					
Varanus giganteus	Perentie					x			x	x
Varanus gouldii	Bungarra					x				
Varanus hamersleyensis	Southern Pilbara Rock Monitor					x			x	x
Varanus panoptes panoptes						x			x	x
Varanus tristis tristis	Racehorse Monitor					x			x	
TYPHLOPIDAE										
Anilios ammodytes						x			x	x
Anilios ganei					P1	x				x
Anilios grypus	Beaked Blind snake					x			x	x
Anilios pilbarensis						x			x	
BOIDAE										
Antaresia perthensis	Pygmy Python					x				x
Antaresia stimsoni stimsoni	Stimson's Python					x			x	x
Aspidites melanocephalus	Black-headed python					x				
Aspidites ramsayi	Woma					x	x			
Liasis olivaceus barroni	Pilbara Olive Python		VU	S3		x	x			+
ELAPIDAE										
Acanthopis wellsi	Pilbara Death Adder					x			x	
Brachyurophis approximans						x			x	
Demansia psammophis cupreiceps	Yellow-faced Whipsnake					x			x	x
Demansia rufescens	Rufous Whipsnake					x			x	
Furina ornata	Moon Snake					x			x	x
Parasuta monachus						x			x	
Pseudechis australis	Mulga Snake					x			x	x
Pseudonaja mengdeni	Western Brown Snake					x			x	x
Pseudonaja modesta	Ringed Brown Snake					x			x	x
Pseudonaja nuchalis	Gwardar; Northern Brown Snake					x				

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous Surveys	Current Survey
			EPBC Act	WC Act	Parks and Wildlife					
Simoselaps anomalus	Desert Banded Snake					x				
Suta fasciata	Rosen's Snake					x				
Suta punctata	Spotted Snake					x				

Table D.3: Bird species list – results of database searches, literature reviews and survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
DROMAIIDAE										
Dromaius novaehollandiae	Emu					x		x	x	x
PHASIANIDAE										
Coturnix ypsilophora	Brown Quail					x				x
ANATIDAE										
Anas gracilis	Grey Teal					x		x		
Anas superciliosa	Pacific Black Duck					x		x	x	
Aytha australis	Hardhead					x		x		
Cygnus atratus	Black Swan					x		x		
Chenonetta jubata	Australian Wood Duck					x			x	
PODICIPEDIDAE										
Tachybaptus novaehollandiae	Australasian Grebe					x		x	x	
Poliocephalus poliocephalus	Hoary-headed Grebe							x	x	
COLUMBIDAE										
Columba livia	Domestic Pigeon	*				x	x			
Geopelia cuneata	Diamond Dove					x		x	x	x
Geopelia striata placida	Peaceful Dove					x		x	x	x
Geophaps plumifera	Spinifex Pigeon					x		x	x	x
Ocyphaps lophotes	Crested Pigeon					x		x	x	x
Phaps chalcoptera	Common Bronzewing					x		x	x	x
Phaps histrionica	Flock Bronzewing					x				
PODARGIDAE										
Podargus strigoides	Tawny Frogmouth					x		x		x
CAPRIMULGIDAE										
Eurostopodus argus	Spotted Nightjar					x			x	x
AEGOTHELIDAE										
Aegotheles cristatus	Australian Owlet-nightjar					x			x	x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
APOPDIDAE										
Apus pacificus	Fork-tailed Swift		Mi	S5			x		x	
ANHINGIDAE										
Anhinga novaehollandiae	Darter					x		x	x	
PHALACROCORACIDAE										
Microcarbo melanoleucos	Little Pied Cormorant							x	x	
Phalacrocorax varius	Pied Cormorant							x		
Phalacrocorax sulcirostris	Little Black Cormorant								x	
PELECANIDAE										
Pelecanus conspicillatus	Australian Pelican					x		x	x	
CICONIIDAE										
Ephippiorhynchus asiaticus	Black-necked stork								x	
ARDEIDAE										
Ardea ibis	Cattle Egret		Mi	S5			x		x	
Ardea modesta	Eastern Great Egret		Mi	S5		x	x	x	x	
Ardea garzetta	Little Egret					x			x	
Ardea pacifica	White-necked Heron					x		x	x	x
Butorides striata	Striated Heron							x		
Egretta novaehollandiae	White-faced Heron					x		x	x	
Nycticorax caledonicus	Nankeen Night-heron					x		x		
THRESKIORNITHIDAE										
Platalea flavipes	Yellow-billed Spoonbill								x	
Threskiornis spinicollis	Straw-necked Ibis					x		x	x	
ACCIPITRIDAE										
Accipiter cirrocephalus	Collared Sparrowhawk					x			x	x
Accipiter fasciatus fasciatus	Brown Goshawk					x		x	x	
Aquila audax	Wedge-tailed Eagle					x		x	x	x
Circus approximans	Swamp Harrier					x				
Circus assimilis	Spotted Harrier					x		x	x	x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Elanus caeruleus	Black-shouldered Kite					x			x	x
Lophoictinia isura	Square-tailed Kite					x		x		
Haliaeetus leucogaster	White-bellied Sea Eagle		Ma				x	x		
Haliastur sphenurus	Whistling Kite					x		x	x	x
Haliastur indus	Brahminy Kite							x		
Hieraaetus morphnoides	Little Eagle					x		x	x	
Milvus migrans	Black Kite					x		x	x	
Panidon haliaetus	Eastern Osprey		Mi	S5			x			
FALCONIDAE										
Falco cenchroides cenchroides	Australian Kestrel					x		x	x	x
Falco berigora berigora	Brown Falcon					x		x	x	x
Falco longipennis	Australian Hobby					x		x	x	
RALLIDAE										
Gallirallus philippensis	Buff-banded Rail					x				
Fulica atra	Eurasian Coot					x		x	x	
OTIDIDAE										
Ardeotis australis	Australian Bustard					x		x	x	x
BURHINIDAE										
Burhinus grallarius	Bush Stone-curlew					x			x	x
RECURVIROSTRIDAE										
Himantopus himantopus	Black-winged Stilt					x			x	
CHARADRIIDAE										
Charadrius veredus	Oriental Plover		Mi	S5			x			
Charadrius ruficapillus	Red-capped Plover							x		
Charadrius leschenaultii	Greater Sand Plover		Mi	S5				x		
Elseyornis melanops	Black-fronted Dotterel					x		x	x	
Vanellus tricolor	Banded Lapwing					x		x		
ROSTRATULIDAE										
Rostratula australis	Australian Painted Snipe		EN	S2			x			

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
SCOLOPACIDAE										
Actitis hypoleucos	Common Sandpiper					x		x		
Calidris acuminata	Sharp-tailed Sandpiper			S5		x				
Numenius phaeopus	Whimbrel			S5				x		
Tringa glareola	Wood Sandpiper			S5		x		x	x	
Tringa nebularia	Common Greenshank			S5				x		
TURNICIDAE										
Turnix velox	Little Button-quail					x		x	x	x
GLAREOLIDAE										
Glareola maldivarum	Oriental Pratincole		Mi	S5			x			
PSITTACIDAE										
Barnardius zonarius zonarius	Australian Ringneck					x		x	x	x
Melopsittacus undulatus	Budgerigar					x		x	x	x
Pezoporus occidentallis	Night Parrot		EN	S2			x			
CACATUIDAE										
Cacatua sanguinea	Little Corella					x		x	x	x
Cacatua roseicapilla	Galah					x		x	x	x
Nymphicus hollandicus	Cockatiel					x		x	x	x
CUCULIDAE										
Cacomantis pallidus	Pallid Cuckoo					x		x	x	x
Chrysococcyx basalis	Horsfield's Bronze Cuckoo					x		x	x	x
Chrysococcyx osculans	Black-eared Cuckoo								x	
Centropus phasianinus	Pheasant Coucal							x	x	x
STRIGIDAE										
Ninox connivens	Barking Owl					x				
Ninox novaeseelandiae boobook	Southern Boobook Owl					x		x	x	x
TYTONIDAE										
Tyto javanica	Eastern Barn Owl					x				

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
ACLEDINIDAE										
Dacelo leachii leachii	Blue-winged Kookaburra					x		x	x	x
Todiramphus pyrrhopygia	Red-backed Kingfisher					x		x	x	x
Todiramphus sanctus	Sacred Kingfisher					x		x	x	
MEROPIDAE										
Merops ornatus	Rainbow Bee-eater		Mi	S5		x	x	x	x	x
PTILONORHYNCHIDAE										
Ptilonorhynchus maculatus guttatus	Western Bowerbird					x			x	x
MALURIDAE										
Amytornis striatus	Striated Grasswren					x		x	x	x
Malurus lamberti assimilis	Variegated Fairy-wren					x		x	x	x
Malurus leucopterus leuconotus	White-winged Fairy-wren					x		x	x	x
Stipiturus ruficeps	Rufous Crowned Emu-wren								x	
ACANTHIZIDAE										
Acanthiza apicalis	Inland Thornbill					x				
Acanthiza uropygialis	Chestnut-rumped Thornbill					x			x	
Gerygone fusca	Western Gerygone					x			x	
Gerygone tenebrosa	Dusky Gerygone							x		
Smicrornis brevirostris	Weebill					x		x	x	x
PARDALOTIDAE										
Pardalotus punctatus	Spotted Pardalote					x				
Pardalotus rubricatus	Red-browed Pardalote					x		x	x	x
Pardalotus striatus	Striated Pardalote					x			x	x
MELIPHAGIDAE										
Acanthagenys rufogularis	Spiny-cheeked Honeyeater					x		x	x	
Certhionyx variegatus	Pied Honeyeater					x			x	
Epthianura tricolor	Crimson Chat					x			x	x
Ptilotula keartlandi	Grey-headed Honeyeater							x	x	x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Ptilotula penicillata	White-plumed Honeyeater							x	x	x
Gavicalis virescens	Singing Honeyeater							x	x	x
Lichmera indistincta	Brown Honeyeater					x		x	x	x
Manorina flavigula	Yellow-throated Miner					x		x	x	x
Melithreptus gularis	Black-chinned Honeyeater					x			x	x
Sugomel nigrum	Black Honeyeater					x			x	x
POMATOSTOMIDAE										
Pomatostomus supercilious	White-browed Babbler					x				
Pomatostomus temporalis	Grey-crowned Babbler					x		x	x	x
CAMPEPHAGIDAE										
Coracina maxima	Ground Cuckoo-shrike					x				
Coracina novaehollandiae	Black-faced Cuckoo-shrike					x		x	x	x
Lalage tricolor	White-winged Triller					x		x		x
PACHYCEPHALIDAE										
Colluricincla harmonica	Grey Shrike-thrush					x		x	x	x
Pachycephala melanura	Mangrove Golden Whistler							x		
Pachycephala lanioides	White-breasted Whistler							x		
Pachycephala rufiventris	Rufous Whistler					x		x	x	x
OREOICIDAE										
Oreoica gutturalis	Crested Bellbird					x		x	x	x
ARTAMIDAE										
Artamus cinereus melanops	Black-faced Woodswallow					x		x	x	x
Artamus leucorynchus	White-breasted Woodswallow							x		
Artamus minor	Little Woodswallow					x			x	x
Artamus personatus	Masked Woodswallow					x				x
CRACTICIDAE										
Cracticus torquatus	Grey Butcherbird								x	
Cracticus nigrogularis	Pied Butcherbird					x		x	x	x
Cracticus tibicen	Australian Magpie					x		x		x

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
RHIPIDURIDAE										
Rhipidura albiscapa	Grey Fantail					x				
Rhipidura phasiana	Mangrove Grey Fantail							x		
Rhipidura leucophrys leucophrys	Willie Wagtail					x		x	x	x
MONARCHIDAE										
Grallina cyanoleuca	Magpie-lark					x		x	x	x
CORVIDAE										
Corvus bennetti	Little Crow					x		x	x	
Corvus orru	Torresian Crow					x		x	x	x
PETROICIDAE										
Melanodryas cucullata	Hooded Robin					x			x	
Petroicas goodenovii	Red-capped Robin					x			x	
ALAUDIDAE										
Mirafra javanica	Horsfield's Bushlark					x		x		x
ACROCEPHALIDAE										
Acrocephalus australis	Australian Reed Warbler								x	
LOCUSTELLIDAE										
Eremiornis carteri	Spinifex-bird					x		x	x	x
Megalurus cruralis	Brown Songlark					x		x	x	
Megalurus mathewsi	Rufous Songlark					x		x	x	x
TIMALIIDAE										
Zosterops luteus	Yellow White-eye							x		
HIRUNDINIDAE										
Cheramoeca leucosternus	White-backed swallow					x				
Hirundo neoxena	Welcome Swallow							x	x	
Hirundo rustica	Barn Swallow		Mi	S5			x			
Petrochelidon ariel	Fairy Martin					x		x	x	
Petrochelidon nigricans	Tree Martin					x		x	x	

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
DICAEIDAE										
Dicaeum hirundinaceum	Mistletoebird					x		x	x	x
ESTRILDIDAE										
Emblema pictum	Painted Finch					x		x	x	x
Neochmia ruficauda subclarescens	Star Finch (Western)					x		x	x	
Taeniopygia guttata	Zebra Finch					x		x	x	x
MOTACILLIDAE										
Motacilla flava	Yellow Wagtail		Mi	S5			x			
Motacilla cinerea	Grey Wagtail		Mi	S5			x			
Anthus australis	Australian Pipit					x		x	x	x

Table D.4: Mammal species list – results of database searches, literature reviews and survey results.

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
TACHYGLOSSIDAE										
Tachyglossus aculeatus	Short-beaked Echidna					x			x	
DASYURIDAE										
Dasycercus blythi	Brush-tailed Mulgara				P4	x	x			
Dasykaluta rosamondae	Little Red Kaluta					x			x	x
Dasyurus hallucatus	Northern Quoll		EN	S2		x	x		x	x
Ningaui ridei	Wongai Ningaui					x				
Ningaui timealeyi	Pilbara Ningaui					x			x	x
Planigale ingrami	Long-tailed Planigale					x			x	
Planigale maculata	Common Planigale					x				
Planigale sp.									x	x
Pseudantechinus roryi	Rory's Pseudantechinus								x	x
Pseudantechinus woolleyae	Woolley's Pseudantechinus					x			x	x
Sminthopsis longicaudata	Long-tailed Dunnart				P4	x	x			
Sminthopsis macroura	Stripe-faced Dunnart					x			x	
Sminthopsis youngsoni	Lesser Hairy-footed Dunnart					x			x	
THYLACOMYIDAE										
Macrotis lagotis	Greater Bilby, Dalgyte		VU	S3			x			
NOTORYCTIDAE										
Notoryctes caurinus	Northern Marsupial Mole		VU				x			
MACROPODIDAE										
Macropus robustus erubescens	Euro, Biggada					x			x	x
Macropus rufus	Red Kangaroo, Marlu					x			x	x
Petrogale rothschildi	Rothschild's Rock-wallaby					x			x	x
PHALANGERIDAE										
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum					x				

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
MEGADERMATIDAE										
Macroderma gigas	Ghost Bat			S3		x	x		x	x
RHINONYCTERIDAE										
Rhinonicteris aurantia Pilbara form	Pilbara Leaf-nosed Bat		VU	S3		x	x		x	x
EMBALLONURIDAE										
Sacclaimus flaviventris	Yellow-bellied Sheath-tailed Bat					x			x	x
Taphozous georgaianus	Common Sheath-tailed Bat					x			x	x
VESPERTILIONIDAE										
Chalinolobus gouldii	Gould's Wattled Bat					x			x	x
Nyctophilus daedalus	Northwestern Long-eared Bat								x	
Nyctophilus geoffroyi	Lesser Long-eared Bat					x			x	x
Scotorepens greyii	Little Broad-nosed Bat					x			x	x
Vespadelus finlaysoni	Finlayson's Cave-bat					x			x	x
MOLOSSIDAE										
Chaerephon jobensis	Greater Northern Free-tailed Bat					x			x	x
Ozimops lumsdenae	Northern Free-tailed Bat					x				x
Tadarida australis	White-striped Free-tailed Bat					x			x	
MURIDAE										
Leggadina lakedownensis	Short-tailed Mouse				P4	x	x			
Mus musculus	House Mouse	*				x	x		x	x
Notomys alexis	Spinifex Hopping-mouse					x			x	
Pseudomys chapmani	Western Pebble-mound Mouse				P4	x	x		x	x
Pseudomys delicatus	Delicate Mouse					x				x
Pseudomys desertor	Desert Mouse					x			x	x
Pseudomys hermannsburgensis	Sandy Inland Mouse					x			x	x
Zyzomys argurus	Common Rock-rat					x			x	x
LEPORIDAE										
Oryctolagus cuniculus	Rabbit	*				x	x			
CANIDAE										

Scientific name	Common name	Introduced	Conservation codes			Nature Map	EPBC Protected Matters Search	Birdlife	Previous surveys	Current survey
			EPBC Act	WC Act	Parks and Wildlife					
Canis lupus dingo	Dingo					x			x	
Canis lupus familiaris	Dog									x
Vulpes vulpes	Red Fox	*				x	x			
FELIDAE										
Felis catus	Cat	*				x	x		x	x
CAMELIDAE										
Camelus dromedarius	Dromedary, Camel	*				x				
EQUIDAE										
Equus asinus	Donkey	*				x	x			
BOVIDAE										
Bos taurus	European Cattle	*				x			x	x
Capra hircus	Goat	*					x			

Notes:
+ = Possible
x = Confirmed/certain

Conservation Codes

EN	Endangered
VU	Vulnerable
Mi	Migratory (Listed)
Ma	Marine (Listed)
S	Schedule
P	Priority

Previous surveys

Biota 2006, Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo

Biota 2007, Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonnica

Biota 2010, Greater Bungaroo Seasonal Fauna Survey

Table D.5: Potential and confirmed Short Range Endemic species within the vicinity of the survey area from database searches and literature review.

