



# PHOENIX

ENVIRONMENTAL SCIENCES

## Flora and vegetation survey for the Edna May Greenfinch Project

Prepared for Evolution Mining Ltd

August 2016

Final Report



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Prepared for Evolution Mining Ltd

Final Report

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## Contents

CONTENTS.....	I
LIST OF FIGURES.....	II
LIST OF TABLES.....	II
LIST OF APPENDICES .....	II
EXECUTIVE SUMMARY .....	III
1 INTRODUCTION.....	5
1.1 Survey objective and scope of works.....	5
2 LEGISLATIVE CONTEXT .....	7
2.1 Commonwealth.....	7
2.2 State .....	8
2.2.1 Threatened and Priority species and communities .....	8
2.2.2 Locally or regionally significant flora and vegetation .....	8
2.2.3 Clearing of native vegetation.....	9
2.2.4 Environmentally Sensitive Areas.....	9
2.3 Introduced flora .....	10
3 EXISTING ENVIRONMENT.....	12
3.1 Interim Biogeographic Regionalisation of Australia (IBRA) .....	12
3.2 Land systems of the study area .....	12
3.3 Climate and weather.....	14
3.4 Land use .....	15
3.5 Native vegetation extent and status.....	15
3.6 Conservation reserves and Environmentally Sensitive Areas.....	15
4 METHODS.....	18
4.1 Desktop review .....	18
4.2 Field survey .....	18
4.2.1 Flora and vegetation .....	18
4.3 Taxonomy and nomenclature.....	22
4.4 Survey personnel .....	22
4.5 Survey limitations .....	23
5 RESULTS .....	24
5.1 Desktop review .....	24
5.1.1 Flora .....	24
5.1.2 Vegetation.....	26
5.2 Field survey .....	29
5.2.1 Flora .....	29
5.2.2 Vegetation.....	32
6 DISCUSSION.....	42
6.1 Flora .....	42
6.2 Vegetation.....	44

7	REFERENCES.....	45
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#### List of Figures

Figure 1-1	Location of the Edna May Greenfinch Project.....	6
Figure 3-1	Land systems of the study area.....	13
Figure 3-2	Annual climate data (average monthly temperatures and rainfall records) and records for the year preceding the field survey for Merredin (BoM 2016).....	14
Figure 3-3	Pre-European vegetation of the study area.....	16
Figure 3-4	Conservation reserves and Environmentally Sensitive Areas.....	17
Figure 4-1	Survey locations in the study area.....	19
Figure 5-1	Location of the EPBC listed TEC Eucalypt woodlands of the Western Australian wheatbelt in the project area.....	28
Figure 5-2	Location of <i>Eremophila resinosa</i> in and around the study area.....	31
Figure 5-3	Vegetation types in the study area.....	35
Figure 5-4	Vegetation condition in the study area.....	37

#### List of Tables

Table 2-1	Terms used to describe introduced flora (DPaW 2015c).....	10
Table 2-2	Description of control categories for declared pests (Government of Western Australia 2013).....	11
Table 3-1	Extent and level of protection of vegetation association intersecting study area (DPaW 2014).....	15
Table 4-1	Vegetation condition rating scale (Keighery 1994).....	21
Table 4-2	Project team.....	22
Table 4-3	Survey limitations.....	23
Table 5-1	Conservation significant flora species identified from the desktop review.....	24
Table 5-2	Priority Ecological Communities identified to occur within 50 km of the Project (Keighery 1994) and current conservation status.....	26
Table 5-3	Flora species recorded in the study area.....	29
Table 5-4	Natural vegetation types and other vegetation recorded in the study area.....	32
Table 5-5	Extent of vegetation types in the study area.....	36
Table 5-6	Vegetation condition in the study area.....	36
Table 5-7	Assessment of occurrence of the TEC 'Eucalypt Woodlands of the Western Australian Wheatbelt' in the study area.....	39
Table 6-1	Comparison of survey effort for flora and vegetation assessments conducted at the Edna May.....	42
Table 6-2	Number of taxa recorded for the most prominent families in flora surveys at the Edna May and their proportion (%) of all taxa.....	43

#### List of Appendices

Appendix 1	Vegetation structural classes (NVIS)
Appendix 2	Key to identify the EPBC listed Threatened Ecological community Eucalypt woodlands of the Western Australian wheatbelt (Department of the Environment 2015a)
Appendix 3	Flora survey site descriptions with species recorded at each site

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## EXECUTIVE SUMMARY

In May 2016, Evolution Mining commissioned Phoenix Environmental Sciences Pty Ltd (Phoenix) to undertake a terrestrial flora and vegetation assessment for the Edna May Greenfinch Project (the Project). The Project is located approximately 1 km north-west of the township of Westonia, 312 km east of Perth

The study area for the assessment covered 14.35 ha. The objective of the survey was to validate the floristic values to inform planning and an environmental impact assessment for the Project. This autumn survey complemented a previous spring survey, together fulfilling the requirements of a Level 2 flora and vegetation assessment. The survey design was consistent with relevant guidelines, including Environmental Protection Authority (EPA) EPA Position Statement (PS) No. 2 (*Environmental protection of native vegetation in WA*), PS No. 3 (*Terrestrial biological surveys as an element of biodiversity protection*), EPA Guidance Statement (GS) 51 (*Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia*), EPA and Department of Parks and Wildlife (DPAW) Technical Guide *Flora and vegetation surveys for environmental impact assessment*.

A desktop review identified 38 conservation significant plant species that may potentially occur in the study area, comprising 11 Threatened species (EPBC Act: one CR, eight EN, two VU; WC Act: two CR, five EN, four VU) and 27 DPAW-listed Priority species (four P1, three P2, 17 P3 and three P4). This included two locations of *Eremophila resinosa* (EN – EPBC Act, WC Act) within the study area. Database searches in 2013 identified that no Threatened Ecological Community (TEC), Priority Ecological Community (PEC) or Environmentally Sensitive Area (ESA) intersected with the study area. Since then 'Eucalypt woodlands of the Western Australian Wheatbelt' has been listed as TEC (CR – EPBC Act) and a search of the DPAW database identified that the survey area occurs within the mapped potential distribution of this community.

The flora and vegetation field survey recorded a total of 51 plant taxa (including subspecies and varieties) from 14 families and 28 genera in the study area comprising nine annuals and 42 perennials. The most prominent families included the Chenopodiaceae, Poaceae, Myrtaceae, Fabaceae and Asteraceae. The number of species recorded per unit area was notably higher than for previous assessments conducted in the broader Edna May mining area reflecting the higher intensity of the current survey. Six introduced flora species were recorded in the study area. None of these species is listed as declared pest or Weed of National Significance (WoNS).

A single plant of the threatened flora *Eremophila resinosa* was recorded within the study area at a previously mapped location. Intensive foot searches in the vicinity of previous records and across the entire study area did not locate any further individuals of the species. No other conservation significant flora species was recorded. The study area represented a range extension for two species, *Eucalyptus campaspe* and *E. stricklandii*; however, both species were recorded in revegetated areas suggesting they had been planted and did not represent natural range extensions for the species.

The survey delineated three natural remnant vegetation types in the study area consisting of a mid open *Eucalyptus longicornis* forest, mid *Eucalyptus longicornis* woodland and tall *Eucalyptus corrugata* mallee woodland which covered just over half (approximately 51%) of the study area. The remainder comprised degraded cleared areas predominantly vegetated with chenopod shrublands, a wastelandform, stockpile and revegetated areas with an overstorey of local mallee eucalypts and non-local *Eucalyptus* species. The condition within the study area varied from completely degraded (cleared areas devoid of vegetation) to patches of remnant woodland in very good condition. The majority of the study area (approximately 85%) was in completely degraded, degraded or good condition.

Of the three vegetation types defined, two (mid open *Eucalyptus longicornis* (Morell) forest and mid *Eucalyptus longicornis* (Morell) woodland) comprised of species representative of the TEC 'Eucalypt

woodlands of the Western Australian Wheatbelt'. However, assessment of the quadrat data recorded for these vegetation types against key diagnostic criteria for the TEC provided in the approved conservation advice indicated that the vegetation in the study area did not meet all required diagnostics.

Prior to clearing, approval from DPaW needs to be sought to remove the *Eremophila resinosa* plant recorded in the study area. Actions to offset the removal of this plant may comprise continuation of the highly successful translocation programme currently conducted for this species by Evolution Mining, and careful extraction of topsoil in the vicinity of the known records and direct respreading in a suitable translocation area.

Current revegetation programs being conducted by Evolution Mining, particularly revegetation of farmland that links with remnant vegetation, targeted at returning a eucalypt overstorey comprised of *Eucalyptus longicornis*, *E. salmonophloia* and *E. salubris* at densities of up to 192 stems per ha, may offset the clearing of woodland in the study area. Established revegetated areas comprised of these species could be considered representative of the EPBC listed TEC.

---

## 1 INTRODUCTION

In April 2016, Evolution Mining Ltd commissioned Phoenix Environmental Sciences Pty Ltd (Phoenix) to undertake a terrestrial flora and vegetation survey for the Edna May Greenfinch Project (the Project). The Project is located approximately 1 km north-west of the township of Westonia and 312 km east of Perth on mining tenement M77/88 (Figure 1-1).

The study area for the survey covered approximately 14.35 ha (Figure 1-1). The flora and vegetation of the study area was most recently surveyed in 2013 as part of a broader study resulting in a broad definition of vegetation types and condition Outback Ecology (2013).

### 1.1 SURVEY OBJECTIVE AND SCOPE OF WORKS

The objective of the terrestrial flora and vegetation assessment was to define the botanical values of the study area to inform project planning and an environmental impact assessment for the Project. Specifically, the objectives were:

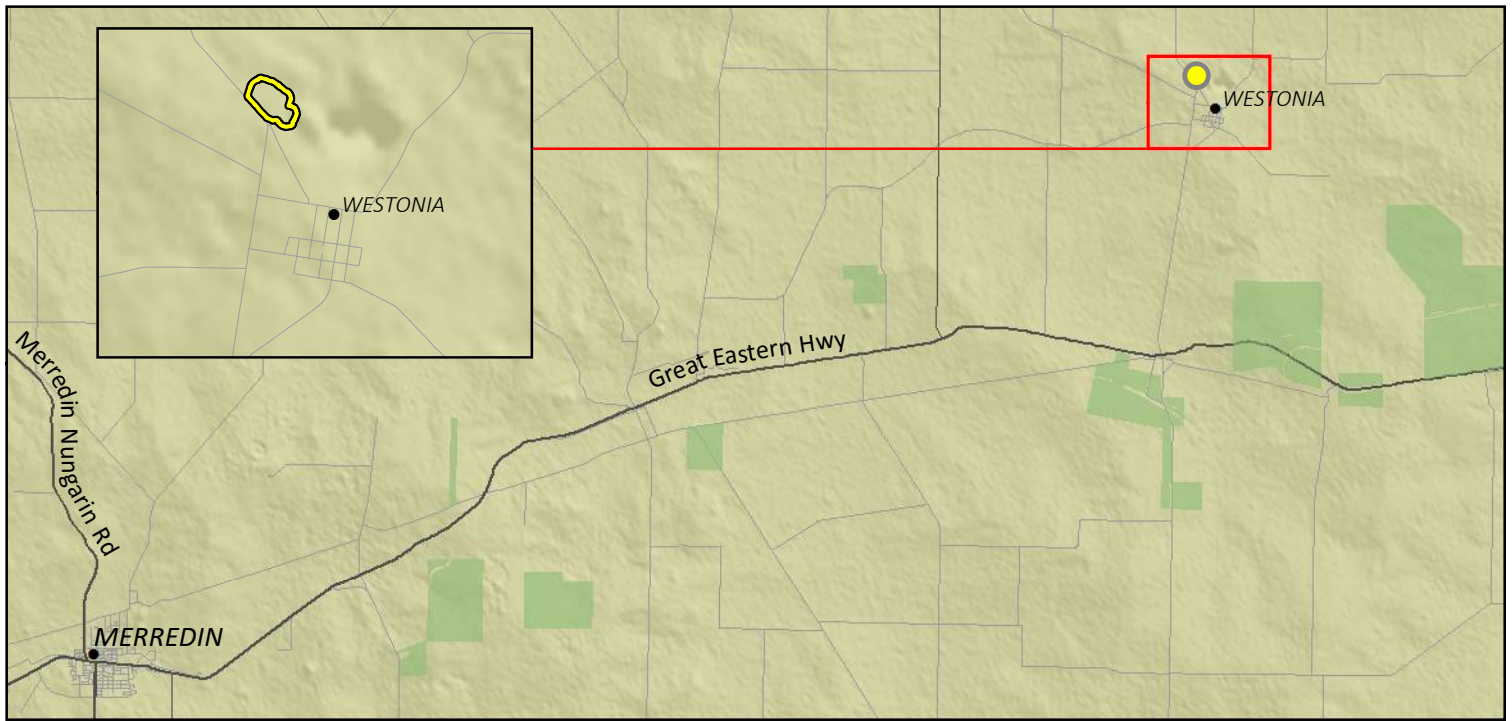
- high detail vegetation mapping of the study area
- targeted searches for the conservation significant species *Eremophila resinosa*
- evaluation of the condition of the vegetation
- assessment of the status of remnant vegetation
- advice with respect to Declared Rare Flora (DRF) under the WC Act (see section 2.2) and potential offset management (if applicable).


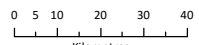
The scope of works to meet these objectives were:


- desktop review, in particular assess the currency of the previous flora and vegetation assessment (Outback Ecology 2013)
- complement the previous single-phase spring survey (Outback Ecology 2013) with a second single-phase autumn survey to a Level 2 terrestrial flora and vegetation survey of the study area
- data analyses, sample processing and species identifications for samples collected during the field survey, and
- preparation of technical report and supporting digital data.

The flora and vegetation survey was conducted in accordance with the following guidelines:

- EPA Position Statement (PS) No. 2 – *Environmental protection of native vegetation in WA* (EPA 2000)
- EPA PS No. 3 – *Terrestrial biological surveys as an element of biodiversity protection* (EPA 2002)
- EPA Guidance Statement (GS) No. 51: *Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia* (EPA 2004)
- Department of Agriculture and Food (DAFWA) *List of declared pests* (DAFWA 2016)
- EPA and DPaW Technical Guide – *Flora and vegetation surveys for environmental impact assessment* (EPA & DPaW 2015).



Evolution Mining Ltd Edna May Vegetation and Flora Survey	
Project No	1116
Date	07 Jun-16
Drawn by	KW
Map author	GW
	
	
1:1,750,000(at A4)      GDA 1994 MGA Zone 50	

 Study area

**Figure 1-1**  
**Location of the Edna May Greenfinch Project**



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## 2 LEGISLATIVE CONTEXT

The protection of flora in Western Australia (WA) is principally governed by three acts:

- Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Wildlife Conservation Act 1950* (WC Act)
- *Environmental Protection Act 1986* (EP Act).

### 2.1 COMMONWEALTH

The EPBC Act is administered by the Federal Department of the Environment (DoE). Under the EPBC Act, actions that have, or are likely to have, a significant impact on a matter of national environmental significance (NES), require approval from the Australian Government Minister for the Environment through a formal referral process. The EPBC Act provides for the listing of threatened native flora, fauna and threatened ecological communities (TECs) as matters of NES.

The Threatened Species Scientific Committee (the Committee) has obligations under the EPBC Act to present advice to the Minister for the Environment (the Minister) in relation to the listing and conservation of threatened ecological communities, including under sections 189, 194N and 266B of the EPBC Act.

Conservation categories applicable to Threatened Flora and Threatened Fauna species under the EPBC Act are as follows:

- Extinct (EX)<sup>1</sup> – 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<sup>1</sup> – taxa whose survival depends upon ongoing conservation measures; without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.

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 (Department of the Environment 2014).

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<sup>1</sup> Species listed as Extinct and Conservation Dependent are not matters of NES and therefore do not trigger the EPBC Act.

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## 2.2 STATE

### 2.2.1 Threatened and Priority species and communities

In WA, the WC Act provides for the listing of protected flora (= Threatened Flora or Declared Rare Flora, DRF) species which are under identifiable threat of extinction. Protected flora listed under the WC Act receive statutory protection and, under current classifications (Western Australian Government 2015), are assigned to one of four categories (schedules):

- Schedule 1 (S1) – flora that are considered likely to become extinct or rare as Critically Endangered (CR) flora
- Schedule 2 (S2) – flora that are considered likely to become extinct or rare as Endangered (EN) flora
- Schedule 3 (S3) – flora that are considered likely to become extinct or rare as Vulnerable (VU) flora
- Schedule 4 (S4) – flora presumed to be extinct (EX).

All listed species are in need of special protection and are declared to be DRF for the purposes of section 23F of the WC Act (Western Australian Government 2015).

Assessments for listing of flora are based on the International Union for Conservation of Nature (IUCN) threat categories.

The Department of Parks and Wildlife (DPaW) administers the WC Act and maintains a non-statutory list of Priority Flora species (updated each year). Priority species are still considered to be of conservation significance – that is they may be rare or threatened – but cannot be considered for listing under the WC Act until there is adequate understanding of their threat levels. Species on the Priority Flora lists are assigned to one of five Priority (P) categories, P1 (highest) – P5 (lowest), based on level of knowledge/concern.

The Minister for Environment may also list ecological communities, which are at risk of becoming destroyed as ‘threatened’. DPaW maintains a list of ministerial-endorsed Threatened Ecological Communities (TECs) (DPaW 2015a) as well as a non-statutory list of Priority Ecological Communities (PECs) (DPaW 2015b) which are also assigned to one of five categories.

Any activities that are deemed to have a significant impact on listed flora species can trigger referral to the Environmental Protection Authority (EPA) for assessment under the EP Act. The EPA’s position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment (EPA 2006).

### 2.2.2 Locally or regionally significant flora and vegetation

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a variety of other reasons than being listed as Threatened or Priority Flora, including where they have keystone roles for threatened species, are representative of the range limit of a species, are locally endemic, are poorly preserved or display anomalous features that indicate a potential new discovery (EPA 2004).

Native vegetation communities may be considered significant for a range of reasons other than listing as a TEC or PEC, including where they have restricted distributions (i.e. to one or two locations or as isolated communities, or are below threshold levels), exhibit unusually high structural and species diversity, are limited to specific landform types, are determined to be uncommon or restricted within the regional or local context, have a role as key habitat for Threatened or Priority species or provide refugial habitats (EPA 2004). Typically, representation of less than one percent of the total study area

(i.e. scarce) or vegetation in Excellent or better condition defines locally (i.e. at the scale of the survey) significant vegetation (Shepherd *et al.* 2002).

A vegetation community is considered regionally significant if it is classified as under-represented, that is, there is less than 30% of its original distribution remaining. Several key criteria are applied to vegetation clearing from a biodiversity perspective, as follows (EPA 2000):

- the 'threshold level' below which species loss appears to accelerate exponentially within an ecosystem level is regarded as being at a level of 30% (of the pre-European, i.e. pre-1750 extent of the vegetation type)
- a level of 10% of the original extent is regarded as being a level representing Endangered
- clearing which would result in an increase in the threat level such that it changes the assigned remaining status classification (see below) should be avoided.

Shepherd *et al.* (2002) have assigned the status of vegetation remaining (to pre-European extent) into five classes:

- Presumed Extinct – probably no longer present in the bioregion
- Endangered<sup>2</sup> – <10% of pre-European extent remains
- Vulnerable<sup>2</sup> – 10–30% of pre-European extent exists
- Depleted<sup>2</sup> – >30% and up to 50% of pre-European extent exists
- Least Concern – >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

### 2.2.3 Clearing of native vegetation

The clearing of native vegetation in WA is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected. Any clearing of native vegetation in WA requires a permit under Part V Division 2 of the EP Act, except where an exemption applies under the act, or is prescribed by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (the Regulations), and the vegetation is not in an Environmentally Sensitive Area (ESA).

### 2.2.4 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 ESA. ESAs are declared in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*, which was gazetted on 8 April 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 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.

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<sup>2</sup> or a combination of depletion, loss of quality, current threats and rarity gives a comparable status.

## 2.3 INTRODUCED FLORA

Introduced flora 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). Specific terms are used in WA to describe introduced flora (Table 2-1).

Some introduced flora are classified as 'declared pest' under *Biosecurity and Agriculture Management Act 2007* (BAM Act) and/or as Weeds of National Significance (WoNS) (Australian Weeds Committee 2012). Under the BAM Act, declared pests are assigned to control categories (Table 2-2).

**Table 2-1 Terms used to describe introduced flora (DPaW 2015c)**

Term	Definition
Declared pest	The BAM Act, Section 22 makes provision for a plant taxon to be listed as a declared pest organism in parts of, or the entire State.
Weed of National Significance	High impact, established weeds causing major economic, environmental and/or social and cultural impacts in a number of states/territories, and have strong potential for further spread.
Environmental weed	An introduced plant that establishes in natural ecosystems and adversely modifies natural processes, resulting in decline of invaded communities (refer to the Environmental Weed Strategy, DEC 1999).
Exotic	A plant occurring in a place to which it is not native.
Invasive plant	One that is introduced and successfully reproduces resulting in the establishment of a population that spreads and threatens ecosystems, habitats or species with economic or environmental harm. Often called weeds when established they can result in harmful impacts to biodiversity, property and life. Not all introduced species are invasive if there are controls on their spread or competitiveness.
Naturalised plant	A plant that is not native to an area but has become established and can reproduce there. Not all naturalised species become weeds or have detrimental environmental or economic effects, but many do.
Weed	A plant that requires some form of action to reduce its harmful effects on the economy, the environment, human health and amenity, and can include plants from other countries or other regions in Australia or WA.

**Table 2-2 Description of control categories for declared pests (Government of Western Australia 2013)**

Control Category	Description
C1 Exclusion	If in the opinion of the Minister introduction of the declared pest into an area or part of an area for which it is declared should be prevented.
C2 Eradication	If in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is feasible.
C3 Management	If in the opinion of the Minister eradication of the declared pest from an area or part of an area for which it is declared is not feasible but that it is necessary to — (i) alleviate the harmful impact of the declared pest in the area; or (ii) reduce the number or distribution of the declared pest in the area; or (iii) prevent or contain the spread of the declared pest in the area.

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## 3 EXISTING ENVIRONMENT

### 3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA (IBRA)

Bioregions are defined as large land areas characterised by broad, landscape-scale natural features, and environmental processes that influence the functions of entire ecosystems. Their purpose is to capture the large-scale geophysical patterns that occur across the Australian continent. The identified patterns in the landscape are linked to fauna and flora assemblages and processes at the broad ecosystem scale. They are a useful means for simplifying and reporting on more complex patterns of biodiversity (Department of the Environment 2015c; Thackway & Cresswell 1995).

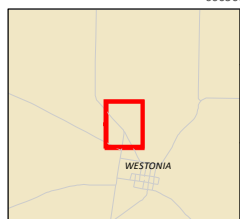
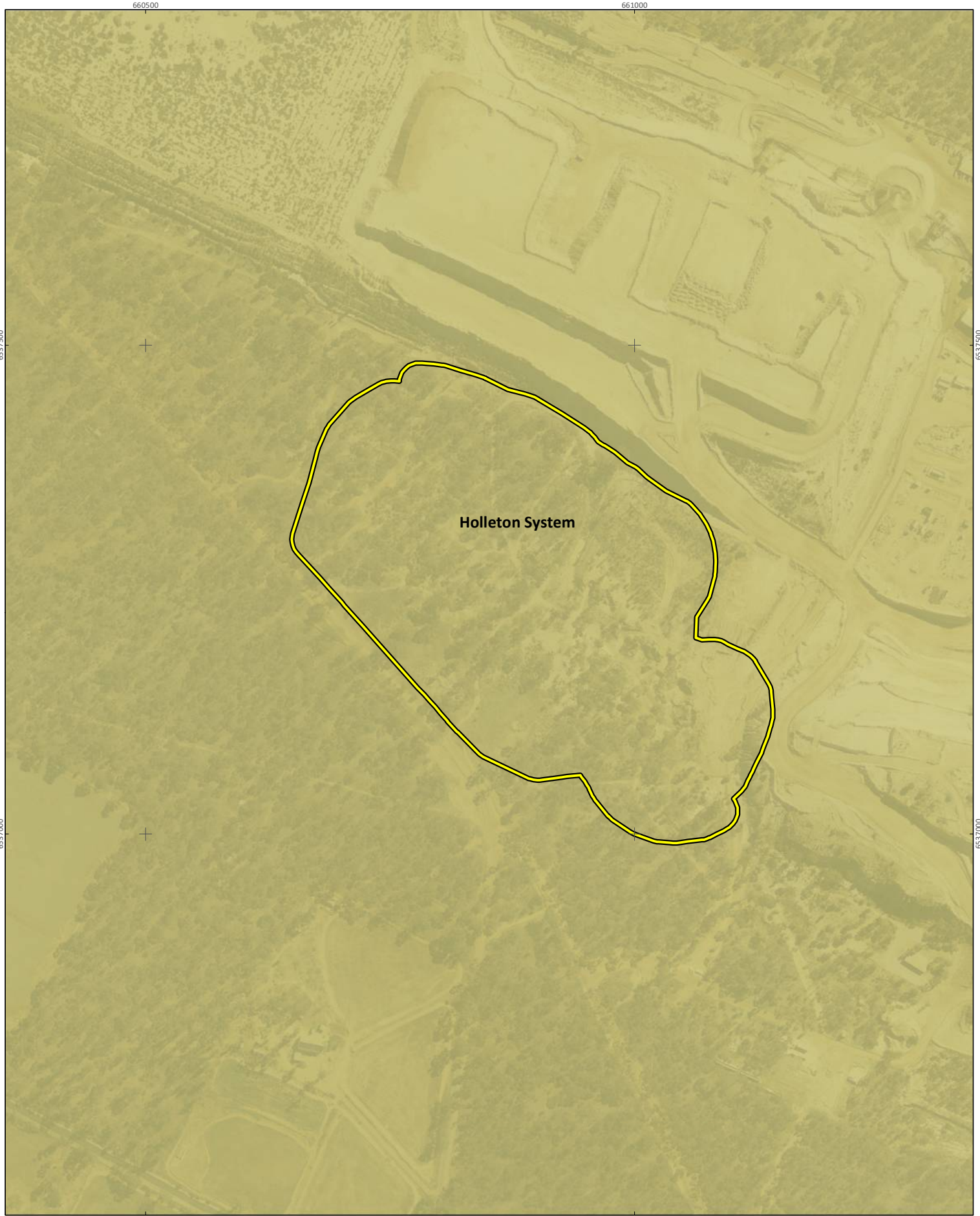
Western Australia contains 26 IBRA bioregions and 53 subregions (Department of the Environment 2015c). The nature and scale of threatening processes varies across the bioregions, as does the extent of intact vegetation and the extent of areas under protection in the State reserve system. The study area falls within the Avon Wheatbelt IBRA region (AVW), which covers an area of 9,517,104 ha. The Avon Wheatbelt biogeographic region contains two subregions:


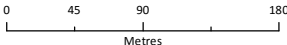
- Merredin (AVW01) ('AW1—Ancient Drainage subregion' in Beecham 2001a)
- Katanning (AVW02) ('AW2—Re-juvenated Drainage subregion' in Beecham 2001b).



The study area is located in the Merredin subregion (6,566,022 ha), which is an ancient peneplain with low relief and a gently undulating landscape. There is no connected drainage; salt lake chains occur as remnants of ancient drainage systems that only function in high rainfall years. Lateritic uplands of the subregion are dominated by yellow sandplain (Beecham 2001a).

### 3.2 LAND SYSTEMS OF THE STUDY AREA

The Department of Agriculture documented State land systems in the detailed mapping of Western Australia's rangelands and arid interior that include the soil-landscape regions, provinces and zones (Tille 2006). A land system is defined as "*an area or group of areas which there is a recurring pattern of topography, soils and vegetation*" (Tille 2006; p. 10) and identifies broad patterns according to rangeland land type to categorize areas of similar landscape and to highlight where major changes occur. The Project occurs entirely within the Holleaton Land System (Figure 3-1), characterised by Lateritic sandplain and other soil formations on low isolated often mafic hills, isolated low hills and rises with yellowish red sandplain and Mallee and Gimlet duplexes on lower slopes.



Evolution Mining Ltd Edna May Vegetation and Flora Survey	
Project No	1116
Date	07 Jun-16
Drawn by	KW
Map author	GW
	
	
1:5,000 (at A4)      GDA 1994 MGA Zone 50	

-  Study area
-  Holleton System

**Figure 3-1**  
**Land system of the study area**

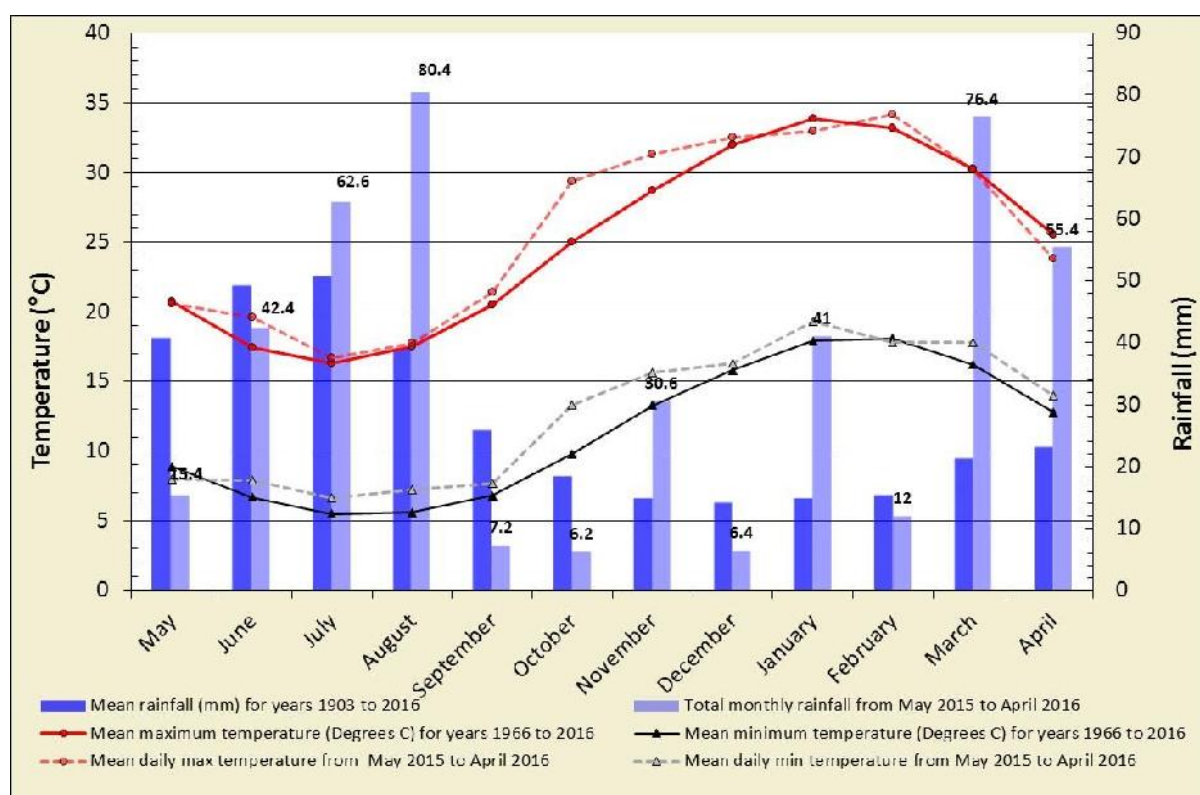


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### 3.3 CLIMATE AND WEATHER

The Merredin subregion of the Avon Wheatbelt bioregion has a semi-arid (dry) warm Mediterranean climate (Beecham 2001a). The closest Bureau of Meteorology (BoM) station is located approximately 55 km west of the Project at Merredin (station number 010092). The long-term mean average annual rainfall is 325.5 mm. Data collected from Merredin indicate that rainfall occurs predominantly in the winter months (Figure 3-2). Highest average monthly temperatures for Merredin are recorded from November to March, with the hottest month being January (mean daily maximum temperature 34 °C). The coldest month on average is July (mean daily minimum temperature 5.5 °C) (Figure 3-2).

Overall rainfall in the 12 months preceding the survey was well above average (436 mm) (BoM 2016) (Figure 3-2). Rainfall in three of the four months immediately preceding the survey more than double the long-term monthly averages.



**Figure 3-2 Annual climate data (average monthly temperatures and rainfall records) and records for the year preceding the field survey for Merredin (BoM 2016)**



### 3.4 LAND USE

The primary land use within the Avon Wheatbelt of Western Australia is dryland agriculture and grazing with smaller areas of Crown and Conservation reserves, rural residential and mining activities (Beecham 2001a).

### 3.5 NATIVE VEGETATION EXTENT AND STATUS

Vegetation of Western Australia has been mapped by Beard at the 1:3,000,000 scale (Beard *et al.* 2013). The Project occurs within vegetation association 536 (

Figure 3-3):

- Medium woodland; Morrell (*Eucalyptus longicornis*) and Rough-fruited Mallee (*Eucalyptus corrugata*).

At a regional scale this vegetation is classed as Depleted as 41.23% of pre-European extent of this association remains across Western Australia (35.54% pre-European extent in the Avon Wheatbelt bioregion) and only 9.82% of the pre-European extent is currently within areas protected for conservation (Table 3-1) (DPaW 2014).

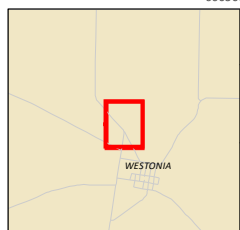
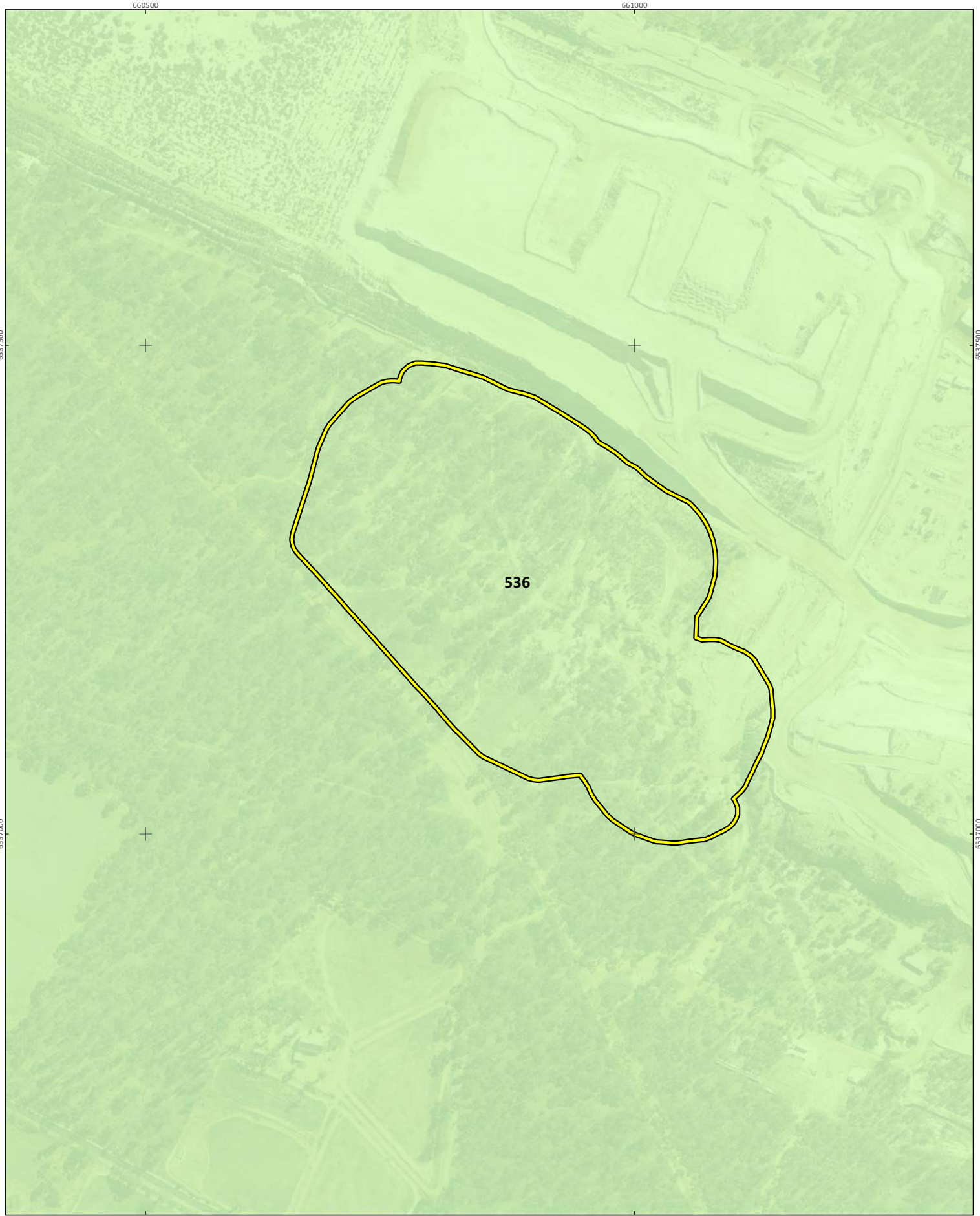
**Table 3-1 Extent and level of protection of vegetation association intersecting study area (DPaW 2014)**


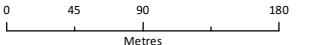
Scale	Pre-European extent (ha)	Current extent (ha)	% remaining	% current extent protected (IUCN I – IV <sup>1</sup> ) for conservation	Status <sup>2</sup>
Vegetation association 536: Medium woodland; Morrell ( <i>Eucalyptus longicornis</i> ) and Rough-fruited Mallee ( <i>Eucalyptus corrugata</i> )					
Western Australia	13,177.53	5,432.82	41.23	9.69	D
Avon Wheatbelt Bioregion	11,170.84	3,970.04	35.54	11.44	D



<sup>1</sup>Lands protected for conservation are defined in the Comprehensive, Adequate and Representative (CAR) Reserve Analysis as being listed in DPaW managed lands and waters dataset as Crown reserves having an IUCN category of I – IV (DPaW 2014). <sup>2</sup>D – Depleted.

### 3.6 CONSERVATION RESERVES AND ENVIRONMENTALLY SENSITIVE AREAS

There are three nature reserves within 10 km of the study area, including Sandford Rocks and Carrabin Nature Reserves, along with remnant vegetation surrounding Westonia (Town Reserve) (Figure 3-4). ESAs with respect to the study area mainly relate to areas covered by vegetation within 50 m of potential Threatened Flora (Figure 3-4), to the extent to which the vegetation is continuous with the vegetation in which the Threatened Flora is located.



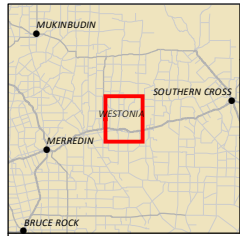
Evolution Mining Ltd Edna May Vegetation and Flora Survey	
Project No	1116
Date	07 Jun-16
Drawn by	KW
Map author	GW
	
	
1:5,000 (at A4)      GDA 1994 MGA Zone 50	

-  Study area
-  Vegetation Association 536:  
Medium woodland; morrel and  
rough fruited mallee (*E. corrugata*)

**Figure 3-3**  
**Pre-European vegetation of the study area**



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 Date 07 Jun-16  
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 Map author GW

0 0.5 1 2 3 4  
 Kilometres

1:100,000 (at A4) GDA 1994 MGA Zone 50

- Study area
  - Environmentally Sensitive Areas (ESAs)
  - Nature Reserve
- DPAW Managed Lands & Waters

**Figure 3-4**  
**Conservation reserves and Environmentally Sensitive Areas in proximity of the Project**



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## 4 METHODS

### 4.1 DESKTOP REVIEW

A literature review was conducted for biological surveys and assessments undertaken within and in the vicinity of the study area. Previous flora and vegetation and survey reports included:

- *Floral Components for a Notice of Intent, Westonia Gold Mine (M77/88 and M77/124 leases)* (Armstrong & Osborne 2003)
- *Westonia Gold mine. Threatened Flora Management Plan* (Outback Ecology 2007)
- *Edna May and Greenfinch Project. Level 2 flora and vegetation assessment* (Outback Ecology 2013)
- *Targeted Eremophila resinosa survey of Edna May* (Phoenix 2015).

The results of recent database searches (Outback Ecology 2013) were utilised to inform the current survey. Nomenclature and conservation status of species identified by the database searches were reviewed utilising Florabase (DPaW 2016a).

A database search for locations of the EPBC Act listed TEC 'Eucalypt Woodlands of the Western Australian Wheatbelt' was requested from DPaW (DPaW 2016c).

### 4.2 FIELD SURVEY

#### 4.2.1 Flora and vegetation

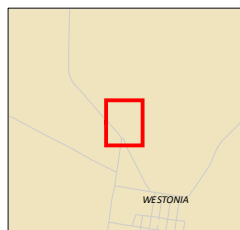
An autumn flora and vegetation survey was undertaken in the study area over two days on 11–12 May 2016, including:


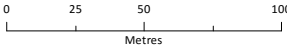
- five quadrats and two relevés (
- Figure 4-1, Appendix 3) (see section 4.2.1.1)
- targeted flora searches (see section 4.2.1.2)
- vegetation mapping (see section 4.2.1.3).




The field survey involved revisiting quadrats completed during the previous baseline survey (Outback Ecology 2013), collecting opportunistic flora specimens of species not encountered in quadrats and searching for Threatened *Eremophila resinosa*.

Prior to the commencement of the field survey, data including satellite imagery, estimated survey boundary, and pre-selected vegetation quadrats were loaded onto tablets using the application GIS Pro version 3.18 (Garafa 2016).

GPS locations of vegetation boundaries and condition, and quadrat, relevé and flora specimen data were recorded on the tablet using Mobile Data Studio (MDS) version 8.0 (CreativityCorp 2016). Photographs were taken at each quadrat and relevé with a Ricoh Caplio 500SE GPS digital camera.



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Map author	GW
	
	
1:2,750 (at A4)	GDA 1994 MGA Zone 50

-  Study area
-  Quadrat
-  Relevé

**Figure 4-1**  
**Survey locations in the study area**



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#### 4.2.1.1 Quadrats and relevés

Quadrat locations were selected to ensure that an accurate representation of the vegetation types present within the study area was sampled adequately. Two methods were used for the selection of quadrat placement within the study area. Preliminary quadrat locations were pre-selected using good quality satellite imagery (Locate 2.0, <https://maps.slip.wa.gov.au/landgate/locate/>) in ArcGIS; they were selected based on apparent changes in the vegetation visible in the aerial imagery. The preliminary quadrat locations were re-assessed during the site visit, while ground-truthing the study area on foot. Some preliminary quadrats were moved to locations that better represented the vegetation community, and new quadrats and relevés were added. In relevés, only dominant vegetation was recorded for the purposes of accurate vegetation mapping.

Quadrats were marked out with flagging tape to accurately identify 10 m x 10 m squares. All flora species present within this area were documented. Some specimens were collected and given a unique collection number to ensure accurate and efficient data management and processing.

The following information was recorded for each quadrat:

- location – the coordinates of the quadrat were recorded in WGS84 projection utilising a MDS
- description of vegetation – a broad description utilising the structural formation and height classes based on National Vegetation Information System (NVIS 2003) (Appendix 1)
- 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 – the condition of the vegetation was recorded utilising the condition scale of (Keighery 1994) (Table 4-1)
- height and percentage foliage cover (PFC) – a visual estimate of the canopy cover of each species present within the 10 m x 10 m quadrat was recorded as a percentage, as was the total vegetation cover, cover of shrubs and trees >2 m tall, cover of shrubs <2 m, total grass cover and total herb cover; PFC of trees was recorded within a 20 m x 20 m area, as per the guidelines recommendation (EPA 2004).
- photograph – a colour photograph of the vegetation within each quadrat
- flora species list – a list including the name of every flora species present within the quadrat; to ensure accurate taxonomic identification of ambiguous flora species present within the study area, collected specimens were pressed and documented for identification using the WA Herbarium resources.

**Table 4-1 Vegetation condition rating scale (Keighery 1994)**

Vegetation condition rating	Vegetation condition	Description
1	Pristine	Pristine or nearly so, no obvious signs of disturbance
2	Excellent	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species
3	Very Good	Vegetation structure altered obvious signs of disturbance
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost without native species

#### 4.2.1.2 Targeted flora searches

Targeted searches were undertaken during the flora and vegetation survey to determine whether the conservation significant species, *Eremophila resinosa* (EPBC – EN, WC Act – EN), occurs in the study area. Searches were conducted traversing the entire study area on foot and focused on habitats considered likely to contain or support the Threatened flora, and previously recorded locations of plants within the study area.

#### 4.2.1.3 Vegetation mapping

The vegetation descriptions from quadrats and relevés from the current survey were grouped according to similarity of community structure (i.e. canopy levels), species composition and the prevalent community structure (i.e. woodland), and matched with previously mapped vegetation at Edna May (Outback Ecology 2013). The vegetation boundaries were mapped utilising satellite imagery (Locate 2.0, <https://maps.slip.wa.gov.au/landgate/locate/>) and from vegetation boundaries recorded on GPS during the field survey.

#### 4.2.1.4 Assessment of conservation significance of mapped vegetation

The floristic composition of vegetation types described in the current survey was compared to that of The EPBC Act listed TEC (CR) and DPaW listed PEC (P3) 'Eucalypt Woodlands of the Western Australian Wheatbelt'. A key to identify the presence of this community derived from information provided in the approved conservation advice for the TEC (Department of the Environment 2015a) is provided in Appendix 2.

### 4.3 TAXONOMY AND NOMENCLATURE

Plant species were identified using local and regional flora keys, and comparisons with named species held at the WA Herbarium. Nomenclature for flora and vegetation used in this report follows Florabase (DPaW 2016a) and advice from the WA Herbarium. The conservation status of all recorded flora was compared against the current lists available on Florabase (DPaW 2016a) and the EPBC Act Threatened species database provided by the Department of the Environment (Department of the Environment 2015b).

### 4.4 SURVEY PERSONNEL

The personnel involved in the survey are presented in Table 4-2.

**Table 4-2 Project team**

	Name	Qualifications	Role/s
<b>Project management</b>	Dr Grant Wells <sup>1</sup>	PhD (Bot.)	Data analyses, taxonomy
<b>Botany</b>	Dr Grant Wells <sup>1</sup>	PhD (Bot.)	Data analyses, taxonomy
	Dr Grace Wells <sup>1</sup>	PhD (Plant Cons.)	GIS, data analyses, vegetation mapping and report writing
<b>GIS</b>	Ms Kathryn Wyatt	B.Inf.Tech, GIS Grad.	GIS, spatial analyses, figure production
<b>Review</b>	Dr Volker Framenau <sup>1,2</sup>	Ph.D. (Zool.), M.Sc. (Cons. Biol.), B.Eng. (Chem. Eng.)	Report review

<sup>1</sup>Phoenix Environmental Sciences; <sup>2</sup>Research Associate WA Museum.



## 4.5 SURVEY LIMITATIONS

No survey limitations were identified with respect to the current technical guide (EPA & DEC 2010) and GS 51 (EPA 2004) (Table 4-3).

**Table 4-3 Survey limitations**

Limitations	Limitation for this survey?	Comments
Availability of contextual information at a regional and local scale	No	Access to online floristic records and information including previous studies undertaken on or in close proximity to the study area provided adequate information on the vegetation of the study area.
Competency/experience of survey personnel, including taxonomy, and experience in the region surveyed	No	The field teams and report authors have extensive experience in conducting terrestrial flora and vegetation surveys within the region and across WA.
Effort and extent; was the appropriate area fully surveyed, were all target groups sampled, were all planned survey methods implemented successfully, was the study area fully surveyed	No	The study area was fully surveyed, all target groups were sampled and all planned survey methods were implemented successfully.
Access throughout the survey area	No	The whole of the study area was accessible by vehicle or on foot.
Timing, weather, season, cycle	No	The survey was conducted in autumn, complementing a previous spring season survey (Outback Ecology 2013) . Both in their entirety can be considered a comprehensive Level 2 survey.
Disturbance that may have affected the results of the survey	No	No disturbances occurring during the period of the field survey are considered to have impacted the results.

## 5 RESULTS

### 5.1 DESKTOP REVIEW

#### 5.1.1 Flora

A search for Threatened and Priority Flora within 20 km of the Project conducted 26 August 2013 (Outback Ecology 2013) identified 31 conservation significant flora species within 20 km of the study area, with five located within 10 km (Table 5-1). An earlier assessment (Armstrong & Osborne 2003) identified a further seven conservation significant species potentially occurring in the study area (Table 5-1).

Eleven species identified in the desktop review are listed at the Federal level (EPBC Act; one CR, eight EN, two VU), with slightly different designations at the State level (WC Act; two CR, five EN, four VU). In addition, DPaW considers 27 species from the desktop review area Priority flora (four P1, three P2, 17 P3, and three P4) (Table 5-1).

**Table 5-1 Conservation significant flora species identified from the desktop review**

Family Genus and species	Current conservation status <sup>2</sup>			Reference <sup>3</sup>
	EPBC Act	WC Act	DPaW Priority list	
Asteraceae				
<i>Vittadinia cervicularis</i> var. <i>oldfieldii</i>			P1	B
Chenopodiaceae				
<i>Roycea pycnophylloides</i>	EN	VU – S3		A
Dilleniaceae				
<i>Hibbertia chartacea</i>			P2	A
<i>Hibbertia glabriuscula</i>			P3	A, B
<i>Hibbertia graniticola</i>			P3	B
Ericaceae				
<i>Leucopogon</i> sp. <i>Ironcaps</i>			P3	A
Fabaceae				
<i>Acacia ancistrophylla</i> var. <i>perarcuata</i> <sup>1</sup>			P3	A, B
<i>Acacia crenulata</i>			P3	A, B
<i>Acacia filifolia</i>			P3	A, B
<i>Acacia formidabilis</i>			P3	B
<i>Acacia lobulata</i>	EN	VU – S3		A, B
<i>Acacia sclerophylla</i> var. <i>teretiuscula</i>			P1	B
<i>Acacia undosa</i>			P3	B
<i>Eutaxia acanthoclada</i>			P3	A
<i>Gastrolobium diabolophyllum</i>	CR	CR – S1		A
Goodeniaceae				

Family Genus and species	Current conservation status <sup>2</sup>			Reference <sup>3</sup>
	EPBC Act	WC Act	DPaW Priority list	
<i>Goodenia granitica</i>			P2	A
Haemodoraceae				
<i>Conostylis albescens</i>			P2	B
Haloragaceae				
<i>Myriophyllum petraeum</i>			P4	A, B
Lamiaceae				
<i>Dicrastylis reticulata</i>			P3	A
<i>Westringia acifolia</i>			P1	A
Malvaceae				
<i>Guichenotia impudica</i>			P3	A
Myrtaceae				
<i>Eucalyptus brevipes</i>	EN	EN – S2		A
<i>Eucalyptus caesia</i> <sup>1</sup>			P4	A, B
<i>Eucalyptus crucis</i> subsp. <i>crucis</i> <sup>1</sup>	VU	EN – S2		A, B
<i>Baeckea</i> sp. Baladjie			P1	A
<i>Baeckea</i> sp. Merredin			P3	A
<i>Verticordia gracilis</i>			P3	B
<i>Verticordia mitodes</i>			P3	A, B
<i>Verticordia stenopetala</i>			P3	A, B
Poaceae				
<i>Austrostipa blackii</i>			P3	B
Proteaceae				
<i>Banksia horrida</i>			P3	A
<i>Banksia rufa</i> subsp. <i>flavescens</i>			P3	A
<i>Banksia shanklandiorum</i>			P4	A, B
<i>Grevillea dryandroides</i> subsp. <i>hirsuta</i>	EN	VU – S3		A
Rutaceae				
<i>Boronia adamsiana</i> <sup>1</sup>	VU	VU – S3		A
Scrophulariaceae				
<i>Eremophila resinosa</i> <sup>1</sup>	EN	EN – S2		A, B
<i>Eremophila virens</i>	EN	EN – S2		A, B
<i>Eremophila viscida</i>	EN	EN – S2		A, B
Solanaceae				
<i>Symonanthus bancroftii</i>	EN	CR - 1		A

1 – Species recorded within 10 km of the Project

2 – CR, Critically Endangered; EN, Endangered; VU, Vulnerable

3 – A, Outback Ecology (2013); B – Armstrong and Osborne (2003)

Three conservation significant species were previously recorded on the mine tenements, *Eremophila resinosa* (EPBC, WC ACT - EN), *Austrostipa blackii* (P3) and *Acacia ancistrophylla* var. *perarcuata* (P3). This included records of two plants of the threatened species *Eremophila resinosa* within the study area (Outback Ecology 2007); however, a subsequent survey (Phoenix 2015) identified that one of these plants had perished.

## 5.1.2 Vegetation

### 5.1.2.1 Threatened and Priority Ecological Communities

The EPBC listed TEC 'Eucalypt Woodlands of the Western Australian Wheatbelt' is defined as eucalypt woodlands dominated by a complex mosaic of eucalypt species with a single tree or mallet form over an understorey that is highly variable in structure and composition (Department of the Environment 2015a). The community occupies a transitional zone between the wetter forests associated with the Darling Range and the southwest coast, and the low woodlands and shrublands of the semi-arid to arid interior. The TEC potentially corresponds to 45 Beard (i.e. Shepherd *et al.* 2002) vegetation associations with the most likely equivalents being 37 associations that are dominant or unique within the Wheatbelt regions (Department of the Environment 2015a). A more detailed description of the TEC is provided in Appendix 2 which also provides a key incorporating the five main diagnostic characteristics that indicate its presence; this was derived from DoE conservation advice for the TEC (Department of the Environment 2015a).

The results of the DPaW database search for the EPBC listed TEC 'Eucalypt woodlands of the Western Australian wheatbelt' identified that the survey area lies within the potential distribution of the community that includes 200 m buffer (Figure 5-1). Notably, the mapped potential distribution also overlies waste landforms and pit areas of the Edna May operations, and adjacent cleared farmland.

