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ENVIRONMENTAL SCIENCES

Great Northern Highway Intersection reconnaissance flora and fauna survey for the Wonmunna Iron Ore Project

Prepared for Wonmunna Iron Ore Pty Ltd

November 2020

Final

Great Northern Highway Intersection reconnaissance flora and fauna survey for the Wonmunna Iron Ore Project

Prepared for Wonmunna Iron Ore Pty Ltd

Version history

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
S.Findlay, C.Woods and M.Clunies-Ross	J.Clark and G.Wells	Draft for client comments	0.1	27-Nov-20	D.Temple-Smith
J.Clark	G.Wells	Final, client comments addressed	1.0	04-Dec-20	D.Temple-Smith

Phoenix Environmental Sciences Pty Ltd

[redacted]

EXECUTIVE SUMMARY

The Wonmunna Iron Ore Project (the Project)is located approximately 74 km WNW of the town of Newman, Western Australia. In November 2020, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Wonmunna Iron Ore Pty Ltd (Wonmunna Iron Ore) to undertake a reconnaissance survey and desktop review for a portion of the Great Northern Highway road reserve adjacent to the Project (a 75.9 ha study area).

The survey aimed to document any significant flora and fauna values within the study area, located in the Shire of East Pilbara and the Eremaean Botanical Province.

The scope of work included Department of Biodiversity, Conservation and Attractions (DBCA) Threatened flora and fauna database searches, identification of the potential occurrence of conservation significant taxa or communities, brief field survey, and mapping of vegetation types and condition.

The flora and vegetation field survey was undertaken on 17 November 2020 and included surveying of six quadrats and two relevés, and targeted flora searches traversing the study area on foot. A total of 68 flora taxa representing 17 families and 39 genera were recorded in the study area and included 66 native species and two introduced species, 59 perennial species, and eight annual or short-lived species and one for which life cycle is not recorded. The most prominent families recorded were Fabaceae, Poaceae, Myrtaceae and Amaranthaceae. No significant flora was recorded in the field study area and significant species identified in the desktop review are not likely to occur.

Four vegetation types were defined for the study area, comprised of two spinifex steppes with scattered *Corymbia hamersleyana* or *Eucalyptus leucophloia* subsp. *leucophloia* trees and two low *Corymbia hamersleyana* and *Eucalyptus victrix,* and *Corymbia hamersleyana* and *Acacia distans* woodlands in creeks. None of the four vegetation types were considered significant or restricted and all vegetation recorded in the current survey area was representative of vegetation previously defined for the adjacent mining lease. The majority of vegetation was recorded in Excellent to Very Good condition.

Previous fauna surveys for the Project (Phoenix 2012a, b, 2014), 0.5km south, outside of the current study area recorded 170 vertebrate taxa comprised of two fish, 2 amphibians, 58 reptiles, 77 birds and 30 mammals (including seven introduced species). The conservation status of many species has changed and many nearby surveys have been completed since the previous Project surveys and therefore state and federal biological database were queried (DAWE 2020; DBCA 2020a, c) and a list of potentially occurring significant species thus compiled.

The resultant species list includes twenty-one significant vertebrate species comprising seven species listed as Threatened, Conservation Dependent or Specially Protected under the *Environmental Protection, Biodiversity and Conservation (EPBC) Act* and/or *Biodiversity and Conservation (BC) Act*. Nine avifauna species are listed as Migratory under the EPBC Act and BC Act. A further five species are listed as Priority by DBCA.

Field methods for the fauna survey included a habitat assessment derived from the flora and vegetation dataset and foot searches for Western Pebble-mound Mouse mounds.

Three broad fauna habitats were identified. Open shrubland of Acacia over hummock (*Triodia* spp.) grasses was the dominant habitat, occupying approximately 68.1% of the study area, followed by Spinifex grassland habitat (11.1%) and Woodland on minor creeklines (7.3%). In total 13.5% of the study area is or has been, cleared.

No conservation significant vertebrate fauna and flora species or vegetation were recorded within the study area. The presence of multiple drainage lines located in the study area may intermittently provide relatively important habitat for significant vertebrate fauna.

It is unlikely that any significant ecological values occur within the study area.

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1 INTRODUCTION

The Wonmunna Iron Ore Project (the Project)is located approximately 74 km WNW of the town of Newman, Western Australia. In November 2020, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Wonmunna Iron Ore to undertake a reconnaissance survey and desktop review for a portion of the Great Northern Highway road reserve adjacent to the Project (a 75.9 ha study area).

The survey aimed to document any significant flora and fauna values within the study area, located in the Shire of East Pilbara and the Eremaean Botanical Province.

1.1 SCOPE OF WORK

The scope of work for the flora and fauna reconnaissance survey was as follows:

- undertake Department of Biodiversity, Conservation and Attractions (DBCA) Threatened flora and fauna, and communities database searches
- complete a desktop review/assessment
- identify the potential occurrence of conservation significant species (if any)
- undertake a reconnaissance field survey
- complete high-level flora, vegetation and fauna habitat mapping
- submit a brief report detailing flora field results and fauna desktop review.

1.2 STUDY AREA

The study area is approximately 75.9 ha and centred along a 3.75 km stretch of road and is located north of existing Project operations (Figure 1-1).

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Wonumunna GNH Intersection study area (75.9 ha)

Wonumunna GNH Intersection study area (75.9 ha)

Wonmunna Iron Ore Project (4,825.3 ha)

Western Australia

Mineral Resources Ltd
Wonmunna Iron Ore Project

Project No	1377-WON-
Date	03-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

0 0.5 1 1.5 km

Scale at A3 - 1:37,500 EPSG:28350

Legend

- The study area
- The Project area
- Approved Indicative Disturbance Footprint
- Major roads

Figure 1-1

Project and study area

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2 LEGISLATIVE CONTEXT

The protection of flora and fauna in WA is principally governed by three acts:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- State *Biodiversity Conservation Act 2016* (BC Act)
- State *Environmental Protection Act 1986* (EP Act).

The BC Act came into full effect on 1 January 2019 and replaced the functions of the *Wildlife Conservation Act 1950* (WC Act).

2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of the Environment and Energy (DoEE). The EPBC Act provides for the listing of Threatened flora, Threatened fauna and Threatened Ecological Communities (TECs) as matters of National Environmental Significance (NES). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of NES, require approval from the Australian Government Minister for the Environment through a formal referral process.

Conservation categories applicable to Threatened flora and fauna species under the EPBC Act are as follows:

- Extinct (EX)[1] – there is no reasonable doubt that the last individual has died
- Extinct in the Wild (EW) – taxa known to survive only in captivity
- Critically Endangered (CR) – taxa facing an extremely high risk of extinction in the wild in the immediate future
- Endangered (EN) – taxa facing a very high risk of extinction in the wild in the near future
- Vulnerable (VU) – taxa facing a high risk of extinction in the wild in the medium-term
- Conservation Dependent (CD)[1] – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable, Endangered or Critically Endangered.

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English & Blyth 1997). There are three categories under which ecological communities can be listed as TECs under the EPBC Act: Critically Endangered, Endangered and Vulnerable.

The EPBC Act is also the enabling legislation for protection of Migratory species as matters of NES under several international agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA)
- China-Australia Migratory Bird Agreement (CAMBA)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn)
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

[1] Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened flora and fauna species[2] in the following categories:

- Critically Endangered (CR) – species facing an extremely high risk of extinction in the wild in the immediate future[3]
- Endangered (EN) – species facing a very high risk of extinction in the wild in the near future[3]
- Vulnerable (VU) – species facing a high risk of extinction in the wild in the medium-term future[3].

Species may also be listed as specially protected (SP) under the BC Act in one or more of the following categories:

- species of special conservation interest (conservation dependent fauna, CD) – species with a naturally low population, restricted natural range, of special interest to science, or subject to or recovering from a significant population decline or reduction in natural range
- Migratory species (Mig.), including birds subject to international agreement
- species otherwise in need of special protection (OS).

The DBCA administers the BC Act and also maintains a non-statutory list of Priority flora and fauna. Priority species are still considered to be of conservation significance – that is they may be Threatened – but cannot be considered for listing under the BC Act until there is adequate understanding of threat levels imposed on them. Species on the Priority flora and fauna lists are assigned to one of four Priority (P) categories, P1 (highest) – P4 (lowest), based on level of knowledge/concern.

2.2.2 Critical habitat

Under the BC Act, habitat is eligible for listing as critical habitat if it is critical to the survival of a Threatened species or a TEC and its listing is otherwise in accordance with the ministerial guidelines.

2.2.3 Threatened and Priority Ecological Communities

The BC Act provides for the listing of TECs in the following categories:

- Critically Endangered – facing an extremely high risk of becoming eligible for listing as a collapsed ecological community in the immediate future[3]
- Endangered – facing a very high risk of becoming eligible for listing as a collapsed ecological community in the near future[3]
- Vulnerable – facing a high risk of becoming eligible for listing as a collapsed ecological community in the medium-term future[3].

[2] The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act.

[3] As determined in accordance with criteria set out in the ministerial guidelines.

An ecological community may be listed as a collapsed ecological community under the BC Act if there is no reasonable doubt that the last occurrence of the ecological community has collapsed or the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure.

The DBCA also maintains a non-statutory list of Priority Ecological Communities (PECs), which may become TECs in the future; however, do not currently meet survey criteria or that are not adequately defined. PECs are assigned to one of five categories depending on their priority for survey or definition, with Priority 1 of highest concern and Priority 5 of lowest concern.

2.2.4 Other significant flora, vegetation and fauna

Under the EPA's environmental factor guidelines, flora, vegetation and fauna may be considered significant for a range of reasons other than listing as a Threatened or Priority species or ecological community.

In addition to listing as Threatened or Priority, EPA (2016a) identifies the following:

- flora may be significant for
    - local endemism or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
    - new species or anomalous features that indicate a potential new species
    - representing the range of a species (particularly at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
    - being unusual species, including restricted subspecies, varieties or naturally occurring hybrids
    - having relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape
- vegetation may be significant for:
    - having restricted distribution
    - subject to a degree of historical impact from threatening processes
    - having a role as a refuge
    - providing an important function required to maintain ecological integrity of a significant ecosystem.

In addition to listing as Threatened or Priority, EPA (2016b) identifies the following attributes that constitute significant fauna:

- species with restricted distribution
- species subject to a degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

Provided in the guide for assessment of applications to clear native vegetation (DER 2014) is a scale for assessing the bioregional conservation status of ecological vegetation classes (Table 2-1).

Table 2-1 Bioregional conservation status of ecological vegetation classes

Conservation status	Description
Presumed extinct	Probably no longer present in the bioregion
Endangered*	Less than 10% of pre-European extent remains
Vulnerable*	10-30% of pre-European extent exists
Depleted*	More than 30% and up to 50% pre-European extent exists
Least concern	More than 50% of pre-European extent exists and subject to little or no degradation over a majority of this area

* or a combination of depletion, loss of quality, current threats and rarity gives a comparable status

2.2.5 Environmentally Sensitive Areas

Under section 51B of the EP Act the Minister for Environment may declare by notice either a specified area of the State or a class of areas of the State to be Environmental Sensitive Areas (ESAs). ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 2005 (Government of Western Australia 2005).