Taxonomic group	Species	Records	SRE category	Source	Remarks
ARACHNIDA					
Araneae: Mygalomorphae (Trapdoor Spiders and Allies)					
Actinopodidae	*Missulena* 'MYG040'	Warramboo	Potential	WA Museum; Biota 2006; Harms and Framenau 2013	
	Missulena 'MYG110'	Millstream-Chichester NP	Potential	WA Museum; Phoenix 2014	
	Missulena sp. indet.	Robe Valley (Mesa A), Warramboo, Delphine, Eliwana-Flying Fish	Potential	WA Museum; Biota 2006; Phoenix 2012, 2014; Harms and Framenau 2013	Likely multiple species
Barychelidae	*Aurecocrypta* 'po3'	NE. of Mardie Station	Potential	WA Museum	
	Idiommata 'MYG110'	Cane River Conservation Park	Potential	WA Museum	
	Synothele 'MYG112'	Mt Amy	Potential	WA Museum; Phoenix 2012	
	Synothele sp. indet.	Bungaroo Valley, Bungaroo South, Robe Valley (Mesa G), Delphine, Eliwana-Flying Fish, Mardie Station	Potential	WA Museum; Biota 2010; Phoenix 2012, 2014	Likely multiple species; listed as Barychelidae in Biota 2006
	Synothele sp. 'pseudidiommata'	Warramboo	Potential	WA Museum; Biota 2006	
Ctenizidae	*Conothele* sp. indet.	Robe Valley (Mesa G), Balla Balla, Eliwana-Flying Fish, Emu Siding, Zebra Hill	Potential	WA Museum; Phoenix 2012, 2014	Likely multiple species
Idiopidae	*Aganippe* sp. 'MYG302-DNA'	Robe Valley (Mesa K)	Confirmed	WA Museum	
	Aganippe sp. indet.	Warramboo	Potential	Biota 2006	
	Eucyrtops sp. indet.	Robe Valley	Potential	Phoenix 2012	
	Euoplos 'MYG082'	Mt Minnie	Potential	WA Museum	
Nemesiidae	*Aname* 'MYG093'	Mt Elvire, Mt Florance, Serenity Valley	Confirmed	WA Museum	
	Aname sp. indet.	Aquila, Onslow, Bungaroo Valley, Bungaroo South, Cane River, Robe Valley, Mt Amy, Mt Brockman, Mt Farquhar, Warramboo, Delphine, Eliwana-Flying Fish	Potential	WA Museum; Phoenix 2014	Likely multiple species
	Kwonkan sp. 'po2'	Mardie Station	Potential	WA Museum; Main 1983; Phoenix 2014	

Taxonomic group	Species	Records	SRE category	Source	Remarks
	Yilgarnia sp. indet.	Robe Valley, Delphine, Eliwana-Flying Fish, Mt Farquhar	Potential	WA Museum; Main 1986, Phoenix 2012, 2014	
Araneae: Araneomorphae ("Modern" Spiders)					
Oonopidae	*Grymeus* sp. indet.	Mt Elvire	Potential	WA Museum	
	Opopaea billroth	Python Pool	Confirmed	Baehr and Harvey 2013	
	Opopaea julianneae	Mt Billroth	Confirmed	Baehr and Harvey 2013	
	Opopea millstream	SSE of Millstream	Confirmed	Baehr and Harvey 2013	
Selenopidae	*Karaops* sp. indet.	Bungaroo Valley, Bungaroo South, Karratha, Middle Robe (Mesa G), Mt Edith, Millstream-Chichester NP, Python Pool, Red Hill Station	Potential	WA Museum; Biota 2010; Crews and Harvey 2011; Crews 2013; Phoenix 2014	Likely multiple species; listed as Selenopidae in Biota 2010
Harvestmen (Opiliones)					
Assamiidae	*Dampetrus* sp. indet.	Balla Balla Railway Project, Delphine, Eliwana-Flying Fish, Mt Herbert, Robe Valley (Mesas A, G, and J)	Potential	Phoenix 2014	
Pseudoscorpiones (Pseudoscorpions)					
Garypidae	*Synsphyronus* sp. indet.	Bungaroo Valley, Cane River, Robe Valley	Potential	Biota 2010, WAM; Harvey 1987, 2010	Listed as *Synsphyronus* sp. in Biota 2010
Garypinidae	*Solinus* sp. indet.	Bungaroo Valley	Potential	WA Museum, Biota 2010	Listed as *Solanus* sp. in Biota 2010
Hyidae	*Indohya* sp. indet.	Bungaroo Valley, Exmouth Limestone, Learmonth, Robe Valley	Potential	WA Museum	Genus known from subterranean and epigean habitats
	Indohya sp. 'Mesa K'	Robe Valley (Mesa K)	Potential	WA Museum	Known from subterranean and epigean habitats
	Indohya sp. 'PSE002'	South-east and South-west of Pannawonica, Mt Delphine	Potential	WA Museum; Harvey 1993; Harvey and Volschenk 2007	Probably unresolved species-complex
Olpiidae	*Austrohorus* sp. indet.	Marra Mamba	Confirmed	Biota 2013	Listed as *Austrohorus* sp. in Biota, 2010
Sternophoridae	*Afrosternophorus* sp. indet.	Cane River Conservation Park	Potential	WA Museum	

Taxonomic group	Species	Records	SRE category	Source	Remarks
Syarinidae	*Ideoblothrus* sp. indet.	Robe Valley (Mesas A, B, K), Congo, Cane River	Potential	WA Museum; Edward & Harvey 2010	Numerous records from subterranean habitats but surface occurrence is likely
Scorpiones (Scorpions)					
Buthidae	*Lychas* 'warramboo 1'	Warramboo	Potential	WA Museum; Biota 2006	
	Lychas 'scottae'	Mt Brockman	Potential	WA Museum	
	Lychas sp. nov.	Middle Robe	Potential	ecologia Environment 2013	
Urodacidae	*Urodacus* cf. 'mckenziei'	Mt Brockman	Potential	WA Museum	
	Urodacus 'hamersley black'	Hamersley Range	Potential	WA Museum	
CRUSTACEA					
Armadillidae	*Acanthodillo* sp. indet.	Eliwana-Flying Fish	Potential	Phoenix 2012	
	Acanthodillo sp. 6	Karratha to Millstream-Chichester NP	Potential	Phoenix 2014	
	Barrowdillo sp. nov. 5	Middle Robe	Potential	ecologia Environment 2013	
	cf. *Barrowdillo* sp. 3	Karratha to Millstream-Chichester NP	Potential	Phoenix 2014	
	cf. *Barrowdillo* sp. 9	Central Pilbara	Potential	Phoenix 2014	
	cf. *Barrowdillo* sp. 10	Central Pilbara	Potential	Phoenix 2014	
	cf. *Barrowdillo* sp. 11	Central Pilbara	Potential	Phoenix 2014	
	Buddelundia 10	Central Pilbara	Potential	Phoenix 2012	Unresolved species-complex
	Buddelundia '10 1016a'	Balla Balla Railway Project	Potential	Phoenix 2014	
	Buddelundia '17'	Central Pilbara	Potential	Phoenix 2014	
	Buddelundia '19'	Central Pilbara	Potential	Phoenix 2014	
	Buddelundia '30'	Bungaroo South, Middle Robe	Potential	ecologia Environment 2013; Phoenix 2014	
	Buddelundia '33'	Central Pilbara, Karratha to Millstream-Chichester NP	Potential	Phoenix 2014	
	Buddelundia '54'	Central Pilbara	Potential	Phoenix 2014	

Taxonomic group	Species	Records	SRE category	Source	Remarks
	Buddelundia '61'	Bungaroo South	Potential	Phoenix 2014	
	Buddelundia '64'	Mt Farquhar, Nammuldi, Mt Brockman	Potential	Phoenix 2014	
	Buddelundia '66'	Mt Farquhar	Potential	Phoenix 2014	
	Buddelundia '76'	Central Pilbara	Potential	Phoenix 2014	
	Buddelundia '92'	Balla Balla Railway Project	Potential	Phoenix 2014	
	Buddelundia '93'	Balla Balla Railway Project	Potential	Phoenix 2014	
	Buddelundia '94'	Balla Balla Railway Project	Potential	Phoenix 2014	
	Buddelundia '95'	Balla Balla Railway Project	Potential	Phoenix 2014	
	Buddelundia sp. indet.	Bungaroo South, Eliwana-Flying Fish, Delphine, Mt Brockman, Mt Farquhar	Potential	Phoenix 2012	Likely multiple species
	Cubaris sp. 999	Eliwana-Flying Fish, Delphine	Potential	Phoenix 2012, 2014	
	Spherillo '999'	Mt Farquhar, Delphine	Potential	Phoenix 2012, 2014	
Philosciidae	Philosciidae 'unknown genus'	Middle Robe	Potential	ecologia Environment 2013	
	Philosciidae 'pannawonica'	Pannawonica	Potential	Phoenix 2014	
DIPLOPODA (Millipedes)					
Paradoxosomatidae	*Antichiropus* sp. indet.	Bungaroo South; Cane River Reserve, Marda Pool, Karratha- and Mardie Stations, Millstream-Chichester NP, Pannawonica Road	Potential	WA Museum; Car *et al.* 2013, Car and Harvey 2014; Phoenix 2014	Likely multiple species
	Antichiropus 'DIP009'	Mt Minnie	Confirmed	WA Museum; Car *et al.* 2013; Car and Harvey 2014	
	Antichiropus 'DIP023'	Mt Berry, Mt Stuart Station	Confirmed	WA Museum; Car *et al.* 2013; Car and Harvey 2014	
	Antichiropus 'DIP024'	Millstream-Chichester NP	Confirmed	WA Museum; Car *et al.* 2013; Car and Harvey 2014	
	Antichiropus 'DIP024'	Millstream-Chichester NP	Confirmed	WA Museum; Car *et al.* 2013; Car and Harvey 2014	
	Antichiropus 'DIP041'	Mt Elvire	Confirmed	WAM; Car *et al.* 2013; Car and Harvey 2014	

Taxonomic group	Species	Records	SRE category	Source	Remarks
	Boreohesperus delicatus	Marda Pool	Confirmed	Car and Harvey 2013	
	Boreohesperus furcosus	Mt Minnie	Confirmed	Car and Harvey 2013	
	Boreohesperus undulatus	Karratha Station, Mt Minnie	Confirmed	Car and Harvey 2013	
Siphonotidae	Siphonotidae sp. indet.	Bungaroo South, near Tom Price (White Quartz Road)	Confirmed	Biota 2006; Phoenix 2014	
CHILOPODA (Centipedes)					
Chilenophilidae	*Sepedonophilus* sp. indet.	Balla Balla, Mt Farquhar	Potential	WA Museum; Phoenix 2014	
Cryptopidae	*Cryptops* sp. indet	Balla Balla, Bungaroo South, Robe Valley (Mesas A and K), Delphine, Eliwana-Flying Fish, Mt Farquhar	Potential	WA Museum; Phoenix 2014	Likely multiple species
Mecistocephalidae	*Mecistocephalus* sp. indet.	Bungaroo South, Delphine, Eliwana-Flying Fish, Mt Farquhar	Potential	WA Museum; Phoenix 2012	Likely multiple species
GASTROPODA (Snails)					
Bothriembryontidae	Bothriembryontidae 'Pilbara'-complex	Hamersley Range, Mt Farquhar, Millstream, Tom Price, Wodgina	Potential	WA Museum, Phoenix 2014	Likely multiple species
Camaenidae	New genus cf. 'Mt Robinson'	Bungaroo South, Delphine	Potential	Phoenix 2012, 2014	
	Plectorhagada meilgana	Glenflorrie Station, Minnie Springs, East of Exmouth Road	Confirmed	Solem 1997; Phoenix 2014	
	Rhagada sp. 'Beasley'[#]	Beasley River, Tom Price	Previously listed but not SRE	Biota 2006, 2013	Genetic species; probably same species as *Rhagada* sp. 'Tom Price' (Biota 2013)
	Rhagada cf. *radleyi*	Millstream, Mt Hebert, Deep Reach Pool, Coolawanyah Station	Confirmed	WA Museum	
	Rhagada sp. indet.	Millstream-Chichester NP, Mardie Homestead, Mt Brockman, Mt Hebert, Mt Price, Mt Turner, Pannawonica Road, Whim Creek	Potential	Whisson and Kirkendale 2014	Known mostly from dead-taken shells; may be multiple species
	Rhagada sp. 'Pannawonica'[#]	Pannawonica, Marra Mamba	Previously listed but not SRE	Biota 2006, 2010, 2013, 2010; Hamilton and Johnson 2015	Genetic species; clearly distinct from *Rhagada* sp. 'Beasley' and *R.* 'Tom Price' (Biota 2013)

Taxonomic group	Species	Records	SRE category	Source	Remarks
Camaenidae	*Rhagada* sp. 'Tom Price'[#]	Beasley River, Tom Price	Previously listed but not SRE	Biota 2013	Genetic species; probably same species as *Rhagada* sp. 'Beasley' (Biota 2013)
	Quistrachia herberti	Bilanoo Hill, Millstream-Chichester NP, Karratha, Mt Farquhar, Mt Herbert	Confirmed	Solem 1997; Whisson and Kirkendale 2014	
	Quistrachia sp. indet.	Balla Balla, Delphine, Marra Mamba, Mt Hebert, Millstream-Chichester BP	Potential	Biota 2013; Phoenix 2012, 2014	Known mostly from dead-taken shells; likely multiple species
	Quistrachia 'X'	Cape Preston	Potential	WA Museum	
Glacidorbidae	*Glacidorbis* sp. indet.	Mardie Station	Potential	WA Museum	
Hydrobiidae	Hydrobiidae sp. indet.	Bungaroo Creek	Confirmed	WA Museum	

[#] previously referred to as *Rhagada* 'small banded' and thought to be a potential SRE species (WAM data); however recent molecular analyses by Biota Environmental Sciences (2013) have shown that this morphospecies consists of three distinct genetic lineages, all with ranges > 10,000 km^2 (Biota 2013).

References:

Baehr, B.C., and Harvey, M.S. (2013) The goblin spider genus *Opopaea* in Australia and the Pacific islands (Araneae: Oonopidae). *Memoirs of the Queensland Museum | Nature* **58**, 107-338.

Biota (2006) Fauna Habitats and Fauna Assemblage of the Mesa A Transport Corridor and Warramboo. Biota Environmental Sciences, Leederville, WA, 105 pp.

Biota (2007) Bungaroo Trial Pit and Transport Corridor to Mesa J, near Pannawonica. Final Report prepared for Biota Environmental Sciences Pty Ltd. Biota Environmental Sciences, Leederville, Western Australia, 67 pp.

Biota (2010) Greater Bungaroo Seasonal Fauna Survey. Biota Environmental Sciences, Leederville, Western Australia, 73 pp.

