



PHOENIX

ENVIRONMENTAL SCIENCES

Targeted flora and short range endemic invertebrate survey
for the FIM IIE Project

Prepared for KCGM Pty Ltd

December 2019

Final Report



Targeted flora and SRE survey for the FIM IIE Project

Prepared for KCGM Pty Ltd

Final Report

Authors: Alice Watt, Jarrad Clark

Reviewer: Karen Crews, Dr Grant Wells

Date: 5 December 2019

Submitted to: Janine Cameron

Version history			
Name	Task	Version	Date
K. Crews	Draft for client comments	1.0	17 April 2019
A. Watt	Final submitted to client	2.0	14 May 2019
K. Crews	Update to final – revised clearing area	3.0	5 December 2019

©Phoenix Environmental Sciences Pty Ltd 2018

The use of this report is solely for the Client for the purpose in which it was prepared. Phoenix Environmental Sciences accepts no responsibility for use beyond this purpose.

All rights are reserved and no part of this report may be reproduced or copied in any form without the written permission of Phoenix Environmental Sciences or the Client.

[Phoenix Environmental Sciences Pty Ltd](#)

1/511 Wanneroo Rd BALCATTWA WA 6021

P: 08 9345 1608

F: 08 6313 0680

E: admin@phoenixenv.com.au

Project code: 1225-FIM-KCG-ECO

Contents

CONTENTS.....	I
LIST OF FIGURES.....	I
LIST OF TABLES.....	I
LIST OF APPENDICES	II
1 INTRODUCTION.....	1
2 EXISTING ENVIRONMENT.....	3
2.1 Interim Biogeographic Regionalisation of Australia	3
2.2 Land systems.....	5
2.3 Climate and weather.....	7
3 METHODS.....	8
3.1 Desktop review	8
3.2 Field survey	8
3.2.1 Flora and vegetation	8
3.2.2 Short-range endemic invertebrates.....	9
3.2.3 Taxonomy and nomenclature	9
3.3 Survey personnel	9
4 RESULTS	11
4.1 Flora and vegetation	11
4.1.2 Short-range endemic invertebrates.....	14
5 DISCUSSION.....	17
6 REFERENCES.....	18

List of Figures

Figure 1-1	Fimiston operational areas, Fim II Extension proposed clearing area and study area ...	2
Figure 2-1	IBRA regions and subregions of the study area	4
Figure 2-2	Land systems of the study area	6
Figure 2-3	Annual climate and weather data for Kalgoorlie-Boulder Airport (no. 012038) (BoM 2019)	7
Figure 3-1	SRE survey sites.....	10
Figure 4-1	<i>Eremophila praecox</i> in the study area	12
Figure 4-2	<i>Eremophila praecox</i> and vegetation types in the study area	13
Figure 4-3	SRE records from survey and updated desktop records for study area	16

List of Tables

Table 2-1	Extent of each land system present in the study area.....	5
Table 4-1	Vegetation types from Botanica Consulting (2015) with <i>Eremophila praecox</i>	11
Table 4-2	SRE taxa from target SRE groups recorded during the survey.....	14

List of Appendices

- Appendix 1 Flora and SRE review for the Fimiston II Tailings Storage Facility Expansion Project memo
- Appendix 2 SRE site locations and descriptions
- Appendix 3 WA Museum molecular identification report

1 INTRODUCTION

The Fimiston Operational Area forms part of Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) operations, located east of the City of Kalgoorlie-Boulder in the Goldfields region of Western Australia (Figure 1-1). This area contains the Fimiston Gold Mine Operations, which comprise the Fimiston Open Pit, waste rock dumps, tailings storage facilities (Fimiston I, Fimiston II and Kaltails) and infrastructure corridors.

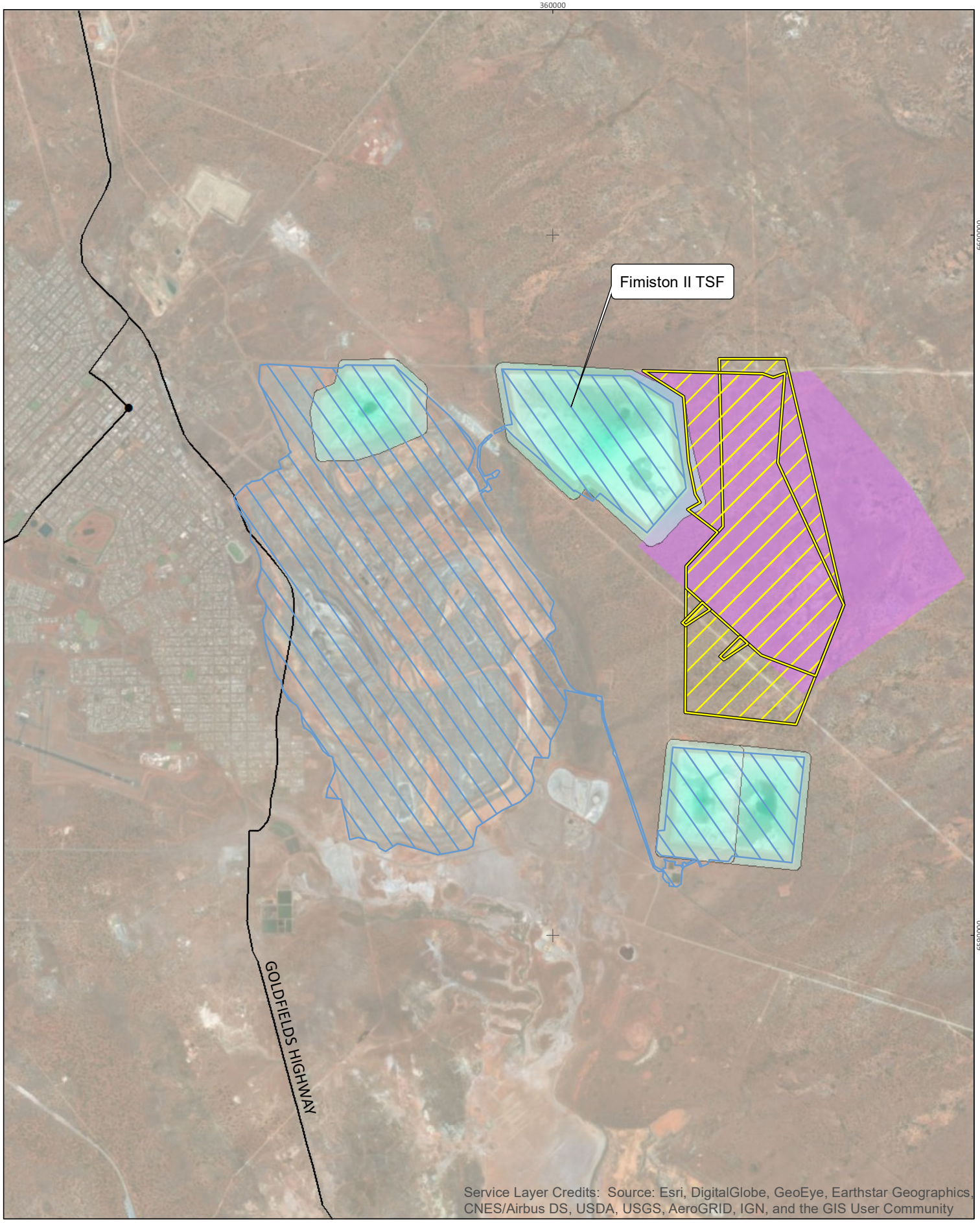
In August 2018, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) to conduct a flora and short range endemic invertebrate (SRE) assessment for the Fimiston II Tailings Storage Facility (TSF) Expansion Project (Fim IIE Project).

Surveys were completed for the Fim IIE Project in spring 2014 and autumn 2015 (Botanica Consulting 2015; Harewood 2015). Phoenix subsequently undertook a data currency review and gap biological survey for the broader Fimiston Operations in spring 2017 (Phoenix 2018b). This report incorporated and updated currency of the previous survey data for the Fim IIE Project, but no additional field work was conducted in the Fim IIE Project Area.

In December 2018, Phoenix (2018a; Appendix 1) undertook:

- a review of the flora and vegetation survey report for the Fim IIE survey area (study area; Figure 1-1) (Botanica Consulting 2015) for compliance with current EPA guidance for terrestrial flora and vegetation surveys (EPA 2016a) to identify any potential major non-compliance and/or additional survey requirements
- a significance and risk-based assessment for SREs known from the study area, in accordance with EPA (2016b) to determine if any SREs may be affected by the Fim IIE Project and/or required further surveys.

The assessment recommended a targeted survey be conducted for significant flora and SRE species. This report documents the findings of the targeted flora and SRE survey.



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



KCGM KCGM Operations Fim IIE Project	
Project No	1225
Date	05-Dec-19
Drawn by	AJ
Map author	KC
1:70,000 (at A4) GDA 1994 MGA Zone 51	

- Fimiston operational areas
- Tailings storage facilities
- Fim II Extension survey area
- Fim II Extension proposed clearing area

Figure 1-1
Fimiston operational areas and Fim II Extension proposed clearing area



All information within this map is current as of 05-Dec-19. 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.

2 EXISTING ENVIRONMENT

2.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The study area occurs over the boundary of the Coolgardie and Murchison bioregions. The majority of the study area (1,008.70 ha, 77.80%) occurs within the Eastern Goldfields subregion (COO3) of the Coolgardie bioregion, with the remaining portion (22.20%, 287.86 ha) occurring in the Eastern Murchison subregion (MUR01) of the Murchison bioregion (Figure 2-1).

The Eastern Goldfields subregion is characterised by (Cowan 2001a):

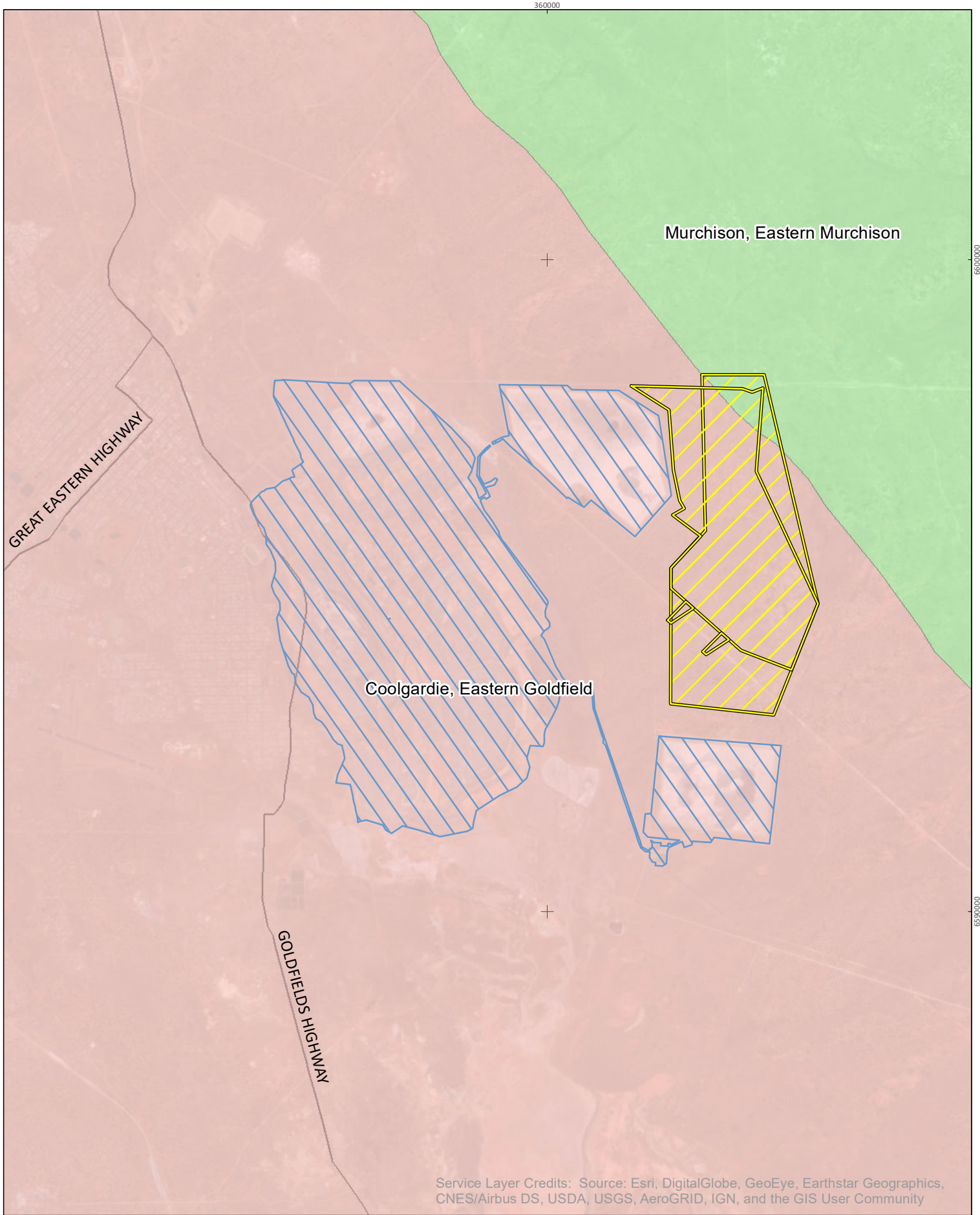
- gently undulating plains interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite
- tertiary soils dominated by calcareous earths overlay eroded gneisses and granites
- vegetation consisting of mallees, *Acacia* thickets and shrub-heaths on sandplains and dwarf shrublands of samphire persisting on salt lakes, surrounded by diverse *Eucalyptus* woodlands, which also occur on ranges and in valleys.
- in the western half, a series of large playa lakes indicate the remnants of ancient major drainage lines
- arid to semi-arid climate with 200–300 mm of mostly summer rainfall.

Rare features within the Eastern Goldfields subregion include highly diverse floristic species and ecosystem diversity, in particular, *Eucalyptus* spp., *Acacia* spp. and ephemeral flora communities of the Fraser Range vegetation complex and Woodline Hills and several notable wetlands including freshwater lakes, large salt lakes, claypans, and freshwater swamps such as Rowles Lagoon, Clear and Muddy Lakes and Swan Lake (Cowan 2001a).