ESAs are areas where the vegetation has high conservation value. Several types of areas are declared ESAs including:

- the area covered by vegetation within 50 metres (m) of Threatened flora, to the extent to which the vegetation is continuous with the vegetation in which the Threatened flora is located
- the area covered by a TEC
- a defined wetland (Ramsar wetlands, conservation category wetlands and nationally important wetlands) and the area within 50 m of the wetland
- Bush Forever sites.

2.2.6 Introduced flora

Introduced flora (weeds) pose threats to biodiversity and natural values by successfully out-competing native species for available nutrients, water, space and sunlight; reducing the natural structural and biological diversity by smothering native plants or preventing them from growing back after clearing, fire or other disturbance; replacing the native plants that animals use for shelter, food and nesting; and altering fire regimes, often making fires hotter and more destructive (AWC 2007).

Management of some weed species is required under Commonwealth or State frameworks. Key classifications for significant introduced flora that are relevant to this report are:

- Declared Pest – the *Biosecurity and Agriculture Management Act 2007*, Section 22 makes provision for a plant taxon to be listed as a Declared Pest organism in parts of, or the entire State. Under the Biosecurity and Agriculture Management Regulations 2013 Declared Pests are assigned to one of three control categories that dictate the level of management required (DPIRD 2019).
- Weed of National Significance (WoNS) – high impact, established introduced flora causing major economic, environmental, social and/or cultural impacts in a number of states/territories, and which have strong potential for further spread (Australian Weeds

Committee 2012). Management is required in accordance with Department of Primary Industries and Regional Development (DPIRD) guidelines for particular WoNS.

Throughout this report, introduced flora species are indicated with an asterisk (*).

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is located in the Hamersley subregion (PIL03) of the Pilbara bioregion (Figure 3-1) which is characterised as a mountainous area of Proterozoic sedimentary ranges and plateaux dissected by basalt, dolerite and shale gorges (Kendrick 2001). The vegetation of the region is largely characterised by Mulga low woodland over bunch grasses on fine textured soils in valley floors, and *Eucalyptus leucophloia* over *Triodia brizoides* on skeletal soils of the ranges (Kendrick 2001).

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Wonumunna GNH Intersection study area (75.9 ha)

Wonmunna Iron Ore Project (4,825.3 ha)

Hamersley (PIL03)

Mineral Resources Ltd
Wonmunna Iron Ore Project

Project No	1377-WON-
Date	02-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

0 0.5 1 1.5 km

Scale at A3 - 1:37,500 EPSG:28350

Legend

- The study area
- The Project area
- Approved Indicative Disturbance Footprint
- Major roads
- IBRA region - Hamersley (PIL03)

Figure 3-1

IBRA regions and subregions of the study area

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3.2 CLIMATE AND WEATHER

The climate of the Hamersley subregion is described as semi-desert tropical, and experiences an average annual rainfall of 300 mm, with the majority of this occurring in summer cyclonic or thunderstorm events (Kendrick 2001). The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and recent historic climate data is Newman Aero (no. 007176), Latitude: 23.42°S Longitude 119.80°E), located 85 km south-east of the study area.

Newman Aero records the highest mean maximum monthly temperature (39.3°C) in December (lowest in June, 23.1°C) and the lowest minimum mean monthly temperature (6.5°C) in July (highest in January, 25.1°C; Figure 3-2)(BoM 2020). Average annual rainfall is 324.3 mm with January and February recording the highest monthly averages (69.8 and 70.2 mm respectively; Figure 3-2).

Daily mean temperatures at Newman Aero preceding the surveys were higher than average for July, August and September, though October temperatures were equivalent to the long-term average (Figure 3-2). Records show lower than average rainfall for July, August and September, with only 9 % of the long-term average rainfall for these months. October experienced above average rainfall however, with 3.9 mm of precipitation more the long-term average (Figure 3-2).

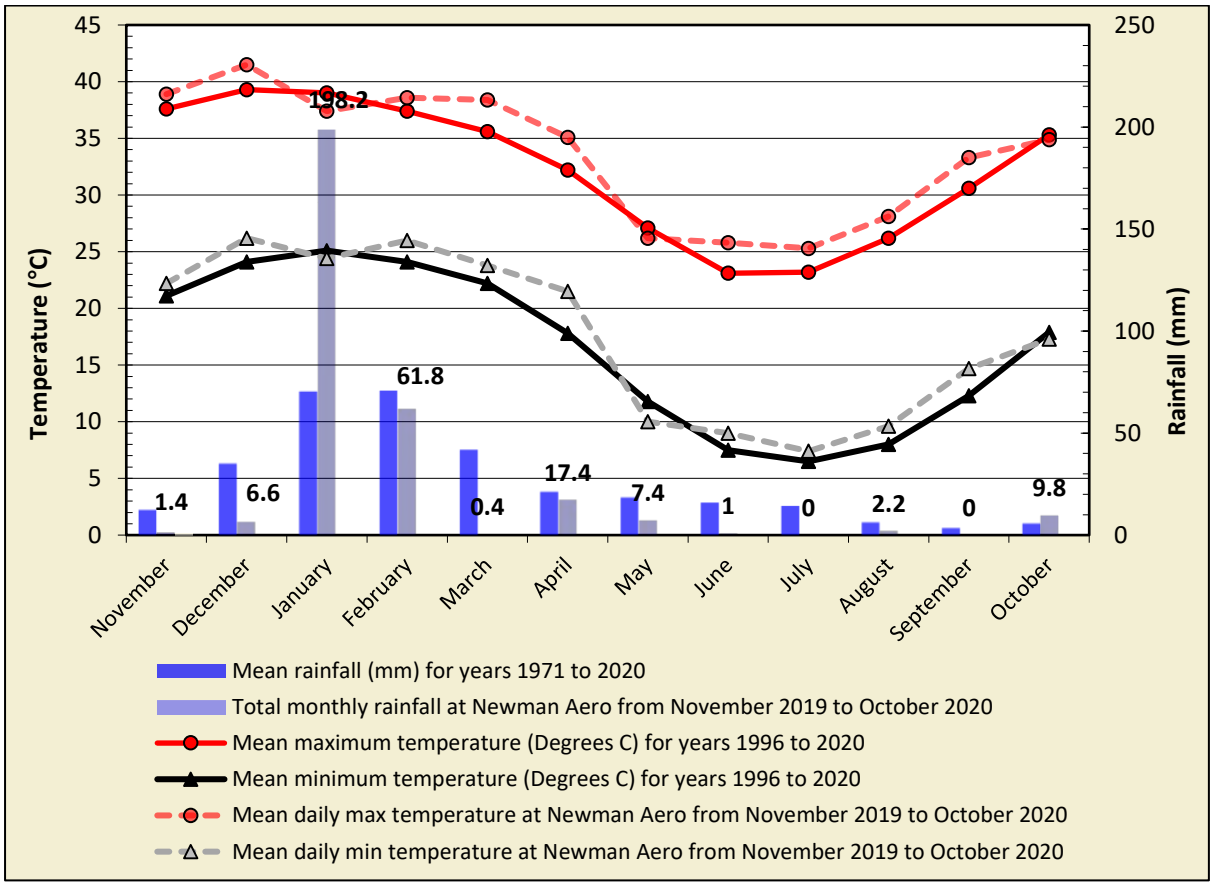

Figure 3-2 Annual climate and weather data for Newman Aero (no. 007176) and mean monthly data for the 12 months preceding the survey (BoM 2020)

3.3 CONSERVATION RESERVES AND ESAS

There are no conservation estates, ESA's, TECs or PECs within the area of the desktop review.

4 METHODS

The survey was conducted in accordance with relevant survey guidelines and guidance, including:

- EPA Environmental Factor Guideline: Flora and vegetation (EPA 2016a)
- EPA Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment (EPA 2016c)
- EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016b)
- EPA Technical Guidance: Terrestrial fauna surveys (EPA 2016d).

4.1 DESKTOP REVIEW

Searches of biological databases were undertaken to identify and prepare lists of significant flora, vegetation and vertebrate fauna that may occur within the study area (Table 4-1). A literature search was conducted for previous published and unpublished reports and/or data for biological surveys conducted within 5 -100km of the study area, to build on the lists developed from the database searches (Table 4-2).

Table 4-1 Database searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (DAWE 2020)	EPBC Act Threatened flora, fauna and ecological communities	Approximate centre point of study area (-23.105554; 119.037480) with 10 km buffer
DBCA Threatened and Priority Flora Database (DBCA 2020d)	Threatened and Priority flora	
DBCA Threatened and Priority Fauna Database (DBCA 2020c)	Threatened and Priority fauna	
DBCA Threatened and Priority Ecological Communities Database (DBCA 2020b)	TECs and PECs	
DBCA NatureMap Database (DBCA 2020a)	Flora and fauna records	

Table 4-2 Previous survey reports included in the desktop review

Report author	Survey description	Project	Location
G&G Environmental (2011), G&G Environmental (2014)	Level 2 Flora and Vegetation Survey	Wonmunna Iron Ore Project	Outside study area
Phoenix (2012b)	Targeted fauna surveys	Wonmunna Iron Ore Project	Outside study area
Phoenix (2012a)	Level 2 vertebrate fauna survey	Wonmunna Iron Ore Project	Outside study area

4.2 FIELD SURVEY

4.2.1 Survey timing

Field survey dates are provided in Table 4-3.

Table 4-3 Survey dates

Survey type	Season	Dates
Flora and vegetation reconnaissance survey	Spring	17 November 2020
Fauna reconnaissance survey (habitat assessment and Western Pebble-mound Mouse searches)	Spring	17 November 2020

4.2.2 Flora and vegetation

Field methods for the flora and vegetation survey of the study area included:

- surveying of quadrats and relevés (see section 4.2.2.1)
- targeted flora searches (section 4.2.2.2)
- vegetation type and condition mapping (sections 4.2.2.3 and 4.2.2.4)

Prior to the commencement of the field survey, data including satellite imagery and survey boundary were loaded onto electronic field devices. The field survey involved assessing and mapping vegetation boundaries, conducting quadrat and relevé sampling and collecting opportunistic flora specimens. GPS locations of vegetation and condition boundaries, survey sites and flora specimen data were recorded digitally.

4.2.2.1 Quadrats and relevés

Quadrat locations were selected to ensure that an accurate representation of the major vegetation types within the study area were sampled adequately. Quadrat and relevé locations were determined in the field while traversing the study area on foot. Relevés were used to record predominantly dominant vegetation for the purposes of accurate vegetation mapping.

In total, six quadrats (50 m x 50 m) and two relevés were surveyed across the study area (Figure 4-1; Appendix 1).

Quadrat sampling dimensions were 50 m x 50 m in accordance with EPA guidance for the Eremaean Botanical Province. The following information was recorded for each quadrat (Appendix 2):

- location – the geographic coordinates of all four corners of the quadrat in WGS84 projection
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (ESCAVI 2003) and in accordance with EPA (2016c) (Appendix 3)
- habitat – a brief description of landform and habitat
- geology – a broad description of surface soil type and rock type
- disturbance history – a description of any observed disturbance including an estimate of time since last fire, weed invasions, soil disturbance, human activity and fauna activity

- vegetation condition – using the condition scale in EPA (2016c) for the Eremaean Botanical Province
- height and percentage foliage cover (PFC) – a visual estimate of cover of total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover
- photograph – a colour photograph of the vegetation within each quadrat in a south-easterly direction from the north-west corner of the quadrat
- flora species list – comprehensive list of all flora species recorded within the quadrat.