Car, C.A., and Harvey, M.S. (2013) A review of the Western Australian keeled millipede genus *Boreohesperus* (Diplopoda, Polydesmida, Paradoxosomatidae). *ZooKeys* **290**, 1-19.

Car, C.A., and Harvey, M.S. (2014) The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 2: species of the Great Western Woodlands region of Western Australia. *Records of the Western Australian Museum* **29**, 20-77.

Car, C.A., Wojcieszek, J.M., and Harvey, M.S. (2013) The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 1: redefinition of the genus and redescriptions of existing species. *Records of the Western Australian Museum* **28**, 83-118.

Crews, S.C. (2013) Thirteen new species of the spider genus *Karaops* (Araneae: Selenopidae) from Western Australia. *Zootaxa* **3647**, 443-469.

Crews, S.C., and Harvey, M.S. (2011) The spider family Selenopidae (Arachnida, Araneae) in Australasia and the Oriental Region. *ZooKeys* **99**, 1-103.

Ecologia (2013) Middle Robe and East Deependale Flora, Vegetation, Vertebrate and Invertebrate Survey. Final Report for Rio Tinto Ltd., ecologia Environment, West Perth, 183 pp.

Edward, K.L., and Harvey, M.S. (2008) Short-range endemism in hypogean environments: the pseudoscorpion genera *Tyrannochthonius* and *Lagynochthonius* (Pseudoscorpiones: Chthoniidae) in the semiarid zone of Western Australia. *Invertebrate Systematics* **22**, 259-293.

Hamilton, Z.R., and Johnson, M.S. (2015) Hybridization between genetically and morphologically divergent forms of *Rhagada* (Gastropoda: Camaenidae) snails at a zone of secondary contact. *Biological Journal of the Linnean Society* **114**, 348-362.

Harms, D., and Framenau, V.W. (2013) New species of Mouse Spiders (Araneae: Mygalomorphae: Actinopodidae: *Missulena*) from the Pilbara region, Western Australia. *Zootaxa* **3637**, 521-540.

Harvey, M.S. (1987) A revision of the genus *Synsphyronus* Chamberlin (Garypidae: Pseudoscorpionida: Arachnida). *Australian Journal of Zoology, Supplementary Series* **126**, 1-99

Harvey, M.S. (1993) The systematics of the Hyidae (Pseudoscorpionida: Neobisioidea). *Invertebrate Taxonomy* **7**, 1-32.

Harvey, M.S. (2010) Two new species of *Synsphyronus* (Pseudoscorpiones: Garypidae) from southern Western Australian granite landforms. *Records of the Western Australian Museum* **26**, 11-22.

Harvey, M.S., and Edward, K.L. (2007) A review of the pseudoscorpion genus *Ideoblothrus* (Pseudoscorpiones, Syarinidae) from western and northern Australia. *Journal of Natural History* **41**, 445-472.

Harvey, M.S., and Volschenk, E.S. (2007) Systematics of the Gondwanan pseudoscorpion family Hyidae (Pseudoscorpiones: Neobisoidea): new data and a revised hypothesis. *Invertebrate Systematics* **21**, 365-406.

Main, B.Y. (1983) Further studies on the systematics of Australian Diplurinae (Chelicerata: Mygalomorphae: Dipluridae): Two new genera from south western Australia. *Journal of Natural History* **17**, 923-949.

Main, B.Y. (1986) Further Studies on the Systematics of Australian Diplurinae (Araneae: Mygalomorphae: Dipluridae): A New Genus from South-western Australia. *Records of the Western Australian Museum* **12**, 8.

Phoenix (2012) Terrestrial fauna surveys for the Buckland Project. Final Report prepared for Iron Ore Holdings Ltd. Phoenix Environmental Sciences, Balcatta, Western Australia, 95 pp.

Phoenix (2014) Terresterial fauna surveys for the Balla Balla Railway Project. Final Report prepared for Preston Consulting on behalf of Rutila Resourcs Ltd. Phoenix Environmental Sciences, Balcatta, Western Australia, 100 pp.

Solem, A., 1997. Camaenid land snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae). VII. Taxa from Dampierland through the Nullarbor. Records of the Western Australian Museum, Perth, W.A.

Whisson, C., and Kirkendale, L. (2014) Field Guide to the terrestrial and freshwater molluscs of the North West, version 1.0. Online at http://museum.wa.gov.au/catalogues-beta/wam-fieldguides/pilbara-snails

Whisson, C., and Köhler, F. (2013) Gastrocopta (Mollusca, Gastropoda, Pupillidae) in the Pilbara region of Western Australia. *ZooKeys* **261**, 15-39.

Table D.6: Amphibian species recorded during the current surveys.

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
HYLIDAE									
Litoria rubella									3
MYOBATRACHIDAE									
Pseudophryne douglasi				3					5
Uperoleia saxatilis									20^

^ calls

Table D.7: Reptile species recorded during the current surveys.

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
AGAMIDAE									
Amphibolurus longirostris			1					2	2
Ctenophorus caudicinctus				1	1	2			
Ctenophorus isolepis isolepis			1						1
Pogona minor									1
CARPHODACTYLIDAE									
Nephurus wheeleri									1
DIPLODACTYLIDAE									
Crenadactylus ocellatus									1
Diplodactylus bilybara	2	2	1	1					1
Lucasium stenodactylum				1					
Lucasium wombeyi			1				1		1
Oedura marmorata				1					1
Strophurus elderi	1		1			1			
GEKKONIDAE									
Gehyra pilbara									1
Gehyra punctata						1	2		
Gehyra variegata							1		
Heteronotia binoei						1		2	
Heternotia spelea									1
Rhynchoedura ornata									1
PYGOPODIDAE									
Delma pax	1							3	
Lialis burtonis									1
EGERNIIDAE									
Cyclodomorphus melanops									3
Ergenia formosa									2
EUGONGYLIDAE									
Carlia munda			2					6	1
Cryptoblepharus ustulatus				1					
Menetia greyii		2							1
Menetia surda								1	
Morethia ruficauda exquisita					3	1			1
SPHENOMORPHIDAE									
Ctenotus grandis titan	1	4	2					4	
Ctenotus pantherinus	6				3	1			

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
Ctenotus rubicundus					1	2			
Ctenotus saxatilis					1		2	2	
Lerista flammicauda									1
Lerista muelleri									1
Notoscincus butleri					1			1	
Notoscincus ornatus									1
VARANIDAE									
Varanus acanthurus					1	3	1		
Varanus bushi								1	
Varanus giganteus	1								3
Varanus panoptes panoptes									1
Varanus hamersleyensis									1
TYPHLOPIDAE									
Anilios ammodytes			1						
Anilios ganei					1				
Anilios grypus	2								
BOIDAE									
Antaresia perthensis						2			
Antaresia stimsoni stimsoni									1
Liasis olivaceus barroni									1+
ELAPIDAE									
Demansia psammophis cupreiceps					1		1		
Furina ornata				1					
Pseudechis australis						1			
Pseudonaja mengdeni			1						
Pseudonaja modesta					1				

+ scat

Table D.8: Bird species recorded during the current surveys.

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
DROMAIIDAE									
Dromaius novaehollandiae		1							1
PHASIANIDAE									
Coturnix ypsilophora									2
COLUMBIDAE									
Geopelia cuneata		4	1				1	1	4
Geopelia striata placida									1
Geophaps plumifera			3	12	1	6	1	7	2
Ocyphaps lophotes	1	1	5	3		5	5	2	
Phaps chalcoptera				1					2
PODARGIDAE									
Podargus strigoides									1
CAPRIMULGIDAE									
Eurostopodus argus		1							5

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
AEGOTHELIDAE									
Aegotheles cristatus						1			
ARDEIDAE									
Ardea pacifica									3
ACCIPITRIDAE									
Accipiter cirrocephalus									1
Aquila audax									1
Circus assimilis	2				1	1	1		
Elanus caeruleus	1				1				
Haliastur sphenurus						1			
OTIDIDAE									
Ardeotis australis									2
FALCONIDAE									
Falco cenchroides cenchroides					2	1			
Falco berigora berigora	1	1							
BURHINIDAE									
Burhinus grallarius									4
TURNICIDAE									
Turnix velox									3
CACATUIDAE									
Cacatua roseicapilla						1			
Cacatua sanguinea		1		10		5	4	8	1
Nymphicus hollandicus									17
PSITTACIDAE									
Barnardius zonarius		1						2	
Eolophus roseicapilla				5		5	4	8	5
Melopsittacus undulatus	16	7	19	25	15	47	12	24	
CUCULIDAE									
Cacomantis pallidus	3	2	5	2	2	1	2	4	3
Chrysococcyx basalis	3	2	1	1	3			2	4
Centropus phasianius									1
STRIGIDAE									
Ninox boobook boobook									1
ALCEDINIDAE									
Dacelo leachii leachii		2							1
Todiramphus pyrrhopygia		1	1		1				2
MEROPIDAE									
Merops ornatus	2	12	9	5				5	11
PTILONORHYNCHIDAE									
Ptilonorhynchus maculatus guttatus					1	1	1		7

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
MALURIDAE									
Amytornis striatus									2
Malurus lamberti assimilis	3			1	9	7		2	
Malurus leucopterus			3		8				1
ACANTHIZIDAE									
Smicrornis brevirostris	1		5	5	10	3	2	8	2
PARDALOTIDAE									
Pardalotus rubricatus				2		1	1	2	1
Pardalotus striatus						1			
MELIPHAGIDAE									
Epthianura tricolor	1		1		2				2
Ptilotula keartlandi	3		2	6	2	3		3	2
Ptilotula penicillata		3						9	2
Gavicalis virescens	10	3	6	1	4	3	4	6	2
Lichmera indistincta		2	1	1				4	
Manorina flavigula	6	1	14	11	3	8	2	12	
Melithreptus gularis				2		3			3
Sugomel nigrum		2				1			
POMATOSTOMIDAE									
Pomatostomus temporalis									4
CAMPEPHAGIDAE									
Coracina novaehollandiae	1	3		3	2			2	
Lalage tricolor		1		2		1			
PACHYCEPHALIDAE									
Colluricincla harmonica		3	1	5	2	1		3	
Pachycephala rufiventris		1			3	2			1
OREOICIDAE									
Oreoica gutturalis	1	3	1	1	2	2	2	2	2
ARTAMIDAE									
Artamus cinereus melanops	3	3							
Artamus minor	1		5						4
Artamus personatus									7
CRACTICIDAE									
Cracticus nigrogularis	3	1	4	6	5	6	5	4	
Cracticus tibicen	2		3						4
RHIPIDURIDAE									
Rhipidura leucophrys leucophrys	1	1	3	1	2	6		1	4
MONARCHIDAE									
Grallina cyanoleuca		4							
CORVIDAE									

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
Corvus orru	2		6	5	2	2	1	6	8
ALAUDIDAE									
Mirafra javanica						1			4
LOCUSTELLIDAE									
Eremiornis carteri	10	3	6		7			3	1
Cincloramphus mathewsi		1			3	1			
DICAEIDAE									
Dicaeum hirundinaceum				1					
ESTRILDIDAE									
Emblema pictum	9	2	13	17	6	1	9	16	8
Taeniopygia guttata	2		2	7	4	4	3	6	
MOTACILLIDAE									
Anthus australis			1						1

Table D.9: Non-volant mammal species recorded during the surrent survey.

Species name	BTG1	BTG2	BTG3	BTG4	BTG5	BTG6	BTG7	BTG8	Other
DASYURIDAE									
Dasykaluta rosamondae		1							
Dasyurus hallucatus						2			9*
Ningaui timealeyi	2		1			1		6	
Planigale species 1				2	1			2	
Pseudantechinus roryi						1			1
Pseudantechinus woolleyae							2		1
MACROPODIDAE									
Osphranter robustus erubescens				3	1				15
Osphranter rufus				2					4
Petrogale rothschildi									3
MURIDAE									
**Mus musculus*	1							4	
Pseudomys chapmani			1					1	27+
Pseudomys delicatulus								1	
Pseudomys desertor	1		4					3	
Pseudomys hermannsburgensis		5	4	1				11	
Zyzomys argurus							7		1
CANIDAE									
**Canis familiaris*									7
FELIDAE									
**Felis catus*									2
BOVIDAE									
**Bos taurus*									51

* no. camera sites; + inactive mounds

Table D.10: Volant mammal (bat) species recorded during the current surveys.

Species Name	JO-BAT-1	JO-BAT-2	MJ1	MJ13	MJ21	MJ5	SRE14	SM80270a	SM76340a	SM110400a	SM75660a	Other
MEGADERMATIDAE												
Macroderma gigas		Low (1 call)	Low (1 call)						Low (3 calls)			3#
RHINONYCTERIDAE												
Rhinonicteris aurantia Pilbara form		Low (23 calls)	High (115 calls)		Low (8 calls)	Low (2 calls)		Low (18 calls)	Low (6 calls)	Low (22 calls)	Low (9 calls)	
EMBALLONURIDAE												
Saccolaimus flaviventris								Low				
Taphozous georgaianus		Low	Med		High	Low			Low	Low	Low	
VESPERTILIONIDAE												
Chalinolobus gouldii		Low	Low		Low	Low		High		Low	Low	
Nyctophilus geoffroyi								Low			Low	
Scotorepens greyii		Low	Low		Low	Low		Low			High	
Vespadelus finlaysoni	High	High	Med		High	Low		Med		Low	High	
MOLOSSIDAE												
Chaerephon jobensis			Low		Low			Med	Low		Low	
Ozimops lumsdenae		Low	Low		Low						Low	

caves in which scats were recorded

Table D.11: Species in SRE groups collected during the current surveys. Potential SRE species are shaded grey and the number of specimens per site is given in the columns.

Species/Site	SRE1b	SRE2b	SRE3b	SRE4b	SRE5b	SRE6b	SRE7b	SRE8b	SRE9b	BTG1	BTG2	BTG3	BTG5	BTG7	BTG8	JO2	JO3	JO10	JO14	MCL01	MJ31	MJ32	MJ36	MJ42	SRE4	SRE13	SRE14	SRE20	Total
PSEUDOSCORPIONIDA (PSEUDOSCORPIONS)																													
Atemnidae																													
Oratemnus sp. nov. 'Bungaroo'									4															4					8
Chthoniidae																													
Austrochthonius sp. 'Bungaroo'		1																											1
Tyrannochthonius sp. 'Bungaroo 2'																												1	1
Tyrannochthonius aridus																									3				3
Hyidae																													
Indohya 'PSE002'																									2				2
Olpiidae																													
Beierolpium 8/4	1	1																											2
Euryolpium sp. 'Bungaroo'					1																								1
Indolpium sp. 'Bungaroo 1'			1																							3			4
Indolpium sp.'Bungaroo 2'									3																		2		5
Syarinidae																													
Ideoblothrus sp. 'Bungaroo'																								2					2
SCORPIONES (SCORPIONS)																													
Buthidae																													
Lychas bituberculatus										1		2																	3
Lychas 'hairy tail'-group			1																								2		3
Lychas 'harveyi'											1																		1
ARANEAE (SPIDERS)																													
Selenopidae																													
Karaops sp. 'Bungaroo'							1																						1
DIPLOPODA																													
Spirobolida																													
Austrostrophus stictopygus							1													1						2	3		7
ISOPODA (SLATERS)																													
Armadillidae																													
Barrowdillo '2'			1												1												3		5
Buddelundia '10bf'								1		9	1	11			4			5											31
Buddelundia '14hr'							1	2				1							1						1		1	1	8
Buddelundia '15'		2	2																							20			24
Buddelundia '30'				2									1								2								5
Buddelundia '36'																		1						3					4
Buddelundia '61'			3		1		5	1						1								2				1	2		16
Buddelundiinae sp. indet.									1						1			1											3
Spherillo sp. indet.									4															1					5

Species/Site	SRE1b	SRE2b	SRE3b	SRE4b	SRE5b	SRE6b	SRE7b	SRE8b	SRE9b	BTG1	BTG2	BTG3	BTG5	BTG7	BTG8	JO2	JO3	JO10	JO14	MCL01	MJ31	MJ32	MJ36	MJ42	SRE4	SRE13	SRE14	SRE20	Total
GASTROPODA (SNAILS)																													
Camaenidae																													
Rhagada sp. 'Pannawonica'						4		1								4	1		2				1	3	3				19
Lymnaeidae																													
Austropeplea cf. *lessoni*																											5		5
Planorbiidae																													
Isidorella cf. *egregia*																											5		5
Pupillidae																													
Gastrocopta hedleyi		2	1																	11				3		20			37
Pupoides beltianus			4																	1				4					9
Subulinidae																													
Eremopeas interioris		4																		1							1		6

Appendix E: Threatened and Priority Fauna Species Likelihood of Occurrence within the Survey Area

This page has been left blank intentionally.