The Eastern Murchison subregion is characterised by (Cowan 2001b):

- many internal drainages
- extensive areas of elevated red desert and plains with minimal dune development
- salt lake systems associated with the occluded Paleodrainage system
- broad plains of red-brown soils and breakaway complexes as well as red sandplains
- vegetation dominated by Mulga woodlands, often rich in ephemerals; hummock grasslands, saltbush shrublands and *Halosarcia* shrublands
- an arid climate, with mainly winter rainfall (200 mm).

Rare features within the Eastern Murchison subregion include calcrete aquifers known to support a wide range of subterranean aquatic fauna that are short range endemics.



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



**Kalgoorlie Consolidated Gold Mines
Flora and SRE assessment for FIM IIE Project**

Project No 1225
Date 05-Dec-19
Drawn by AJ
Map author KC



0 1 2
Kilometers
1:75,000 (at A4) GDA 1994 MGA Zone 51

- Fim II Extension proposed clearing area
- Fimiston operational areas
- IBRA Region, subregion
- Coolgardie, Eastern Goldfield
- Murchison, Eastern Murchison

Figure 2-1
IBRA regions and subregions of the study area



All information within this map is current as of 05-Dec-19. 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.

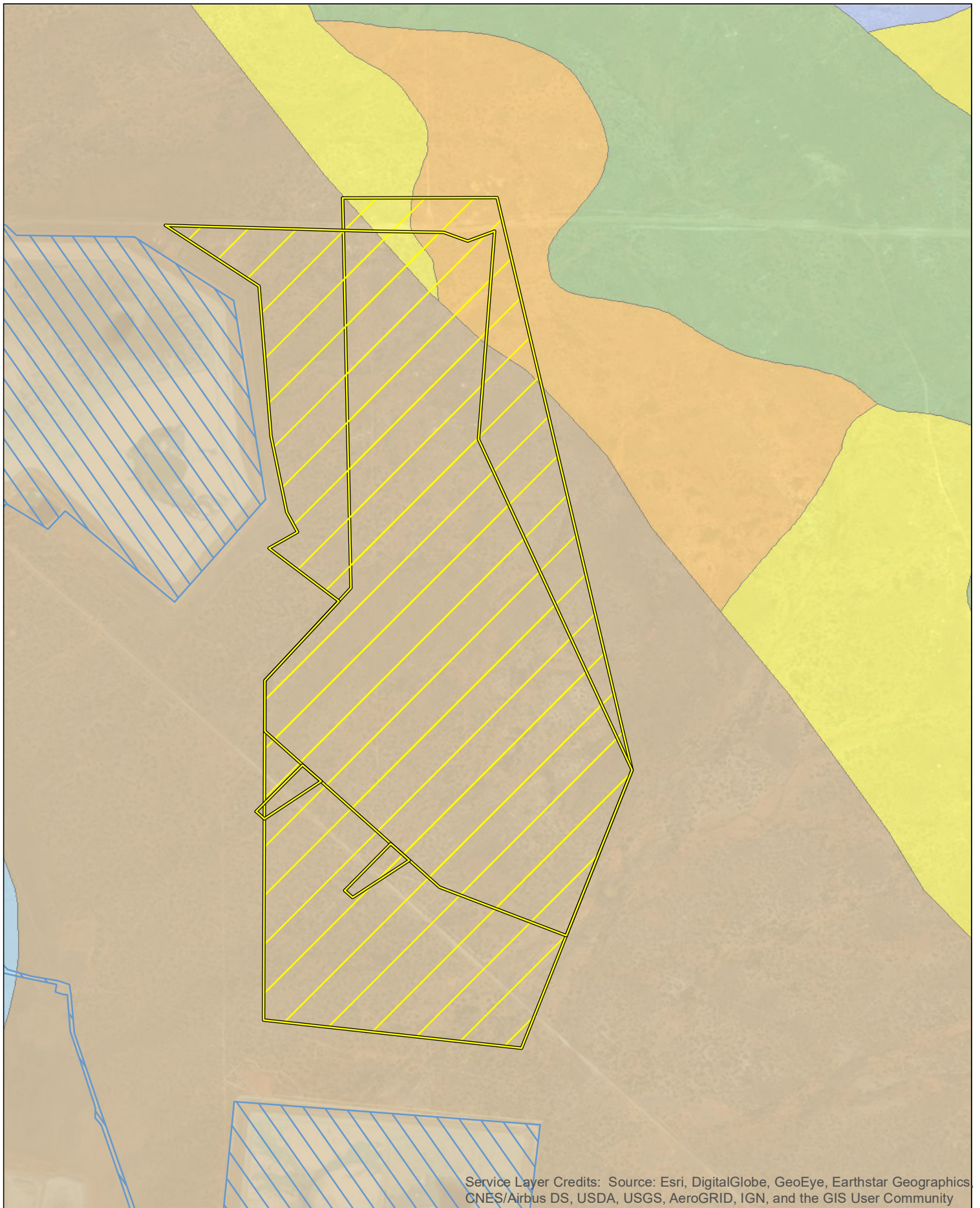
2.2 LAND SYSTEMS

The Department of Agriculture and Food Western Australia (DAFWA) partially mapped the land systems of the Eastern Murchison and Eastern Goldfields subregions from aerial photography (DAFWA 2014).

The study area intersects four land systems, Graves, Gumland, Moriarty and Mx43 (Figure 2-2; Table 2-1). The Mx43 land system is defined by gently undulating valley plains and pediment with some outcrop of basic rock (DAFWA 2014). The Gumland land system is defined by extensive pediplains supporting eucalypt woodlands with halophytic and non-halophytic shrub understoreys (DAFWA 2014). The Graves land system is defined by basalt and greenstone rises and low hills supporting eucalypt woodlands with prominent saltbush and bluebush understory (DAFWA 2014). The Moriarty land system is defined by low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys (DAFWA 2014). The study area occurs predominantly within the Mx43 land system, approximately 78% of the study area (Table 2-1).

Table 2-1 **Extent of each land system present in the study area**

Land system	Study area (ha)	Percentage of study area
Graves	9.39	0.72
Gumland	88.26	6.81
Moriarty	190.50	14.69
Mx43	1008.41	77.78
Total	1296.56	100%



	Kalgoorlie Consolidated Gold Mines Flora and SRE assessment for FIM IIE Project		Fimiston operational areas	Land system	Figure 2-2 Land systems of the study area
	Project No 1225 Date 05-Dec-19 Drawn by AJ Map author KC		Fim II Extension proposed clearing area	BB5 Graves System Gumland System Moriarty System Mx43 Zed System	
<small>All information within this map is current as of 05-Dec-19. 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.</small>		<small>1:30,000 (at A4)</small>	<small>GDA 1994 MGA Zone 51</small>		

2.3 CLIMATE AND WEATHER

The climate of the Eastern Goldfields subregion is described as arid to semi-arid and the Eastern Murchison is defined as arid, both with 200–300 mm of annual rainfall, the majority occurring during winter months (Cowan 2001a, b). The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and historic climate data is located at Kalgoorlie-Boulder Airport (Site 012038; Latitude: 30.78°S Longitude: 121.45°E).

Kalgoorlie-Boulder Airport records the highest maximum mean monthly temperature (33.6°C) in January, the lowest maximum mean annual temperature (16.8°C) in July (BoM 2019). The highest minimum mean monthly temp (18.3°C) is recorded in January with the lowest (5.1°C) recorded in July (BoM 2019). Average annual rainfall is 267.7 mm with January, February and June recording the highest monthly averages (27.5, 31.2 and 27.2 mm respectively) (BoM 2019). Tropical rain-bearing depressions moving southwards from northern Australian waters can cause heavy rainfall events in summer (BoM 2019) (Figure 2-3).

Records from Kalgoorlie-Boulder Airport weather station show well above average rainfall occurred in summer (December to February), but rainfall was consistently below monthly averages following this. Total rainfall in the three months prior to the survey was well above average despite below average rainfall in September. The mean daily minimum and maximum temperatures were typically slightly higher than annual averages for the 12 months preceding the field surveys (Figure 2-3).

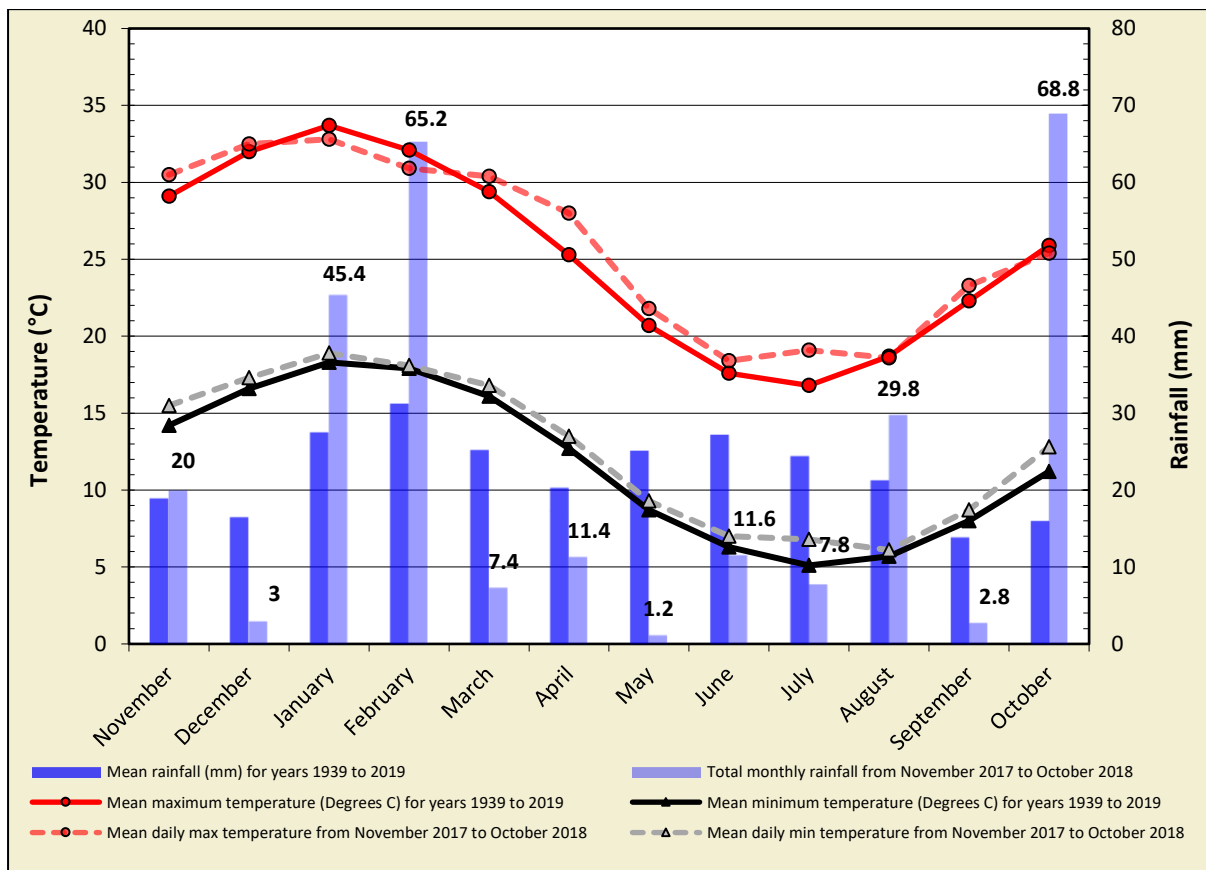


Figure 2-3 Annual climate and weather data for Kalgoorlie-Boulder Airport (no. 012038) (BoM 2019)

3 METHODS

The surveys were conducted in accordance with EPA guidelines, where applicable including:

- *Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment* (EPA 2016a)
- *Technical Guidance: Sampling of short range endemic invertebrate fauna* (EPA 2016b).

3.1 DESKTOP REVIEW

A desktop review was previously undertaken in a separate report (Phoenix 2018a; Appendix 1).

3.2 FIELD SURVEY

The targeted flora survey was undertaken on 13-14 November 2018. The SRE survey was undertaken on 7-9 November and 13-14 December 2018.

3.2.1 Flora and vegetation

Targeted searches were undertaken throughout the study area in suitable habitat for species identified as potentially present in the previous review (Appendix 1). Search effort was particularly directed to habitat considered suitable for *Eremophila praecox* (P1) as it had been previously been recorded by Phoenix in proximity to the study area (Phoenix 2018b) in similar habitat to that of the study area.

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

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

The vegetation descriptions and type boundaries of the Botanica Consulting (2015) survey were assessed during the field survey.

3.2.2 Short-range endemic invertebrates

Ten sites were sampled for SREs using wet pitfall traps. All sites were located outside the Fim IIE proposed clearing area (Figure 3-1; Appendix 2).

Five 1 L pitfall traps (plastic jars) filled with propylene glycol were installed at each site. Traps were buried at ground level and lids were placed over the top at approximately 25 mm above the ground to avoid vertebrate by-catch as much as possible. The traps were left open for a period of approximately five weeks.

On retrieval, pit traps were dug up, sealed and placed in zip lock bags for transport to Phoenix's laboratory in Perth for sorting.