To ensure accurate taxonomic identification of flora species present within the study area, collections were made of each specimen at least once and each collection was pressed and documented for identification using the WA Herbarium resources.

For each species identified, records on FloraBase and the Australasian Virtual Herbarium were consulted to provide information on known ranges to determine whether the study area represented a range extension for the species.

Relevés were sampled within vegetation units where dominant species, soils and topography were representative of vegetation surveyed in quadrats. Information collected in relevés was the same as for quadrats with the exception that:

- only a single geographic coordinate was recorded
- only prominent flora species were recorded.

4.2.2.2 Targeted flora searches

Targeted searches were undertaken for significant flora (Threatened and Priority), Declared Pests and WoNS. Remnant vegetation was traversed by foot in meandering transects with the searches focused on habitats considered likely to support significant flora, in addition to previously recorded locations of significant plants or populations in close proximity to the study area.

If a flora species was considered to potentially be a significant species (i.e. similar floristic characteristics and occurring within suitable habitat) the following information was collected:

- GPS coordinates, including population boundary where applicable
- description of the habitat and floristic community in which the potential significant species was located
- population size estimate (i.e. estimated number of individual plants) where applicable
- specimen collection for taxonomic identification and lodgement at the WA Herbarium
- photograph of live plant in situ and description of important details, such as flower colour, height of individual or average height of population.

Following the field survey, the likelihood of occurrence for each significant flora species identified in the desktop review was assessed and assigned to one of three ratings:

- recorded – species recorded within the study area by previous or current survey
- possible – study area within known range of species; potential habitat within the study area, records within 5 km of study area and may not have been detectible during survey (e.g. survey conducted outside flowering period, annual plant survey conducted outside likely

period of occurrence, small herbaceous plant in dense vegetation), or entire area of habitat not thoroughly searched

- unlikely – study area outside known range of species and/or no suitable habitat present in study area and/or suitable/potential habitat present but study area considered adequately searched for the species.

4.2.2.3 Vegetation type mapping

Vegetation mapping was undertaken at a scale of 1:5,000 using Native Vegetation Information System (NVIS) sub-association level (L5) for structural descriptions (ESCAVI 2003). The vegetation descriptions from quadrats and relevés from the survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and combination of species and the prevalent community structure (i.e. woodland, shrubland, etc.). Distinct vegetation units (the floristic group) classified the vegetation at a local scale. Local scale vegetation units were described at NVIS Level V – Association (ESCAVI 2003). The term 'vegetation type' was used for local scale vegetation units in accordance with EPA technical guidance (EPA 2016c). The vegetation boundaries were mapped utilising ArcGIS ESRI imagery and from vegetation boundaries recorded on GPS during the field survey.

4.2.2.4 Vegetation condition mapping

The condition of vegetation was mapped across the study area based on the appropriate condition scale for the Eremaean Botanical Province (Trudgen 1988 in EPA 2016c) (Table 4-4). The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranges from Excellent being the highest rating to Completely Degraded as the lowest.

Table 4-4 Vegetation condition rating scale (EPA 2016c)

Condition rating	Description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

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Wonumunna GNH Intersection study area (75.9 ha)
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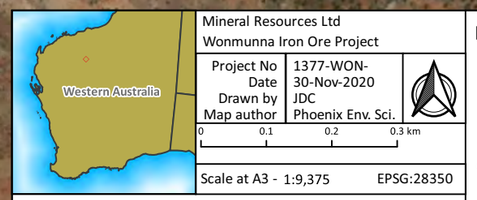

Mineral Resources Ltd
Wonmunna Iron Ore Project

Project No	1377-WON-
Date	30-Nov-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

0 0.1 0.2 0.3 km

Scale at A3 - 1:9,375 EPSG:28350

Legend

- Survey sites
- Targeted search tracks
- The study area
- Major roads

Figure 4-1

Survey sites

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4.2.3 Terrestrial fauna

Field methods for the fauna survey included foot searches for Western Pebble-mound Mouse mounds whereby the study area was traversed and the location of any mounds were to be recorded on GPS and a photograph of the mound was taken. A total of eight survey sites form the basis for the habitat assessment and delineation (Figure 4-1; Appendix 1).

4.2.3.1 Habitat assessment

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Using the flora and vegetation dataset, habitats with the potential to support significant terrestrial fauna species were identified based on known habitats of such species within the Pilbara bioregion.

4.2.3.2 Western Pebble-mound Mouse targeted searches

During the field survey characteristic mounds of the Western Pebble-mound Mouse were searched for on foot concurrently with the targeted flora survey.

4.2.3.3 Likelihood of occurrence assessment

Following the field survey, the likelihood of occurrence for each significant fauna species identified in the desktop review was assessed and assigned to one of four ratings:

- recorded – species recorded within the study area by previous or current survey
- likely – study area within current known range of species, suitable habitat within the study area and home range of species intersects study area based on known records
- possible – study area within current known range of species, suitable habitat within the study area and home range of species does not intersect study area based on known records
- unlikely – study area outside current known range of species or no suitable habitat present in study area.

4.2.4 Survey personnel

The personnel involved in the surveys are listed in Table 4-5. All survey work was carried out under relevant licences issued by DBCA under the BC Act.

Table 4-5 Survey personnel

Name	Permit	Qualifications	Role/s
Dr Grant Wells	FB62000227 TFL 103-1920	PhD (Botany)	Project management, field survey, taxonomy, reporting
Dr Grace Wells	NA	PhD (Botany)	Field survey, GIS, mapping, reporting
Calum Woods	TFL 36-2021	MSc (Cons. Biol.)	Reporting, data management, taxonomy
Mary-Anne Clunies-Ross	NA	BSci (Env.Mgt.)	Data management, reporting

Name	Permit	Qualifications	Role/s
Jarrad Clark	NA	BSc (Env.Mgt.)	Reporting
Dr Ikrom Nishanbaev	NA	PhD	GIS, figures

5 RESULTS

5.1 DESKTOP REVIEW

5.1.1 Flora and vegetation

5.1.1.1 Flora assemblage

The desktop review identified records of 82 flora taxa within the desktop search extent comprising 24 families and 48 genera that included 81 native flora, one naturalised species and five Priority flora species (DBCA 2020a). Previous surveys in close proximity to the study area recorded 270 flora taxa comprising 42 families and 124 genera in a much larger area, 4,840 ha that included eight introduced species and one Priority flora, *Gymnanthera cunninghamii*.

5.1.1.2 Significant flora

Records of ten significant flora species were identified within the desktop search extent (DAWE 2020), comprising one Threatened flora listed under the EPBC Act and nine Priority flora (Table 5-1).

No records of significant flora occurred in the study area (Figure 5-1).

Table 5-1 Significant flora identified in the desktop review

Species	Status	Proximity to study area	Habitat
Lepidium catapycnon	VU (EPBC Act); P4 (DBCA)	9.7 km S of study area	Low open woodland of *Eucalyptus leucophloia* over scattered low shrubs of *Scaevola acacioides* and *Tribulus suberosus* over open hummock grassland of *Triodia wiseana* in skeletal soils on hillsides (WA Herbarium 2020).
Aristida lazaridis	P2 (DBCA)	9.1 km NW of study area	Tussock grassland of *Aristida latifolia*, *Eulalia aurea* and *Aristida inaequiglumis* with shrubland of *Senna artemisioides* subsp. *filifolia*, *Eremophila longifolia* and *Acacia dictyophleba* with low open woodland of *Eucalyptus xerothermica* and *Corymbia hamerselyana*. In sand or loam (WA Herbarium 2020).
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2 (DBCA)	9.5 km NE of study area	Low woodland of *Acacia citrinoviridis*, *A. pruinocarpa* and *Corymbia ferriticola* over open shrublands of *Dodonaea pachyneura, A. maitlandii*, *A. aptaneura* and *Eremophila latrobei* subsp. glabra over very open tussock grassland of *Triodia* sp., *Eriachne mucronata*, *Cymbopogon ambiguus* and *Aristida burbidgeae*. In gullies and drainage lines (WA Herbarium 2020).
Acacia subtiliformis	P3 (DBCA)	8.7 km NE of study area	*Eucalyptus leucophloia* low open woodland, over *Hakea chordophylla*, *Acacia maitlandii* and *Acacia hamersleyensis* scattered tall shrubs, over *Eriachne mucronata* and *Eriachne ciliate* scattered to very open tussock grasses, over *Triodia wiseana* hummock

Species	Status	Proximity to study area	Habitat
			grassland on rocky calcrete plateau (WA Herbarium 2020).
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3 (DBCA)	3.1 km N of study area	Hummock grassland of *Triodia wiseana*, isolated low trees of *Corymbia hamersleyana* and isolated tall shrubs of *Acacia synchronicia* in red-brown clay soil with calcrete pebbles on low undulating plain and swampy plains (WA Herbarium 2020).
Grevillea saxicola	P3 (DBCA)	6.5 km N of study area	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia aptaneura* tall open shrubland over *Scaevola acacioides* scattered low shrubs over *Triodia wiseana* open hummock grassland with *Eriachne mucronata* very open tussock grassland. In brown, red or orange loamy and rocky soil of scree slopes and foothills (WA Herbarium 2020).
Gymnanthera cunninghamii	P3 (DBCA)	0.8 km S of the study area	Open Woodland of *Eucalyptus camaldulensis* and *Melaleuca argentea* with a high shrubland of *Acacia tumida* var. *pilbarensis* and *A. colei* and an open shrubland of mixed *Melaleuca* spp. In creek beds (G&G Environmental 2014).
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3 (DBCA)	9.7 km NW of study area	*Acacia aptaneura/incurvaneura* and *A. pruinocarpa* tall shrubland over *Eremophila forrestii* subsp. *forrestii* and *Psydrax latifolia* shrubland over *Ptilotus obovatus* low shrubland over *Triodia epactia* and *T. longiceps* open hummock grassland and *Enneapogon caerulescens* and *Chrysopogon fallax* grassland on plains (WA Herbarium 2020).
Triodia sp. Mt Ella (M.E. Trudgen 12739)	P3 (DBCA)	9.9 km NE of study area	*Corymbia hamersleyana* and *Eucalyptus leucophloia* low open woodland over *Petalostylis labicheoides*, *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* open scrub over *Triodia pungens* very open hummock grassland. On scree slopes with skeletal red-brown loam soils (WA Herbarium 2020).
Ptilotus mollis	P4 (DBCA)	6.9 km E of study area	*Eucalyptus leucophloia* woodland over *Acacia bivenosa* shrubland over *Triodia epactia* and *T. wiseana* hummock grassland. On slopes and hills (WA Herbarium 2020).