Table E.1: Likelihood of occurrence of conservation significant vertebrate fauna species occurring in the vicinity of the survey area.

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Reptiles						
Delma concinna major (Javelin Legless Lizard)			P1	This species of legless lizard is found in Shark Bay in Western Australia. Probable misidentification with *Delma* species.	Low	Low
Notoscincus butleri (Lined Soil-crevice Skink)			P4	Arid, rocky, near coastal Pilbara regions. Associated with spinifex-dominated areas near creeks and river margins.	High – previously recorded	Recorded
Anilios ganei (blindsnake)			P1	Little information is available on this species but it is believed to be associated with moist gorges and gullies.	High – previously recorded	Recorded
Liasis olivaceus barroni (Pilbara Olive Python)	VU	S3		Generally rocky habitats in close association to permanent and semi-permanent water sources.	High	Recorded
Birds						
Apus pacificus (Fork-tailed Swift)	Mi	S5		Largely an aerial species independent of the terrestrial environment.	High	Moderate
Ardea ibis (Cattle Egret)	Mi	S5		Largely a wetland species however can exploit drier open habitats more than other heron species.	Moderate	Moderate - may be present seasonally
Ardea modesta (Eastern Great Egret)	Mi	S5		Wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral).	Moderate	Moderate - may be present seasonally
Haliaeetus leucogaster (White-bellied Sea Eagle)	Ma	S5		This species is common in coastal environments but have been known to occur inland at times. It is generally found close to prey sources is an opportunistic carnivore and consumes a wide variety of animal prey, including carrion.	Low	Low
Panidon haliaetus (Eastern Osprey)	Mi	S5		Favours coastal areas, especially the mouths of large rivers, lagoons and lakes.	Low	Low

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Charadrius veredus (Oriental Plover)	Mi	S5		Breeding habitat includes arid grasslands, saltpans; non-breeding habitat includes grasslands, salt-fields, and coastal regions.	Low	Low
Glareola maldivarum (Oriental Pratincole)		S5		Feeds in the air and roosts on bare ground besides water	Low	Low
Charadrius leschenaultii (Greater Sand Plover)		S5		This species is almost entirely coastal, inhabiting littoral and estuarine habitats. It mainly occurs on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons.	Low	Low
Rostratula australis (Australian Painted Snipe)	EN	S2		Shallow terrestrial freshwater wetlands, temporary/permanent lakes, swamps and claypans with emergent grass, sedges, rushes and samphire.	Low	Low
Calidris acuminata (Sharp-tailed Sandpiper)		S5		Muddy edges of shallow fresh/brackish wetlands with emergent sedges, saltmarsh, grass and low vegetation.	Low	Low
Numenius phaeopus (Whimbrel)		S5		Primarily found in coastal habitats such as beaches, dunes, mudflats and mangroves however there are also scattered inland records.	Low	Low
Tringa glareola (Wood Sandpiper)		S5		Occurs mainly on freshwater wetlands of the inland interior and arid regions.	Low	Low
Tringa nebularia (Common Greenshank)		S5		Inland wetlands and coastal habitats of varying salinity. Typically large mudflats, saltmarsh, mangroves and seagrass	Low	Low
Pezoporus occidentalis (Night Parrot)	EN	S2		Samphire and chenopod shrublands	Low	Low
Merops ornatus (Rainbow Bee-eater)	Mi	S5		Lightly wooded, preferably sandy soil, near drainage channels and creek lines.	High – previously recorded	Recorded
Hirundo rustica (Barn Swallow)	Mi	S5		Coastal open country generally, especially near surface water and man-made structures (bridges and power wires).	Moderate	Low

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Motacilla flava (Yellow Wagtail)	Mi	S5		Damp short-grass flats, rice stubbles and edge of swamps, sewage ponds, bore overflows, grazed or mowed grass and irrigated areas.	Low	Low
Motacilla cinerea (Grey Wagtail)	Mi	S5		Mainly banks and rocks in fast-running freshwater habitats such as rivers, creeks, streams and around waterfalls.	Low	Low
Mammals						
Dasycercus blythi (Brush-tailed Mulgara)			P4	*Triodia* hummock and *Acacia* shrublands of sand or sandy-loam.	Low	Low
Dasyurus hallucatus (Northern Quoll)	EN	S2		Dissected rocky escarpments and rocky eucalypt woodland.	High – previously recorded	Recorded
Leggadina lakedownensis (Short-tailed Mouse, Karekanga)			P4	Open tussock and hummock grassland, *Acacia* shrubland and savannah woodland on alluvial clay / sandy soils.	Low	Low
Macrotis lagotis (Greater Bilby, Dalgyte)	VU	S3		Sand or sandy-loam in hummock grassland and or *Acacia* shrublands.	Low	Low
Notoryctes caurinus (Northern Marsupial Mole)	VU			Lives primarily underground of sand dunes and sandy soils along river flats.	Low	Low
Macroderma gigas (Ghost Bat)		S3		A wide range from rainforest, monsoon and vine scrub in the tropics to open woodlands and arid areas.	High – previously recorded	Recorded
Rhinonicteris aurantia (Pilbara form) (Pilbara Leaf-nosed Bat)	VU	S3		Deep warm, humid caves or rock cracks.	High	Recorded

Scientific name (common name)	Conservation codes			Preferred habitat	Likelihood of occurrence	
	EPBC Act	WC Act	Parks and Wildlife		Pre-survey	Post-survey
Pseudomys chapmani (Western Pebble-mound Mouse)			P4	Gentle rocky slopes, hills and spurs with small pebble surface cover and sparse vegetation.	High – previously recorded	Recorded
Sminthopis longicaudata (Long-tailed Dunnart)			P4	Common in rocky screes with hummock grassland and *Acacia* shrubs, tall open shrubland and woodlands.	High	High

Conservation Codes

EN	Endangered
VU	Vulnerable
Mi	Migratory (Listed)
Ma	Marine (Listed)
S	Schedule
P	Priority

Table E.2: Likelihood of SRE groups occurring in the vicinity of the survey area.

SRE group	Likelihood of occurrence
Mygalomorph Spiders	The desktop review identified a moderately diverse mygalomorph spider fauna (trapdoor spiders and allies), with at least 13 potential SRE species in five families: Actinopodidae (2 species), Barychelidae (4), Ctenizidae (1), Idiopidae (3) and Nemesiidae (3). Mygalomorph spiders generally have a high proportion of SRE species and recent studies have inferred high regional endemism and the presence of range-restricted species (Castalanelli *et al.* 2014; Harms and Framenau 2013; Harvey *et al.* 2012). It is possible that SRE mygalomorph spiders occur on the survey area but it should also be noted that all mygalomorph species collected previously from within the survey area (*Aname* spp. and *Synothele* spp.) were locally widespread and not considered SRE fauna (e.g. Biota 2007, 2010).
Araneomoprh spiders	Two spider families with potential SRE species have been recorded: wall crab spiders (family Selenopidae) and goblin spiders (Oonopidae). Selenopid spiders have been collected frequently but species identification is difficult because they were usually juveniles. These spiders are habitat specialists that live under rocks and have limited abilities of dispersal (Crews and Harvey 2011, Crews 2013). It is possible that this group is present on the rocky hills and breakaways in the survey area. Oonopid spiders are very small in body length, usually < 0.4 cm, and live in leaf litter. Three confirmed SRE species in the genus *Opopaea* and a potential SRE *Grymeus* species are known from the wider survey area and there is a slight possibility that additional species may occur in the study area.
Harvestmen	The harvestmen fauna of the Pilbara is depauperate and the only documented genus in the search area, *Dampetrus* (family Assamiidae), has been collected infrequently and always in low numbers. Collections are from moist leaf litter in relict habitats (e.g. gorges or between large rock boulders) and caves, suggesting an apparent moisture-dependence of these animals (Shear 2001). *Dampetrus* is likely to contain SRE species and has been collected from the Buckland Project in the ultimate vicinity of the survey area (e.g. Phoenix 2014); hence the occurrence of this genus in the study area is possible.
Pseudoscorpions	The pseudoscorpion fauna in the Search area was moderately diverse with at least seven potential SRE species in six families: Garypidae (1 species), Garypinidae (1), Hyidae (2), Olpiidae (1), Sternophoridae (1), and Syarinidae (1). The arid-adapted family Olpiidae is very diverse in the Pilbara but only one species, *Austrohorus* sp. indet., is currently considered a potential SRE (Biota 2013). *Synsphyronus* species in the family Garypidae are habitat specialists that live under rocks and have been collected previously from the hills and breakaways at Bungaroo (Biota 2010). *Ideoblothrus* and *Indohya* species are known from moist leaf litter in the search area and the available taxonomic literature points to high regional endemism and range restriction in this fauna (Harvey 1993; Harvey and Edward 2007; Harvey and Volschenk 2007). A seventh family, the Chthoniidae, has a high proportion of SRE species but has been recorded in the Pilbara primarily from subterranean habitats (Edward and Harvey 2008). Overall, it is likely that SRE pseudoscorpion species occur in the survey area.

SRE group	Likelihood of occurrence
Scorpions	Two genera of scorpions, *Lychas* and *Urodacus*, have been recorded in the search area. Most scorpions are arid-adapted and considered widespread across the Pilbara (e.g. Ecologia 2013) but there are also five potential SRE species. The Pilbara Biodiversity Survey recorded ten morphospecies of *Lychas* but the taxonomic resolution is currently poor and there are likely many more species (Volschenk *et al.* 2010). Scorpions will almost definitely occur in the search area but most species should be widespread. The presence of SRE scorpion species is possible but the likelihood low.
Slaters	This group is poorly documented in Western Australia and there are no taxonomic revisions, hence species identification is difficult and often tentative. It appears, however, that there are at least 25 potential SRE species in the search area, many of which have been collected in the ultimate vicinity of the survey area (Phoenix 2012). The species belong primarily to the family Armadillidae (23 species), slaters that roll up as a ball when disturbed, and the genera *Barrowdillo* (5) and *Buddelundia* (15). The family Philosciidae, slaters that cannot roll up, are much less diverse. Based on the data available, the occurrence of range-restricted isopods in the survey area is almost certain.
Millipedes	This group is ecologically diverse and there are some very widespread species in the Pilbara, such as the fire millipede *Austrostrophus stictopygus*, whereas almost all species in the genera *Antichiropus* and *Boreohesperus* (family Paradoxosomatidae) are SREs. Three species of *Boreohesperus* have recently been described (Car and Harvey 2013) in the wider search area but their known ranges do not overlap with the survey area. At least five species in the genus *Antichiropus* are also known (WAM data) and there are numerous additional records of unidentified juveniles in the search area. The family Siphonotidae (sucking millipedes) has also been recorded from Bungaroo South (Biota 2006). Based on the data available, it is likely that range-restricted millipedes occur in the survey area.
Centipedes	Almost nothing is known about the centipede fauna of the Pilbara but three families, Chilenophilidae, Cryptopidae and Mecistocephalidae, have been recorded and are likely to include SRE species. The records of *Cryptops* sp. indet., *Mecistocephalus* sp. indet. and *Sependophilus* sp. indet. are likely to represent multiple, potentially range-restricted species but DNA studies would be required to confirm this because the morphology is mostly inconclusive. It is possible that all three families occur in the search area.
Snails	This group is moderately well documented in the search area and there are at least seven terrestrial snail species in the families Bothriembryontidae and Camaenidae and two aquatic species in the families Glacidorbidae and Hydrobiidae that have been recorded as potential or confirmed SREs in past environmental assessments. The camaenid genus *Quistrachia* is present with at least two potential SRE species and a second genus, *Rhagada*, is common and frequently collected during environmental surveys. Species identification in *Rhagada* is often difficult because species are morphologically cryptic, have a variable shell morphology, occur in sympatry, and hybridise (Hamilton and Johnson 2015). Some species of *Rhagada* were previously treated as potential SREs but are now known to be widespread (Biota 2013). Based on the data available, the presence of snails in the survey area is highly likely.

Appendix F: Fauna Habitat Mapping

This page has been left blank intentionally.

420000 425000 430000 435000 440000 445000 450000 455000 460000

7590000 7585000 7580000 7575000 7570000 7565000

Pannawonica Rail

Bungaroo Access Road

Millstream Yarraloola Road

A B C D E F G H I J K L M N O P

MJ39 MJ38 M01 MJ37 MJ36 MJ28 JO-HAB-1 MJ35 JO13 JO12 M17b MJ26 M15 MJ41 SRE14 SRE14 JO10 MJ19 MJ17 JO9 M14b MJ12 MJ18 M14b Walk 2 28/5

Legend

- Roads
- Railway
- Map Extent
- Heritage Areas
- Survey Area
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:115,000 (A3)

0 2 4 6 8 10 Kilometres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1_Overview

7592000 420000 7593000

7591000

420000

7590000 421000

422000

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

M17

Millstream Yarraloola Road

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1A: Vertebrate Fauna Habitat Mapping

astron

Author: J. Oates	Date: 03-03-2016	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1A	Metres 0 100 200 300 400 500

N

7589000 422000 7590000 423000

422000 7588000 423000 424000

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1B: Vertebrate Fauna Habitat Mapping

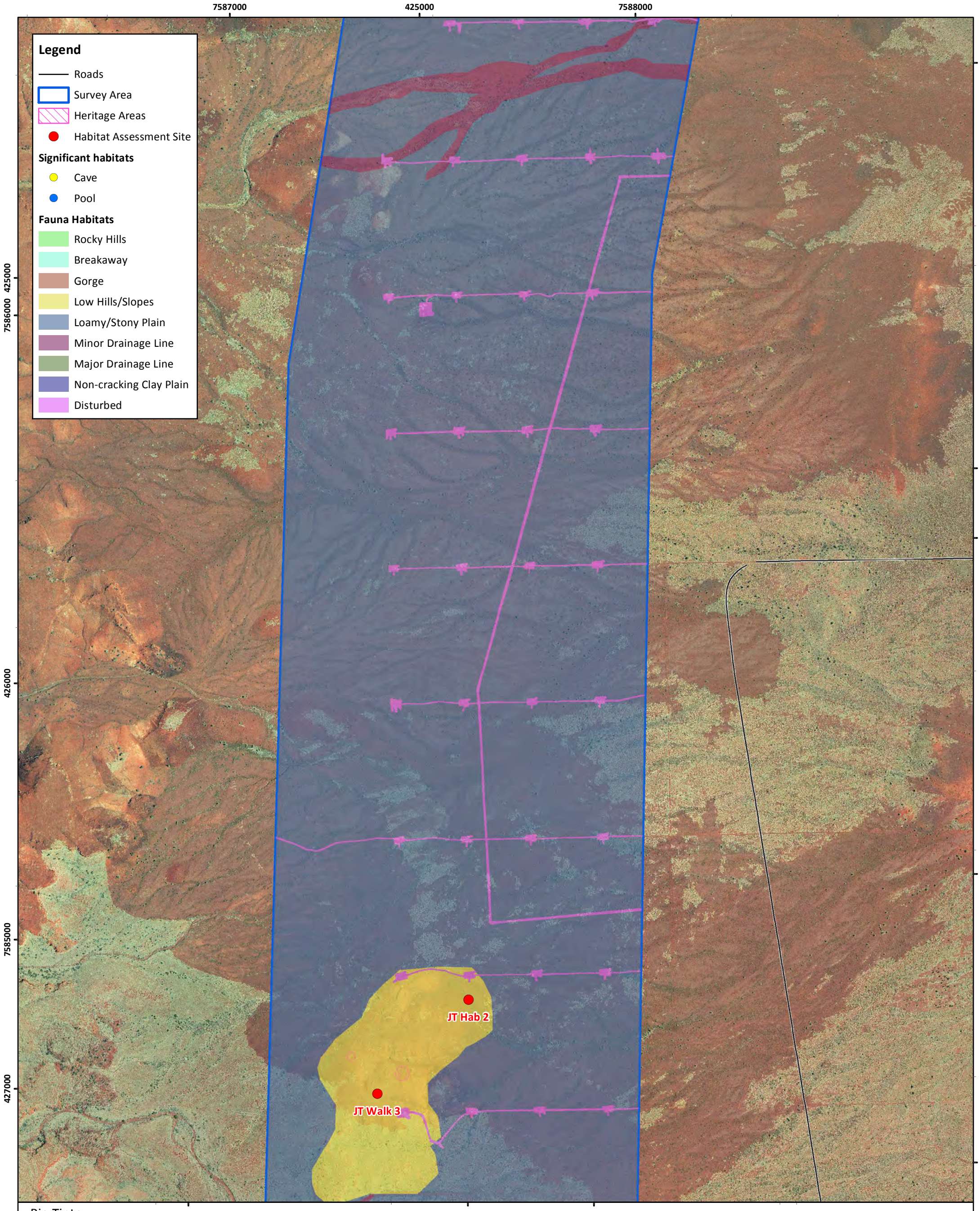
astron

Author: J. Oates	Date: 03-03-2016
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1B