3.2.3 Taxonomy and nomenclature

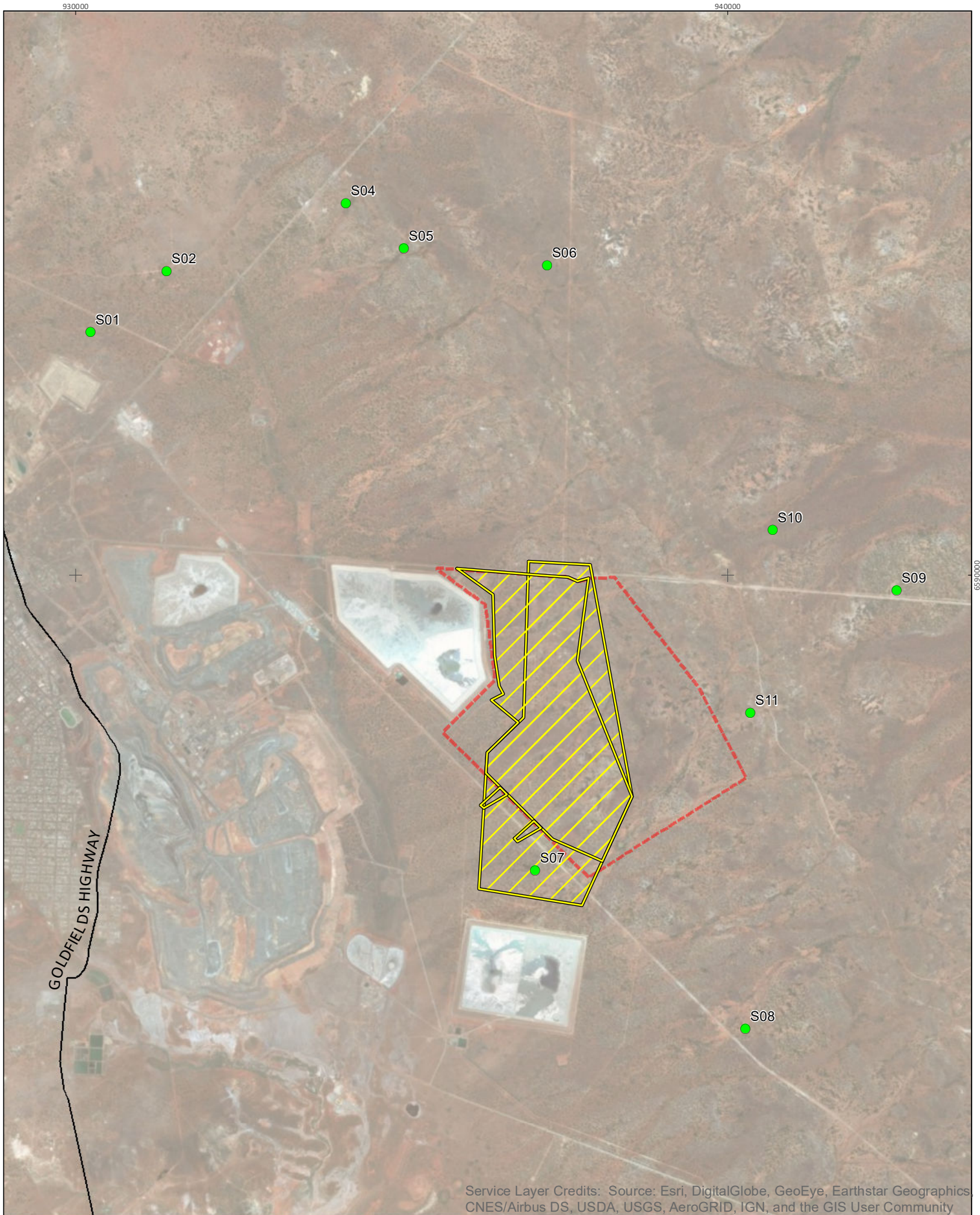
Plant species were identified using local and regional flora keys, and comparisons with named species held at the WA Herbarium. Nomenclature for flora and vegetation used in this report follows that used by FloraBase (DBCA 2017a) and the WA Herbarium, in line with EPA requirements for Environmental Impact Assessment (EIA). The conservation status of all recorded flora was compared against the current lists available on FloraBase and the EPBC Act Threatened Flora list provided by the DoEE (2017).

Two invertebrate specimens were sequenced for possible matches to previously collected taxa (Appendix 3).

3.3 SURVEY PERSONNEL

The flora survey was undertaken by Dr Grant Wells and Alice Watt. The SRE survey was undertaken by Jarrad Clark, Dr Simon Judd and Dr John Scanlon.

The identity of Priority flora records was confirmed with Mike Hislop of the WA Herbarium. Invertebrate taxonomy was completed by Dr Mark Harvey, Dr Volker Framenau, Dr Erich Volschenk and Dr Nerida Wilson.



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

	Kalgoorlie Consolidated Gold Mines Flora and SRE assessment for FIM IIE Project		Figure 3-1 SRE survey sites													
	<table border="1"> <tr> <td>Project No</td> <td>1225</td> <td rowspan="4"> </td> </tr> <tr> <td>Date</td> <td>05-Dec-19</td> </tr> <tr> <td>Drawn by</td> <td>AJ</td> </tr> <tr> <td>Map author</td> <td>KC</td> </tr> </table>	Project No		1225		Date	05-Dec-19	Drawn by	AJ	Map author	KC	<table border="1"> <tr> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td colspan="3" style="text-align: center;">Kilometers</td> </tr> </table>	0	1	2	Kilometers
Project No	1225															
Date	05-Dec-19															
Drawn by	AJ															
Map author	KC															
0	1	2														
Kilometers																
<small>All information within this map is current as of 05-Dec-19. 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.</small>																

4 RESULTS

4.1 FLORA AND VEGETATION

4.1.1.1 Significant flora

A total of 20 plants, 11 confirmed and nine possible identifications of the Priority 1 *Eremophila praecox* were recorded in the study area (Figure 4-2). The plants were recorded in seven vegetation types, covering 61% of the study area mapped by Botanica Consulting (2015) (Table 4-1).

Table 4-1 Vegetation types from Botanica Consulting (2015) with *Eremophila praecox*

Vegetation type	Vegetation description	Area (ha) of study area	% of study area
RP-EW1	Low woodland of <i>Eucalyptus ravida</i> over low scrub of <i>Eremophila pustulata</i> / <i>Eremophila scoparia</i> and <i>Atriplex vesicaria</i> .	83.21	6.42
CLP-EW4	Low woodland of <i>Eucalyptus lesouefii</i> over open low scrub of <i>Exocarpos aphyllus</i> and open dwarf scrub of <i>Eremophila parvifolia</i> / <i>Olearia muelleri</i> .	65.87	5.08
RHS/RP-EOW/CFW	Open low woodland of <i>Eucalyptus lesouefii</i> / <i>Eucalyptus transcontinentalis</i> / <i>Casuarina pauper</i> over low scrub of <i>Acacia kalgoorliensis</i> and open dwarf scrub of <i>Westringia rigida</i> .	67.54	5.21
OD-EW2	Low woodland of <i>Eucalyptus stricklandii</i> / <i>Eucalyptus ravida</i> over low scrub of <i>Eremophila scoparia</i> and dwarf scrub of <i>Atriplex vesicaria</i> .	248.88	19.20
CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scoparia/ <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	47.49	3.66
CLP-EW2	Low woodland of <i>Eucalyptus salmonophloia</i> over low scrub of <i>Eremophila scoparia</i> / <i>Cratystylis subspinescens</i> and dwarf scrub of <i>Maireana sedifolia</i> / <i>Eremophila parvifolia</i> .	277.97	21.44
Total		790.97	61.00

Eremophila praecox is a Broom-like shrub, 1.5–3.0 m high with purple flowers in October or December. In WA, it has previously been recorded from the Eastern Goldfields subregion of the Coolgardie Bioregion (DBCA 2019a). The species is known from 25 records in WA (DBCA 2017b, 2019b) and 47 in South Australia (ALA 2019). The habitat descriptions include:

- undulating plains with red brown sandy loam
- low woodland LAi over dwarf scrub SCi, with *Eucalyptus clelandii*, *Eremophila ionantha*, *E. parvifolia*, *E. scopari*, *Senna* spp. *Solanum lasiophyllum* and *Olearia muelleri* on low plain with moist red brown loam soil
- *Eucalyptus* woodland and shrubland with salmon gum, broom bush, naked lady, *Eremophila* spp., tan wattle, *Acacia hemiteles*, *Melaleuca* and *cassia* on plain in loam soil

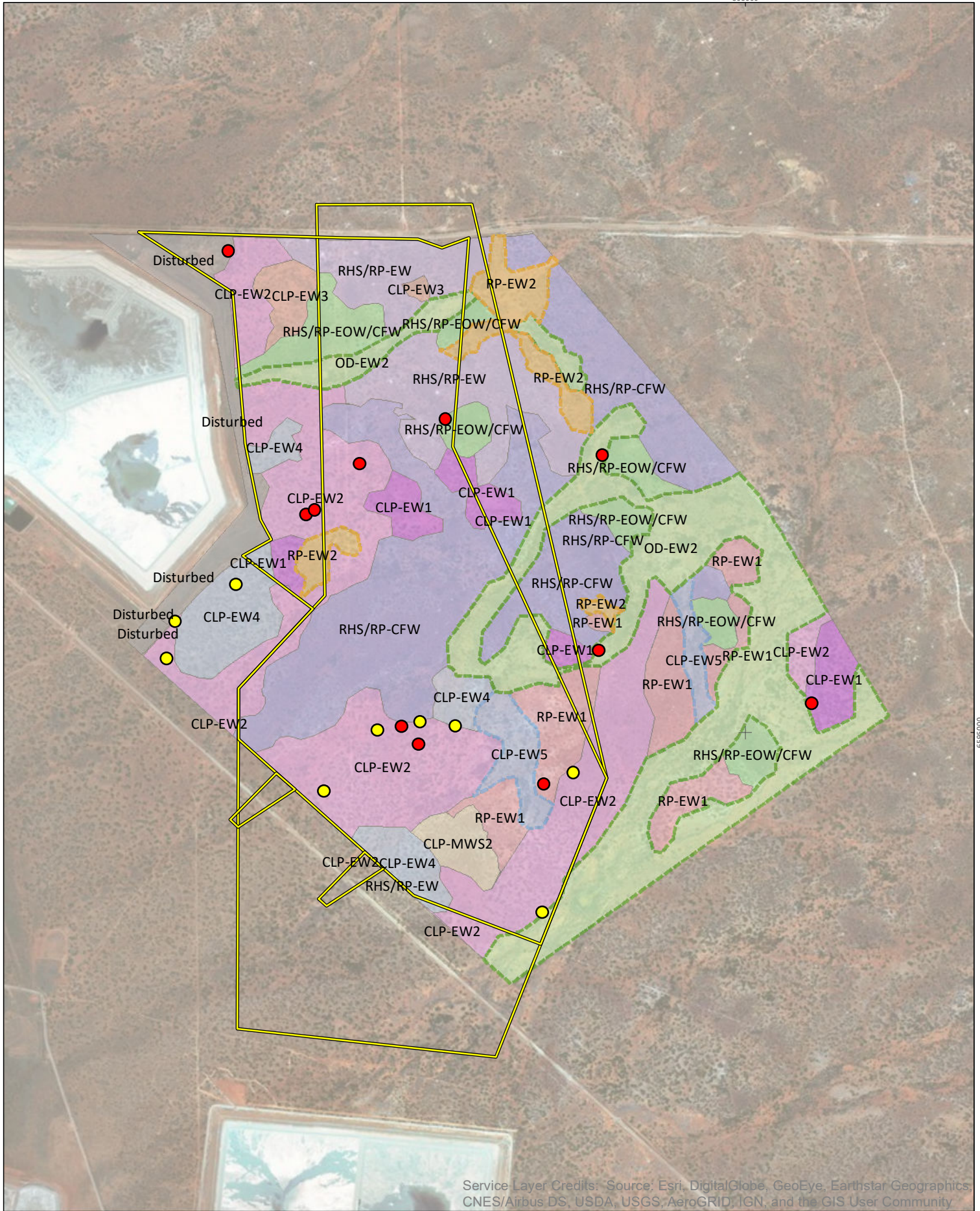
- *Eucalyptus* woodland of *Eucalyptus salmonophloia* and *E. lesouefii* and dense understory of seven species of *Eremophila* and *Halgania rigida* on break in slope between low stony rise and flat plain without stony mantle
- *Eucalyptus* woodland over *Triodia* on low dune with red brown loamy sand.



Figure 4-1 *Eremophila praecox* in the study area

4.1.1.2 Vegetation types

In general, the vegetation types that Botanica Consulting (2015) defined for the study area were consistent with observations during the current survey; however, drainage lines were noted that were not mapped by Botanica Consulting (2015) and instead were incorporated into the broader vegetation types throughout the study area. Three vegetation types, OD-EW2, RP-EW2 and CLP-EW5 were mainly mapped in the drainage lines. A small section of the study area (18.96 ha) had not been mapped by Botanica Consulting (2015), so the vegetation types were extrapolated to complete mapping for the study area (Figure 4-2).



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

	Kalgoorlie Consolidated Gold Mines Flora and SRE assessment for FIM IIE Project			Figure 4-2 <i>Eremophila praecox</i> and vegetation types in the study area	
	Project No 1225 Date 05-Dec-19 Drawn by AJ Map author KC				
	0 0.5 1 Kilometers 1:30,000 (at A4) GDA 1994 MGA Zone 51	All information within this map is current as of 05-Dec-19. 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.	P:\GIS\Projects\KCGM_Super\PH1225-FIM-KCG-EGD\Maping\MapDocuments\Figures\1225-5_2-FIM-KCG-EGD_MapTypes_FimExt.mxd		PHOENIX ENVIRONMENTAL SCIENCES

4.1.2 Short-range endemic invertebrates

4.1.2.1 Field results

Nine specimens of taxa from the target SRE groups (Appendix 1) were collected in the survey, comprising three trapdoor spiders, two millipedes and four scorpions (Table 4-2).

A *Missulena* specimen collected from site S08, south of the Fim IIE proposed clearing area (Figure 4-3) was sequenced and confirmed to be a match with *Missulena harewoodi* previously only known from one specimen within Fim IIE survey area (Figure 4-3; Appendix 1). This record confirms the distribution of *M. harewoodi* extends beyond the Fimiston Operations. The new record was collected from habitat described as “an open woodland of Salmon Gum, *Eucalyptus* and She-oak trees to 15 m, over tall *Grevillea* and *Acacia* shrubs to 4 m over mid *Acacia* shrubs to 2.5 m over low *Acacia*, *Sclerolaena* and *Eremophila* to 1 m, on hard clay soils” (Appendix 2). Traps were placed in She-oak thicket. The previous record was recorded in vegetation described as “mid *Eucalyptus lesouefii* woodland over mid *Eremophila scoparia*, *Cratystylis conocephala* and *Senna artemisioides* subsp. *filifolia* shrubland over low open *Olearia muelleri*, *Exocarpos aphyllus* and *Scaevola spinescens* shrubland”. The variability in habitat descriptions suggests *M. harewoodi* is not confined to a highly specific vegetation type. Accordingly, the SRE status has been revised from confirmed to potential SRE.

Gaius austini (Table 4-2; Figure 4-3) is conspecific with *Gaius* ‘kalgoorlie’ reported in Appendix 1. *Gaius* ‘kalgoorlie’ has been formally described as *G. austini* and is a widespread species, not considered an SRE.