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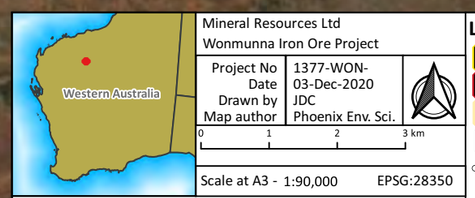
Weeli Wolli Spring Community

Wonumunna GNH Intersection study area (75.9 ha)

Wonmunna Iron Ore Project (4,825.3 ha)



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Wonmunna Iron Ore Project

Project No	1377-WON-
Date	03-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

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Scale at A3 - 1:90,000 EPSG:28350

Legend

- The study area
- Desktop review area
- The Project area
- Approved Indicative Disturbance Footprint
- Major roads
- TEC/PEC within the desktop boundary

Desktop significant flora

- VU (EPBC Act; P4 DBCA list)
- P2 (DBCA list)
- P3 (DBCA list)
- P4 (DBCA list)

Figure 5-1

Desktop records of significant flora and vegetation

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5.1.1.3 Introduced flora

The desktop review identified records of nine introduced species within the desktop search extent, of which none are Declared Pests or WoNS (Table 5-2).

Table 5-2 Desktop records of significant weeds

Species	Declared Pest	WoNS
**Alternantha pungens*	N	N
**Bidens bipinnata*	N	N
**Cenchrus ciliaris*	N	N
*Cenchrus setiger	N	N
**Flaveria trinervia*	N	N
**Malvastrum americanum*	N	N
**Sigesbeckia orientalis*	N	N
**Sonchus oleraceus*	N	N
**Vachellia farnesiana*	N	N

5.1.1.4 Vegetation associations

Regional scale vegetation mapping by Shepherd *et al.* (2002) mapped two vegetation associations in the study area (Table 5-3; Figure 5-2). The remaining extent of all vegetation associations at the Statewide scale exceeds 50% and they are therefore considered of Least Concern (Table 5-3). Both associations have over 95% remaining at the bioregional and subregional scales (Shepherd *et al.* 2002).

Table 5-3 Statewide extent of Pre-European vegetation associations present in the study area (Shepherd *et al.* 2002)

Vegetation association	Pre-European extent (ha)	Current extent (ha)	Remaining (%)	Current extent in DBCA lands (%)	% of study area
29; Mulga (*Acacia aneura*) and associated species	7,903,991	7,898,973	99.9	472,982	37.2
82; Hummock grassland with scattered bloodwoods & snappy gum *Triodia* spp., *Corymbia dichromophloia*, *Eucalyptus leucophloia*	2,565,901	2,553,206	99.5	32,222	62.8

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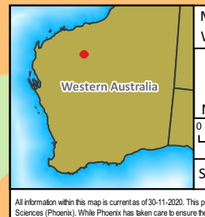
Pre-european vegetation within the desktop boundary

- Annual grasses Enneapogon spp. Aristida spp. etc on dry plains and salt water grasses Sporobolus virginicus on the coast
- Hummock grassland with scattered bloodwoods & snappy gum Triodia spp., Corymbia dichromophloia, Eucalyptus leucophloia
- Mulga Acacia aneura and associated species.

Weeli Wolli Spring Community

Wonumunna GNH Intersection study area (75.9 ha)

Wonmunna Iron Ore Project (4,825.3 ha)



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Project No	1377-WON-
Date	30-Nov-2020
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Map author	Phoenix Env. Sci.

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Scale at A3 - 1:90,000 EPSG:28350

Legend

- The study area
- Desktop review area
- The Project area
- Approved Indicative Disturbance Footprint
- Major roads
- TEC/PEC within the desktop boundary

Figure 5-2

Vegetation associations of the study area

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5.1.1.5 Significant vegetation

The DBCA Threatened and Priority Ecological Communities database search identified no TECs and one PEC within the desktop search extent (Figure 5-1; Table 5-4). The PEC does not intersect the study area.

Table 5-4 TECs and PECs identified in the desktop review

Community name	Status	Proximity to study area	Description
Weeli Wolli Spring Community	P1 (DBCA)	7.2 km NE of study	Weeli Wolli Spring's riparian woodland and forest associations are unusual because of the composition of the understorey. The sedge and herbfield communities that fringe many of the pools and associated water bodies along the main channels of Weeli Wolli Creek have not been recorded from any other wetland site in the Pilbara.

Survey of the adjacent Wonmunna mining lease identified no vegetation representative of a listed TEC or PEC and no regionally significant vegetation (G&G Environmental 2011).

5.1.2 Terrestrial fauna

5.1.2.1 Significant vertebrate fauna

The desktop review focused on significant species, however, the most relevant previous surveys (Phoenix 2012a, b, 2014) which took place approximately 1.1–9.6 km to the south of the current study area, recorded 170 vertebrate taxa comprised of two fish, 2 amphibians, 58 reptiles, 77 birds and 30 mammals (including seven introduced).

Twenty-one significant vertebrate species were identified in the desktop review, including four reptiles, 13 birds and four mammals. These species comprised seven species listed as Threatened, Conservation Dependent or Specially Protected under the EPBC Act and/or BC Act (Table 5-11; Figure 5-3). Nine avifauna species are listed as Migratory under the EPBC Act and BC Act. A further five species are listed as Priority by DBCA.

Table 5-5 Summary of significant fauna identified in desktop review

Scientific name (21)	Vernacular	DBCA List	BC Act	EPBC Act
Reptiles (4)				
Anilios ganei	Gane's blind snake (Pilbara)	P1		
Lerista macropisthopus subsp. Remota	unpatterned robust slider (Robertson Range)	P2		
Liasis olivaceus subsp. Barroni	Pilbara Olive Python		VU	VU
Underwoodisaurus seorsus	Pilbara Barking Gecko	P2		
Birds (13)				

Scientific name (21)	Vernacular	DBCA List	BC Act	EPBC Act
Actitis hypoleucos	Common Sandpiper		Mig.	Mig.
Apus pacificus	Fork-tailed Swift		Mig.	Mig.
Calidris acuminata	Sharp-tailed Sandpiper		Mig.	Mig.
Calidris ferruginea	Curlew Sandpiper		CR	CR/Mig.
Calidris melanotos	Pectoral Sandpiper		Mig.	Mig.
Charadrius veredus	Oriental Plover		Mig.	Mig.
Elanus scriptus	Letter-winged Kite	P4		
Falco hypoleucos	Grey Falcon		VU	
Hirundo rustica	Barn Swallow		Mig.	Mig.
Motacilla cinerea	Grey Wagtail		Mig.	Mig.
Motacilla flava	Yellow Wagtail		Mig.	Mig.
Pezoporus occidentalis	Night Parrot		CR	EN
Rostratula australis	Australian Painted Snipe		EN	EN
Mammals (4)				
Dasyurus hallucatus	Northern Quoll		EN	EN
Macroderma gigas	Ghost Bat		VU	VU
Pseudomys chapmani	Western Pebble-mound Mouse	P4		
Rhinonicteris aurantia (Pilbara)	Pilbara leaf-nosed bat		VU	VU
	Total	**5**	**15**	**14**

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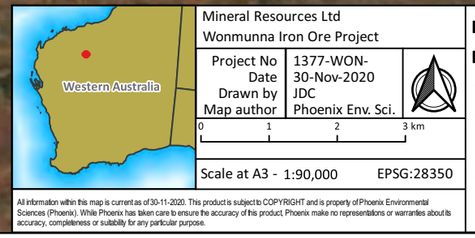
Weeli Wolli Spring Community

Wonumunna GNH Intersection study area (75.9 ha)

Wonmunna Iron Ore Project (4,825.3 ha)



Mineral Resources Ltd
Wonmunna Iron Ore Project

Project No	1377-WON-30
Date	30-Nov-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

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Scale at A3 - 1:90,000 EPSG:28350

Legend

Desktop significant fauna

- CR/Mig./CR (EPBC & BC Act)
- EN (EPBC & BC Acts)
- EN/CR (EPBC Act; BC Act)
- VU (BC Act)
- VU (EPBC & BC Acts)
- Mig. (EPBC & BC Acts)
- P1 (DBCA list)
- P2 (DBCA list)
- P4 (DBCA list)

- The study area
- Desktop review area
- The Project area
- Approved Indicative Disturbance Footprint
- Major roads
- TEC/PEC within the desktop boundary

Figure 5-3

Desktop records of significant vertebrate fauna

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5.2 FIELD SURVEY

5.2.1 Flora and vegetation

5.2.1.1 Flora assemblage

A total of 68 flora taxa representing 17 families and 39 genera identified to species level were recorded in the study area during the field surveys (Appendix 5). The assemblage included 66 native species and two introduced species, including 59 perennial species, and eight annual or short-lived species and one for which life cycle is not recorded. The most prominent families recorded were Fabaceae (17 spp.), Poaceae (12 spp.), Myrtaceae (8 spp.) and Amaranthaceae (6 spp.).

5.2.1.2 Significant flora

No significant flora was recorded in the study area.

The likelihood of occurrence assessment (section 4.2.2.2) for the remaining significant species identified in the desktop review (section 5.1.1.2) determined all are unlikely to occur (Table 5-6).

Table 5-6 Likelihood of occurrence for significant flora identified in the desktop review

Species	Status	Likelihood of occurrence
Lepidium catapycnon	VU (EPBC Act); P4 (DBCA)	Unlikely, suitable habitat found in the study area but adequately searched for the species
Aristida lazaridis	P2 (DBCA)	Unlikely, no habitat found in the study area
Hibiscus sp. Gurinbiddy Range (M.E. Trudgen MET 15708)	P2 (DBCA)	Unlikely, no suitable habitat in study area
Acacia subtiliformis	P3 (DBCA)	Unlikely, suitable habitat found in the study area, but area adequately searched for the species
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3 (DBCA)	Unlikely, no suitable habitat in study area
Grevillea saxicola	P3 (DBCA)	Unlikely, suitable habitat found in the study area but adequately searched for the species
Gymnanthera cunninghamii	P3 (DBCA)	Unlikely, suitable habitat found in the study area but adequately searched for the species
Rhagodia sp. Hamersley (M. Trudgen 17794)	P3 (DBCA)	Unlikely, no suitable habitat in study area
Triodia sp. Mt Ella (M.E. Trudgen 12739)	P3 (DBCA)	Unlikely, no suitable habitat in study area
Ptilotus mollis	P4 (DBCA)	Unlikely, suitable habitat found in the study area but adequately searched for the species

5.2.1.3 Introduced flora

Two introduced flora species were recorded during the survey, of which none are a WoNS/Declared Pest (Table 5-7).

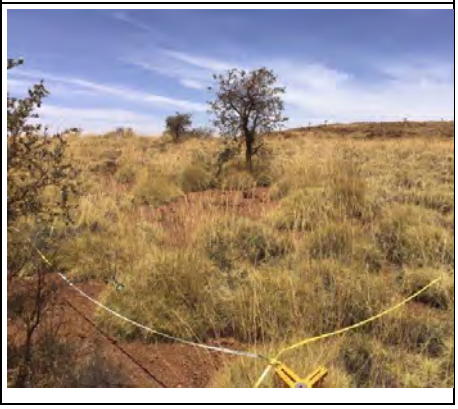
Table 5-7 Introduced flora recorded in the field survey

Family	Species	Declared Pest	WoNS
Asteraceae	**Flaveria trinervia*	no	no
Poaceae	**Cenchrus ciliaris*	no	no

5.2.1.4 Vegetation types

Four vegetation types were defined for the study area. They comprised two spinifex steppes with scattered *Corymbia hamersleyana* or *Eucalyptus leucophloia* subsp. *leucophloia* trees (ChAiTw, ElErTw) and two low *Corymbia hamersleyana* and *Eucalyptus victrix,* and *Corymbia hamersleyana* and *Acacia distans* woodlands in creeks (Table 5-8; Figure 5-4). None of the vegetation types were considered significant or restricted.