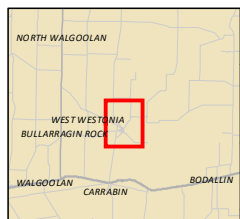
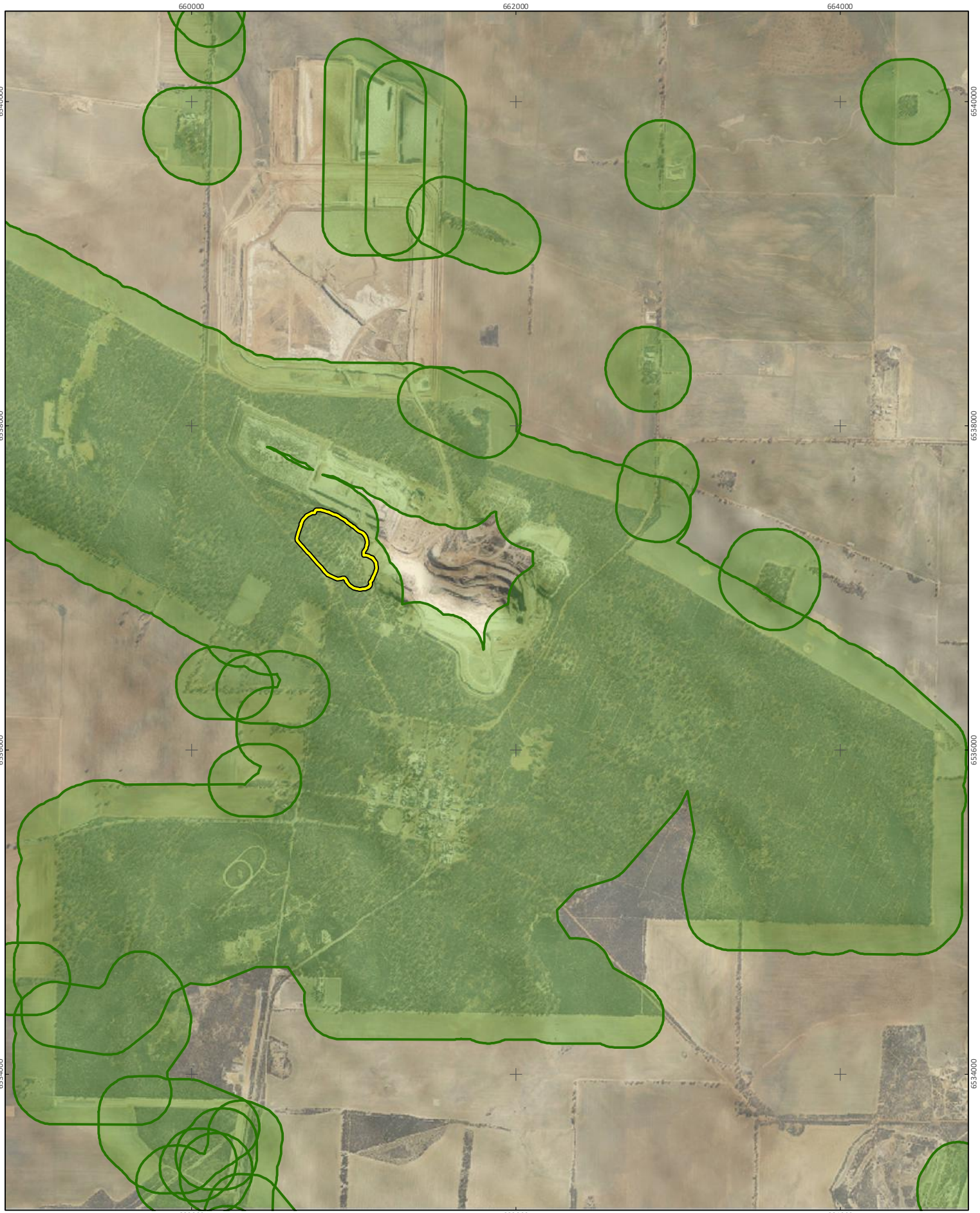
Of six PECs identified within 50 km of the study area in 2013 (Outback Ecology 2013), five are recognised today (Table 5-2). Four of these are recognised as subtype of the 'Eucalypt woodlands of the Western Australian Wheatbelt' (EPBC TEC – CR; DPaW – P3); one, Red Morrel Woodlands of the Wheatbelt, at Federal level, and three, Gimlet, Salmon Gum and York Gum woodlands, at State level (Table 5-2).


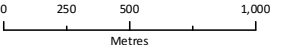
**Table 5-2 Priority Ecological Communities identified to occur within 50 km of the Project (Keighery 1994) and current conservation status.**



Community name	Conservation status August 2013 (Outback Ecology 2013)	Current conservation status	
		WA	EPBC Act
Freshwater basin wetlands of the central Wheatbelt	Preliminary	Not listed	Not listed
Gimlet Woodlands of the Wheatbelt	Preliminary	P3 (sub type)	Not listed
Highclere Hills (Mayfield) Vegetation Complex (BIF)	P1	P1	Not listed
Red Morrel Woodlands of the Wheatbelt	P1	P1	Critically Endangered TEC (sub type)

---

Salmon Gum Woodlands of the Wheatbelt	Preliminary	P3 (sub type)	Not listed
York Gum Woodlands of the Wheatbelt	Preliminary	P3 (sub type)	Not listed



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-  Study area
-  TEC: Eucalypt woodlands of the Western Australian Wheatbelt

**Figure 5-1**  
**Location of the EPBC listed TEC Eucalypt woodlands of the Western Australian wheatbelt in the study area**



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## 5.2 FIELD SURVEY

### 5.2.1 Flora

A total of 51 plant taxa (including subspecies and varieties), representing 14 families and 28 genera were recorded in the study area (Table 5-3), including:

- 45 (88.2%) native and six (11.8%) introduced species
- nine (17.6%) annual and 42 (82.4%) perennial species.

The most prominent families in the current survey were the Chenopodiaceae, Fabaceae, Myrtaceae, Poaceae and Asteraceae.

**Table 5-3 Flora species recorded in the study area**

Family	Genus and species
Poaceae	<i>Austrostipa elegantissima</i>
	<i>Austrostipa hemipogon</i>
	<i>Austrostipa nitida</i>
	* <i>Bromus rubens</i>
	* <i>Ehrharta longiflora</i>
Zygophyllaceae	<i>Zygophyllum compressum</i>
	<i>Zygophyllum eremaeum</i>
Fabaceae	<i>Acacia burkittii</i>
	<i>Acacia colletioides</i>
	<i>Acacia erinacea</i>
	<i>Acacia hemiteles</i>
	<i>Acacia merrallii</i>
	<i>Senna artemisioides</i> subsp. <i>filifolia</i>
	<i>Templetonia ceracea</i>
	<i>Templetonia smithiana</i>
	Myrtaceae
<i>Eucalyptus celastroides</i> subsp. <i>virella</i>	
<i>Eucalyptus corrugata</i>	
<i>Eucalyptus longicornis</i>	
<i>Eucalyptus salubris</i>	
<i>Eucalyptus stricklandii</i>	
<i>Eucalyptus yilgarnensis</i>	
<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	
Brassicaceae	* <i>Carrichtera annua</i>
Santalaceae	<i>Exocarpos aphyllus</i>
	<i>Santalum acuminatum</i>
Polygonaceae	* <i>Rumex vesicarius</i>
Amaranthaceae	<i>Ptilotus holosericeus</i>
	<i>Ptilotus nobilis</i>
Chenopodiaceae	<i>Atriplex nummularia</i>

Family	Genus and species
	<i>Atriplex stipitata</i>
	<i>Atriplex vesicaria</i>
	<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>
	<i>Maireana brevifolia</i>
	<i>Maireana radiata</i>
	<i>Maireana trichoptera</i>
	<i>Rhagodia drummondii</i>
	<i>Rhagodia preissii</i> subsp. <i>preissii</i>
	<i>Salsola australis</i>
	<i>Sclerolaena diacantha</i>
Aizoaceae	* <i>Mesembryanthemum nodiflorum</i>
Apocynaceae	<i>Alyxia buxifolia</i>
Scrophulariaceae	<i>Eremophila decipiens</i>
	<i>Eremophila ionantha</i>
	<i>Eremophila resinosa</i>
Goodeniaceae	<i>Scaevola spinescens</i>
Asteraceae	<i>Olearia muelleri</i>
	<i>Podolepis capillaris</i>
	* <i>Sonchus oleraceus</i>
	<i>Vittadinia gracilis</i>

\* Introduced flora.

### 5.2.1.1 Conservation significant flora

A single plant of *Eremophila resinosa* was recorded in the study area at a previously mapped location, B0814 (Figure 5-2). The death of a second plant previously recorded was confirmed during the field survey, the location remains marked with a post and plant label. A thorough foot search conducted in the vicinity of these records and across the study area did not locate any more plants of the species.

No other conservation significant flora species was recorded.

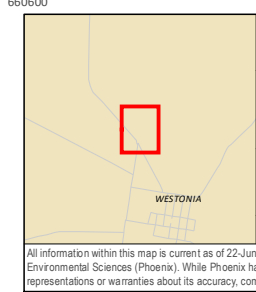
### 5.2.1.2 Introduced flora


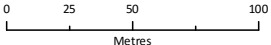
A total of six introduced flora species from five families were recorded in the study area (Table 5-3). None of these species are listed as a declared pest or WoNS.



### 5.2.1.3 Range extensions

The Project represents an eastern range extension for two species, *Eucalyptus campaspe* and *E. stricklandii* (DPaW 2016a, b). However, both species were recorded in areas of historic revegetation and it is considered that both were planted and do not represent a 'natural' extension of the species range and therefore do not incur any conservation significance.






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Date	22-Jun-16
Drawn by	KW
Map author	GW
	
	
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-  Study area
-  *Eremophila resinosa* records

**Figure 5-2**  
**Location of *Eremophila resinosa* in and around the study area**



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## 5.2.2 Vegetation


Three natural vegetation types were defined for the Project interspersed between cleared and degraded areas, a waste landform/stockpile and historically revegetated areas (Table 5-4; Figure 5-3). The natural vegetation comprised an open Morell forest (MWEI - *Eucalyptus longicornis* forest occasionally with *E. salubris* trees), Morell woodland (MWEIMel - *Eucalyptus longicornis* woodland over *Melaleuca pauperiflora* subsp. *fastigiata* shrubland) and Rough Fruited Mallee woodland (RFMEcEI - *Eucalyptus corrugata* mallee woodland over mid *E. longicornis* woodland).




Revegetated areas typically comprised *Eucalyptus* spp. woodlands/mallee woodlands over chenopod shrubs or chenopod shrublands (Table 5-4). The woodlands typically included tree species not from the local area, e.g. *Eucalyptus campaspe* and *E. stricklandii* (Appendix 3) associated with local mallee species, e.g. *Eucalyptus celastroides* subsp. *virella* and *E. yilgarnensis*.




The vegetation of cleared and degraded areas comprised chenopod shrubs and grasses. The area mapped as stockpile comprised a landform of dumped material revegetated mainly with *Eucalyptus corrugata* over chenopods (Table 5-4).

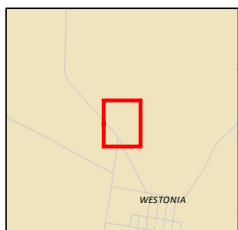
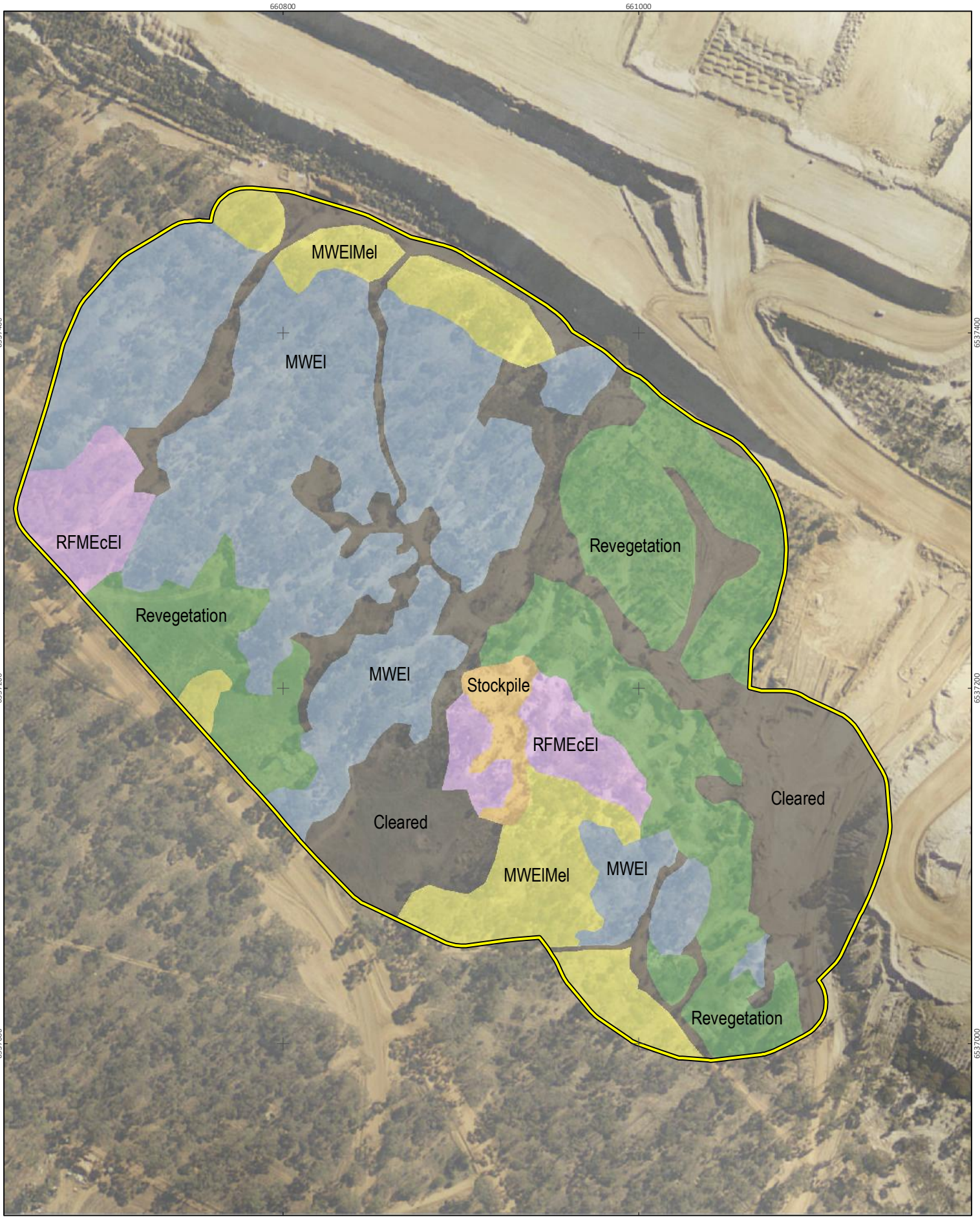
Just over half of the study area (approximately 51 %) comprised natural remnant vegetation (Figure 5-3; Table 5-5) with the remaining areas being the stockpile, cleared and degraded areas, and revegetation. MWEI was the most common vegetation type comprising 67.6 % of the natural vegetation, followed by MWEIMel (20.3 %) and RFMEcEI (12.1 %).


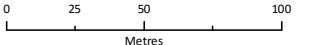
**Table 5-4 Natural vegetation types and other vegetation recorded in the study area**

Vegetation code	Description	Quadrat codes	Photograph
<b>Natural vegetation types</b>			
MWEI	Mid open <i>Eucalyptus longicornis</i> forest occasionally with <i>E. salubris</i> trees over isolated tall <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubs over low <i>Atriplex stipitata</i> , <i>A. vesicaria</i> and <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> chenopod shrubland and low <i>Sclerolaena diacantha</i> chenopod forbs.	EMW03, EMW04	

Vegetation code	Description	Quadrat codes	Photograph
MWEIMel	Mid <i>Eucalyptus longicornis</i> woodland over tall open <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubland over low open <i>Maireana radiata</i> , <i>M. trichoptera</i> and <i>Enchylaena tomentosa</i> chenopod shrubland over isolated low <i>Austrostipa hemipogon</i> tussock grasses and isolated low <i>Sclerolaena diacantha</i> forbs.	EMW01	
RFMEcEI	Tall <i>Eucalyptus corrugata</i> mallee woodland over mid <i>E. longicornis</i> woodland over isolated tall <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubs over sparse low <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> , <i>Maireana radiata</i> and <i>M. trichoptera</i> chenopod shrubland over sparse low <i>Austrostipa</i> spp. tussock grassland.	EMW05	
<b>Other vegetation</b>			
Revegetation – Rehabilitated dump	Low open <i>Eucalyptus salubris</i> , <i>E. stricklandii</i> and <i>E. celastroides</i> subsp. <i>viarella</i> woodland over mid <i>Atriplex nummularia</i> and <i>A. vesicaria</i> shrubland over isolated mid <i>Austrostipa elegantissima</i> tussock grasses and isolated low <i>*Carrichtera annua</i> forbs	EMW06	

Vegetation code	Description	Quadrat codes	Photograph
Revegetation – Old, historic rehabilitation	Tall <i>Eucalyptus campaspe</i> and <i>E. yilgarnensis</i> mallee woodland over isolated tall <i>Eremophila ionantha</i> shrubs over low open <i>Maireana brevifolia</i> shrubland over isolated low <i>*Ehrharta longiflora</i> tussock grasses and isolated low <i>*Carrichtera annua</i> forbs	EMW07R	
Cleared and degraded area	Low sparse <i>Atriplex stipitata</i> shrubland over low open <i>Austrostipa hemipogon</i> tussock grassland and sparse low <i>*Carrichtera annua</i> forbland. Historically cleared area with signs of historic operations, vehicle tracks, litter and weed infestation present.		
Stockpile	<i>Eucalyptus corrugata</i> mallee over low open chenopod shrubland		



Evolution Mining Ltd Edna May Vegetation and Flora Survey	
Project No	1116
Date	22-Jun-16
Drawn by	KW
Map author	GW
	
	
1:2,750 (at A4)	GDA 1994 MGA Zone 50

-  Study area
-  MWEI
-  MWEIMel
-  RFMEcEI
-  Revegetation
-  Stockpile
-  Cleared

**Figure 5-3**  
**Vegetation types in the study area**



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**Table 5-5 Extent of vegetation types in the study area**

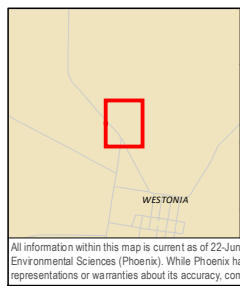
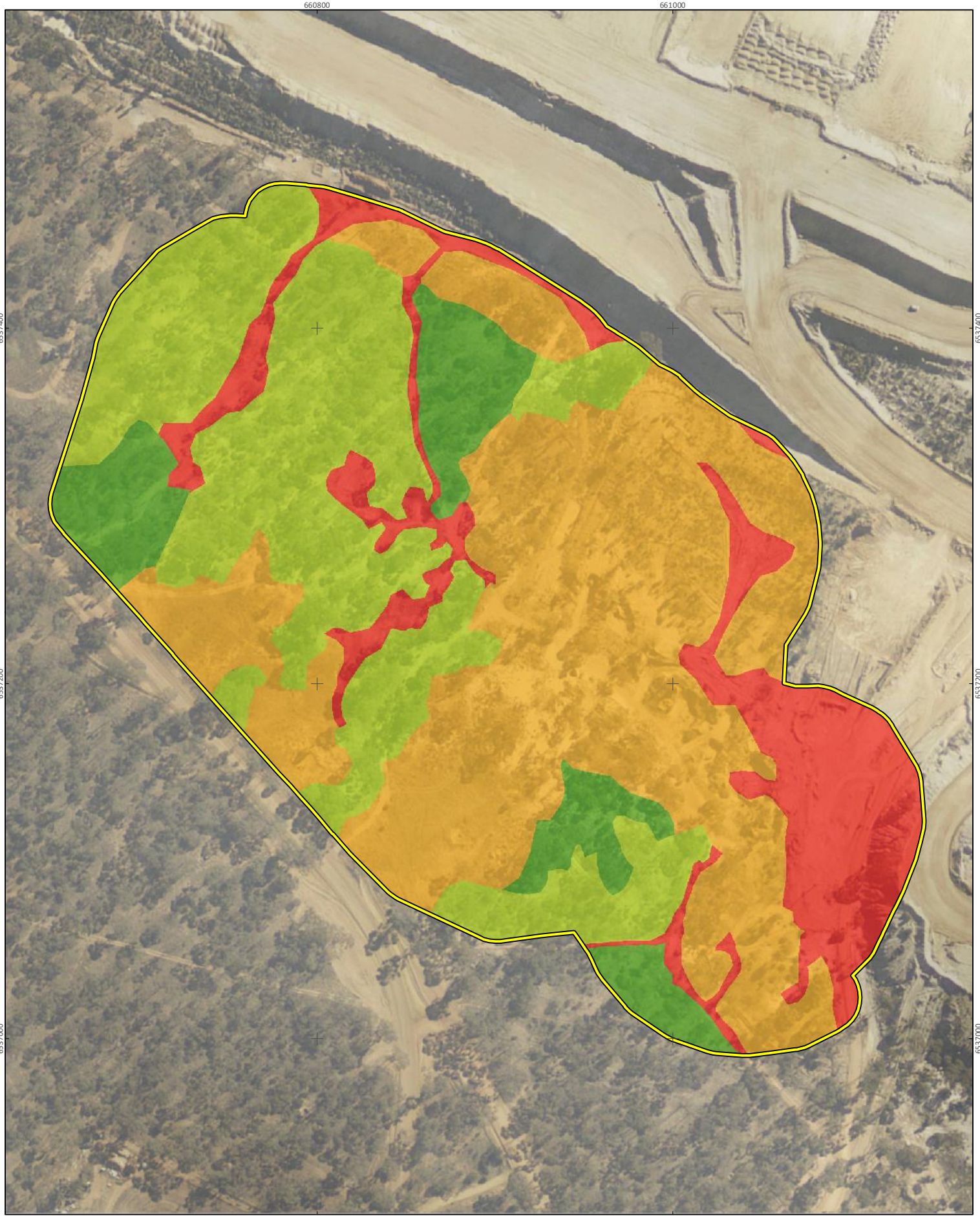
Vegetation	Area (ha)	Percentage (%) of study area
<b>Natural vegetation</b>		
MWEI	4.95	34.52
MWEIMel	1.49	10.36
RFMEcEI	0.88	6.16
<b>Other vegetation types</b>		
Revegetation	3.28	22.88
Cleared	3.53	24.61
Stockpile	0.21	1.47
<b>Total:</b>	<b>14.34</b>	<b>100.00</b>


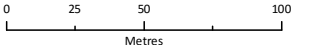
### 5.2.2.1 Vegetation condition

The condition of the vegetation in the Project was Very Good to Completely Degraded, with in excess of 80% of the area in good to completely degraded condition (Figure 5-4; Table 5-6). Therefore, according to the scale of (Keighery 1994) the majority of the Project has “Vegetation structure significantly altered by very obvious signs of multiple disturbances but retains basic vegetation structure or ability to regenerate it” (Table 4-1).

**Table 5-6 Vegetation condition in the study area**


Condition (Keighery 1994)	Area (ha)	Percentage (%) of study area
Very Good	2.15	14.96
Good	6.28	43.82
Degraded	4.46	31.05
Completely Degraded	1.45	10.17
<b>Total:</b>	<b>14.34</b>	<b>100.00</b>



Evolution Mining Ltd Edna May Vegetation and Flora Survey	
Project No	1116
Date	22-Jun-16
Drawn by	KW
Map author	GW
	
	
1:2,750 (at A4)      GDA 1994 MGA Zone 50	

-  Study area
-  Very Good
-  Good
-  Degraded
-  Completely Degraded

**Figure 5-4**  
**Vegetation condition in the study area**



**PHOENIX**  
ENVIRONMENTAL SCIENCES

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### 5.2.2.2 Threatened and Priority Ecological Communities

An assessment of potential occurrence of EPBC Act listed TEC 'Eucalypt Woodlands of the Western Australian Wheatbelt' in the study area, against the diagnostic key (Appendix 2) revealed that it is unlikely that the patches of remnant vegetation in the study area comprise the TEC. Two vegetation types (MWEI and MWEIMel) had adequate cover of listed *Eucalyptus* species and a native understorey, but none of the vegetation described in the survey quadrats aligned with all five diagnostic characteristics for the TEC (Table 5-7). This was largely the result of smaller than required patch size and/or vegetation condition categories that included inadequate number of mature trees. For example, vegetation rated to be in very good condition, being comprised of suitable *Eucalyptus* species, satisfactory tree cover and low weed cover had patch size lower than the required 2 ha. Conversely, vegetation rated as Degraded to Good had TEC listed species, but less than 5 mature trees per 0.5 ha (Table 5-7).

### 5.2.2.3 Local significance of vegetation

The Threatened flora *Eremophila resinosa* was recorded in vegetation type MWEIMel within the project and subsequently this vegetation may be considered locally significant as it represents habitat for a Threatened species.

### 5.2.2.4 Regional significance of vegetation

A vegetation community is considered regionally significant if it is classified as under-represented, that is, there is less than 30% of its original distribution remaining. The vegetation types recorded for the project are representative of the broader vegetation association 536 that has in excess of 30% pre-European extent for both the Avon bioregion and the state of Western Australia.



**Table 5-7 Assessment of occurrence of the TEC 'Eucalypt Woodlands of the Western Australian Wheatbelt' in the study area**

Quadrat	Vegetation type	Diagnostic features					Outcome
		Location Located in AVW-bioregion	Minimum crown canopy Eucalypt woodlands with min. tree canopy crown cover in mature woodland 10% (or <10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings)	Dominant tree canopy One or more key tree species in Appendix 2, Table 1 are dominant or co-dominant, predominantly single trunked, and other species Appendix 2, Table 2 are present in the tree canopy <sup>2</sup>	Native understorey Native understorey present and matches one of the structural categories in Appendix 2	Vegetation condition Condition rating within a patch of minimum 2 ha (non-roadside) or 5 ha (degraded non-roadside) or 5 m width (roadside) falls within one of four condition categories (A, B, C or D, Appendix 2) according to the scale of Keighery (1994)	
EMW01	MWEIMel	Location: AVW01	Crown cover: 25%	Dominant species: <i>Eucalyptus longicornis</i> Other tree canopy species: none present	Chenopod-dominated understorey	Patch type: non-roadside, 0.9 ha Condition: good to very good Category: A Mature trees <sup>3</sup> may be present or absent Exotic plant species account for 0–30% of total vegetation cover in the understorey layers	Unlikely; patch too small, below 2 ha
EMW03	MWEI	Location: AVW01	Crown cover: 40%	Dominant species: <i>Eucalyptus longicornis</i> Other tree canopy species: none present	Chenopod-dominated understorey	Patch type: non-roadside, 0.5 Ha Condition: very good Category: A Mature trees <sup>3</sup> may be present or absent Exotic plant species account for 0–30% of total vegetation cover in the understorey layers	Unlikely; patch too small, below 2 ha
EMW04	MWEI	Location: AVW01	Crown cover: 30%	Dominant species: <i>Eucalyptus longicornis</i>	Chenopod-dominated understorey	Patch type: non-roadside, 4 ha Condition: degraded to good	Unlikely;

Quadrat	Vegetation type	Diagnostic features					Outcome
		Location Located in AVW-bioregion	Minimum crown canopy Eucalypt woodlands with min. tree canopy crown cover in mature woodland 10% (or <10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings)	Dominant tree canopy One or more key tree species in Appendix 2, Table 1 are dominant or co-dominant, predominantly single trunked, and other species Appendix 2, Table 2 are present in the tree canopy <sup>2</sup>	Native understorey Native understorey present and matches one of the structural categories in Appendix 2	Vegetation condition Condition rating within a patch of minimum 2 ha (non-roadside) or 5 ha (degraded non-roadside) or 5 m width (roadside) falls within one of four condition categories (A, B, C or D, Appendix 2) according to the scale of Keighery (1994)	
				Other tree canopy species: <i>Eucalyptus salubris</i>		Category: D Mature trees <sup>3</sup> are present with at least 5 trees per 0.5 ha. Minimum patch size (non-roadside) 5 ha or more. Exotic plant species account more than 50 to 70% of total vegetation cover in the understorey	patch too small, below 4 ha, less than 5 mature trees per 0.5 ha
EMW05	RFMEcEI	Location: AVW01	Crown cover: 15%	Dominant species: <i>Eucalyptus corrugata</i> (mallee) Not listed in Tables 1 or 2. Other tree canopy species: <i>Eucalyptus longicornis</i>	Chenopod-dominated understorey	Patch type: non-roadside, 0.4 Ha Condition: very good Category: A Mature trees <sup>3</sup> may be present or absent Exotic plant species account for 0–30% of total vegetation cover in the understorey layers.	Unlikely <i>Eucalyptus corrugata</i> mallee more dominant than <i>Eucalyptus longicornis</i> Patch too small, below 2 Ha
EMW06	Revegetation	Location: AVW01	Crown cover: less than 10%	Dominant species: None listed in Table1 or 2	Planted scrub and Chenopod-dominated understorey	Patch type: non-roadside, 1.2 Ha Condition: degraded Category: D	Not TEC No dominant

Quadrat	Vegetation type	Diagnostic features				Outcome	
		Location Located in AVW-bioregion	Minimum crown canopy Eucalypt woodlands with min. tree canopy cover in mature woodland 10% (or <10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings)	Dominant tree canopy One or more key tree species in Appendix 2, Table 1 are dominant or co-dominant, predominantly single trunked, and other species Appendix 2, Table 2 are present in the tree canopy <sup>2</sup>	Native understorey Native understorey present and matches one of the structural categories in Appendix 2		Vegetation condition Condition rating within a patch of minimum 2 ha (non-roadside) or 5 ha (degraded non-roadside) or 5 m width (roadside) falls within one of four condition categories (A, B, C or D, Appendix 2) according to the scale of Keighery (1994)
						Mature trees <sup>3</sup> are present with at least 5 trees per 0.5 ha. Minimum patch size (non-roadside) 5 ha or more. Exotic plant species account more than 50 to 70% of total vegetation cover in the understorey.	TEC listed <i>Eucalyptus</i> species, Patch too small, below 4 ha

<sup>1</sup>AVW01 – Avon Wheatbelt bioregion, subregion Merredin.

<sup>2</sup>Species in (Appendix 2, Table 2 or other taxa, but these collectively do not occur as dominants in the tree canopy.

<sup>3</sup> Mature trees have a diameter at breast height (dbh) of 30 cm or above.

## 6 DISCUSSION

In assessing development proposals, the EPA's broad objective for flora and vegetation surveys is to maintain representation, diversity, viability and ecological function at the species, population and community level (EPA 2015). Accordingly, the aim of this assessment was to determine the conservation significant (i.e. EPBC and WC Act listed) flora species and vegetation communities present or likely to be present to enable an impact assessment to be completed and management actions to be identified.

Within this framework, however, this survey should not be interpreted as a standalone assessment. It complements a recent broader study that incorporated the study area (Outback Ecology 2013). Both were conducted in different seasons (Outback Ecology spring, this study autumn), therefore together fulfilling the requirements of a comprehensive Level 2 flora and vegetation study. Within the smaller study area of this survey, however, survey intensity was overall higher resulting in an overall higher resolution of floristic data, in particular comparatively high species richness and the discrimination of more vegetation types in comparison to previous surveys.

### 6.1 FLORA

The previous study by Outback Ecology (2013) had a single quadrat and no relevé in the current study area, in comparison to the five quadrats and two relevés of this survey. This higher intensity of this survey was reflected by a four-fold higher species richness per unit area than that recorded in the previous assessments (Table 6-1).

**Table 6-1 Comparison of survey effort for flora and vegetation assessments conducted at the Edna May**

Survey	Study area (ha)	Survey effort (person days)	No. recorded			
			Species or subspecies [sub/species per ha]	Genera	Families	Weeds
Current survey	14.35	4	51 [3.6]	28	14	6
Outback Ecology (2013)	208 <sup>1</sup>	12	193 [0.9]	112	44	22
Armstrong and Osborne (2003)	n/a	n/a	68 [n/a]	39	25	3

<sup>1</sup>Only a total of 159 ha were surveyed at Level 2.

Four species, including one introduced species, were recorded for Edna May for the first time; however, none of these were conservation significant:

- *Acacia burkittii* (Fabaceae)
- *Austrostipa nitida* (Poaceae)
- *Eucalyptus campaspe* (Myrtaceae)
- *Eucalyptus stricklandii* (Myrtaceae)
- \**Rumex vesicarius* (Polygonaceae).

Whilst the five most common plant families were the same for all surveys at Edna May (Table 6-2), Chenopodiaceae were the most species rich in this and Armstrong and Osborne's (2003) survey, but the least species rich in the survey by Outback Ecology (2013). These differences may reflect differences (and complementarity) in survey timing as the Outback Ecology (2013) survey was the only one conducted in spring.

**Table 6-2** Number of taxa recorded for the most prominent families in flora surveys at the Edna May and their proportion (%) of all taxa

Family	Current survey	Outback Ecology (2013)	Armstrong and Osborne (2003)
Chenopodiaceae	11	19	13
Fabaceae	8	14	11
Myrtaceae	8	19	11
Poaceae	5	20	4
Asteraceae	4	29	4
<b>Total number of species in the five prominent families</b>	<b>36</b>	<b>101</b>	<b>43</b>
<b>Proportion (%) of all taxa</b>	<b>70.6</b>	<b>52.3</b>	<b>63.2</b>

Both recent surveys, this survey and that of Outback Ecology (2013), identified a single conservation significant species in the study area, *Eremophila resinosa* (EPBC and WC Act – EN). Of two populations previously mapped (Outback Ecology 2013), only one represented by a single plant in the northern parts of the study area persisted (Figure 5-2).

If possible, disturbance at this location should be avoided; however, should removal of the single plant be necessary for further development, the following recommendations should be considered:

- Approval from DPaW should be sought prior to any clearing taking place.
- Evolution Mining has conducted a highly successful translocation program for this species over a number of years (Phoenix 2015) and continuation of the translocation program may offset the loss of the naturally occurring plant.
- Careful collection of topsoil (dry stripping and immediate respreading) surrounding previous records of the species and respreading at a suitable translocation area to facilitate potential for establishment of the species from any naturally occurring soil stored seed.

## 6.2 VEGETATION

A total of three natural remnant vegetation communities were defined in contrast to a single vegetation unit identified by the previous broader scale survey (Outback Ecology 2013). The open Morell forest and woodland (MWEI and MWEIMel) aligned closely with the broader vegetation type previously recorded within the study area: “Morrel Woodland described as “Woodland of *Eucalyptus longicornis* with patches of *Eucalyptus celastroides* subsp. *virella* and very occasional *E. salubris* or *E. salmonophloia* over Tall Open Scrub (Patches of) *Melaleuca sheathiana* over Low Open Shrubland of *Olearia muelleri* over Low Scattered Chenopods; *Atriplex vesicaria* and *Maireana georgei* over Very Open Tussock Grassland of *Austrostipa* spp. on red brown cracking clay loam plain” (Outback Ecology 2013).

The mallee woodland (RFMEcEl) aligns with a broader vegetation type recorded in close proximity to the project, Rough Fruited Mallee Woodland described as “Open woodland of *Eucalyptus corrugata* over a Mixed Shrubland including *Senna artemisioides* subsp. *filifolia*, *Eremophila ionantha*, *Acacia ligulata*, *Exocarpos aphyllus* and/or *Dodonaea microzyga* var. *acrolobata* over a sparse Low Shrubland of *Grevillea pacuaria*, *Olearia muelleri*, *Maireana radiata* and *Enchylaena tomentosa* with scattered tussocks of *Austrostipa trichophylla/eremophila* and numerous small annual herbs (sparse) on orange clay loam plain” (Outback Ecology 2013).

Results from the DPaW database search placed the current survey area within the mapped potential distribution of the EPBC listed TEC Eucalypt woodlands of the Western Australian Wheatbelt that includes mine operational areas, waste landforms and adjacent cleared farmland in its buffer of 200 m around each patch of vegetation. Detailed assessment of the vegetation in the survey area against diagnostics provided in the approved conservation advice for the TEC indicated that none of the vegetation types recorded fulfilled all of the criteria of the EPBC listed TEC. The vegetation types of the survey area are therefore also unlikely to represent the DPaW listed PEC ‘Red Morrel Woodlands of the Wheatbelt’ (see Table 5-2).

All of the natural woodland communities in the project align with the Beard’s regional vegetation association 536, Medium woodland; Morrel and rough fruited mallee (*E. corrugata*). This vegetation has in excess of 30% pre-European extent remaining and is therefore not considered regionally conservation significant.

*Eremophila resinosa* was recorded in vegetation type MWEIMel in the study area and therefore this vegetation type was considered locally conservation significant as habitat for a Threatened species. The Threatened species has been recorded outside of the study area at several locations in *Eucalyptus longicornis* and *E. corrugata* woodlands (Phoenix 2015), and consequently each of the remnant vegetation types of the study area may also be considered locally significant.

Almost half of the study area comprised cleared and degraded areas including a waste landform, stockpile and revegetated areas. Evolution Mining are currently engaged in revegetation of some 69 ha of farmland paddocks that link with the remnant vegetation of the Edna May mine tenements (Bella Bamford pers. comm.). These activities include planting an overstorey of *Eucalyptus* trees representative of the TEC including *E. longicornis*, *E. salmonophloia* and *E. salubris* at combined densities of up to 192 stems/ha. Revegetation of the farmland in particular may be considered an offset to any clearing within the Project. Notably, the approved conservation advice (Department of the Environment 2015a) considers suitable revegetation as representative of the TEC ‘Eucalypt Woodlands of the Western Australian Wheatbelt’.

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**Appendix 1 Vegetation structural classes (NVIS)**

**Height Classes**

Height	Growth form					
Height class	Height range (m)	Tree, vine (Mid & Upper), palm (single-stemmed)	Shrub, heath shrub, chenopod shrub, ferns, Samphire shrub, cycad, tree-fern, Grass-tree, palm (multi-stemmed)	Tree mallee, Mallee Shrub	Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (Ground)	Bryophyte, lichen, seagrass, aquatic
8	>30	tall	N/A	N/A	N/A	N/A
7	10-30	mid	N/A	tall	N/A	N/A
6	<10	low	N/A	mid	N/A	N/A
5	<3	N/A	N/A	low	N/A	N/A
4	>2	N/A	tall	N/A	tall	N/A
3	1-2	N/A	mid	N/A	tall	N/A
2	0.5-1	N/A	low	N/A	mid	tall
1	<0.5	N/A	low	N/A	low	low

**Structural Formation Classes**

Growth form	Height ranges (m)	Structural formation classes					
Foliage cover % (cover #)		70-100% (5)	30-70% (4)	10-30% (3)	<10% (2)	0-5% (1)	≈0% (N)
tree, palm	<10,10-30,>30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs

Growth form	Height ranges (m)	Structural formation classes					
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns
bryophyte	<0.5	closed bryophyteland	bryophyteland	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens
vine	<10,10-30,>30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines
aquatic	0-0.5,<1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics
seagrass	0-0.5,<1	closed seagrass bed	seagrass bed	open seagrass bed	sparse seagrass bed	isolated seagrasses	isolated clumps of seagrasses

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**Appendix 2 Key to identify the EPBC listed Threatened Ecological community Eucalypt woodlands of the Western Australian wheatbelt (Department of the Environment 2015a)**

The TEC 'Eucalypt woodlands of the Western Australian Wheatbelt' is composed of eucalypt woodlands dominated by a complex mosaic of eucalypt species with a single tree or mallet form over an understorey that is highly variable in structure and composition. A mallet habit refers to a eucalypt with a single, slender trunk and steep-angled branches that give rise to a dense crown. Many eucalypt species are considered iconic within the Wheatbelt landscape, for example, *Eucalyptus salmonophloia* (salmon gum), *E. loxophleba* subsp. *loxophleba* (York gum), *Eucalyptus rudis* subsp. *rudis*, *E. salubris* (gimlet), *E. wandoo* (wandoo) and the mallet group of species. Associated species may include *Acacia acuminata* (jam), *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah). The understorey structures are often bare to sparse, herbaceous, shrub or heath, chenopod-dominated, thickets (*Melaleuca* spp.) and saline areas with *Tecticornia* spp. The main diagnostic features include location, minimum crown cover of the tree canopy of 10% in a mature woodland, presence of key species and a minimum condition according to scale of Keighery (1994) that depends on size of a patch, weed cover and presence of mature trees. A patch is defined as a discrete and mostly continuous area of the ecological community and may include small-scale variations and disturbances, such as tracks or breaks, watercourses/drainage lines or localised changes in vegetation that do not act as a permanent barrier or significantly alter its overall functionality. Each patch of the community includes a buffer zone, an area that lies immediately outside the edge of a patch but is not part of the ecological community. The buffer zone is designed to minimise this risk to the ecological community.

Woodland vegetation with a very sparse eucalypt tree canopy and woodlands dominated by mallee forms characterised by multiple stems of similar size arising at or near ground level are not part of the ecological community. The ecological community is not likely to be present if it is dominated by non-eucalypt species in the tree canopy, for instance *Acacia acuminata* (jam) or *Allocasuarina huegeliana* (rock sheoak) even though these species may be present as an understorey or minor canopy component.

The community occupies a transitional zone between the wetter forests associated with the Darling Range and the southwest coast, and the low woodlands and shrublands of the semi-arid to arid interior. The Wheatbelt region where the ecological community occurs mostly encompasses two IBRA2 subregions: Avon Wheatbelt subregion AVW01 Merredin and Avon Wheatbelt subregion AVW02 Katanning. Patches of the ecological community may extend into adjacent areas of the primary Wheatbelt bioregions, such as the easternmost parts of the Jarrah Forest bioregion forming an extension of the Avon Wheatbelt landscape in that they comprise areas subject to similar climate, landscape and threats. A third IBRA2 subregion includes Mallee subregion MAL02 Western Mallee and is located south of Perth. The ecological community is generally associated with the flatter, undulating relief, including drainage lines and saline areas.

The WA Wheatbelt woodlands ecological community potentially corresponds to 45 Beard (Shepherd *et al.* 2002) vegetation associations. The most likely equivalents are with the 37 associations that are dominant or unique within the Wheatbelt regions.

## Diagnostic 1 Location

### *Survey location occurs within one of the following three regions:*

- Avon Wheatbelt bioregion - subregions AVW01 Merredin and AVW02 Katanning
- Mallee bioregion - MAL02 Western Mallee only
- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt, and are effectively an extension of the Avon Wheatbelt landscape. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that fall below 600 mm mean annual rainfall (Figure 1), are off the Darling Range, associated with the Yilgarn Craton geology and are generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. The ecological community generally falls within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.....2

### *Survey location occurs within region:*

- Jarrah Forest bioregion – outlying patches in the eastern parts of JAF01 Northern Jarrah Forests and JAF02 Jarrah Forests adjacent to the Avon Wheatbelt. Within the Jarrah Forest bioregion, the ecological community occurs on landscapes that ARE ABOVE the 600 mm isohyet, are ON the Darling Range, NOT associated with the Yilgarn Craton geology and are NOT generally heavily cleared. This covers the eastern to southeastern-most parts of the bioregion. It generally DOES NOT fall within the 300 to 600 mm average annual rainfall isohyets. The isohyets based on the latest 30-year average between 1976 to 2005 (BoM 2016) are most applicable to the current climatic regime.....**NOT TEC**

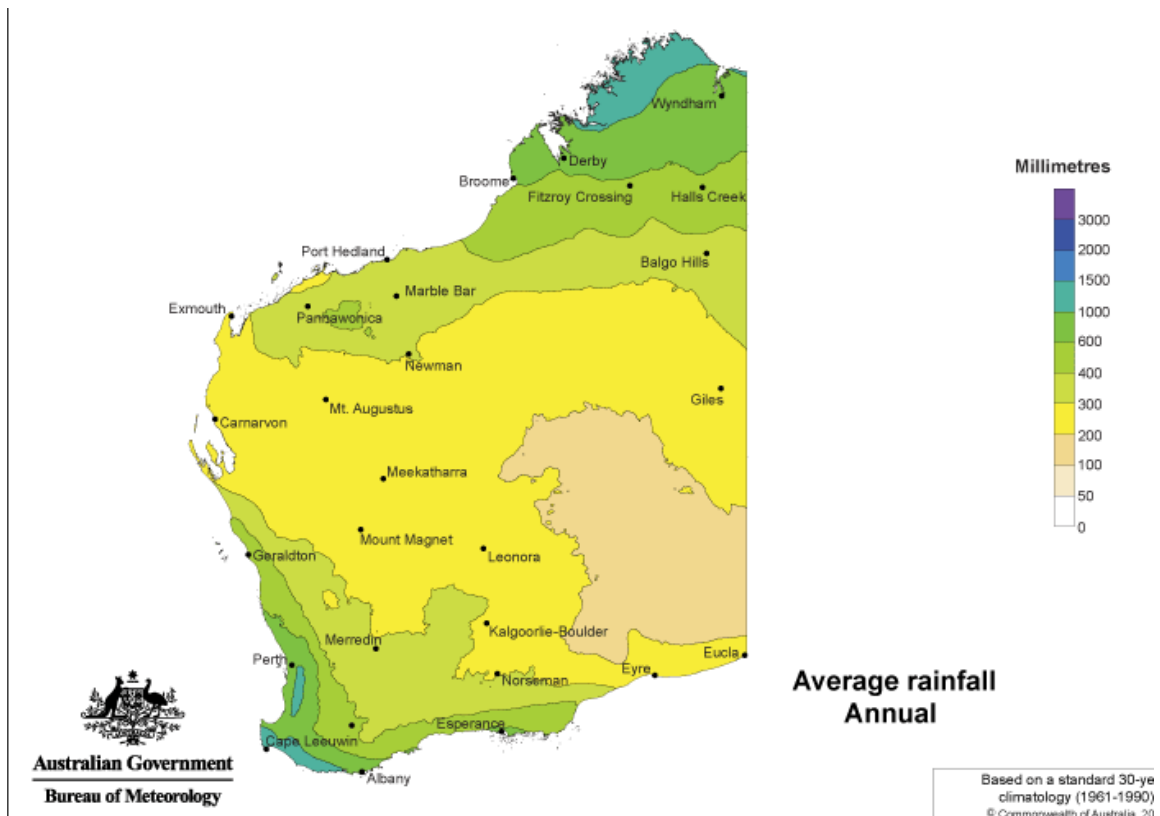


Figure 1 Isohyets of Western Australia (BoM 2016)

### Diagnostic 2 Minimum crown canopy

The structure of the ecological community is a woodland in which the minimum crown cover of the tree canopy in a mature eucalypt woodland is 10% (crowns measured as if they are opaque). The maximum tree canopy cover usually is up to 40%. It may be higher in certain circumstances, for instance trees with a mallet growth form (multi-stemmed upper canopy) may be more densely spaced, or disturbances such as fire may result in an increased cover of canopy species during regeneration.

.....3

Crown cover of trees less than 10% but area recently disturbed (e.g. fire), presence of seedlings and/or saplings.

.....3

Crown cover of trees less than 10%, no evidence of recent disturbance, no presence of seedlings or saplings.

.....**NOT TEC**

### Diagnostic 3 Dominant *Eucalyptus* tree canopy

One or more of the key tree species in [Table 1](#) are dominant or co-dominant, the trees are predominantly single trunked, not mallee (multi-stemmed).

.....4

Other species are present in the tree canopy (e.g. species in [Table 2](#) or other taxa) but these collectively do not occur as dominants in the tree canopy.

.....4

Dominant woodlands with a mallee subcanopy (lower tree layer of mallee or non-eucalypt tree species). Upper eucalypt tree canopy must be present dominated by key woodland species in [Table 2](#) and have cover of 10% or more.

.....4

Other species are present in the tree canopy (e.g. species in [Table 2](#) or other taxa) and these collectively do occur as dominants in the tree canopy.

.....NOT TEC

**Table 1 Key eucalypt species. One or more of these species are dominant or co-dominant within a given patch of the ecological community**

Scientific name	Common name/s
<i>Eucalyptus accedens</i>	powder-bark; powder-bark wandoo
<i>Eucalyptus aequioperta</i>	Welcome Hill gum
<i>Eucalyptus alipes</i>	Hyden mallet
<i>Eucalyptus astringens</i> subsp. <i>astringens</i>	brown mallet
<i>Eucalyptus capillosa</i>	wheatbelt wandoo
<i>Eucalyptus densa</i> subsp. <i>densa</i>	narrow-leaved blue mallet
<i>Eucalyptus extensa</i>	yellow mallet
<i>Eucalyptus falcata</i>	silver mallet
<i>Eucalyptus gardneri</i> subsp. <i>gardneri</i>	blue mallet
<i>Eucalyptus goniocarpa</i>	Lake King mallet
<i>Eucalyptus kondininensis</i>	Kondinin blackbutt
<i>Eucalyptus longicornis</i>	red morrel
<i>Eucalyptus loxophleba</i> subsp. <i>loxophleba</i>	York gum
<i>Eucalyptus melanoxylon</i>	black morrel
<i>Eucalyptus mimica</i> subsp. <i>continens</i>	hooded mallet
<i>Eucalyptus mimica</i> subsp. <i>mimica</i>	Newdegate mallet
<i>Eucalyptus myriadena</i>	small-fruited gum; blackbutt
<i>Eucalyptus occidentalis</i>	flat-topped yate
<i>Eucalyptus ornata</i>	ornamental silver mallet; ornate mallet
<i>Eucalyptus recta</i>	Mt Yule silver mallet; Cadoux mallet
<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	flooded gum
<i>Eucalyptus salicola</i>	salt gum; salt salmon gum
<i>Eucalyptus salmonophloia</i>	salmon gum

Scientific name	Common name/s
<i>Eucalyptus salubris</i>	gimlet
<i>Eucalyptus sargentii</i> subsp. <i>sargentii</i>	salt river gum
<i>Eucalyptus singularis</i>	ridge-top mallet
<i>Eucalyptus spathulata</i> subsp. <i>spathulata</i>	swamp mallet
<i>Eucalyptus spathulata</i> subsp. <i>salina</i>	Salt River mallet
<i>Eucalyptus urna</i>	merrit
<i>Eucalyptus wandoo</i> subsp. <i>pulverea</i>	wandoo
<i>Eucalyptus wandoo</i> subsp. <i>wandoo</i>	wandoo

**Table 2 Associated canopy species that may be present within the ecological community but are not dominant or co-dominant<sup>1</sup>**

Scientific name	Common name/s
<i>Acacia acuminata</i>	jam
<i>Allocasuarina huegeliana</i>	rock sheoak
<i>Corymbia calophylla</i>	marri
<i>Eucalyptus annulata</i>	prickly-fruited mallee
<i>Eucalyptus arachnaea</i> subsp. <i>arachnaea</i>	black-stemmed mallee
<i>Eucalyptus arachnaea</i> subsp. <i>arrecta</i>	black-stemmed mallet
<i>Eucalyptus armillata</i>	flanged mallee
<i>Eucalyptus calycogona</i> subsp. <i>calycogona</i>	square-fruited mallee
<i>Eucalyptus camaldulensis</i> subsp. <i>arida</i>	river red gum
<i>Eucalyptus celastroides</i> subsp. <i>virella</i>	wheatbelt mallee
<i>Eucalyptus cylindriflora</i>	Goldfields white mallee
<i>Eucalyptus decipiens</i>	redheart; moit
<i>Eucalyptus drummondii</i>	Drummond's mallee
<i>Eucalyptus eremophila</i>	sand mallee
<i>Eucalyptus erythronema</i> subsp. <i>erythronema</i>	red-flowered mallee
<i>Eucalyptus erythronema</i> subsp. <i>inornata</i>	yellow-flowered mallee
<i>Eucalyptus eudesmioides</i>	Kalbarri mallee
<i>Eucalyptus flocktoniae</i> subsp. <i>flocktoniae</i>	Flockton's mallee
<i>Eucalyptus gittinsii</i> subsp. <i>illucida</i>	northern sandplain mallee
<i>Eucalyptus incrassata</i>	ridge-fruited mallee
<i>Eucalyptus kochii</i> subsp. <i>plenissima</i>	Trayning mallee
<i>Eucalyptus leptopoda</i> subsp. <i>leptopoda</i>	Merredin mallee; Tammin mallee
<i>Eucalyptus loxophleba</i> subsp. <i>gratae</i>	Lake Grace mallee
<i>Eucalyptus loxophleba</i> subsp. <i>lissophloia</i>	smooth-barked York gum
<i>Eucalyptus loxophleba</i> subsp. <i>supralaevis</i>	blackbutt York gum
<i>Eucalyptus macrocarpa</i>	mottlecah
<i>Eucalyptus marginata</i>	jarrah
<i>Eucalyptus moderata</i>	redwood mallee
<i>Eucalyptus obtusiflora</i>	Dongara mallee



<i>Eucalyptus olivina</i>	olive-leaved mallee
<i>Eucalyptus orthostemon</i>	diverse mallee
<i>Eucalyptus perangusta</i>	fine-leaved mallee
<i>Eucalyptus phaenophylla</i>	common southern mallee
<i>Eucalyptus phenax</i> subsp. <i>phenax</i>	white mallee
<i>Eucalyptus pileata</i>	capped mallee
<i>Eucalyptus platypus</i> subsp. <i>platypus</i>	moort
<i>Eucalyptus polita</i>	Parker Range mallet
<i>Eucalyptus sheathiana</i>	ribbon-barked mallee
<i>Eucalyptus sporadica</i>	Burngup mallee
<i>Eucalyptus subangusta</i> subsp. <i>subangusta</i>	grey mallee

The list is not comprehensive and presents the more common taxa encountered.

### Diagnostic 4 Native understorey

**A native understorey is present but is of variable composition, being a combination of grasses, other herbs and shrubs. A list of key species is summarised in Table 3. Any one of the structural understorey categories may or may not be present.**

**Bare to sparse understorey** (e.g. under some mallet woodlands).

.....5

**Herbaceous understorey** – a ground layer of forbs and/or graminoids though a few, scattered shrubs may be present.

.....5

**Scrub or heath understorey** – comprises a mixture of diverse shrubs of variable height and cover. A ground layer of herbs and grasses is present to variable extent.

.....5

**Chenopod-dominated understorey** – a subset of the scrub category in which the prominent species present are saltbushes, bluebushes and related taxa (e.g. *Atriplex*, *Enchylaena*, *Maireana*, *Rhagodia* and *Sclerolaena*).

.....5

**Thickets** of taller shrub species understorey (e.g. *Melaleuca pauperiflora*, *M. acuminata*, *M. uncinata*, *M. lanceolata*, *M. sheathiana*, *M. adnata*, *M. cucullata* and/or *M. lateriflora*, *Allocasuarina campestris* with *Melaleuca hamata* or *M. scalena*). A range of other shrub and ground layer species may occur among or below the thickets.