The third trapdoor spider, *Teyl* MGG021, is a widespread species, not SRE (Table 4-2; Figure 4-3). It is not a match with any of the previously recorded taxa for the study area.

An *Antichiropus* specimen collected from site S10 east of the Fim IIE proposed clearing area and study area (Figure 4-3) was sequenced and determined not to be a match with the previously recorded *Antichiropus* 'DIP067' (WAM refs WAMT139886 and WAMT144904; Appendix 1). *Antichiropus* 'DIP067' therefore currently remains only known from study area but outside the Fim IIE proposed clearing area (Figure 4-3). A second millipede collected, *Siphonotidae* sp. indet., is from a different family to *Antichiropus* and therefore was not sequenced.

Four scorpions collected (Table 4-2; Figure 4-3) were determined not to be a match with the *Lychas* ‘annulatus-complex’ specimens previously recorded in the Fimiston Operations (Figure 4-3; Appendix 1). The status of the *L. ‘annulatus-complex’* records therefore remains as ‘potential’ SRE. It is noted that *L. ‘annulatus-complex’* has not been collected from the Fim IIE proposed clearing area (Appendix 1).

Table 4-2 SRE taxa from target SRE groups recorded during the survey

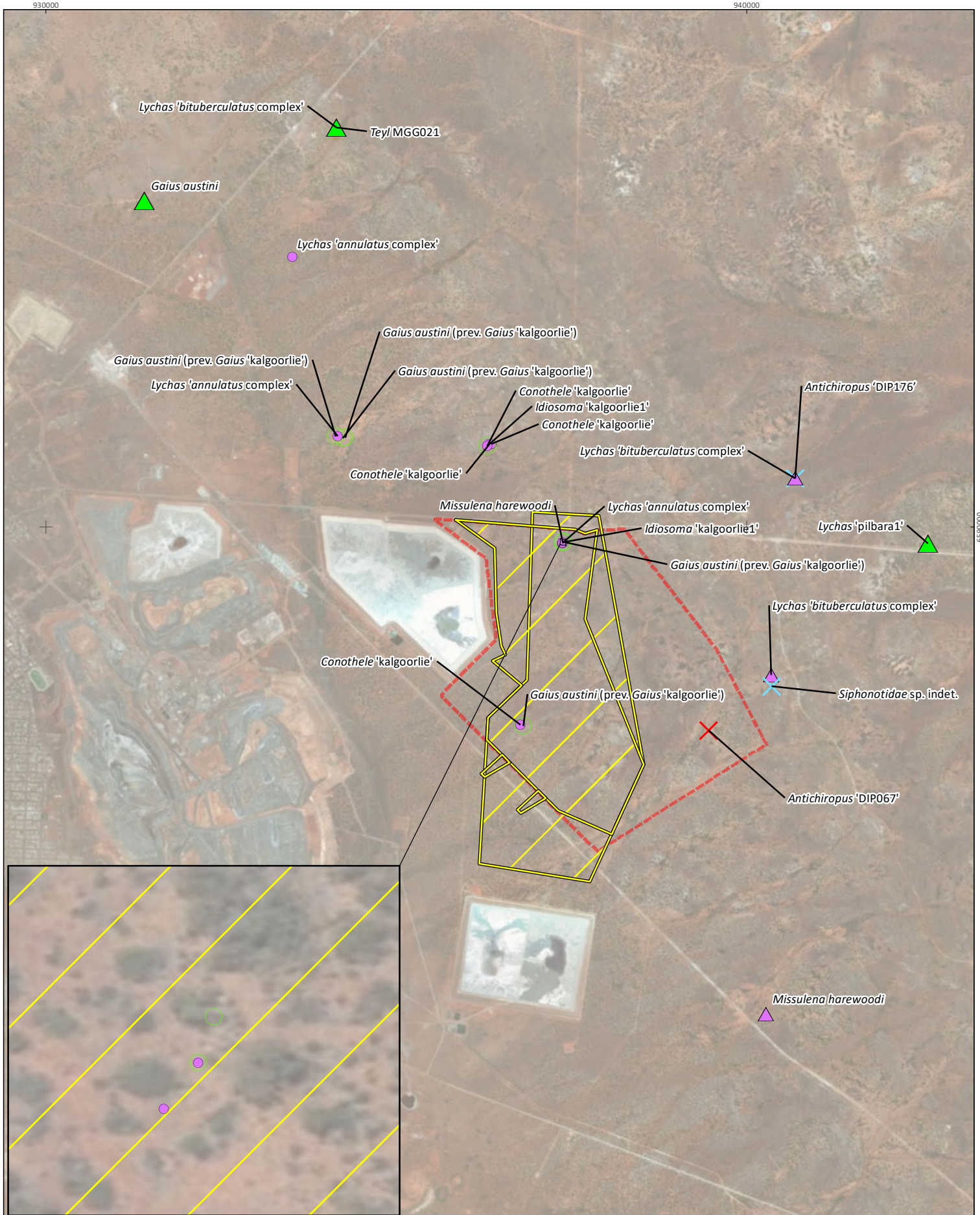
Species	Latitude	Longitude	SRE status	Remarks
Trapdoor spiders				
<i>Gaius austini</i>	-30.702865	121.502725	Non-SRE	Previously reported as <i>Gaius</i> ‘kalgoorlie’ (Appendix 1), now formally described as <i>G. austini</i> by (Rix <i>et al.</i> 2018), not considered SRE.
<i>Missulena harewoodi</i>	-30.804192	121.600078	Potential SRE	Specimen sequenced - match with <i>M. harewoodi</i> .
<i>Teyl</i> MGG021	-30.692472	121.530875	Non-SRE	Mark Harvey identified as <i>Teyl</i> MYG021, recorded throughout the western Goldfields region.

Species	Latitude	Longitude	SRE status	Remarks
Scorpions				
<i>Lychas 'bituberculatus complex'</i>	-30.692472	121.530875	Potential	Species complex containing multiple taxa, some of which may be SREs
<i>Lychas 'bituberculatus complex'</i>	-30.735172	121.601183	Potential	Species complex containing multiple taxa, some of which may be SREs
<i>Lychas 'bituberculatus complex'</i>	-30.760564	121.598848	Potential	Species complex containing multiple taxa, some of which may be SREs
<i>Lychas 'pilbara1'</i>	-30.742824	121.621332	Non-SRE	widespread
Millipedes				
<i>Antichiropus 'DIP176'</i>	-30.735172	121.601183	Confirmed	Specimen sequenced - is not conspecific with <i>Antichiropus 'DIP067'</i> from previous survey (Appendix 1).
<i>Siphonotidae sp. indet.</i>	-30.761983	121.598968	Confirmed	Significant specimens as these are rarely collected in arid/semi-arid areas. Need to be lodged with WAM for further identification. Non-target group but needs to be lodged with WAM.

4.1.2.2 SRE taxa within the Fim IIE proposed clearing area

Following the results of the current SRE survey and desktop records (Phoenix 2018a), four potential SRE taxa are known from the Fim II proposed clearing area, represented by three mygalomorph spiders and one scorpion (Figure 4-3):

- *Missulena harewoodi* – potential SRE, recorded from one location within the Fim IIE proposed clearing area in a previous survey (Appendix 1) and from site S08 south of the Fimiston Operations in the current survey. Recorded from two diverse woodland types – (1) *Eucalyptus salmonophloia*, *Casuarina sp.* woodland and (2) *E. lesouefii* woodland.
- *Conothele 'kalgoorlie'* – potential SRE, recorded from one location within the Fim IE proposed clearing area and from several sites north of this in a previous survey (Appendix 1) in two vegetation types *E. lesouefii* woodland and *Casuarina pauper* woodland.
- *Idiosoma 'kalgoorlie1'* – potential SRE, recorded from one location within the Fim IE proposed clearing area and from one location north of this in a previous survey (Appendix 1) in two *Eucalyptus lesouefii* woodlands, one a low open woodland over a low *Maireana sedifolia*/*Eremophila scoparia*/*Cratystylis conocephala* scrub, the other a mid-woodland over tall *Eremophila scoparia* and *Exocarpos aphyllus* shrubland.
- *Lychas 'annulatus complex'* – potential SRE, recorded from one location within the Fim IE proposed clearing area and from two sites north of this in a previous survey (Appendix 1) in three vegetation type, *Casuarina pauper* woodland, *Eucalyptus lesouefii* woodland and *E. salmonophloia* woodland.



	Kalgoorlie Consolidated Gold Mines Flora and SRE assessment for FIM IIE Project			Figure 4-3 SRE records from survey and updated desktop records for study area	
	Project No 1225 Date 05-Dec-19 Drawn by AJ Map author KC				
		1:70,000 (at A4) GDA 1994 MGA Zone 50			

All information within this map is current as of 05-Dec-19. 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.

5 DISCUSSION

The 11 *Eremophila praecox* (P1) and nine possible plants of this species identified in the study area (Figure 4-2) represent the only known Priority flora species records from the study area, as there were no Threatened or Priority flora recorded in the survey by Botanica Consulting (2015). These records represent a new population for the species as it occurs more than 500 m from any of the desktop records. A total of 19 records are listed in NatureMap database (DBCA 2019b). Phoenix also recently recorded an additional population (nine plants) 18 km NW of the current study area (Phoenix 2019) and had previously recorded a separate population (three plants) approximately 6 km west of the current study area in 2017 (Phoenix 2018b).

It was not possible to ascertain what proportion of the total population of *Eremophila praecox* is represented by the plants recorded in the study area as numbers of plants are not available for the majority of desktop records (DBCA 2019a, b). Plants in the current survey were recorded both in and outside the Fim IIE proposed clearing area and therefore it is likely that some *E. praecox* plants will need to be removed for the Project. Based on Phoenix's observations, this species tends to occur in low abundance but across a fairly broad habitat range and it is likely additional populations occur in surrounding remnant vegetation to the study area. The Project is therefore unlikely to have a significant impact on the species; however, it is recommended to avoid clearing of *E. praecox* plants as far as practicable.

No SRE taxa currently known from the Fimiston Operations are restricted to the Fim IIE proposed clearing area. The four potential SRE taxa recorded within the proposed clearing area (*Missulena harewoodi*, *Conothele* 'kalgoorlie', *Idiosoma* 'kalgoorlie1' and *Lychas* 'annulatus complex') are also known from records outside it. All four species have also been recorded from at least two different woodland vegetation types.

The EPA (EPA 2016b) recognises two main types of habitats that are considered highly prospective for SRE taxa:

- sheltered habitats and microhabitats – such as south facing hill slopes, drainage systems, deep gorges, mound springs and isolated rock piles
- habitat isolates – in the Goldfields these include isolated salt lakes, sandstone/limestone outcrops, isolated mesas, granite outcrops and banded ironstones (EPA 2016b; Phoenix 2018c)

The four potential SRE taxa from the proposed clearing area were all recorded from woodland communities that do not appear to be associated with any of the above features. Woodlands are known to support SREs, including woodland specialist mygalomorphs (e.g. Phoenix 2018c) mainly where there is a thick layer of litter in high density vegetation; however, distributions are on a regional scale (e.g. Rix *et al.* 2018) in contrast to the more extreme cases of short range endemism that occur highly confined island or relictual habitats as described above. It is considered highly likely that the distributions for the four potential SRE taxa from the Fim IIE proposed clearing area extend well beyond their current known extents.

The *Antichiropus* genus is well documented to be highly restricted. Car and Harvey (2014) undertook a taxonomic review of *Antrichiropus* millipedes from the Great Western Woodlands – which the study area falls within – and described 30 new species, most of which were classified as SREs due to restricted ranges. As *Antichiropus* 'DIP067' was not re-collected, is not a match with any of the named species, and remains only known from the single location located south of the Fim IIE proposed clearing area, remnant vegetation in the proximity of the record should therefore be protected, at least until such time as a broader distribution for the taxon has been confirmed.

6 REFERENCES

- ALA. 2019. *Atlas of Living Australia*. Available at: <http://www.ala.org.au/>
- BoM. 2019. *Climate statistics for Australian locations*. Commonwealth of Australia, Bureau of Meteorology. Available at: <http://www.bom.gov.au/climate/data/>
- Botanica Consulting. 2015. *Tailings Storage Facility Expansion. Level 2 flora and vegetation report, spring 2014 and autumn 2015*. Botanica Consulting Pty Ltd, Boulder, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd.
- Car, C. A. & Harvey, M. S. 2014. The millipede genus *Antichiropus* (Diplopoda: Polydesmida: Paradoxosomatidae), part 2: species of the Great Western Woodlands region of Western Australia. *Records of the Western Australian Museum* **29**: 20–77.
- Cowan, M. 2001a. *Inter-Bioregionalisation of Australia*. Department of Conservation and Land Management, Perth, WA. Available at: <http://www.environment.gov.au/land/nrs/science/ibra#ibra>
- Cowan, M. 2001b. Murchison 1 (MUR1—East Murchison subregion). In: May, J. E. & McKenzie, N. L. (eds) *A biodiversity audit of Western Australia's 53 biogeographical subregions in 2002*. Department of Conservation and Land Management, Perth, WA, pp. 466–479.
- DAFWA. 2014. *Soil-landscape systems of Western Australia*. Department of Agriculture and Food Western Australia, South Perth, WA. Dataset provided by DAFWA, April 2015.
- DBCA. 2017a. *Florabase*. Department of Biodiversity, Conservation and Attractions. Available at: <http://florabase.dpaw.wa.gov.au/>
- DBCA. 2017b. *NatureMap*. Department of Biodiversity, Conservation and Attractions. Available at: <https://naturemap.dpaw.wa.gov.au/default.aspx>
- DBCA. 2019a. *Florabase*. Department of Biodiversity, Conservation and Attractions. Available at: <https://florabase.dpaw.wa.gov.au/>
- DBCA. 2019b. *NatureMap*. Department of Biodiversity, Conservation and Attractions. Available at: <https://naturemap.dpaw.wa.gov.au/default.aspx>
- DoEE. 2017. *EPBC Act list of threatened flora*. Department of the Environment and Energy, Canberra, ACT. Available at: <http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora>
- EPA. 2016a. *Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EPA%20Technical%20Guidance%20-%20Flora%20and%20Vegetation%20survey_Dec13.pdf
- EPA. 2016b. *Technical Guidance: Sampling of short range endemic invertebrate fauna*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Sampling-SREs-Dec-2016.pdf
- Harewood, G. 2015. *Fauna survey (Level 2 - Phase 1 and 2). Proposed Tails Storage Facility Expansion*. Bunbury, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd and Botanica Consulting Pty Ltd.
- Phoenix. 2017. *Terrestrial fauna survey for the St Ives Gold Mine Beyond 2018 Project*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for St Ives Gold Mining Company Pty Ltd.
- Phoenix. 2018a. *Flora and SRE review for the Fimiston II Tailings Storage Facility Expansion Project*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd.
- Phoenix. 2018b. *Gap analysis, biological survey and consolidation report for the Fimiston Gold Mine Operations*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd.