Table 5-8 Vegetation types, description and extent in the study area

Vegetation type	Site/s	Vegetation description	Extent in study area (ha and %)	Representative photograph
ChEvTt (C2 in G&G Environmental 2014)	W001	Low *Corymbia hamersleyana* and *Eucalyptus victrix* woodland over tall open *Acacia* ssp., *Melaleuca bracteata* and *Petalostylis labicheoides* shrubland over **Cenchrus ciliaris*, *Eulalia aurea* and *Themeda triandra* grassland.	3.7, 4.9%	
ChAiTw (SS1 in G&G Environmental 2014)	W002 W003 W006	Isolated low *Corymbia hamersleyana* trees and *Eucalyptus gamophylla* mallee over isolated mid *Acacia inaequilatera*, *A. bivenosa* and *Hakea chordophylla* shrubs over low *Triodia wiseana* hummock grassland.	51.7, 68.1%	

Vegetation type	Site/s	Vegetation description	Extent in study area (ha and %)	Representative photograph
ElErTw (M2 in G&G Environmental 2014)	W005 W008	Isolated low trees to open woodland of *Eucalyptus leucophloia* subsp. *leucophloia* and *E. repullulans* over isolated *Acacia inaequilatera*, *Acacia arida and Scaevola acacioides* shrubs over low *Triodia wiseana* hummock grassland.	8.4, 11.1%	
ChAdTspp (C6 in G&G Environmental 2014)	W007	Low open *Corymbia hamersleyana* and *Acacia distans* woodland over tall open *Petalostylis labicheoides* and *Acacia bivenosa* shrubland over *Cymbopogon ambiguus*, *Themeda triandra* and *Triodia* spp. grassland.	1.8, 2.4%	
Road		Great Northern Highway.	7.1, 9.4%	
Previously disturbed		Tracks and other disturbances present	3.2, 4.2%	

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Vegetation
- Great Northern Highway
- Historically cleared. Some vegetation currently present - recolonised from neighbouring areas
- Isolated low C. hamersleyana trees and E. gamophylla mallee over isolated mid A. inaequilatera, A. bivenosa and H. chordophylla shrubs over low T. wiseana hummock grassland.
- Isolated low trees to open woodland of E. leucophloia subsp. leucophloia and E. repullulans over isolated A. inaequilatera, A. arida and S. acacioides shrubs over low T. wiseana hummock grassland.
- Low C. hamersleyana and E. victrix woodland over tall open Acacia ssp., M. bracteata and P. labicheoides shrubland over *C. ciliaris, E. aurea and T. triandra grassland.
- Low open C. hamersleyana and A. distans woodland over tall open P. labicheoides and A. bivenosa shrubland over C. ambiguus, T. triandra and Triodia spp. grassland.

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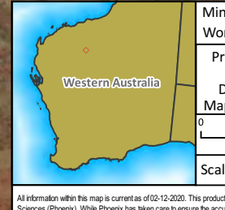
Disturbed ChAiTw ChAiTw ChAiTw ChAiTw ChAiTw ChAiTw Disturbed ChAiTw Disturbed ChAiTw Disturbed ChAiTw Disturbed Road ChEvTt ChAiTw ChEvTt ChAiTw ChEvTt ChAiTw ChAiTw ChAiTw Disturbed ChAiTw ChAiTw ChAiTw ChAiTw ChAiTw ChAiTw ChEvTt Disturbed ElErTw Disturbed ElErTw

Wonumunna GNH Intersection study area (75.9 ha)



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Wonmunna Iron Ore Project

Project No	1377-WON-
Date	02-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

0 0.1 0.2 0.3 km

Scale at A3 - 1:9,375 EPSG:28350

Legend
- The study area
- Major roads

Figure 5-4

Vegetation types recorded in the field survey

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5.2.1.5 Vegetation condition

Vegetation in the study area was recorded to be in Excellent to Good condition (Figure 5-5) with the majority (95%) in Excellent to Very Good condition (Table 5-9). The disturbances included vehicle tracks, gas pipeline and weed infestation in creeks and were included in condition rating assessed within sampling sites. Only the Great Northern Highway was rated as Completely Degraded.

Table 5-9 Vegetation condition – extent of each condition rating in study area

Condition rating	Area (ha)	% of study area	% of native vegetation
Excellent	31.6	41.7	48.2
Very Good	30.3	39.9	46.1
Good	3.7	4.9	5.7
Poor	0	0	0
Degraded	0	0	0
Completely Degraded	10.3	13.5	NA

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Wonumunna GNH Intersection study area (75.9 ha)

Western Australia

Mineral Resources Ltd
Wonmunna Iron Ore Project

Project No	1377-WON-
Date	02-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

0 0.1 0.2 0.3 km

Scale at A3 - 1:9,375 EPSG:28350

Legend

- The study area
- Major roads

Vegetation condition

- Excellent
- Very Good
- Good
- Completely Degraded

Figure 5-5

Vegetation condition in the study area

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5.2.1.6 Significant vegetation

No significant vegetation was recorded in the study area.

5.2.2 Terrestrial fauna

No evidence of significant fauna occupation was recorded during the field survey.

5.2.2.1 Fauna habitats

Three broad fauna habitats were identified in the study area based on the flora and vegetation survey data (Table 5-10; Figure 5-6). Open shrubland of *Acacia* over hummock (*Triodia* spp.) grasses was the dominant habitat, occupying approximately 68.1% of the study area, followed by Spinifex grassland habitat (11.1%) and Woodland on minor creekline (7.3%) (Table 5-10; Figure 5-6). In total 13.5% of the study area is or has been, cleared.

The distribution of fauna habitats (Figure 5-6) indicates that the western 70% of the study area is dominated by open shrubland of *Acacia* over hummock (*Triodia* spp.) grasses being bisected by two instances of minor drainage lines. In the eastern 30%, open shrubland of *Acacia* over hummock (*Triodia* spp.) grasses are replaced by Spinifex hummock grasslands on stony plains south of the highway; and a third drainage line intersects both of these habitats. Western Pebble-mound Mouse was expected to occur on the Spinifex hummock grasslands on stony plains but was not recorded.

Table 5-10 Fauna habitats of the study area

Habitat description	Corresponding vegetation types and mapping units	Area (ha)	% of study area
Open shrubland of Acacia over hummock (*Triodia spp*.) grasses (shrubland) Open shrubland habitat with variable structure and species diversity. Often dominated by *Acacia* species over mixed small to medium shrubs and mixed hummock (Triodia spp.) grasses.	ChAiTw	51.7	68.1
Cleared and disturbed Existing cleared areas or infrastructure including tracks and roads	Road and previously disturbed	10.3	13.5
Spinifex hummock grasslands on stony plains (hummock grassland) Spinifex hummock grasslands (*Triodia* species) on stony plains and low stony hills dominated by of various life stages with scattered or sparsely scattered patches of small to medium *Acacia* shrubs on stony substrates.	ElErTw	8.4	11.1
Woodland on minor creekline (woodland) Mainly linear habitat occurring from hill slopes extending to the surrounding plains, or small tributaries that flow into more major drainage lines.	ChEvTt/ ChAdTspp	5.5	7.3
Total	**3**	**75.9**	**100%**

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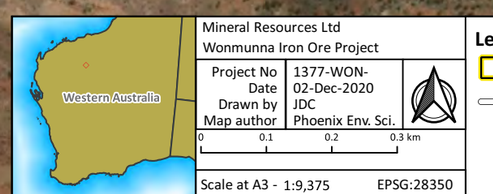
Wonumunna GNH Intersection study area (75.9 ha)



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Project No	1377-WON-
Date	02-Dec-2020
Drawn by	JDC
Map author	Phoenix Env. Sci.

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Scale at A3 - 1:9,375 EPSG:28350

Legend

- The study area
- Major roads

Fauna habitats

- cleared
- Open shrubland of Acacia over hummock (Triodia spp.) grasses
- Spinifex hummock grasslands on stony plains
- Woodland on minor creekline

Figure 5-6

Fauna habitats in the study area

PHOENIX ENVIRONMENTAL SCIENCES

5.2.2.2 Significant fauna

No significant fauna was recorded in the study area. The Western Pebble-mound Mouse *Pseudomys chapmani* (Priority 4) has been recorded several times in close proximity to the study, e.g. 135 m north outside the study area in 2004 and 2005 (DBCA 2020c) and 1.5 km south of the study area (Phoenix 2012a) (Figure 5-3; Table 5-11). The species is therefore considered likely to occur in the study area, despite none of their characteristic mounds being located during the field survey.

Four species that were listed as significant fauna at the time of the original baseline surveys for the Project, the Australian Bustard *Ardeotis australis*, Bush Stone-Curlew *Burhinus grallarius*, Rainbow bee-eater *Merops ornatus* and Star finch *Neochmia ruficauda subclarescens* have also been recorded in close proximity to the study area; however, all are no longer protected by the BC Act or listed under DBCA's Priority fauna listing process.

The likelihood of occurrence assessment for the remaining significant fauna species identified in the desktop review determined that seven species may possibly occur and then remaining 13 are unlikely to occur (Table 5-11).

Table 5-11 Likelihood of occurrence assessment for significant vertebrate fauna identified in the desktop review

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Reptiles (4)							
Anilios ganei Gane's blind snake (Pilbara)	P1 (DBCA)	8.85 km outside study area	The species is known from few records at scattered localities between Newman and Pannawonica (Wilson & Swan 2017). The scant records indicate that it is often associated with moist ridges and gullies.			√	**Possible**. Suitable habitat present.
Lerista macropisthopus remota unpatterned robust slider (Robertson Range)	P2 (DBCA)	2.8 – 4.7 km outside the study area	The subspecies *L. m. remota* occurs in the arid central interior of WA in Acacia shrublands and woodlands (Wilson & Swan 2013).The subspecies is often recorded from loose soil below leaf litter at the base of shrubs (Storr *et al.* 1999; Wilson & Swan 2013).	√		√	**Possible**. Suitable habitat present.
Liasis olivaceus subsp. Barroni Pilbara Olive Python	VU (EPBC, BC Acts)	9.7 km outside study area	The Pilbara Olive Python is thought to be endemic to the Pilbara, with scattered records from across the region, including some offshore islands (Barker & Barker 1994; Pearson 2007; Smith 1981). The species is nocturnal and cryptic, retreating into rock crevices during the day and is less active during the winter months (DSEWPaC 2011). It is commonly found in rocky areas in association with watercourses and pools and often associated with areas of permanent pooling water near rocky habitats, such as gullies, gorges and rocky ranges or boulder sites. It has also been recorded in riparian vegetation along major rivers, such as the Robe River (Barker & Barker 1994; Pearson 2007; Pearson *et al.* 2003).				**Unlikely.** No suitable habitat.