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500



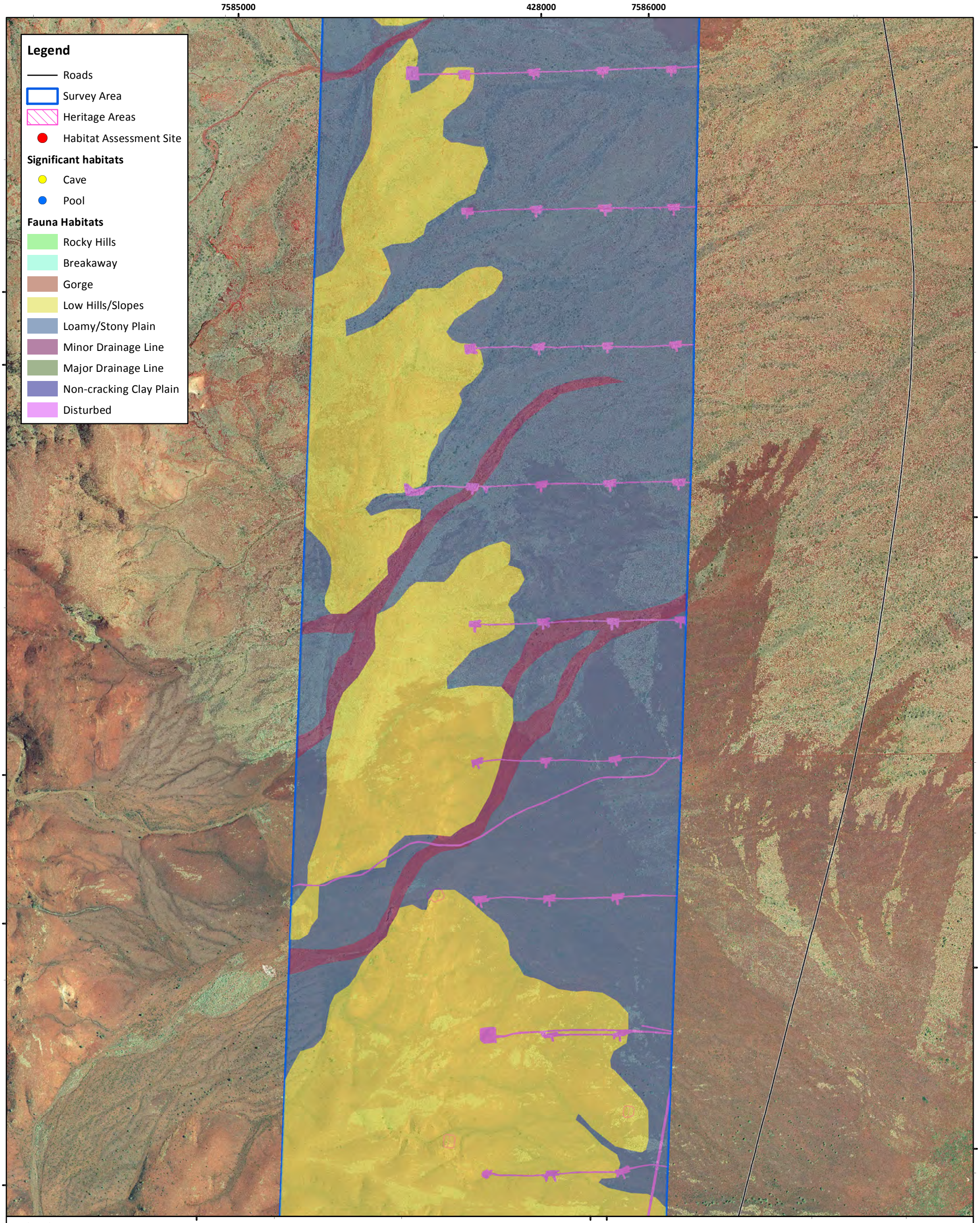
Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1C: Vertebrate Fauna Habitat Mapping

astron

Author: J. Oates	Date: 03-03-2016	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1C	Metres 0 100 200 300 400 500



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1D: Vertebrate Fauna Habitat Mapping

Author: J. Oates	Date: 03-03-2016	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1D	Metres 0 100 200 300 400 500

7582000 430000 7583000 431000

430000 431000 432000 7580000

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

JO-HAB-3

JO-HAB-2

JO-HAB-4

M17

M13

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1E: Vertebrate Fauna Habitat Mapping

astron

Author: J. Oates	Date: 03-03-2016
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1E

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500

N

7580000 433000 7581000 7582000

433000 7579000 434000 435000

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

MJ33 MJ20

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1F: Vertebrate Fauna Habitat Mapping

astron

Author: J. Oates	Date: 03-03-2016
Drawn: W.An	14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1F

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500

435000
7578000
7579000
436000
7580000
435000
7577000
436000
7576000
JO11

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1G: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1G

437000 7577000 438000 7578000 7579000

437000 438000 7575000 439000

M14c

MJ10

M17b

MJ39

M01

MJ38

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1H: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1H

7575000
440000
7577000
441000
7574000
440000
441000
MJ26
JO-HAB-1
MJ37
MJ36
M15
MJ35
JO12

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1I: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1I

7574000 442000 7575000 443000 7576000

7573000

442000

443000

JO10

JO13

MJ19

MJ18

MJ17

JO9

MJ41

MJ20A

M14b

M14b

MJ15

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1J: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1J

7572000 444000 7573000 7574000 445000 7575000

444000

7571000

445000

MJ15

MJ12

SRE14

SRE14

JT Walk 1

Walk 2 28/5

JO-1

JT Walk 2

MJ32

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1K: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates Drawn: W. An Date: 03-03-2016 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1K

7571000 446000 7572000 447000 7573000

446000

7570000

447000

MJ32
MJ30
MJ30
MJ29
MJ25
JO4
JO5
JO5
JO7
SRE13
Pool 1
JO-HAB-6
JO-HAB-5
JO3
JO8B
JO8A
M03
M03
MJ23
JO8
MJ22 - pool 4
MJ22 - pool 3
MJ22 - pool 2
MJ22 - pool 1
MJ22

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1L: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1L

447000 7569000 448000 7570000 7571000 449000

447000

448000

7567000

449000

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

M02

JO-BAT-2

JO-BAT-2

M08

M14

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1M: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1M

7571000 449000 7572000 450000 7573000

449000

7570000

450000

M14

M07

M06

M04

M05

JT Walk 30/05

JT GB Cave 1

M14

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1N: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1N

7568000 450000 7569000 451000 7570000

450000

451000

7566000

M08s

M09

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1O: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1O

7566000 452000 7567000 453000 7569000

452000

453000

Rpool3

M11c

M11b

M11

Rpool2

M12

Legend

- Roads
- Survey Area
- Heritage Areas
- Habitat Assessment Site

Significant habitats

- Cave
- Pool

Fauna Habitats

- Rocky Hills
- Breakaway
- Gorge
- Low Hills/Slopes
- Loamy/Stony Plain
- Minor Drainage Line
- Major Drainage Line
- Non-cracking Clay Plain
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.1P: Vertebrate Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_FaunaHabitat_FigF1P

This page has been left blank intentionally.

418000 420000 422000 424000 426000 428000 430000 432000 434000

7594000 7592000 7590000 7588000 7586000 7584000 7582000

Pannawonica Rail

Bungaroo Access Road

Mills-tream Yarrabola Road

Jinmawurrada Creek

Bungaroo Creek

Map Extent

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Northern Quoll Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.2A: Northern Quoll Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF2A_NQHSM

426000 428000 430000 432000 434000 436000 438000 440000 442000

7584000 7582000 7580000 7578000 7576000 7574000 7572000

Bungaroo Creek

Millstream Yarraloola Road

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Northern Quoll Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.2B: Northern Quoll Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF2B_NQHSM

442000 444000 446000 448000 450000 452000 454000 456000

7574000
7572000
7570000
7568000
7566000

Bungaroo Creek

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Northern Quoll Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.2C: Northern Quoll Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF2C_NQHSM

This page has been left blank intentionally.

418000 420000 422000 424000 426000 428000 430000 432000 434000

7594000 7592000 7590000 7588000 7586000 7584000 7582000

Pannawonica Rail

Bungaroo Access Road

Mills-tream Yarrabola Road

Jimmawurrada Creek

Bungaroo Creek

Map Extent

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Leaf-nosed Bat Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.3A: Pilbara Leaf-nosed Bat Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF3A_PLBHSM

Author: J. Oates Drawn: W. An Date: 03-03-2016

426000 428000 430000 432000 434000 436000 438000 440000 442000

7584000 7582000 7580000 7578000 7576000 7574000 7572000

Bungaroo Creek

Millstream Yarraloola Road

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Leaf-nosed Bat Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.3B: Pilbara Leaf-nosed Bat Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF3B_PLBHSM

442000 444000 446000 448000 450000 452000 454000 456000

7574000
7572000
7570000
7568000
7566000

Bungaroo Creek

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Leaf-nosed Bat Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.3C: Pilbara Leaf-nosed Bat Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF3C_PLBHSM

This page has been left blank intentionally.

418000 420000 422000 424000 426000 428000 430000 432000 434000

7594000 7592000 7590000 7588000 7586000 7584000 7582000

Pannawonica Rail

Bungaroo Access Road

Mills-tream Yarrabola Road

Jimmawurrada Creek

Bungaroo Creek

Map Extent

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Olive Python Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.4A: Pilbara Olive Python Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF4A_POPHSM

426000 428000 430000 432000 434000 436000 438000 440000 442000

7584000 7582000 7580000 7578000 7576000 7574000 7572000

Bungaroo Creek

Millstream Yarraloola Road

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Olive Python Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.4B: Pilbara Olive Python Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF4B_POPHSM

442000 444000 446000 448000 450000 452000 454000 456000

7574000
7572000
7570000
7568000
7566000

Bungaroo Creek

Legend

- Habitat Assessment Site
- Roads
- Railway
- Watercourse
- Survey Area

Pilbara Leaf-nosed Bat Habitat Suitability Mapping

- Potential shelter and foraging habitat
- Suitable foraging and dispersal habitat
- Limited foraging and dispersal habitat

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.3C: Pilbara Leaf-nosed Bat Habitat Suitability Mapping

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigF3C_PLBHSM

This page has been left blank intentionally.

Site ID	Location		Reason	Photograph
JO-BAT-2	448687	7569055	Possible Ghost Bat and Pilbara Leaf-nosed Bat cave; calls of both species recorded.	
MJ10	439658	7578177	Possible roost cave, no bats recorded.	
MJ32	447442	7573351	Possible roost cave, no bats recorded.	

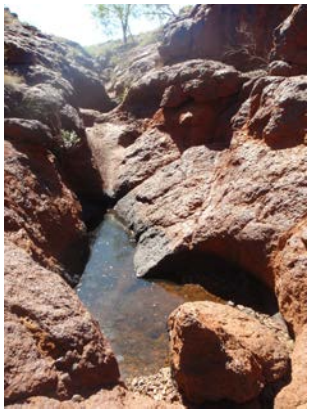
Site ID	Location		Reason	Photograph
M02	448668	7569079	Possible Pilbara Leaf-nosed Bat and Ghost Bat roost, calls of both species recorded.	
M08s	450747	7568576	Overhang – shallow feed cave for Ghost Bats, scats recorded.	
M14	449452	7571114	Ghost Bat feed cave, 5-10 scats observed.	

Site ID	Location		Reason	Photograph
M17	432041	7581397	Ghost Bat feed cave, 20-30 scats and feeding debris observed.	
M14b	443690	7572830	Ghost Bat feed cave, 50-100 scats and feeding debris observed.	
M14c	437393	7575997	Ghost Bat feed cave, 5-10 scats and feeding debris observed.	

Site ID	Location		Reason	Photograph
Water Sources				
Soak	434524	7580396	Soak; no permanent water but moist soil.	
SRE14	445623	7574303	Spring, permanent pool.	
MJ15	443488	7571983	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	

Site ID	Location		Reason	Photograph
MJ15	443483	7571908	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
Pool 1	447010	7570477	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat, 1-2m deep with tadpoles.	
MJ22 - pool 1	448164	7569863	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
MJ22 - pool 2	447744	7569655	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	

Site ID	Location		Reason	Photograph
MJ22 - pool 3	447661	7569564	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
MJ22 - pool 4	447505	7569368	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
JO5	447402	7572423	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
M03	447785	7570585	Small semi-permanent pool in rock hole in small gully; possible Northern Quoll and Pilbara Olive Python habitat.	

Site ID	Location		Reason	Photograph
M05	451170	7571514	Small semi-permanent pool in rock hole in small gully; possible Northern Quoll and Pilbara Olive Python habitat.	
M06	450918	7571646	Small semi-permanent pool in rock hole in small gully; possible Northern Quoll and Pilbara Olive Python habitat.	
M07	450350	7570644	Two small semi-permanent pool in rock hole in small gully; possible Northern Quoll and Pilbara Olive Python habitat.	

Site ID	Location		Reason	Photograph
M09	451521	7567677	Semi-permanent pool in narrow deep gorge; possible Northern Quoll and Pilbara Olive Python habitat.	
Rpool2	454478	7566715	Semi-permanent pool; possible Northern Quoll and Pilbara Olive Python habitat.	
Rpool3	452882	7567775	Small semi-permanent pool less than 1m diameter.	

Site ID	Location		Reason	Photograph
M11	453958	7565900	Semi- permanent pool in isolated gorge with cave; possible Northern Quoll and Pilbara Olive Python habitat.	
M11b	454212	7567339	Semi-permanent pool in narrow shaded gorge; possible Northern Quoll and Pilbara Olive Python habitat.	
M11c	454178	7567358	Deep semi-permanent pool in very narrow shaded gorge; possible Northern Quoll and Pilbara Olive Python habitat.	No photo

This page has been left blank intentionally.