- Phoenix. 2018c. *Terrestrial fauna survey for the St Ives Gold Mine Beyond 2018 Project*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for St Ives Gold Mining Company Pty Ltd.
- Phoenix. 2019. *Regional flora, vegetation and terrestrial fauna survey for the Gidji Operations*. Phoenix Environmental Sciences, Balcatta, WA. Unpublished report prepared for KCGM Operations.
- Rix, M. G., Huey, J. A., Cooper, S. J. B., Austin, A. D. & Harvey, M. S. 2018. Conservation systematics of the shield-backed trapdoor spiders of the *nigrum*-group (Mygalomorphae, Idiopidae, *Idiosoma*): integrative taxonomy reveals a diverse and threatened fauna from south-western Australia. *Zookeys* **756**: 1–121 <http://dx.doi.org/10.3897/zookeys.756.24397>.

Appendix 1 **Flora and SRE review for the Fimiston II Tailings Storage Facility Expansion Project memo**

Memo

To: Catherine Wharton, Alfred Gura

From: Grace Wells, Karen Crews

Date: 11 December 2018

Subject: Flora and SRE review for the Fimiston II Tailings Storage Facility Expansion Project



Dear Catherine,

This memo presents the findings of a review of terrestrial flora and vegetation, and short-range endemic fauna undertaken by Phoenix Environmental Sciences for the Fimiston II Tailings Storage Facility Expansion Project (Fim IIE Project).

1 INTRODUCTION

The Fimiston Operational Area forms part of Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) operations, located east of the City of Kalgoorlie-Boulder in the Goldfields region of Western Australia (Figure 1-1). This area contains the Fimiston Gold Mine Operations, which comprise the Fimiston Open Pit, waste rock dumps, tailings storage facilities (Fimiston I, Fimiston II and Kaltails) and infrastructure corridors.

KCGM required a flora and short-range endemic invertebrate (SRE) assessment to inform the environmental approvals for the Fim IIE Project.

Previously, surveys were completed for the Fim IIE Project in spring 2014 and autumn 2015 (Botanica Consulting 2015; Harewood 2015). Phoenix subsequently undertook a data currency review and gap biological survey for the broader Fimiston Operations in spring 2017 (Phoenix 2018). The report incorporated and updated currency of the previous survey data for the Fim IIE Project, but no additional field work was conducted in the Fim IIE Project Area.

The currency and adequacy of the flora and vegetation survey (Botanica Consulting 2015) required review in light of the age of the survey and the release since that time of updated Environmental Protection Authority (EPA) guidance on terrestrial flora and vegetation surveys (EPA 2016a, c).

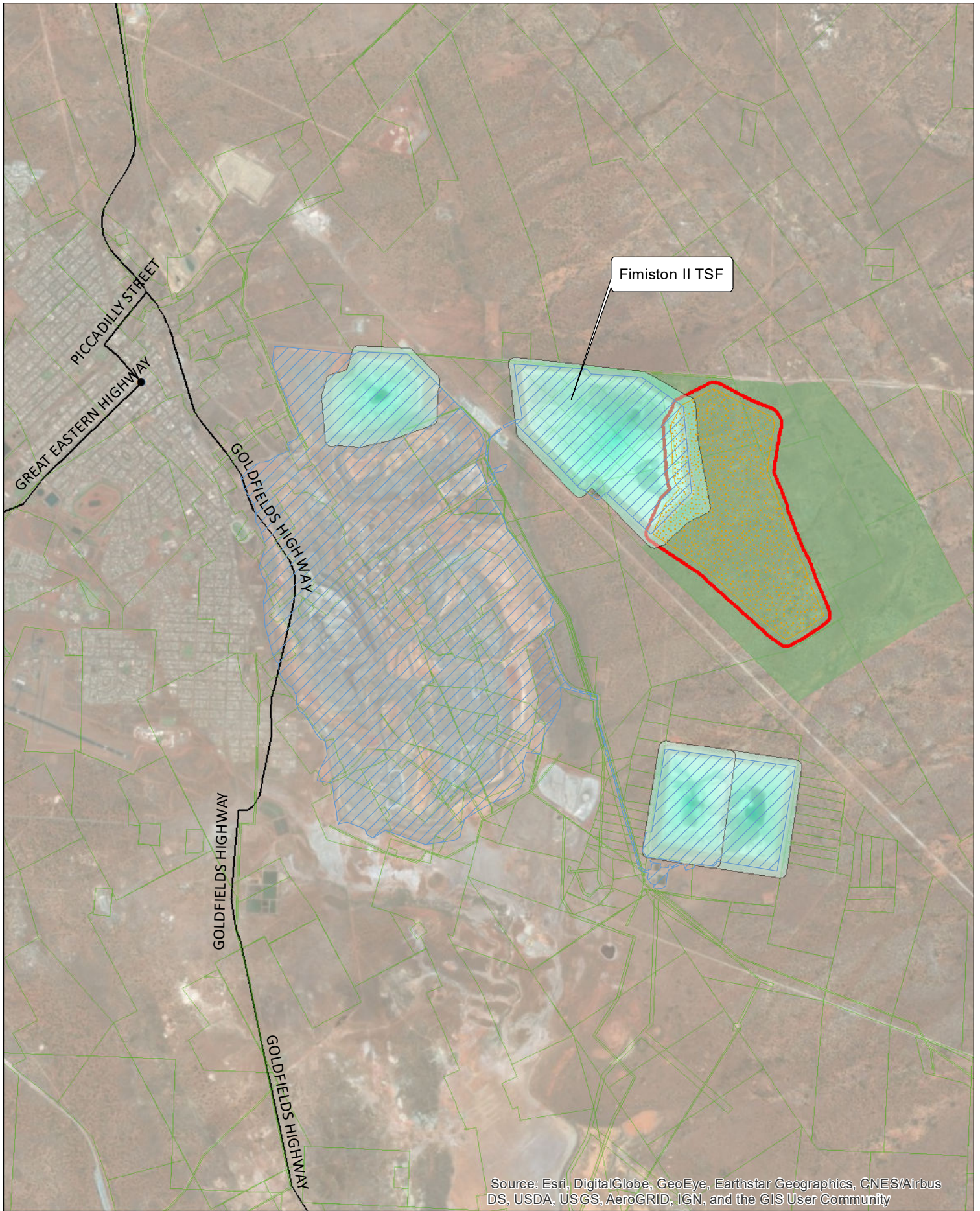
Harewood (2015) collected SRE invertebrates in the Fim IIE Project Area in November/December and April. Several of the taxa were determined by still to be only known from Harewood (2015) survey area.

The permitting strategy for the Fim IIE Project is part of a larger strategic project which will entail a Part IV approval under section 38 of the *Environmental Protection Act 1986* (EP Act) and is likely to be assessed under Public Environmental Review (PER). Referral for the project is scheduled to commence in June 2019 with submission of the PER in June 2020 with an 18-month assessment timeframe (approval is anticipated in late 2021). Therefore, currency of the flora and vegetation survey was required to take these timeframes into consideration.

1.1 SCOPE OF WORK

The flora and vegetation survey report for the study area (Botanica Consulting 2015) was reviewed for compliance with current EPA guidance for terrestrial flora and vegetation surveys (EPA 2016c) to identify any potential major non-compliance and/or additional survey requirements.

A significance and risk-based assessment was undertaken for the SREs known from the study area, in accordance with Department of Mines and Petroleum (2016) to determine if any SREs may be affected by the Fim IIE Project and/or required further surveys.



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



KCGM KCGM Operations Fim IIE Project		
Project No	1225	
Date	04-Dec-18	
Map author	KC	
1:70,311 (at A4)		GDA 1994 MGA Zone 50

- ▭ Fimiston operational areas
- ▭ Fim II Extension footprint
- ▭ Tailings storage facilities
- ▭ Fim II Extension footprint plus 100m buffer
- ▭ Fim II Extension survey area

Figure 1-1
Fim II Extension footprint and survey area



All information within this map is current as of 04-Dec-18. 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.

Memo

1.2 STUDY AREA

The study area for this scope of work was the area delineated in Figure 1-1 as 'Survey Area_Fim II Extension' encompassing the 'Fim II Extension_Footprint' and a 100 m buffer of the footprint.

2 FLORA AND VEGETATION

Botanica Consulting (2015) completed a Level 2 flora and vegetation survey over approximately 3,260 ha in 2014 and 2015 in accordance with Guidance Statement No. 51 Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004). The survey area covered the entirety of the current study area.

The initial survey (spring) was conducted between the 24 September and 28 October 2014, in which a total of 64 (20 m x 20 m) quadrats were established, including 25 within the current study area. The quadrats were revisited in autumn from the 14–16 April 2015.

Targeted searches for flora of conservation significance were also conducted within the survey area by Botanica Consulting (2015) between 24 September and 28 October 2014 and 14–16 April 2015. The objective of the targeted survey was to verify if any flora of conservation significance identified as potentially occurring within the survey area during the desktop assessment were located within the survey area.

Searches of the following databases were undertaken by Botanica Consulting (2015) to aid in the compilation of a list of flora taxa within the survey area: Department of Parks and Wildlife (DPaW)¹ *NatureMap* Database (DPaW 2014) and Australian Government Department of the Environment (DotE)² Protected matters search tool (DotE 2014). Prior to the field survey, a combined search of the DPaW's flora and ecological communities of conservation significance databases (DPaW, 2014a) were also undertaken.

One Threatened flora species was identified through the Botanica Consulting (2015) desktop review, *Gastrolobium graniticum*, but was considered unlikely to occur in the survey area due to the absence of suitable habitat (granite outcrops). The Phoenix (2018) desktop review for the Fimiston Operations identified a second Threatened flora species, *Tecticornia flabelliformis* (VU under the EPBC Act; Priority 1 at State level), but considered the species unlikely to occur in the study area due to lack of suitable habitat.

Eleven Priority flora were identified in the Botanica Consulting (2015) desktop review, including five species that were considered by the authors to have potential to occur in their survey area (Table 2-1). Two lichens were also identified, including one considered to possibly occur but these are not considered further as EPA (2016a) deals with vascular flora only.

Priority flora and their respective vegetation types were targeted in the Botanica Consulting (2015) survey and all occurrences were traversed on foot specifically looking for the Priority flora associated with that vegetation description.

The Phoenix (2018) desktop review for the Fimiston Operations identified an additional nine Priority flora, including four species that were considered to have potential to occur (Table 2-1).

¹ Now Department of Biodiversity, Conservation and Attractions (DBCA).

² Now Department of the Environment and Energy.

Memo

Table 2-1 Significant flora species from desktop reviews assessed as having potential to occur in study area

Species	Current status	Habitat (DBCA 2017)	Likelihood of occurrence	Identified in Botanica Consulting (2015)?	Identified in Phoenix (2018)?
<i>Angianthus prostratus</i>	P3	Red clay, beach of salt lake, saline depressions	Botanica considered this 'possible' Phoenix considered this 'unlikely'	Yes	Yes
<i>Chrysocephalum apiculatum</i> subsp. <i>norsemanense</i>	P3	Undulating and flat plains, sandy loam soils	Possible, potential habitat present	No	Yes
<i>Elachanthus pusillus</i>	P2	Low plain, red-orange loam-clay, red loam on drainage flat	Possible, potential habitat present	Yes	Yes
<i>Eremophila caerulea</i> subsp. <i>merrallii</i>	P4	Clay or loam undulating plains	Possible, potential habitat present	No	Yes
<i>Eremophila praecox</i>	P1	Undulating plains with red brown sandy loam	Possible Recorded by Phoenix	Yes	Yes
<i>Lepidium fasciculatum</i>	P3	Erect annual, herb, (0.1-)0.3-0.6 m high. Habitat requirements unknown. The DPAW record is from 1961 and no information provided.	Possible	Yes	No
<i>Notisia intonsa</i>	P3	Plain, ironstone, red-orange sandy clay	Possible, potential habitat present	No	Yes
<i>Ptilotus chortophytus</i>	P1	Quartz / rocky low hill, breakaways, rocky hills	Unlikely, no suitable habitat present	No	Yes
<i>Ptilotus procumbens</i>	P1	Red clay, red sandy loam	Possible, potential habitat present	Yes	Yes

The conservation significance of flora taxa was assessed by Botanica Consulting (2015) using data from the following sources:

- EPBC Act. Administered by DotE
- WC Act. Administered by the WA DPaW (Govt. of WA 2015)
- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List – the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no

Memo

legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria

- DPaW Priority Flora list. A non-legislative list maintained by DPaW for management purposes (DPaW, 2014).

No Threatened or Priority flora were recorded in the field survey by Botanica Consulting (2015).

No threatened ecological community (TEC) listed under the EPBC Act or WC Act, or Priority Ecological Community (PEC) listed by the DPaW¹ was recorded in the field survey by Botanica Consulting (2015).

Vegetation communities were classified in accordance with the NVIS to a minimum Level 5 classification which includes recording dominant growth form, height, cover and species for the three traditional strata. PATN analysis was conducted to determine similarity in species composition. The objective of Level 2 survey was to have at least two quadrats per vegetation community to capture the floristic variations within the survey area. Currently, the objective of a detailed survey is to aim for at least three quadrats per vegetation community (EPA 2016c).

Fourteen vegetation communities were identified within the Botanica Consulting (2015) study area; 12 of these were recorded in the current study area: CLP-EW1, CLP-EW2, CLP-EW3, CLP-EW4, CLP-EW5, CLP-MWS2, RP-EW1, RP-EW2, RHS/RP-EW, RHS/RP-CFW, RHS/RP-EOW/CFW, OD-EW2. Statistical analysis found there was a high degree of homogeneity between all of the vegetation types of the current study area except one, CLP-MW2 which presented as distinct only because of the presence of a hummock grassland understorey.