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Underwoodisaurus seorsus Pilbara Barking Gecko	P2 (DBCA)	9.6 km outside study area	Found in the Hamersley Range in the southern Pilbara (Doughty & Oliver 2011), in rocky areas, as well as gorges with sparse tree cover, low shrubs and spinifex (Cogger 2014; Doughty & Oliver 2011).				**Unlikely**. No suitable habitat present.
Birds (13)							
Actitis hypoleucos Common Sandpiper	Mig (EPBC, BC Acts)	*Recorded outside the study area	In Western Australia the species is mostly coastal with some inland records (Geering *et al.* 2007). They are found across a wide range of wetlands: small ponds, large inlets, mudflats where they forage on the shore usually close to the vegetation.				**Unlikely.** No suitable habitat.
Apus pacificus Fork-tailed Swift	Mig (EPBC, BC Acts)	*Recorded outside the study area	The Fork-tailed Swift is a widespread migratory species that overwinters in Australia. It can be found across most of WA and is uncommon to moderately common in the north-west. They occur in a wide range of dry or open habitats, including riparian woodlands, tea-tree swamps, low scrub, heathland, saltmarsh, grassland and spinifex sandplains, open farmland and inland and coastal sand-dunes (Department of the Environment 2014).				**Possible**. Could forage, occasionally above the study area.
Calidris acuminate Sharp-tailed Sandpiper	Mig (EPBC, BC Acts)	*Recorded outside the study area	The distribution of the species in Australia depends on water quantity conditions; some large wetlands may be available inland after important rainfall, but only occasionally. The distribution on the coast is more regular, the conditions being more consistent.				**Unlikely.** No suitable habitat.

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Calidris ferruginea Curlew Sandpiper	CR (EPBC Act); CR/Mig (BC Act)	*Recorded outside the study area	In Australia they are mostly found on the coast but can also forage inland, in open shallow wetlands (DoEE 2018).				**Unlikely.** No suitable habitat.
Calidris melanotos Pectoral Sandpiper	Mig (EPBC, BC Acts)	*Recorded outside the study area	Found in wetlands, inland as well as on the coast. The species typically uses shallow fresh to saline wetlands such as coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.				**Unlikely.** No suitable habitat.
Charadrius veredus Oriental Plover	Mig (EPBC, BC Acts)	*Recorded outside the study area	The Oriental Plover has a widespread distribution but most records are along the north-western coast between Exmouth Gulf and Derby (DoEE 2020). Inland habitats occupied by the species include sparsely vegetated plains or recently burnt open areas.				**Unlikely** to occur due to lack of suitable habitat.
Elanus scriptus Letter-winged Kite	P4 (DBCA)	9.96 km outside study area	Letter-winged Kites is a rare non-breeding visitor to WA (Johnstone & Storr 1998). The species is irruptive with a fluctuating range, depending on prey abundance. In poor years the species is possibly the rarest breeding raptor in Australia (Garnett *et al.* 2011). They are mostly found in the eastern Australian arid zone.	√	√	√	**Possible**. May forage within the study area if rodent population number permit. It will not breed in the study area.

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Falco hypoleucos Grey Falcon	VU (BC Act)	*EPBC database	The Grey Falcon is a widespread but rare species inhabiting much of the semi-arid interior of Australia. Its distribution is centred on inland drainage systems. It has a large foraging range and habitat usage, extending from timbered plains, such as Acacia shrublands, into open grasslands (Garnett & Crowley 2000). The Grey Falcon almost exclusively preys on birds (Schoenjahn 2012).	√	√	√	**Possible**. May forage within the study area. It will not breed in the study area.
Hirundo rustica Barn Swallow	Mig (EPBC, BC Acts)	*EPBC database	Barn Swallows only occur in Australia as migrants. In WA, they occur in coastal Pilbara and coastal Kimberley. They feed on a wide range of invertebrates they catch in flight, usually over the water (seashore but also inland freshwater) (Johnstone & Storr 2004).				**Unlikely** . Study area outside known range.
Motacilla cinereal Grey Wagtail	Mig (EPBC, BC Acts)	*EPBC database	A vagrant visitor to Australia that inhabits fast flowing streams and rivers (IUCN 2019).				**Unlikely**. No suitable habitat.
Motacilla flava Yellow Wagtail	Mig (EPBC, BC Acts)	*EPBC database	Primary inhabits a range of damp or wet habitats with low vegetation including damp meadows, marshes, waterside pastures, and sewage farms (IUCN 2019).				**Unlikely**. No suitable habitat.

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Pezoporus occidentalis Night Parrot	EN (EPBC Act); CR (BC Act)	*EPBC database	The species appears to favour dense vegetation comprising old-growth (often > 50 years unburnt) spinifex (*Triodia* spp.) especially hummocks that are ring-forming for roosting and nesting. Such areas may also be associated with dense chenopod shrubs. It is thought that spinifex hummocks that are <40-50 cm in height are not likely to provide adequate shelter for roosting and nesting (DPaW 2017). Foraging appears to take place in habitats containing various native grasses and herbs in addition to spinifex, and these areas may or may not contain shrubs or low trees. Favoured sites may vary with the season and local conditions, and may not necessarily occur within or adjacent to roosting areas, as they have been observed to fly up to 40 kms in a night (DPaW 2017). *Triodia* species are thought to provide a food resource while flowering and seeding. The succulent genus *Sclerolaena* has also been shown to be a source of food and moisture and other succulent chenopods species are also considered likely to be important. Foraging habitat is likely to be more important if it is adjacent to or within about 10 km of patches of *Triodia* deemed suitable as roosting habitat.				**Unlikely**. No suitable habitat.
Rostratula australis Australian Painted Snipe	EN (EPBC Act, BC Act)	*EPBC database	The species is found inland as well as on the coast across continental Australia. West Australian records are almost exclusively from the south-west and the Kimberley. The Australian Painted Snipe feeds and breeds in shallow water surrounded with dense vegetation.				**Unlikely**. No suitable habitat.
Mammals (4)							

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Dasyurus hallucatus Northern Quoll	EN (EPBC Act, BC Act)	7.5-7.8 km outside study area	This primarily nocturnal species makes its dens in rock crevices, tree holes or occasionally termite mounds. It will dispense across many different habitats but likely prefers the cover afforded by larger creeklines.			√	**Possible**. Suitable foraging/dispersal habitat present only.
Macroderma gigas Ghost Bat	VU (EPBC Act, BC Act)	7.4 – 9.8 km outside study area	Ghost Bat prefers to roost in caves beneath bluffs of low, rounded hills composed of Marra Mamba geology, and granite rock piles in the Pilbara. It has been recorded roosting in large colonies within sandstone caves, within boulder piles and in abandoned mines (Churchill 2008).				**Possible**. Suitable foraging habitat only.
Pseudomys chapmani Western Pebble-mound Mouse	P4 (DBCA)	0.1 – 8 km outside study area	The Western Pebble-mound Mouse is widespread in the ranges of the central and southern Pilbara and extends into the Little Sandy Desert Ranges (Van Dyck & Strahan 2008). The mounds are located on the gentle slopes of rocky ranges covered in rocky mulch, hard spinifex and sparse trees and shrubs (*Eucalyptus*, *Senna*, *Acacia* and *Ptilotus*). They are also often found near *Acacia*-dominated drainage lines (Van Dyck & Strahan 2008).	√	√		**Likely**. Recorded 130m north the study area. Suitable habitat present (predominantly Spinifex hummock grasslands on stony plains). Twenty-eight records within close proximity to the study area.

Species	Status	Proximity to study area	Habitat and distribution	Habitats			Likelihood of occurrence
				Shrubland	Hummock grasslands	Woodland on minor creekline	
Rhinonicteris aurantia (Pilbara) Pilbara Leaf-nosed Bat	VU (EPBC Act, BC Act)	5.9 – 7.8 km outside study area	The Pilbara Leaf-nosed Bat is endemic to Australia and has a range stretching from the Pilbara to Queensland. The Pilbara form, however, is restricted to the Pilbara region where it roosts in caves and mine with stable, warm and humid microclimates. Limited suitable habitat combined with its poor ability to maintain heat and water balance are the most important factors threatening the survival of this species (Baudinette *et al.* 2000).				**Unlikely**. No suitable habitat.

*EPBC Protected Matters search - 'species or habitat may be present' but no records

5.3 SURVEY LIMITATIONS

The limitations of the field survey have been considered in accordance with EPA (2016c, d) (Table 5-12).

Table 5-12 Consideration of potential survey limitations

Limitations	Comments
Availability of contextual information at a regional and local scale	No limitation, the study area was small and occurred adjacent to a large area subject to detailed survey previously. Previous desktop assessments and those conducted for the current survey provided adequate local and regional knowledge for the small study area.
Competency/experience of the team carrying out the survey	No limitation, Dr Grace Wells and Dr Grant Wells have a combined experience of in excess of 25 years' experience of surveys in the Pilbara bioregion including conducting the detailed survey of the Wonmunna mining lease adjacent to the current study area.
Scope and completeness	No limitation, the survey conducted covered the required scope of works.
Proportion of flora and fauna recorded and/or collected, any identification issues	No limitation, all specimens collected were identified to species level, no annual significant flora were identified on the desktop assessment and subsequently it is unlikely that any significant annual species were absent due to time of survey, sufficient survey was conducted to identify any significant perennial flora.
Access within the study area	No limitation, the entire study area was readily accessible by foot.
Timing, rainfall, season	No limitation, all specimens collected were identified to species level, no annual significant flora were identified on the desktop assessment and subsequently it is unlikely that any significant annual species were absent due to time of survey, sufficient survey was conducted to identify any significant perennial flora.
Disturbance that may have affected the results of the survey	No limitation, there were no recent fires or fire scars that may have temporally impacted the surveys and no recent ground disturbances.

6 DISCUSSION

6.1 FLORA AND VEGETATION

The desktop assessment and reconnaissance survey findings for the current study area are consistent with those of the previous detailed survey of the adjacent Wonmunna mine lease (G&G Environmental 2011, 2014) with no vegetation representing a TEC or PEC and all vegetation recorded in the current survey area was representative of vegetation previously defined for the adjacent mining lease.

No significant flora were recorded and this reflects the paucity of significant flora identified in the previous survey (a single plant of *Gymnanthera cunnighamii* P3) and the lack of significant flora records in the area determined from the database searches (DAWE 2020; DBCA 2020a, d).

6.2 TERRESTRIAL FAUNA

6.2.1 Vertebrate fauna

Of the fauna habitats identified within the study area, drainage lines are the most restricted and possibly have the highest value for the majority of significant species. These areas are likely to act as wildlife corridors providing foraging and dispersal opportunities for a variety of fauna species due to their greater structural diversity and periodic availability of water. It is, however, unlikely that any significant species are restricted to this habitat.

Open shrubland of Acacia over hummock (*Triodia* spp.) grasses are abundant within the study area and the broader region and. Spinifex hummock grasslands on stony plains occur over a moderate portion of the study area. The stony soil/substrate and reduced vegetation structure means it is likely to support fewer significant species, as compared with the other more abundant habitat, open shrubland of Acacia over hummock (*Triodia* spp.) grasses. It is, however, typical habitat for Western Pebble-mound Mouse in this area of the Pilbara.

6.3 CONCLUSION

No significant vertebrate fauna and flora species or vegetation were recorded within the study area. The presence of multiple drainage lines located in the study area may intermittently provide relatively important habitat for significant vertebrate fauna.