420000 425000 430000 435000 440000 445000 450000 455000 460000

7590000 7585000 7580000 7575000 7570000 7565000

Pannaworinca Rail

Bungaroo Access Road

Millstream Yarraloola Road

A B C D E F G H I J K L M N O P

Legend

- Roads
- Railway
- Map Extent
- Heritage Areas
- Survey Area

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5: SRE Fauna Habitat Mapping

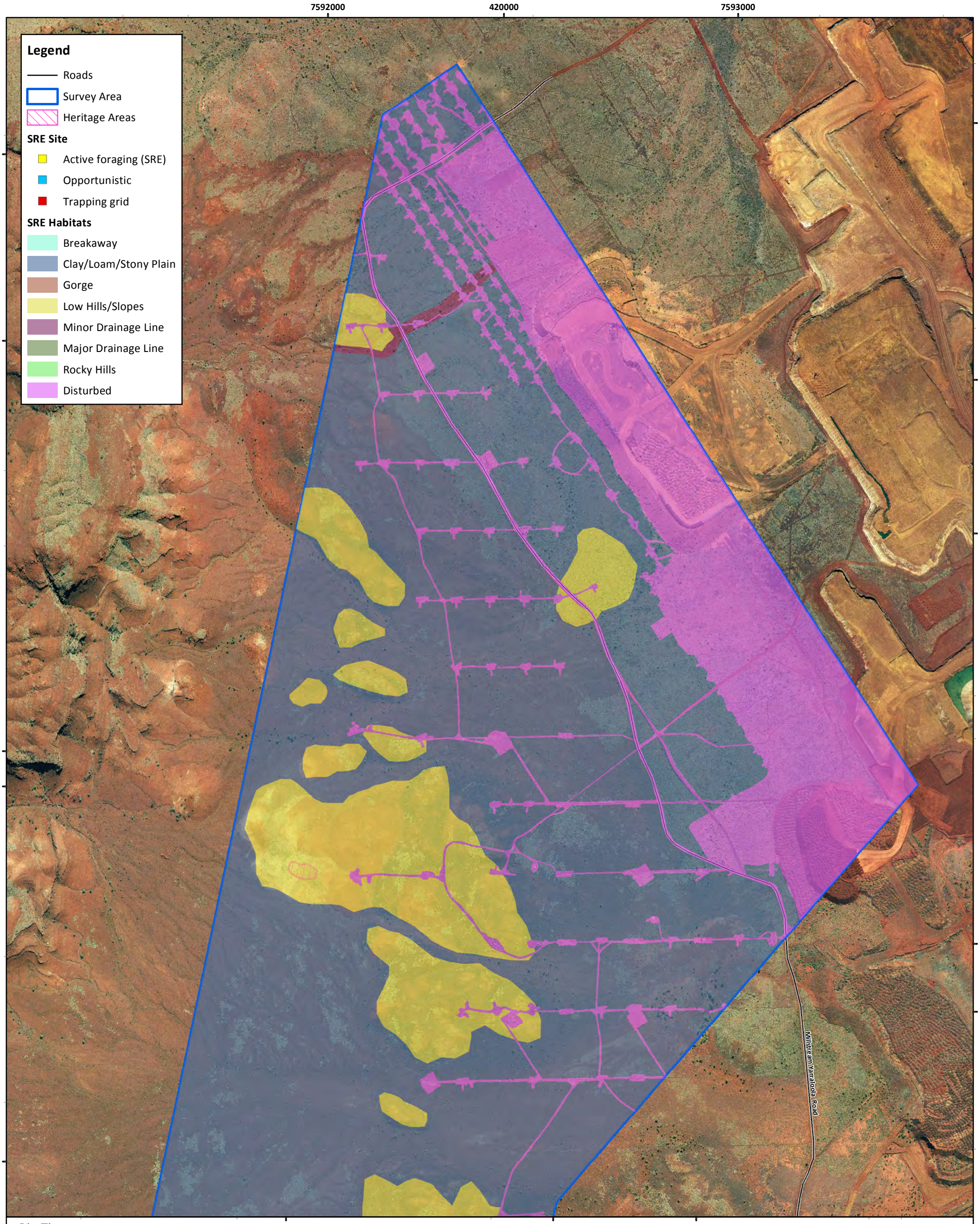
Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:115,000 (A3)

0 2 4 6 8 10 Kilometres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_SRE_FigF5_Overview



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5A: SRE Fauna Habitat Mapping

Author: J. Oates	Date: 03-03-2016	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5A	Metres 0 100 200 300 400 500

7589000 422000 7590000 423000

422000

7588000

423000

424000

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

BTG2

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5B: SRE Fauna Habitat Mapping

Author: J. Oates	Date: 03-03-2016
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5B

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

0 100 200 300 400 500 Metres

N

7587000 425000 7588000

7586000 425000

426000

7585000

427000

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5C: SRE Fauna Habitat Mapping

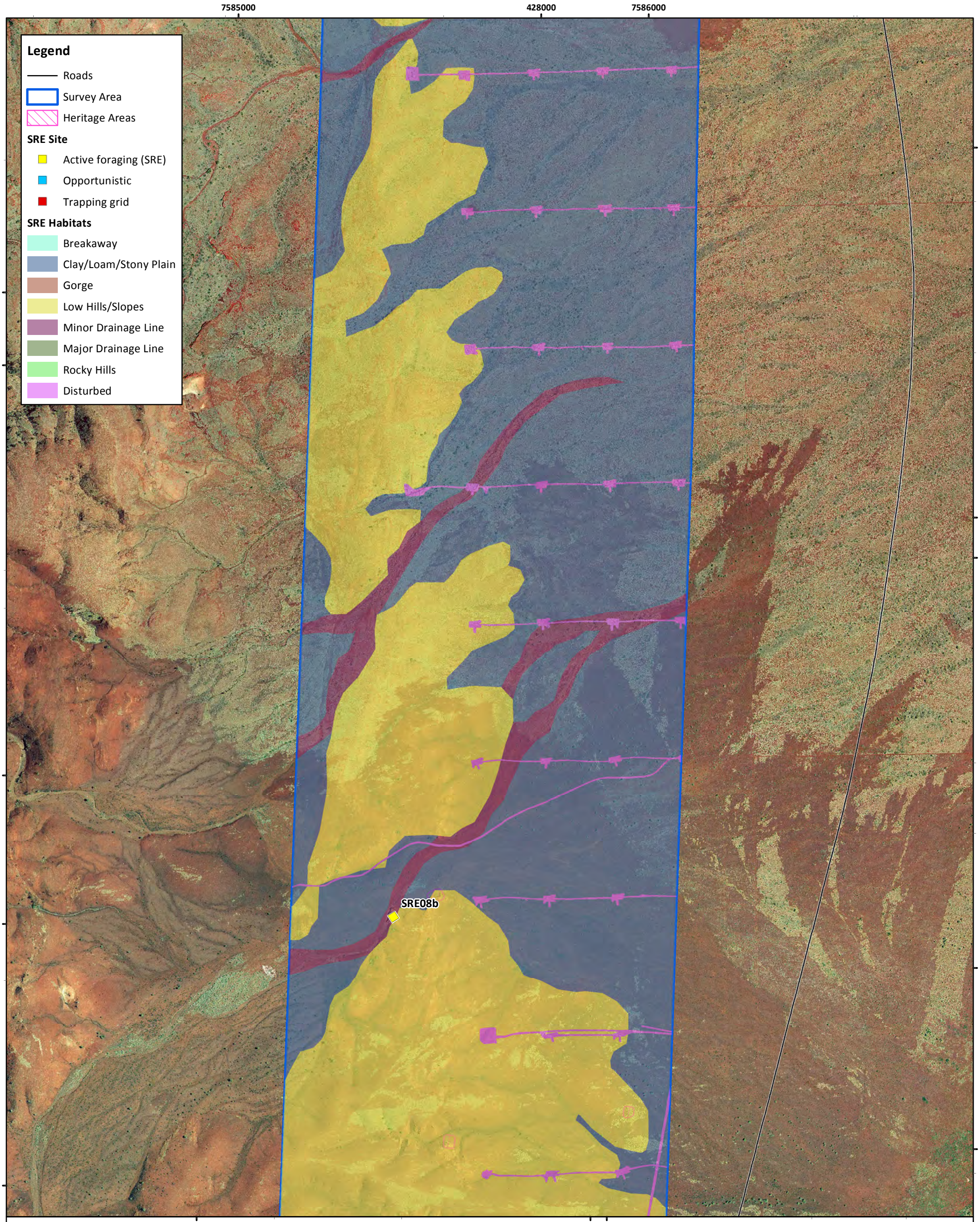
astron

Author: J. Oates	Date: 03-03-2016
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5C

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5D: SRE Fauna Habitat Mapping

Author: J. Oates	Date: 03-03-2016
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5D

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500

7582000 430000 7583000 431000

430000 431000 432000 7580000

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5E: SRE Fauna Habitat Mapping

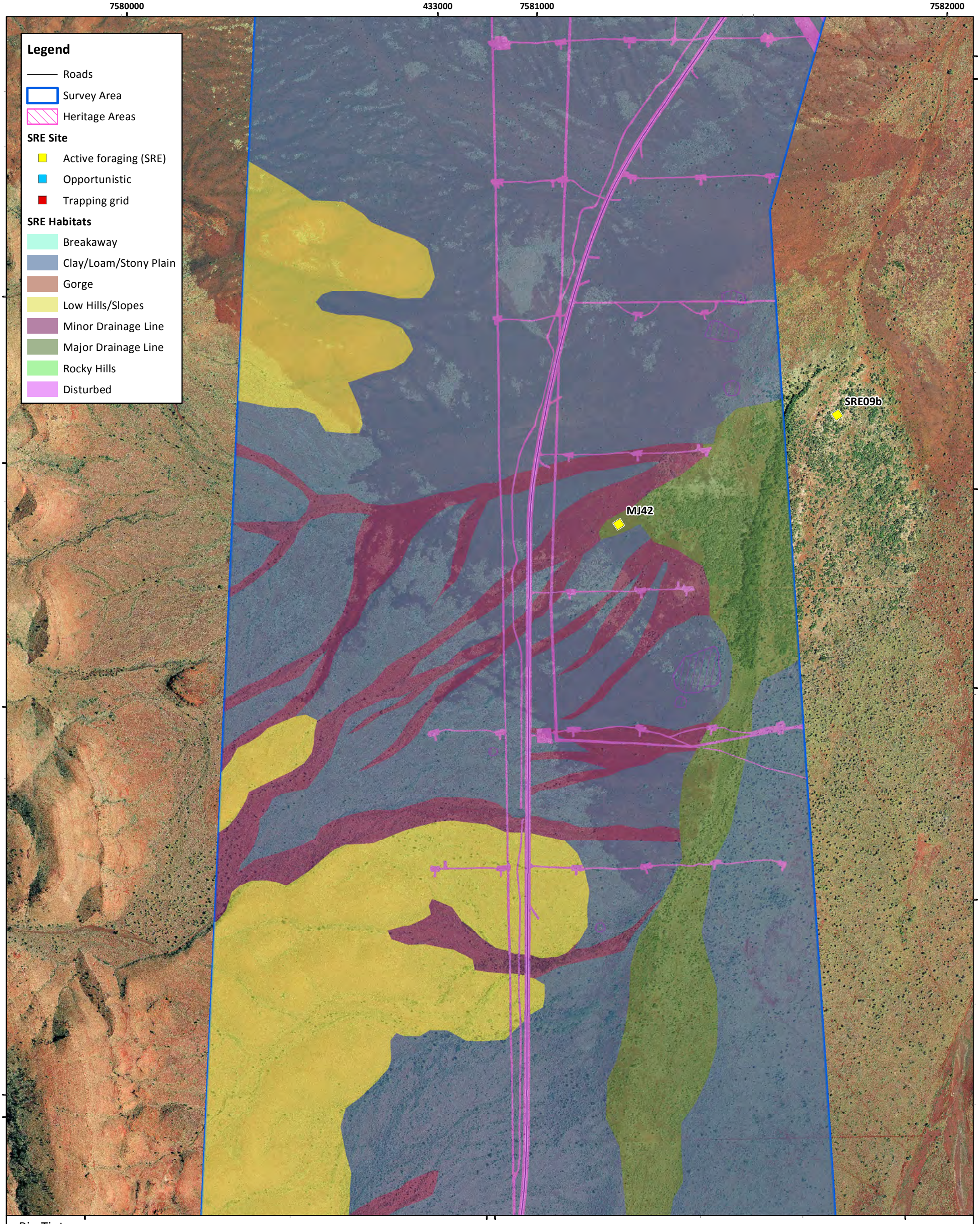
Author: J. Oates	Date: 03-03-2016
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5E

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)

Metres

0 100 200 300 400 500

N



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5F: SRE Fauna Habitat Mapping

Author: J. Oates	Date: 03-03-2016	Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1: 10,000 (A3)
Drawn: W. An	14263-15-BIDR-2Rev0_160303_SRE_FigF5F	Metres 0 100 200 300 400 500

435000
7578000
7579000
436000
7580000
435000
7577000
436000
7576000
JO11

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5G: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5G

437000 7577000 438000 7578000 7579000

437000
438000
7575000
439000

JO14
MCL01

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5H: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5H

7575000
440000
7577000
441000
7574000
440000
441000
BTG6
MJ36
JO2

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5I: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5I

7574000 442000 7575000 443000 7576000

7573000

442000

443000

JO10

JO13A

SRE20

MCL02

BTG4

JO9

SRE3

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5J: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5J

7572000 444000 7573000 7574000 445000 7575000

444000

7571000

445000

SRE14

SRE4

BTG7

MJ31 MJ32

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5K: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5K

7571000 446000 7572000 447000 7573000

446000

7570000

447000

MJ31 MJ32

JO8

JO6

BTG3

BTG8

SRE13

JO3

BTG1

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5L: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5L

447000 7569000 448000 7570000 7571000 449000

447000

448000

7567000

449000

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

BTG5

SRE03b

SRE04b

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5M: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5M

7571000 449000 7572000 450000 7573000

449000

7570000

450000

SRE01b

SRE02b

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5N: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5N

7568000 450000 7569000 451000 7570000

450000

451000

7566000

SRE05b

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5O: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5O

7566000 452000 7567000 453000 7569000

452000

453000

SRE07b

SRE06b

Legend

- Roads
- Survey Area
- Heritage Areas

SRE Site

- Active foraging (SRE)
- Opportunistic
- Trapping grid

SRE Habitats

- Breakaway
- Clay/Loam/Stony Plain
- Gorge
- Low Hills/Slopes
- Minor Drainage Line
- Major Drainage Line
- Rocky Hills
- Disturbed

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure F.5P: SRE Fauna Habitat Mapping

Datum: GDA 1994 - Projection: MGA Zone 50 - Scale: 1:10,000 (A3)

0 100 200 300 400 500 600 700 800 900 1,000 Metres

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | 14263-15-BIDR-2Rev0_160303_SRE_FigF5P

This page has been left blank intentionally.

Appendix G: Conservation Significant and SRE Fauna Locations

This page has been left blank intentionally.

418000 420000 422000 424000 426000 428000 430000 432000 434000

7594000 7592000 7590000 7588000 7586000 7584000 7582000

Lined Soil-crevice Skink (1)

Lined Soil-crevice Skink (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Rainbow Bee-eater (2)

Lined Soil-crevice Skink (2)

Rainbow Bee-eater (1)

Western Pebble-mound Mouse (6)

Western Pebble-mound Mouse (2)

Ghost Bat (1)

Legend

Survey Area

Current Records

- Ghost Bat (*Macroderma gigas*) - Calls
- Ghost Bat (*Macroderma gigas*) - Scat
- Lined Soil-crevice Skink (*Notoscinus butleri*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual (camera)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Calls
- Pilbara Olive Python (*Liasis olivaceus barroni*) - Scat
- Rainbow Bee-eater (*Merops ornatus*) - Individual
- Rainbow Bee-eater (*Merops ornatus*) - Individual (Camera)
- Unnamed Blindsnake (*Anilios ganei*) - Individual
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Mound
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Individual

Previous Records

- Blindsnake (*Anilios ganei*)
- Ghost Bat (*Macroderma gigas*)
- Lined Soil-crevice Skink (*Notoscinus butleri*)
- Rainbow Bee-eater (*Merops ornatus*)
- Western Pebble-mound Mouse (*Pseudomys chapmani*)

Map Extent

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.1A: Locations of Previous and Current Records of Conservation Significant Vertebrate Fauna Species

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 20-04-2016 | Figure Ref: 14263-15-BIDR-2Rev1_160420_FigG1A_ConSigFauna

This page has been left blank intentionally.

426000 428000 430000 432000 434000 436000 438000 440000 442000

7584000 7582000 7580000 7578000 7576000 7574000 7572000

Western Pebble-mound Mouse (2)

Ghost Bat (1)

Lined Soil-crevice Skink (2)

Rainbow Bee-eater (1)

Rainbow Bee-eater (1)

Ghost Bat (1)

Pilbara Leaf-nosed Bat (1)

Pilbara Olive Python (1)

Pilbara Leaf-nosed Bat (2)

Western Pebble-mound Mouse (1)

Ghost Bat (1)

Ghost Bat (1)

Pilbara Leaf-nosed Bat (1)

Map Extent

Northern Quoll (1)

Northern Quoll (2)

Northern Quoll (9)

Rainbow Bee-eater (1)

Northern Quoll (2)

Rainbow Bee-eater (4)

Ghost Bat (2)

Rainbow Bee-eater (2)

Ghost Bat (2)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Western Pebble-mound Mouse (1)

Legend

Survey Area

Current Records

- Ghost Bat (*Macroderma gigas*) - Calls
- Ghost Bat (*Macroderma gigas*) - Scat
- Lined Soil-crevice Skink (*Notoscinus butleri*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual (camera)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Calls
- Pilbara Olive Python (*Liasis olivaceus barroni*) - Scat
- Rainbow Bee-eater (*Merops ornatus*) - Individual
- Rainbow Bee-eater (*Merops ornatus*) - Individual (Camera)
- Unnamed Blindsnake (*Anilios ganei*) - Individual
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Mound
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Individual

Previous Records

- Blindsnake (*Anilios ganei*)
- Ghost Bat (*Macroderma gigas*)
- Lined Soil-crevice Skink (*Notoscinus butleri*)
- Rainbow Bee-eater (*Merops ornatus*)
- Western Pebble-mound Mouse (*Pseudomys chapmani*)

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.1B: Locations of Previous and Current Records of Conservation Significant Vertebrate Fauna Species

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigG1B_ConSigFauna

This page has been left blank intentionally.