.....5

**Salt tolerant species understorey** (e.g. samphire, *Tecticornia* spp.).

.....5

Shrublands or herblands in which the tree canopy layer is very sparse to absent, either naturally or maintained so through long-term disturbance. Native vegetation where a tree canopy was formerly present is often referred to as ‘derived’ or ‘secondary’ vegetation. These sites would fall below the 10 per cent minimum canopy cover threshold for a woodland.....**NOT TEC**

**Table 3 Understorey species**

Scientific name	Common name/s
<b>Shrubs</b>	
<i>Acacia acuaria</i>	
<i>Acacia colletioides</i>	wait-a-while
<i>Acacia erinacea</i>	
<i>Acacia hemiteles</i>	
<i>Acacia lasiocalyx</i>	silver wattle
<i>Acacia lasiocarpa</i>	panjang
<i>Acacia leptospermoides</i>	
<i>Acacia mackeyana</i>	
<i>Acacia merrallii</i>	
<i>Acacia microbotrya.</i>	manna wattle
<i>Acacia pulchella</i>	prickly mooses
<i>Allocasuarina acutivalvis</i>	
<i>Allocasuarina campestris</i>	
<i>Allocasuarina humilis</i>	dwarf sheoak
<i>Allocasuarina lehmanniana</i>	dune sheoak
<i>Allocasuarina microstachya</i>	
<i>Argyrolottis turbinata</i>	
<i>Astroloma epacridis</i>	
<i>Banksia armata</i>	prickly dryandra
<i>Banksia sessilis</i>	parrot bush
<i>Beyeria brevifolia</i>	
<i>Bossiaea divaricata</i>	
<i>Bossiaea eriocarpa</i>	common brown pea
<i>Bossiaea halophila</i>	
<i>Callistemon phoeniceus</i>	lesser bottlebrush
<i>Calothamnus quadrifidus</i>	one-sided bottlebrush
<i>Calothamnus quadrifidus</i> subsp. <i>asper</i>	one-sided bottlebrush
<i>Comesperma integerrimum</i>	
<i>Conostylis setigera</i>	
<i>Dampiera lavandulacea</i>	
<i>Darwinia</i> sp. <i>Karonie</i>	
<i>Daviesia nematophylla</i>	
<i>Daviesia triflora</i>	
<i>Dodonaea bursariifolia</i>	
<i>Dodonaea inaequifolia</i>	
<i>Dodonaea pinifolia</i>	
<i>Dodonaea viscosa</i>	sticky hopbush
<i>Eremophila decipiens</i>	slender fuchsia
<i>Eremophila ionantha</i>	violet-flowered eremophila
<i>Eremophila oppositifolia</i>	weeooka

Scientific name	Common name/s
<i>Eremophila scoparia</i>	broom bush
<i>Exocarpos aphyllus</i>	leafless ballart
<i>Gastrolobium microcarpum</i>	sandplain poison
<i>Gastrolobium parviflorum</i>	
<i>Gastrolobium spinosum</i>	prickly poison
<i>Gastrolobium tricuspdatum</i>	
<i>Gastrolobium trilobum</i>	bullock poison
<i>Grevillea acuaria</i>	
<i>Grevillea huegelii</i>	
<i>Grevillea tenuiflora</i>	tassel grevillea
<i>Hakea laurina</i>	pincushion hakea
<i>Hakea lissocarpha</i>	honey bush
<i>Hakea multilineata</i>	grass-leaf hakea
<i>Hakea petiolaris</i>	sea urchin hakea
<i>Hakea preissii</i>	needle tree
<i>Hakea varia</i>	variable-leaved hakea
<i>Hibbertia commutata</i>	
<i>Hibbertia exasperata</i>	
<i>Hibbertia hypericoides</i>	yellow buttercups
<i>Hovea chorizemifolia</i>	holly-leaved hovea
<i>Hypocalymma angustifolium</i>	white myrtle
<i>Leptomeria preissiana</i>	
<i>Leptospermum erubescens</i>	roadside teatree
<i>Lycium australe</i>	
Australian boxthorn	
<i>Melaleuca acuminata</i>	
<i>Melaleuca adnata</i>	
<i>Melaleuca atroviridis</i>	
<i>Melaleuca brophyi</i>	
<i>Melaleuca cucullata</i>	
<i>Melaleuca cuticularis</i>	saltwater paperbark
<i>Melaleuca halmaturorum</i>	
<i>Melaleuca hamata</i>	
<i>Melaleuca hamulosa</i>	
<i>Melaleuca lanceolata</i>	
Rottneest teatree	
<i>Melaleuca lateriflora</i>	gorada
<i>Melaleuca marginata</i>	
<i>Melaleuca pauperiflora</i>	boree
<i>Melaleuca radula</i>	graceful honeymyrtle
<i>Melaleuca raphiophylla</i>	swamp paperbark
<i>Melaleuca scalena</i>	

Scientific name	Common name/s
<i>Melaleuca strobophylla</i>	
<i>Melaleuca teuthidoides</i>	
<i>Melaleuca thyoides</i>	
<i>Melaleuca uncinata</i> group	broom bush
<i>Melaleuca viminea</i>	mohan
<i>Olearia muelleri</i>	
Goldfields daisy	
<i>Olearia</i> sp. Kennedy Range	
<i>Petrophile divaricata</i>	
<i>Petrophile shuttleworthiana</i>	
<i>Petrophile squamata</i>	
<i>Petrophile striata</i>	
<i>Phebalium filifolium</i>	slender phebalium
<i>Phebalium lepidotum</i>	
<i>Phebalium microphyllum</i>	
<i>Phebalium tuberosum</i>	
<i>Pimelea argentea</i>	silvery-leaved pimelea
<i>Pittosporum angustifolium</i>	
<i>Platysace maxwellii</i>	karno
<i>Rhadinothamnus rudis</i>	
<i>Santalum acuminata</i>	quandong
<i>Santalum spicatum</i>	sandalwood
<i>Scaevola spinescens</i>	currant bush
<i>Senna artemisioides</i>	
<i>Styphelia tenuiflora</i>	common pinheath
<i>Templetonia sulcata</i>	centipede bush
<i>Trymalium elachophyllum</i>	
<i>Trymalium ledifolium</i>	
<i>Westringia cephalantha</i>	
<i>Xanthorrhoea drummondii</i>	
<b>Chenopods</b>	
<i>Atriplex acutibractea</i>	toothed saltbush
<i>Atriplex paludosa</i>	marsh saltbush
<i>Atriplex semibaccata</i>	berry saltbush
<i>Atriplex stipitata</i>	mallee saltbush
<i>Atriplex vesicaria</i>	bladder saltbush
<i>Enchylaena lanata / tomentosa</i> complex	barrier saltbush
<i>Maireana brevifolia</i>	small-leaf bluebush
<i>Maireana erioclada</i>	
<i>Maireana marginata</i>	
<i>Maireana trichoptera</i>	downy bluebush
<i>Rhagodia drummondii</i>	

Scientific name	Common name/s
<i>Rhagodia preissii</i>	
<i>Sclerolaena diacantha</i>	grey copperburr
<i>Tecticornia spp.</i>	samphire
<i>Threlkeldia diffusa</i>	coast bonefruit
<b>Forbs</b>	
<i>Actinobole uliginosum</i>	flannel cudweed
<i>Asteridea athrixioides</i>	
<i>Blennospora drummondii</i>	
<i>Borya nitida</i>	pincushions
<i>Borya sphaerocephala</i>	pincushions
<i>Brachyscome ciliaris</i>	
<i>Brachyscome lineariloba</i>	
<i>Caesia micrantha</i>	pale fringe-lily
<i>Caladenia flava</i>	cowslip orchid
<i>Calandrinia calyptrata</i>	pink purslane
<i>Calandrinia eremaea</i>	twining purslane
<i>Calotis hispidula</i>	bindy eye
<i>Carpobrotus modestus</i>	inland pigface
<i>Centipeda crateriformis</i> subsp. <i>crateriformis</i>	
<i>Chamaescilla corymbosa</i>	blue squill
<i>Chamaexeros serra</i>	little fringe-leaf
<i>Cotula coronopifolia</i>	waterbuttons
<i>Crassula colorata</i>	dense stonecrop
<i>Crassula exserta</i>	
<i>Dampiera juncea</i>	rush-like dampiera
<i>Dampiera lindleyi</i>	
<i>Daucus glochidiatus</i>	Australian carrot
<i>Dianella brevicaulis</i>	
<i>Dichopogon capillipes</i>	
<i>Disphyma crassifolium</i>	round-leaved pigface
<i>Drosera macrantha</i>	bridal rainbow
<i>Erodium cygnorum</i>	blue heronsbill
<i>Gilberta tenuifolia</i>	
<i>Gnephosis drummondii</i>	
<i>Gnephosis tenuissima</i>	
<i>Gnephosis tridens</i>	
<i>Gonocarpus nodulosus</i>	
<i>Goodenia berardiana</i>	
<i>Helichrysum leucopsideum</i>	
<i>Helichrysum luteoalbum</i>	Jersey cudweed
<i>Lagenophora huegelii</i>	
<i>Lawrencella rosea</i>	

Scientific name	Common name/s
<i>Lepidium rotundum</i>	veined peppergrass
<i>Podolepis capillaris</i>	wiry podolepis
<i>Podolepis lessonii</i>	
<i>Podotroche angustifolia</i>	sticky longheads
<i>Poranthera microphylla</i>	small poranthera
<i>Pterostylis sanguinea</i>	
<i>Ptilotus spathulatus</i>	
<i>Rhodanthe laevis</i>	
<i>Senecio glossanthus</i>	slender groundsel
<i>Spergularia marina</i>	
<i>Stylidium calcaratum</i>	book triggerplant
<i>Thysanotus patersonii</i>	
<i>Trachymene cyanopetala</i>	
<i>Trachymene ornata</i>	spongefruit
<i>Trachymene pilosa</i>	native parsnip
<i>Velleia cynopotamica</i>	
<i>Waitzia acuminata</i>	orange immortelle
<i>Zygophyllum ovatum</i>	dwarf twinleaf
<b>Graminoids</b>	
<i>Amphipogon caricinus - strictus complex</i>	greybeard grass
<i>Austrostipa elegantissima</i>	
<i>Austrostipa hemipogon</i>	
<i>Austrostipa nitida</i>	
<i>Austrostipa trichophylla</i>	
<i>Centrolepis polygyna</i>	wiry centrolepis
<i>Desmocladius asper</i>	
<i>Desmocladius flexuosus</i>	
<i>Gahnia ancistrophylla</i>	hook-leaf saw sedge
<i>Gahnia australis</i>	
<i>Harperia lateriflora</i>	
<i>Juncus bufonius</i>	toad rush
<i>Lachnagrostis filiformis</i>	blowgrass
<i>Lepidosperma leptostachyum</i>	
<i>Lepidosperma resinosum</i>	
<i>Lepidosperma sp. aff. tenue</i>	
<i>Lepidosperma tenue</i>	
<i>Lepidosperma viscidum</i>	sticky sword sedge
<i>Lomandra effusa</i>	scented matrush
<i>Lomandra micrantha</i> subsp. <i>micrantha</i>	small-flower matrush
<i>Lomandra nutans</i>	
<i>Meeboldina coangustata</i>	
<i>Mesomelaena preissii</i>	

Scientific name	Common name/s
<i>Neurachne alopecuroides</i>	foxtail mulga grass
<i>Rytidosperma caespitosum</i>	
<i>Rytidosperma setaceum</i> group	
<i>Schoenus nanus</i>	tiny bog-rush
<i>Schoenus sculptus</i>	gimlet bog-rush
<i>Schoenus subfascicularis</i>	

## Diagnostic 5 Vegetation condition

**Minimum condition for patches of the WA Wheatbelt Woodlands ecological community. For each category, both the weed cover and mature tree presence criteria must apply plus one of either patch size or patch width, depending on whether the patch is a roadside remnant or not.**

### Category A:

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

.....TEC

**Patch width roadside only** (based on the native understorey component not width of the tree canopy) 5 m or more.

.....TEC

Patch corresponds to a condition of pristine / excellent / very good (Keighery, 1994) or a high RCV (RCC, 2014).

Exotic plant species account for 0 to 30% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees (diameter at breast height (dbh) of 30 cm or above) may be present or absent.

Patch size (non-roadside) less than 2 ha.

.....NOT TEC

**Patch width roadside only** (based on the native understorey component not width of the tree canopy) less than 5 m.

.....NOT TEC

### Category B:

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014).

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

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Patch size (non-roadside) 2 ha or more with no gap in native vegetation cover exceeding 50 m width.

.....TEC

**Patch width roadside only** (based on the native understorey component not width of the tree canopy) 5 m or more.

.....TEC

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Patch size (non-roadside) less than 2 ha.

.....NOT TEC

**Patch width roadside only** (based on the native understorey component not width of the tree canopy) less than 5 m.

.....NOT TEC

**Category C:**

Patch corresponds to a condition of good (Keighery, 1994) or a medium-high RCV (RCC, 2014), **AND** retains important habitat features.

Exotic plant species account for more than 30, to 50% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

Minimum patch size (non-roadside) 5 ha or more.

.....TEC

Patch size (non- roadside) less than 5 ha

.....NOT TEC

**Category D:**

Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-Low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Mature trees are present with at least 5 trees per 0.5 ha.

Minimum patch size (non-roadside) 5 ha or more.

.....TEC

**Patch width roadside only** (based on the native understorey component not width of the tree canopy) 5 m or more

.....TEC



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Patch corresponds to a condition of degraded to good (Keighery, 1994) or a medium-low to medium-high RCV (RCC, 2014).

Exotic plant species account for more than 50 to 70% of total vegetation cover in the understorey layers (i.e. below the tree canopy).

Less than 5 mature trees per 0.5 ha are present.

.....**NOT TEC**

**Appendix 3 Flora survey site descriptions with species recorded at each site**

Flora and vegetation survey of the proposed Greenfinch disturbance footprint

Evolution Mining Pty Ltd

<b>Site:</b>	EMW01	<b>Type:</b>	Quadrat (20 m x 20 m)
<b>Date:</b>	11/05/2016	<b>Position:</b>	-31.29055, 118.691317
<b>Total vegetation cover (%):</b>	50	<b>Topography:</b>	plain
<b>Tree/shrub cover &gt;2 m (%):</b>	35	<b>Soil colour:</b>	red-brown
<b>Shrub cover &lt;2 m (%):</b>	15	<b>Soil:</b>	sandy clay, clay loam
<b>Grass cover (%):</b>	1	<b>Rock type:</b>	none
<b>Herb cover (%):</b>	2	<b>Fire age:</b>	>5 years
<b>Disturbance details:</b>	exploration (drill pads and access tracks), historic operations, vehicle tracks		
<b>Vegetation condition:</b>	Very good, Keighery (1994)		
<b>Vegetation description:</b>	Mid <i>Eucalyptus longicornis</i> wooldand over tall open <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubland over low open <i>Maireana radiata</i> , <i>M. trichoptera</i> and <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> sachenopod shrubland over isolated low <i>Austrostipa hemipogon</i> tussock grasses and isolated low <i>Sclerolaena diacantha</i> forbs.		



Species	Cover (%)	Height (m)	Weeds	Conservation status
<i>Eucalyptus longicornis</i>	25.0	20.00		
<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	15.0	05.00		
<i>Maireana radiata</i>	10.0	00.60		
<i>Maireana trichoptera</i>	03.0	00.30		
<i>Austrostipa hemipogon</i>	02.0	00.30		
<i>Sclerolaena diacantha</i>	02.0	00.20		
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	02.0	00.30		
<i>Exocarpos aphyllus</i>	01.0	03.00		
<i>Zygophyllum compressum</i>	00.1	00.15		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	01.00		
<i>Olearia muelleri</i>	00.1	00.50		

**Flora and vegetation survey of the proposed Greenfinch disturbance footprint**

Evolution Mining Pty Ltd

<b>Site:</b>	EMW03	<b>Type:</b>	Quadrat (20 m x 20 m)
<b>Date:</b>	11/05/2016	<b>Position:</b>	-31.286944, 118.690286
<b>Total vegetation cover (%):</b>	65	<b>Topography:</b>	plain
<b>Tree/shrub cover &gt;2 m (%):</b>	40	<b>Soil colour:</b>	red-brown
<b>Shrub cover &lt;2 m (%):</b>	40	<b>Soil:</b>	sandy clay, clay loam
<b>Grass cover (%):</b>	0.1	<b>Rock type:</b>	none
<b>Herb cover (%):</b>	2	<b>Fire age:</b>	>5 years
<b>Disturbance details:</b>	exploration (drill pads and access tracks), historic clearing, historic operations, litter		
<b>Vegetation condition:</b>	Very good, Keighery (1994)		
<b>Vegetation description:</b>	Mid open <i>Eucalyptus longicornis</i> forest over low <i>Atriplex vesicaria</i> , <i>A. stipitata</i> and <i>Maireana trichoptera</i> chenopod shrubland.		



Species	Cover (%)	Height (m)	Weeds	Conservation status
<i>Eucalyptus longicornis</i>	40.0	20.00		
<i>Atriplex vesicaria</i>	25.0	00.80		
<i>Atriplex stipitata</i>	15.0	00.60		
<i>Sclerolaena diacantha</i>	02.0	00.15		
<i>Maireana trichoptera</i>	02.0	00.30		
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	01.0	00.40		
<i>Zygophyllum eremaeum</i>	00.1	00.50		
<i>Templetonia ceracea</i>	00.1	01.20		
<i>Templetonia smithiana</i>	00.1	01.50		
<i>Rhagodia drummondii</i>	00.1	00.60		
<i>Rhagodia preissii</i> subsp. <i>preissii</i>	00.1	01.80		

Flora and vegetation survey of the proposed Greenfinch disturbance footprint

Evolution Mining Pty Ltd

<b>Site:</b>	EMW04	<b>Type:</b>	Quadrat (20 m x 20 m)
<b>Date:</b>	11/05/2016	<b>Position:</b>	-31.287201, 118.689183
<b>Total vegetation cover (%):</b>	60	<b>Topography:</b>	plain
<b>Tree/shrub cover &gt;2 m (%):</b>	35	<b>Soil colour:</b>	red-brown
<b>Shrub cover &lt;2 m (%):</b>	30	<b>Soil:</b>	sandy clay, clay loam
<b>Grass cover (%):</b>	0.5	<b>Rock type:</b>	none
<b>Herb cover (%):</b>	10	<b>Fire age:</b>	>5 years
<b>Disturbance details:</b>	exploration (drill pads and access tracks), historic clearing, historic operations, litter		
<b>Vegetation condition:</b>	Good, Keighery (1994)		
<b>Vegetation description:</b>	Mid open <i>Eucalyptus longicornia</i> and <i>E. salubris</i> forest over isolated tall <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubs over low <i>Atriplex stipitata</i> , <i>Enchylaena tomentosa</i> and <i>Maireana trichoptera</i> chenopod shrubland over sparse mid <i>Austrostipa elegantissima</i> tussock grassland over low open <i>Sclerolaena diacantha</i> forbland.		



Species	Cover (%)	Height (m)	Weeds	Conservation status
<i>Eucalyptus longicornis</i>	30.0	20.00		
<i>Atriplex stipitata</i>	20.0	00.60		
<i>Sclerolaena diacantha</i>	10.0	00.15		
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	05.0	00.30		
<i>Maireana trichoptera</i>	05.0	00.30		
<i>Eucalyptus salubris</i>	05.0	15.00		
<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	01.0	03.00		
<i>Templetonia smithiana</i>	01.0	01.50		
<i>Carrichtera annua</i>	01.0	00.30	*	
<i>Austrostipa elegantissima</i>	00.5	00.60		
<i>Zygophyllum compressum</i>	00.1	00.20		
<i>Salsola australis</i>	00.1	00.30		
<i>Rhagodia preissii</i> subsp. <i>preissii</i>	00.1	01.00		
<i>Santalum acuminatum</i>	00.1	01.50		
<i>Ptilotus holosericeus</i>	00.1	00.01		

Flora and vegetation survey of the proposed Greenfinch disturbance footprint

Evolution Mining Pty Ltd

<b>Site:</b>	EMW05	<b>Type:</b>	Quadrat (20 m x 20 m)
<b>Date:</b>	11/05/2016	<b>Position:</b>	-31.287417, 118.688115
<b>Total vegetation cover (%):</b>	50	<b>Topography:</b>	plain
<b>Tree/shrub cover &gt;2 m (%):</b>	35	<b>Soil colour:</b>	red-brown
<b>Shrub cover &lt;2 m (%):</b>	10	<b>Soil:</b>	sandy clay, clay loam
<b>Grass cover (%):</b>	2	<b>Rock type:</b>	none
<b>Herb cover (%):</b>	1	<b>Fire age:</b>	>5 years
<b>Disturbance details:</b>	erosion channels, exploration (drill pads and access tracks), historic clearing, historic operations, litter, vehicle tracks,		
<b>Vegetation condition:</b>	Very good, Keighery (1994)		
<b>Vegetation description:</b>	Tall <i>Eucalyptus corrugata</i> mallee woodland over mid <i>E. longicornis</i> woodland over isolated tall <i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i> shrubs over sparse low <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> , <i>Maireana radiata</i> and <i>M. trichoptera</i> chenopod shrubland over sparse low <i>Austrostipa</i> spp. tussock grassland.		



Species	Cover (%)	Height (m)	Weeds	Conservation status
<i>Eucalyptus corrugata</i>	20.0	12.00		
<i>Eucalyptus longicornis</i>	15.0	15.00		
<i>Melaleuca pauperiflora</i> subsp. <i>fastigiata</i>	04.0	04.00		
<i>Maireana radiata</i>	03.0	00.30		
<i>Maireana trichoptera</i>	03.0	00.40		
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	03.0	00.40		
<i>Atriplex stipitata</i>	01.0	00.60		
<i>Austrostipa nitida</i>	01.0	00.20		
<i>Austrostipa hemipogon</i>	00.5	00.40		
<i>Austrostipa elegantissima</i>	00.1	00.40		
<i>Rhagodia preissii</i> subsp. <i>preissii</i>	00.1	00.80		
<i>Rhagodia drummondii</i>	00.1	00.80		
<i>Senna artemisioides</i> subsp. <i>filifolia</i>	00.1	00.80		
<i>Sclerolaena diacantha</i>	00.1	00.20		
<i>Zygophyllum compressum</i>	00.1	00.15		
<i>Ptilotus holosericeus</i>	00.1	00.01		
<i>Templetonia smithiana</i>	00.1	00.60		

Flora and vegetation survey of the proposed Greenfinch disturbance footprint

Evolution Mining Pty Ltd

<b>Site:</b>	EMW06	<b>Type:</b>	Quadrat (20 m x 20 m)
<b>Date:</b>	11/05/2016	<b>Position:</b>	-31.287218, 118.691125
<b>Total vegetation cover (%):</b>	40	<b>Topography:</b>	sand dune
<b>Tree/shrub cover &gt;2 m (%):</b>	10	<b>Soil colour:</b>	red-orange
<b>Shrub cover &lt;2 m (%):</b>	35	<b>Soil:</b>	gravel / alluvial, sandy clay, laterite
<b>Grass cover (%):</b>	2	<b>Rock type:</b>	none
<b>Herb cover (%):</b>	2	<b>Fire age:</b>	not evident
<b>Disturbance details:</b>	excavation, historic operations, revegetation		
<b>Vegetation condition:</b>	Degraded, Keighery (1994)		
<b>Vegetation description:</b>	Low open <i>Eucalyptus salubris</i> , <i>E. stricklandii</i> and <i>E. celastroides</i> subsp. <i>virella</i> woodland over mid <i>Atriplex nummularia</i> and <i>A. vesicaria</i> shrubland over isolated mid <i>Austrostipa elegantissima</i> tussock grasses and isolated low <i>*Carrichtera annua</i> forbs.		



Species	Cover (%)	Height (m)	Weeds	Conservation status
<i>Atriplex vesicaria</i>	25.0	01.20		
<i>Atriplex nummularia</i>	10.0	02.00		
<i>Eucalyptus celastroides</i> subsp. <i>virella</i>	04.0	05.00		
<i>Carrichtera annua</i>	02.0	00.15	*	
<i>Eucalyptus stricklandii</i>	02.0	05.00		
<i>Eucalyptus salubris</i>	02.0	09.00		
<i>Bromus rubens</i>	01.0	00.20	*	
<i>Austrostipa elegantissima</i>	01.0	00.60		
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	00.1	00.50		
<i>Ptilotus nobilis</i>	00.1	00.05		
<i>Zygophyllum eremaeum</i>	00.1	00.30		
<i>Sclerolaena diacantha</i>	00.1	00.15		
<i>Sonchus oleraceus</i>	00.1	00.20	*	
<i>Acacia burkittii</i>	00.1	01.50		
<i>Maireana trichoptera</i>	00.1	00.20		



# PHOENIX

ENVIRONMENTAL SCIENCES

## Targeted *Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

October 2017

Final Report





Targeted *Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

Draft Report, Rev 01

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Date: 12 October 2017

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	Choose an item.		
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## Contents

CONTENTS.....	II
EXECUTIVE SUMMARY .....	IV
1 INTRODUCTION.....	5
1.1 Background .....	5
1.2 Scope of work and survey objectives.....	5
1.3 <i>Eremophila resinosa</i> life history and ecology .....	8
1.3.1 General biology and identification.....	8
1.3.2 Taxonomy and nomenclature .....	9
1.3.3 Habitat and distribution.....	10
1.3.4 Conservation status and threatening processes.....	11
2 METHODS.....	12
2.1 Desktop review .....	12
2.2 Field surveys.....	12
2.2.1 Survey of extant populations.....	12
2.2.2 Survey for regional natural populations .....	13
2.3 Data Analysis.....	14
2.4 Project personnel.....	14
3 RESULTS .....	15
3.1 Climate data .....	15
3.2 Annual changes to <i>E. resinosa</i> populations 2016-2017 .....	16
3.2.1 Number of living plants in populations A, B, C, D, F and G .....	16
3.2.2 Proportion of plants flowering and/or exhibiting new growth .....	19
3.2.3 Foliage cumulative volume of populations and proportion of living foliage .....	20
3.3 Regional <i>Eremophila resinosa</i> populations.....	21
3.3.1 Number of living plants in populations H, I, L, WN and WS.....	21
3.3.2 Proportion of plants flowering in regional populations.....	22
3.3.3 Foliage cumulative volume of populations and proportion of living foliage in regional populations .....	23
3.3.4 New regional <i>Eremophila resinosa</i> populations .....	24
3.4 Survey limitations .....	30
4 DISCUSSION.....	30
4.1 Number of living plants.....	30
4.2 Proportion of plants flowering and exhibiting new growth .....	30
4.3 Foliage cumulative volume and proportion of branches with living foliage .....	30
5 CONCLUSION.....	31
6 REFERENCES.....	32

## List of Figures

Figure 1-1	Location of the Edna May Gold Project .....	6
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Figure 1-2	Known <i>Eremophila resinosa</i> populations and study area for the survey .....	7
Figure 1-3	<i>Eremophila resinosa</i> plants at the Edna May Gold Project.....	9
Figure 3-1	Mean annual rainfall and annual rainfall totals for Merredin (010092) from 2012 to 2016. Red line represents mean rainfall from 2010 to 2017.....	15
Figure 3-2	Rainfall and temperature means recorded at Merredin in the 12 months prior to the survey compared to the long term averages.....	16
Figure 3-3	Number of live <i>Eremophila resinosa</i> plants recorded annually.....	17
Figure 3-4	Proportion (%) of living <i>Eremophila resinosa</i> plants from the previous monitoring period recorded as dead in the subsequent monitoring period .....	18
Figure 3-5	Proportion (%) of <i>Eremophila resinosa</i> plants recorded alive in 2010 still living or dead by 2017.	19
Figure 3-6	Proportion (%) of <i>Eremophila resinosa</i> plants recorded flowering.....	19
Figure 3-7	Proportion of <i>Eremophila resinosa</i> plants recorded exhibiting new growth.....	20
Figure 3-8	Foliage-cumulative volume of <i>Eremophila resinosa</i> plants at each population since 2010	20
Figure 3-9	Average proportion (%) of living foliage on <i>Eremophila resinosa</i> plants since 2010 ...	21
Figure 3-10	Number of live <i>Eremophila resinosa</i> plants recorded annually in regional populations	22
Figure 3-11	Proportion (%) of <i>Eremophila resinosa</i> plants recorded flowering in regional populations	22
Figure 3-12	Foliage-cumulative volume of <i>Eremophila resinosa</i> plants at each regional population	23
Figure 3-13	Average foliage cover (%) of <i>Eremophila resinosa</i> in regional populations .....	23
Figure 3-14	Regional populations of <i>Eremophila resinosa</i> found in the 2017 monitoring period...	29

### List of Tables

Table 1-1	Summary of population size for <i>Eremophila resinosa</i> at the Edna May Gold Project (Phoenix 2016).....	10
Table 2-1	Literature reviewed for the current survey of <i>Eremophila resinosa</i> .....	12
Table 2-2	Parameters recorded for individual <i>Eremophila resinosa</i> plants at the Edna May Gold Project	13
Table 2-3	Data collected for relevés completed at new regional populations.....	13
Table 2-4	Project team.....	14
Table 3-1	Summary of <i>Eremophila resinosa</i> plant records in 2017 in comparison with previous monitoring period.....	17
Table 3-2	Data recorded for new <i>Eremophila resinosa</i> plants located at population D, F and G in 2017	18
Table 3-3	Summary of <i>Eremophila resinosa</i> regional plant records in 2017 in comparison with previous monitoring period .....	21
The survey for new regional populations of <i>Eremophila resinosa</i> located an additional 78 individuals at four new populations (GR, WNN, WB and LM) in 2017, the data for which are summarised in Table 3-4. ....		
Table 3-4		24
Table 3-5	Data recorded for <i>Eremophila resinosa</i> plants located at the new populations identified in 2017	24
Appendix 1	Description of all known natural <i>Eremophila resinosa</i> populations (DEC 2009).....	33

## EXECUTIVE SUMMARY

Edna May Operations Pty Ltd operates the Edna May Gold Project, a conventional open pit gold mine. The Project is located near the townsite of Westonia, 312 km east of Perth in the Avon Wheatbelt bioregion of Western Australia.

In accordance with the requirements of the Westonia Gold Mine Threatened Flora Management Plan, Edna May Operations Pty engaged Phoenix Environmental Sciences Pty Ltd to undertake a targeted survey of populations of the Threatened flora species *Eremophila resinosa* that surround the Edna May Gold Project. Assessments have been conducted annually since 2006.

The main objective of the survey was to monitor existing known populations and capture new populations and individual plants of *E. resinosa*. The assessments included the extent and condition of known *E. resinosa* populations, analysis of temporal and spatial changes within populations and survey for any new regional populations.

The survey was conducted by Dr Grant Wells and Alice Watt in September 2017. All known locations of *E. resinosa* plants in the 11 populations (six original, one added in 2015 and four regional populations discovered in 2016) were assessed during the field survey. Plant condition (alive, dead, stressed), plant dimensions (diameter, height), state (presence of flowers, new growth) and foliage cover (% branches with foliage) was recorded. Observations of any apparent disturbances to, or in the vicinity of, the plants were also recorded. Areas immediately surrounding the plants were searched for any individuals not previously recorded. In addition, searches were conducted for new populations in areas of suitable habitat at a number of 'regional' locations identified on the FloraBase and NatureMap databases.

A total of 259 living *E. resinosa* plants were identified from populations A-G during the 2017 survey, an overall increase of two plants since the 2016 survey. New plants were recorded at three populations, including population G. Population G, first recorded in 2015 was expanded by 13 individuals in 2016 and four in 2017. The numbers in populations A and B remained unchanged between the 2016 and 2017 monitoring periods while they increased in population D. The total number of living plants in population C decreased. One plant died in populations C and F. Except for population C, overall living plant numbers at populations A, B, D and F decreased slightly since 2010.

A search for additional populations based on historic FloraBase data resulted in five regional populations found in 2016 (38 plants) within 20 km radius of the Project (two of those were located by Edna May Operations staff) and four populations in 2017 (78 plants) within 100 km radius of the Project. Conducting searches in the vicinity of other historic records in the future may return additional individuals of *E. resinosa* in the future as the species is known from 80 locations within approximately 100 km of Westonia.

Data were compared with the regional populations between 2016 and 2017 monitoring periods. Trends observed in the mine-site populations (A-G) were reflected in the regional populations and there was no evidence of impacts from current mining activities on the extant populations. It remains apparent that the small number of deaths are a result of natural attrition. *Eremophila resinosa* is a disturbance species. Disturbance species are lost if disturbance frequencies are low and it may therefore be anticipated that the decline in some *E. resinosa* populations at the Edna May Gold Project will continue in the absence of disturbance/stochastic events.

## 1 INTRODUCTION

As a requirement of the Westonia Gold Mine Threatened Flora Management Plan (the management plan) (Outback Ecology 2007), populations of a Threatened species, *Eremophila resinosa* that surround the Edna May Gold Project (the Project) have been surveyed annually since January 2006 (MWH 2014).

In September 2017, Phoenix Environmental Sciences Pty Ltd (Phoenix) undertook the annual *Eremophila resinosa* survey for the Project. This report documents the survey undertaken between 29 August - 3 September 2017 at all known locations of *E. resinosa* plants in the 11 populations surveyed in 2016 (six surveyed since 2006, a population identified in 2015 and four regional populations included during the last, 2016 monitoring period) (Figure 1-2), and includes results of a search for additional populations based on historic FloraBase data within approximately 100 km of Westonia.

### 1.1 BACKGROUND

The Project is located 312 km east of Perth (Figure 1-1) in the Avon Wheatbelt bioregion of Western Australia. The Project operates on mining tenements L77/18, L77/233, G77/122, M77/88, M77/110 and M77/124.

Gold mining has been conducted historically at the Project since the 1950's. Current operations commenced in 2009 utilising conventional open pit mining by drill and blast, load and haul (Evolution Mining 2015). Processing of the ore utilises a carbon in leach (CIL) process and SAG mill Ball mill pebble Crusher Feed Forward circuit with a nominal treatment rate of 2.6 Mtpa.

Monitoring of *Eremophila resinosa* populations at the Project is conducted in accordance with the requirements of the management plan (Outback Ecology 2007). The management plan requires annual (spring) monitoring of known populations including recording:

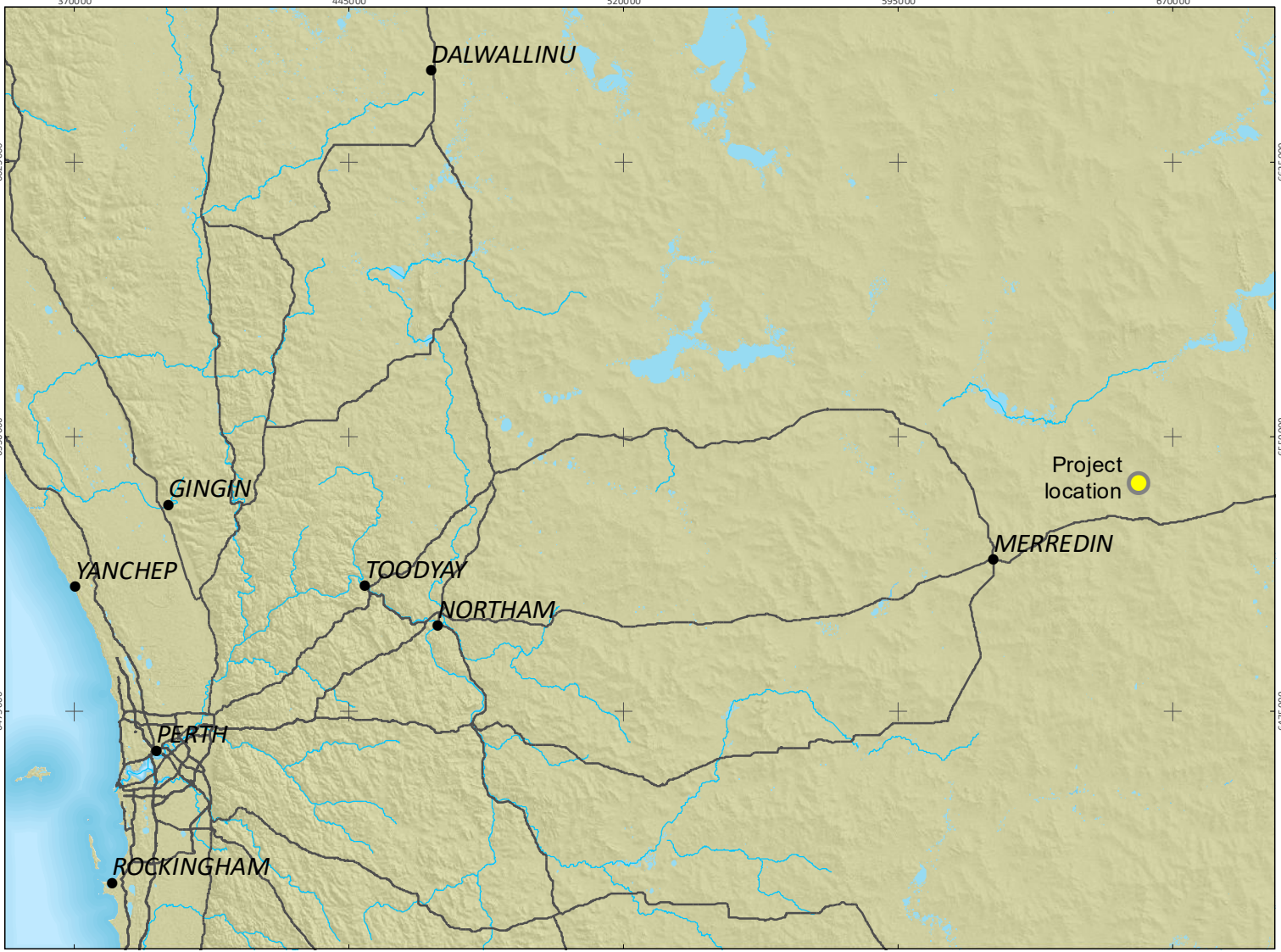
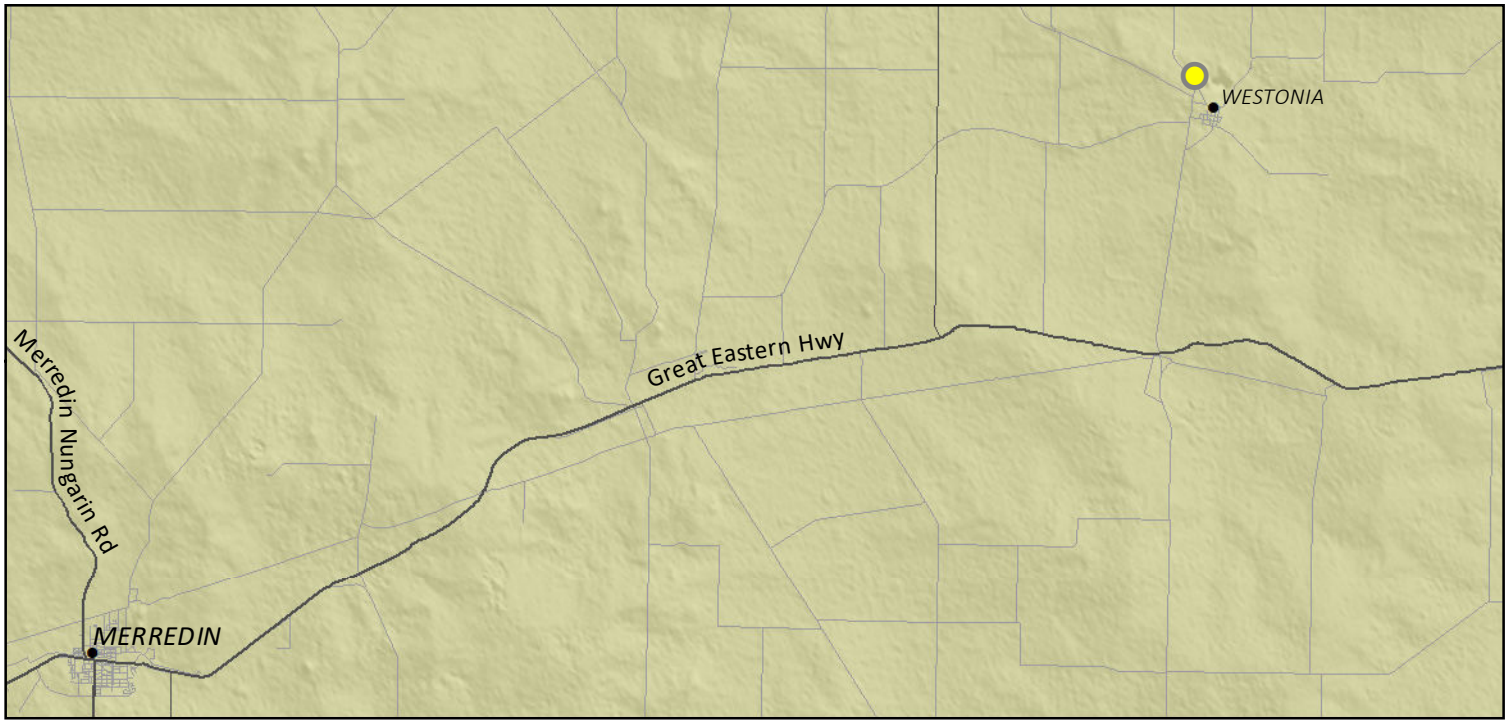
- location of populations
- number of plants at each population
- percentage of foliage cover
- health of each plant

The results of the monitoring programme contribute to regulatory reporting requirements including annual environmental reporting and clearing permit reporting obligations.

### 1.2 SCOPE OF WORK AND SURVEY OBJECTIVES

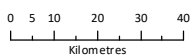
The scope of works as provided by Edna May Operations for the Project was to monitor existing known populations and document new populations of *Eremophila resinosa* with the following specific objectives:

- assess the extent and condition of known *E. resinosa* populations
- evaluate and map the condition, disturbances and any damage to individuals
- analyse temporal and spatial changes from the annual monitoring survey
- undertake a survey for regional populations
- present a comprehensive report detailing key findings, changes, impacts and details of regional populations identified.



Edna May Operations Pty Ltd  
Edna May Gold Project

Project No 1167  
Date 16/10/2017  
Drawn by GW  
Map author JC

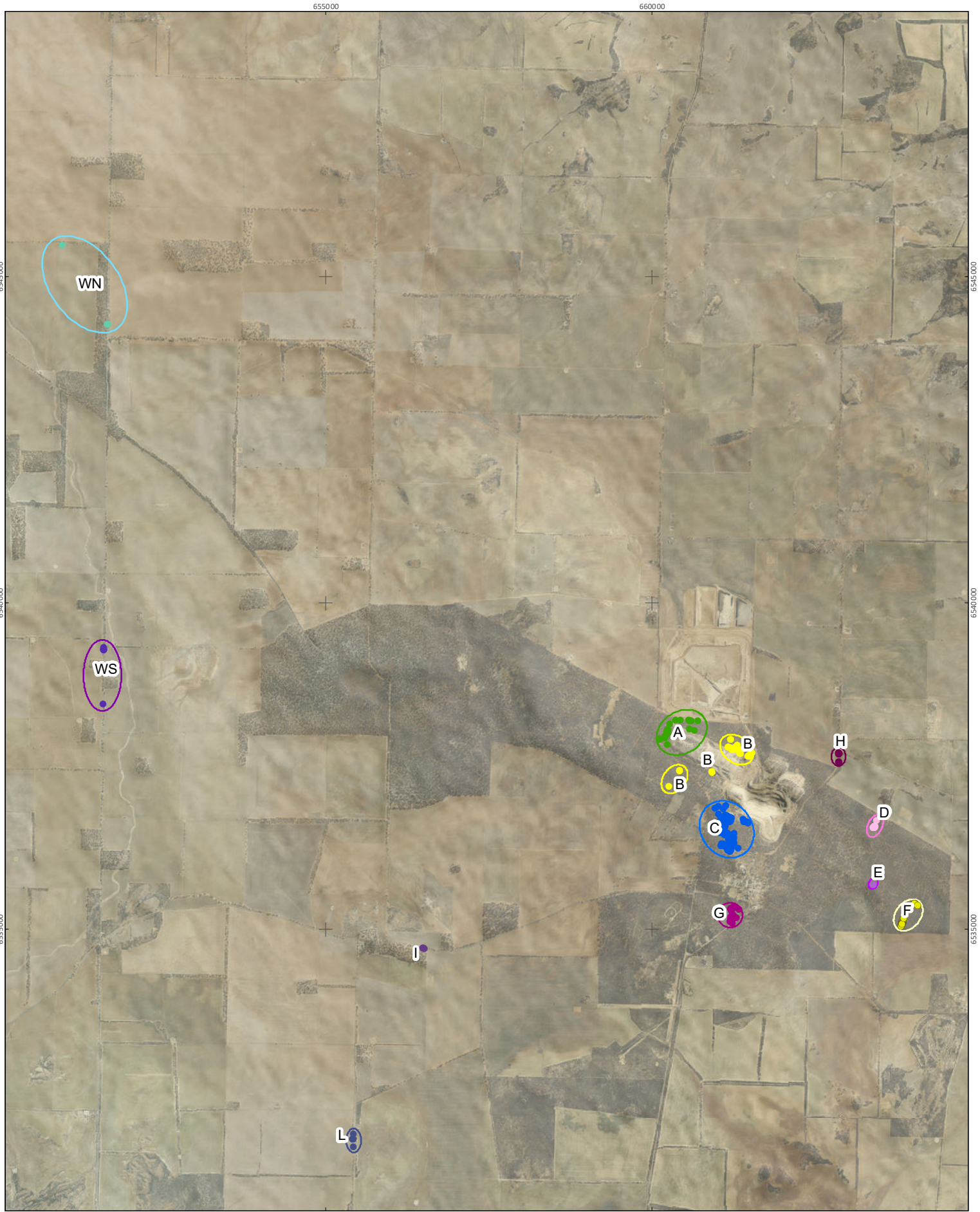


1:1,750,000(at A4) GDA 1994 MGA Zone 50

All information within this map is current as of 16/10/2017. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.

**Figure 1-1**  
**Location of the Edna May Gold Project**





Edna May Operations Pty Ltd Edna May Gold Project		
Project No	1167	
Date	16/10/2017	
Drawn by	GW	
Map author	GW	
1:74,600(at A4)		GDA 1994 MGA Zone 50

### Known *Eremophila resinosa* populations

- A
- B
- C
- D
- E

- F
- G
- H
- I
- L
- WN
- WS

**Figure 1-2**  
Known *Eremophila resinosa* populations and study area for the survey



The following deliverables were to be provided:

- spatial data containing *Eremophila resinosa* locations and habitats
- baseline data for all new *E. resinosa* plants and populations recorded during the field survey
- comprehensive report that details analysis of any temporal and spatial changes to *E. resinosa* populations, assessment and discussion of any changes to populations perceived to have arisen from impacts from the operation of the Project.

## **1.3 EREMOPHILA RESINOSA LIFE HISTORY AND ECOLOGY**

### **1.3.1 General biology and identification**

A recovery plan (DEC (2009) provides the following description of *Eremophila resinosa*:

*Eremophila resinosa* (Figure 1-3) is a spreading shrub 40-80 cm tall, 60-100 cm wide. Branches densely covered in short white tomentum (short woolly hairs) and sprinkled with resinous tubercles. Leaves 4-8 mm long by 2-3 mm wide; alternate, obovate, obtuse with a minute point, rather thick, flat, hoary with stellate hairs on both sides. Peduncles axillary, solitary, exceedingly short. Calyx-segments, linear-lanceolate. Corolla 15 mm long, funnel-shaped, the tube scarcely exceeding the calyx, the throat dilated with five free lobes, each 5 mm long, all pointed, the upper ones recurved, the lower ones spreading, all sprinkled outside with stellate tomentum; *throat* covered in long sparse hairs with a ring of numerous hairs occurring at the base. Flowers blue or purple, spotted inside; when young corolla is white. Four stamens not exceeding the length of the corolla. Ovary densely tomentose, four celled, with one ovule in each cell.

*Eremophila resinosa* has been described as a disturbance opportunist (Mr. R Dixon in MWH (2014)).

Historic observations of populations located near the Project recorded the species growing up to a diameter of 2 m (MWH 2014), however in 2016 an individual was recorded at a diameter of 2.75 m.

Flowering appears to occur all year round but with the main flowering time being October and November. Fruits mainly develop in December to January with records of limited fruiting occurring in November and March (DEC 2009).





Figure 1-3 *Eremophila resinosa* plants at the Edna May Gold Project

### 1.3.2 Taxonomy and nomenclature

*Eremophila resinosa*, common name Resinous Eremophila, is a member of the Scrophulariaceae family. The species name *resinosa* arises from the resinous tubercles (small rounded nodules or raised areas) located on plant stems.

### 1.3.3 Habitat and distribution

In 2008 *Eremophila resinosa* was known from 26 natural populations and 1,418 plants (Appendix 1) all of which occur in the central eastern Wheatbelt of Western Australia. Populations occur on road reserves, rail reserve, private property and shire reserves (DEC 2009). Currently, there are 80 records listed on NatureMap (DBCA 2017b).

*Eremophila resinosa* occurs on soil types from sandy loams to loams and clays in open mallee woodland with a mixed *Acacia* scrub understorey. Species associated with *Eremophila resinosa* include *Eucalyptus salubris*, *E. salmonophloia*, *E. longicornis*, *E. transcontinentalis*, *Acacia acuminata*, *A. erinacea*, *A. hemiteles* and *Eremophila oppositifolia*.

Historically in excess of 700 *E. resinosa* plants were recorded around the Project. Over the period 2008 to 2012 a total of 525 plants, including all plants at two populations were removed as a result of exploration and mining activities (Outback Ecology 2012). Of six original populations (A – F) (Figure 1-2), population B has been further divided into three sub-populations. The single plant at population E was recorded as dead in the 2013 survey. In 2016, a total of 235 plants were recorded (Table 1-1) at the populations.

Observations of the monitored populations (Outback Ecology 2007) indicate that *E. resinosa* prefers disturbed areas, colonises well in disturbed areas and where competition from other plants is removed, survives drought conditions and grows along road verges subject to dust and vehicle emissions. Natural regeneration of *Eremophila* plants follows disturbance and heavy rains. New individuals are most likely to be found within newly disturbed areas and roadsides (MWH 2014). At the Edna May Gold Project, populations occur in areas of historical disturbance including the base of waste landforms, along historic exploration grid lines, roadsides, and historic and current tracks (MWH 2014).

**Table 1-1 Summary of population size for *Eremophila resinosa* at the Edna May Gold Project (Phoenix 2016)**

Population	No. living individuals
Population A	33
Population B – total	24
Population B (NE Sub-population)	22
Population B (SW Sub-population)	1
Population B (WO Sub-population)	1
Population C	121
Population D	48
Population E	0
Population F	10
<b>Total</b>	<b>235</b>

### 1.3.4 Conservation status and threatening processes

In WA, the *Wildlife Conservation Act 1950* (Wildlife Conservation (WC) Act) provides for the listing of native flora (Protected or Declared Rare) species which are under identifiable threat of extinction. Protected flora listed under the WC Act receive statutory protection but they are also assigned to one of seven categories (schedules) (Western Australian Government 2015):

- Schedule 1 (S1) – flora that are considered likely to become extinct or rare as critically endangered (CR) flora
- Schedule 2 (S2) – flora that are considered likely to become extinct or rare as endangered (EN) flora
- Schedule 3 (S3) – flora that are considered likely to become extinct or rare as vulnerable (VU) flora
- Schedule 4 (S4) – flora presumed to be extinct (EX).

*Eremophila resinosa* is listed as Threatened (DBCA 2017a) and Schedule 2 protected flora by (Western Australian Government 2015). Nationally, it is listed as Endangered under the EPBC Act (1999).

The main threats to the species are road, rail and firebreak maintenance, farming operations including grazing and fence maintenance, weeds, degradation of habitat through activities such as traffic and rubbish dumping, inappropriate fire regimes, low seed set and poor recruitment. Monitoring of known populations by Department of Parks and Wildlife (DPaW) between 1993 and 2008 showed that none had a recruitment event in this period (DEC 2009).

It is considered that all known habitat is critical to the survival of the species and that all extant wild and translocated populations are important. Habitat critical to the survival of *E. resinosa* includes all extant populations, areas of similar habitat surrounding these populations and similar habitat that may contain the species or be suitable for future translocations.

A translocation programme for *Eremophila resinosa* was initiated in 2004 when five clones of the species were planted at Westonia. Since the initial translocation, multiple plantings of seed risen plants (seedlings) have successfully been established with over 4000 plants and survival rates of around 80% (BGPA 2015). Approximately 2,000,000 fruit have been placed in long term storage as a further resource for future translocation requirements.

## 2 METHODS

### 2.1 DESKTOP REVIEW

The most recent annual survey of the known *Eremophila resinosa* populations and several websites were reviewed prior to the field survey (Table 2-1). The primary aims of the review were to:

- inform the previous extent and condition of the *Eremophila resinosa* populations
- inform the biology and preferred habitat of *E. resinosa* to facilitate field searches for new individuals in extant populations and for new populations
- update the current conservation status for the species
- identify prospective search areas for new populations from vegetation and habitat mapping

**Table 2-1 Literature reviewed for the current survey of *Eremophila resinosa***

Reference	Description
DBCA (2017a)	FloraBase available at <a href="https://florabase.dpaw.wa.gov.au/">https://florabase.dpaw.wa.gov.au/</a>
(DPaW 2017)	Conservation codes for Western Australian flora and fauna available at <a href="https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf">https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf</a>
Outback Ecology (2007)	<i>Westonia Gold Mine. Threatened Flora Management Plan</i>
DEC (2009)	<i>Resinous Eremophila (Eremophila resinosa) Recovery Plan</i>
Evolution Mining (2015)	Edna May available at <a href="http://www.evolutionmining.com.au/edna-may/">http://www.evolutionmining.com.au/edna-may/</a>
BGPA (2015)	<i>Eremophila translocation</i> available at <a href="http://www.bgpa.wa.gov.au/about-us?catid=0&amp;id=1178">http://www.bgpa.wa.gov.au/about-us?catid=0&amp;id=1178</a>
Phoenix (2016)	Targeted <i>Eremophila resinosa</i> survey of the Edna May Gold Project

### 2.2 FIELD SURVEYS

The spring 2017 survey was conducted from 29 August - 3 September. The field methods are as described in Phoenix (2016) and MWH (2014), and continued to be strictly complied with.

#### 2.2.1 Survey of extant populations

A GPS unit was used to locate all records (living and dead) of *Eremophila resinosa* plants in populations at the Project. Plant identity was confirmed in the field from the plant tag and stake placed at each location. Plant dimension and condition data recorded are summarised in Table 2-2. The location of any new plants sighted during the field survey was recorded with a handheld GPS, the plant assigned a unique field code and demarked with a stake and identity tag.

A description of any apparent recent disturbance/impact (i.e. within the monitoring period) on the populations and individual plants was also recorded.

**Table 2-2 Parameters recorded for individual *Eremophila resinosa* plants at the Edna May Gold Project**

Parameter	Details recorded
Plant health	<ul style="list-style-type: none"> <li>• plant condition; alive, dead or showing signs of stress</li> <li>• percentage of branches containing live foliage (%)</li> <li>• presence of new growth</li> <li>• presence of flowers or flower buds</li> </ul>
Plant dimensions	<ul style="list-style-type: none"> <li>• maximum diameter of living foliage (m)</li> <li>• perpendicular diameter (m)</li> <li>• height (cm)</li> </ul>

All data analyses conducted for the current assessment follows the previous assessment methodology (Phoenix 2016).

## 2.2.2 Survey for regional natural populations

Areas in the vicinity of extant populations included in the monitoring program were systematically searched. Areas of disturbance, including historic and recent disturbances, were specifically targeted and searched by foot.

The locations of any new plants sighted in these populations were recorded, the plant assigned a unique field code, demarked with a stake and identity tag, and dimension and condition data were recorded.

A number of 'regional' populations identified in the literature review within 100 km circumference from the mine were surveyed. Roadside foot searches were conducted in the immediate vicinity of the known population record, between Declared Rare Flora markers observed in the field and in other areas of suitable roadside remnant vegetation.

The location of plants identified in the regional populations were recorded and the plant assigned a unique field code. In the majority of cases dimension and condition data were also recorded. In addition, a relevé vegetation survey for each regional population was completed (Table 2-3).