The vegetation communities were represented by a total of 30 families, 63 genera and 136 taxa (including sub-species and variants).

The survey effort, timing and methodology of the survey was mostly compliant with that of a detailed survey under current EPA guidance (EPA 2016c) as summarised in Table 2-2.

Memo

Table 2-2 Review of Botanica Consulting (2015) survey against current EPA guidance (EPA 2016c)

Key points	Compliant?	Remedial action
Background research and description of regional setting (e.g. vegetation, land systems and soils)	yes	none
Description of survey objectives and methodology	yes	none
Data collection e.g. standard size quadrats used (20m ²) and analysis methodology (PATN)	yes	none
Standard set of information collected (e.g NVIS, Government database searches)	yes	none
Survey effort, i.e. 64 quadrats resulting in 14 vegetation types	yes	none
Spring and autumn survey done at appropriate times of year	yes	none
Detection of significant flora	Targeted searches conducted, however, survey is several years old, populations of significant flora may be present that were not present in 2014/15, four Priority species potentially present that were not targeted searched in 2014/15. Also, since then the Priority 1 <i>Eremophila praecox</i> has been recorded in proximity in similar habitat to that of the survey area.	Recommend additional targeted searches for significant flora.
EPA GS51 for Level 2 survey required a minimum of 2 quadrats per vegetation type identified. Detailed survey under current guidance requires 3 quadrats per vegetation type identified.	yes Large number of quadrats sampled within the study area, and sites sampled over two seasons. Quadrat locations were not available as spatial data for this review. However, based on review of maps, multiple quadrats were sampled in most vegetation types. Some vegetation units appear to have less than 3 quadrats but these are small in extent within the study area and therefore impractical to sample 3 quadrats. Taking into account the location of the survey area, in historically modified Goldfields location, the sampling intensity is considered adequate.	none

Memo

3 SREs

3.1.1 Overview of SREs

SRE fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km², that may also be disjunct and highly localised (Harvey 2002; Ponder & Colgan 2002). Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002):

- relictual short-range endemism – where drying climate has forced range contraction into small pockets with remaining moist conditions (e.g. south-facing rock faces or slopes of mountains or gullies)
- habitat specialisation – SREs that may have settled in particular isolated habitat types (e.g. rocky or granite outcrops) by means of dispersal and evolved in isolation into distinct species.

However, SRE invertebrates have also been reported in more widespread habitats such as spinifex plains or woodlands, mainly in groups with low dispersal capabilities, for example mygalomorph spiders and millipedes.

Invertebrate groups that contain SRE taxa are generally well distributed across the Australian landscape and well adapted to semi-arid environments due to a variety of behavioural and morphological features that have developed to avoid desiccation and predation. They generally possess (Harvey 2002):

- poor powers of dispersal
- confinement to discontinuous habitats
- seasonality, i.e. only active in cooler or wetter months
- slow growth
- low levels of fecundity.

There can be uncertainty in categorising a specimen as SRE due to a number of factors including poor regional survey density, lack of taxonomic research and problems of identification, i.e. specimens that may represent SREs cannot be identified to species level based on the life stage at hand. For example, in contrast to mature males, juvenile and female millipedes, mygalomorph spiders and scorpions cannot be identified to species level. Molecular techniques such as ‘barcoding’ (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome taxonomic or identification problems.

Currently, there is no accepted system to determine the likelihood that a species is an SRE. The WA Museum applies a three tier-rating (confirmed, potential and not SRE) (Western Australian Museum 2013) which was adopted in this assessment. Confirmed SREs are taxa for which the distribution is known to be less than 10 000km², the taxonomy is well known and the group is well represented in collections and/ or via comprehensive sampling. Potential SREs include those taxa for which there is incomplete knowledge of the geographic distribution of the group and its taxonomy, and the group is not well represented in collections.

Any SRE categorisation of a taxon is based on the information available at the time. As new information emerges from additional surveys, the SRE status may change and therefore the SRE status is dynamic.

Memo

The EPA's environmental factor guideline for Terrestrial Fauna (EPA 2016b) identifies species with restricted distributions as being significant fauna in the context of environmental impact assessments (EIA). SRE fauna need to be considered in EIA as localised, small populations of species are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa (Department of Mines and Petroleum 2016). Some key threatening processes for SRE fauna include:

- clearing of native vegetation (habitat removal)
- changes to fire regimes
- introduction and/or spread of weeds and soil pathogens
- fragmentation and subdivision of habitats
- changes to surface hydrology.

Several SRE invertebrate taxa are listed as Threatened Fauna under the EPBC Act or WC Act and several others are listed on DBCA's Priority Fauna list; however, these lists cannot be relied on as a complete guide to significant SRE taxa within a particular location. The most up-to-date listings of invertebrates and their distribution are available through the WA Museum invertebrate databases, including the Arachnology/Myriapodology, Mollusca and Crustacea databases.

3.1.2 SREs from study area

Currently, nine taxa are known from the Fimiston Operations, representing at least eight species (Table 3-1). The ninth, *Conothele* indet. may represent *Conothele* 'kalgoorlie' or *Conothele* 'MYG554'.

Two taxa are currently only known from the Fim II Extension survey area (Table 3-1): *Missulena harewoodi* and *Antichiropus* 'DIP067'. These warrant targeted survey to extend knowledge of their distributions and habitat preferences.

Two taxa are currently known from the Fim II Extension Footprint (Table 3-1): *Conothele* 'kalgoorlie' and *Gaius* 'kalgoorlie'. Both species were also collected outside the footprint. *Gaius* 'kalgoorlie' was collected from a variety of vegetation types including widely distributed Salmon Gum woodland and is unlikely to be confined to Fimiston Operations. *Conothele* 'kalgoorlie' however, was collected from a more restricted vegetation type (CLP-EW1); the specimen from the Fim II Extension Footprint was from *Casuarina pauper* woodland that extends beyond the Fim II Extension survey area but clearing of this woodland within the footprint would remove a large extent of the potential habitat for *Conothele* 'kalgoorlie'. A targeted survey for this species is therefore warranted to improve knowledge of its distribution and habitat preferences to inform an EIA for the Fim IIE Project.

Idiosoma 'kalgoorlie 1' was recorded only ~250 m east of the Fim IIE footprint and at one other location north of the Fim II Extension survey area. Two vegetation types of the species records appear to have limited representation within surveyed areas. Therefore, additional collections of this species are also recommended to improve knowledge of the species distribution and confirm it is not confined to restricted vegetation types.

No taxa have been recorded only from the Fim II Extension Footprint.

Memo

Table 3-1 SREs collected in the Fimiston Operations, Fim II Extension footprint and Fim II Extension survey area

Species	SRE category	Location	Sites	Veg. type	Veg. description	Assessment	
<i>Missulena harewoodi</i> (<i>Missulena</i> 'kalgoorlie')	Confirmed	Only known from single male specimen in Fim IIE survey area but outside Fim IIE footprint. Record only ~250 m from footprint.	TS 5	RHS/RP-EW	Mid <i>Eucalyptus lesouefii</i> woodland over mid <i>Eremophila scoparia</i> , <i>Cratystylis conocephala</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low open <i>Olearia muelleri</i> , <i>Exocarpos aphyllus</i> and <i>Scaevola spinescens</i> shrubland.	Only known from single specimen in vegetation type which appears to occur as small pockets. Record is <300 m from Fim IIE footprint. Species is one of several <i>Missulena</i> currently only known from very limited numbers of specimens (Framenau & Harms 2017). Recommend targeted survey to demonstrate wider distribution and collect additional data on habitat preferences.	
<i>Idiommata</i> 'kalgoorlie'	Potential	KCGM tenements, north of Fim IIE survey area and footprint. Distribution unknown, SRE rating based on other species in genus.	TS 1	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	Known from 3 sites in two vegetation types. No records from Fim IIE survey area, therefore does not require targeted survey for Fim IIE Project. Taxon is currently only known from KCGM tenements; however unlikely to be confined to KCGM Operations. Additional collections would improve knowledge of species distribution but does not require targeted survey for Fim IIE Project.	
			TS 2	CLP-EW2	Mid <i>Eucalyptus salmonophloia</i> woodland over tall open <i>Eremophila scoparia</i> and <i>Exocarpos aphyllus</i> shrubland over mid open <i>Acacia hemiteles</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>chenopod</i> spp. shrubland.		
<i>Conothele</i> 'kalgoorlie'	Potential	Within Fim IIE footprint and north of Fim IIE survey area in KCGM tenements. Distribution unknown, SRE rating based on other species in genus.	TS 1	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	Recorded from several sites and two vegetation types. Is not confined to Fim IIE footprint but only known from KCGM tenements. Clearing within the Fim IIE footprint would remove a large extent of the vegetation type the taxon was recorded from. Additional collections warranted to improve knowledge of species distribution and habitat preferences.	
			TS 4		RHS/RP-CFW		Mid open <i>Casuarina pauper</i> woodland over tall open <i>Acacia acuminata</i> , <i>Eremophila scoparia</i> and <i>Exocarpos aphyllus</i> shrubland over mid open <i>Acacia hemiteles</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Acacia nyssophylla</i> shrubland.
<i>Conothele</i> 'MYG554'	Potential	Recorded in KCGM tenements north of Fim IIE survey area and 0.6 km SW of Ora Banda (~70 km NW of survey area).	TS 1	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	Demonstrated wider distribution than KCGM Operations. Not at risk from Fim IIE Project. Does not require targeted survey for Fim IIE Project.	
<i>Conothele</i> sp. indet.	Potential	Recorded in KCGM tenements north of Fim IIE survey area.	TS 1	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	May represent <i>Conothele</i> 'kalgoorlie' or <i>Conothele</i> 'MYG554'. Taxonomy cannot be resolved further for this taxon. Targeted survey therefore not possible.	
<i>Gaius</i> 'kalgoorlie'	Potential	Within Fim IIE footprint, Fim IIE survey area outside footprint and north of Fim IIE survey area. Distribution unknown, SRE rating based on other species in genus	TS 3	OD-EW1	Low woodland of <i>Eucalyptus salmonophloia</i> over low scrub of <i>Acacia hemiteles</i> / <i>Eremophila ionantha</i> / <i>Maireana sedifolia</i> and dwarf scrub of <i>Atriplex vesicaria</i> / <i>Eremophila parvifolia</i> .	Recorded from several sites in multiple vegetation types. Vegetation well represented in surveyed areas and likely to extend beyond. Only known from KCGM tenements; however, unlikely to be confined to KCGM Operations. Additional collections would improve knowledge of species distribution but does not require targeted survey for Fim IIE Project.	
			TS 4		RHS/RP-CFW		Mid open <i>Casuarina pauper</i> woodland over tall open <i>Acacia acuminata</i> , <i>Eremophila scoparia</i> and <i>Exocarpos aphyllus</i> shrubland over mid open <i>Acacia hemiteles</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Acacia nyssophylla</i> shrubland.
			TS 5		RHS/RP-EW		Mid <i>Eucalyptus lesouefii</i> woodland over mid <i>Eremophila scoparia</i> , <i>Cratystylis conocephala</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low open <i>Olearia muelleri</i> , <i>Exocarpos aphyllus</i> and <i>Scaevola spinescens</i> shrubland.
<i>Idiosoma</i> 'kalgoorlie 1'	Potential	Within Fim IIE survey area ~250 m east of Fim IIE footprint and north of	TS 5	RHS/RP-EW	Mid <i>Eucalyptus lesouefii</i> woodland over mid <i>Eremophila scoparia</i> , <i>Cratystylis conocephala</i> and <i>Senna artemisioides</i> subsp. <i>filifolia</i> shrubland over low open <i>Olearia muelleri</i> , <i>Exocarpos aphyllus</i> and <i>Scaevola spinescens</i> shrubland.	Recorded from two sites in two vegetation types that have limited representation in surveyed areas. No records in Fim IIE footprint. Only known from KCGM tenements. Additional	

Memo

Species	SRE category	Location	Sites	Veg. type	Veg. description	Assessment
		Fim IIE survey area in KCGM tenements.	TS 1	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	collections would improve knowledge of species distribution. Recommend including in targeted survey.
<i>Lychas 'annulatus-complex'</i>	Potential	Within Fim IIE survey area ~240 m north of Fim IIE footprint and north of Fim IIE survey area in KCGM tenements.	TS 5	RHS/RP-CFW	Mid open <i>Casuarina pauper</i> woodland over tall open <i>Acacia acuminata</i> , <i>Eremophila scoparia</i> and <i>Exocarpos aphyllus</i> shrubland over mid open <i>Acacia hemiteles</i> , <i>Senna artemisioides</i> subsp. <i>filifolia</i> and <i>Acacia nyssophylla</i> shrubland.	Taxonomy of species-complex poorly known. Recorded at multiple sites in multiple vegetation types. No records from Fim IIE footprint. Vegetation widespread. Only known from KCGM tenements; however, unlikely to be confined to KCGM Operations. Additional collections would improve knowledge of species distribution but does not require targeted survey for Fim IIE Project.
			TS 2	CLP-EW1	Low woodland of <i>Eucalyptus lesouefii</i> over low scrub of <i>Maireana sedifolia</i> / <i>Eremophila scoparia</i> / <i>Cratystylis conocephala</i> and dwarf scrub of <i>Eremophila parvifolia</i> .	
			TS 3	OD-EW1	Low woodland of <i>Eucalyptus salmonophloia</i> over low scrub of <i>Acacia hemiteles</i> / <i>Eremophila ionantha</i> / <i>Maireana sedifolia</i> and dwarf scrub of <i>Atriplex vesicaria</i> / <i>Eremophila parvifolia</i> .	
<i>Antichiropus 'DIP067'</i>	Confirmed	Within Fim IIE survey area ~1.6 km east of Fim IIE footprint.	TS 6	OD-EW2	Low woodland of <i>Eucalyptus stricklandii</i> / <i>Eucalyptus ravida</i> over low scrub of <i>Eremophila scoparia</i> and dwarf scrub of <i>Atriplex vesicaria</i> .	Only known from Fim IIE survey area. <i>Antichiropus</i> genus is well documented to be highly restricted. Recommend targeted survey to demonstrate wider distribution.