442000 444000 446000 448000 450000 452000 454000 456000

7574000 7572000 7570000 7568000 7566000

Northern Quoll (9)
Northern Quoll (1)
Lined Soil-crevice Skink (2)
Pilbara Leaf-nosed Bat (1)
Ghost Bat (1)
Ghost Bat (1)
Lined Soil-crevice Skink (4)
Lined Soil-crevice Skink (2)
Western Pebble-mound Mouse (1)
Ghost Bat (1)
Blind Snake (1)
Rainbow Bee-eater (1)
Rainbow Bee-eater (4)
Rainbow Bee-eater (1)
Western Pebble-mound Mouse (1)
Northern Quoll (2)
Lined Soil-crevice Skink (1)
Western Pebble-mound Mouse (1)
Rainbow Bee-eater (4)
Western Pebble-mound Mouse (1)
Ghost Bat (1)
Rainbow Bee-eater (1)
Western Pebble-mound Mouse (3)
Rainbow Bee-eater (2)
Pilbara Leaf-nosed Bat (2)
Rainbow Bee-eater (1)
Unnamed Blindsnake (1)
Lined Soil-crevice Skink (1)
Ghost Bat (1)
Ghost Bat (4)
Pilbara Leaf-nosed Bat (3)
Ghost Bat (1)
Ghost Bat (1)
Pilbara Leaf-nosed Bat (3)

Pilbara Leaf-nosed Batl (1)
Northern Quoll (4)
Northern Quoll (6)
Northern Quoll (1)
Rainbow Bee-eater (2)
Western Pebble-mound Mouse (1)

Map Extent

Legend

Survey Area

Current Records

- Ghost Bat (*Macroderma gigas*) - Calls
- Ghost Bat (*Macroderma gigas*) - Scat
- Lined Soil-crevice Skink (*Notoscinus butleri*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual
- Northern Quoll (*Dasyurus hallucatus*) - Individual (camera)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) - Calls
- Pilbara Olive Python (*Liasis olivaceus barroni*) - Scat
- Rainbow Bee-eater (*Merops ornatus*) - Individual
- Rainbow Bee-eater (*Merops ornatus*) - Individual (Camera)
- Unnamed Blindsnake (*Anilios ganei*) - Individual
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Mound
- Western Pebble-mound Mouse (*Pseudomys chapmani*) - Individual

Previous Records

- Blindsnake (*Anilios ganei*)
- Ghost Bat (*Macroderma gigas*)
- Lined Soil-crevice Skink (*Notoscinus butleri*)
- Rainbow Bee-eater (*Merops ornatus*)
- Western Pebble-mound Mouse (*Pseudomys chapmani*)

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.1C: Locations of Previous and Current Records of Conservation Significant Vertebrate Fauna Species

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 21-04-2016 | Figure Ref: 14263-15-BIDR-2Rev1_160421_FigG1C_ConSigFauna

This page has been left blank intentionally

Table G.1 Locations of vertebrate conservation significant species recorded during the current surveys.

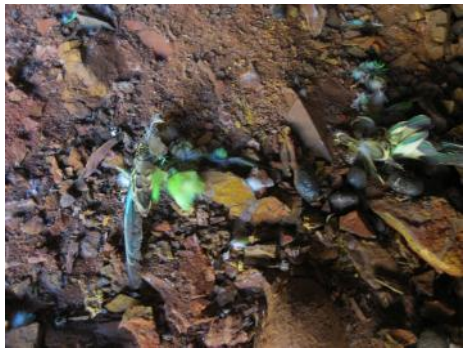
Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Reptiles							
Liasis olivaceus barroni (Pilbara Olive Python)	S3, VU	MJ39	440273	7577774	Scat	Major drainage line	
Notoscincus butleri (Lined Soil-crevice Skink)	P4	BTG5	448691	7569936	1 individual	Rocky hills/breakaway	
		BTG8	447130	7571289	1 individual	Major drainage line	

Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Anilios ganei (Unnamed Blind Snake)	P1	BTG5	448691	7569936	1 individual	Rocky hills/breakaway	
Birds							
Merops ornatus (Rainbow Bee-eater)	S5, Mi	BTG1	448330	7570651	2 individuals	Loamy plain	
		BTG2	448330	7570651	12 individuals	Loamy plain	
		BTG3	446956	7571385	9 individuals	Loamy plain	
		BTG4	443829	7574519	5 individuals	Breakaway	
		BTG8	447130	7571289	6 individuals	Creekline	
		Opp	436614	7578393	2 individuals	Loamy plain	
		Opp	447121	7572269	2 individuals	Stony plain	
		Opp	439477	7577992	2 individuals	Breakaway	
		Opp	442085	7575821	1 individual	Breakaway	
		Opp	446817	7571401	4 individuals	Drainage line	
		Cam27b	447985	7570585	1 individual	Gully	
		M14	449452	7571114	3 individuals	Sandyloamy plain	

Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Mammals							
Dasyurus hallucatus (Northern Quoll)	S2, EN	BTG6	441463	7576528	2 individuals	Rocky hills/breakaway	
		JT Cam	444524	7571280	Camera	Gorge	
		MJ2	441348	7576597	Camera	Gorge	
		MJ3	442015	7575929	Camera	Gorge	
		MJ4	442085	7575821	Camera	Breakaway	
		MJ6	444405	7575145	Camera	Gorge	
		MJ7	444408	7575155	Camera	Breakaway	
		MJ8	444094	7575263	Camera	Gorge	
		SRE14	445526	7574200	Camera	Gorge	
		SRE14	445621	7574306	Camera	Gorge	

Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Pseudomys chapmani (Western Pebble-mound Mouse)	P4	BTG1	448330	7570651	3 inactive mounds	Loamy plain	
		BTG3	446956	7571385	Trapped individual	Loamy plain	
		BTG4	443781	7574465	3 inactive mounds	Breakaway	
		BTG8	447130	7571289	Trapped individual	Creekline	
		Opp	431701	7583155	2 inactive mounds	Stony plain	
		Opp	427570	7585573	1 inactive mound	Hillcrest	
		Opp	427502	7585638	1 inactive mound	Hillcrest	
		Opp	427588	7585639	1 inactive mound	Hillcrest	
		Opp	427517	7585823	1 inactive mound	Hillcrest	
		Opp	427530	7585896	1 inactive mound	Hillcrest	
		Opp	427575	7585938	1 inactive mound	Hillcrest	
		Opp	446434	7570975	1 inactive mound	Stony plain	
		Opp	422502	7590437	1 inactive mound	Hillcrest	
		Opp	422350	7590627	1 inactive mound	Hillcrest	
		Opp	439112	7575395	1 inactive mound	Hillcrest	
		Opp	439078	7575154	1 inactive mound	Hillcrest	
		Opp	439101	7575118	1 inactive mound	Hillcrest	
		Opp	439028	7575269	1 inactive mound	Hillcrest	
		Opp	438989	7575185	1 inactive mound	Hillcrest	
		Opp	438692	7575051	1 inactive mound	Hillcrest	

Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Pseudomys chapmani (Western Pebble-mound Mouse)	P4	Opp	438632	7575529	1 inactive mound	Hillcrest	
		Opp	438632	7575654	1 inactive mound	Hillcrest	
		Opp	438777	7575684	1 inactive mound	Hillcrest	
		Opp	437557	7576005	1 inactive mound	Hillcrest	
Rhinonicteris aurantia Pilbara form (Pilbara Leaf-nosed Bat)	S3, VU	JO-BAT-2	448687	7569055	Acoustic recording	Breakaway - cave	No photo
		MJ1	439477	7577992	Acoustic recording	Breakaway	
		MJ21	441772	7573035	Acoustic recording	Gorge	
		MJ5	444217	7575288	Acoustic recording	Gorge	
		SM11040a	448005	7570584	Acoustic recording	Gully/gorge	
		SM7566a	453982	7565918	Acoustic recording	Gully/gorge	
		SM7634a	448668	7569079	Acoustic recording	Breakaway - cave	
		SM8027a	440219	7577074	Acoustic recording	Stony plain	
Macroderma gigas (Ghost Bat)	S3	JO-BAT-2	448687	7569055	Acoustic recording	Breakaway - cave	
		JT GB Cave 1	451025	7570122	Scats (2 piles of ~50 scats)	Gorge - cave	
		MJ1	439477	7577992	Acoustic recording	Breakaway	
		MJ19	441772	7573032	Scats	Gorge - cave	
		MJ30	447125	7572647	Scats/feeding debris	Gorge - cave	

Species name (Common name)	Conservation status	Site ID	Location		Observation type	Habitat	Photograph
Macroderma gigas (Ghost Bat)	S3	M08	449703	7568370	Scats (5-10)	Breakaway - cave	
		M14	449452	7571114	Scats (5-10)	Breakaway - cave	
		M14b	443690	7572830	Scats (5-10)	Breakaway - cave	
		M14c	437393	7575997	Scats (20-30)/feeding debris	Breakaway - cave	
		M17	432041	7581397	Scats (50-100)	Breakaway - cave	
		SM7566a	453982	7565918	Acoustic recording	Gully/gorge	
		SM7634a	448668	7569079	Acoustic recording	Breakaway - cave	

420000 425000 430000 435000 440000 445000 450000 455000

7590000 7585000 7580000 7575000 7570000

Buddelundia '10bf'

Buddelundia '14hr'
Buddelundia '10bf'
Buddelundia '61'

Spherillo sp. indet.
Buddelundia '36'

Buddelundia '14hr'

Buddelundia '61'
Barrowdillo '2'
Barrowdillo '14hr'
Buddelundia '30'
Buddelundia '61'
Buddelundia '15'
Buddelundia '61'

Buddelundia '10bf'
Buddelundia '36'
Buddelundia '14hr'
Buddelundia '10bf'
Buddelundia '15'
Buddelundia '30'
Buddelundia '61'
Barrowdillo '2'
Buddelundia '15'
Buddelundia '30'
Buddelundia '14hr'
Buddelundia '61'
Buddelundia '61'

Buddelundia '10bf'
Buddelundia '14hr'
Buddelundia '10bf'
Barrowdillo '2'
Buddelundiinae sp. indet.

Buddelundia '61'
Buddelundia '14hr'

Legend

- Survey Area

Armadillidae

- *Barrowdillo* '2'
- *Buddelundia* '10bf'
- *Buddelundia* '14hr'
- *Buddelundia* '15'
- *Buddelundia* '30'
- *Buddelundia* '36'
- *Buddelundia* '61'
- *Buddelundiinae* sp. indet.
- *Spherillo* sp. indet.

Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.2: Distribution of slater species collected in the survey area

Datum: GDA 1994
Projection: MGA Zone 50

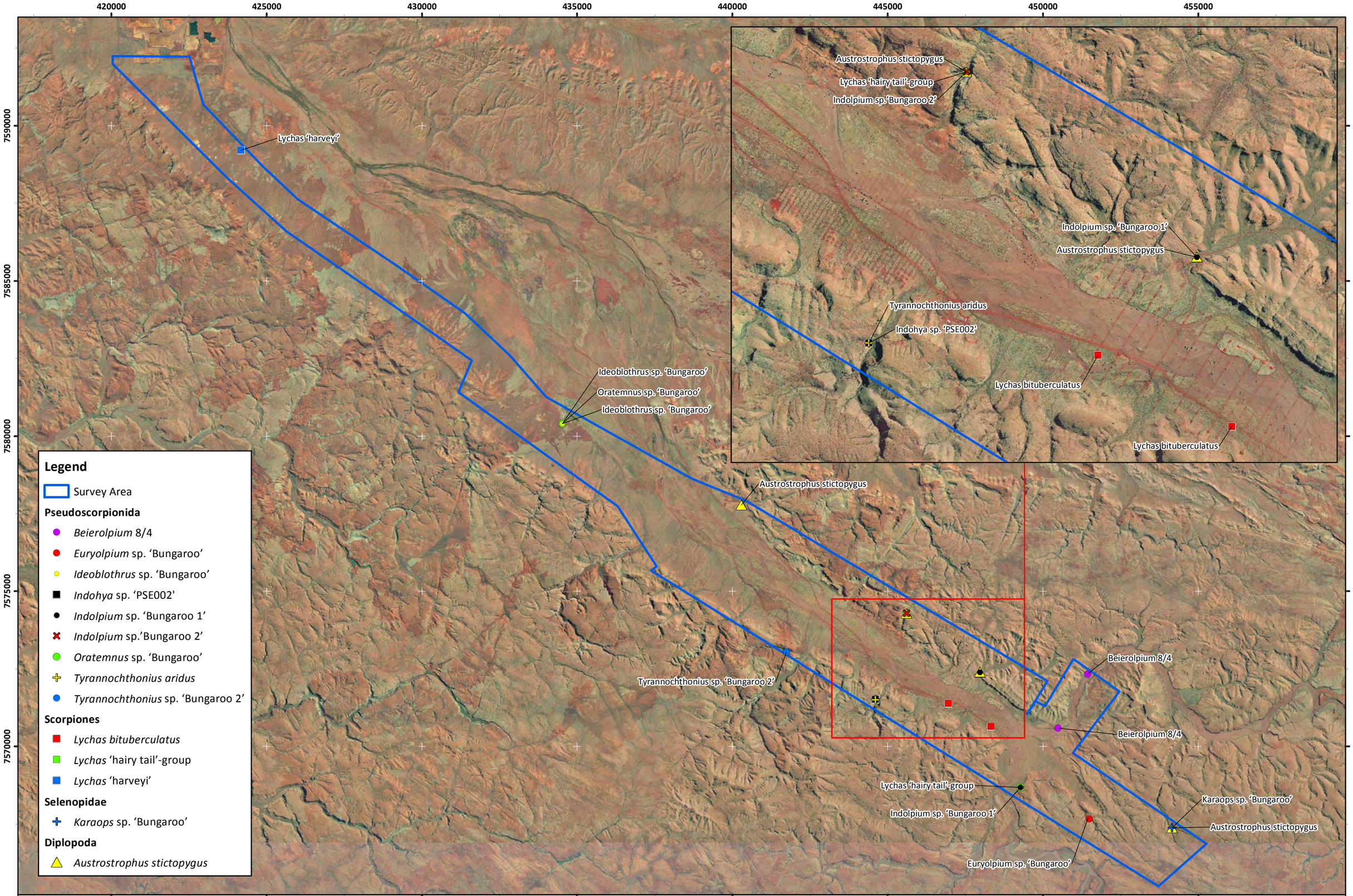
0 2 4 6 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigG2_Slater

This page has been left blank intentionally.