It is unlikely that any significant ecological values occur within the study area.

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Appendix 1 Survey site locations

Sitename	Sample type	Latitude	Longitude
W001	Quadrat	-23.102788	119.014385
W002	Relevé	-23.103185	119.012523
W003	Quadrat	-23.101709	119.023401
W004	Quadrat	-23.105659	119.034351
W005	Quadrat	-23.105641	119.037778
W006	Quadrat	-23.104509	119.041235
W007	Quadrat	-23.106463	119.045527
W008	Relevé	-23.106169	119.042233

Appendix 2 Site descriptions

Site details			
Site	**W001**	**Position (WGS84)**	-23.1027882938179, 119.01438351029
Slope	gentle	**Topography**	creek
Soil colour	red-brown	**Soil texture**	sand, clay loam
Rock cover (%)	0	**Rock type**	quartz, sandstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Low *Corymbia hamersleyana* and *Eucalyptus victrix* woodland over tall open *Acacia atkinsiana* and *Melaleuca eleuterostachya* shrubland over *Cenchrus ciliaris, Eulalia urea* and *Themeda triandra* grassla		
Habitat	woodland		
Disturbance	Grazing-low, Livestock tracks, Weed infestation		
Vegetation condition	Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	60	**Tree cover (%)**	30
Shrub cover (%)	10	**Grass cover (%**	45
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (31)	Status	Cover (%)	Height (m)
**Cenchrus ciliaris*	Weed	20	0.4
Eucalyptus victrix		10	5
Melaleuca bracteata		10	2.5
Eulalia aurea		10	0.5
Themeda triandra		10	0.5
Corymbia hamersleyana		5	4
Acacia atkinsiana		5	3
Acacia bivenosa		2	1.5
Triodia angusta		2	0.5
Triodia wiseana		2	0.2
Melaleuca glomerata		1	2
Petalostylis labicheoides		0.5	2
Acacia dictyophleba		0.5	1.8
Pluchea dentex		0.5	0.4
Acacia pyrifolia		0.1	1.5
Gossypium sturtianum var. *sturtianum*		0.1	1
Jasminum didymum subsp. *lineare*		0.1	1
Cymbopogon ambiguus		0.1	0.5
Corchorus lasiocarpus subsp. *lasiocarpus*		0.1	0.5
Trichodesma zeylanicum		0.1	0.5
**Flaveria trinervia*	Weed	0.1	0.4
Ptilotus clementii		0.1	0.4
Indigofera rugosa		0.1	0.4
Androcalva luteiflora		0.1	0.3
Stemodia grossa		0.1	0.3
Euphorbia australis var. *subtomentosa*		0.1	0.2
Ptilotus exaltatus		0.1	0.2
Eragrostis cumingii		0.1	0.15
Enneapogon caerulescens		0.1	0.15
Sporobolus australasicus		0.1	0.1
Pterocaulon sphacelatum		0.1	

Site details			
Site	**W002**	**Position (WGS84)**	-23.103185, 119.012523
Slope	gentle	**Topography**	undulating plain
Soil colour	red-brown	**Soil texture**	sandy clay, clay loam
Rock cover (%)	0	**Rock type**	ferrous - ironstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over low *Triodia wiseana* hummock grassland.		
Habitat	spinifex grassland		
Disturbance	None evident		
Vegetation condition	Excellent	**Fire age**	old (5-10 years)
Total veg. cover (%)	50	**Tree cover (%)**	1
Shrub cover (%)	5	**Grass cover (%**	50
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	17-Nov-2020	unbounded	Grant Wells

Species (7)	Status	Cover (%)	Height (m)
Triodia wiseana		50	0.2
Acacia inaequilatera		1	2
Acacia arida		1	1.1
Androcalva luteiflora		1	0.8
Corymbia hamersleyana		1	
Ptilotus calostachyus		0.1	0.5
Ptilotus astrolasius		0.1	0.3

Site details			
Site	**W003**	**Position (WGS84)**	-23.101709, 119.023401
Slope	moderate	**Topography**	undulating plain
Soil colour	red-brown	**Soil texture**	sandy clay, clay loam
Rock cover (%)	0	**Rock type**	sandstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Isolated low *Corymbia hamersleyana* trees over isolated mid *Acacia inaequilatera* shrubs over low *Triodia wiseana* hummock grassland.		
Habitat	spinifex grassland		
Disturbance	Excavation, Litter, Vehicle tracks		
Vegetation condition	Very Good	**Fire age**	old (5-10 years)
Total veg. cover (%)	60	**Tree cover (%)**	0.1
Shrub cover (%)	2	**Grass cover (%**	60
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (12)	Status	Cover (%)	Height (m)
Triodia wiseana		60	0.4
Acacia inaequilatera		2	1.8
Triodia angusta		1	0.5
Cymbopogon ambiguus		1	0.5
Ptilotus rotundifolius		0.2	1
Corymbia hamersleyana		0.1	3
Senna artemisioides subsp. *oligophylla*		0.1	1.8
Gossypium sturtianum var. *sturtianum*		0.1	1.5
Ptilotus astrolasius		0.1	0.5
Corchorus lasiocarpus		0.1	0.4
Ptilotus exaltatus		0.1	0.3
Goodenia triodiophila		0.1	0.2

Site details			
Site	**W004**	**Position (WGS84)**	-23.1056593467566, 119.034351209298
Slope	gentle	**Topography**	creek
Soil colour	red-brown	**Soil texture**	sand
Rock cover (%)	0	**Rock type**	quartz, sandstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Low open Co*rymbia hamersleyana* and *Eucalyptus victrix* woodland over *Acacia bivenosa* and *Petalostylis labicheoides* shrubland over *Cenchrus ciliaris*, *Eulalia urea* and *Themeda triandra* grass		
Habitat	open woodland		
Disturbance	Evidence of feral animals, Litter, Weed infestation		
Vegetation condition	Good	**Fire age**	old (5-10 years)
Total veg. cover (%)	90	**Tree cover (%)**	18
Shrub cover (%)	2	**Grass cover (%**	90
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (32)	Status	Cover (%)	Height (m)
**Cenchrus ciliaris*	Weed	60	0.5
Themeda triandra		15	0.5
Eulalia aurea		10	0.5
Eucalyptus victrix		6	5
Acacia bivenosa		6	2.2
Corymbia hamersleyana		2	5
Petalostylis labicheoides		2	2.5
Cymbopogon ambiguus		2	0.5
Triodia wiseana		2	0.4
Acacia maitlandii		1	1.8
Melaleuca glomerata		1	1.2
Androcalva luteiflora		1	1.2
Triodia angusta		1	0.6
Gossypium sturtianum var. *sturtianum*		0.2	1.5
Enneapogon robustissimus		0.2	0.4
Acacia inaequilatera		0.1	2
Acacia dictyophleba		0.1	1.8
Acacia tenuissima		0.1	1.7
Eremophila longifolia		0.1	1.5
Acacia pyrifolia		0.1	1.5
Ptilotus rotundifolius		0.1	1
Jasminum didymum subsp. *lineare*		0.1	1
Trichodesma zeylanicum		0.1	0.5
Capparis lasiantha		0.1	0.4
Senna artemisioides subsp. *helmsii*		0.1	0.4
Ptilotus clementii		0.1	0.3
Pterocaulon sphacelatum		0.1	0.3
Scaevola parvifolia subsp. *pilbarae*		0.1	0.25
Streptoglossa bubakii		0.1	0.25
Sida rohlenae		0.1	0.2
Sida fibulifera		0.1	0.2
Sporobolus australasicus		0.1	0.2

Site details			
Site	**W005**	**Position (WGS84)**	-23.105641, 119.037778
Slope	gentle	**Topography**	hill slope
Soil colour	red-brown	**Soil texture**	clay loam
Rock cover (%)	0	**Rock type**	ferrous - ironstone, quartz

Observation details - visit 1 (17 Nov 2020)			
Sample description	Isolated low *Eucalyptus leucophloia* and *E. repullulans* trees over isolated tall *Acacia inaequilatera* shrubs over low *Triodia wiseana* hummock grassland.		
Habitat	spinifex grassland		
Disturbance	Vehicle tracks		
Vegetation condition	Excellent	**Fire age**	old (5-10 years)
Total veg. cover (%)	65	**Tree cover (%)**	4
Shrub cover (%)	1	**Grass cover (%**	65
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (11)	Status	Cover (%)	Height (m)
Triodia wiseana		65	0.3
Eucalyptus leucophloia		2	3.5
Eucalyptus repullulans		2	2.2
Acacia tenuissima		0.1	2
Acacia synchronicia		0.1	2
Acacia bivenosa		0.1	1.8
Melaleuca eleuterostachya		0.1	1.2
Jasminum didymum subsp. *lineare*		0.1	1.2
Jasminum didymum		0.1	1
Ptilotus obovatus		0.1	0.4
Maireana georgei		0.1	0.3

Site details			
Site	**W006**	**Position (WGS84)**	-23.104509, 119.041235
Slope	moderate	**Topography**	hill slope
Soil colour	red-brown	**Soil texture**	sandy clay, clay loam
Rock cover (%)	0	**Rock type**	sandstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Isolated low *Corymbia hamersleyana* trees and *Eucalyptus gamophylla* mallee over isolated tall *Hakea chordophylla*, *Acacia inaequilatera* and *Acacia bivenosa* shrubs over low *Triodia wiseana* hummock gr		
Habitat	spinifex grassland		
Disturbance	Historic clearing, Vehicle tracks		
Vegetation condition	Very Good	**Fire age**	old (5-10 years)
Total veg. cover (%)	65	**Tree cover (%)**	1
Shrub cover (%)	1	**Grass cover (%**	65
Herb cover (%)	0		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (11)	Status	Cover (%)	Height (m)
Triodia wiseana		65	0.3
Acacia inaequilatera		1	2
Eucalyptus gamophylla		1	1.8
Hakea chordophylla		0.5	2.5
Acacia bivenosa		0.5	2
Corymbia hamersleyana		0.1	3
Acacia tenuissima		0.1	1
Ptilotus rotundifolius		0.1	0.8
Scaevola acacioides		0.1	0.4
Corchorus lasiocarpus		0.1	0.4
Heliotropium chrysocarpum		0.1	0.25

Site details			
Site	**W007**	**Position (WGS84)**	-23.106463, 119.045527
Slope	moderate	**Topography**	creek
Soil colour	red-brown	**Soil texture**	sand, sandy clay, clay loam
Rock cover (%)	0	**Rock type**	ferrous - ironstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Low open *Corymbia hamersleyana* and *Acacia distans* woodland over tall open *Petalostylis labicheoides* and *Acacia bivenosa* shrubland over *Cymbopogon ambiguus*, *Themeda triandra* and *Triodia* sp		
Habitat	shrubland		
Disturbance	Evidence of feral animals, Weed infestation		
Vegetation condition	Very Good	**Fire age**	old (5-10 years)
Total veg. cover (%)	70	**Tree cover (%)**	15
Shrub cover (%)	5	**Grass cover (%**	70
Herb cover (%)	0.1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Quadrat	1	17-Nov-2020	50m x 50m	Grant Wells