**Table 2-3 Data collected for relevés completed at new regional populations**

Environmental data	Biological data
Habitat type	Total Vegetation Cover (%)
Topography	Tree/shrub cover >2m (%)
Slope	Shrub cover <2m (%)
Soil Texture	Grass cover (%)
Soil Colour	Herb cover (%)
Rock Type	Disturbance
	Fire History
	Vegetation Description

Environmental data	Biological data
	Vegetation Condition (Keighery 1996-4 in EPA 2016 (EPA 2016))
	Site Photo
	Species – names
	Species – cover (%)
	Species – height (m)
	Species – number of individuals (if protected under Environmental and Protection and Biodiversity and Conservation (EPBC) Act or WC Act or DPaW Priority species.)

## 2.3 DATA ANALYSIS

All data analyses conducted for the current assessment follows the previous assessment methodology (Phoenix 2015). A new parameter introduced in 2016, termed Foliage-Cumulative Volume, replaced the Cumulative Volume to increase accuracy of current measures by taking into account the growth habit of the species. *E. resinosa* plants can die-off in the centre, while continuing to grow at the extremities. The measure of cumulative volume only shows increasing plant volume at extremities when in reality the volume of living foliage may remain unchanged or decrease. Multiplying the cumulative volume with the proportion of foliage cover overcomes the over-estimation of cumulative volume as is countered by the decreasing foliage cover value.

It is derived by multiplying Cumulative Volume (m<sup>3</sup>) by Foliage Cover (as an integer).

$$FCV = \text{Foliage cover (\%)} \times \text{Cumulative Volume (m}^3\text{)}$$

## 2.4 PROJECT PERSONNEL

The personnel involved in the survey are presented (Table 2-4).

**Table 2-4 Project team**

Name	Qualifications	Role/s
Dr Grant Wells	PhD (Botany)	Project manager, field survey and reporting
Alice Watt	Ba.Sci (Botany and Cons. Bio.) (Hons)	Field survey, reporting
Dr Grace Wells	PhD (Botany)	Field pre-mobilisation logistics, GIS, reporting
Anna Leung	Ba.Sci (Env. Sci.) (Hons)	GIS and map production

### 3 RESULTS

#### 3.1 CLIMATE DATA

The closest Bureau of Meteorology (BoM) station is located approximately 55 km west of the Project at Merredin (station number 010092).

Annual rainfall in three of the five years prior to the current survey was below average with higher than average rainfall occurring in 2015 and 2016 (Figure 3-1). In the immediate 12 months prior to the field survey (August 2016 to July 2017), Merredin received below average rainfall (277.9 mm of rainfall, in comparison with the long term annual average of 326.5 mm) (BoM 2017). Below average rainfall was also recorded in the four months prior to the field survey (Figure 3-2) following very high falls in the summer months (December 2016 to February 2017).

Mean average maximum temperatures three months prior to the survey were above average and minimum temperatures were in line with the average temperatures (Figure 3-2).

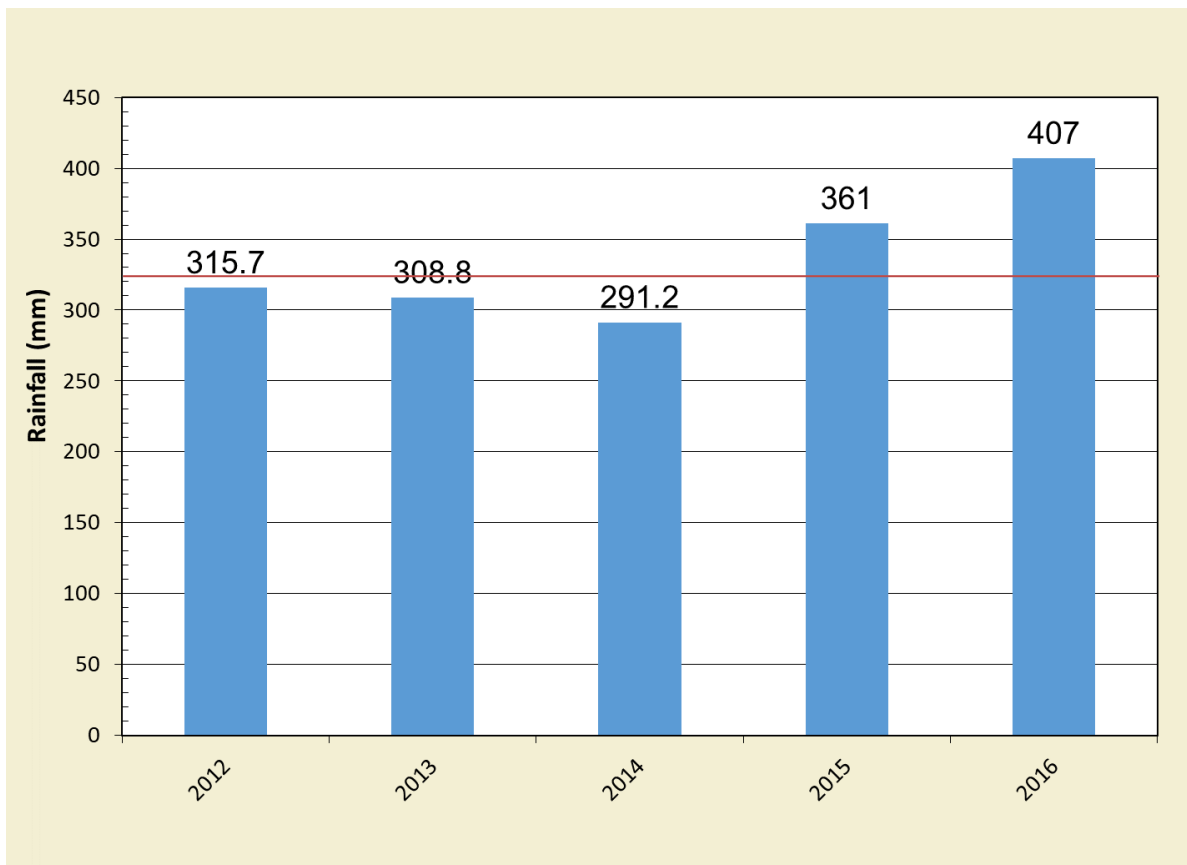


Figure 3-1 Mean annual rainfall and annual rainfall totals for Merredin (010092) from 2012 to 2016. Red line represents mean rainfall from 2010 to 2017.

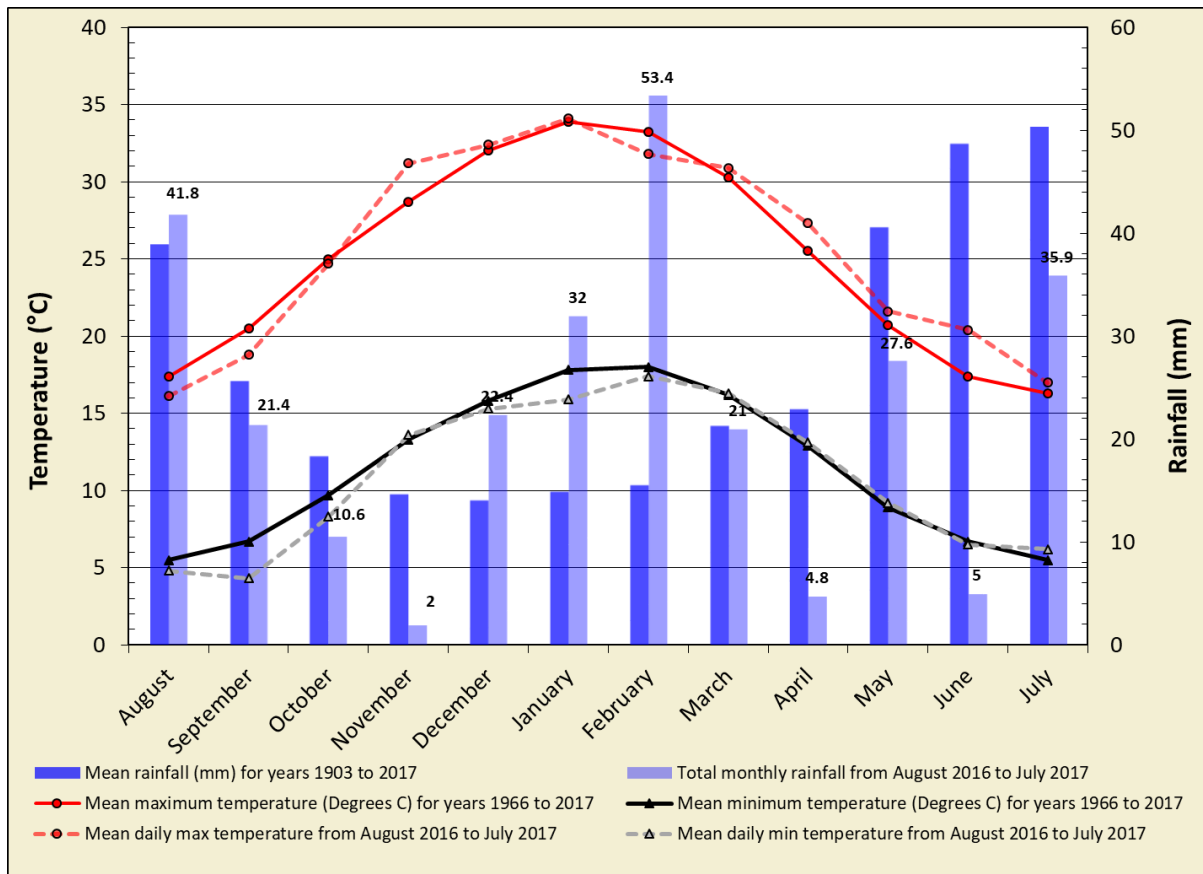


Figure 3-2 Rainfall and temperature means recorded at Merredin in the 12 months prior to the survey compared to the long term averages

### 3.2 ANNUAL CHANGES TO *E. RESINOSA* POPULATIONS 2016-2017

#### 3.2.1 Number of living plants in populations A, B, C, D, F and G

A total of 259 living *E. resinosa* plants were identified from populations A-G during the 2017 survey which is an overall increase of two plants from the total of 257 living plants identified in the 2016 survey (Figure 3-3; Table 3-1). New plants were recorded in population D (1), F (2) and G (4).

Overall living plant numbers in populations A, B, D and F decreased slightly since 2010 (Figure 3-3). The numbers in population C fluctuated over the years but were higher in 2017 than they were in 2010.

Between the 2016 and 2017 monitoring periods, the numbers in populations A and B remained unchanged while they increased in population D (from 48 to 49) (Table 3-1). In population F two new plants were recorded, one had died and one could not be found resulting in no net change to plant numbers since 2016. The total number of living plants in population C decreased to 118 with one plant recorded as dead and two not found in 2017. The number of individuals in population G increased in 2017 from 21 to 25. Data for new plants recorded in 2017 are summarised in Table 3-2.



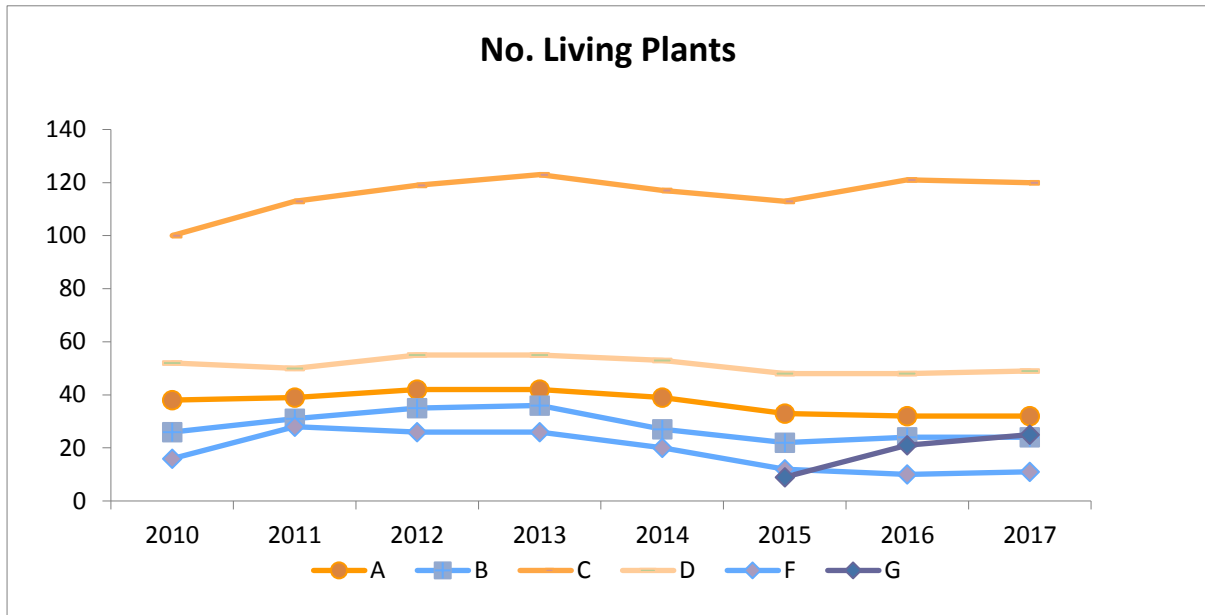


Figure 3-3 Number of live *Eremophila resinosa* plants recorded annually

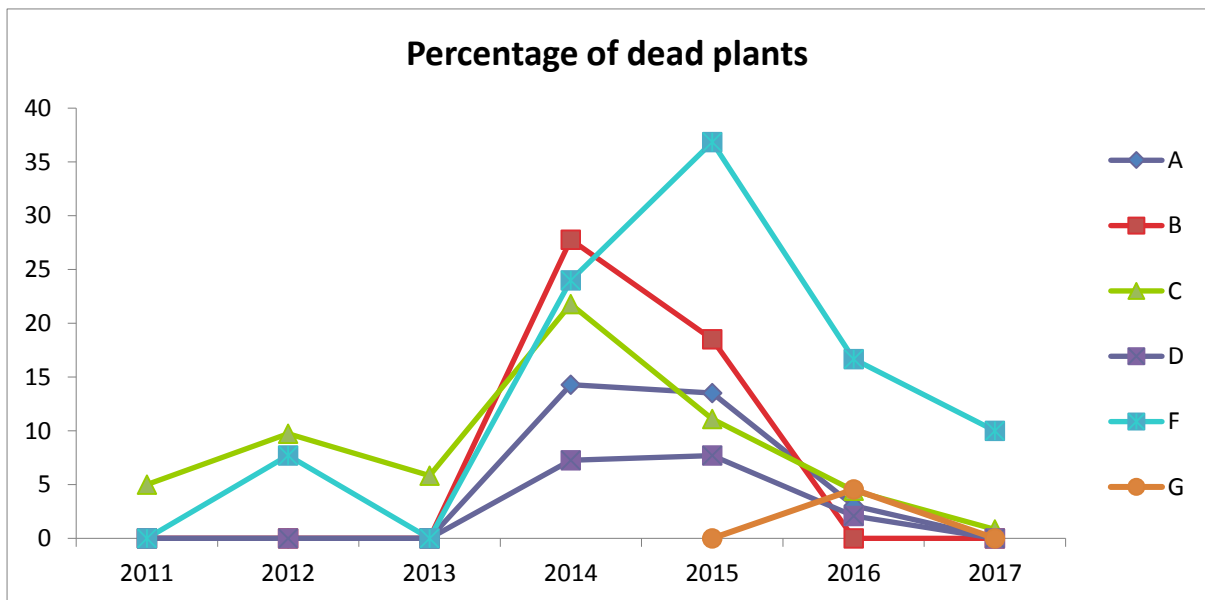
Table 3-1 Summary of *Eremophila resinosa* plant records in 2017 in comparison with previous monitoring period

Population	Total Living plants 2016	Total Living plants 2017 found	Total Dead plants 2016	Total Dead plants 2017	New plants 2017	Died between 2016-2017
A	33	33	26	26	0	0
B	24	24	21	21	0	0
C	121	118	63	64	0	1
D	48	49	12	12	1	0
F	10	10	19	20	2	1
G	21	25	1	1	4	0
Total	257	259	142	144	7	2

**Table 3-2** Data recorded for new *Eremophila resinosa* plants located at population D, F and G in 2017

Plant identification		Co-ordinates		Floristics			Plant dimensions and height		
Code	Plant tag	Latitude	Longitude	Flowering	Growth	% living foliage	Diam. 1	Diam. 2	Height(m)
D2017	261	-31.2939	118.717		G	50	0.1	0.11	0.22
F2017	351	-31.3072	118.7217		G	100	0.03	0.02	0.08
F2017a	311	-31.3072	118.7216	F	G	100	0.41	0.22	0.53
G2017-024		-31.3058	118.6942		G	50	0.73	0.66	0.35
G2017-025		-31.3064	118.6944		G	80	0.33	0.29	0.37
G2017-026		-31.3064	118.6943		G	50	1.12	0.63	0.79
G2017-027		-31.3066	118.6941	F	G	100	0.32	0.29	0.37

The proportion of plant deaths recorded at all populations decreased in comparison with the previous monitoring period and were the lowest for the last three monitoring periods (Figure 3-4).



**Figure 3-4** Proportion (%) of living *Eremophila resinosa* plants from the previous monitoring period recorded as dead in the subsequent monitoring period

The proportion of plant death has varied substantially since 2010 monitoring period, both within and between populations (Figure 3-5). For example, while less than 20% of plants recorded alive in 2010 were dead by 2017 at population D, over 80% of plants alive in 2010 were dead by 2017 in the nearby population F. Small proportion of plants could not be found at populations C and D.

Population C is the largest population in the monitoring programme followed by population D (Table 3-1).

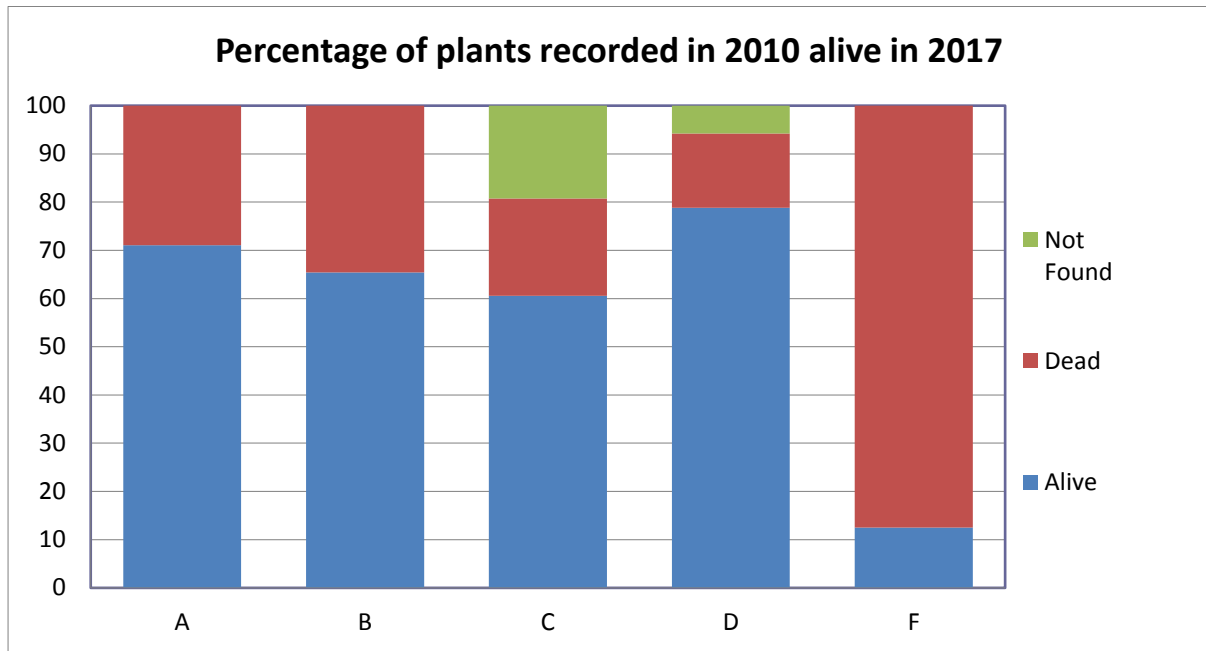


Figure 3-5 Proportion (%) of *Eremophila resinosa* plants recorded alive in 2010 still living or dead by 2017.

### 3.2.2 Proportion of plants flowering and/or exhibiting new growth

The proportion of flowering plants has fluctuated substantially between monitoring periods (Figure 3-6). The proportion of plants flowering in all populations (except population B) in 2015 was the highest recorded since 2011, and in 2016 it was higher again. The values decreased dramatically in all populations (except population F) in 2017. Population F recorded an increase in the proportion of flowering plants since the 2015 period.

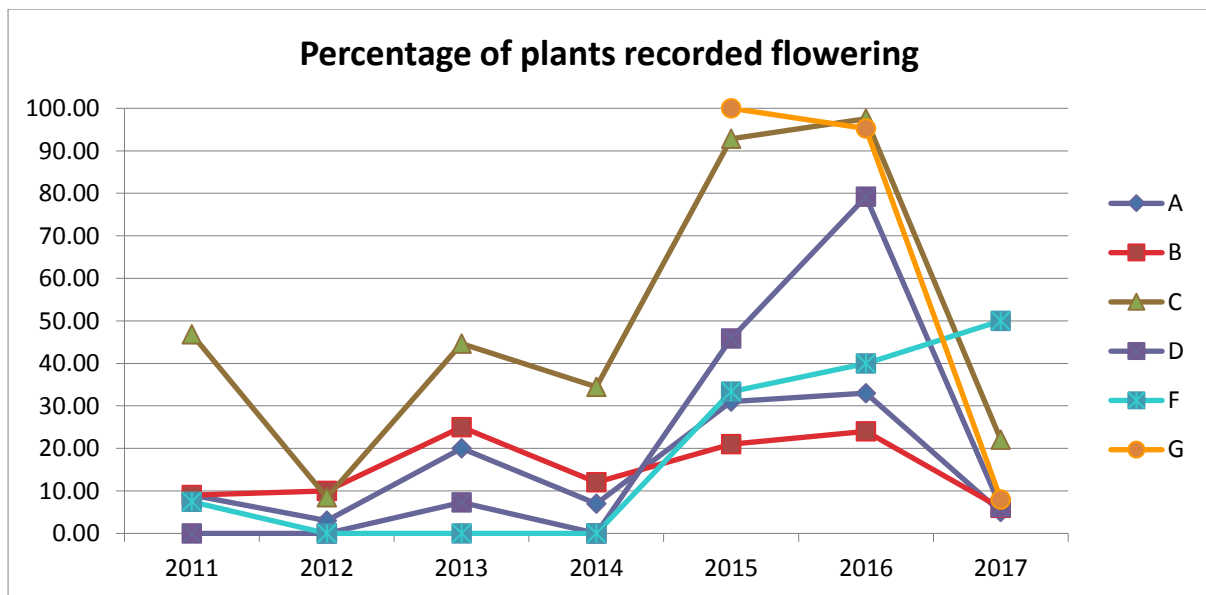


Figure 3-6 Proportion (%) of *Eremophila resinosa* plants recorded flowering

The majority of plants exhibited new growth across each of the monitoring periods until 2016 (Figure 3-7). The values decreased in the 2017 monitoring period.

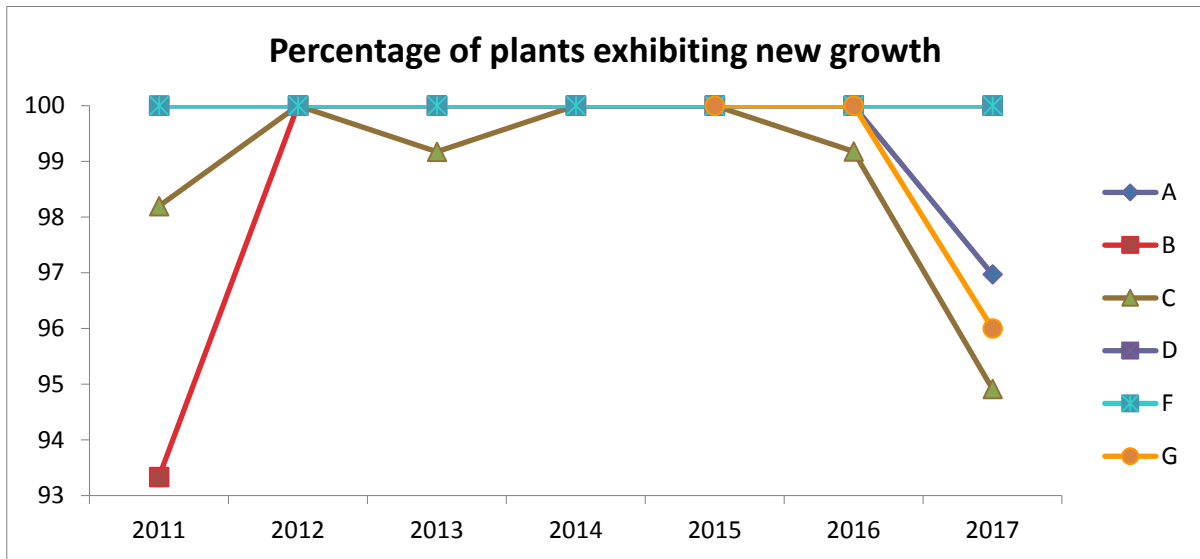


Figure 3-7 Proportion of *Eremophila resinosa* plants recorded exhibiting new growth

### 3.2.3 Foliage cumulative volume of populations and proportion of living foliage

Foliage cumulative volume was introduced in 2016 (Phoenix 2016) as an expansion of the standard cumulative volume to factor in the growth habit of the species over time. The measure ‘foliage cumulative volume’ multiplies the cumulative volume by the foliage cover.

The volume of foliage across all populations (except population C) have remained stable from year to year (Figure 3-8). Population C recorded a large increase in 2016, since the peak in 2012, and then decreased from 2016 to 2017. Despite the increase in cumulative volume across the populations, the trend toward lower average foliage cover (%) evident since 2011 has continued (Figure 3-9).

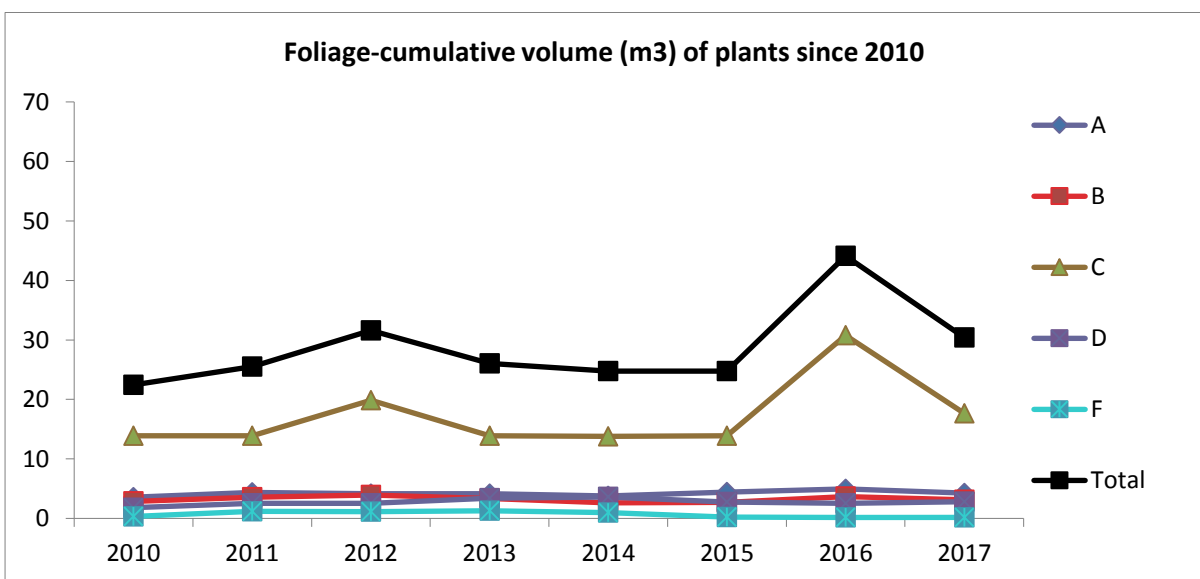


Figure 3-8 Foliage-cumulative volume of *Eremophila resinosa* plants at each population since 2010

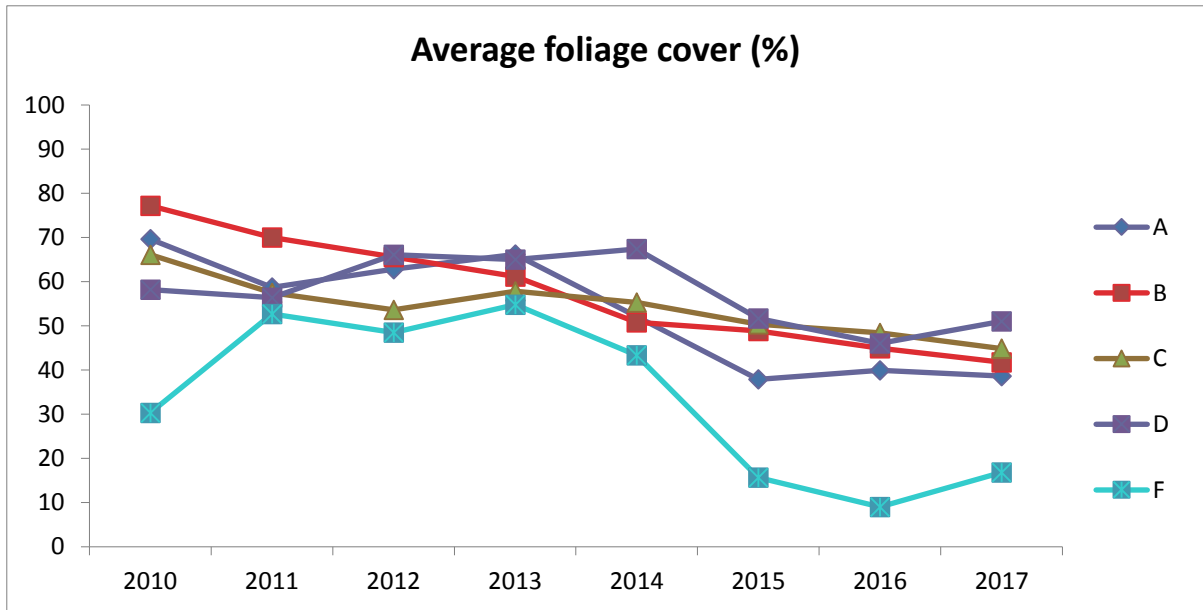


Figure 3-9 Average proportion (%) of living foliage on *Eremophila resinosa* plants since 2010

### 3.3 REGIONAL *EREMOPHILA RESINOSA* POPULATIONS

#### 3.3.1 Number of living plants in populations H, I, L, WN and WS

A total of 30 living plants of *Eremophila resinosa* were recorded at five regional populations (H, I, L, WN and WS) in 2016 located within ~20 km of Westonia (Figure 3-14). All individuals were growing on disturbed roadsides. Two plants were recorded as dead in the current (2017) monitoring period, one at population H and one at population L (Table 3-3). Similar to the local populations A-F and G, overall living plant numbers at the regional populations decreased since the last monitoring period (Figure 3-10).

Table 3-3 Summary of *Eremophila resinosa* regional plant records in 2017 in comparison with previous monitoring period

Population	Total Living plants 2016	Total Living plants 2017 found	New plants 2017	Died between 2016-2017
H	13	12	0	1
I	3	3	0	0
L	5	4	0	1
WN	2	2	0	0
WS	7	7	0	0
Total	30	28	0	2

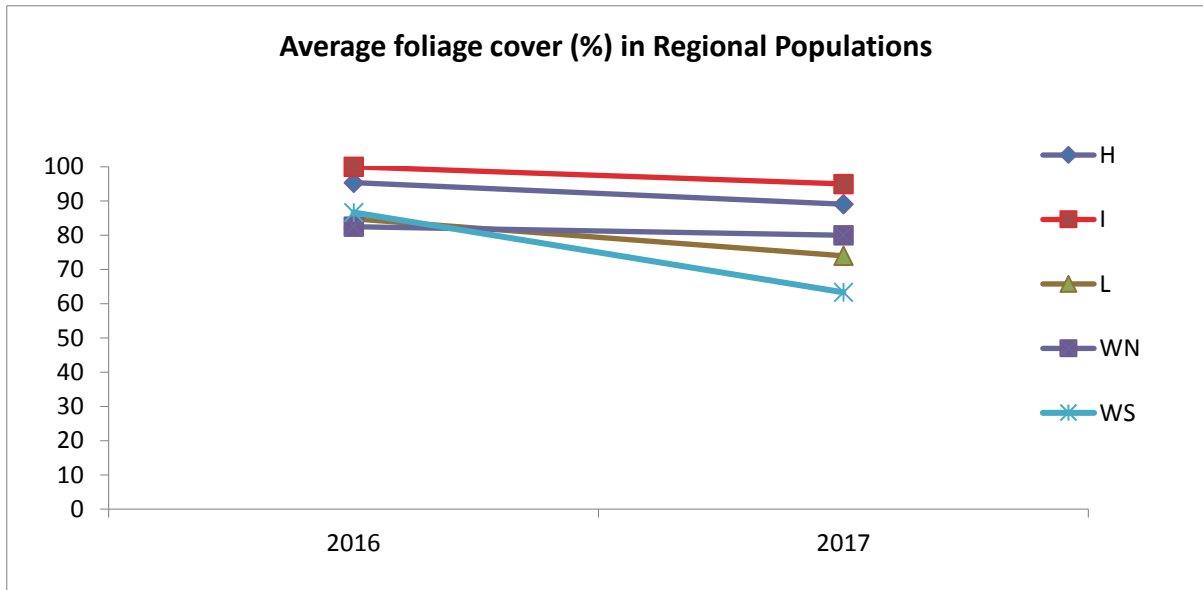


Figure 3-10 Number of live *Eremophila resinosa* plants recorded annually in regional populations

### 3.3.2 Proportion of plants flowering in regional populations

Similar to the local populations A-F and G, flowering decreased markedly at the regional populations since the last monitoring period (Figure 3-11).

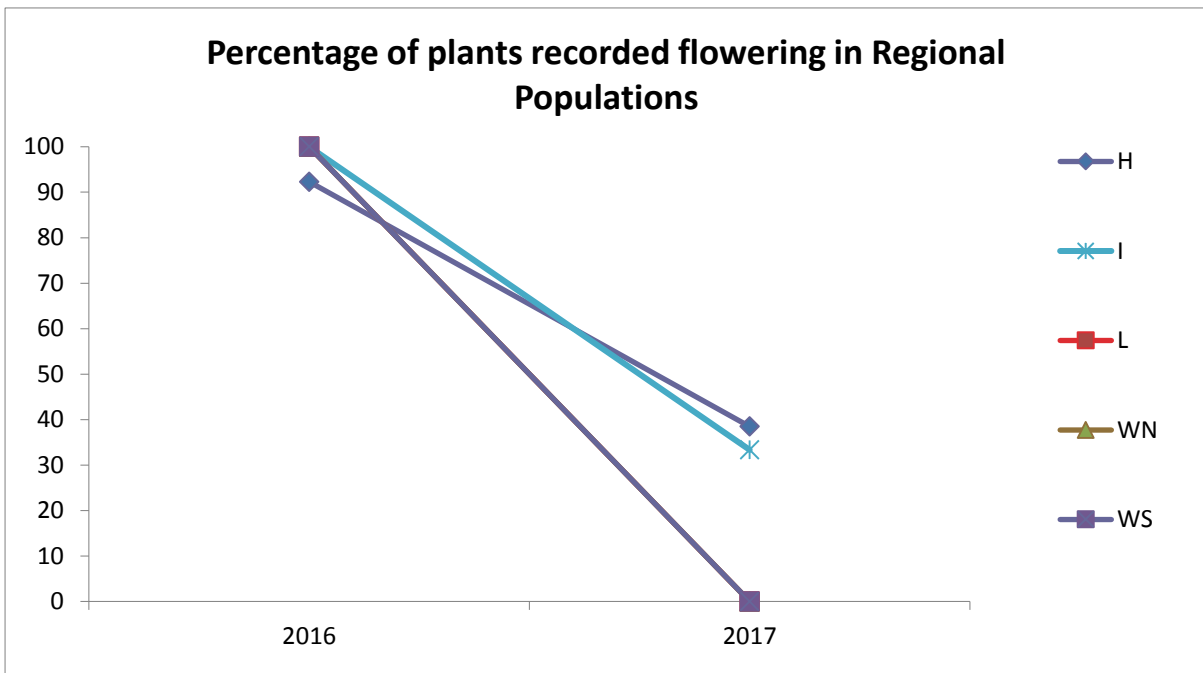


Figure 3-11 Proportion (%) of *Eremophila resinosa* plants recorded flowering in regional populations

### 3.3.3 Foliage cumulative volume of populations and proportion of living foliage in regional populations

The total foliage cumulative volume in regional populations decreased slightly between 2016 and 2017 monitoring periods (Figure 3-12). The values in some populations increased slightly but decreased in others. This reflects the trend of lower foliage cover (%) evident in the mine site populations A-G over the same period (Figure 3-13).

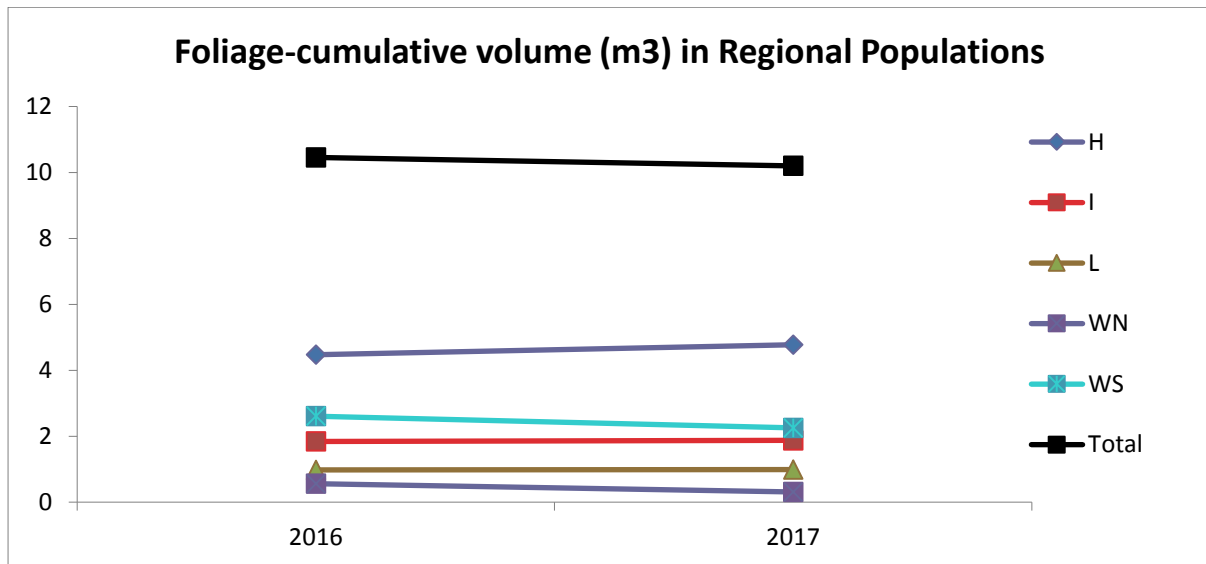


Figure 3-12 Foliage-cumulative volume of *Eremophila resinosa* plants at each regional population

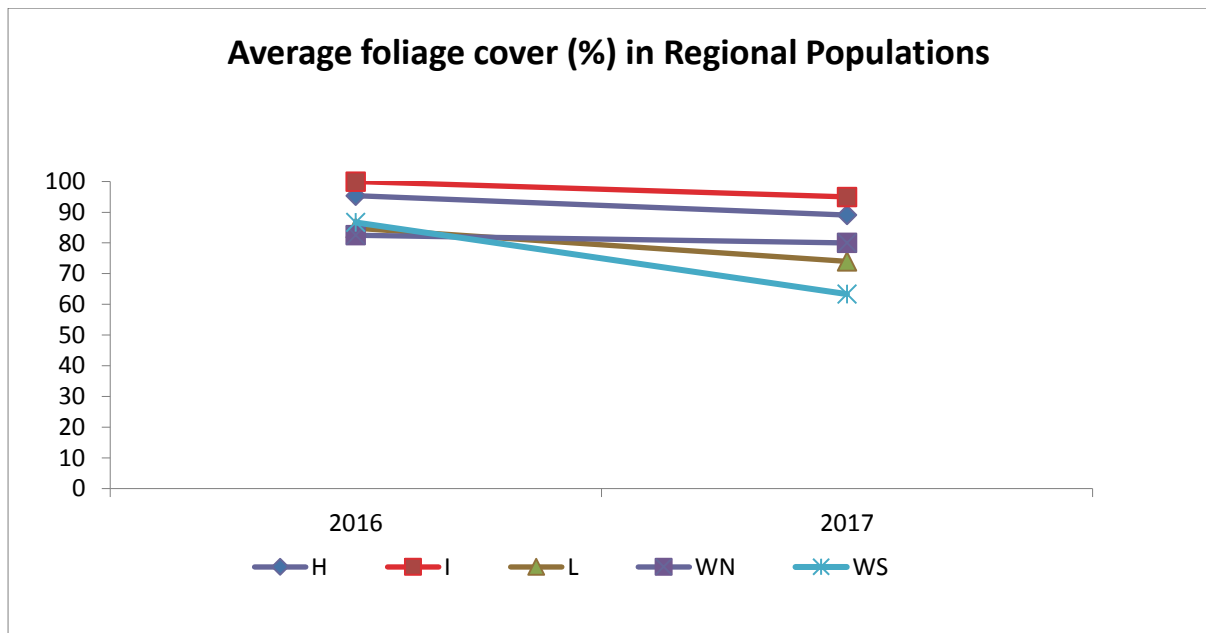


Figure 3-13 Average foliage cover (%) of *Eremophila resinosa* in regional populations

### 3.3.4 New regional *Eremophila resinosa* populations

The survey for new regional populations of *Eremophila resinosa* located an additional 78 individuals at four new populations (GR, WNN, WB and LM) in 2017, the data for which are summarised in Table 3-4.

All individuals from the new populations are located within ~100 km of Westonia. The plants are growing on road-verges that can be considered disturbed areas.

**Table 3-5 Data recorded for *Eremophila resinosa* plants located at the new populations identified in 2017**

Popul- ation	Plant code	Co-ordinates GDA 94, Zone 50 J		Flowering	Growth	Living foliage (%)	Plant dimensions and height (m)		
		Eastings	Northings				Diam. 1	Diam. 2	Height
GR	GR2017-001	551680.9622	6580349.0304		G	100	0.71	0.37	0.59
GR	GR2017-002	551680.0186	6580313.0101		G	80	0.67	0.15	0.29
GR	GR2017-003	551679.9782	6580009.0101		G	90	1.12	0.61	0.83
GR	GR2017-004	551675.9702	6580010.0236		G	40	0.75	0.4	1.3
GR	GR2017-005	551675.9654	6580009.0296		G	85	1.1	0.78	0.9
GR	GR2017-006	551677.9710	6580008.0258		G	95	1.15	0.87	1.22
GR	GR2017-007	551679.0105	6580006.0235		G	100	0.35	0.27	0.53
GR	GR2017-008	551679.9685	6580007.0129		G	99	0.6	0.5	0.84
GR	GR2017-009	551679.9540	6580004.0217		G	95	0.2	0.14	0.4
GR	GR2017-010	551679.0008	6580004.0263		G	50	0.42	0.26	0.6
GR	GR2017-011	551679.0269	6579949.9425			50	0.18	0.1	0.55
GR	GR2017-012	551678.9834	6579940.9691		G	100	0.39	0.24	0.68
GR	GR2017-013	551679.0456	6579933.9830		G	50	0.77	0.17	0.67
GR	GR2017-014	551679.0456	6579933.9830		G	98	1.24	0.38	0.88



*Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

Popul- ation	Plant code	Co-ordinates GDA 94, Zone 50 J		Flowering	Growth	Living foliage (%)	Plant dimensions and height (m)		
		Eastings	Northings				Diam. 1	Diam. 2	Height
GR	GR2017-015	551677.0111	6579929.0044		G	98	0.41	0.3	0.73
GR	GR2017-016	551680.0127	6579917.0249		G	95	0.88	0.72	0.72
GR	GR2017-017	551678.9585	6579916.0267		G	100	0.41	0.29	0.46
GR	GR2017-018	551680.9512	6579914.0291		G	100	0.85	0.46	0.65
GR	GR2017-019	551680.0030	6579915.0277		G	100	0.93	0.52	0.81
GR	GR2017-020	551679.9885	6579912.0365		G	60	0.3	0.37	0.66
GR	GR2017-021	551679.0256	6579910.0439		G	100	0.5	0.4	0.48
GR	GR2017-022	551679.0111	6579907.0527		G	80	1.1	0.7	0.54
GR	GR2017-023	551676.0278	6579902.9705		G	90	1.15	0.7	1.06
GR	GR2017-024	551678.0205	6579900.9636		G	90	0.9	0.54	0.83
GR	GR2017-025	551678.0108	6579898.9664			80	0.38	0.17	0.57
GR	GR2017-026	551677.9624	6579888.9896		G	100	0.6	0.4	0.45
GR	GR2017-027	551676.9803	6579883.0120		G	100	1.1	0.9	1.44
GR	GR2017-028	551676.9803	6579883.0120		G	60	1.12	0.76	1.05
GR	GR2017-029	551678.0102	6579879.0217		G	90	0.41	0.44	0.79
GR	GR2017-030	551676.9658	6579880.0208		G	50	0.96	0.56	1.2
GR	GR2017-031	551680.0108	6579877.0148		G	80	0.67	0.6	1.3
GR	GR2017-032	551678.0289	6579863.0622		G	100	0.84	0.8	0.65

*Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

Popul-ation	Plant code	Co-ordinates GDA 94, Zone 50 J		Flowering	Growth	Living foliage (%)	Plant dimensions and height (m)		
		Eastings	Northings				Diam. 1	Diam. 2	Height
GR	GR2017-033	551680.0247	6579860.0614		G	100	0.62	0.7	0.57
GR	GR2017-034	551677.9945	6579855.9652		G	80	0.5	0.21	0.76
GR	GR2017-035	551676.9452	6579855.9703		G	100	0.7	0.48	0.73
GR	GR2017-036	551677.9848	6579853.9680		G	60	0.6	0.18	0.82
GR	GR2017-037	551678.0287	6579507.9600		G	50	0.28	0.2	0.89
GR	GR2017-038	551675.0267	6579499.9948		G	80	0.5	0.4	0.72
GR	GR2017-039	551677.0186	6579378.9609		G	80	1.78	1.66	1.17
GR	GR2017-040	551680.0096	6579345.0396		G	100	1.4	1	1.24
GR	GR2017-041	551680.0423	6579331.9596		G	100	0.74	0.7	0.77
GR	GR2017-042	551677.0258	6579321.0034		G	90	1	0.57	0.5
GR	GR2017-043	551676.0388	6579314.0224		G	50	1.24	1	0.9
GR	GR2017-044	551675.0041	6579279.0059		G	40	0.74	0.2	1.2
GR	GR2017-045	551679.0110	6579258.0385		G	100	0.72	0.72	0.91
GR	GR2017-046	551657.9523	6579525.0201		G	70	0.47	0.21	0.55
GR	GR2017-047	551659.9648	6579546.9522		G	40	0.67	0.39	0.91
GR	GR2017-048	-30.9156	117.5405		G	100	0.17	0.11	0.31
GR	GR2017-049	551646.9727	6579626.0321		G	100	0.21	0.17	0.45
GR	GR2017-050	551648.0220	6579626.0270		G	100	0.17	0.14	0.33

*Eremophila resinosa* survey of the Edna May Gold Project

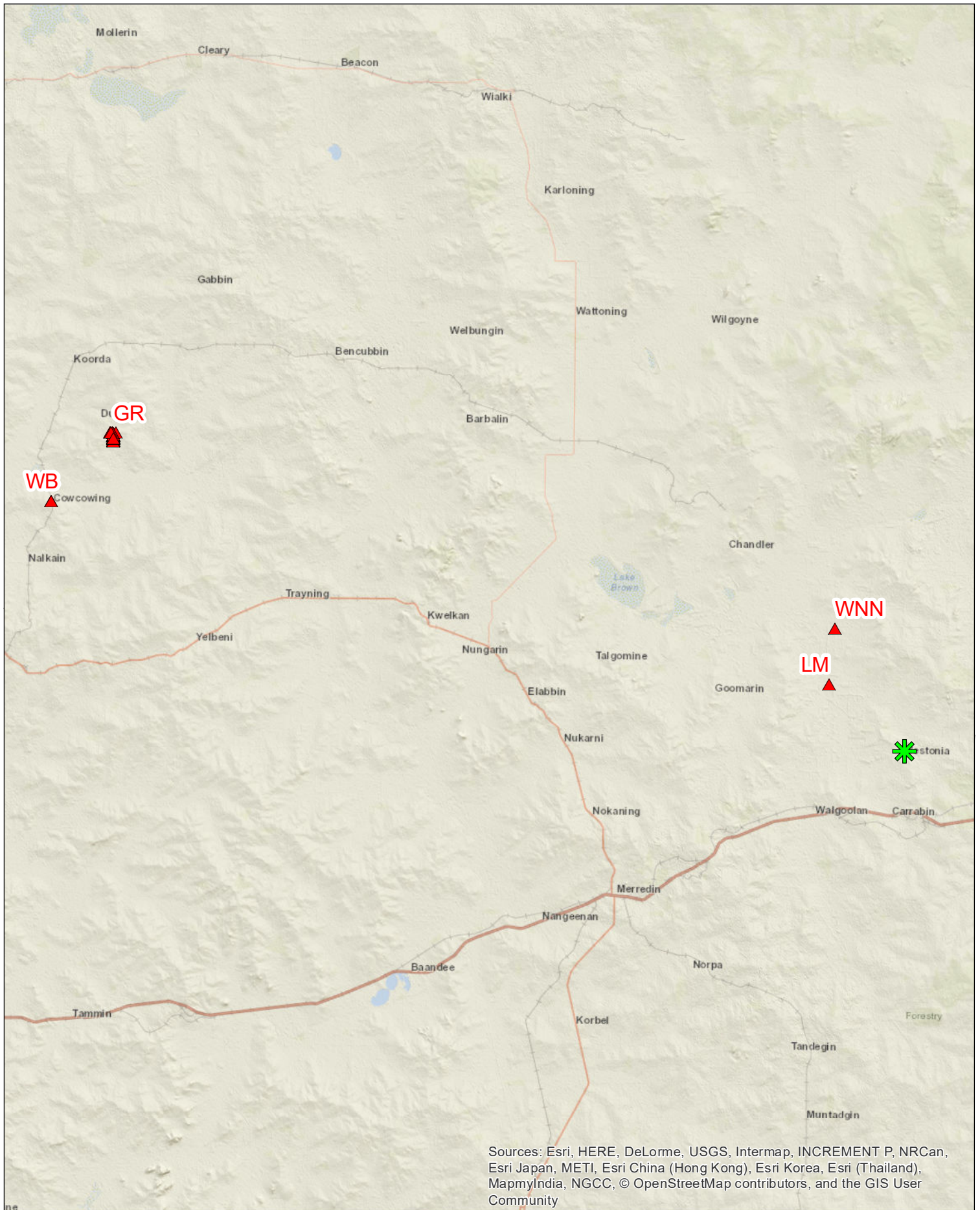
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Popul- ation	Plant code	Co-ordinates GDA 94, Zone 50 J		Flowering	Growth	Living foliage (%)	Plant dimensions and height (m)		
		Eastings	Northings				Diam. 1	Diam. 2	Height
GR	GR2017-051	551646.0294	6579628.0339		G	90	0.82	0.36	0.75
GR	GR2017-052	551642.9699	6579628.0488		G	100	0.9	0.02	0.2
GR	GR2017-053	551642.9651	6579627.0548			30	0.9	0.06	0.22
GR	GR2017-054	551642.0265	6579630.0506		G	100	0.22	0.14	0.33
GR	GR2017-055	551642.9989	6579634.0310		G	100	0.1	0.1	0.38
GR	GR2017-056	551641.9546	6579635.0394		G	100	0.47	0.4	0.47
GR	GR2017-057	551641.9546	6579635.0394		G	100	0.16	0.14	0.52
GR	GR2017-058	551633.0398	6579629.9826			100	0.22	0.22	0.33
GR	GR2017-059	551658.9784	6579659.0075		G	100	0.34	0.3	0.34
GR	GR2017-060	551664.0074	6579828.9911		G	90	1.36	0.6	1.25
GR	GR2017-061	551664.9733	6579829.9804		G	95	0.5	0.35	1.02
GR	GR2017-062	551663.0373	6579884.9653		G	50	0.54	0.2	1.04
GR	GR2017-063	551665.9800	6579959.9827		G	100	0.23	0.14	0.29
GR	GR2017-064	551661.0052	6579977.9636		G	10	0.9	0.3	0.57
GR	GR2017-065	551661.0100	6579978.9575			50	0.44	0.4	0.49
GR	GR2017-066	551661.9709	6580078.0351		G	5	1.1	0.3	1.07
GR	GR2017-067	551661.9902	6580082.0202		G	50	0.22	0.14	0.36
GR	GR2017-068	552056.9723	6580441.9538		G	100	1.07	0.63	0.99

*Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

Popul- ation	Plant code	Co-ordinates GDA 94, Zone 50 J		Flowering	Growth	Living foliage (%)	Plant dimensions and height (m)		
		Eastings	Northings				Diam. 1	Diam. 2	Height
GR	GR2017-069	551606.9887	6580446.0278		G	90	1.53	0.85	0.58
GR	GR2017-070	551515.0448	6580443.0355		G	30	0.4	0.4	1.18
GR	GR2017-071	551287.0403	6580444.0237		G	100	0.27	0.17	0.49
GR	GR2017-072	551215.0027	6580448.0300		G	100	0.34	0.31	0.43
GR	GR2017-073	551213.9534	6580448.0351		G	100	0.46	0.4	0.72
GR	GR2017-074	551307.9556	6580460.9971		G	100	0.2	0.13	0.53
WNN	W2017-001	651772.01	6553237.00			100	0.74	0.69	0.52
WB	WB2017-001	543020.01	6570907.96		G	100	1.08	0.82	0.31
WB	WB2017-002	543026.95	6570945.96		G	100	1.14	0.47	0.44
LM	LM2017-01	650978.0129	6545526.008		G	75	1.39	1.03	0.46



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

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	Project No Date Drawn by Map author	1167 16/10/2017 GW GW
1:680,000 (at A4)      GDA 1994 MGA Zone 50		
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Project location

**Regional *Eremophila resinosa* populations**

- GR
- LM
- WB
- WNN

**Figure 3-14**  
**Regional populations of *Eremophila resinosa* found in the 2017 monitoring period**



### **3.4 SURVEY LIMITATIONS**

Phoenix (2015) highlighted the potential for observer error to affect the results of the survey in each year and provided evidence where this seemed to have occurred in the past. To ensure that observer error was minimised the same principal observer as in 2015 undertook or supervised all measurements in 2016 and 2017 monitoring periods.