Memo

3.1.3 Risk assessment

A risk-based assessment that infers potential distribution of SRE species based on habitat may be conducted if an impact on a site that harbours unique records of a particular SRE cannot be avoided.

The SREs were collected from habitat types that are likely to be represented outside of Fimiston Operations.

Overall, there are few habitats that would support short-range endemism in terrestrial invertebrates in the Goldfields; exceptions include salt lakes some of which are known to harbour endemic invertebrates, and banded ironstone formations. However, diversity and endemism in invertebrates of the Goldfields woodlands has been highlighted in several recent studies on particular groups, e.g. Idiopidae trapdoor spiders, *Antichiropus* millipedes and Bothriembryon snails (several publications in Framenau & Harms 2017).

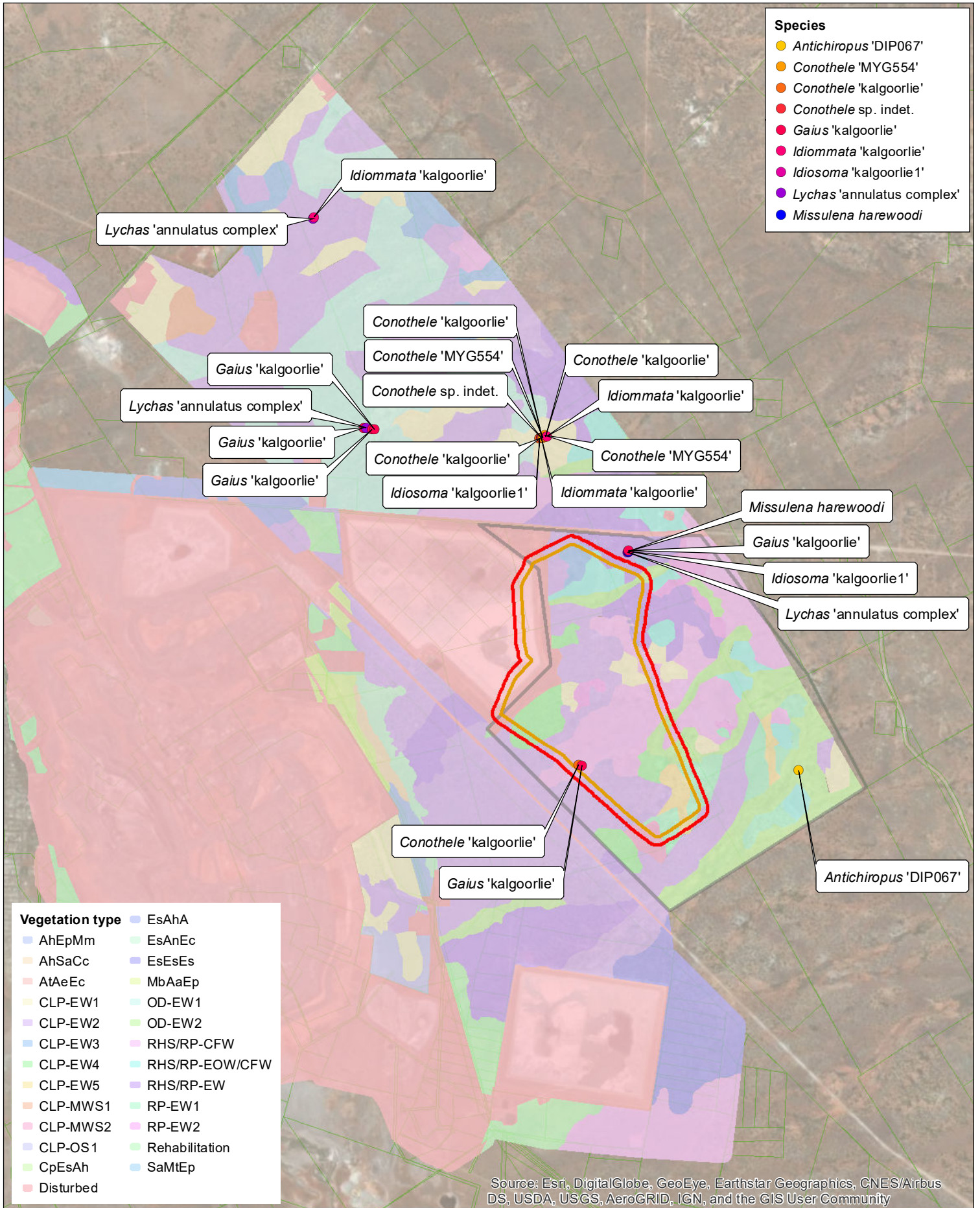
Habitat isolates for SRE taxa can be identified from vegetation type mapping as vegetation types reflect changes in geology, landform, soil type and hydrology – all of which are likely factors in governing the distribution of SRE taxa (Department of Mines and Petroleum 2016). If vegetation units are restricted to the potential impact area, and are especially different from adjoining units, then there is the potential for some SREs to be similarly confined.

Based on the vegetation type descriptions, the Fim II Extension Footprint and survey area do not contain any obvious examples of restricted habitats or geographic features that are typically known to support SRE taxa, for example isolated rock outcrops, gorges, rocky gullies and drainage features. The two *Antichiropus* millipedes from the Fim II Extension survey area were collected from a low woodland of *Eucalyptus stricklandii*/*E. ravidia*; *E. stricklandii* is typically associated with gravelly soils on stony hillsides/ridges and therefore this vegetation type may have some isolating characteristics.

All SRE records from the Fim II Extension Footprint were from RHS/RP-CFW *Cauarina pauper* woodland which occurs fairly extensively within the footprint and extends eastwards beyond the footprint and Fim II Extension survey area (Figure 3-1). *Cauarina pauper* woodland within the Fim II Extension survey area is surrounded primarily by eucalypt woodlands. The potential for *C. pauper* woodland to act as an isolating habitat could occur if, for example, an SRE species has a particular dependency on *C. pauper*. All species from the Fim II Extension Footprint were also recorded in at least one other vegetation type suggesting this is not the case.

However, insufficient information exists on habitat preferences and distribution to demonstrate with confidence that all the SRE taxa are adequately represented beyond the KCGM Operations. Targeted surveys have therefore been recommended for several taxa to enable an informed impact assessment for the Fim IIE Project.

The targeted survey should aim to collect additional specimens of the target taxa outside the Fim II Extension survey area, as well as additional habitat data. This will allow for a risk-based impact assessment that uses habitat as surrogate for inferring distribution boundaries where additional specimen collections are not achieved.



	KCGM KCGM Operations Fim IIE Project		<p>Figure 3-1 SREs and vegetation types</p>	
	Project No 1225 Date 07-Dec-18 Drawn by JH Map author KC			<ul style="list-style-type: none"> ■ Fim II Extension footprint ■ Fim II Extension plus 100m buffer ■ Fim II Extension survey area
	<p>1:60,000 (at A4) GDA 1994 MGA Zone 50</p>			

All information within this map is current as of 07-Dec-18. 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.

Up: phoenix.enviro\02\file-server\GIS\Projects\KCGM\3u\perp1225-FIM-KC-G-ECO\Maps\gim\02\documents\Figures\1225-3_1-FIM-KCG-ECO_SRE_Vegetation.docx.mxd

Memo

4 REFERENCES

- Botanica Consulting. 2015. *Tailings Storage Facility Expansion. Level 2 flora and vegetation report, spring 2014 and autumn 2015*. Botanica Consulting Pty Ltd, Boulder, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd.
- DBCA. 2017. *Florabase*. Department of Biodiversity, Conservation and Attractions. Available at: <http://florabase.dpaw.wa.gov.au/>
- Department of Mines and Petroleum. 2016. *Guidelines for Mining Proposals in Western Australia*. Department of Mines and Petroleum, Government of Western Australia, Perth, WA. Available at: <http://www.dmp.wa.gov.au/Documents/Environment/ENV-MEB-213.pdf>
- DotE. 2014. *Protected matters search tool*. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra, ACT. Available at: <http://www.environment.gov.au/epbc/pmst/index.html>
- DPaW. 2014. *NatureMap*. Department of Parks and Wildlife, Perth, WA. Available at: <http://naturemap.dec.wa.gov.au/>
- EPA. 2004. *Guidance for the assessment of environmental factors (in accordance with the Environmental Protection Act 1986). Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia. No. 51*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/docs/1839_gs51.pdf
- EPA. 2016a. *Environmental Factor Guideline: Flora and vegetation*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Guideline-Flora-Vegetation-131216_4.pdf
- EPA. 2016b. *Environmental Factor Guideline: Terrestrial fauna*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Guideline-Terrestrial-Fauna-131216_3.pdf
- EPA. 2016c. *Technical Guidance: Flora and vegetation surveys for Environmental Impact Assessment*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EPA%20Technical%20Guidance%20-%20Flora%20and%20Vegetation%20survey_Dec13.pdf
- Framenau, V. W. & Harms, D. 2017. A new species of Mouse Spider (Actinopodidae, *Missulena*) from the Goldfields region of Western Australia. *Evolutionary Systematics* **1**: 39–46.
- Harewood, G. 2015. *Fauna survey (Level 2 - Phase 1 and 2). Proposed Tails Storage Facility Expansion*. Bunbury, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd and Botanica Consulting Pty Ltd.
- Harvey, M. S. 2002. Short-range endemism among the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* **16**: 555–570.
- Hebert, P. D. N., A., C., Ball, S. L. & de Waard, J. R. 2003a. Biological identifications through DNA barcodes. *Proceedings of the Royal Society London B* **270**: 313–321.
- Hebert, P. D. N., Ratnasingham, S. & de Waard, J. R. 2003b. Barcoding animal life: Cytochrome c oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society London B, Supplement* **270**: 96–99.
- Phoenix. 2018. *Gap analysis, biological survey and consolidation report for the Fimiston Gold Mine Operations*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Kalgoorlie Consolidated Gold Mines Pty Ltd.

Memo

Ponder, W. F. & Colgan, D. J. 2002. What makes a narrow-range taxon? Insights from Australian freshwater snails. *Invertebrate Systematics* **16**: 571–582.

Western Australian Museum. 2013. *WAM short-range endemic categories*. Western Australian Museum, Welshpool, WA.

Appendix 2 SRE site locations and descriptions

Site: S01 (Wet pitfall trap) (-30.711687, 121.490917)

Habitat description: Shrubland on creekline. Dense shrubland of mixed tall shrubs including Quandong, over mixed mid and low *Acacia* shrubs and *Eremophila*, over sparse native grasses and sparse herbs.

Habitat type: shrubland

Topography: drainage line

Slope: negligible

Soil: sandy clay, loam

Soil colour: red-brow

Rock type: none

Fire age: >5 years

Disturbance: litter, livestock tracks, vehicle tracks



Site: S02 (Wet pitfall trap) (-30.702865, 121.502725)

Habitat description: Salmon gum open woodland. Trees to 15m over mixed mid *Acacia* and *Eremophila* shrubs. Dense litter and plentiful stick debris under trees; bare earth elsewhere.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: none



Site: S04 (Wet pitfall trap) (-30.692472, 121.530875)

Habitat description: Woodland of salmon gum and mallee *Eucalyptus* trees to 15m, over tall *Acacia* shrubs to 4m, over mid *Grevillea* and *Acacia* shrubs to 2.5m, over low *Acacia*, *Sclerolaena* and *Eremophila* shrubs to 1m. Four strata present. Dense litter and plentiful debris. Hard clay soils.

Habitat type: woodland

Topography: plain

Slope: negligible

Soil: sandy clay

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: S05 (Wet pitfall trap) (-30.698385, 121.540435)

Habitat description: Woodland of *Eucalyptus* species to 12m, over over tall *Acacia* shrubs to 4m over mid *Acacia* shrubs to 2.5m, over mixed low shrubs to 1.5m. Deep litter and plentiful debris, on wet clay loam soils. Headwaters of creek.

Habitat type: woodland

Topography: drainage line

Slope: negligible

Soil: sandy clay, loam

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: evidence of feral animals



Site: S06 (Wet pitfall trap) (-30.699967, 121.563393)

Habitat description: Isolated *Eucalyptus* trees to 9m over tall and mid diverse shrubland to 3m over low shrubs to 1m, on stoney soils. Litter under shrubs; otherwise bare earth.

Habitat type: shrubland

Topography: hill top

Slope: gentle

Soil: sandy clay

Soil colour: brown, yellow

Rock type: basalt

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), vehicle tracks



Site: S07 (Wet pitfall trap) (-30.783513, 121.565474)

Habitat description: Open woodland of Salmon Gum and *Eucalyptus* trees to 18m over tall *Grevillea* and *Acacia* shrubs to 4m over mid *Acacia* shrubs to 2m over mixed low shrubs to 1m. Dense litter under trees and shrubs; plentiful debris.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: sandy clay

Soil colour: red-brown

Rock type: basalt

Fire age: >5 years

Disturbance: exploration (drill pads and access tracks), vehicle tracks



Site: S08 (Wet pitfall trap) (-30.804192, 121.600078)

Habitat description: Open woodland of Salmon Gum, *Eucalyptus* and She-oak trees to 15m, over tall *Grevillea* and *Acacia* shrubs to 4m over mid *Acacia* shrubs to 2.5m over low *Acacia*, *Sclerolaena* and *Eremophila* to 1m, on hard clay soils. Traps placed in sheoak thicket.

Habitat type: open woodland

Topography: drainage line

Slope: negligible

Soil: clay

Soil colour: red-orange, brown

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks



Site: S09 (Wet pitfall trap) (-30.742824, 121.621332)

Habitat description: Open woodland. Salmon gum to 10m over mid *Acacia* shrubs to 3m over low mixed shrubs dominated by *Eremophila*. Dense litter and plentiful stick and log debris under trees.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: grazing – low



Site: S10 (Wet pitfall trap) (-30.735172, 121.601183)

Habitat description: Open woodland of Eucalyptus trees to 12m over tall mixed shrubs to 3m over mixed medium and low shrubs. Dense litter under *Eucalyptus* trees; plentiful stick and debris.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: clay loam

Soil colour: red-brown

Rock type: basalt

Fire age: >5 years

Disturbance: vehicle tracks



Site: S11 (Wet pitfall trap) (-30.760564, 121.598848)

Habitat description: Salmon gum and she-oak (to 10m) open woodland alongside drainage line. *Eremophila* and *Acacia* shrubs to 3m, over low mixed shrubs. Sheet flow evident. Good leaf litter cover under she-oaks. Stick and log debris plentiful.