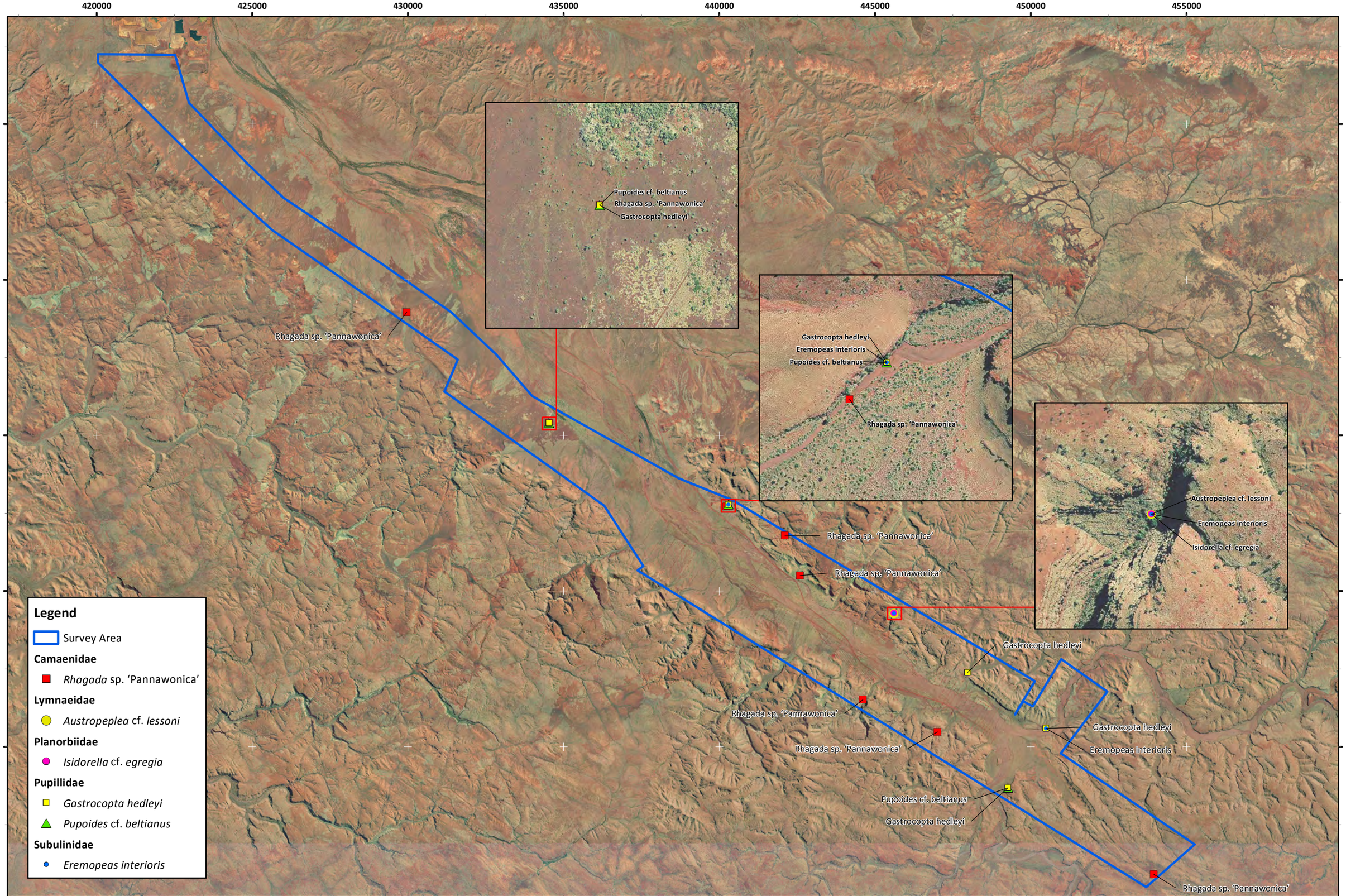
Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.3: Distribution of pseudoscorpion, scorpion, spider and millipede species in the survey area.

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigG3_Scorpion

This page has been left blank intentionally.



Rio Tinto

Bungaroo Level 2 Fauna Assessment

Figure G.4: Distribution of non-marine snail species collected in the survey area

Datum: GDA 1994
Projection: MGA Zone 50

0 1 2 3 4 5 Km

N

astron

Author: J. Oates | Drawn: W. An | Date: 03-03-2016 | Figure Ref: 14263-15-BIDR-2Rev0_160303_FigG4_Snail

This page has been left blank intentionally.

Table G.2 Locations of potential SRE invertebrate fauna species recorded during the current surveys.

Family	Species name	SRE status	Sites	Easting	Northing	No. of specimens	Habitat/s	Microhabitats
Pseudoscorpionida (Pseudoscorpions)								
Chthoniidae	*Tyrannochthonius* sp. 'Bungaroo 2'	Potential	SRE20	441739	7573041	1	Gorge	Moist leaf litter
Syarinidae	*Ideoblothrus* sp. 'Bungaroo'	Potential	MJ42	434524	7580396	2	Soak in Major Drainage Line	Moist leaf litter
	Euryolpium sp. 'Bungaroo'	Potential	SRE5b	451488	7567670	1	Gorge	Moist leaf litter
Scorpiones (Scorpions)								
Buthidae	*Lychas* 'hairy tail'-group	Potential	SRE14	445327	7573750	2	Spring in Gorge	Moist leaf litter
			SRE3b	449272	7568684	1	Breakaway	Moist leaf litter
Araneae (Spiders)								
Selenopidae	*Karaops sp. 'Bungaroo'*	Potential	SRE7b	454155	7567375	1	Gorge	Moist leaf litter
Isopoda (Slaters)								
Armadillidae	*Buddelundia* '61'	Potential	BTG7	445248	7571716	1	Breakaway / Rocky Hill	Moist leaf litter
			MJ32	447442	7573351	2	Breakaway	Moist leaf litter
			SRE13	447972	7572389	1	Major Drainage Line	Moist leaf litter
			SRE14	445621	7574306	2	Spring in Gorge	Moist leaf litter
			SRE3b	449272	7568684	3	Breakaway	Moist leaf litter
			SRE5b	451488	7567670	1	Gorge	Moist leaf litter
			SRE7b	454155	7567375	5	Gorge	Moist leaf litter
			SRE8b	429958	7583955	1	Breakaway	Moist leaf litter
	Buddelundiinae sp. indet.	Potential	BTG8	447130	7571716	1	Major Drainage Line	Moist leaf litter
			JO10	442070	7575010	1	Drainage Line	Moist leaf litter
			SRE9b	434603	7581101	1	Drainage Line	Moist leaf litter

Family	Species name	SRE status	Sites	Easting	Northing	No. of specimens	Habitat/s	Microhabitats
Armadillidae	*Spherillo* sp. indet.	Potential	MJ42	434524	7580396	1	Soak in Major Drainage Line	Moist leaf litter
			SRE9b	434603	7581101	4	Drainage Line	Moist leaf litter

Appendix H: List of Specimens Lodged with Western Australian Museum

This page has been left blank intentionally.

Table H.1 List of specimens submitted to the Western Australian Museum.

Species	Site	Latitude	Longitude	No of specimens	Collecting Date	WAM Rego
Buddelundia '10bf'	BTG1	21°57'32.53"S	116°29'58.46"E	5	28/05/2015	C60682
Buddelundia '10bf'	BTG1	21°57'32.53"S	116°29'58.46"E	4	30/05/2015	C60680
Buddelundia '14hr'	BTG3	21°57'08.52"S	116°29'10.64"E	1	31/05/2015	C60665
Buddelundia '10bf'	BTG3	21°57'08.52"S	116°29'10.64"E	11	26/05/2015	C60681
Buddelundia '30'	BTG5	21°58'27.43"S	116°30'10.85"E	1	26/05/2015	C60663
Buddelundia '61'	BTG7	21°56'57.57"S	116°28'11.13"E	1	26/05/2015	C60674
Buddelundiinae sp. indet.	BTG8	21°57'11.66"S	116°29'16.69"E	1	28/5/2015	C60671
Barrowdillo '2'	BTG8	21°57'11.66"S	116°29'16.69"E	1	26/05/2015	C60672
Buddelundia '10bf'	BTG8	21°57'11.66"S	116°29'16.69"E	4	28/05/2015	C60683
Buddelundia '36'	JO10	21°55'41.65"S	116°26'20.63"E	1	29/05/2015	C60662
Buddelundia '10bf'	JO10	21°55'41.65"S	116°26'20.63"E	5	29/05/2015	C60684
Buddelundia '14hr'	JO14	21°53'41.95"S	116°25'16.80"E	1	30/05/2015	C60667
Buddelundia '30'	MJ31	21°56'05.05"S	116°29'27.63"E	2	30/05/2015	C60664
Buddelundia '61'	MJ32	21°56'04.66"S	116°29'27.81"E	2	29/05/2015	C60675
Spherillo sp. indet.	MJ42	21°52'14.06"S	116°21'58.51"E	1	31/05/2015	C60660
Buddelundia '36'	MJ42	21°52'14.06"S	116°21'58.51"E	3	31/05/2015	C60661
Buddelundia '61'	SRE13	21°56'35.99"S	116°28'24.02"E	1	29/05/2015	C60676
Buddelundia '15'	SRE13	21°56'35.99"S	116°28'24.02"E	4	29/05/2015	C60678
Buddelundia '15'	SRE13	21°56'35.99"S	116°28'24.02"E	16	29/05/2015	C60679
Buddelundia '14hr'	SRE14	21°55'34.03"S	116°28'24.02"E	1	28/05/2015	C60669
Barrowdillo '2'	SRE14	21°55'34.03"S	116°28'24.02"E	3	28/05/2015	C60673
Buddelundia '61'	SRE14	21°55'34.03"S	116°28'24.02"E	2	28/05/2015	C60677
Buddelundia '14hr'	SRE20	21°56'14.09"S	116°26'08.97"E	1	26/05/2015	C60666
Buddelundia '14hr'	SRE4	21°57'04.23"S	116°27'48.90"E	1	26/05/2015	C60668

Species	Site	Latitude	Longitude	No of specimens	Collecting Date	WAM Rego
Buddelundia '15'	SRE2b	21°58'06.41"S	116°31'13.65"E	2	5/08/2015	C60686
Buddelundia '15'	SRE3b	21°59'08.21"S	116°30'30.97"E	2	6/08/2015	C60687
Buddelundia '61'	SRE3b	21°59'08.21"S	116°30'30.97"E	3	6/08/2015	C60688
Buddelundia '30'	SRE4b	21°59'23.89"S	116°30'54.49"E	2	6/08/2015	C60689
Buddelundia '61'	SRE5b	21°59'41.41"S	116°31'48.14"E	1	6/08/2015	C60690
Buddelundia '61'	SRE7b	21°59'51.27"S	116°33'21.12"E	5	7/08/2015	C60691
Buddelundia '14hr'	SRE7b	21°59'51.27"S	116°33'21.12"E	1	7/08/2015	C60692
Buddelundia '10bf'	SRE8b	21°50'51.91"S	116°32'40.39"E	1	4/08/2015	C60693
Buddelundia '61'	SRE8b	21°50'51.91"S	116°32'40.39"E	1	6/08/2015	C60694
Buddelundia '14hr'	SRE8b	21°50'51.91"S	116°32'40.39"E	2	9/08/2015	C60695
Buddelundiinae sp. indet.	SRE9b	21°52'22.62"S	116°22'01.23"E	1	10/08/2015	C60696
Spherillo sp. indet.	SRE9b	21°52'22.62"S	116°22'01.23"E	4	10/08/2015	C60697
Austrostrophus stictopygos	MCL01	21°54'11.36"S	116°25'18.95"E	1	30/05/2015	T137754
Austrostrophus stictopygos	SRE7b	21°59'51.27"S	116°33'21.12"E	1	7/08/2015	T137771
Austrostrophus stictopygos	SRE13	21°56'35.99"S	116°28'24.02"E	2	29/05/2015	T137757
Austrostrophus stictopygos	SRE14	21°55'34.03"S	116°28'24.02"E	3	28/05/2015	T137759
Oratemnus sp. 'Bungaroo'	MJ42	21°52'14.06"S	116°21'58.51"E	4	31/05/2015	T137755
Oratemnus sp. 'Bungaroo'	SRE9b	21°52'22.62"S	116°22'01.23"E	4	10/08/2015	T137773
Austrochthonius sp. 'Bungaroo'	SRE2b	21°58'06.41"S	116°31'13.65"E	1	5/08/2015	T137764
Tyrannochthonius aridus	SRE4	21°57'04.23"S	116°27'48.90"E	3	26/05/2015	T137768
Tyrannochthonius sp. 'Bungaroo 2'	SRE20	21°56'14.09"S	116°26'08.97"E	1	26/05/2015	T137763
Indohya 'PSE002'	SRE4	21°57'04.23"S	116°27'48.90"E	2	26/05/2015	T137769
Beierolpium 8/4	SRE1b	21°57'09.69"S	116°31'46.89"E	1	5/08/2015	T137762
Beierolpium 8/4	SRE2b	21°58'06.41"S	116°31'13.65"E	1	5/08/2015	T137765
Euryolpium sp. 'Bungaroo'	SRE5b	21°59'41.41"S	116°31'48.14"E	1	6/08/2015	T137770

Species	Site	Latitude	Longitude	No of specimens	Collecting Date	WAM Rego
Indolpium sp. 'Bungaroo 1'	SRE13	21°56'35.99"S	116°28'24.02"E	3	29/05/2015	T137758
Indolpium sp. 'Bungaroo 1'	SRE3b	21°59'08.21"S	116°30'30.97"E	1	6/08/2015	T137766
Indolpium sp.'Bungaroo 2'	SRE14	21°55'34.03"S	116°28'24.02"E	2	28/05/2015	T137760
Indolpium sp.'Bungaroo 2'	SRE9b	21°52'22.62"S	116°22'01.23"E	3	10/08/2015	T137774
Ideoblothrus sp. 'Bungaroo'	MJ42	21°52'14.06"S	116°21'58.51"E	2	31/05/2015	T137756
Lychas bituberculatus	BTG2	21°47'57.32"S	116°15'59.12"E	1	11/08/2015	T137750
Lychas bituberculatus	BTG3	21°57'08.52"S	116°29'10.64"E	1	30/05/2015	T137752
Lychas bituberculatus	BTG3	21°57'08.52"S	116°29'10.64"E	1	31/05/2015	T137753
Lychas 'hairy tail'-group	SRE3b	21°59'08.21"S	116°30'30.97"E	1	6/08/2015	T137767
Lychas 'hairy tail'-group	SRE14	21°55'34.03"S	116°28'24.02"E	2	28/05/2015	T137761
Lychas 'harveyi'	BTG2	21°47'57.32"S	116°15'59.12"E	1	10/08/2015	T137751
Karaops sp. 'Bungaroo'	SRE7b	21°59'51.27"S	116°33'21.12"E	1	7/08/2015	T137772
Rhagada sp. 'Pannawonica'	JO2	21°55'25.76"S	116°26'38.99"E	4	27/05/2015	S88361
Rhagada sp. 'Pannawonica'	JO3	21°58'09.65"S	116°29'12.30"E	1	28/05/2015	S88362
Rhagada sp. 'Pannawonica'	JO14	21°53'41.95"S	116°25'16.80"E	2	30/05/2015	S88360
Rhagada sp. 'Pannawonica'	MJ36	21°54'43.68"S	116°26'22.11"E	1	30/05/2015	S88366
Rhagada sp. 'Pannawonica'	MJ42	21°52'14.06"S	116°21'58.51"E	3	31/05/2015	S88367
Rhagada sp. 'Pannawonica'	SRE4	21°57'04.23"S	116°27'48.90"E	3	26/05/2015	S88379
Rhagada sp. 'Pannawonica'	SRE6b	22°00'39.12"S	116°33'13.85"E	4	7/08/2015	S88380
Rhagada sp. 'Pannawonica'	SRE8b	21°50'51.91"S	116°32'40.39"E	1	9/08/2015	S88381
Austropeplea cf. *lessoni*	SRE14	21°55'34.03"S	116°28'24.02"E	3	28/05/2015	S88371
Austropeplea cf. *lessoni*	SRE14	21°55'34.03"S	116°28'24.02"E	2	28/05/2015	S88372
Isidorella cf. *egregia*	SRE14	21°55'34.03"S	116°28'24.02"E	5	28/05/2015	S88373
Gastrocopta hedleyi	MCL01	21°54'11.36"S	116°25'18.95"E	11	30/05/2015	S88363
Gastrocopta hedleyi	MJ42	21°52'14.06"S	116°21'58.51"E	3	31/05/2015	S88368

Species	Site	Latitude	Longitude	No of specimens	Collecting Date	WAM Rego
Gastrocopta hedleyi	SRE2b	21°58'06.41"S	116°31'13.65"E	2	5/08/2015	S88375
Gastrocopta hedleyi	SRE3b	21°59'08.21"S	116°30'30.97"E	1	6/08/2015	S88377
Gastrocopta hedleyi	SRE13	21°56'35.99"S	116°28'24.02"E	20	29/05/2015	S88370
Pupoides cf. *beltianus*	MCLO1	21°54'11.36"S	116°25'18.95"E	1	30/05/2015	S88364
Pupoides cf. *beltianus*	MJ42	21°52'14.06"S	116°21'58.51"E	4	31/05/2015	S88369
Pupoides cf. *beltianus*	SRE3b	21°59'08.21"S	116°30'30.97"E	4	6/08/2015	S88378
Pupoides cf. *beltianus*	MCLO1	21°54'11.36"S	116°25'18.95"E	1	30/05/2015	S88365
Pupoides cf. *beltianus*	SRE2b	21°58'06.41"S	116°31'13.65"E	4	5/08/2015	S88376
Pupoides cf. *beltianus*	SRE14	21°55'34.03"S	116°28'24.02"E	1	28/05/2015	S88374