There were no limitations to the current survey. Field time limitations that precluded the opportunity to search further DPaW records in the vicinity of the Westonia townsite were noted in Phoenix (2015). These and other areas were targeted in 2016 and 2017 where a number of new populations of *E. resinosa* were found.

## **4 DISCUSSION**

### **4.1 NUMBER OF LIVING PLANTS**

Despite some recruitment the results continue to show a small number of plant death in some populations. A total of two plants recorded as living in 2016 were dead in 2017. Two plants also died in this period at the regional populations. There were no evident recent impacts/disturbances in the vicinity of any of the dead plants that may have contributed to the deaths and no evidence of grazing or physical impacts (e.g. broken branches). Subsequently, it appeared that plants died from natural attrition. *Eremophila resinosa* is a disturbance opportunist. Disturbance species typically continue to decline if disturbance frequencies are low.

### **4.2 PROPORTION OF PLANTS FLOWERING AND EXHIBITING NEW GROWTH**

The proportion of plants recorded flowering and exhibiting new growth decreased markedly in 2017 at all populations, including the regional populations found within 20 km of the mine-site. While there was below average rainfall 12 months before the survey and in particular five months prior, the difference may be attributed primarily to the timing of the monitoring period and late start of the spring season. It has been previously identified (Phoenix 2015) that the historic data indicated no clear correlation between total annual rainfall and flowering/new growth and the optimal flowering time is between October and November (DEC 2009).

Typically, monitoring has been undertaken from mid September to October with the proportion of plants flowering and exhibiting new growth in 2016 the highest recorded since 2011. The 2016 monitoring occurred 10-13 October. The current monitoring took place between 29 August - 3 September 2017. Therefore, some of the individuals of *Eremophila resinosa* may flower and exhibit new growth later in the 2017 spring season.

### **4.3 FOLIAGE CUMULATIVE VOLUME AND PROPORTION OF BRANCHES WITH LIVING FOLIAGE**

In 2017 'cumulative volume' measure was supplemented with the 'foliage cumulative volume' measure to account for the growth habit of the species. It has been observed (Phoenix 2016) that as plants age, stems die-off from the centre of the plant and new growth occurs at the branch extremity. This results in a plant with a large internal volume being foliage free in the centre. Subsequently, large calculated volumes recorded as 'cumulative volume' did not accurately represent the total growth and therefore did not reflect the true health of the individuals within populations.

The cumulative volume multiplied by the foliage cover generated more stable results showing little change in foliage cumulative volume across all mine-site populations (except population C) from year to year. Population C recorded a large increase in foliage cumulative volume in 2016 due to discovery of 10 new plants. In 2017 despite the discovery of one additional plant foliage cumulative volume declined reflecting the decrease in average foliage cover of plants in the population.

The trend toward lower average foliage cover evident since 2011 has continued, indicating that overall the mine-site populations (A-G) are in slow decline. This trend was also evident at the regional populations found within 20 km of the mine-site.

## 5 CONCLUSION

Phoenix (2015) concluded that all of the natural *Eremophila resinosa* populations at the Edna May Gold Project are in a slow state of decline. In 2017 this decline was still evident with a small number of deaths recorded at some populations in the vicinity of mine-site as well as regionally. As in previous monitoring periods, most plants appeared healthy, there was no evidence of impacts from current mining activities on the extant populations and it is apparent that the decline is again a result of natural attrition.

*Eremophila resinosa* has been described as a disturbance species (Mr. R Dixon in MWH (2014)). Disturbance species are lost if disturbance frequencies are low and it may therefore be anticipated that the decline in *E. resinosa* populations at the Edna May Gold Project will continue in the absence of disturbance/stochastic events. This trend is evidenced by the species occurrence in historically disturbed areas across its range, recruitment only evident in areas where there has been a recent physical disturbance (e.g. Warrachuppin Road in the 2016 survey) and the continued loss of plants across all populations.

The ongoing translocation program at the Edna May Gold Project ensures the persistence of the extant populations of the species within suitable habitat around the Westonia townsite. As significant recruitment has not been recorded in populations A-F in 2017 the translocation is particularly important. The increase of plants in population G was due to more intense search around historic FloraBase database records.

The search for new populations based on historic FloraBase data resulted in five new populations being recorded within 20 km radius of the mine-site in 2016 and a further five populations within 100 km radius of the mine-site in 2017. This strongly suggests that other populations are yet to be located in the region and conducting searches in the vicinity of other historic records may return additional individuals of *E. resinosa* in the future as the species is known from 80 locations within approximately 100 km of Westonia.

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**Appendix 1 Description of all known natural *Eremophila resinosa* populations (DEC 2009)**

<b>Pop. no.</b>	<b>Location</b>	<b>Land status</b>	<b>Year/no. plants</b>
<b>1a</b>	N of Westonia	Shire Road Reserve	1993 37 [1]* 2003 14* 2005 7 2008 7
<b>1b</b>	N of Westonia	Shire Road Reserve	1993 37 [1]* 2003 14* 2005 4 2008 5
<b>1c</b>	N of Westonia	Shire Road Reserve	1993 37 [1]* 2005 2 2003 14*
<b>2a</b>	NW of Mukinbudin	Shire Road Reserve	2003 9 2005 3 2008 4
<b>2b</b>	NW of Mukinbudin	Shire Road Reserve	2003 6 2008 4
<b>2c</b>	Cowcowing	Shire Reserve	1991 14 2003 5 2005 3 2006 4
<b>3</b>	SW of Westonia	Shire Road Reserve	1989 44 [2] 2000 30 2008 13
<b>4a</b>	NW of Nungarin	WestNet Rail reserve	1991 4* 1994 3 2005 5* 2008 4
<b>4b</b>	NW of Nungarin	Main Roads Western Australia (WA) reserve	1991 4* 1994 1 2005 5* 2008 0
<b>5</b>	NW of Westonia	Shire Road Reserve	1993 2 2005 2 2008 2
<b>6</b>	SW of Westonia	Main Roads WA reserve	1992 15 2005 3 2008 26
<b>7</b>	NW of Westonia	Shire Road Reserve	1991 4 2003 0 2008 0
<b>8</b>	NW of Westonia	Shire Road Reserve	2000 0 2008 2
<b>9</b>	NW of Westonia	Shire Road Reserve	1992 12 2003 7 [5]

*Eremophila resinosa* survey of the Edna May Gold Project

Prepared for Edna May Operations Pty Ltd

Pop. no.	Location	Land status	Year/no. plants
			2008 5
10	NW of Westonia	Shire Road Reserve	1992 9 2005 3 2006 2 [1] 2008 1
11	NW of Westonia	Shire Road Reserve	1992 1 2003 1 2008 1
12	SW of Westonia	Shire Road Reserve	1993 37 [3] 2005 19 2008 34
13	Westonia	Shire Reserve – Race Track	1993 214 (1) 2006 53 2008 53
14a	S of Koorda	Shire Road Reserve	1992 100 (1) 1999 100 2003 82 2008 57
14b	S of Koorda	Shire Road Reserve	2003 4 2005 10 2008 8
15	NW of Westonia	Shire Road Reserve	1995 5 2003 2 2008 1
16a	Westonia	Shire Reserve – proposed hospital site	1993 120 (30) 2003 21 [1] 2008 21
16b	Westonia	Shire Road Reserve	2005 6 2008 6
17a	NW of Nungarin	Shire Road Reserve	1993 1 1995 1 2008 1
17b	NW of Nungarin	Shire Road Reserve	1993 1 1995 1 2008 1
18	NW of Westonia	Shire Road Reserve	1994 2 2006 1 2008 1
19	NW of Westonia	Shire Road Reserve	1994 1 1999 0 2008 0
20	NW of Westonia	Shire Road Reserve	1994 1 2006 0 2008 0
21	NW of Westonia	Private Property	1996 1

*Eremophila resinosa* survey of the Edna May Gold Project

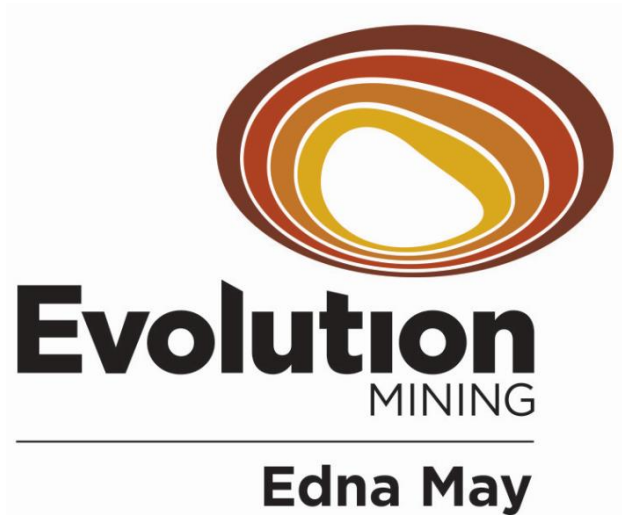
Prepared for Edna May Operations Pty Ltd

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Pop. no.	Location	Land status	Year/no. plants
			2008 3
22	E of Kalannie	Main Roads WA reserve	2001 13 2008 13
23	NW of Westonia	Shire Reserve and Mining Lease	2003 441 2004 426 [15 removed] 2008 1133
24	N of Westonia	Shire Reserve	2005 571 2006 509 [62] 2008 ?
25	N of Westonia	Shire Road Reserve	2008 1
26	N of Westonia	Private Property	2008 5







## Flora Management Plan

EMO-ENV-PLN-1208

Version	Date	Description	Reviewed	Approved
1	01/03/2010	Issued		
2	29/12/2014	Reviewed	J Coad	J Coad
3	03/02/2017	Reviewed	B Bamford	M McLaughlin

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 1 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

# Flora Management Plan



**Evolution**  
MINING

Edna May

## TABLE OF CONTENTS

1. SCOPE .....	3
2. BACKGROUND .....	3
3. CURRENT STATUS .....	3
3.1 Distribution and Habitat Surrounding the Mining Operations .....	4
3.2 <i>Eremophila resinosa</i> Translocation Program.....	4
3.3 Biodiversity Corridor Project .....	5
4. POTENTIAL IMPACTS .....	5
5. ENVIRONMENTAL OBJECTIVES .....	6
6. MANAGEMENT & IMPLEMENTATION STRATEGY .....	7
7. STAKEHOLDER CONSULTATION .....	15
8. TRAINING AND AWARENESS.....	15
9. PERFORMANCE MONITORING .....	15
10. RELEVANT LEGISLATION.....	15
11. RELEVANT INTERNAL DOCUMENTS.....	16
12. AUDITING AND REPORTING .....	16
13. REVIEW AND REVISION .....	17
14. DEFINITIONS.....	17

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 2 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

## 1. SCOPE

This Flora Management Plan provides a management framework for the implementation, monitoring and review of actions aimed at minimising adverse impacts from construction and mining activities on flora (including Declared Rare Flora (DRF) and Priority Flora) and vegetation communities. Specifically, Edna May Operation (EMO) proposes to:

- Maintain the abundance, diversity, geographic distribution and productivity of terrestrial flora at species and ecosystem levels;
- Protect and minimise impact to DRF and Priority Flora located within the Edna May Operations Leases;
- Clear vegetation only within approved areas and where possible minimise clearing activity; and
- Ensure that land rehabilitation is implemented progressively.

## 2. BACKGROUND

In 2003, EMO prepared a management plan for DRF species *Eremophila resinosa*, which was endorsed by CALM (now DPaW). The management plan was subsequently updated in 2007 (Westonia Gold Mine Threatened Flora Management Plan, 2007) to include both the mining and exploration activities. Ongoing compliance with the plan will ensure that all due care is taken in preserving this species during planning and operational stages of the EMO.

This plan complements (but does not replace) the existing Westonia Gold Mine Threatened Flora Management Plan, 2007 (Outback Ecology, 2007).

## 3. CURRENT STATUS

Of the 767 ha which make up the mining leases of the Edna May Gold Project, over 50% of the area consists of cleared farmland. The farmland was cleared before the 1930's and has been regularly cropped. The remaining land consists of previously disturbed mined areas and natural bushland.

Eucalyptus Woodland is the dominant native vegetation type in the region, with *Eucalyptus salubris* (gimlet), *E. salmonophloia* (salmon gum) and *E. longicornis* (Red Morrell) the common tree and mallee species. The understorey composition and structure is variable in response to changing soil conditions, however typical associations are low chenopod shrubs or mid-tall *Acacia/Melaleuca* shrubs. Four vegetation 'map-units' (associations) have been identified within the tenement boundaries. These included; Mixed Eucalypt Low Forest, Gimlet Low Forest, Dense Thicket with various dominants, and Open Low Grass. Of the various vegetation map units identified, the Gimlet Low Forest is noted as having regional value.

The DRF species *E. resinosa* was identified within the vicinity of the operation. Nearly all the plants were found growing in areas of disturbance where the earlier vegetation had been removed, but where the topsoil had been left in place.

In addition to the DRF *E. resinosa*, ten Priority Flora species have been sampled within or very close to, the EMO tenements. These species include:

- *Acacia ancistrophylla* var. *perarcuata* (P3) – this species has been recorded approximately 10.7 km south of the Westonia mine on the Carrabin Nature Reserve (No. 16235). It is described as favouring undulating plains of red sand or clay loam.
- *Acacia filifolia* (P3) – this species has previously been identified approximately 17.5 km south-east of the mine site near Bodallin in remnant bushland adjacent to Great Eastern Highway. It is

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 3 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017



described as favouring yellow sand or gravely lateritic sand on sandplains.

- *Dicrastylis corymbosa* (P3) – has been recorded 10.7 km south of the mine in remnant vegetation near Carrabin (in or near Carrabin Nature Reserve No. 16235). It favours yellow/brown sand (Florabase, 2007).
- *Dryandra horrida* (P3) – the closest known occurrence of this species is 16.5 km to the southwest of the mine. This species occurs on sand, sometimes with gravel.
- *Dryandra shanklandiorum* (P4) – this species has been recorded 10.4 km south of the mine near Carrabin (in or near Carrabin Nature Reserve No. 16235). It is described as favouring white/yellow sand with lateritic gravel.
- *Euryomyrtus leptospermoides* (P3) – has been recorded approximately 12.3 km south-west of the mine in vegetation described as ‘heath’ within the Conservation of Flora and Fauna Reserve No. 16000. It favours undulating plains of yellow or white sand, clayey sand or gravel.
- *Hibbertia glabriuscula* (P2) - this species has been recorded approximately 13.1 km south-east of the Westonia mine. It favours yellow sand over laterite on sandplains with some laterite breakaways.
- *Muriophyllum petraeum* (P4) – according to the database search, this species has been identified 9.3 km west of the mine on Bullarragin Rock (a granite outcrop that lies within Parkland and Recreation Reserve No. 18273) near the corner of Warralackin Road and Leaches Road. Although surrounded by Westonia Mines exploration tenements, the reserve is excluded.
- *Verticordia mitodes* (P3) – this species has been recorded 10.7 km south of the mine in remnant vegetation south of Carrabin (in or near Carrabin Nature Reserve No. 16235). It favours yellow sand on undulating plains.
- *Verticordia stenopetala* (P3) – has been recorded 11.2 km south–west of the mine in or near Carrabin Nature Reserve No. 16235. It favours undulating plains of yellow sand, sometimes with gravel (Outback Ecology, 2007).

### 3.1 Distribution and Habitat Surrounding the Mining Operations

*E. resinosa* favours sandy loams and clays and is found in areas of Open Mallee Woodland with mixed *Acacia* Scrub understorey. Species associated with *E. resinosa* include *Eucalyptus salubris* (Gimlet), *E. salmonophloia* (Salmon Gum), *E. longicornis* (Red Morrel), *E. transcontinentalis* (Redwood) and *Acacia acuminata* (Jam), *A. erinacea*, *A. hemiteles* and *Eremophila oppositifolia* (Weeooka) (Outback Ecology, 2007A).

The habitat surrounding the mine site supporting *E. resinosa* was described by Armstrong and Osborne (2003) as Mixed Eucalypt Low Forest of *Eucalyptus longicornis*, *E. yilgarniensis*, *E. salubris* and *E. corrugata*. The mid stratum was Scrub to Thicket dominated by *Melaleuca lanceolata* while the understorey consisted of Open Dwarf Scrub to Dwarf Scrub of *Acacia*, *Eremophila*, *Dodonaea* and *Atriplex* species. Patches of Open Low Grass dominated by *Austrodanthonia* sp. and *Amphipogon strictus* were occasionally present (Outback Ecology, 2007A).

Around EMO, *E. resinosa* tends to favour disturbed areas where there is a substantial part of the original vegetation and/or its associated soil present. Within the boundary of the tenements, a number of small populations (sometimes single plants) exist on road verges, exploration tracks and within areas cleared for agricultural use. The greatest threat to such populations appears to be road maintenance and weed infestation.

### 3.2 *Eremophila resinosa* Translocation Program

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 4 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

As a result of mine planning, 15 plants of *E. resinosa* were removed in 2003 - 2004, after approval from the Minister for the Environment was obtained. While every attempt was made to limit the impact on DRF, it was necessary to remove the plants that occurred within the proposed location of the processing plant and expanded pit. Seed and tissue culture were utilised from these plants in a Translocation Program.

The translocation program for *E. resinosa* was started in 2004 by the Botanic Gardens and Park Authority (BGPA) and led by Bob Dixon. The program was funded initially by Catalpa Resources (formerly Westonia Mines Limited) and now continued with funding from EMO.

There are currently nine translocation sites, six are located in remnant vegetation surrounding the town and three are located on farmland north of the mine.

BGPA managed the translocation program up until the retirement of Bob Dixon in mid-2015. Environmental staff at EMO now maintain and monitor all of the Translocation Sites and a report is developed annually and submitted to DPaW.

An annual survey of *E. resinosa* on the mining lease and surrounds is undertaken and a report is submitted to the DPaW. This report provides information on the health of the population. In recent years the survey area has been extended and further searches conducted for new populations.

### 3.3 Biodiversity Corridor Project

This project was established with the aim of creating a wildlife corridor on EMO leases north of the pit, which consisted of cleared agricultural areas and mining infrastructure and link these to the Westonia Common and other remnant vegetation surrounding the mine site.

As part of the project Dr Geoff Woodall was engaged to provide advice and direct seeding services using a specialised machine he developed, the CommVeg seeder. A small trial area of approximately 5ha was directed seeded and hand planted with seedlings in winter 2015 and this was followed up by a further 92ha in 2016. Over 75,000 seedlings were planted in 2015-2016 by hand planting or a Chatsfield tree planter.

This project met a commitment which was made in a previous Mining proposal to establish a vegetation corridor along the western side of the Integrated Waste Landform (IWL). The project also trialled direct seeding 10ha of *E. resinosa* at two sites (Translocation Site 7 and 8) as part of the 92ha project.

## 4. POTENTIAL IMPACTS

Clearing of vegetation for the construction of pits, waste landforms, roads, tailings storage facilities, other infrastructure can lead to the following potential impacts:

- Loss of fauna habitat;
- Establishment and spread of introduced species (weeds);
- Reduced habitat connectivity;
- Loss of DRF or Priority Flora;
- Breach of legislation should clearing be undertaken without a permit to clear; and
- Breach of legislation should DRF be removed without a permit to remove.

Exploration activities can lead to the following potential impacts to flora and vegetation (if activities are not managed appropriately):

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 5 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

- Introduction of invasive species;
- Damage to native flora where travelling off established roads and tracks;
- Damage to native flora through the parking of vehicles and machinery in undesignated areas occurs (parking of vehicles and rigs outside of drilling areas/pads for example);
- Damage and/or removal of native flora including DRF and Priority Flora;
- Spillage or discharge of saline water;
- Spillage or discharge of hazardous substances such as hydrocarbons and chemicals (addressed in the Hydrocarbon and Dangerous Goods Management Plan); and
- Unauthorised land clearing or over clearing when establishing drill pads and service corridors.

Other potential impacts to flora and vegetation during construction and mining activities include:

- Erosion and sediment runoff from waste landforms leading to:
  - Smothering or burial of flora with sediment;
  - Removal of topsoil and viable growth medium; and
  - Removal of *E. resinosa* populations through direct erosion.
- Dust generated from mining and construction activities could smother vegetation and result in loss of vegetation (refer to Air Emissions Management Plan EMO-ENV-PLN-1203);
- Saline water used for dust suppression may damage native flora and prevent the re-establishment of native flora;
- Damage to vegetation from driving off designated roads / tracks;
- Modification of fire regimes;
- Spillage or discharge of hazardous substances such as hydrocarbons and chemicals (addressed in the Hydrocarbon and Dangerous Goods Management Plan);
- Impacts to vegetation from TSF or evaporation pond seepage causing groundwater mounding; and
- Impacts to vegetation from groundwater extraction, lowering the water table.

## 5. ENVIRONMENTAL OBJECTIVES

This Flora Management Plan has been developed to satisfy the following objectives:

- Manage and minimise adverse impacts from exploration, construction and mining activities to native flora and fauna;
- Maintain the abundance, diversity, geographic distribution and productivity of terrestrial flora at species and ecosystem levels;
- Protect and minimise impact to DRF and Priority Flora located within the Mining and Exploration Leases;
- Disturb land only within approved clearing envelopes; and

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 6 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017



- Implement progressive rehabilitation as areas become available.

## 6. MANAGEMENT & IMPLEMENTATION STRATEGY

A Flora Management Strategy has been devised to comply with legislation and to minimise adverse impacts to native flora and fauna (**Table 1**), along with the title of the role responsible for implementing each action and an indication of the timing for implementation.

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 7 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

**Table 1: Flora Management & Implementation Strategy**

MANAGEMENT ACTION	TIMING	RESPONSIBILITY	EVIDENCE	
<i>General</i>				
FMIS 1	All land clearing activities and activities with the potential to impact on flora at Edna May will comply with Clearing Permits, Program of Works (POW), relevant local and state regulations and Australian standards.	Ongoing	Department Managers / Superintendents	Procedure documentation. Clearing permit forms.
<i>Stakeholder Consultation</i>				
FMIS 2	Where required, EMO will liaise with neighbours where land clearing, or activities which potentially impact upon the regions flora, may impact upon them.	Ongoing	General / Community Manager	Communications Register and records.
FMIS 3	Complaints register to assist in indicating improvements or failings in flora management actions	Ongoing	Community Manager	QHSE Incidents. Summarised in AER.
<i>Land Clearing / Ground Disturbance</i>				
FMIS 4	No clearing on site to be undertaken without the completion and sign off (by all required personnel) of an Internal Clearing Form. The clearing of native flora is to be avoided where possible.	Ongoing	All employees / contractors	Signed internal Clearing Form records
FMIS 5	No clearing or ground disturbance to be completed for any mining activities without following the Clearing and Ground Disturbance Procedure (EMO-ENV-PRO-1201).	Ongoing	All employees / contractors	Documented procedure
FMIS 6	<p>Prior to clearing any remnant vegetation the following should be undertaken:</p> <ul style="list-style-type: none"> <li>Determine whether ground disturbance can be relocated to a previously disturbed area.</li> <li>The clearing and ground disturbance procedure is followed.</li> <li>Where an external Clearing Permit is required the Native Vegetation Assessment Branch (NVAB) of the DMP is contacted to discuss the requirement for a clearing permit.</li> <li>A flora survey of the area to be cleared has been completed including a targeted survey for <i>E. resinosa</i>.</li> <li>A Clearing Permit has been obtained and approved by the NVAB if required.</li> </ul> <p>The standard approval period for a clearing permit varies (2-6 months -it may exceed this), and it is essential that mine planning accommodate such time frames.</p>	Ongoing	General Manager	Clearing Permit and relevant documentation. Survey records.
FMIS 7	<p>Vegetative material and topsoil removed by clearing is retained and the Topsoil Stripping Procedure is followed (EMO-ENV-WP-1222). The topsoil and vegetative material is stockpiled in an area that has already been cleared. Top soil stockpiles should not exceed 2 m in bush land areas and 4 m in farmland areas.</p> <p>Signs are to be erected marking topsoil stockpiles.</p>	Ongoing	Environmental Department / Mining Supervisors	Evidence of topsoil stockpiles. Topsoil Register. Evidence of signage.

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 8 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

FMIS 8	<p>During clearing activities;</p> <ul style="list-style-type: none"> <li>Earth moving machinery must be cleaned of soil and vegetation prior to entering and leaving the area to be cleared.</li> <li>The clearing permit holder must ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared.</li> </ul> <p>The movement of machines and other vehicles must be restricted to the limits of the area to be cleared.</p>	Ongoing	Environmental Department / Mining Supervisors	Field Inspections
FMIS 9	<p>Prior to exploration activities occurring within mining or exploration tenements;</p> <ul style="list-style-type: none"> <li>A flora survey of the area should be undertaken during an appropriate period (spring) to identify locations of any DRF or Priority Flora.</li> <li>Historic tracks and gridlines that require reestablishment for mining or exploration purposes should be searched for <i>E. resinosa</i>.</li> <li>All localities of DRF and Priority Flora should be clearly demarcated to prevent accidental damage.</li> <li>Prior to exploration activities occurring, it is an EMO requirement that a Pre-Exploration Vegetation Checklist be completed, to ensure the area has been searched for DRF and Priority Flora.</li> <li>If DRF are identified within 50 m of disturbance or the disturbance is within an environmentally sensitive area (ESA) a clearing permit will need to be obtained. Otherwise permission to clear can be obtained through a POW.</li> <li>If drilling activities are to impact on Priority Flora, liaison with DPaW Merredin should be undertaken.</li> <li>If DRF are identified in the proposed disturbance area the following actions should be taken: <ul style="list-style-type: none"> <li>Modify grid to avoid DRF;</li> <li>If this is not possible, obtain a Permit To Take DRF from the DPaW</li> <li>Liaison with DPaW Merredin should be undertaken.</li> <li>Apply for a Clearing Permit.</li> </ul> </li> </ul> <p>No clearing to be undertaken without the appropriate clearing permit, POW or Permit To Take DRF in place and a completed internal clearing form.</p> <p>The standard approval period for a clearing permit varies (2-6 months -it may exceed this), and it is essential that mine planning accommodate such time frames.</p>	Ongoing	Geology Manager / Environmental Department	Flora surveys. Pre-Exploration Vegetation Checklist. Correspondence Register.
<b>Taking of Rare Flora</b>				
FMIS 10	Taking of protected flora will only occur when it is authorised by, and carried out in accordance with the terms and conditions of the licence issued by DPaW under section 23F of the <i>Wildlife Conservation Act 1950</i> .	Ongoing	Environmental Department	Permit to Take Reports. Permit To Take licence.

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 9 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

FMIS 11	A person shall not wilfully take any protected flora unless: <ul style="list-style-type: none"> <li>Written approval from the DPaW has been received; and</li> <li>Approval from the Environmental Advisor is received.</li> </ul>	Ongoing	Environmental Department	Permit to Take Reports Permit To Take licence
<b>Vehicle Usage</b>				
FMIS 12	In order to minimise disturbance and prevent unintentional impacts through the use of machinery and vehicles, no machinery or vehicle is to travel off designated roads and tracks.	Ongoing	All employees / contractors	Field Inspections
<b>Waste Dumping Strategy</b>				
FMIS 13	To ensure that waste rock does not encroach on <i>E. resinosa</i> : <ul style="list-style-type: none"> <li>Dumping of waste rock on existing landforms and the old TSF is restricted to the approved clearing area and current toe;</li> <li>Toe pegs will be put in place to indicate the extent of the waste dump and a design map will be available to all site personnel.</li> </ul> <p>The dumping strategy will be checked by the Principal Engineer prior to dumping in new areas. Where dumping is to occur in areas in close proximity to <i>E. resinosa</i>, then mining crews are to be informed of the potential risks of operating in areas where <i>E. resinosa</i> are located.</p>	Ongoing	Mining Manager / Principal Engineer	Waste Dump Design
FMIS 14	To ensure that operations do not encroach on <i>E. resinosa</i> during selective mining of low grade stockpiles: <ul style="list-style-type: none"> <li>Access routes and buffer zones will be clearly marked for vehicles and machinery prior to work commencing; and</li> <li>The mining strategy will be checked by the Principal Engineer and mining crews informed of the potential risks of operating in areas where <i>E. resinosa</i> are located.</li> </ul>	Ongoing	Mining Manager / Principal Engineer	Weekly Plan
<b>Saline Water / Dust Control</b>				
FMIS 15	To prevent the vegetation (including <i>E. resinosa</i> ) from being adversely affected by saline water which will be used to suppress dust on haul and ancillary roads, the following will be undertaken: <ul style="list-style-type: none"> <li>Roads will be bunded in areas adjacent to <i>E. resinosa</i> to prevent saline water from draining into the surrounding environment.</li> <li>Where considered necessary, runoff from the roads will be directed to drainage sumps.</li> <li>Operators of water trucks will be informed of the potential environmental consequences of over spraying onto vegetated zones along the side of roads;</li> <li>Bunding, drains and sumps will be maintained.</li> </ul> <p>Further information on the management actions for minimising dust emissions is presented in the Air Emissions Management Plan (EMO-ENV-PLN-1203).</p>	Ongoing	Mining Manager / Environmental Department	Vegetation Photo. Monitoring records. Water Cart operating procedures.

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 10 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

FMIS 16	<ul style="list-style-type: none"> <li>All water pipelines carrying saline water will, wherever practically feasible, be located along major roads;</li> <li>The pipelines will either be buried or banded;</li> <li>All buried pipelines will have leak detection measures in place; and</li> <li>The pipelines will be inspected weekly for maintenance requirements.</li> </ul>	Ongoing	Processing Manager / Superintendent	Records of routine inspections, servicing and maintenance. Evidence of banding / burial for entire length of pipeline.
<b>Drainage</b>				
FMIS 17	<p>Surface water management structures are required to effectively capture stormwater and allow for safe and efficient operations. Drainage must be designed to prevent the release of hazardous substances to the environment and protect flora and vegetation (particularly <i>E. resinosa</i>). In order to achieve this:</p> <ul style="list-style-type: none"> <li>All mine affected water is to be contained and utilised on site;</li> <li>Hazardous storage areas are not to drain to vegetation or waterways;</li> <li>Surface water drains are not to direct overflow to natural areas where vegetation is present (particularly where <i>E. resinosa</i> is known to occur);</li> <li>Drainage is to be constructed so that runoff from rainfall does not cause erosion leading to sediment being spread over surrounding vegetation and in particular populations of <i>E. resinosa</i> situated next to waste landforms;</li> <li>Drains and sediment traps are to be regularly inspected and maintained.</li> </ul>	Ongoing	Mining / Processing Managers	Field Inspections
<b>Weeds</b>				
FMIS 18	<p>Weeds will be managed and controlled by the relevant Area Supervisors with advice from the Environmental Advisor/s. Should weed problems be excessive in areas where <i>E. resinosa</i> are present, weed control will be carried out by hand.</p> <p>Should chemical control of weeds be necessary on the Mining Leases, spot spraying will be carried out and care taken to avoid the spraying on windy days. DO NOT spray near DRF.</p> <p>Further information on weeds is presented in the Weed and Pest Management Plan (EMO-ENV-PLN-1210) and the Weed Spraying procedure (EMO-ENV-WP-1225).</p>	Ongoing	Area Supervisors	Field Inspections records
<b>Fire</b>				
FMIS 19	<p>Control of bushfires in Western Australia is provided through the <i>Bush Fires Act 1954</i> and its regulations. The management objective is to reduce the threat of fire to the public, site personnel, property and the environment. In order to achieve this, the following will be implemented:</p> <ul style="list-style-type: none"> <li>Acquisition and maintenance of site based mobile fire fighting equipment;</li> <li>Each vehicle will contain a portable fire extinguisher;</li> <li>The training of personnel in the use of fire fighting equipment to combat a fire;</li> </ul>	Ongoing	HSE Superintendent	Maintenance and Training records

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 11 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017



	<ul style="list-style-type: none"> <li>No fires are to be lit on the mine site without the approval of the General Manager; and</li> <li>Adherence to the <i>Bush fires Act 1954</i> and local government regulations.</li> </ul> <p>The sites Emergency Response Plan and related procedures contain further details regarding the management of the risk of fire.</p>			
<b>Rehabilitation</b>				
FMIS 20	<p>As part of revegetation activities <i>E. resinosa</i> will be included in the native species seed mix to be applied to disturbed areas. Approval from the DPaW will be sought prior to:</p> <ul style="list-style-type: none"> <li>Undertaking translocation of DRF; and</li> <li>Prior to the collection of any seed from <i>E. resinosa</i>.</li> </ul>	Ongoing	Environmental Department	Summarised in AER. Translocation Approval documents. Permit To Take reports.
FMIS 21	Cleared areas will be progressively rehabilitated as they become available.	Ongoing	General Manager	Site Rehabilitation Plan. Summarised in AER.
<b>Training &amp; Awareness</b>				
FMIS 22	<p>General site inductions will be used to raise the awareness of the workforce about conservation issues and particularly the status of the DRF species <i>Eremophila resinosa</i>.</p> <p>Pertinent contractors coming onto site are aware of weed hygiene requirements and have cleaned down vehicles and equipment prior to arriving on site.</p>	Ongoing	All employees / contractors	Induction Presentation. Delivery Inspection Sheet.
<b>Monitoring &amp; Contingencies</b>				
FMIS 23	<p>The monitoring requirements are as follows:</p> <ul style="list-style-type: none"> <li>Weekly inspection of saline water pipelines</li> <li>Monthly inspection of bunds, sumps and drains and fencing associated with the management of <i>E. resinosa</i>;</li> <li>Annual recording of <i>E. resinosa</i> plant numbers and location, density, cover and health; and</li> <li>Weekly inspection of the established translocation sites.</li> </ul>	Ongoing	Environmental Department	Field Inspection Sheets. Survey Reports.
FMIS 24	<p>Photographic monitoring of vegetation surrounding the IWL to determine any impacts from mining such as groundwater alteration / dust:</p> <ul style="list-style-type: none"> <li>Monthly photographs every 50 m along the southern boundary of the IWL; and</li> <li>3 Monthly photographs of the remnant vegetation strip to the east of IWL in the adjacent paddock.</li> </ul>	Ongoing	Environmental Department	Photopoint Monitoring Records. Summarised in AER.
FMIS 25	Where signs of plant stress as a result of mining activities (e.g. smothering of vegetation from dust or damage to vegetation via the discharge of saline water) are observed, the Native Vegetation Assessment Branch of the DMP will be notified.	Ongoing	Environmental Department	Photopoint Monitoring Records

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 12 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

FMIS 26	<p>Non compliances can be identified through a variety of means including; inspections, audits, environmental monitoring and opportunistic observations.</p> <p>Non-compliances with this management plan, relevant legislation and permits will be addressed through:</p> <ul style="list-style-type: none"> <li>• Site based incident reporting system (QHSE), and remedial action tracking;</li> <li>• External reports to relevant regulatory authorities (DPaW, DMP) through correspondence and the AER;</li> <li>• Education of personnel through site-wide notifications, environmental alerts, inductions, toolbox talks, and newsletters;</li> <li>• Response to direct complaints from stakeholders as recorded in the “Complaints Register”; and</li> <li>• Consultation with stakeholders on a regular basis to address issues at an informal level</li> </ul>	Ongoing	Environmental Department	QHSE Incident database. Inspection and audit reports. Complaints Register. Stakeholder consultation register.
FMIS 27	An annual report detailing monitoring and other activities at the translocation sites will be developed and submitted to DPaW on an annual basis, due by December 31 <sup>st</sup> each calendar year.	Annually	Environmental Department	Annual Reports
<b>Auditing &amp; Reporting</b>				
FMIS 28	<p>In the event that an incident occurs resulting in the disturbance of <i>E. resinosa</i> (or any other DRF or Priority Flora) and/or where land is cleared without prior authorisation and permits, the General Manager and Environmental Advisor are to be notified as soon as practicable.</p> <p>The Environmental Advisor is to ensure that the environmental incident has been contained and made safe, cleaned up if required and actions taken to prevent a similar event occurring.</p> <p>Should an environmental incident result in the damage to, or loss of plants of <i>E. resinosa</i> or any other DRF or Priority Flora, then the General Manager will report the incident to the regulatory authority within 24 hrs.</p>	Ongoing	Environmental Department	QHSE Incident database. Summarised in AER.
FMIS 29	If adverse impacts to flora and vegetation are observed, they will be reported to the Environment Department immediately. An incident report will then be prepared and submitted within 24 hrs. The incident report will identify contingency actions to be implemented and the date for completion of contingency actions.	Ongoing	All employees / contractors	QHSE Incident database
FMIS 30	Breaches of license or tenement conditions will be reported to the relevant authority (DER or DMP) within 24hrs, and summarised through the AER, as part of Operating License. External reporting of incidents is the responsibility of the General Manager with assistance from the Environmental Advisors.	Ongoing	General Manager	QHSE Incident database. Summarised in AER. Correspondence Register.
FMIS 31	Identification of any rare or endangered flora species will be reported to the DPaW for appropriate registration and management. For each new plant discovered the location will be accurately recorded by GPS and identified on site plans and maps. Appropriate management requirements for	Annually	Environmental Department	Threatened Flora Report Forms

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 13 of 18</b>
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

	new plant/communities and/or populations will be developed in consultation with the DPaW.			
FMIS 32	An annual flora ( <i>E. resinosa</i> ) report will be completed on the status of the mine site populations (external consultant).	Annually	Environmental Department	Annual Reports
FMIS 33	An annual report on the translocation sites will be developed and submitted to DPaW by December 31 <sup>st</sup> each calendar year.	Annually	Environmental Department	Annual Reports
<b>Review &amp; Revision</b>				
FMIS 34	The General Manager will allocate resources to review and implement this Management Plan. They will ensure appropriate action is being taken on non-compliances, and offer support to environmental staff through directives to site personnel	Ongoing	General Manager	Compliance Audits
FMIS 35	The Flora Management Plan will be internally reviewed at least on a 2-yearly basis. Reviews will be conducted at key stages of the Edna May project based on planning requirements; review of incidents, audits and corrective actions; legal requirements; and analysis of monitoring results. The reviews will incorporate feedback from stakeholders including community and regulators.	Ongoing	Environmental Department	Revision Record

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 14 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017



## 7. STAKEHOLDER CONSULTATION

Edna May has developed a Complaints Register to record complaints from stakeholders, and record actions taken to address these complaints by site personnel. Evolution Mining aims to maintain a healthy relationship with neighbouring stakeholders by promoting open and honest communications regarding any hazards that may impact upon the operations neighbours.

Further detail regarding community consultation undertaken for the Edna May is provided in the Environmental Management System Manual.

## 8. TRAINING AND AWARENESS

General site inductions will be used to raise the awareness of the workforce about conservation of flora and vegetation and particularly the protection of the DRF *E. resinosa*.

Additional area specific training will be undertaken where required.

## 9. PERFORMANCE MONITORING

The following monitoring will be undertaken:

- Weekly inspection of saline water pipelines;
- Monthly inspection of bunds, sumps and drains and fencing associated with the management of *E. resinosa*;
- Annual recording of *E. resinosa* plant numbers and location, density, cover and health.
- Photographic monitoring of vegetation surrounding the IWL to determine any impacts from mining such as groundwater alteration / dust:
- Monthly photopoint monitoring every 50 m along the southern boundary of the IWL;
- 3 Monthly photopoint monitoring of the remnant vegetation strip to the east of IWL in the adjacent paddock;
- Inspections by regulatory bodies such as the DER and DMP;
- Group quarterly compliance assurance audits;
- Weekly inspection and monitoring of translocation sites;
- An annual report detailing monitoring and other activities at the translocation sites will be developed and submitted to DPaW on an annual basis, due by December 31<sup>st</sup> each calendar year.
- EFA monitoring (once rehabilitation is completed).

## 10. RELEVANT LEGISLATION

- *Biodiversity Conservation Act 2016*
- *Mining Act 1978*;
- *Mines Safety and Inspection Act 1994*;
- *Mines Safety and Inspection Regulations 1995*;
- *Environmental Protection Act 1986*;
- *Conservation and Land Management Act 1984*;
- *Environmental Protection Regulations 1987*;
- *Soil and Land Conservation Act 1945*; and

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 15 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

- *Environmental Protection and Biodiversity Conservation Act, 1999*

## 11. RELEVANT INTERNAL DOCUMENTS

The following relevant internal documents can be located on QHSE;

- Environmental Management System Manual (EMO-ENV-MAN-1201)
- Air Emissions Management Plan (EMO-ENV-PLN-1203);
- Hydrocarbon and Dangerous Goods Management Plan (EMO-ENV-PLN-1205);
- Fauna Management Plan (EMO-ENV-PLN-1207);
- Weed and Pest Management Plan (EMO-ENV-PLN-1210);
- Water Management Plan (EMO-ENV-PLN-1209);
- Topsoil Management Plan (EMO-ENV-PLN-1215);
- Stormwater Management Plan (EMO-ENV-PLN-1216);
- Clearing and Ground Disturbance Procedure (EMO-ENV-WP-1201);
- Skeleton Weed Procedure (EMO-ENV-WP-1219);
- Photo Point Monitoring Procedure (EMO-ENV-WP-1221);
- Topsoil Stripping Procedure (EMO-ENV-WP-1222);
- Weed Spraying Procedure (EMO-ENV-WP-1225) and
- Exploration Rehabilitation Procedure (EMO-ENV-WP-1228).

Other relevant documents include;

- DER Site Operating Licence L8422/2010/2
- DER WWTP Licence L8811/2014/1
- Westonia Gold Mine Threatened Flora Management Plan, 2007 (Outback Ecology, 2007);
- Edna May Gold Mining Proposal May, 2009;
- EMO Edna May Gold Project Works Approval, March 2009, Works Approval Number 4546/2009/1;
- Request for Addendum to Works Approval W4546/2009/1 Granted on 2 July 2009 for the Edna May Gold Mine, Westonia.
- Permit To Take applications / reports
- *E. resinosa* Annual Survey reports
- EMO Mine Closure Plan (2016) and
- EMO Compliance Register.

## 12. AUDITING AND REPORTING

This EMP and its outcomes, commitments and the implementation of the management actions will be audited and revised where required. The key management actions identified in **Table 1** will be the basis for this audit.

The results of inspections, audits and incident reports or complaints received relating to flora will be included in the AER submitted to the statutory authorities. This will be additional to any event-based reporting.

The Edna May internal reporting system will record any non-compliance relating to flora

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 16 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017

management. The non-compliances will be recorded and will not be closed out until corrective measures are in place. These will also be summarised in the AER.

Breaches of licenses, permits or tenement conditions which result in an adverse effect on the environment will be reported to DER or DMP within 24 hours and summarised in the AER. The timelines and responsibilities associated with reporting are detailed in Table 1. External reporting of incidents is the responsibility of the General Manager with assistance from the Environmental Department.

As described in Section 10, compliance assurance audits will be undertaken by Group on a quarterly basis and may include this Management Plan.

### 13. REVIEW AND REVISION

This EMP is intended to be adaptive and is subject to change as new information becomes available. It incorporates the formal requirements of the DER Operating Licence as well as Tenement Conditions.

This EMP will be reviewed by the Environmental Department as a minimum every 2 years from the commencement of operation, or in the following circumstances,

- Procedures are required to be modified; or
- The Project scope has changed significantly.

Review of this EMP will seek to address the following questions:

- Is the background information about the Project current?
- Are there cross references to other documents (including procedures) that should be added?
- Has any further consultation of a material nature been undertaken?
- Has the scope of the plan changed in a material way?
- Is there any new or revised legislation or policy that should be considered?
- Are any of the management actions fully complete such that they can be removed?
- Should any new management actions be added, either as a result of incident reports, inspection results, project changes or other developments?
- Are the performance indicators effective in assessing performance?
- Are there better alternative indicators?
- Has monitoring highlighted any gaps in the program, and should the existing monitoring program be modified?
- Is the allocation of responsibilities for each management action appropriate? Is the review period for this plan appropriate?
- If the assessment identifies the need for changes to the management plan, such changes will be implemented and the plan reissued.

### 14. DEFINITIONS

Ground Disturbance	Ground disturbance is any activity occurring on ground within the Project area that will result in the loss of vegetation. Examples of ground disturbance include: <ul style="list-style-type: none"> <li>• Excavation</li> <li>• Removal of vegetation, topsoil, subsoil or gravel</li> </ul>
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FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	Page 17 of 18
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	08 February 2017

# Flora Management Plan

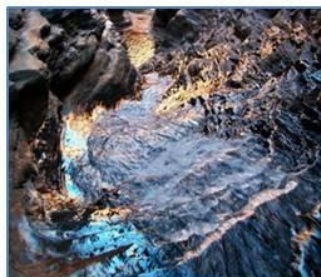


**Evolution**  
MINING

Edna May

	<ul style="list-style-type: none"> <li>• Grading of a natural ground surface</li> <li>• Alteration of a surface water flow path</li> <li>• Creation of an exploration track</li> <li>• Driving vehicles off authorised roads and access tracks.</li> </ul> <p>Note that a dig permit may also be required for any excavation greater than 300 mm.</p>
Remnant Vegetation	Ground covered by native vegetation in its natural state. This includes any vegetation that has had the ground disturbed around it. For example, an isolated large tree.
Historically Cleared Area	Areas that were previously cleared from historic mining but now supports vegetation regrowth. For example, vegetation on old waste dumps.
Actively Cleared	Remnant bushland and historically cleared areas that have been cleared legally as part of the development of the Edna May project. For example, the plant site, ROM and IWL.
Ground Disturbance Form	Internal documentation to monitor and record clearing /ground disturbance and to minimise clearing incidents.
Clearing Permit	Permit received from the Department of Mines and Petroleum (DMP) Native Vegetation Branch to undertake clearing of specified areas.

FLORA MANAGEMENT PLAN	EMO-ENV-PLN-1208	Owner: Environment	Approver: Environment
Version control: 3	Issue date: 03/02/2017	Revision date: 03/02/2019	<b>Page 18 of 18</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	08 February 2017



# Evolution Mining Limited Edna May and Greenfinch Projects

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Level 1 Fauna Assessment

July 2014



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## Edna May and Greenfinch Projects: Level 1 Fauna Assessment

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Outback Ecology has prepared this document using data and information supplied to Outback Ecology by Evolution Mining and other individuals and organisations, most of whom are referred to in this document. Where possible, throughout the document the source of data used has been identified. Unless stated otherwise, Outback Ecology has not verified such data and information. Outback Ecology does not represent such data and information as true or accurate, and disclaims all liability with respect to the use of such data and information. All parties relying on this document, do so entirely at their own risk in the knowledge that the document was prepared using information that Outback Ecology has not verified.

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## Executive Summary

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Evolution Mining is currently evaluating the potential of developing the Edna May and Greenfinch Project (the Project). The Project consists of an open cut gold mine which has a current mine life of 9 years and is located immediately north of the town of Westonia, approximately 60 km west of Southern Cross in the Wheatbelt region of Western Australia. Evolution Mining commissioned Outback Ecology to undertake a level 1 fauna assessment of the Project (this Assessment). The results of this assessment are intended to be reviewed by government regulators in advance of any changes in mine planning. This is intended to reduce lag times between decision making and implementing changes. The area assessed (the Study Area) consists of a 166 hectare portion of land adjacent to Evolution Mining's existing Edna May operations.

The specific objectives of the Assessment were to:

- undertake a desktop study to develop inventories of terrestrial vertebrate and SRE invertebrate species previously identified in the Study Area, or likely to be present in the Study Area;
- provide a description of broad vertebrate fauna habitats, sensitive habitats and terrestrial SRE invertebrate fauna habitats expected to occur within the Study Area, based on the outcomes of the desktop study;
- verify the results of the desktop study through low level sampling of fauna assemblages and mapping of broad fauna habitats present within the Study Area via a reconnaissance survey;
- undertake targeted searches for vertebrate fauna species of conservation significance (including the Malleefowl, *Leipoa ocellata*), SRE invertebrate fauna and invertebrate fauna of conservation significance (i.e. the Shield-backed Trapdoor Spider, *Idiosoma nigrum*, and Tree-stem Trapdoor Spider, *Aganippe castellum*), or habitat likely to support these;
- assess the findings of the reconnaissance survey in a regional context by making comparisons with available data from other localities within the bioregion; and
- identify the potential impacts of the Project on the terrestrial fauna assemblages and habitat in the area.

Survey methodology consisted of targeted and opportunistic searching, habitat assessments and the deployment of baited motion-sensor cameras and SM2BAT+ units. Based on habitat characteristics, five locations were chosen to deploy baited motion-sensor cameras (Reconyx Hyperfire HC600). Additionally, a SM2BAT+ recorder was deployed at four locations within the Study Area for a single night to recorded bat activity in the Study Area.

Four broad fauna habitat types were identified within the Study Area comprising, Mixed Shrubland, *Eucalyptus longicornis* Woodland, mixed Mallee Woodland and *Eucalyptus salubris* Woodland. These habitats within the Study Area were in good to very good condition, with the exception of areas previously disturbed by mining activities. As the Study Area encompasses a large area of remnant native vegetation, which is important in a sub-regional context, all habitat types are considered to be significant to vertebrate fauna. The Study Area lies within a 2,418 ha portion of remnant native

vegetation, which is the 30<sup>th</sup> largest portion of remnant native vegetation within the subregion (i.e. 99.87% of remnant native vegetation that occurs in the subregion occurs in portions smaller than the portion of remnant native vegetation in which the Study Area is located).

A total of 37 species (34 native species) were recorded in this assessment comprising, 23 native birds, 8 native mammals, 3 reptiles and 3 introduced species. None of these species are of conservation significance and all were identified by the database searches as potentially occurring in the Study Area.

The desktop study identified 29 species of conservation significance that potentially occur in the Study Area. Of these, the Western Spiny-tailed Skink (*Egernia stokesii badia*) and the Rainbow Bee-eater (*Merops ornatus*) and snails of the Short-range Endemic genus *Bothriembryon* were considered Very Likely to occur within the Study Area. The Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Carpet Python (*Morelia spilota imbricata*), Bush Stone-curlew (*Burhinus grallarius*) and Brush Bronzewing (*Phaps elegans*) were considered Likely to occur and the Malleefowl (*Leipoa ocellata*), Shield-backed Trapdoor Spider (*Idiosoma nigrum*), Tree-stem Trapdoor Spider (*Aganippe castellum*), Chuditch (*Dasyurus geoffroi*), Red-tailed Phascogale (*Phascogale calura*) and Australian Bustard (*Ardeotis australis*) were considered to Possibly occur within the Study Area. The remaining 16 species were considered Unlikely to occur in the Study Area due to a lack of suitable habitat or the Study Area occurring outside of the species known distribution.

## TABLE OF CONTENTS

<b>1. INTRODUCTION .....</b>	<b>1</b>
1.1. Project Background and Location.....	1
1.2. Report Scope and Objectives .....	1
<b>2. EXISTING ENVIRONMENT .....</b>	<b>4</b>
2.1. Biogeographic Region .....	4
2.2. Climate .....	4
2.3. Soil Landscapes .....	6
2.4. Land Use .....	6
<b>3. DESKTOP STUDY .....</b>	<b>11</b>
3.1. Database Searches .....	11
3.2. Literature Review .....	11
<b>4. SURVEY METHODOLOGY .....</b>	<b>15</b>
4.1. Survey Timing and Weather .....	15
4.2. Habitat Assessment and Site Selection.....	16
4.3. Targeted Searching.....	16
4.4. Opportunistic Searching .....	17
4.5. Motion Sensor Cameras .....	17
4.6. Bat Echolocation Recording .....	17
4.7. Taxonomy and Nomenclature.....	22
4.8. Study Team and Licensing.....	22
<b>5. RESULTS AND DISCUSSION .....</b>	<b>23</b>
5.1. Fauna Habitats in the subregion and Study Area.....	23
5.1.1. Shrubland dominated by <i>Acacia</i> spp. and <i>Melaleuca</i> spp. ....	24
5.1.2. Mixed Woodland dominated by Gimlet ( <i>Eucalyptus salubris</i> ).....	25
5.1.3. Mixed Woodland dominated by <i>Eucalyptus longicornis</i> .....	26
5.1.4. Mixed <i>Eucalyptus</i> Mallee Woodland .....	27
5.2. Fauna Recorded .....	30
5.3. Fauna of Conservation Significance .....	30
5.3.1. Threatened Fauna.....	31
5.3.2. Priority Fauna .....	33
5.3.3. Migratory Birds .....	34
5.3.4. SRE Invertebrate Fauna .....	34
5.4. Limitations and Constraints.....	35
<b>6. THREATENING PROCESSES .....</b>	<b>38</b>
6.1.1. Habitat Removal and Modification .....	38
6.1.2. Collision With Vehicles .....	38
6.1.3. Inappropriate Fire Regimes.....	38

6.1.4.	Noise and Vibration .....	39
6.1.5.	Artificial Light Exposure.....	39
6.1.6.	Dust Emissions.....	40
6.1.7.	Introduced Flora .....	40
6.1.8.	Introduced Fauna .....	40
<b>7.</b>	<b>CONCLUSIONS .....</b>	<b>42</b>
<b>8.</b>	<b>REFERENCES .....</b>	<b>43</b>

## TABLES

Table 1:	Characteristics of Soil-landscapes of the Study Area	8
Table 2:	Detailed summary of vertebrate fauna species richness from desktop study	13
Table 3:	Key findings of relevant past studies	14
Table 4:	Daily weather observations at Merredin, for the October and June survey phases	15
Table 5:	Motion Sensor Camera, SM2 Bat Detectors Sites in the Study Area	22
Table 6:	Study Team for the Field Surveys	22
Table 7:	Broad Fauna Habitats within the Study Area	23
Table 8:	Threatened fauna potentially occurring in the Study Area	32
Table 9:	Priority fauna potentially occurring in the Study Area	33
Table 10:	Migratory bird species potentially occurring in the Study Area	34
Table 11:	Discussion of the potential limitations and constraints of this Assessment	36

## FIGURES

Figure 1:	Regional location of the Study Area	2
Figure 2:	Location of the Study Area	3
Figure 3:	The Study Area with respect to IBRA bioregions and subregions	5
Figure 4:	Climate data for Merredin BOM station (BOM station number: 010092)	6
Figure 5:	Soil landscapes of the Study Area	9
Figure 6:	Land use and locations of native remnant vegetation in and around the Study Area	10
Figure 7:	Long-term rainfall prior to the survey, at Westonia Weather Station	16
Figure 8:	The location of habitat assessments within the component of the Study Area surrounding Greenfinch	18
Figure 9:	The location of targeted search and habitat assessments in the Della Bosca Study Area	19
Figure 10:	The location of targeted searches and spotlighting within the component of the Study Area surrounding Greenfinch	20
Figure 11:	The location of motion sensor camera and SM2 deployments within the component of the Study Area surrounding Greenfinch	21
Figure 12:	Broad fauna habitats within the component of the Study Area surrounding Greenfinch	28
Figure 13:	Broad fauna habitats within the Della Bosca component of the Study Area	29
Figure 14:	Terrestrial SRE Invertebrate Collection Records in relation to the Study Area	37

## **APPENDICES**

APPENDIX A - Vertebrate Fauna Recorded in Tenement E69/3065 Study Area and Surrounds

APPENDIX B - Codes and Terms Used to Describe Fauna of Conservation Significance

APPENDIX C - Raw Data from Habitat Assessments

## 1. INTRODUCTION

### 1.1. Project Background and Location

Evolution Mining is currently evaluating the potential of developing the Edna May and Greenfinch Project (the Project). The Project consists of an open cut gold mine which has a current mine life of 9 years and is located immediately north of the town of Westonia, approximately 60 km west of Southern Cross in the Wheatbelt region of Western Australia (WA) (**Figure 1**). Evolution Mining commissioned Outback Ecology to undertake a level 1 fauna assessment of the Project (this Assessment). The results of this assessment are intended to be reviewed by government regulators in advance of any changes in mine planning. The area assessed (the Study Area) consists of a 166 hectare (ha) portion of land adjacent to Evolution Mining's existing Edna May operations (**Figure 2**).