Species (28)	Status	Cover (%)	Height (m)
Themeda triandra		30	0.5
Cymbopogon ambiguus		30	0.5
Petalostylis labicheoides		12	2
Triodia wiseana		5	0.3
Acacia distans		4	4
Corymbia hamersleyana		2	5
Eucalyptus leucophloia subsp. *leucophloia*		2	3.5
Acacia bivenosa		2	2.2
Androcalva luteiflora		2	0.8
Triodia angusta		1	0.6
Gossypium sturtianum var. *sturtianum*		0.5	1.5
Ptilotus obovatus		0.5	0.7
Eriachne mucronata		0.5	0.3
Eremophila forrestii subsp. *forrestii*		0.1	1.8
Acacia tenuissima		0.1	1.5
Jasminum didymum subsp. *lineare*		0.1	1.2
Acacia tetragonophylla		0.1	1
Acacia maitlandii		0.1	1
Acacia kempeana		0.1	1
Scaevola acacioides		0.1	1
Capparis lasiantha		0.1	0.6
Enneapogon robustissimus		0.1	0.45
Lepidium pedicellosum		0.1	0.4
Pterocaulon sphacelatum		0.1	0.4
**Flaveria trinervia*	Weed	0.1	0.3
Maireana triptera		0.1	0.25
Eriachne pulchella subsp. *dominii*		0.1	0.1
Bulbostylis turbinata		0.1	0.06

Site details			
Site	**W008**	**Position (WGS84)**	-23.106169, 119.042233
Slope	moderate	**Topography**	hill slope
Soil colour	red-brown	**Soil texture**	clay loam
Rock cover (%)	0	**Rock type**	sandstone

Observation details - visit 1 (17 Nov 2020)			
Sample description	Low open *Eucalyptus leucophloia* and *E. repullulans* woodland over isolated *Acacia arida* and *Scaevola acacioides* shrubs over *Triodia wiseana* hummock grassland.		
Habitat	spinifex grassland		
Disturbance	None evident		
Vegetation condition	Excellent	**Fire age**	old (5-10 years)
Total veg. cover (%)	70	**Tree cover (%)**	5
Shrub cover (%)	2	**Grass cover (%**	70
Herb cover (%)	1		

Sample and effort summary				
Sample method	**Visit**	**Sample date**	**Dimensions**	**Observer**
Relevé	1	17-Nov-2020	unbounded	Grant Wells

Species (13)	Status	Cover (%)	Height (m)
Triodia wiseana		70	0.4
Eucalyptus leucophloia		5	3
Eucalyptus repullulans		5	2.5
Scaevola acacioides		2	1
Acacia arida		1	1
Acacia bivenosa		0.1	2.2
Acacia tenuissima		0.1	1.2
Senna glutinosa subsp. *pruinosa*		0.1	1
Acacia synchronicia		0.1	1
Ptilotus obovatus		0.1	0.7
Ptilotus astrolasius		0.1	0.4
Corchorus lasiocarpus		0.1	0.4
Goodenia triodiophila		0.1	0.15

Appendix 3 NVIS hierarchy

Western Australia current practice			National standard		
Hierarchy of terms	**Brief description in WA**	**Indicative scale**	**NVIS Level**	**Description**	**NVIS structural/floristic components required**
Vegetation formation	Structure and growth form – e.g. Forest, Woodland.	1:5 000 000	I	Class	Dominant growth form for the ecologically or structurally dominant stratum.
Vegetation sub-formation	Structural and dominant vegetation layer - Eucalypt Forest, Banksia Woodland.	1:2 500 000 I	II	Structural Formation	Dominant growth form, cover and height for the ecologically or structurally dominant stratum.
Vegetation association	Structural form and dominant species – e.g. Medium woodland; York gum (*Eucalyptus loxophleba*) & Wandoo.	1:1 000 000 to 1:250 000	III	Broad Floristic Formation	Dominant growth form, cover, height and dominant land cover genus for the uppermost or dominant stratum.
Vegetation complex	Structural and floristic description linked to geomorphology – e.g. Quindalup Complex.	1:250 000 to 1:100 000	IV	Sub-Formation	Dominant growth form, cover, height and dominant genus and Family for the three traditional strata. (i.e. Upper, Mid and Ground).
Vegetation type	Floristic definition by strata with structural detail. Often represented with a code and floristic description.	1:100 000 to 1:10 000	V	Association	Dominant growth form, height, cover and up to three species for the three traditional strata. (i.e. Upper, Mid and Ground).
Plant community	Basic unit of vegetation classification, site specific and highly localised with detailed floristics for each stratum.	1:10 000	VI	Sub-Association	Dominant growth form, height, cover and up to five species for all layers/ strata.
Floristic Community Type	Floristic composition definition; e.g. Northern banksia woodlands over herb rich shrublands on the Swan Coastal Plain.	No absolute scale			

Appendix 4 Vertebrate fauna desktop results

Scientific name	Common name	Conservation status	Desktop	Phoenix data
Birds (17)				
Elanus scriptus	Letter-winged Kite	P4 (DBCA list)		
Apus pacificus	Fork-tailed Swift	Mig. (EPBC & BC Acts)	1	
Burhinus grallarius	Bush Stone-curlew			1
Charadrius veredus	Oriental Plover	Mig. (EPBC & BC Acts)	1	
Neochmia ruficauda subclarescens	Star Finch (western)			1
Falco hypoleucos	Grey Falcon	VU (BC Act)	1	
Hirundo rustica	Barn Swallow	Mig. (EPBC & BC Acts)	1	
Merops ornatus	Rainbow Bee-eater			1
Motacilla cinerea	Grey Wagtail	Mig. (EPBC & BC Acts)	1	
Motacilla flava	Yellow Wagtail	Mig. (EPBC & BC Acts)	1	
Ardeotis australis	Australian Bustard			1
Pezoporus occidentalis	Night Parrot	EN/CR (EPBC Act; BC Act)	1	
Rostratula australis	Australian Painted Snipe	EN (EPBC & BC Acts)	1	
Actitis hypoleucos	Common Sandpiper	Mig. (EPBC & BC Acts)	1	
Calidris acuminata	Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)	1	
Calidris ferruginea	Curlew Sandpiper	CR/Mig./CR (EPBC Act; BC Act)	1	
Calidris melanotos	Pectoral Sandpiper	Mig. (EPBC & BC Acts)	1	
Mammals (15)				
Bos taurus	European Cattle		1	
Camelus dromedarius	Dromedary		2	
Canis familiaris	Dog		1	
Vulpes	Red Fox		1	
Dasyurus hallucatus	Northern Quoll	EN (EPBC & BC Acts)	3	
Equus asinus	Donkey		2	
Equus caballus	Horse		1	
Felis catus	Cat		2	
Rhinonicteris aurantia (Pilbara)	Pilbara Leaf-nosed Bat	VU (EPBC & BC Acts)	2	
Oryctolagus cuniculus	Rabbit		2	
Petrogale sp.	rock wallaby		1	
Macroderma gigas	Ghost Bat	VU (EPBC & BC Acts)	3	
Mus musculus	House Mouse		2	
Pseudomys chapmani	Western Pebble-mound Mouse	P4 (DBCA list)	2	

Scientific name	Common name	Conservation status	Desktop	Phoenix data
Pseudomys nanus	Western Chestnut Mouse			1
Reptiles (4)				
Liasis olivaceus barroni	Pilbara Olive Python	VU (EPBC & BC Acts)	2	
Underwoodisaurus seorsus	Pilbara Barking Gecko	P2 (DBCA list)	2	
Lerista macropisthopus remota	unpatterned robust slider (Robertson Range)	P2 (DBCA list)	1	
Anilios ganei	Gane's blind snake (Pilbara)	P1 (DBCA list)	1	

Appendix 5 Flora species inventory

Family	Species
Amaranthaceae	*Ptilotus astrolasius*
Amaranthaceae	*Ptilotus calostachyus*
Amaranthaceae	*Ptilotus clementii*
Amaranthaceae	*Ptilotus exaltatus*
Amaranthaceae	*Ptilotus macrocephalus*
Amaranthaceae	*Ptilotus obovatus*
Amaranthaceae	*Ptilotus rotundifolius*
Asteraceae	**Flaveria trinervia*
Asteraceae	*Pluchea dentex*
Asteraceae	*Pterocaulon sphacelatum*
Asteraceae	*Streptoglossa bubakii*
Boraginaceae	*Heliotropium chrysocarpum*
Boraginaceae	*Trichodesma zeylanicum*
Brassicaceae	*Lepidium pedicellosum*
Capparaceae	*Capparis lasiantha*
Chenopodiaceae	*Maireana georgei*
Chenopodiaceae	*Maireana triptera*
Cyperaceae	*Bulbostylis turbinata*
Euphorbiaceae	*Euphorbia australis* var. *subtomentosa*
Fabaceae	*Acacia arida*
Fabaceae	*Acacia atkinsiana*
Fabaceae	*Acacia bivenosa*
Fabaceae	*Acacia dictyophleba*
Fabaceae	*Acacia distans*
Fabaceae	*Acacia inaequilatera*
Fabaceae	*Acacia kempeana*
Fabaceae	*Acacia maitlandii*
Fabaceae	*Acacia pyrifolia*
Fabaceae	*Acacia synchronicia*
Fabaceae	*Acacia tenuissima*
Fabaceae	*Acacia tetragonophylla*
Fabaceae	*Indigofera rugosa*
Fabaceae	*Petalostylis labicheoides*
Fabaceae	*Senna artemisioides* subsp. *helmsii*
Fabaceae	*Senna artemisioides* subsp. *oligophylla*
Fabaceae	*Senna glutinosa* subsp. *pruinosa*
Goodeniaceae	*Goodenia triodiophila*
Goodeniaceae	*Scaevola acacioides*
Goodeniaceae	*Scaevola parvifolia* subsp. *pilbarae*
Malvaceae	*Androcalva luteiflora*
Malvaceae	*Corchorus lasiocarpus* subsp. *lasiocarpus*
Malvaceae	*Gossypium sturtianum* var. *sturtianum*
Malvaceae	*Sida fibulifera*
Malvaceae	*Sida rohlenae*

Family	Species
Myrtaceae	*Corymbia hamersleyana*
Myrtaceae	*Eucalyptus gamophylla*
Myrtaceae	*Eucalyptus leucophloia* subsp. *leucophloia*
Myrtaceae	*Eucalyptus repullulans*
Myrtaceae	*Eucalyptus victrix*
Myrtaceae	*Melaleuca bracteata*
Myrtaceae	*Melaleuca eleuterostachya*
Myrtaceae	*Melaleuca glomerata*
Oleaceae	*Jasminum didymum* subsp. *lineare*
Plantaginaceae	*Stemodia grossa*
Poaceae	**Cenchrus ciliaris*
Poaceae	*Cymbopogon ambiguus*
Poaceae	*Enneapogon caerulescens*
Poaceae	*Enneapogon robustissimus*
Poaceae	*Eragrostis cumingii*
Poaceae	*Eriachne mucronata*
Poaceae	*Eriachne pulchella* subsp. *dominii*
Poaceae	*Eulalia aurea*
Poaceae	*Sporobolus australasicus*
Poaceae	*Themeda triandra*
Poaceae	*Triodia angusta*
Poaceae	*Triodia wiseana*
Proteaceae	*Hakea chordophylla*
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*
Scrophulariaceae	*Eremophila longifolia*