### 1.2. Report Scope and Objectives

The purpose of this Assessment was to gather background biological information on the terrestrial vertebrate fauna, short-range endemic (SRE) invertebrate fauna and fauna habitats of the Study Area, in order to support future permit and approvals documentation for Evolution Mining. To this end, the specific objectives of the Assessment were to:

- undertake a desktop study to develop inventories of terrestrial vertebrate and SRE invertebrate species previously identified in the Study Area, or likely to be present in the Study Area;
- provide a description of broad vertebrate fauna habitats, sensitive habitats and terrestrial SRE invertebrate fauna habitats expected to occur within the Study Area, based on the outcomes of the desktop study;
- verify the results of the desktop study through low level sampling of fauna assemblages and mapping of broad fauna habitats present within the Study Area via a reconnaissance survey;
- undertake targeted searches for vertebrate fauna species of conservation significance (including the Malleefowl, *Leipoa ocellata*), SRE invertebrate fauna and invertebrate fauna of conservation significance (ie the Shield-backed Trapdoor Spider, *Idiosoma nigrum*, and Tree-stem Trapdoor Spider, *Aganippe castellum*), or habitat likely to support these;
- assess the findings of the reconnaissance survey in a regional context by making comparisons with available data from other localities within the bioregion; and
- identify the potential impacts of the Project on the terrestrial fauna assemblages and habitat in the area.

The objectives and methods of this Assessment were aligned with the following regulatory guidelines:

- Environmental Protection Authority (EPA) *Position Statement 3 Terrestrial Biological Surveys as an Element of Biodiversity Protection* (2002);
- EPA Guidance 56 *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA: Environmental Protection Authority 2004);
- EPA and Department of Environment and Conservation (DEC) *Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (EPA and DEC: Environmental Protection Authority and Department of Environment and Conservation 2010);
- Environmental Protection Authority *Guidance No. 20, Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in Western Australia* (EPA: Environmental Protection Authority 2009); and
- *National Manual for the Malleefowl Monitoring System: Standards, Protocols and Monitoring Procedures, National Malleefowl Monitoring Project* (Natural Heritage Trust 2007).

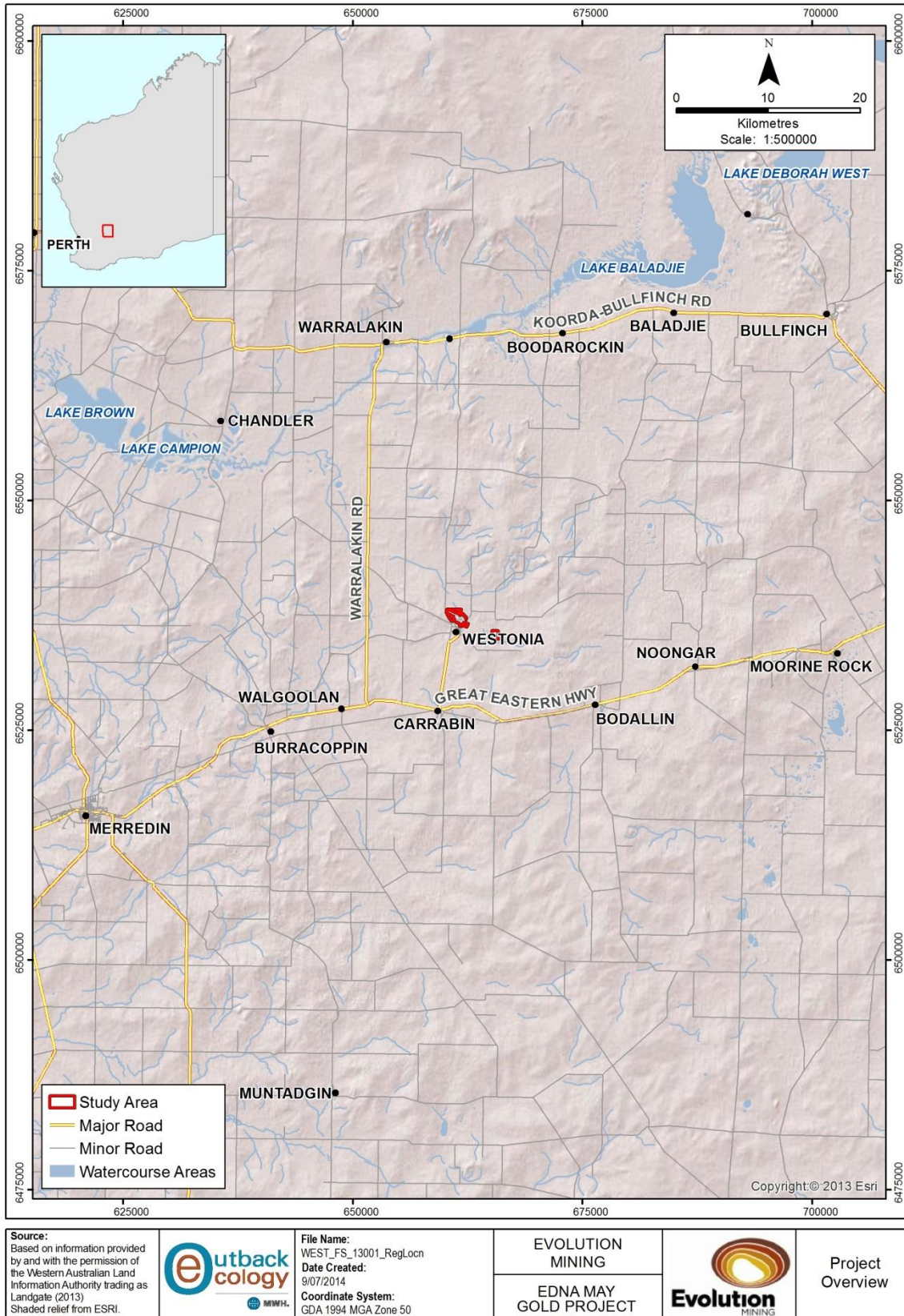


Figure 1: Regional location of the Study Area



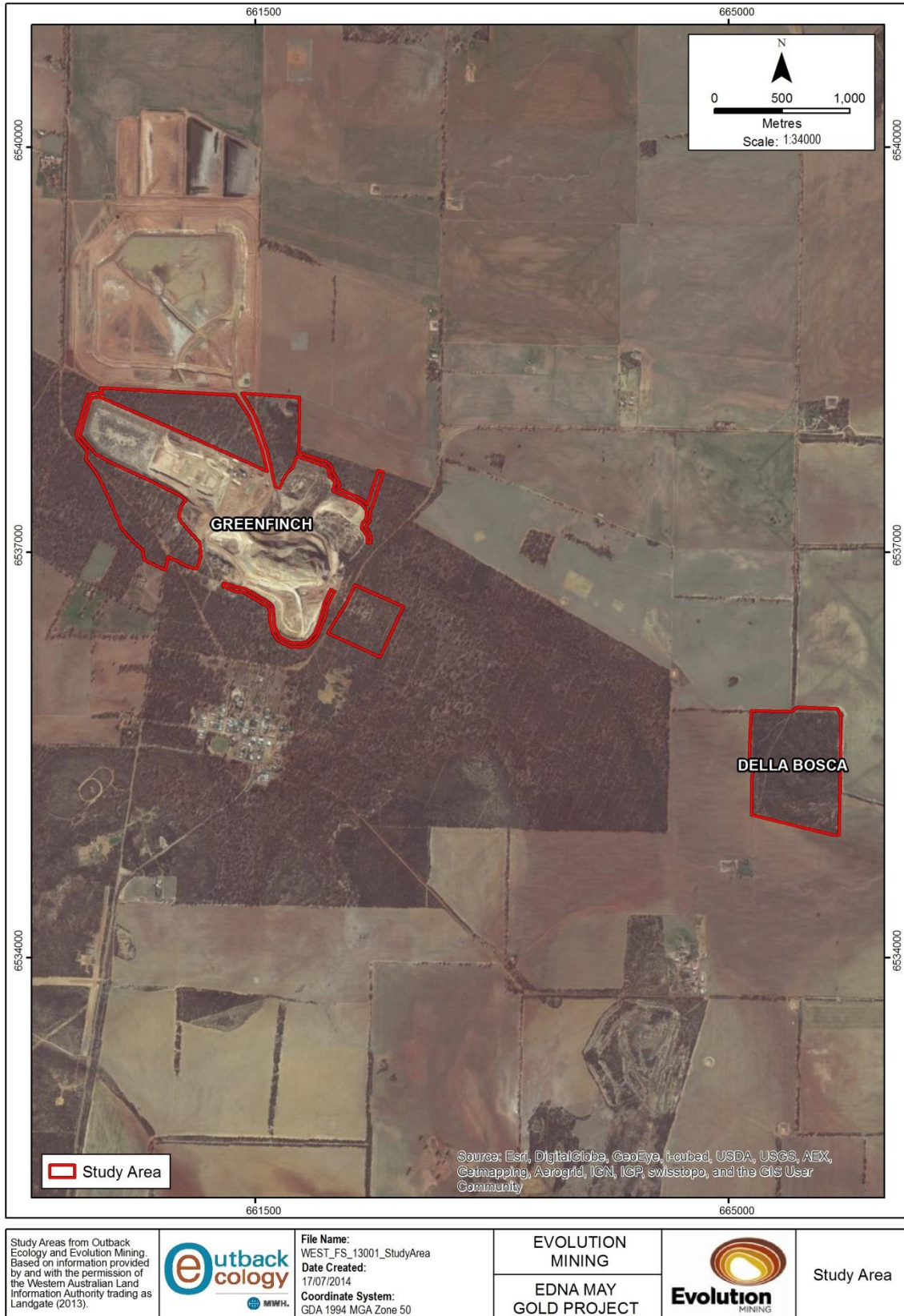


Figure 2: Location of the Study Area

## 2. EXISTING ENVIRONMENT

### 2.1. Biogeographic Region

The Study Area occurs in the Avon Wheatbelt bioregion, as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) classification system (McKenzie *et al.* 2003) (**Figure 3**). The Avon Wheatbelt biogeographic region encompasses 9,578,999 ha of land and has a semi-arid warm Mediterranean climate. There is little connected drainage in the bioregion with salt lake chains occurring as remnants of ancient drainage systems that only function in very wet years.

Land uses are primarily dryland agriculture and grazing. Smaller areas include Crown reserves (mainly conservation estate), mining operations and rural residential communities. The region has been extensively cleared for agriculture and grazed by stock, and consequently has numerous environmental problems, threatened ecological communities and species at risk (Beecham 2001). Remnant vegetation, wetlands, riparian systems, populations of species and ecosystems at risk are in poor condition, with the trend expected to decline. Extensive clearing of native vegetation has led to salinity problems being experienced throughout the bioregion. The Avon Wheatbelt bioregion has experienced declines in its mammalian fauna, in concert with an increased presence of invasive species (Beecham 2001). Small mammals (35 – 7,000g weight range) are particularly threatened by fox predation.

The region is divided into two major components: the Avon Wheatbelt 1 (AW1 – Ancient Drainage) subregion and the Avon Wheatbelt 2 subregion (AW2 – Re-juvenated Drainage). The Study Area lies within the Avon Wheatbelt 1 subregion which encompasses 6,566,022 ha and broadly comprises gently undulating landscapes of low relief; proteaceous scrub heaths on residual lateritic uplands and mixed woodlands on quaternary alluvial soils. The Study Area is dominated by mixed woodland of Mallee and *Eucalyptus* species. There are eight Threatened Ecological Communities (TEC's) within the Avon Wheatbelt 1 subregion with a further five ecosystems listed as being 'at risk', and three wetlands of subregional significance (Beecham 2001). No TEC's or wetlands of subregional significance occur within the Study Area.

### 2.2. Climate

The Avon Wheatbelt bioregion climate is semi-arid warm Mediterranean and is characterised by hot dry summers and wet winters. Climate is controlled primarily by 'southern oscillation of the anticyclonic belt' with relatively small influence of the 'El Nino' effect. The closest Bureau of Meteorology (BOM) weather station providing long-term data is located at Merredin (BOM station: 010092), approximately 42 km to the south-west. The Merredin BOM station has a long term mean annual rainfall of 325.8 millimetres (mm), with the majority of this rain falling between May and August (**Figure 4**). Approximately 70% of annual rainfall falls during the 5-month growing period (May-September) and is of relatively low variability. Long-term statistics indicate that the monthly mean maximum temperatures range from 19° C in July to 37.4 ° C in January, and mean minimum temperatures range between 14.2 ° C in July to 30.9° C in January (BOM 2014).

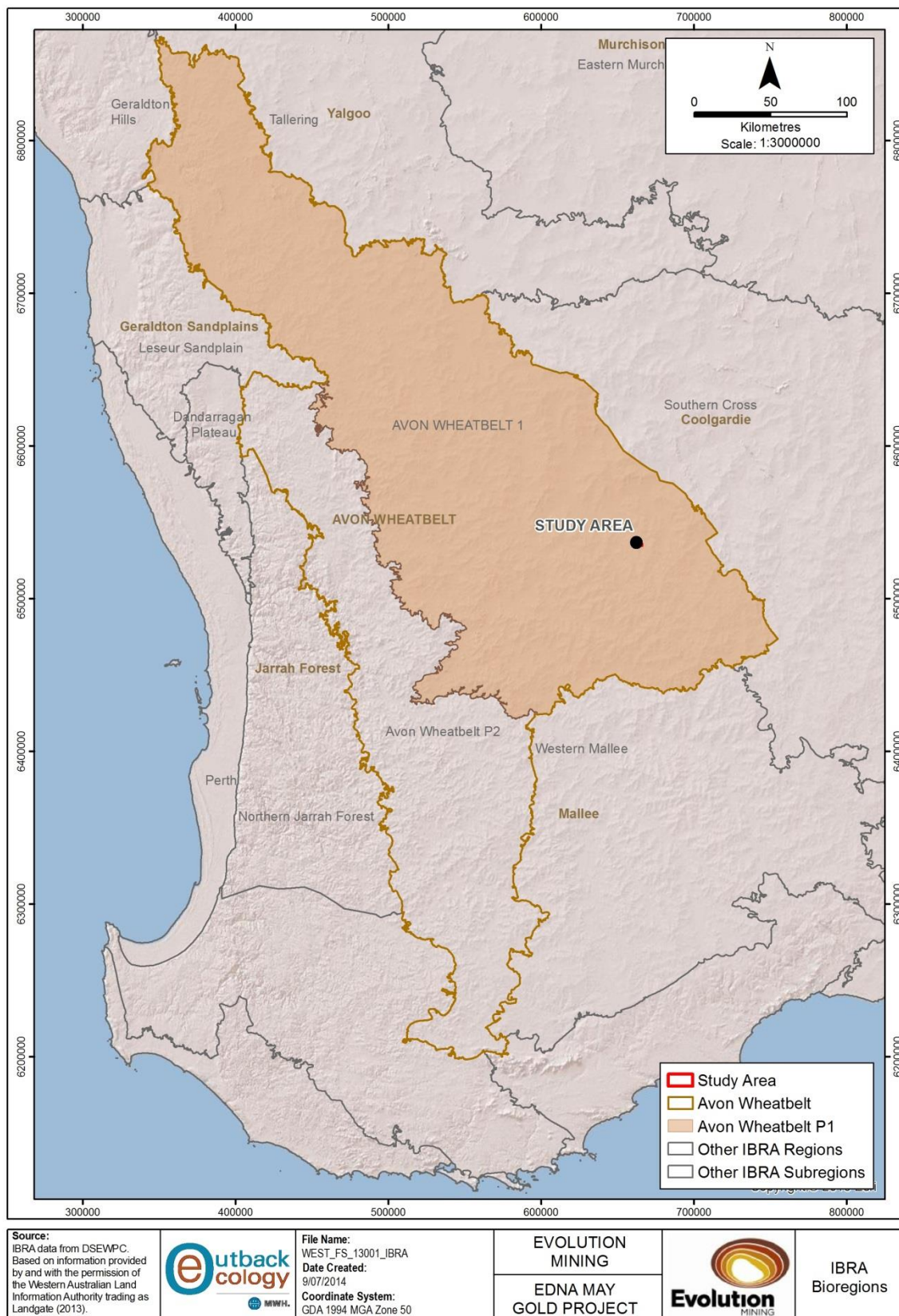
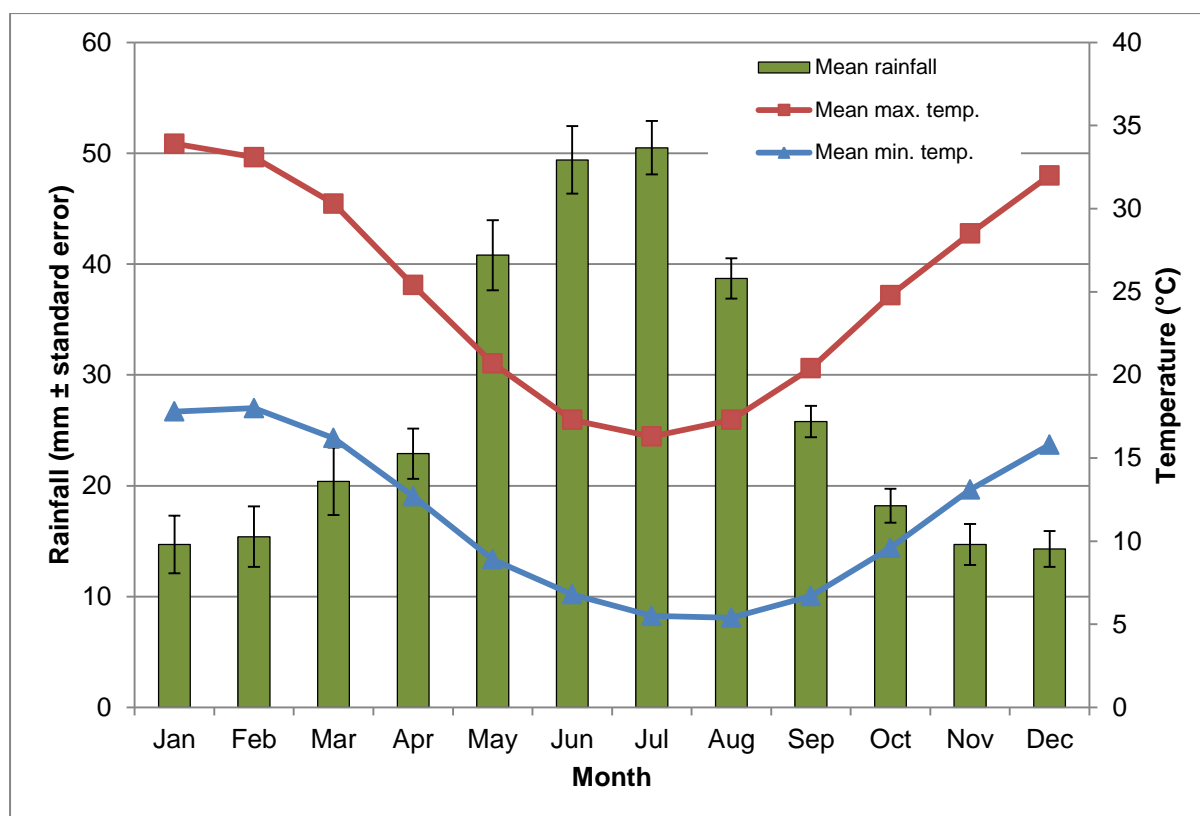


Figure 3: The Study Area with respect to IBRA bioregions and subregions



**Figure 4: Climate data for Merredin BOM station (BOM station number: 010092)**

Source data: (BOM 2014) 1903 - 2014

### 2.3. Soil Landscapes

The Department of Agriculture in Western Australia, with support from the National Soil Conservation Program (NSCP), National Landcare Program (NLP) and Natural Heritage Trust (NHT), has completed a 15-year mapping program to provide a soil and land resource inventory for approximately 25 million hectares in the south-west agricultural areas of Western Australia. This report provides an overview of the soil-landscape mapping program for south-western Australia.

An assessment of these soil landscapes provides an indication of the occurrence and distribution of broad scale fauna habitats within and surrounding the Study Area. The Study Area contains six soil landscapes (**Figure 5, Table 1**). Of these, five are associated with naturally occurring soil landscapes and the sixth, Holleton Mine Phase, is related to disturbed lands associated with mining activities.

### 2.4. Land Use

The Study Area lies within the Avon Wheatbelt 1 subregion which is dominated by dryland agriculture and grazing on improved pastures with lesser areas of Unallocated Crown Land (UCL) and Crown Reserves, rural residential land and mining areas (**Figure 6**).

Conservation reserves in the vicinity of the Study Area include the Carrabin Nature Reserve and the Sandford Rocks Nature Reserve, approximately 13 km to the south and ten km to the north-east

respectively. Both reserves and other remnant vegetation (**Figure 6**) contain important refuge habitat for terrestrial fauna including granite outcrops, permanent water pools and various scrub and woodlands.

Table 1: Characteristics of Soil-landscapes of the Study Area

Soil Landscape	Landform Description	Soil Description	Vegetation Description	Extent in Study Area (ha)
Holleton Mine Phase	Disturbance by Mining			41
Tandegin 1	Crestal and upper slope sandplain with weakly expressed, weakly indurated breakaways and colluvial backslopes comprising gravelly yellow sands, earths and gravels with Tammar and Kwongan heath.	Shallow sandy and loamy gravels on crests and breakaways, yellow sandy earths on backslopes, grading to deep yellow sands with Fe nodulation at depth	<i>Kwongan with mixed low open woodland dominated by Acacia, Allocasuarina, Proteaceae and Melaleuca species</i>	33
Baladjie 3	Saline playa lake & surrounding lunettes. Salt lake soils with salt & gypsum crystal rich surfaces, pale deep sands & calcareous loamy earths	Lacustrine Tertiary sediment deposits with aeolian deposits around the margins of lakes	Salt lake soil associated calcareous loamy earths	33
Tandegin 2	Very smoothly undulating sandy aeolian deposits on uplands located directly south east of valley sources, comprising deep yellow sands and earths with gravels forming from recent lateritisation, typically vegetated by Banksia woodland.	Deep yellow sands and gravelly sands. Shallow gravels and duricrust may be exposed on crests	<i>Kwongan with mixed low open woodland dominated by Acacia, Allocasuarina, Proteaceae &amp; Melaleuca species</i>	23
Holleton 3d	Dolerite rock and soil	N/A	N/A	23
Holleton 3 Granite Phase	Irregular undulating rises to undulating low hills with shallow soils and fresh rock outcrop.	Mainly alkaline to neutral sandy duplexes with gritty gradational soils fringing small rock outcrops, minor loams & loamy duplexes	Complex associations containing York Gum, <i>Acacia acuminata</i> , <i>A. lasiocalyx</i> , <i>Allocasuarina campestris</i> & shrubby understorey, & Mallee	8
Baladjie 2	Level to very gently inclined plains, including some very gently inclined valley slopes. Dominant soils Calcareous loamy earths and Alkaline red shall	Quaternary and Tertiary sedimentary deposits	Salmon gum-gimlet-morrel woodland	2
Holleton 2 Sand Plain Phase	Isolated low hills and rises with yellowish red sandplain and red duplexes	Mafic ironstone gravelly soils grading downslope to yellow loamy earths, bordered by acid shallow and sandy duplexes and interspersed with alkaline re	<i>Proteaceae</i> and <i>Casuarinaceae</i> on ironstone gravelly soils, <i>acacia</i> species with minor <i>Proteaceae</i> on yellow earths and Mallee	3
<b>Total</b>				<b>166 ha (100.0%)</b>

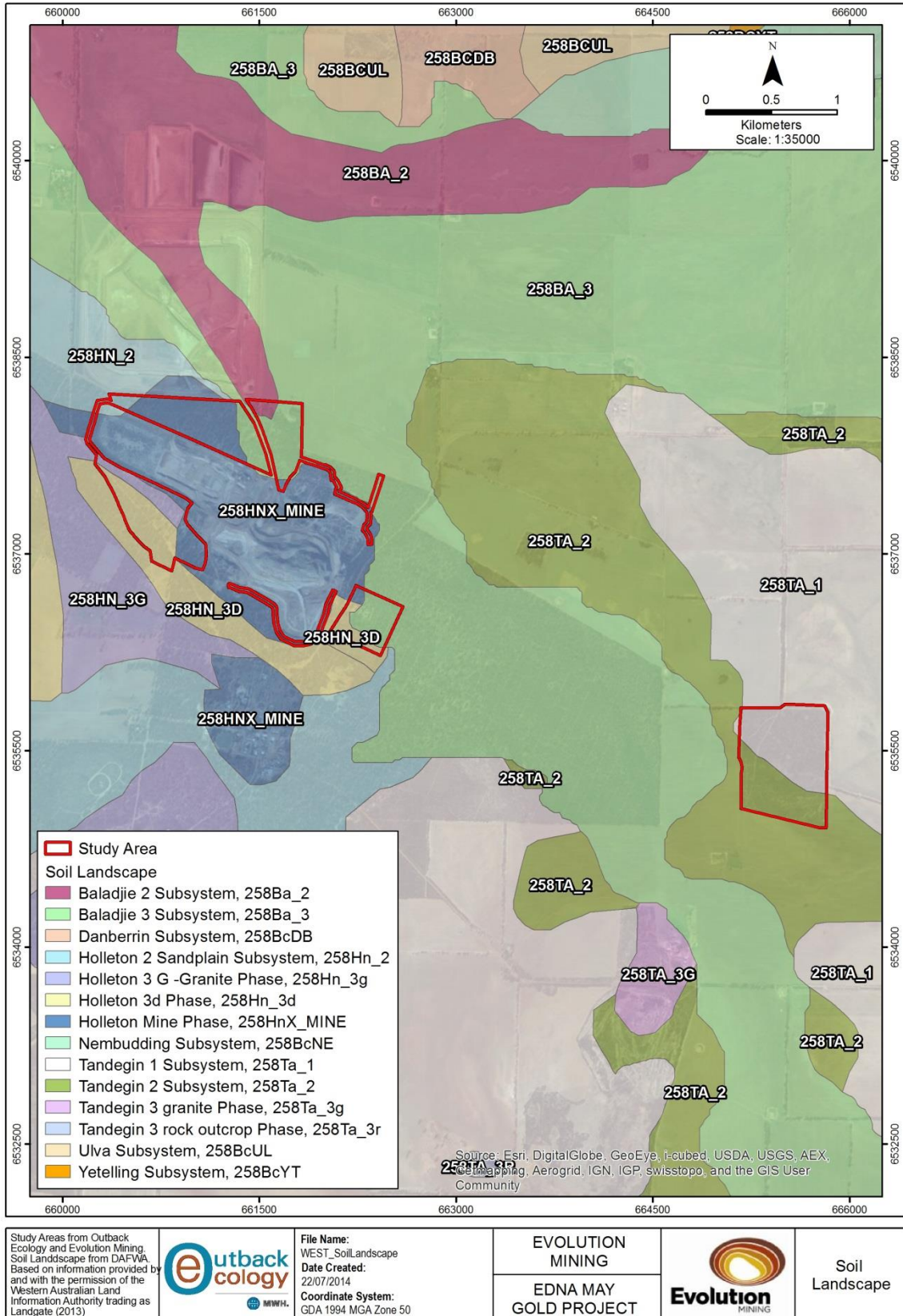


Figure 5: Soil landscapes of the Study Area

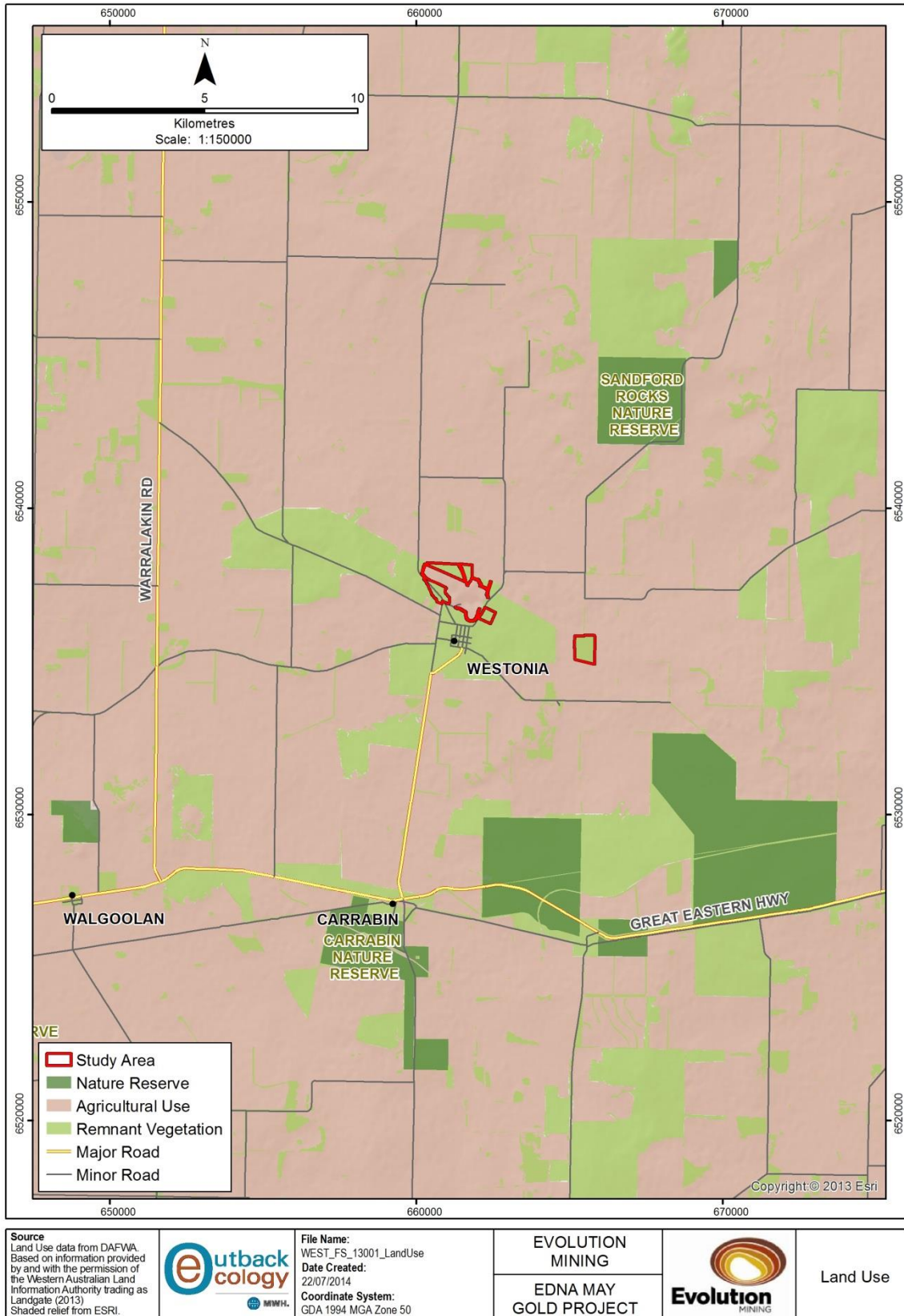


Figure 6: Land use and locations of native remnant vegetation in and around the Study Area



### 3. DESKTOP STUDY

Database searches and a literature review were undertaken prior to the field survey to identify the vertebrate and invertebrate fauna which potentially occur in the Study Area. Collectively, the database searches and literature review identified a total of 236 species of extant, vertebrate fauna that potentially occur in the Study Area. The key results of the database searches and literature review are presented in **Section 3.1** and **Section 3.2**, and for species of conservation significance the likelihood of their occurring in the Study Area is described in **Section 5.3**. The complete inventory of species generated by the desktop study is presented in **Appendix A**.

#### 3.1. Database Searches

For the purpose of database searching, the Study Area was defined as either a central point with coordinates 661157 mE 6537514 mS (GDA 1994, UTM 50J) or a polygon comprising the Study Area. The databases and search areas used were:

- the WA DEC's NatureMap database (DEC: Department of Environment and Conservation 2013a), with a search area consisting of the central point surrounded by a circular buffer zone of 40 km radius;
- the WA DEC's Threatened and Priority Fauna Database (DEC: Department of Environment and Conservation 2013b), with a search area consisting of the Study Area with a buffer of 75 km;
- the BirdLife Australia Atlas database (Birdlife Australia 2013), with a search area consisting of the Study Area with a buffer of 75 km;
- the Protected Matters Search Tool (DSEWPaC: Department of Sustainability 2013a), with a search area consisting of the central point surrounded by a circular buffer zone of 75 km radius; and
- the WA Museum arachnid, myriapod and mollusc collections (WAM: Western Australian Museum 2013), with a search area consisting of the central point surrounding by a square box with side of 100 km.

The database searches for the Study Area reported a total of 225 vertebrate fauna species (218 native species) (**Appendix A**), of which 27 are of conservation significance (**Section 6.3**), including:

- 15 threatened species; i.e. those species listed as Endangered or Vulnerable under the *EPBC Act* and/or Schedule 1 and/or Schedule 4 under the *WA Wildlife Conservation Act 1950 (WC Act)*;
- three priority species; i.e. those species on DEC's Priority Fauna Species list; and
- ten migratory species (including 2 species listed as "threatened" species"); i.e. those species listed as Migratory under the *EPBC Act* and/or as Schedule 3 under the *WC Act*.

#### 3.2. Literature Review

The literature review identified two previous studies of relevance (**Table 3**). For these studies, the results were collated to generate an inventory of the vertebrate fauna known to occur in the locality of the Study Area and within the surrounding wider region (**Appendix A**).

A detailed summary of vertebrate fauna species richness from the desktop study is presented in **Table 2**. Previous studies in the vicinity of the Study Area reported a total of 68 vertebrate fauna species (67 native species), of which one, the Rainbow Bee-eater (*Merops ornatus*) is listed as a “migratory” species.

The key findings of relevant past studies are presented in **Table 3**.

**Table 2: Detailed summary of vertebrate fauna species richness from desktop study**

Taxa	This Study	Literature Review			Database searches					Total
		A	B	Total	C	D	E	F	Total	
Amphibians	0	0	0	<b>0</b>	0	0	5	0	<b>5</b>	<b>5</b>
Native Birds	22	43	42	<b>61</b>	16	140	95	7	<b>152</b>	<b>157</b>
Introduced Birds	0	0	0	<b>0</b>	0	3	3	0	<b>3</b>	<b>3</b>
Native Mammals	8	2	0	<b>2</b>	8	0	12	1	<b>17</b>	<b>22</b>
Introduced Mammals	3	1	0	<b>1</b>	0	0	4	0	<b>4</b>	<b>5</b>
Reptiles	3	4	0	<b>4</b>	2	0	41	1	<b>44</b>	<b>44</b>
<b>Total Native Species</b>	<b>33</b>	<b>49</b>	<b>42</b>	<b>67</b>	<b>26</b>	<b>140</b>	<b>153</b>	<b>9</b>	<b>218</b>	<b>228</b>
<b>Total Species</b>	<b>36</b>	<b>50</b>	<b>42</b>	<b>68</b>	<b>26</b>	<b>143</b>	<b>160</b>	<b>9</b>	<b>225</b>	<b>236</b>

**Surveys considered in Literature Review**

- A** Vertebrate Fauna of the Westonia Mine Lease  
**B** Avian Fauna of the Westonia Commons and Waste Rock Dumps

**Database Searches**

- C** Threatened and Priority Fauna Database – DEC (2013b)  
**D** BirdData: Custom Atlas Bird List – BirdLife Australia (2013)  
**E** NatureMap Database – DEC (2013a)  
**F** Protected Matters Search Tool – DSEWPac (2013a)

**Table 3: Key findings of relevant past studies**

Code Reference(s)	Survey details	Proximity to Study Area	Methods	Habitats defined or noted	Vertebrate fauna assemblage found	Fauna of conservation significance	Notes
<b>A</b> Bamford Consulting Ecologists (2002)	<p><u>Project:</u> Vertebrate Fauna of the Westonia Mine Lease</p> <p><u>Client:</u> Knight Piesold Consulting</p> <p><u>Survey type:</u> Level 1 Assessment</p> <p><u>Survey date:</u> October 2002</p>	Coincident with and adjacent to the Study Area	<ul style="list-style-type: none"> <li>• Avifauna census</li> <li>• Targeted searches</li> <li>• Spotlighting</li> </ul>	<ul style="list-style-type: none"> <li>• Open paddock</li> <li>• Eucalypt woodland</li> <li>• Mixed mulga shrubland</li> <li>• Revegetation areas</li> </ul>	<p><u>51 species:</u></p> <ul style="list-style-type: none"> <li>• 2 native mammal</li> <li>• 1 introduced species</li> <li>• 44 bird</li> <li>• 4 reptile</li> </ul>	<p><u>Priority and Migratory:</u></p> <ul style="list-style-type: none"> <li>• Rainbow Bee-eater</li> </ul>	<p>As the site had been logged in the past, there was little evidence of significant hollows that would be used by cockatoos (e.g. Red-tailed Black Cockatoo or Carnaby's Cockatoo) for breeding. Narrow hollow stumps (20-30cm diameter) standing throughout the site.</p> <p>No night birds were recorded during spotlighting, possibly due to the lack of nesting hollows or the lack of prey.</p> <p>Eucalypt woodland and Mixed Mulga shrublands are known to occur within the Study Area. Fauna identified during this assessment within these habitats are likely to occur within the Study Area</p>
<b>B</b> Simmons (2002)	<p><u>Project:</u> Avian Fauna of the Westonia Commons and Waste Rock Dumps</p> <p><u>Study type:</u> Avifauna Survey</p> <p><u>Survey date:</u> Autumn 2001 and 2002</p>	Coincident with and adjacent to the Study Area	<ul style="list-style-type: none"> <li>• Avifauna Census</li> <li>• Opportunistic recording</li> </ul>	<ul style="list-style-type: none"> <li>• Remnant vegetation</li> <li>• Revegetation areas</li> <li>• Disturbed habitat (Mine and Waste Rock Dump (WRD))</li> </ul>	<p><u>37 species:</u></p> <ul style="list-style-type: none"> <li>• 37 bird</li> </ul>	<p><u>Priority and Migratory:</u></p> <ul style="list-style-type: none"> <li>• Rainbow Bee-eater</li> </ul>	<p>Some species that were present reflect relatively undisturbed natural vegetation, adjacent to the Waste Rock Landforms (WRLs)</p>

## 4. SURVEY METHODOLOGY

### 4.1. Survey Timing and Weather

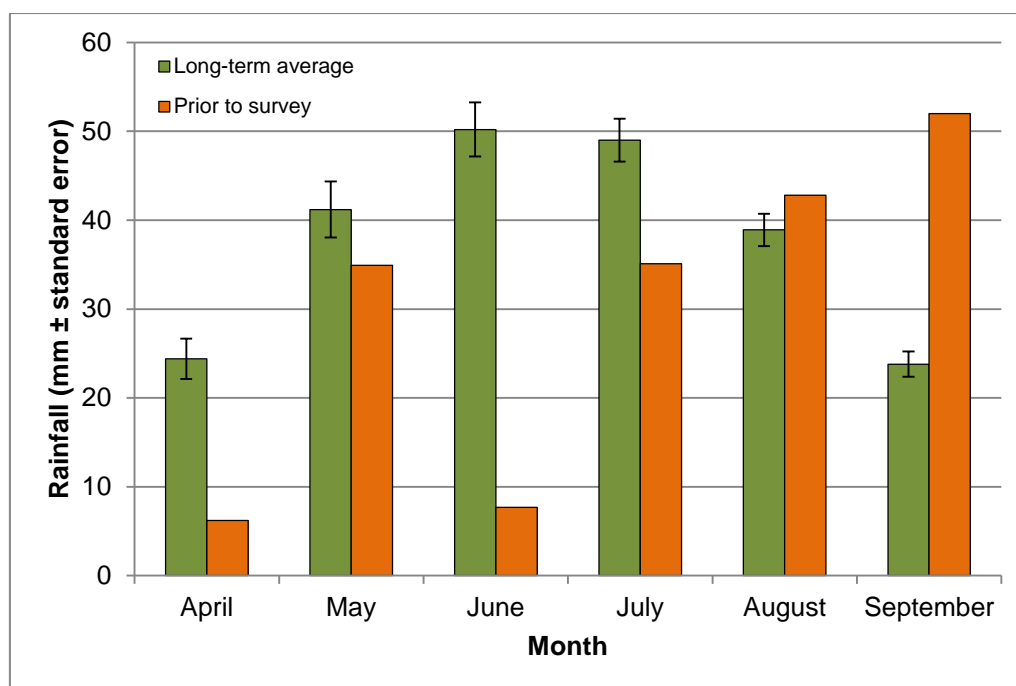
The survey of the Study Area was conducted in two phases; the first phase covered the Greenfinch area from the 7 to 11 October 2013 and the second phase covered the Della Bosca area on 25 June 2014 (**Figure 2**). The weather was appropriate for both phases of the Level 1 survey, although it should be noted that wet conditions experienced from 8 to 10 October 2013 may not have been optimal for documenting reptiles or bats (**During the** second phase survey in June, maximum and minimum temperatures at Merredin BOM station (number: 010092) were 18.4°C and 0.5°C, respectively (BOM 2014). No rainfall was experienced within the Study Area during the survey period, however a total of 13.4 mm of rainfall was received at the Westonia Meteorology Station in the five days prior to the survey (BOM 2014). Low temperatures experienced during the survey period may not have been optimal for the documenting of reptiles and bats.

Table 4). During the first phase in October, maximum and minimum temperatures at Merredin BOM station (number: 010092) during the period were 29.9°C and 5.4°C, respectively. Mean maximum and minimum temperatures were 24.0°C and 6.8°C and total rainfall at Westonia Meteorological Station (less than 1 km south of the Study Area) during the survey was 6.0 mm (**Table 4**). Total rainfall at Westonia Meteorological Station, in the six months prior to the first phase was 178.7 mm, which is below the long-term average total of 227.35 mm for this period (**Figure 7**). However, in the three months leading up to the survey period, slightly above average rainfall was experienced when compared to the long-term averages (**Figure 7**).

During the second phase survey in June, maximum and minimum temperatures at Merredin BOM station (number: 010092) were 18.4°C and 0.5°C, respectively (BOM 2014). No rainfall was experienced within the Study Area during the survey period, however a total of 13.4 mm of rainfall was received at the Westonia Meteorology Station in the five days prior to the survey (BOM 2014). Low temperatures experienced during the survey period may not have been optimal for the documenting of reptiles and bats.

**Table 4: Daily weather observations at Merredin, for the October and June survey phases**

Date	Temperature (°C)		Relative humidity (%)	
	Min	Max	9.00 am	3.00 pm
7/10/2013	5.4	29.9	54	13
8/10/2013	6.8	28.0	70	28
9/10/2013	11.0	16.1	88	60
10/10/2013	5.6	22.2	61	39
11/10/2013	5.5	24.0	69	36
25/06/2014	0.5	18.4	95	42



**Figure 7: Long-term rainfall prior to the survey, at Westonia Weather Station**

Source data: (BOM 2014) 1915 – 2014

#### 4.2. Habitat Assessment and Site Selection

Broad habitat types within the Study Area were identified in the field and representative areas were chosen for habitat assessment (**Figure 8, Figure 9, Appendix C**). The purpose of the habitat assessments was to characterise the quality and complexity of habitat for terrestrial fauna (including SRE species), with a focus on species of conservation significance. The following parameters were considered:

- vegetation cover, condition and species composition;
- estimate of leaf litter cover percentage and type;
- presence or absence of logs or other habitat structures;
- presence or absence of water; and
- type and level of disturbance.

Each of the representative areas was given a rating of excellent, very good, good, moderate, degraded or completely degraded based on the overall condition of the habitat for fauna. Once the habitat types were identified, sites for systematic fauna searches were identified. Subsequent to the field survey, the habitat information was used in conjunction with aerial photography and topographic maps to produce habitat maps for the Study Area.

#### 4.3. Targeted Searching

Based on habitat characteristics and to provide spatial coverage of the Study Area, habitats with the potential to support fauna species of conservation significance (those listed under the *EPBC Act*, the *WC Act* or DEC's Priority Fauna List) were identified during the desktop study and during field reconnaissance of the Study Area (**Figure 9, Figure 10**). Each search was performed by one

zoologist, and the total systematic search effort for this Study was 16 person-hours. Each targeted search involved:

- observation and documentation of all vertebrate fauna seen or heard, or whose presence was inferred from tracks, scats or burrows;
- active hand-searching for cryptic species by overturning logs and stones, and searching beneath leaf litter and the bark of dead trees; and
- active visual and hand-searching for invertebrate species of conservation significance, Shield-backed Trapdoor Spider (*Idiosoma nigrum*) and the Tree-stem Trapdoor Spider (*Aganippe castellum*), by searching for evidence of distinctive trapdoor spider burrow entrances, raking and searching beneath leaf litter.

#### **4.4. Opportunistic Searching**

Within the Study Area vertebrate fauna that were observed outside of the targeted search programme were documented and the resulting records were classified as 'opportunistic'. Opportunistic records supplement those obtained during the targeted sampling, and may have been generated as a result of direct or indirect fauna observations made:

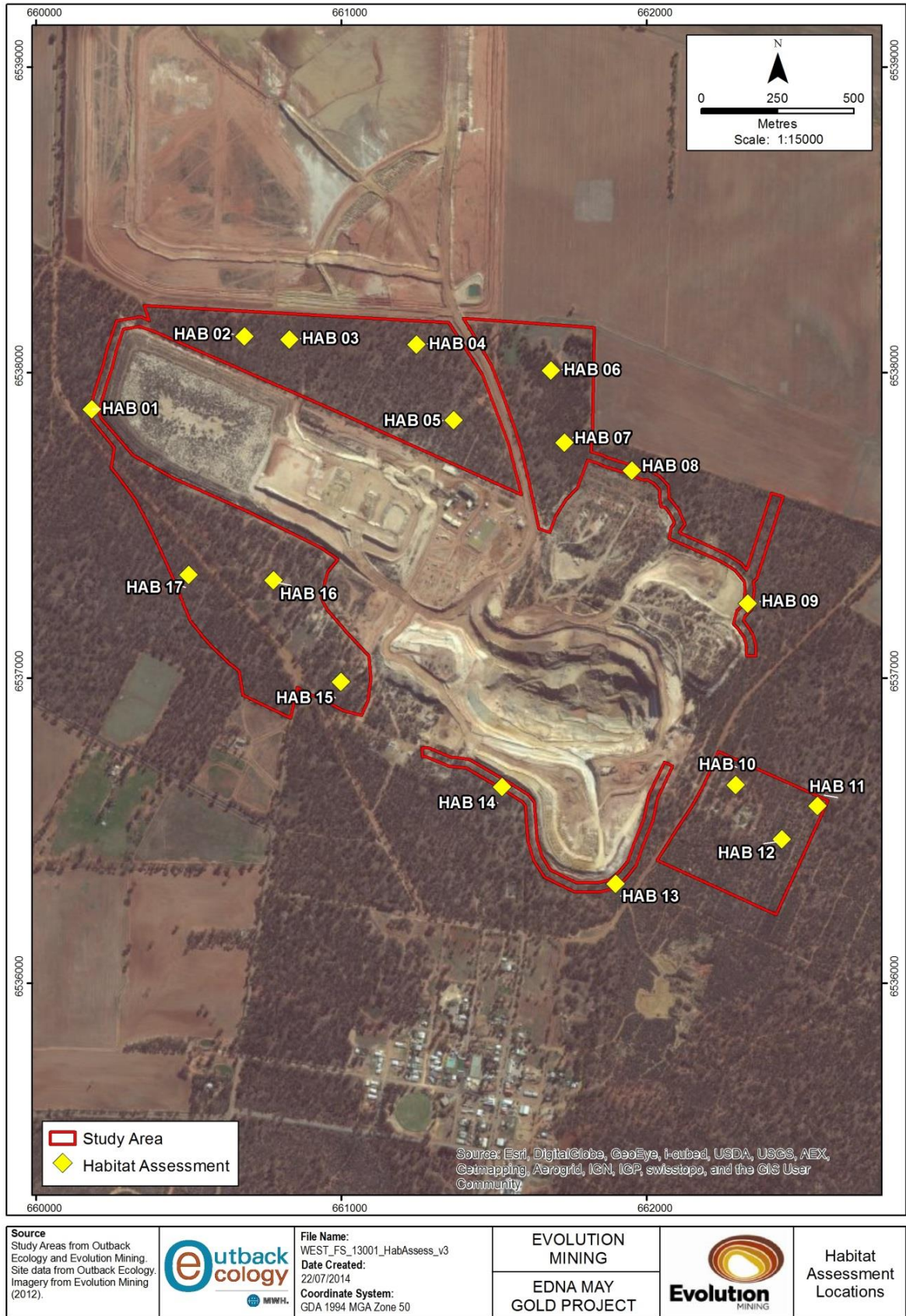
- before or after the targeted searches and aural surveys;
- while habitat mapping or travelling to and from search sites; and
- at any other time whilst working in or travelling within the Study Area.

#### **4.5. Motion Sensor Cameras**

Based on habitat characteristics and to ensure spatial coverage of the Study Area, five locations were chosen to deploy motion-sensor cameras (**Figure 11, Table 5**). The cameras (Reconyx Hyperfire HC600) were baited with a mixture of peanut butter, rolled oats, honey and sardines in oil. Bait was checked on the second day following deployment and replenished where it had been taken. The cameras were intended to record the activities of diurnal and nocturnally active species including macropods, small mammals such as dasyurids and rodents, reptiles and bird species. The total effort for camera trapping was 18 trap-nights.

#### **4.6. Bat Echolocation Recording**

An SM2BAT+ (SM2) recorder, manufactured by Wildlife Acoustics USA was deployed at four locations within the Study Area for a single night (**Figure 11, Table 5**). The SM2 was deployed in locations with habitats features likely to support bat fauna (i.e. in close proximity to a historical mine shaft). Subsequent to the field survey all recordings were analysed by Bat Call WA, providing a species list for each deployment location. The total effort for bat echolocation recording was four SM2 nights.



**Figure 8: The location of habitat assessments within the component of the Study Area surrounding Greenfinch**



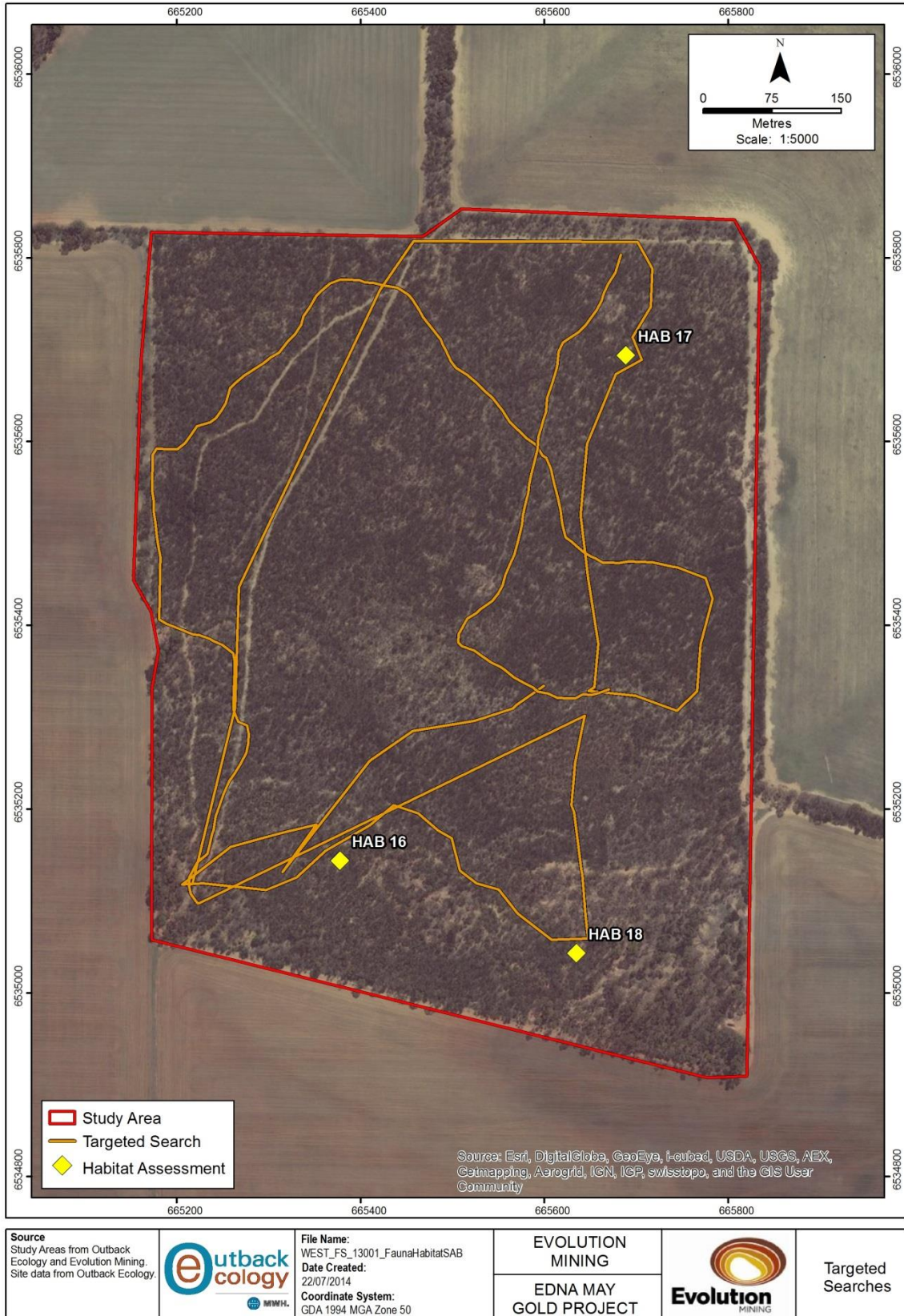
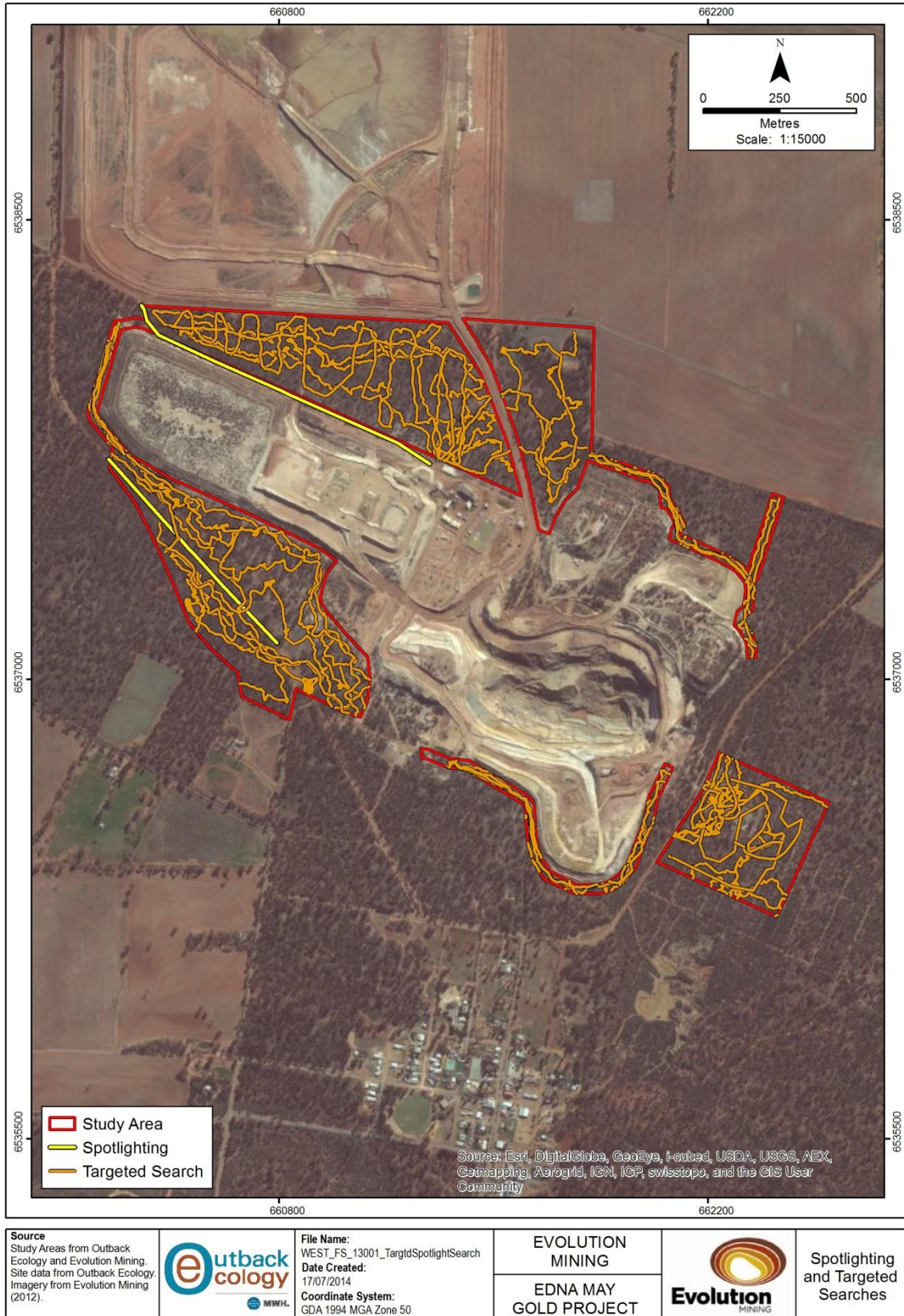
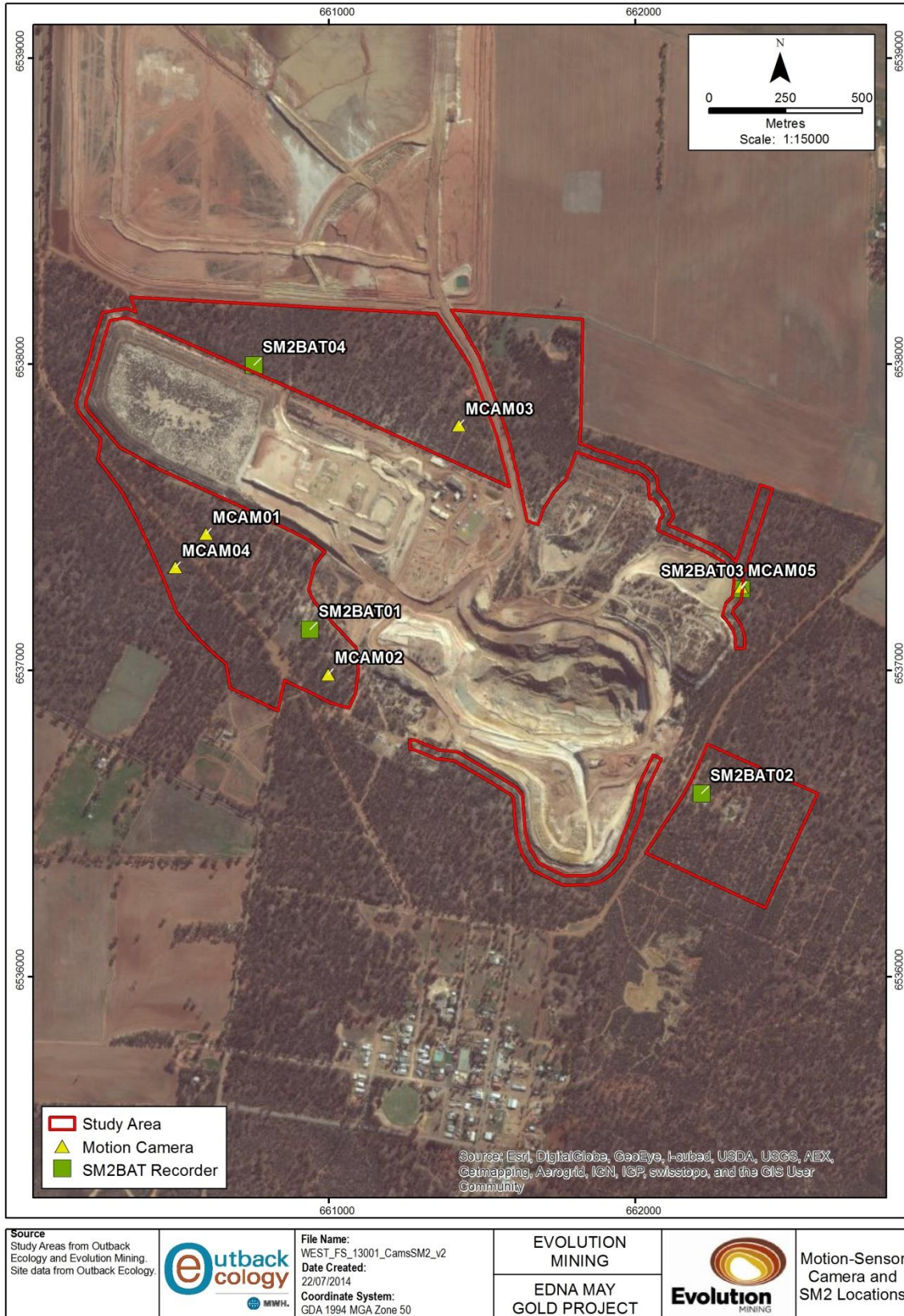


Figure 9: The location of targeted search and habitat assessments in the Della Bosca Study Area



**Figure 10: The location of targeted searches and spotlighting within the component of the Study Area surrounding Greenfinch**



**Figure 11: The location of motion sensor camera and SM2 deployments within the component of the Study Area surrounding Greenfinch**

**Table 5: Motion Sensor Camera, SM2 Bat Detectors Sites in the Study Area**

Site Name	Type	Deployment Duration (Days)	Habitat	Co-ordinates (50J UTM)	
				East	North
MCAM01	Motion Camera	4	<i>E. longicornis</i> Woodland	660600	6537446
MCAM02	Motion Camera	4	<i>E. longicornis</i> Woodland	660999	6536987
MCAM03	Motion Camera	4	<i>E. longicornis</i> Woodland	661425	6537800
MCAM04	Motion Camera	4	<i>E. longicornis</i> Woodland	660500	6537337
MCAM05	Motion Camera	2	<i>E. salubris</i> Woodland	662347	6537272
SM2BAT01	SM2BAT Recorder	1	Disturbance	660939	6537134
SM2BAT02	SM2BAT Recorder	1	<i>E. salubris</i> Woodland	662217	6536599
SM2BAT03	SM2BAT Recorder	1	<i>E. salubris</i> Woodland	662347	6537266
SM2BAT04	SM2BAT Recorder	1	<i>E. longicornis</i> Woodland	660756	6537997

#### 4.7. Taxonomy and Nomenclature

The nomenclature and taxonomy of all mammals, reptiles and amphibians in this report follow the Checklist of the Vertebrates of Western Australia (WAM 2009), and those of all birds follow the Birds Australia Checklist of Australian Birds (2008). Relevant texts, from which information on more recent taxonomic updates and general patterns of distribution are available, were also considered for:

- non-volant mammals (Menkhorst and Knight 2010, Van Dyck and Strahan 2008);
- bats (Churchill 2008);
- birds (Johnstone and Storr 1998, Morcombe 2003, Pizzey and Knight 2007);
- reptiles (Cogger 2000, Wilson and Swan 2008, Wilson and Swan 2010); and
- amphibians (Cogger 2000, Tyler and Doughty 2009).

#### 4.8. Study Team and Licensing

The field survey of the Study Area was conducted by Outback Ecology (**Table 6**). Bat echolocation recordings from SM2BATs were analysed by Bob Bullen, a bat specialist from Bat Call WA. The field survey was conducted under Licences to Take Fauna for Scientific Purposes (DEC Regulation 17 Licence) number SF009477 and SF009885.

**Table 6: Study Team for the Field Surveys**

Study Area	Reg. 17 License Number	Person	Discipline	Qualifications	Position
Greenfinch	SF009477	Rory Swiderski	Zoologist	BSc (Biol and Env Sci) MSc (Env Ass and	Environmental Scientist
Della Bosca	SF009885	Blair Parsons	Zoologist	BSc (Biol/Env Sci) (Hons) PhD (Zool)	Senior Principal Environmental Scientist
		Matt Quinn	Invertebrate Zoologist	BSc (Env. And Marine Sci.)	Environmental Scientist

## 5. RESULTS AND DISCUSSION

### 5.1. Fauna Habitats in the subregion and Study Area

Approximately 797,222 ha (12 %) of the subregion comprises remnant native vegetation. Due to extensive clearing within the subregion, the remnant native vegetation forms habitat isolates (refugia) with little to no connecting vegetation corridors. These isolates are therefore extremely important for the conservation of fauna within the subregion.

How and Dell (2000) showed a positive correlation between the size of native remnant vegetation and vertebrate species diversity, emphasising the importance of remnant native vegetation to vertebrate diversity in the subregion. The Study Area lies within a 2,418 ha remnant of native vegetation, which is the 30<sup>th</sup> largest remnant of native vegetation within the subregion (i.e. 99.87% of the remnants of native vegetation in the subregion are smaller than the remnant vegetation within the Study Area) (Beard 1975). All habitat types in the Study Area are considered to be significant to vertebrate fauna.

Four broad fauna habitat types were identified within the Study Area and two mine shafts were located, which may provide habitat for bats (**Table 7, Figure 12**). Mixed Woodland dominated by Red Morrel (*Eucalyptus longicornis*) was the dominant habitat type comprising 36% of the Study Area. There was no evidence of recent fire activity in the Study Area.

**Table 7: Broad Fauna Habitats within the Study Area**

Broad habitat type	Size within Study Area (ha)	Proportion of Study Area (%)
Shrubland dominated by <i>Acacia</i> spp. and <i>Melaleuca</i> spp.	58	35
Mixed Woodland dominated by Gimlet ( <i>Eucalyptus salubris</i> )	29	17
Mixed Woodland dominated by Red Morrel ( <i>Eucalyptus longicornis</i> )	59	36
Mixed <i>Eucalyptus</i> Mallee Woodland	8	5
<b>Total<sup>1</sup></b>	<b>154</b>	<b>93</b>

<sup>1</sup>The Study Area includes 12 ha of disturbance (7% of the Study Area), which was not classified as a habitat type; consequently, sizes do not sum to the total area of the Study Area and the proportions do not sum to 100%.

### 5.1.1. Shrubland dominated by *Acacia* spp. and *Melaleuca* spp.

Approximately 58 ha (35%) of the Study Area consists of a mixed shrubland habitat type (**Table 7, Figure 12 Figure 13**). This habitat generally consists of a mixed *Acacia* shrubland over a grassland a very open low shrubland dominated by *Atriplex* species (**Plate 1**). Fauna of conservation significance known to occupy habitats such as this include the Malleefowl (*Leipoa ocellata*), Western Spiny-tailed Skink (*Egernia stokesii badia*), Bush Stone-curlew (*Burhinus grallarius*), Australian Bustard (*Ardeotis australis*) and Shield-backed Trapdoor Spider (*Idiosoma nigrum*).



**Plate 1: Mixed Shrubland Habitat Type**

### 5.1.2. Mixed Woodland dominated by Gimlet (*Eucalyptus salubris*)

Approximately 29 ha (17%) of the Study Area consists of an *Eucalyptus salubris* Woodland habitat type (**Table 7, Figure 12**). This habitat generally consists of a gimlet (*E. salubris*) woodland over a sparse shrubland dominated by *Acacia* spp. over very open low shrubland dominated by *Atriplex* species (**Plate 2**). Fauna of conservation significance known to occupy habitats such as this include the Short-billed Black Cockatoo (*Calyptorhynchus latirostris*), Western Spiny-tailed Skink (*Egernia stokesii badia*), Chuditch (*Dasyurus geoffroii*) and Carpet Python (*Morelia spilota*).



**Plate 2: *Eucalyptus salubris* Woodland Habitat Type**

### 5.1.3. Mixed Woodland dominated by *Eucalyptus longicornis*

Approximately 59 ha (36%) of the Study Area consists of a *Eucalyptus longicornis* Woodland habitat type (**Table 7, Figure 12**). This habitat generally consists of *E. longicornis* woodland over a sparse shrubland dominated by *Acacia* spp. over very open low shrubland dominated by *Atriplex* species (**Plate 3**). This habitat type is likely to support the Short-billed Black Cockatoo (*Calyptorhynchus latirostris*), Western Spiny-tailed Skink (*Egernia stokesii badia*), Chuditch (*Dasyurus geoffroi*) and Carpet Python (*Morelia spilota*).



**Plate 3: *Eucalyptus longicornis* Woodland Habitat Type**

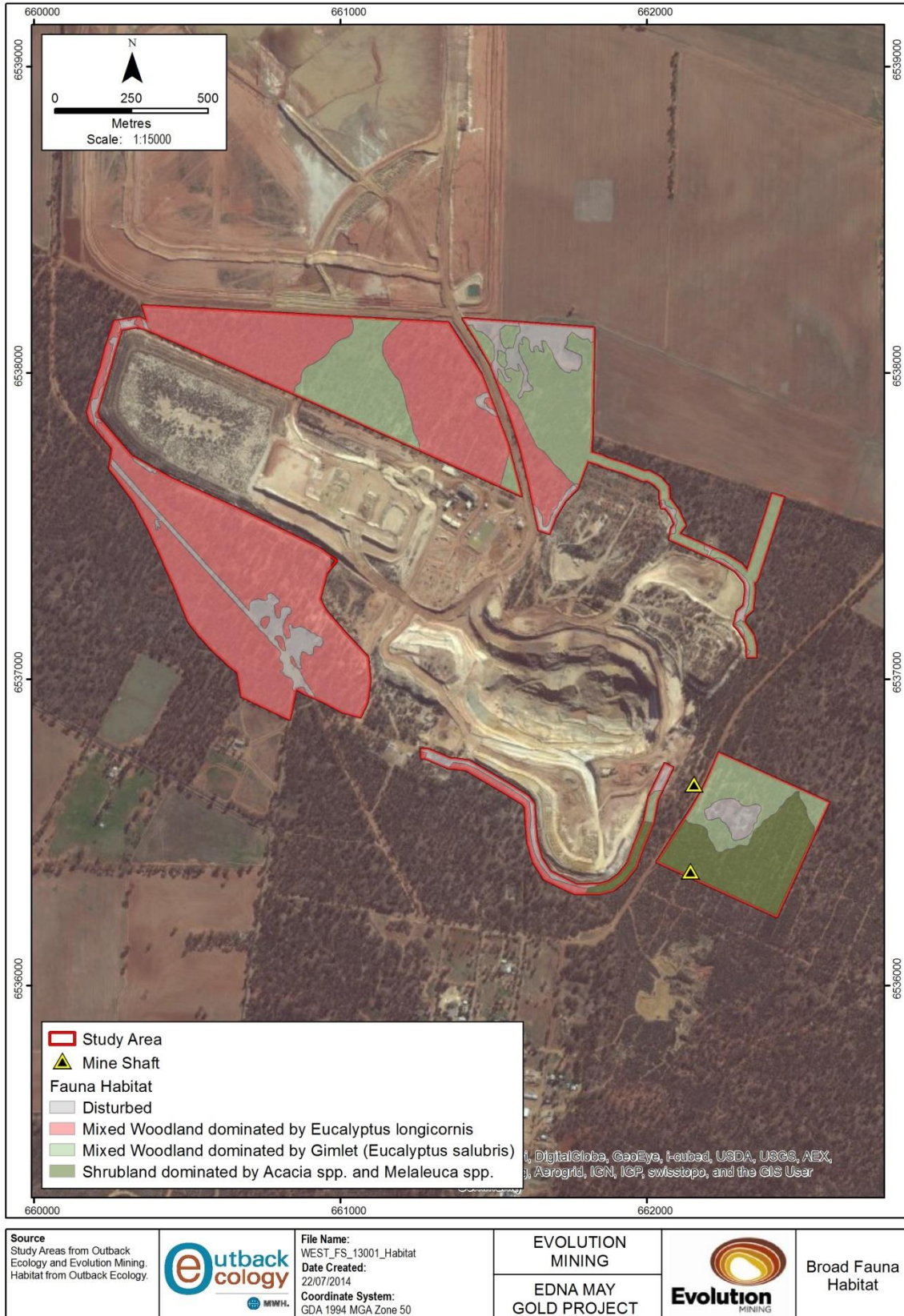


#### 5.1.4. Mixed *Eucalyptus* Mallee Woodland

Approximately 8 ha (5%) of the Study Area consists of a Mixed *Eucalyptus* Mallee Woodland habitat type (**Table 7, Figure 13**). This habitat generally consists of a mixed *Eucalyptus* Mallee Woodland over a sparse shrubland dominated by *Acacia* spp. over an open grassland dominated by *Eragrostis* species (**Plate 4**). This habitat type may support fauna of conservation significance such as the Western Spiny-tailed Skink (*Egernia stokesii badia*), Bush Stone-curlew (*Burhinus grallarius*), Australian Bustard (*Ardeotis australis*) Carpet Python (*Morelia spilota*).



**Plate 4: Mixed *Eucalyptus* Mallee Woodland Habitat Type**



**Figure 12: Broad fauna habitats within the component of the Study Area surrounding Greenfinch**



**Figure 13: Broad fauna habitats within the Della Bosca component of the Study Area**

## 5.2. Fauna Recorded

A total of 37 species (34 native species) were recorded in this assessment comprising, 23 native birds, 8 native mammals, 3 reptiles and 3 introduced species (**Appendix A**). None of these species are of conservation significance and all were identified by the database searches as potentially occurring in the Study Area.

## 5.3. Fauna of Conservation Significance

The desktop study identified 28 species of conservation significance that potentially occur in the Study Area (see **Section 4**). Of these:

- 17 species are listed as Threatened under the EPBC Act and/or WC Act (**Section 5.3.1**);
- three species are recognized by DEC as Priority fauna (**Section 5.3.2**); and
- ten species (including two species also listed as Threatened under the EPBC Act and/or WC Act) are listed as Migratory under the EPBC Act, being subject to international agreements such as the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals) (**Section 5.3.3**).

In **Section 5.3.1** to **Section 5.3.3** the likelihood of each of these species of conservation significance occurring in the Study Area has been assessed and ranked. The rankings were assigned using the following definitions:

**Confirmed** – the presence of the species in the Study Area has been recorded unambiguously during the last ten years (i.e. during recent surveys of the Study Area or from recent records obtained via database searches);

**Very likely** – the Study Area lies within the known distribution of the species and contains suitable habitat(s), plus the species generally occurs in suitable habitat and has been recorded nearby within the last 20 years;

**Likely** – the Study Area lies within the known distribution of the species and the species has been recorded nearby within the last 20 years; however, either:

- a. the Study Area contains only a small area of suitable habitat, or habitat that is only marginally suitable; or
- b. the species is generally rare and patchily distributed in suitable habitat;

**Possible** – there is an outside chance of occurrence, because:

- a. the Study Area is just outside the known distribution of the species, but it does contain suitable and sufficient habitat (the species may be common, rare, or patchily distributed); or
- b. the Study Area lies within the known distribution of the species, but the species is very rare and/or patchily distributed; or
- c. the Study Area lies on the edge of, or within, the known distribution and has suitable habitat, but the species has not been recorded in the area for over 20 years; or

**Unlikely** – the Study Area lies outside the known distribution of the species, the Study Area does not contain suitable habitat, and the species has not been recorded in the area for over 20 years.

For each species of conservation significance identified by the literature review and database searches as potentially occurring within the Study Area, the reason why a particular rank was assigned is explained. Additional species information is also provided for those species that could Possibly occur or are Likely, Very Likely or Confirmed as occurring within the Study Area. Of the 28 terrestrial vertebrate species of conservation significance that potentially occur within the Study Area, 16 species were considered Unlikely to occur in the Study Area due to a lack of suitable habitat or the Study Area occurring outside of the species known distribution (**Appendix A**). These comprised the;

- Fork-tailed Swift (*Fork-tailed Swift*);
- Eastern Great Egret (*Ardea modesta*);
- Cattle Egret (*Ardea ibis*);
- Major Mitchell's Cockatoo (*Lophochroa leadbeateri*);
- Peregrine Falcon (*Falco peregrinus*);
- Common Sandpiper (*Actitis hypoleucos*);
- Sharp-tailed Sandpiper (*Calidris acuminata*);
- Curlew Sandpiper (*Calidris ferruginea*);
- Red-necked Stint (*Calidris ruficollis*);
- Common Greenshank (*Tringa nebularia*);
- Numbat (*Myrmecobius fasciatus*);
- Black-flanked rock-wallaby (*Petrogale lateralis lateralis*);
- Greater Bilby (*Macrotis lagotis*);
- Greater Stick-nest Rat (*Leporillus conditor*);
- Abrolhos Dwarf Bearded Dragon (*Pogona minor minima*); and
- Woma (*Aspidites ramsayi*).

The remaining 12 fauna species of conservation significance were considered Possible, Likely or Very Likely to occur within the Study Area and are discussed in **Section 5.3.1** to **Section 5.3.3**. These comprised ten native vertebrate fauna species and two invertebrate species of conservation significance. None of the above species were Confirmed during this field survey component of this Assessment.

#### 5.3.1. Threatened Fauna

Legislation has been developed at a Commonwealth (EPBC Act) and State (WC Act) level to protect fauna species that have been formally recognised as rare, threatened with extinction or having high conservation value. For the full definitions of conservation significance under these Acts, see **Appendix B**. The desktop study identified 7 Threatened species that could potentially occur in the Study Area, none of which were recorded during the field survey (**Table 8**).

**Table 8: Threatened fauna potentially occurring in the Study Area**

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC Act <sup>1</sup>	In WA <sup>2</sup>	Literature review	Databases	
Carnaby's Black Cockatoo ( <i>Calyptorhynchus latirostris</i> )	EN	S1		1	Likely
<b>Reason for likelihood rank:</b> The Study Area lies within the species distribution of the species and the species has been sighted flying over the Study Area in the past, however breeding is unlikely to occur in the Study Area and surrounds (DSEWPC 2010). This is because the survey did not identify any trees with large hollows that would be considered suitable for breeding within the Study Area. If the species occurs within the Study Area, it is likely to use the Study Area intermittently foraging purposes only. Suitable foraging habitat (Eucalyptus Woodland; 81% of the Study Area) occurs within the Study Area. Extensive targeted searching for the species was conducted within the Study Area, however no evidence of the species was recorded (Outback Ecology 2014).					
Malleefowl ( <i>Leipoa ocellata</i> )	VU	S1		4	Possible
<b>Reason for likelihood rank:</b> The Study Area lies within the species distribution of the Malleefowl (DSEWPaC: Department of Sustainability 2013b). Numerous records of this species have been located within a 15km radius of the Study Area, however the majority of these records are over 10 years old (Parsons 2008, Parsons <i>et al.</i> 2009). Mixed Acacia and Melaleuca shrubland in the Study Area may present suitable habitat for foraging and dispersal, however the habitat type was largely degraded and open and considered unsuitable for mound building. Two inactive mounds were recorded within the Shrubland dominated by <i>Acacia</i> spp. and <i>Melaleuca</i> spp. habitat type that occurred within the Della Bosca Study Area, however it is unlikely that the species still occurs in this habitat type due to its degraded nature.					
Chuditch ( <i>Dasyurus geoffroi</i> )	VU	S1		1	Possible
<b>Reason for likelihood rank:</b> The Study Area lies within the species distribution of the Chuditch (DSEWPaC: Department of Sustainability 2013b). The Chuditch has previously been recorded within 40 km of the Project, however, no information was available as to when this species was recorded (DEC: Department of Environment and Conservation 2013a). There is potential that this is a historical record and the species no longer inhabits the area surrounding the Study Area. Although suitable habitat (Eucalyptus Woodland; 81% of the Study Area) occurs within the Study Area, the wheat belt population of this species is highly fragmented and has a patchy distribution within the region.					
Red-tailed Phascogale ( <i>Phascogale calura</i> )	EN	S1		2	Possible
<b>Reason for likelihood rank:</b> The Study Area is located on the north-eastern boundary of the species distribution ((DSEWPaC: Department of Sustainability 2013b). Generally this species is associated with <i>Allocasuarina</i> woodlands with hollow-containing eucalypts ( <i>Eucalyptus wandoo</i> ) and <i>Gastrolobium</i> spp. (Kitchener 1981, Maxwell <i>et al.</i> 1996), which do not occur within the Study Area.					
Western Spiny-tailed Skink ( <i>Egernia stokesii badia</i> )	EN	S1		1	Very Likely
<b>Reason for likelihood rank:</b> The Study Area lies within the species distribution of the Western Spiny-tailed Skink (DSEWPaC: Department of Sustainability 2013b). Populations persist in woodland patches as small as one hectare and completely surrounded by wheatfields. Suitable habitat for the species occurs throughout the Study Area. Greater numbers of individuals are likely to be found where numerous fallen logs are found, such as sites HAB03, HAB10 and HAB13 ( <b>Figure 8, Appendix C</b> ).					
Shield-backed Trapdoor Spider ( <i>Idiosoma nigrum</i> )	VU	S1		1	Possible
<b>Reason for likelihood rank:</b> The Study Area lies within the western edge of the species distribution (DSEWPaC: Department of Sustainability 2013b). Suitable habitat (Mixed Shrubland; 10% of the Study Area) occurs within the Study Area, however leaf litter accumulation within this habitat type appears to be disturbed by sheet flow water run-off from the surrounding Waste Rock Landform. Without permanent leaf litter accumulations, the species is unlikely to establish burrows within the Study Area. It is possible that the species occurs in areas where leaf litter accumulations are undisturbed, however extensive targeted searches in these areas failed to identify the species within the Study Area. Extensive targeted searching for the species was conducted within the Study Area, however no evidence of the species was recorded (Outback Ecology 2014).					

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC Act <sup>1</sup>	In WA <sup>2</sup>	Literature review	Databases	
Carpet Python ( <i>Morelia spilota imbricata</i> )		S4		1	Likely
<b>Reason for likelihood rank:</b> The Study Area is located on the northern boundary of the species distribution (Wilson and Swan 2008). The close record of this species was occurs near Merredin, approximately 40 km south-west of the Study Area (DEC: Department of Environment and Conservation 2013b). Suitable habitat (Eucalyptus Woodland; 81% of the Study Area) occurs within the Study Area. The species may also utilise the Mixed Shrubland habitat type (10% of the Study Area) within the Study Area for foraging purposes.					

<sup>1</sup>Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – EN: Endangered, VU: Vulnerable; <sup>2</sup> Status under the Western Australian *Wildlife Conservation Act 1950* – S1: Schedule 1, S4: Schedule 4. See **Appendix B** for full definitions of conservation status

### 5.3.2. Priority Fauna

The WA DEC recognises several species that are not listed under the WC Act or the EPBC Act but for which there is some conservation concern, and has produced a supplementary list of Priority Fauna. For the full definitions of Priority Fauna rankings, see **Appendix B**. The desktop study identified four species of Priority Fauna that potentially occur within the Study Area, none of which were recorded during the survey (**Table 9**).

**Table 9: Priority fauna potentially occurring in the Study Area**

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC Act	In WA <sup>1</sup>	Literature review	Databases	
Bush Stone-curlew ( <i>Burhinus grallarius</i> )		P4		1	Likely
<b>Reason for likelihood rank:</b> The Study Area lies within the known distribution of the species and contains suitable habitat of open woodland and dry water courses (Pizzey and Knight 2007). The close record of this species was occurs near Elabbin, approximately 50 km west of the Study Area (DEC: Department of Environment and Conservation 2013b). Suitably habitat for this species occurs throughout the Study Area.					
Brush Bronzewing ( <i>Phaps elegans</i> )		P4		1	Likely
<b>Reason for likelihood rank:</b> The Study Area lies within the known distribution of the species and contains suitable habitat of dry woodlands and shrublands (Pizzey and Knight 2007). The close record of this species was occurs near Chiddarcooping Rock, approximately 45 km north of the Study Area (Birdlife Australia 2013). Suitably habitat for this species occurs throughout the Study Area					
Australian Bustard ( <i>Ardeotis australis</i> )		P4		3	Possible
<b>Reason for likelihood rank:</b> The Study Area lies within the known distribution of the species, however does not contain suitable habitat of tussock grassland and arid scrub (Pizzey and Knight 2007). This species has been recorded at Bodallin and Meriden. Approximately 17 km south-east and 50 km south-west of the Study Area respectively (Birdlife Australia 2013, DEC: Department of Environment and Conservation 2013b).					
Tree-stem Trapdoor Spider ( <i>Aganippe castellum</i> )		P4		1	Possible
The Study Area lies within the species distribution of the Tree-stem Trapdoor Spider (DSEWPaC: Department of Sustainability 2013b). This species is likely to occur throughout the Study Area in habitats which support trees and shrubs with sturdy trunk, and are subject to seasonal inundation by water, such as sites HAB06, HAB09, HAB11 and HAB13 ( <b>Figure 8, Appendix C</b> ). However, it should be noted that the majority of the Study Area possessed hard, clay soils and that this species prefers sand or loamy type substrates.					

<sup>1</sup>Status under the DEC Priority Fauna List – P1, Priority 1 Fauna; P2, Priority 2 Fauna; P3, Priority 3 Fauna; P4, Priority 4 Fauna; P5, Priority 5 Fauna. See **Appendix B** for full definitions of conservation status

### 5.3.3. Migratory Birds

Many species of migratory bird are listed under the EPBC Act, the WC Act and international agreements including the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement, Republic of Korea Australia Migratory Bird Agreement and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The desktop study identified ten listed Migratory species that have the potential to occur in the Study Area and its surrounds, none of which was recorded during the field survey (**Table 10**).

**Table 10: Migratory bird species potentially occurring in the Study Area**

Common name (species name)	Conservation status		Number of		Likelihood of occurrence
	EPBC Act <sup>1</sup>	In WA <sup>2</sup>	Literature review	Databases	
Rainbow Bee-eater ( <i>Merops ornatus</i> )	M	S3	1	4	Very Likely
<b>Reason for likelihood rank:</b> The Study Area lies within the known distribution of the Rainbow Bee-eater and contains suitable habitat of lightly wooded sandy country (Johnstone and Storr 1998, Pizzey and Knight 2007). Suitable habitat for the species occurs throughout the Study Area. The Rainbow Bee-eater was recorded in one survey conducted within 1 km of the Study Area ( <b>Section 3, Appendix A</b> ) and another individual was sited approximately 300 m outside of the Study Area during this assessment. The species has also been recorded at numerous locations within 40 km of the Study Area (DEC: Department of Environment and Conservation 2013a). The Rainbow Bee-eater is likely to utilise the Study Area for foraging purposes only.					

<sup>1</sup>Status under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* – EN: Endangered, VU: Vulnerable, M: Migratory; <sup>2</sup>Status under the Western Australian *Wildlife Conservation Act 1950* – S3: Schedule 3 (Migratory birds). See **Appendix B** for full definitions of conservation status.

### 5.3.4. SRE Invertebrate Fauna

The EPA's guidance statement 20 (2009) states that SRE invertebrate taxa have emerged in recent years as a potentially significant biodiversity issue for environmental impact assessment in WA. Although not specifically listed under either federal (EPBC act) or state (WA Act) legislation, the EPA will aim to ensure that proposal do not potentially threaten the viability of, or lead to the extinction of SRE species. This is consistent with the purpose of the Wildlife Conservation Act 1950, which aims 'to provide for the conservation and protection of wildlife' and also with principles 1 to 3 within Section 4A of the Environmental Protection Act 1986 ('Object and principles') relating to the conservation of biodiversity and ecological integrity, intergenerational equity and the precautionary principle.

The desktop study identified five SRE invertebrate species, *Aname* 'MYG268', *Antichiropus* 'danberrin 3', *Bothriembryon sedgwicki*, *Synsphyronus elegans* and *Atelomastix bamfordi*, that have been identified within a 100 km radius of the Study Area (**Figure 14**). Due to the limited information available regarding the habitat preferences of the above species it is not possible to make an assessment of the likelihood of occurrence of the above species in the Study Area.

It should be noted that the subregion consists largely of lands cleared for pastoral activity and therefore areas of remnant native vegetation will provide habitat isolates for any terrestrial SRE invertebrate fauna which reside within them. Due to their poor powers of dispersal, populations of terrestrial SRE invertebrates in the subregion are likely to be fragmented and genetic exchange



between populations is unlikely. The Study Area contains numerous areas with a large amount of leaf litter accumulation, such as sites HAB01, HAB 04, HAB 06, HAB07, HAB08, HAB10, HAB13, HAB15, HAB 16 and HAB17, which is a micro-habitat known to support SRE invertebrates species (**Figure 8, Appendix C**).

#### **5.4. Limitations and Constraints**

There are a number of possible limitations and constraints that can impinge on the adequacy of fauna surveys (EPA 2004). These are discussed below, with respect to the October 2013 and June 2014 surveys of the Study Area (**Table 11**). All fauna surveys are limited to some degree by time and seasonal factors, and ideally multiple surveys of an area would be undertaken over a number of years and within a number of different seasons.

**Table 11: Discussion of the potential limitations and constraints of this Assessment**

Factor	Constraint	Comments
Competency and experience of consultants	No	The surveyors were fauna specialists employed by Outback Ecology, with appropriate qualifications and/or several years of experience undertaking fauna surveys of this nature.
Scope	No	Fauna groups were surveyed using standardised and well-established techniques, and previous surrounding the Study Area was reviewed. Bat echolocation recordings were analysed by Bob Bullen of Bat Call WA
Proportion of fauna identified	No	The desktop and field species inventories are comparable to counts obtained during previous surveys of a similar size and scope. Although the database searches and some studies in the wider region recorded substantially more species, these were performed over larger areas with a wider range of habitat types (including cleared farmland) and sampling techniques/duration.
Information sources (eg historic or recent)	No	The Study Area is located in a relatively well-surveyed region, and the results of past surveys were included as part of the Assessment.
Proportion of task achieved, and further work which might be needed	No	Planned survey works were conducted according to scope. Additional areas were surveyed as instructed by site personnel.
Timing / weather / season / cycle	Partial	This report details the results of a spring survey. The weather was appropriate for a Level 1 survey, although it should be noted that wet conditions experienced from 8 to 10 October may not have been optimal for documenting reptiles or bats ( <b>Table 4</b> ).
Disturbances	Yes	Historical disturbances were present within the Study Area (e.g. old mine shafts and workings, agriculture, exploration lines) likely to have affected the results of this study.
Intensity	No	The Study Area was sampled for a total of 22 trap nights (motion-sensor cameras and SM2BAT recorders), with a total of 16 person hours spent targeted searching. This level of field survey effort is appropriate for a Level 1 assessment
Completeness	No	The survey was complete. Search effort was distributed effectively among habitat types and with appropriate geographical spread
Resources	No	Resources were adequate to carry out the survey satisfactorily, and the survey participants were competent in identification of species present
Remoteness / access problems	No	Access to the Study Area was good and adequate survey coverage was achieved
Availability of contextual information	No	The data available for the Avon Wheatbelt bioregion was adequate for the level of survey work undertaken during this Assessment.

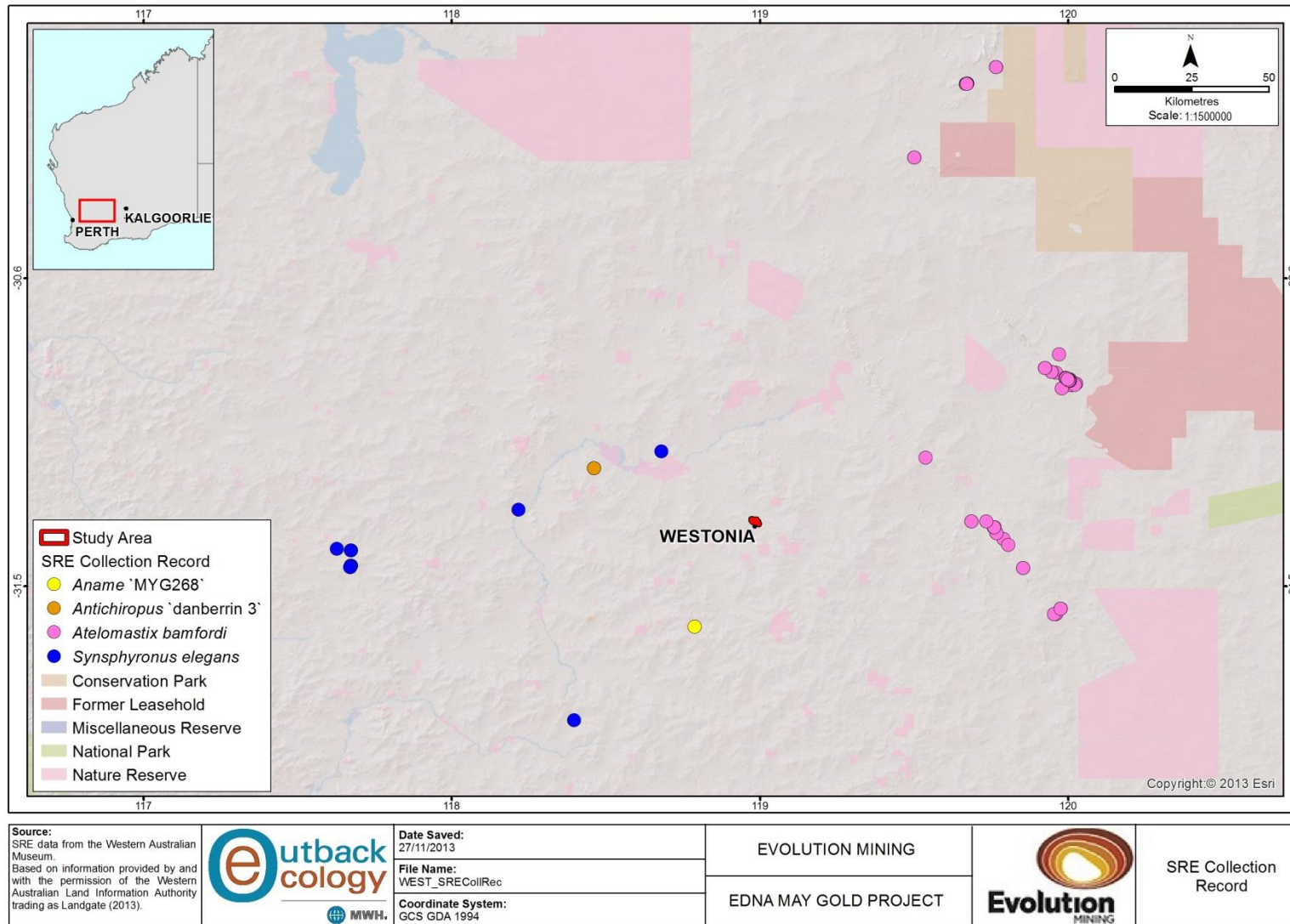


Figure 14: Terrestrial SRE Invertebrate Collection Records in relation to the Study Area

## 6. THREATENING PROCESSES

Threatening processes relevant to the Avon Wheatbelt bioregion, in which the Project lies, have been identified by the Australian Natural Resources Audit (ANRA) and include feral predators, inappropriate fire regimes, grazing by introduced herbivores, and invasive weeds. Aspects of the Project that constitute threatening processes with potential to impact upon fauna or fauna habitats include the following:

- habitat removal and modification;
- collision with vehicles;
- inappropriate fire regimes;
- noise and vibration;
- artificial light exposure;
- dust emissions;
- introduced flora; and
- introduced fauna.

### 6.1.1. Habitat Removal and Modification

Clearing vegetation is a necessary aspect of the Project, with the greatest potential to impact upon fauna habitats and fauna assemblages present in the Study Area. Land clearance will result in a reduction in the size of habitats and may reduce the quality of those habitats due to increased edge effects and habitat fragmentation (Davis *et al.* in press, Watson *et al.* 2003). Remnant native vegetation located within the Study Area is important in a regional sense as clearing within the bioregion has been extensive and remnant vegetation is likely to provide refuge for native fauna, including fauna of conservation significance.

Land clearance is likely to result in the direct loss of individual animals. Although more mobile fauna may be able to avoid immediate impact from development of the Project and ongoing operations, the degree of subsequent impact is dependent on the availability of suitable habitat elsewhere in the vicinity and the ability of individual species to disperse to these habitats. Nesting birds and their young may also be directly affected by clearing, although this potential impact can be reduced by considering the timing of clearance activities.

### 6.1.2. Collision With Vehicles

Vehicle collisions may have an impact on some fauna depending on the amount of traffic present within the Study Area. Collisions typically only involve individual animals and are considerably more likely to occur at night (Rowden *et al.* 2008). Ground-dwelling species that have been recorded from these habitats in the Study Area include the Malleefowl, Chuditch, Bush Stone-curlew and Australian Bustard. Individuals of these species may be at risk when in the vicinity of roads.

### 6.1.3. Inappropriate Fire Regimes

The development may alter the fire regime of the Study Area through the introduction of unplanned fire resulting from vehicle movements and/or other mining activities. Fire may impact fauna via direct contact, or indirectly by long-term habitat modification brought about by inappropriate fire frequency

and intensity. Species most at risk of direct contact impacts by fire include, but are not limited to, small, sedentary species such as the Western Spiny-tailed Skink, Tree-steam Trapdoor Spider and Shield-backed Trapdoor Spider. The impact of inappropriate fire regimes may be reduced through the implementation of an appropriate fire management plan.

#### 6.1.4. Noise and Vibration

The development and ongoing operation of the Project is likely to generate noise and vibration due to blasting, general operation of heavy machinery and vehicles, diesel generators and the presence of personnel. The effects of noise on wildlife have been well studied, although responses vary depending on the species and on the age and sex of the individual animal (for comprehensive summaries, see Larkin *et al.* 1996, Radle 2007). General responses to noise, across a wide variety of animal species, range from interruptions in feeding and resting behaviour to complete abandonment of a habitat area. Noise may lead to reduced population densities in small mammals, nest failure and decreased population densities in birds (Slabbekoorn and Ripmeester 2008), and abandoning of roost sites and a reduced hunting efficiency in bats due to disturbance of their echolocation system.

Vibration may have a negative effect of terrestrial invertebrate fauna that occurs within the Study Area. Raven (2008), suggests that vibrations created by blasting and heavy earthmoving equipment may actually attract spiders and other arachnids, which subsequently places these individuals at risk of direct contact with mining activities. Shallow burrowing mygalomorph spiders, such as the Shield-backed Trapdoor Spider, are most likely to be effected by artificial vibrations. Additionally, scorpions may be affected by vibration as they rely on vibrations for prey detection, navigation and courting (Volschenk 2011). Without further research, it is not possible to predict or quantify the noise and vibration impacts on terrestrial invertebrate species, including those of conservation significance with potential to occur in the Study Area such as the Tree-steam Trapdoor Spider and Shield-backed Trapdoor Spider

#### 6.1.5. Artificial Light Exposure

Exposure of fauna to artificial light may interfere with biological and behavioural activities that are governed by the length of day or photoperiod, including reproduction, dormancy, foraging and migration (Bradshaw and Holzapfel 2007, Le Corre *et al.* 2002, Stone *et al.* 2009). Some examples include reduced foraging activity in nocturnal mice following exposure to artificial light (Bird *et al.* 2004), suspension of normal feeding and reproductive behaviour in nocturnal frogs exposed to artificial light (Harder 2002) .

Light pollution has also been shown to interfere with timing of songbird choruses, potentially leading to reduction in breeding success or survival (Miller 2006). See Longcore and Rich (2004) for a broad review of some of the ecological consequences of light pollution. This artificial light may have detrimental effects on resident bird, mammal and reptile species, and it is likely to have an adverse effect on the natural foraging behaviour of bats. This aspect of the Project is likely to result in highly localised impacts to fauna, however, these impacts will range from negligible to nonexistent effects on fauna at a regional scale.

#### 6.1.6. Dust Emissions

The development and operation of the Project will create dust emissions due to construction, blasting, haulage and general traffic activities. Dust emissions may affect surrounding vegetation. High levels of dust have been associated with a reduction in plant growth and productivity, resulting in degradation of the overall ecosystem and an increased risk of disease in plants (Farmer 1993). Dust has also been linked to changes in soil chemistry and the structure of vegetation communities (Farmer 1993). Changes in vegetation as a result of dust may reduce the suitability of some habitats for fauna within close proximity to the Project; however, effects on fauna and fauna habitat are expected to be negligible to non-existent on a regional scale.

#### 6.1.7. Introduced Flora

Environmental weeds may be brought in by mobile equipment during construction and operation of the Project. Weed invasion is widely recognised as having a negative impact on fauna species, as it can fundamentally alter the composition and structure of native vegetation communities (Cowie and Werner 1993, Gordon 1998). In the extreme, entire ecosystems can be modified (Sodhi and Ehrlich 2010).

Invasion by non-native species typically results in declines in native plant species richness, but the response of fauna may be more complicated with individual invasions potentially resulting in increase, decrease or no-change scenarios for different assemblages (Grice 2006). For example, even at low densities, Buffel Grass (*Cenchrus ciliaris*) can affect the composition of ground vegetation, birds and ant fauna, leading to declines in some species (Binks *et al.* 2005, Smyth *et al.* 2009). There is potential for substantial change to occur to vegetation communities in the Study Area, should invasive flora be introduced and become established. At present, minimal introduced flora occurs within the throughout the Study Area, with scattered weeds being recorded at most habitat assessment sites (**Appendix C**).

#### 6.1.8. Introduced Fauna

Introduced fauna, both herbivorous and predatory, cause fundamental changes to ecosystems and are thought to have contributed to the decline and extinction of many species in Australia (Abbott 2002, Burbidge and McKenzie 1989, Dickman 1996, Ford *et al.* 2001, Short and Smith 1994). Of the 19 key threatening processes listed under the EPBC Act, 11 are concerned with introduced flora and fauna. Predation of native fauna by the Fox and the Feral Cat are key threatening processes of high prominence. Predation by Feral Cats predominantly affects mammals and birds, and has little or negligible impact on reptiles, amphibians and fishes (Dickman 1996). Introduced herbivores have been responsible for widespread degradation of much of semi-arid Australia due to overgrazing (Morton 1990, Newsome 1971).

Three species of introduced fauna were recorded in the area surveyed during the baseline survey: the Domestic Sheep (*Ovis aries*), Fox (*Vulpes vulpes*), Rabbit (*Oryctolagus cuniculus*). The desktop study also identified an additional two introduced mammal species that may occur within the Study Area, comprising the Cat (*Felis catus*) and House Mouse (*Mus musculus*). The Project may provide

additional resources or habitat which attract and support a greater abundance of these species in the Study Area. Introduced predators like the Feral Cat may also be attracted into the Study Area as a result of the scavenging opportunities generated by the presence of road kill along the haul road. This may in turn adversely affect populations of native fauna. Of particular concern would be an increase in the size of the local population of Feral Cat, which is not only a direct predator of the Malleefowl, Chuditch, Bush Stone-curlew and Australian Bustard and other ground-dwelling fauna, but also compete for food resources and habitat requirements with these and other species. This aspect of the Project is likely to result in localised impacts to fauna, although at a regional scale these impacts will range from negligible to non-existent, depending on the efficacy of measures implemented by the Project to limit the introduction or spread of introduced fauna.

## 7. CONCLUSIONS

A total of 37 species (34 native species) were recorded in this assessment comprising, 23 native birds, 8 native mammals, 3 reptiles and 3 introduced species. None of these species are of conservation significance and all were identified by the database searches as potentially occurring in the Study Area.

The desktop study identified 29 species of conservation significance that potentially occur in the Study Area. Of these, the Western Spiny-tailed Skink (*Egernia stokesii badia*) and the Rainbow Bee-eater (*Merops ornatus*) and snails of the Short-range Endemic genus *Bothriembryon* were considered Very Likely to occur within the Study Area. The Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*), Carpet Python (*Morelia spilota imbricata*), Bush Stone-curlew (*Burhinus grallarius*) and Brush Bronzewing (*Phaps elegans*) were considered Likely to occur and the Malleefowl (*Leipoa ocellata*), Shield-backed Trapdoor Spider (*Idiosoma nigrum*), Tree-stem Trapdoor Spider (*Aganippe castellum*), Chuditch (*Dasyurus geoffroi*), Red-tailed Phascogale (*Phascogale calura*) and Australian Bustard (*Ardeotis australis*) were considered to Possibly occur within the Study Area. The remaining 16 species were considered Unlikely to occur in the Study Area due to a lack of suitable habitat or the Study Area occurring outside of the species known distribution.

Although vertebrate fauna assemblages and vertebrate fauna habitats were adequately documented in terms of a Level 1 Fauna Assessment, further survey effort would almost certainly add to existing species lists for the Study Area. However, expansion of the species list for the Study Area would be unlikely to substantially alter conclusions regarding either the likelihood of occurrence of fauna of conservation significance, or the local and regional importance of vertebrate fauna habitats.

Four broad fauna habitat types were identified within the Study Area comprising, Mixed Shrubland, *Eucalyptus longicornis* Woodland, mixed Mallee Woodland and *Eucalyptus salubris* Woodland. As the Study Area encompasses a large area of remnant native vegetation, which is important in a sub-regional context, all habitat types are considered to be significant to vertebrate fauna. The Study Area lies within a 2,418 ha portion of remnant native vegetation, which is the 30<sup>th</sup> largest portion of remnant native vegetation within the subregion (i.e. 99.87% of remnant native vegetation that occurs in the subregion occurs in portions smaller than the portion of remnant native vegetation in which the Study Area is located). Approximately 797,222 ha (12 %) of the subregion comprises remnant native vegetation. These isolates are extremely important for the conservation of fauna within the subregion.



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**Appendix A****Terrestrial Vertebrate Fauna Recorded Within and Surrounding the Study Area**

This Appendix contains a species list comprising all vertebrate fauna recorded during the field survey, literature review and database searches

**Legend****Abbreviations and symbols**

- \* Introduced species.
- X Recorded during a field survey, or as part of a database or regional information search.

EPBC Act – Entries in this column indicate the status of each species under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act): CR, Critically Endangered; E, Endangered; VU, Vulnerable; and M, Migratory. If a cell is empty, the species is not listed as Threatened under the EPBC Act.

In WA – Entries in this column indicate the status of each species in Western Australia. If a species is listed as Threatened under Schedule 1, 3 or 4 of the *Wildlife Conservation Act 1950* (WA) (WC Act), the Schedule on which it is listed is provided: S1, Schedule 1, Fauna that is rare or is likely to become extinct; S3, Schedule 3, Migratory birds protected under an international agreement; and S4, Schedule 4, Other specially protected fauna. Species not listed under the WC Act may be listed on the Department of Environment and Conservation's list of Priority Fauna. In these cases, their rankings are provided: P1, Priority 1; P2, Priority 2; P3, Priority 3; and P4, Priority 4.

**Surveys considered in Literature Review**

- A Vertebrate Fauna of the Westonia Mine Lease
- B Avian Fauna of the Westonia Commons and Waste Rock Dumps

**Database Searches**

- C Threatened and Priority Fauna Database – DEC (2013b)
- D BirdData: Custom Atlas Bird List – BirdLife Australia (2013)
- E NatureMap Database – DEC (2013a)
- F Protected Matters Search Tool – DSEWPaC (2013a)

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<b>Mammals</b>										
<b>BOVIDAE</b>										
<i>Ovis aries</i>	Domestic Sheep*			X						
<b>BURRAMYIDAE</b>										
<i>Cercartetus concinnus</i>	Western Pygmy-possum								X	
<b>CANIDAE</b>										
<i>Vulpes vulpes</i>	Fox*			X					X	
<b>DASYURIDAE</b>										
<i>Dasyurus geoffroii</i>	Chuditch								X	
<i>Dasyurus geoffroii geoffroii</i>	Western Quoll						X			
<i>Phascogale calura</i>	Red-tailed Phascogale	EN	EN				X			X
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale						X			
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart								X	
<i>Sminthopsis dolichura</i>	Little Long-tailed Dunnart								X	
<i>Sminthopsis granulipes</i>	White-tailed Dunnart								X	
<b>FELIDAE</b>										
<i>Felis catus</i>	Cat*								X	
<b>LEPORIDAE</b>										
<i>Oryctolagus cuniculus</i>	Rabbit*			X	X				X	
<b>MACROPODIDAE</b>										
<i>Macropus fuliginosus</i>	Western Grey Kangaroo			X					X	
<i>Macropus robustus</i>	Common Wallaroo				X					
<i>Petrogale lateralis lateralis</i>	Black-flanked rock-wallaby	VU	VU				X			
<b>MOLOSSIDAE</b>										

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Mormopterus "sp 4"</i>	South-western Free-tailed Bat			X						
<i>Tadarida australis australis</i>				X					X	
<b>MURIDAE</b>										
<i>Leporillus conditor</i>	Greater Stick-nest Rat	VU	VU				X		X	
<i>Mus musculus</i>	House Mouse*								X	
<i>Notomys mitchellii</i>	Mitchell's Hopping-mouse								X	
<b>MYRMECOBIIDAE</b>										
<i>Myrmecobius fasciatus</i>	Numbat	VU	VU				X		X	
<b>POTOROIDAE</b>										
<i>Bettongia penicillata</i>	Brush-tailed Bettong						X		X	
<b>TACHYGLOSSIDAE</b>										
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna			X	X				X	
<b>THYLACOMYIDAE</b>										
<i>Macrotis lagotis</i>	Greater Bilby	VU	VU				X			
<b>VESPERTILIONIDAE</b>										
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat			X						
<i>Chalinolobus morio</i>	Chocolate Wattled Bat			X						
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat			X						
<i>Vespadelus regulus</i>	Southern Forest Bat			X						
<b>Birds</b>										
<b>ACANTHIZIDAE</b>										
<i>Acanthiza apicalis</i>	Inland Thornbill				X	X		X	X	
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				X	X		X	X	
<i>Acanthiza inornata</i>	Western Thornbill			X		X				

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Acanthiza iredalei</i>	Slender-billed Thornbill									X
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill			X	X			X	X	
<i>Aphelocephala leucopsis</i>	Southern Whiteface							X	X	
<i>Calamanthus campestris</i>	Rufous Fieldwren							X		
<i>Gerygone fusca</i>	Western Gerygone				X	X		X	X	
<i>Hylacola cauta</i>	Shy Heathwren						X	X		
<i>Pyrrholaemus brunneus</i>	Redthroat							X	X	
<i>Sericornis frontalis</i>	White-browed Scrubwren							X	X	
<i>Smicronis brevirostris</i>	Weebill				X	X		X	X	
<b>ACCIPITRIDAE</b>										
<i>Accipiter cirrocephalus</i>	Collared Sparrowhawk							X		
<i>Accipiter fasciatus</i>	Brown Goshawk							X	X	
<i>Aquila audax</i>	Wedge-tailed Eagle				X	X		X	X	
<i>Circus approximans</i>	Swamp Harrier							X		
<i>Circus assimilis</i>	Spotted Harrier							X	X	
<i>Elanus axillaris</i>	Black-shouldered Kite				X	X		X		
<i>Haliastur sphenurus</i>	Whistling Kite							X	X	
<i>Hieraetus morphnoides</i>	Little Eagle							X		
<i>Lophoictinia isura</i>	Square-tailed Kite							X		
<b>AEGOTHELIDAE</b>										
<i>Aegotheles cristatus</i>	Australian Owlet-nightjar							X	X	
<b>ANATIDAE</b>										
<i>Anas gracilis</i>	Grey Teal							X	X	
<i>Anas platyrhynchos</i>	Mallard*							X		

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Anas superciliosa</i>	Pacific Black Duck							X	X	
<i>Aythya australis</i>	Hardhead							X		
<i>Biziura lobata</i>	Musk Duck							X		
<i>Chenonetta jubata</i>	Australian Wood Duck			X				X	X	
<i>Cygnus atratus</i>	Black Swan							X		
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck							X	X	
<i>Tadorna tadornoides</i>	Australian Shelduck							X	X	
<b>ANHINGIDAE</b>										
Anhinga novaehollandiae	Australasian Darter							X		
<b>APODIDAE</b>										
<i>Apus pacificus</i>	Fork-tailed Swift	M								X
<b>ARDEIDAE</b>										
<i>Ardea ibis</i>	Cattle Egret	M								X
<i>Ardea modesta</i>	Eastern Great Egret	M								X
<i>Egretta novaehollandiae</i>	White-faced Heron							X		
<b>ARTAMIDAE</b>										
<i>Artamus cinereus</i>	Black-faced Woodswallow				X			X	X	
<i>Artamus cyanopterus</i>	Dusky Woodswallow					X		X	X	
<i>Artamus personatus</i>	Masked Woodswallow					X		X		
<i>Cracticus nigrogularis</i>	Pied Butcherbird			X	X			X	X	
<i>Cracticus tibicen</i>	Australian Magpie			X	X			X	X	
<i>Cracticus torquatus</i>	Grey Butcherbird				X	X		X	X	
<i>Strepera versicolor</i>	Grey Currawong			X		X		X	X	
<b>BURHINIDAE</b>										
<i>Burhinus grallarius</i>	Bush Stone-curlew		P4					X		



Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<b>CACATUIDAE</b>										
<i>Cacatua pastinator</i>	Western Corella							X	X	
<i>Cacatua sanguinea</i>	Little Corella			X					X	
<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo				X		X	X	X	
<i>Calyptorhynchus latirostris</i>	Short-billed Black-Cockatoo (Carnaby's Black Cockatoo)	EN	EN							X
<i>Eolophus roseicapillus</i>	Galah			X	X	X		X		
<i>Lophochroa leadbeateri</i>	Major Mitchell's Cockatoo		S4				X	X		
<i>Nymphicus hollandicus</i>	Cockatiel				X			X	X	
<b>CAMPEPHAGIDAE</b>										
<i>Coracina maxima</i>	Ground Cuckoo-shrike							X		
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike			X	X			X	X	
<i>Lalage sueurii</i>	White-winged Triller				X			X		
<b>CASUARIIDAE</b>										
<i>Dromaius novaehollandiae</i>	Emu					X		X	X	
<b>CHARADRIIDAE</b>										
<i>Charadrius ruficapillus</i>	Red-capped Plover							X	X	
<i>Elseornis melanops</i>	Black-fronted Dotterel							X		
<i>Thinornis rubricollis</i>	Hooded Plover						X	X		
<i>Vanellus tricolor</i>	Banded Lapwing							X	X	
<b>CLIMACTERIDAE</b>										
<i>Climacteris rufa</i>	Rufous Treecreeper					X		X	X	
<b>COLUMBIDAE</b>										
<i>Columba livia</i>	Rock Dove*							X	X	
<i>Ocyphaps lophotes</i>	Crested Pigeon			X	X			X	X	

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Phaps chalcoptera</i>	Common Bronzewing			X	X	X		X	X	
<i>Phaps elegans</i>	Brush Bronzewing (Abrolhos pop)		P4					X		
<i>Streptopelia senegalensis</i>	Laughing Turtle-Dove*							X	X	
<b>CORVIDAE</b>										
<i>Corvus bennetti</i>	Little Crow							X	X	
<i>Corvus coronoides</i>	Australian Raven			X	X	X		X	X	
<b>CUCULIDAE</b>										
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo							X	X	
<i>Cacomantis pallidus</i>	Pallid Cuckoo							X	X	
<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo							X		
<i>Chalcites osculans</i>	Black-eared Cuckoo							X		
<b>ESTRILDIDAE</b>										
<i>Taeniopygia guttata</i>	Zebra Finch			X				X	X	
<b>EUROSTOPODIDAE</b>										
<i>Eurostopodus argus</i>	Spotted Nightjar							X	X	
<b>FALCONIDAE</b>										
<i>Falco berigora</i>	Brown Falcon					X		X	X	
<i>Falco cenchroides</i>	Nankeen Kestrel					X		X	X	
<i>Falco longipennis</i>	Australian Hobby					X		X	X	
<i>Falco peregrinus</i>	Peregrine Falcon		S4				X	X	X	
<b>HALCYONIDAE</b>										
<i>Dacelo novaeguineae</i>	Laughing Kookaburra					X				
<i>Halcyon pileata</i>	Black-capped Kingfisher								X	
<i>Todiramphus pyrrhopygius</i>	Red-backed Kingfisher							X		

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Todiramphus sanctus</i>	Sacred Kingfisher				X			X		
<b>HIRUNDINIDAE</b>										
<i>Cheramoeca leucosterna</i>	White-backed Swallow							X		
<i>Hirundo neoxena</i>	Welcome Swallow				X	X		X	X	
<i>Petrochelidon ariel</i>	Fairy Martin							X		
<i>Petrochelidon nigricans</i>	Tree Martin			X	X			X		
<b>LARIDAE</b>										
<i>Chroicocephalus novaehollandiae</i>	Silver Gull							X		
<b>MALURIDAE</b>										
<i>Malurus lamberti</i>	Variiegated Fairy-wren			X						
<i>Malurus leucopterus</i>	White-winged Fairy-wren							X	X	
<i>Malurus pulcherrimus</i>	Blue-breasted Fairy-wren				X	X		X	X	
<i>Malurus splendens</i>	Splendid Fairy-wren							X	X	
<b>MEGALURIDAE</b>										
<i>Cincloramphus cruralis</i>	Brown Songlark					X		X	X	
<i>Cincloramphus mathewsi</i>	Rufous Songlark							X	X	
<b>MEGAPODIIDAE</b>										
<i>Leipoa ocellata</i>	Malleefowl	VU	VU				X	X	X	X
<b>MELIPHAGIDAE</b>										
<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater				X	X		X	X	
<i>Anthochaera carunculata</i>	Red Wattlebird			X	X	X		X	X	
<i>Certhionyx variegatus</i>	Pied Honeyeater							X	X	
<i>Epthianura albifrons</i>	White-fronted Chat							X	X	
<i>Epthianura tricolor</i>	Crimson Chat							X	X	

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Glyciphila melanops</i>	Tawny-crowned Honeyeater							X		
<i>Lichenostomus cratitius</i>	Purple-gaped Honeyeater								X	
<i>Lichenostomus leucotis</i>	White-eared Honeyeater				X			X	X	
<i>Lichenostomus ornatus</i>	Yellow-plumed Honeyeater							X		
<i>Lichenostomus virescens</i>	Singing Honeyeater			X	X	X		X		
<i>Lichmera indistincta</i>	Brown Honeyeater				X	X		X	X	
<i>Manorina flavigula</i>	Yellow-throated Miner			X	X	X		X	X	
<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater				X			X	X	
<i>Phylidonyris niger</i>	White-cheeked Honeyeater							X		
<i>Phylidonyris novaehollandiae</i>	New Holland Honeyeater					X				
<i>Purnella albifrons</i>	White-fronted Honeyeater							X	X	
<i>Sugomel niger</i>	Black Honeyeater							X		
<b>MEROPIDAE</b>										
<i>Merops ornatus</i>	Rainbow Bee-eater	M			X	X	X	X	X	X
<b>MONARCHIDAE</b>										
<i>Grallina cyanoleuca</i>	Magpie-lark			X	X			X	X	
<i>Myiagra inquieta</i>	Restless Flycatcher							X		
<b>MOTACILLIDAE</b>										
<i>Anthus novaeseelandiae</i>	Australasian Pipit				X			X		
<b>NECTARINIIDAE</b>										
<i>Dicaeum hirundinaceum</i>	Mistletoebird					X				
<b>NEOSITTIDAE</b>										

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Daphoenositta chrysoptera</i>	Varied Sittella				X			X	X	
<b>OTIDIDAE</b>										
<i>Ardeotis australis</i>	Australian Bustard		P4				X	X	X	
<b>PACHYCEPHALIDAE</b>										
<i>Colluricincla harmonica</i>	Grey Shrike-thrush			X	X	X		X	X	
<i>Oreoica gutturalis</i>	Crested Bellbird				X		X	X	X	
<i>Pachycephala inornata</i>	Gilbert's Whistler							X		
<i>Pachycephala pectoralis</i>	Golden Whistler					X		X	X	
<i>Pachycephala rufiventris</i>	Rufous Whistler				X			X	X	
<b>PARDALOTIDAE</b>										
<i>Pardalotus punctatus</i>	Spotted Pardalote					X			X	
<i>Pardalotus striatus</i>	Striated Pardalote				X	X		X	X	
<b>PELECANIDAE</b>										
<i>Pelecanus conspicillatus</i>	Australian Pelican							X		
<b>PETROICIDAE</b>										
<i>Drymodes brunneopygia</i>	Southern Scrub-robin							X	X	
<i>Eopsaltria griseogularis</i>	Western Yellow Robin							X		
<i>Melanodryas cucullata</i>	Hooded Robin							X		
<i>Microeca fascinans</i>	Jacky Winter				X	X		X	X	
<i>Petroica goodenovii</i>	Red-capped Robin			X	X	X		X	X	
<b>PHALACROCORACIDAE</b>										
<i>Microcarbo melanoleucos</i>	Little Pied Cormorant							X		
<b>PHASIANIDAE</b>										
<i>Coturnix pectoralis</i>	Stubble Quail							X	X	

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<b>PODARGIDAE</b>										
<i>Podargus strigoides</i>	Tawny Frogmouth							X	X	
<b>PODICIPEDIDAE</b>										
<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe							X	X	
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe							X	X	
<b>POMATOSTOMIDAE</b>										
<i>Pomatostomus superciliosus</i>	White-browed Babbler						X	X	X	
<b>PSITTACIDAE</b>										
<i>Barnardius zonarius</i>	Australian Ringneck			X	X	X		X	X	
<i>Glossopsitta porphyrocephala</i>	Purple-crowned Lorikeet				X			X	X	
<i>Melopsittacus undulatus</i>	Budgerigar							X	X	
<i>Neophema elegans</i>	Elegant Parrot							X	X	
<i>Platycercus icterotis</i>	Western Rosella							X	X	
<i>Polytelis anthopeplus</i>	Regent Parrot							X	X	
<i>Psephotus varius</i>	Mulga Parrot					X		X		
<b>RALLIDAE</b>										
<i>Fulica atra</i>	Eurasian Coot							X		
<b>RECURVIROSTRIDAE</b>										
<i>Cladorhynchus leucocephalus</i>	Banded Stilt							X	X	
<i>Himantopus himantopus</i>	Black-winged Stilt							X	X	
<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet							X	X	
<b>RHIPIDURIDAE</b>										
<i>Rhipidura albiscapa</i>	Grey Fantail					X		X		

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Rhipidura leucophrys</i>	Willie Wagtail				X	X		X	X	
<i>Rhipidura rufiventris</i>	Northern Fantail								X	
<b>SCOLOPACIDAE</b>										
<i>Actitis hypoleucos</i>	Common Sandpiper	M					X	X		
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	M					X			
<i>Calidris ferruginea</i>	Curlew Sandpiper	M	VU				X	X		
<i>Calidris ruficollis</i>	Red-necked Stint	M					X	X		
<i>Tringa nebularia</i>	Common Greenshank	M					X	X		
<b>STRIGIDAE</b>										
<i>Ninox novaeseelandiae</i>	Southern Boobook Owl							X	X	
<b>THRESKIORNITHIDAE</b>										
<i>Threskiornis molucca</i>	Australian White Ibis							X		
<b>TIMALIIDAE</b>										
<i>Zosterops lateralis</i>	Silvereye					X		X	X	
<b>TURNICIDAE</b>										
<i>Turnix varius</i>	Painted Button-quail							X		
<b>TYTONIDAE</b>										
<i>Tyto javanica</i>	Eastern Barn Owl							X		
<b>Reptiles</b>										
<b>AGAMIDAE</b>										
<i>Ctenophorus cristatus</i>	Crested Dragon								X	
<i>Ctenophorus maculatus</i>	Spotted Military Dragon								X	
<i>Ctenophorus reticulatus</i>	Western Netted Dragon								X	
<i>Ctenophorus salinarum</i>	Claypan Dragon								X	
<i>Ctenophorus scutulatus</i>	Lozenge-marked Dragon								X	

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Moloch horridus</i>	Thorny Devil								X	
<i>Pogona minor minima</i>	Abrolhos Dwarf Bearded Dragon		VU						X	
<b>ELAPIDAE</b>										
<i>Brachyuropsis semifasciatus</i>	Southern Shovel-nosed Snake								X	
<i>Parasuta gouldii</i>	Gould's Hooded Snake								X	
<i>Parasuta monachus</i>	Monk Snake								X	
<i>Pseudechis australis</i>	King Brown Snake								X	
<i>Pseudonaja affinis</i>	Dugite			X						
<i>Pseudonaja mengdeni</i>	Mengden's Brown Snake								X	
<i>Pseudonaja modesta</i>	Ringed Brown Snake								X	
<i>Pseudonaja nuchalis</i>	Western Brown Snake								X	
<i>Simoselaps bertholdi</i>	Jan's Banded Snake								X	
<i>Suta fasciata</i>	Rosen's Snake								X	
<b>GEKKONIDAE</b>										
<i>Crenadactylus ocellatus</i>	Clawless Gecko			X					X	
<i>Diplodactylus granariensis</i>	Wheat-belt Stone Gecko				X				X	
<i>Diplodactylus pulcher</i>	Fine-faced Gecko								X	
<i>Gehyra variegata</i>	Tree Dtella								X	
<i>Lucasium maini</i>	Main's Ground Gecko				X				X	
<i>Strophurus assimilis</i>	Goldfields Spiny-tailed Gecko								X	
<i>Strophurus spinigerus</i>	South-western Spiny-tailed Gecko								X	
<b>PYGOPODIDAE</b>										
<i>Delma fraseri</i>	Fraser's Delma								X	



Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Lialis burtonis</i>	Burton's Snake-lizard								X	
<i>Pygopus lepidopodus</i>	Common Scaly-foot								X	
<b>PYTHONIDAE</b>										
<i>Aspidites ramsayi</i>	Woma		S4				X		X	
<i>Morelia spilota imbricata</i>	Carpet Python		S4				X			
<b>SCINCIDAE</b>										
<i>Cryptoblepharus buchananii</i>									X	
<i>Cryptoblepharus plagiocephalus</i>	Callose-palmed Shinning-skink								X	
<i>Ctenotus impar</i>	Odd-striped Ctenotus								X	
<i>Ctenotus schomburgkii</i>	Barred Wedgesnout Ctenotus								X	
<i>Egernia stokesii badia</i>	Western Spiny-tailed Skink	EN	VU							X
<i>Lerista distinguenda</i>	South-western Orange-tailed Slider								X	
<i>Lerista kingi</i>									X	
<i>Lerista macropisthopus</i>	Unpatterned Robust Slider								X	
<i>Lerista muelleri</i>	Wood Mulch-slider								X	
<i>Menetia greyii</i>	Common Dwarf Skink								X	
<i>Morethia butleri</i>	Woodland Morethia Skink								X	
<i>Morethia obscura</i>	Shrubland Morethia Skink								X	
<i>Tiliqua rugosa</i>	Shingle-back			X	X				X	
<b>TYPHLOPIDAE</b>										
<i>Ramphotyphlops waitii</i>	Beaked Blind Snake								X	
<b>VARANIDAE</b>										

Species Name	Common Name	Conservation Status		This survey	Literature review		Database searches			
		EPBC	WC		A	B	C	D	E	F
<i>Varanus gouldii</i>	Gould's Goanna				X				X	
<b><u>Amphibians</u></b>										
<b>LIMNODYNASTIDAE</b>										
<i>Limnodynastes dorsalis</i>	Bullfrog								X	
<i>Neobatrachus kunapalari</i>	Kunapalari Frog								X	
<i>Neobatrachus pelobatoides</i>	Humming Frog								X	
<b>MYOBATRACHIDAE</b>										
<i>Crinia pseudinsignifera</i>	False Western Froglet								X	
<i>Pseudophryne guentheri</i>	Gunther's Toadlet								X	

## Appendix B

### Definitions of Codes and Terms Used to Describe Fauna of Conservation Significance

Fauna may be accorded legislative protection by being listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) and/or the *Wildlife Conservation Act 1950* (WA) (WC Act), or by being listed on the WA Department of Environment and Conservation's *Priority Species List*. This Appendix presents a summary of the different rankings and listings used to describe conservation status. Some categories, such as 'extinct', 'extinct in the wild' and 'conservation dependent' (EPBC Act) are not presented here, as the table includes only the information needed to fully understand the codes presented in the preceding report. Refer to the relevant legislation for a full description of all codes in use, as well as their associated criteria.

### Definitions of Codes and Terms Used to Describe Conservation Significance Status

Status	Code	Description
<b>Categories used under the EPBC Act</b>		
Critically Endangered	CR	Fauna that is considered to be facing an extremely high risk of extinction in the wild in the immediate future
Endangered	EN	Fauna that is considered to be facing a very high risk of extinction in the wild in the near future
Vulnerable	VU	Fauna that is considered to be facing a high risk of extinction in the wild in the medium-term future
Migratory	M	Species that migrate to, over and within Australia and its external territories.
<b>Schedules used under the WC Act</b>		
Schedule 1	S1	Fauna that is rare or likely to become extinct. Threatened fauna listed under Schedule 1 of the WC Act are further ranked by the DEC, according to the level of threat facing each species. The ranks are CR, EN and VU.
	CR	Critically endangered: considered to be facing an extremely high risk of extinction in the wild
	EN	Endangered: considered to be facing a very high risk of extinction in the wild
	VU	Vulnerable: considered to be facing a high risk of extinction in the wild
Schedule 2	S2	Fauna that is presumed to be extinct
Schedule 3	S3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds
Schedule 4	S4	Fauna that is in need of special protection, other than for reasons mentioned above
<b>DEC Priority Fauna Lists</b>		
Priority 1	P1	Taxa with few, poorly known populations on threatened lands. These are known from few specimens or sight records from one or a few localities on lands not managed for conservation, eg agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands. These are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, eg national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands. These are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4	P4	Taxa in need of monitoring. These are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring. These are not considered threatened but are subject to a specific conservation programme, the cessation of which would result in the species becoming threatened within five years.

**Appendix C****Raw Data from Habitat Assessments**

This Appendix contains the raw data obtained from habitat assessments conducted during this survey.

**Location assessed:** HAB01

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** *E. longicornis* Woodland

**Date:** 8 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	3	7	10	15	Tree	<i>E. longicornis</i>
Middle	1	5			Shrub	<i>Acacia</i> spp
Lower	0.2	0.5			Tussock Grasses	<i>Atriplex</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	40	5	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** None

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange sandy clay

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 200 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A waste rock landform (WRL) was constructed adjacent to this habitat assessment site. A drainage canal had been constructed between the site and the WRL. Site was located in an area of disturbance within *E. longicornis* Woodland habitat which is why no vegetation data was recorded.

**Location assessed:** HAB02

**UTM (WGS84 50 J):** 660683 6538118

**Habitat Type:** *E. longicornis* Woodland

**Date:** 8 October 2013



### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	3	8	25	40	Tree	<i>E. longicornis</i>
Middle	1	3			Shrub	<i>Acacia</i> spp
Lower	0.2	0.5			Tussock Grasses	<i>Atriplex</i> spp

### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	25	20	25

### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** None

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Nil

### SOILS AND GEOLOGY

**Soil type and colour:** Orange loamy fine sand

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 6 to 20 mm

**Coarse surface particle roundness:** Angular

### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

### ADDITIONAL NOTES

Large amount of leaf/stick litter present at site – may provide suitable habitat for invertebrates.

**Location assessed:** HAB03

**UTM (WGS84 50 J):** 660830 6538108

**Habitat Type:** *E. longicornis* Woodland

**Date:** 8 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	3	7			Tree	<i>E. longicornis</i>
Middle	1	3			Shrub	<i>Acacia spp</i>
Lower	0.2	0.5			Tussock Grass	<i>Atriplex spp</i>

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	30	15	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, scattered

**Evidence of recruitment:** No

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** Nil

#### SOILS AND GEOLOGY

**Soil type and colour:** Hard grey loam with red sands underneath

**Rock exposure:** >50% of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 6 – 20 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A high amount of leaf debris was present at this site.



**Location assessed:** HAB04

**UTM (WGS84 50 J):** 661246 6538091

**Habitat Type:** *E. longicornis* Woodland

**Date:** 8 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	5	20	20	40	Tree	<i>E. longicornis</i>
Middle	1	3			Shrub	<i>Melaleuca spp</i>
Lower	0.1	0.4			Tussock Grass	<i>Atriplex spp</i>

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	40	5	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, scattered

**Evidence of recruitment:** Yes, *E. longicornis* Woodland

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Nil

#### SOILS AND GEOLOGY

**Soil type and colour:** Red fine sands

**Rock exposure:** <20 of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Level (0-3)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Sparse vegetation was present at site with large trees scattered throughout.

**Location assessed:** HAB05

**UTM (WGS84 50 J):** 661368 6537844

**Habitat Type:** *E. longicornis* Woodland

**Date:** 8 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	5	25			Tree	<i>E. longicornis</i>
Middle	1	3			Shrub	<i>Melaleuca spp</i>
Lower	0.1	0.4			Tussock Grass	<i>Atriplex spp</i>

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
60	20	15	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** Yes, tussock grasses

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Nil

#### SOILS AND GEOLOGY

**Soil type and colour:** Red fine sand

**Rock exposure:** <20 of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 – 20 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Sparse woodland with large areas of bare ground.

**Location assessed:** HAB06

**UTM (WGS84 50 J):** 661687 6538006

**Habitat Type:** *E. salubris* Woodland

**Date:** 9 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	6	10			Tree	<i>E. salubris</i>
Middle						
Lower	0.2	0.5			Tussock Grass	Various perennial spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
25	50	25	0

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes minor *E. salubris*

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Red clay

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** May be or prone to waterlogging

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Heavily disturbed with no middle stratum present.

**Location assessed:** HAB07

**UTM (WGS84 50 J):** 661731 6537771

**Habitat Type:** *E. salubris* Woodland

**Date:** 9 October 2013 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	4	6	60	70	Tree	<i>E. salubris</i>
Middle	1	2	20	30	Shrub	<i>Acacia</i> and <i>Maleleuca</i> spp
Lower	0.2	1			Sedge	<i>Chenopod</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
20	60	10	10

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** Yes, minimal *E. salubris*

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange clay

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** None

**Coarse surface particle roundness:** None

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

**Location assessed:** HAB08

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** *E. salubris* Woodland

**Date:** 9 October 2013



### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	4	6	50	70	Mallee	<i>E. salubris</i>
Middle	1	2	10	20	Shrub	<i>Acacia</i> spp
Lower	0.1	0.5	5	10	Sedge	

### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
20	60	10	10

### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** Yes, minor *E. salubris*

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

### SOILS AND GEOLOGY

**Soil type and colour:** Light orange clay loam

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** None

**Coarse surface particle roundness:** None

### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface slightly disturbed (some compacting, signs of increased run-off, some pedestalled tussocks)

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

### ADDITIONAL NOTES

Limited shrubland, high levels of leaf debris present

**Location assessed:** HAB09

**UTM (WGS84 50 J):** 661958 6537694

**Habitat Type:** *E. salubris* Woodland

**Date:** 9 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	5	20	20	30	Tree	<i>E. salubris</i>
Middle	1	2	50	80	Shrub	<i>Acacia</i> and <i>Malelueca</i> spp
Lower	0.1	0.5	10	20	Sedge	<i>Acacia</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	15	25	10

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** Yes, minimal *Acacia* spp

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange loam clay

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface slightly disturbed (some compacting, signs of increased run-off, some pedestalled tussocks)

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Prone to waterlogging and inundation

**Fire:** Yes, less than 2 years ago

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Reduced leaf debris as a result of fire.

**Location assessed:** HAB10

**UTM (WGS84 50 J):** 662293 6536650

**Habitat Type:** *E. salubris* Woodland

**Date:** 9 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	4	10	40	60	Tree	<i>E. salubris</i>
Middle	1	3	10	20	Shrub	<i>Acacia</i> and <i>Maleluca</i> spp
Lower		0.5	10	25	Sedge	

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	40	5	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes, minimal *Maleluca* spp

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange sandy loam

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 20 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A lot of historical drill lines/disturbance

**Location assessed:** HAB11

**UTM (WGS84 50 J):** 660778 6537320

**Habitat Type:** *E. salubris* Woodland

**Date:** 11 October 2013

#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	8	15	40	70	Tree	<i>E. salubris</i>
Middle	1	3	10	30	Shrubs	<i>Acacia</i> and <i>Malelueca</i> spp
Lower	0.2	1			Sedge	<i>Chenopod</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
35	35	20	10

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes, minimal *chenopod* spp

**Trees with visible hollows (> 5 cm):** No

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Fine orange silt

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** No effective disturbance, natural

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Prone to inundation

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Good quality Mallee woodland with more woodland bird species present



**Location assessed:** HAB12

**UTM (WGS84 50 J):** 662443 6536472

**Habitat Type:** Mixed Shrubland

**Date:** 10 October 2013

#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	2.5	4	20	50	Shrubs	<i>Allocasuarina</i> spp
Middle	1	3	50	80	Shrubs	<i>Acacia</i> spp
Lower		1			Tussock Grasses	<i>Atriplex</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
30	30	30	10

#### GENERAL

**Presence of large trees (20 cm DBH):** No

**Evidence of recruitment:** No

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Nil

#### SOILS AND GEOLOGY

**Soil type and colour:** Light orange coarse sand

**Rock exposure:** <20% of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** No effective disturbance, natural

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

Transitional woodland habitat, shrubs dominant with small areas of sandy substrate which support tussock grasslands

**Location assessed:** HAB13

**UTM (WGS84 50 J):** 662293 6536650

**Habitat Type:** Mixed Shrubland

**Date:** 10 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	2	4	70	80	Shrub	<i>Allocasuarina</i> spp
Middle		1			Shrub	<i>Malelueca</i> spp
Lower		0.5			Sedge	

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	40	5	5

#### GENERAL

**Presence of large trees (20 cm DBH):** No

**Evidence of recruitment:** Yes, minimal *Allocasuarina* spp

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange sand

**Rock exposure:** <20% of site has exposed bedrock or cemented layers

**Coarse surface particles:** 30 – 60% of site covered by rocks

**Coarse surface particle sizes:** 2 to 60 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Prone to waterlogging and inundation

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

**Location assessed:** HAB14

**UTM (WGS84 50 J):** 661527 6536643

**Habitat Type:** *E. longicornis* Woodland

**Date:** 10 November 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	6	20	40	50	Tree	<i>E. longicornis</i>
Middle	1	3			Shrub	<i>Acacia</i> and <i>Malelueca</i> spp
Lower		1	40	50	Sedge	<i>Atriplex</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	30	15	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes, occasional *Eucalyptus* spp

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Light orange coarse sand

**Rock exposure:** <20% of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 200 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface slightly disturbed (some compacting, signs of increased run-off, some pedestalled tussocks)

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A lot of historical drill lines/disturbance

**Location assessed:** HAB15

**UTM (WGS84 50 J):** 660999 6536987

**Habitat Type:** *E. longicornis* Woodland

**Date:** 7 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	10	20	20	40	Tree	<i>Eucalyptus</i> spp
Middle	1	4	10	25	Shrub	<i>Maleueca</i> spp
Lower		0.5	5	10	Sedge	<i>Atriplex</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
40	50	5	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** Yes, occasional *Maleueca* and *Atriplex* spp

**Trees with visible hollows (> 5 cm):** None observed

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Light orange sandy loam

**Rock exposure:** <20% of site has exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 60 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A lot of historical drill lines/disturbance

**Location assessed:** HAB16

**UTM (WGS84 50 J):** 660778 6537320

**Habitat Type:** *E. longicornis* Woodland

**Date:** 10 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	6	20	30	60	Tree	<i>E. longicornis</i>
Middle	1	3	10	20	Shrubs	<i>Acacia</i> and <i>Maleueca</i> spp
Lower	0.5	0.5	30	60	Sedge	<i>Chenopod</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
40	40	10	10

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes, moderate *chenopod* spp

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Orange clay fine particles

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 6 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** No effective disturbance, natural

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Evidence of rabbits present

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

A lot of historical drill lines/disturbance

**Location assessed:** HAB17

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** *E. longicornis* Woodland

**Date:** 7 October 2013



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	5	8	40	60	Tree	<i>E. salubris</i>
Middle	0.5	3	10	25	Shrub	<i>Acacia</i> spp
Lower		0.5			Tussock Grasses	<i>Atriplex</i> spp

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
20	60	10	10

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, common

**Evidence of recruitment:** Yes, occasional *Acacia* spp

**Trees with visible hollows (> 5 cm):** Yes

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** Scattered weeds

#### SOILS AND GEOLOGY

**Soil type and colour:** Light red sands

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** 2 to 20 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** Limited clearing (selective logging)

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** No

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** No obvious grazing or trampling impacts on vegetation

#### ADDITIONAL NOTES

High coarse woody debris suitable for the Western Spiny-tailed Skink, evidence of old mining disturbance.

**Location assessed:** HAB18

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** Mixed Mallee Woodland

**Date:** 25 June 2014



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	4	6	20	30	Mallee/Shrub	<i>Eucalyptus</i> spp.
Middle	1.2	1.8	5	15	Shrub	<i>Santalum acuminatum</i>
Lower	0.2	0.4	20	30	Tussock	<i>Eragrostis</i> spp.

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
30	30	40	0

#### GENERAL

**Presence of large trees (20 cm DBH):** No

**Evidence of recruitment:** Yes

**Trees with visible hollows (> 5 cm):** No

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** No

#### SOILS AND GEOLOGY

**Soil type and colour:** Light brown sandy loam

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** None

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Moderately inclined (5-15)

**Disturbance:** Heavy grazing

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Sheep

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** Evidence of grazing present

#### ADDITIONAL NOTES

Good Malleefowl habitat, however remnant is unlikely to support species due to size.

**Location assessed:** HAB19

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** Mixed Shrubland

**Date:** 25 June 2014



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	2.5	3.5	40	70	Shrub	<i>Acacia</i> spp.
Middle	1.5	1.7	5	10	Shrub	<i>Acacia</i> spp.
Lower	0.5	0.5	20	40	Shrub	Myrtaceous spp.

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
40	30	30	0

#### GENERAL

**Presence of large trees (20 cm DBH):** No

**Evidence of recruitment:** Yes, occasional *Acacia* spp

**Trees with visible hollows (> 5 cm):** No

**Presence of coarse woody debris:** Occasional fallen logs/debris

**Weeds:** No

#### SOILS AND GEOLOGY

**Soil type and colour:** Light brown sandy loam

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** < 2 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** No effective disturbance other than grazing by hoofed animals

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Sheep

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** Minor grazing and trampling impacts to vegetation



**Location assessed:** HAB20

**UTM (WGS84 50 J):** 660183 6537879

**Habitat Type:** Mixed Mallee Woodland

**Date:** 25 June 2014



#### VEGETATION

Stratum	Height (m)		Cover (%)		Growth form	Dominant species
	Min	Max	Min	Max		
Upper	8	12	15	25	Tree/Mallee	<i>Eucalyptus</i> spp.
Middle	2	3	15	60	Shrub	<i>Melaleuca acuminata</i>
Lower	0.1	0.3	2	5	Tussock	<i>Eragrostis</i> spp.

#### GROUND COVER

Bare soil (%)	Litter (%)	Perennials (%)	Annuals (%)
50	45	0	5

#### GENERAL

**Presence of large trees (20 cm DBH):** Yes, occasional

**Evidence of recruitment:** No

**Trees with visible hollows (> 5 cm):** No

**Presence of coarse woody debris:** Fallen logs/debris common

**Weeds:** No

#### SOILS AND GEOLOGY

**Soil type and colour:** Light brown sandy loam

**Rock exposure:** No exposed bedrock or cemented layers

**Coarse surface particles:** Common – <30% of site covered by rocks

**Coarse surface particle sizes:** < 2 mm

**Coarse surface particle roundness:** Angular

#### ENVIRONMENT

**Slope and aspect:** Gently inclined (3-5)

**Disturbance:** No effective disturbance other than grazing by hoofed animals

**Erosion:** Soil surface stable and undisturbed

**Landform:** Plain

**Feral animals and stock:** Sheep

**Water impacts:** Site is not prone to waterlogging, inundation and flooding

**Fire:** No burnt tree and shrub remnants, no obvious signs of recent fire

**Site degradation:** Minor grazing and trampling impacts to vegetation



## Fauna Management Plan

**EMO-ENV-PLN-1207**

Version	Date	Description	Reviewed	Approved
1	01/03/2010	New Document		
2	02/01/2015	Revised Plan	Jamie Coad	Bella Bamford
3	20/02/2017	Revised plan	Kim Stone	Bella Bamford



## TABLE OF CONTENTS

1. Intent.....	3
2. Current status .....	3
3. Potential Impacts .....	3
4. Environmental Objectives .....	4
5. Performance Indicators.....	4
6. Fauna Management and Implementation strategy .....	4
7. Stakeholder Consultation .....	11
8. Training and Awareness .....	11
9. Performance Monitoring.....	11
10. Contingencies .....	11
11. Auditing and Reporting .....	11
12. Review and Revision .....	12
13. Relevant Legislation and Documents.....	13
13.1 Relevant Legislation.....	13
13.2 Internal Documents.....	13
DEFINITIONS .....	14
14. REVISION RECORD .....	14

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 2 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017



## 1. INTENT

This Fauna Management Plan provides a management framework for the implementation, monitoring and review of management actions aimed at minimising or avoiding adverse impacts to fauna and fauna habitats surrounding the operations. Specifically, Edna May Operations (EMO) proposes to:

- Prevent or minimise impacts to the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels;
- Minimise impacts to fauna habitats; and
- Adopt practices aimed at minimising impacts on fauna, including: controlling the extent of open excavations; regularly checking areas where animals could become trapped; actively managing features such as raw water storages, domestic waste storages, processing water storage, tailings supernatant pond and lighting which may attract fauna.

## 2. CURRENT STATUS

From published records and observations a wide variety of fauna may reside on tenements in which the Edna May mine resides, including 8 species of frogs, 57 species of reptiles, 117 species of birds and 26 species of mammals (of which 5 are introduced). No rare or endangered fauna species have been identified, but may be present. If present, these species would most likely reside in remnant vegetation areas surrounding the mining operation rather than the disturbed areas associated with the current mine and cleared agricultural land (Catalpa Resources, 2009).

A number of feral animals have been reported and eradication / capture programs are undertaken.

## 3. POTENTIAL IMPACTS

Potential impacts to fauna from mine activities include:

- Habitat loss as a result of clearing or land contamination;
- Population isolation as a result of habitat fragmentation;
- Noise impacting natural behavioural patterns of fauna;
- Death as a result of vehicle collisions;
- Death as a result of cyanide poisoning;
- Death as a result of becoming trapped in mine infrastructure and water storages; and
- Disturbance to rare or endangered species.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	Page 3 of 14
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017



## 4. ENVIRONMENTAL OBJECTIVES

The Fauna Management Plan has been developed to satisfy the following objectives:

- Maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels;
- Minimise impacts to fauna habitats;
- Adopt practices aimed at minimising impacts on fauna, including: controlling the extent of open excavations; regularly checking areas where animals could become trapped; actively managing features such as water storages, domestic waste storages, processing water storage, tailings supernatant pond and lighting which may attract fauna;
- Disturb land only within approved clearing envelopes; and
- Ensure that land rehabilitation is implemented progressively.

## 5. PERFORMANCE INDICATORS

Edna May will monitor its environmental performance in relation to:

- Conformance with the fauna management and implementation strategy (Section 6) (completion of actions specified within nominated timeframe);
- Compliance with regulatory requirements; and
- Effectiveness and efficiency of management actions.

The means by which conformance with the management actions required under this Fauna Management Plan will be demonstrated are indicated under the column headed “evidence” in TABLE 1.

## 6. FAUNA MANAGEMENT AND IMPLEMENTATION STRATEGY

Fauna management strategies at EMO have been devised to comply with legislation and to minimise adverse impacts to fauna and fauna habitats (TABLE 1), along with the title of the role responsible for implementing each action and an indication of the timing for implementation.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 4 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017

# Fauna Management Plan

**TABLE 1: FAUNA MANAGEMENT IMPLEMENTATION ACTIONS**

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
<b>General</b>				
FnMIS 1	All land clearing activities and activities with the potential to impact on fauna habitat at Edna May operations will comply with clearing permits, programme of works (POW), relevant local and state regulations and Australian standards.	Prior to Clearing	General Manager Senior Environmental Advisor	Clearing and Ground Disturbance Procedure Clearing Register Internal and External Clearing permits
<b>Stakeholder consultation</b>				
FnMIS 2	Where required, Edna May Operations will liaise with the operations neighbours and stakeholders where land clearing, or activities may have or have had impact upon the regions flora and fauna.	Prior to Clearing	General Manager People and Culture and Community Manager	Communications register and records. Incident reporting (QHSE)
FnMIS 3	Maintain a Complaints Register to assist in indicating improvements or failings in flora management actions.	Continuous	People and Culture and Community Manager	Complaints register included in incident database (QHSE). Summarised in the Annual Environmental Report (AER)
<b>Native fauna management</b>				
FnMIS 4	Firearms are not permitted within the Edna May tenement boundary without Resident Manager approval. No shooting or deliberate harming of native fauna is permitted.	Continuous	General Manager	Induction presentation. No fire arms onsite.
FnMIS 5	Direct contact with fauna is to be avoided. For example, the feeding of fauna, whether native or introduced, is not permitted.	Continuous	General Manager	Induction presentation.
FnMIS 6	Snakes and other reptiles will not be wilfully harmed or killed.  If a snake or other reptile is observed within populated areas where there is a risk to people or the animal, the reptile's location shall be reported to the Environment Department immediately. They will arrange a trained reptile handler to remove it to a safe location away from populated areas.	Continuous	General Manager Environmental Advisor/s Trained Reptile Handlers	Induction Incident reporting (QHSE) Reptile Handlers licence, list and training certificates Snake relocation register
FnMIS 7	Mallee Fowl are known to occur in the area. Any sightings of Mallee Fowl or their nests must be reported to an Environmental Advisor.	Continuous	Environmental Advisors	Incident reporting (QHSE)

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 5 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017

# Fauna Management Plan

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
FnMIS 8	<p>All fauna injuries and deaths must be reported to the Environment Department immediately.</p> <p>If an animal is injured during mining operations (including vehicle strike traveling to and from site or a suspected poisoning) stop and check the animal. If the animal is dead and is a female marsupial check if there is any offspring in the pouch that can be saved. If offspring is alive, contact the Environment department immediately.</p> <p>If fauna is injured during mining operations and it is unlikely that the animal can be saved, the Environmental Advisor will organise for the animal to be euthanized using the most humane method possible. If the animal can be saved the Environmental Advisor will organise for the animal to be taken to a qualified veterinarian or carer.</p>	Continuous	Environmental Advisor	<p>Induction presentation</p> <p>Incident reporting (QHSE)</p>
<b>Land clearing / ground disturbance – mining and exploration activities</b>				
FnMIS 9	<p>Conserve fauna habitat where possible by:</p> <ul style="list-style-type: none"> <li>(i) avoid clearing of native vegetation;</li> <li>(ii) minimise the amount of native vegetation to be cleared; and</li> <li>(iii) reduce the impact of clearing on any environmental value.</li> </ul> <p>Clearing and exploration activities will only be undertaken in accordance with the Flora Management Plan (EMO-ENV-PLN-1208) and the Clearing and Ground Disturbance Procedure (EMO-ENV-PRO-1201).</p>	Continuous	General Manager	<p>Clearing and Ground Disturbance Procedure</p> <p>Internal and External Clearing permits</p> <p>Clearing Register</p>
<b>Introduced fauna</b>				
FnMIS 10	<p>An autumn and spring 1080 Baiting Program will be completed to control foxes and rabbits. Cat trapping will be conducted regularly to control feral cat numbers. Cats will be humanely euthanised by the Ranger or a veterinarian. Rodent baiting will be completed as required.</p>	When required	Environmental Advisors	<p>Cat Trapping Register</p> <p>1080 Baiting records and licence</p>
FnMIS 11	<p>Appropriate waste management (including the regular covering of the landfill) and ensuring bins on site / village containing food scraps have</p>	Continuous	General Manager	<p>Landfill covering procedure</p> <p>Weekly landfill inspection records</p>

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 6 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017

# Fauna Management Plan

Edna May

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
	<p>lids to prevent attraction of fauna and increase in feral animal population.</p> <p>For further detail on waste management refer to the Waste Management Plan.</p>			
FnMIS 12	Domestic dogs and cats are not permitted within the Edna May tenement boundary. This is to prevent domesticated dogs and cats from harming native fauna.	Continuous	General Manager	Induction presentation. No domestic cats and dogs on site.
FnMIS 13	All employees are to report animal sightings (including feral animals) to the Environmental Department.	Continuous	Environmental Officer	Incident reporting (QHSE) Cat trapping register
<b>Dust</b>				
FnMIS 14	To minimise the impact of dust on fauna and their habitat dust will be managed as per the EMO Air Emissions Management Plan (EMO-ENV-PLN-1203) and Crusher and Coarse Ore Stockpile Dust Management Plan (EMO-ENV-PLN-1213)	Continuous	General Manager Processing Manager Mining Manager	Documented Procedures Dust analysis readings and reports Effective dust control systems in place and operational
<b>Vehicle Usage</b>				
FnMIS 15	In order to minimise disturbance and prevent unintentional impacts through the use of machinery and vehicles, no vehicles are to travel off designated road / tracks.	Continuous	All personnel	No vehicle off designated roads/ tracks. Incident reporting (QHSE)
<b>Fauna entrapment (and impact) from water bodies and excavations</b>				
FnMIS 16	Access by fauna to the decant pond within the TSF will be limited during operations and WAD CN levels to be maintained below 50mg/L during operations.	Continuous	Processing Manager	Monitoring records of TSF Decant. Incident reporting (QHSE)
FnMIS 17	The surface of the TSF will be capped and rehabilitated with a design developed during operations.	Mine Closure	Environmental Advisors	Mine Closure Plan
FnMIS 18	An egress point will be in place where required on the edges of water storage ponds to prevent fauna from becoming trapped and drowning.	Continuous	Processing Manager	Evidence of egress points in place.
FnMIS 19	Excavations, sumps and drill holes will be backfilled or plugged shortly after use to prevent fauna entrapment.	Continuous	Exploration Manager General Manager	Evidence that excavations, sumps, drill holes are backfilled or covered.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 7 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017



# Fauna Management Plan

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
<b>Training and awareness</b>				
FnMIS 20	General site inductions and monthly prestart presentations will be used to raise the awareness of the workforce about conservation issues in regards to fauna and fauna habitat.	Continuous	Environmental Advisors	Section detailing fauna impacts and management included in induction presentation. Monthly Environmental Awareness Presentations
<b>Monitoring and Contingencies</b>				
FnMIS 21	Regular inspections of the TSF cells (as per the Tailings Operating Manual) including the observation of any stress or deaths of fauna surrounding or within the IWL.	Operations	Processing Manager	Tailings Operating Manual Daily IWL Inspection Log Sheets
FnMIS 22	Regular monitoring for entrapment in excavations, sumps and water storage ponds will be undertaken.		Processing Manager Mining Manager Geology Manager	Weekly Borefields line inspections Daily processing checks
FnMIS 23	Regular inspections for signs or observations of introduced fauna.	Continuous	Environmental Advisors	Records of inspection findings.
FnMIS 24	<p>If adverse impacts to fauna or fauna habitat are observed the Environment department will be notified immediately and an incident report will be prepared and submitted within 24 hrs. The incident report will identify corrective actions to be implemented and the date for their completion.</p> <p>Non compliances can be identified through a variety of means including; inspections, audits, environmental monitoring and opportunistic observations.</p> <p>Non-compliances with this management plan, relevant legislation and permits will be addressed through:</p> <ul style="list-style-type: none"> <li>• Site based incident reporting system (QHSE), and remedial action tracking;</li> <li>• External reports to relevant regulatory authorities (DER, DMP) through correspondence and the AER;</li> </ul>	Continuous	General Manager	Incident reporting (QHSE). Summarised in the AER Inspection and audit reports, complaints register, stakeholder consultation database and records.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 8 of 14</b>
<b>e-Controlled Copy Document Uncontrolled When Printed</b>		Date Printed:	23 February 2017

# Fauna Management Plan

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
	<ul style="list-style-type: none"> <li>Education of personnel through site-wide notifications, Environmental Alerts, inductions, toolbox/pre-start talks, and newsletters;</li> <li>Response to direct complaints from stakeholders as recorded in the "Complaints Register"; and</li> <li>Consultation with stakeholders on a regular basis to address issues at an informal level</li> </ul>			
<b>Auditing and Reporting</b>				
FnMIS 25	Fauna related activities and impacts will be summarised in the AER.	Annually	Environmental Advisors	Summarised in the AER
FnMIS 26	If adverse impacts to fauna or fauna habitat are observed, the Environment Department will be notified immediately and an incident report will be prepared and submitted within 24 hrs. The incident report will identify contingency actions to be implemented and the date for completion of contingency actions.	Continuous	All Personnel	Incident reports within incident data base. These incident reports should document contingency actions. Summarised in the AER
FnMIS 27	Breaches of licence or tenement conditions will be reported to the relevant authority (DER or DMP) within 24 hrs, and summarised through the Annual Audit Compliance Report (AACR) and the AER, as part of the operating license. External reporting of incidents is the responsibility of the General Manager with assistance from the Environmental Advisors.	Continuous	General Manager / Environmental Advisors	Incident database. Summarised in AER. Communications register.
FnMIS 28	EMO incident management system will be used to record all environmental incidents; to track and manage corrective actions resulting from environmental incidents; to track and address community complaints; and to record audit outcomes.	Continuous	All Personnel	Incident reporting (QHSE) Action tracking (QHSE) Summarised in the AER
FnMIS 29	Quarterly environmental audits will be organised by the Group Environment and Sustainability Manager.	Quarterly	General Manager	Quarterly audit reports
<b>Review and Revision</b>				
FnMIS 30	The General Manager will review this EMP, and allocate resources to implement it. They will ensure appropriate action is being taken on non-compliances, and offer support to environmental staff through directives to site personnel	Annually	General Manager	Fauna management actions on site

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 9 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017

# Fauna Management Plan



Edna May

Edna May

REF	MANAGEMENT ACTIONS	TIMING	DELEGATED RESPONSIBILITY	EVIDENCE
FnMIS 31	The Fauna Management Plan will be internally reviewed at least on a 2-yearly basis. Reviews will be conducted at key stages of the Project based on planning requirements; review of incidents, audits and corrective actions; legal requirements; and analysis of monitoring results. The reviews will incorporate feedback from relevant Community Stakeholders and DER / DMP staff.	Biennially	Environmental Advisors	Revision Record

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 10 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017



## 7. STAKEHOLDER CONSULTATION

EMO has developed a Complaints Register to record complaints from stakeholders, and record actions taken to address these complaints by site personnel. Evolution Mining aims to maintain a healthy relationship with neighbouring stakeholders by promoting open and honest communications regarding any hazards that may impact upon the operations neighbours or the environment.

It is unlikely that any incident relating to fauna management will impact upon neighbouring residents or that any complaints will be made in relation to fauna management.

Further detail regarding community consultation undertaken for the EMO is provided in the Environmental Management System Manual.

## 8. TRAINING AND AWARENESS

General site inductions and pre-start presentations are used to raise the awareness of the workforce about conservation of fauna and fauna habitat. Additional area specific training is undertaken where required. Posters are also provided around the site describing the native fauna found in the Westonia Region. A snake poster has also been provided, describing the types of snakes in the area and their level of venom.

## 9. PERFORMANCE MONITORING

The following monitoring are undertaken:

- Daily inspections of the TSF cells (as per Tailings Operating Manual) including the observation of any stress or deaths of fauna surrounding or within the IWL (tailings ponded water);
- Regular monitoring for entrapment in excavations, sumps and water storage ponds will be undertaken;
- Regular inspections for signs or observations of introduced fauna;
- Undertake flora and vegetation monitoring as per the Flora Management plan for the monitoring of fauna habitat;
- Quarterly corporate environmental audits;
- Inspections by regulatory bodies such as the DER and DMP; and
- Annual environmental audits.

## 10. CONTINGENCIES

If adverse impacts to fauna and fauna habitat are observed, the Environment Department will be notified immediately and an incident report will be prepared and submitted within 24 hours. The incident report will identify contingency actions to be implemented and the date for completion of contingency actions

## 11. AUDITING AND REPORTING

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	Page 11 of 14
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	23 February 2017



This EMP and its outcomes, commitments and the implementation of the management actions will be audited annually and where required, they will be revised.

The results of inspections, audits and incident reports or complaints received relating to fauna and fauna habitat impacts will be included in AER. This will be additional to any event-based reporting.

The EMO internal reporting system (QHSE) will record any non-compliance relating to fauna and fauna habitat. The non-compliances will be recorded and will not be closed out until corrective measures are in place. These will also be summarised in the AER.

Breaches of licenses, permits or tenement conditions will be reported within 24hrs to the DER or DMP and summarised in the AER. The timelines and responsibilities associated with reporting are detailed in Table 1. External reporting of incidents is the responsibility of the Resident Manager with assistance from the Environmental Advisors.

## 12. REVIEW AND REVISION

This plan is intended to be adaptive and is subject to change as new information becomes available. The plan will be reviewed to incorporate the formal requirements of DER Operating Licence.

This plan will be reviewed by the Environmental Advisor/s every 2 years from the commencement of operation, or in the following circumstances:

- Routine inspections detects that a trigger has been breached or that a trigger is at risk of being breached; or
- The Project scope has changed significantly.

Review of this EMP will seek to address the following questions:

- Is the background information about the Project current?
- Are there cross references to other documents (including procedures) that should be added?
- Has any further consultation of a material nature been undertaken?
- Has the scope of the plan changed in a material way?
- Is there any new or revised legislation or policy that should be considered?
- Are any of the management actions fully complete such that they can be removed?
- Should any new management actions be added, either as a result of incident reports, inspection results, project changes or other developments?
- Are the performance indicators effective in assessing performance?
- Are there better alternative indicators?
- Has monitoring highlighted any gaps in the program, and should the existing monitoring program be modified?
- Is the allocation of responsibilities for each management action appropriate?
- Is the review period for this plan appropriate?

If the assessment identifies the need for changes to the management plan, such changes will be implemented and the plan re-issued.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	Page 12 of 14
e-Controlled Copy Document Uncontrolled When Printed		Date Printed:	23 February 2017



## 13. RELEVANT LEGISLATION AND DOCUMENTS

### 13.1 Relevant Legislation

- *Biodiversity Conservation Act 2016*
- *Mines Safety and Inspection Act 1994;*
- *Mines Safety and Inspection Regulations 1995;*
- *Environmental Protection Act 1986;*
- *Conservation and Land Management Act 1984;*
- *Environmental Protection Regulations 1987;*
- *Soil and Land Conservation Act 1945;*
- *Chamber of Minerals and Energy: Mine Closure Guideline for Minerals Operations in Western Australia (2000);*
- *EPA Position Statement No. 7 Principles of Environmental Protection (EPA, 2004b);*
- *Department of Industry, Tourism and Resources: Biodiversity Management (February 2007);*
- *Environmental Protection and Biodiversity Conservation Act, 1999 (Commonwealth) (EPBC Act); and*
- *Wildlife Conservation Act, 1950.*

### 13.2 Internal Documents

- [EMO-ENV-PLN-1201 Environmental Management Systems Manual](#)
- [EMO-MIN-PLN-1400 Traffic Management Plan/Pit Permit Road Rules](#)
- [EMO-ENV-PLN-1208 Flora Management Plan](#)
- [EMO-ENV-PLN-1202 Landfill Management Plan](#)
- [EMO-ENV-PRO-1201 Clearing and Ground Disturbance Procedure](#)
- [EMO-ENV-PRO-1202 Covering of Landfill Procedure](#)
- [EMO-ENV-WP-1212 Native Fauna Procedure](#)
- [EMO-ENV-WP-1215 Managing Injured & Deceased Native Fauna](#)

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 13 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017

# Fauna Management Plan



**Evolution**  
MINING

**Edna May**

**Edna May**

## DEFINITIONS

Fauna	All the animals that live in a particular area, time period, or environment.
Habitat	The natural home or environment of an animal, plant, or other organism.

Fauna Management Plan	EMO-ENV-PLN-1207	Owner: Environmental	Approver: Senior Environmental Advisor
Version control: 3	Issue date: 20/02/2017	Revision date: 20/02/2019	<b>Page 14 of 14</b>
<b>e-Controlled Copy</b>	<b>Document Uncontrolled When Printed</b>	Date Printed:	23 February 2017