Habitat type: open woodland

Topography: plain

Slope: negligible

Soil: sandy clay, loam

Soil colour: red-brown

Rock type: none

Fire age: >5 years

Disturbance: vehicle tracks,



Appendix 3 WA Museum molecular identification report

Molecular identification of terrestrial invertebrates (Actinopodidae and Paradoxosomatidae) from near Kalgoorlie, Western Australia

Report to *Phoenix Environmental Services*

27 March 2019

Nerida Wilson, Joel Huey and Mark Harvey

Molecular Systematics Unit & Department of Terrestrial Zoology,
Western Australian Museum,
Locked Bag 49, Welshpool DC, Western Australia 6986, Australia



WESTERN
AUSTRALIAN
MUSEUM

Although identifications in this report were consistent with the best available information and current scientific thinking at the time of identification the use of this report is at the risk of the user. Any liability to users of this report for loss of any kind arising out of the use of this report or the information and identifications it contains is expressly disclaimed.

Summary

Phoenix Environmental requested DNA barcoding of two specimens of terrestrial invertebrates from the Pilbara region of Western Australia. This included mygalomorph spiders (n=1) and a myriapod (n=1) (see Appendix 1 for specimen details). The main objectives of the WA Museum's Molecular Systematics Unit (MSU) were to use COI DNA barcoding to determine the taxonomic identity of the available specimens.

DNA was extracted and DNA barcoding sequences (COI) were amplified by PCR in the MSU and sequenced at the Australian Genomic Research Facility (AGRF) Perth node. DNA sequences were BLASTED against publically accessible sequences in GenBank and with data sets derived from current research projects at WA Museum. The top 20 blast hits for each major taxon were gathered, duplicates removed, and analysed with a Maximum Likelihood phylogenetic analysis using a GTR+G model of evolution and 100 bootstraps (RAxML). Distances were calculated via tree-based estimates of identical bases in Geneious v9.1.8.

A summary of successful specimen identifications is in Table 1.

Table 1. Summary of identifications of queried specimens.

INFRAORDER	GENUS	SPECIES	# OF SPECIMENS
Mygalomorphae	<i>Missulena</i>	<i>harewoodi</i>	1
Polydesmida	<i>Antichiropus</i>	'DIP176'	1

Results

COI DNA barcodes were amplified and successfully sequenced from both specimens. The two COI sequences were compared to existing data held by the WA Museum data and the publically accessible GenBank database. A summary of the comparison (BLAST results) is provided in Table 2. Excised relevant parts of the resulting Maximum Likelihood tree are provided in Appendix 2 for visualisation of genetic relationships. The new DNA sequences have been submitted to Genbank and the accession numbers are available in Appendix 1, as well as with the raw data in Appendix 3.

The mygalomorph WAM 147517 matched closely to the holotype of a described species in the genus *Missulena*, and can be confidently identified as *Missulena harewoodi* (Appendix 2a).

The millipede WAM T147518 has a 93.4%% pairwise divergence with *Antichiropus* 'DIP065' from near Kalgoorlie (Appendix 2b). Because the genus is still under study, there is no useful known divergence threshold that may indicate a new species. Taking into account the topology of the tree, and the distance location of the nearest most similar species, this species appears previously unsequenced, and is here designated as 'DIP176'.

Table 2. Summary of BLAST analysis

REGNO (FIELD NO)	SPECIES	SUMMARY OF BLAST RESULTS
WAM T147517	<i>Missulena harewoodi</i>	WAMT147517 shares 95.43% genetic pairwise similarity with WAMT142820 (=MF693350) <i>Missulena harewoodi</i> .
WAM T147518	<i>Antichiropus</i> 'DIP176'	WAMT146002 shares 93.44% genetic pairwise similarity with WAMT141023 (DIP065).

Conclusions

The main objectives were to compare successful COI sequences from the queried specimens to DNA barcoding sequences held at WAM and those publically accessible in GenBank. One mygalomorph specimen matched the holotype of the species *Missulena harewoodi* (GenBank MF693350). The millipede represents a new lineage of *Antichiropus*, not represented in queried databases.

WAM-MSU-461
Report by Western Australian Museum

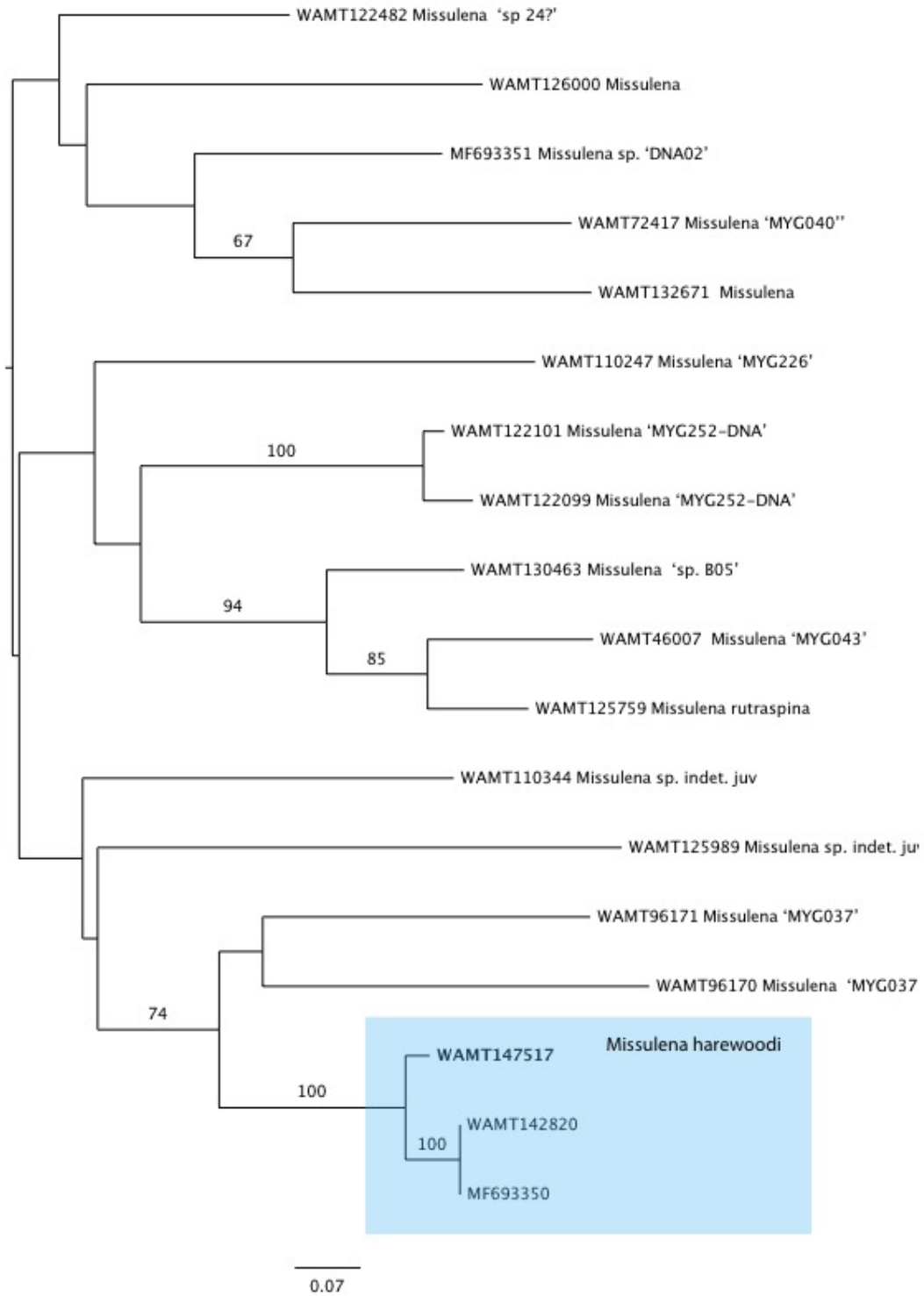
Appendix 1. Specimen data for six queried specimens

REGNO	GENBANK	FAMILY	GENUS	SPECIES	SITE	LATITUDE	LONGITUDE
T147517	MH715491	Actinopodidae	<i>Missulena</i>	sp.	ca. 5.5 km NNE. of Kalgoorlie	30°42'10.31"S	121°30'09.81"E
T147518	MH715492	Paradoxosomatidae	<i>Antichiropus</i>	'broad arrows'?	ca. 12 km E. of Kalgoorlie	30°44'06.62"S	121°36'4.26"E

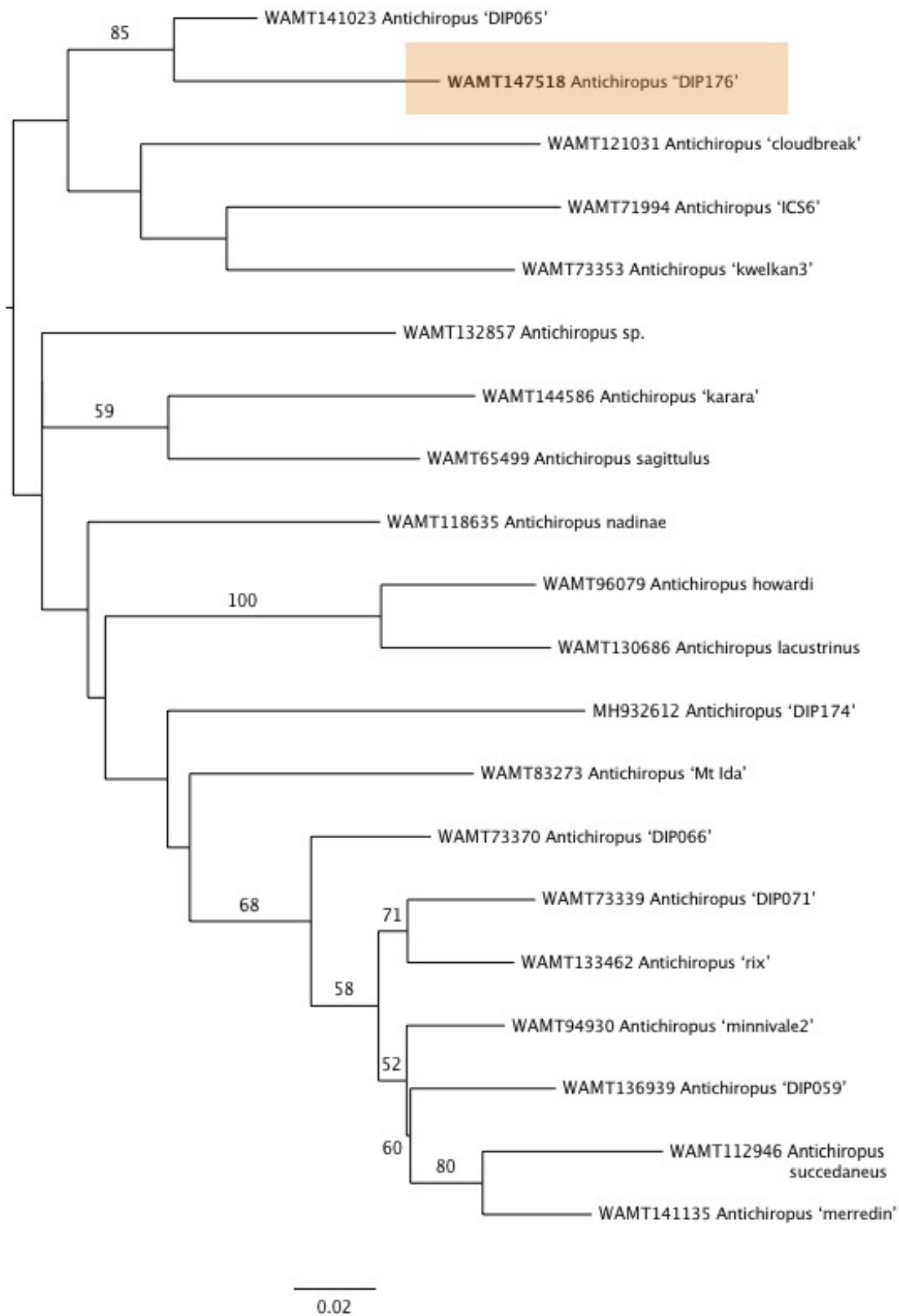
WAM-MSU-461
Report by Western Australian Museum

Appendix 2. Excerpt from Maximum Likelihood tree of COI, to be used *ONLY* for visualisation of genetic relationships. Bootstrap values less than 50 have been removed.

a) *Missulena*



b) *Antichiropus*



WAM-MSU-461
Report by Western Australian Museum

Appendix 3. COI DNA sequence data generated in this report

>WAMT147517 = MK715491

```
AACAATGTATTTGATTTTTGGTGTGGTCTGCTATATTAGGGACTTCTATGAGAGTAATTATTCGGACTGAG
TTGGGTCAGGTTGGTAGACTTTTAGGGGATGATCATTGTATAATGTAATTGTAAGTCTCATGCTTTAGTAA
TGATTTTTTTTATAGTTATGCCTATTATGATTGGAGGGTTTGGTAATTGGTTAGTTCCTTTGATGTTAGGAGC
TCCTGATATAGCTTTTCCTCGAATGAATAATTTGAGATTTTGGCTTTTACCACCATCTCTATTTATATTATTG
TTGTCGTCAGTGATTGAGAGAGGTGTGGGGGCTGGGTGAACAATTTATCCTCCATTATCTTCGGGATTAGGCC
ATAGAGGGGGAGGAATAGATTTTGTATTTTTTCTTTGCATTTGGCAGGGGCTTCTTCTATTATGGGAGCAAT
TAATTTTATTTCTACTGTTGTTAATATACGGGTGAGTGGTATAACAATAGAGAGGGTATCGTTATTTGTGTGA
TCAGTATTGGTTACTGCTATTTTGTATTGTTGTCATTACCTGTATTGGCTGGGGCTGTTACTATATTATTGA
CTGATCGTAATTTAATACTACTTTTTTTTGATCCTGCTGGGGGAGGGGATCCAGTGTGTTTCAGCACTTATT
T
```

>WAMT147518 = MK715492

```
AACTTTATATTTAATTTTTGGTGTGGGCTGGAATTATTGGGCTGCTTTAAGAGGAATGATTCGTATAGAA
TTAGGTCATTCTGGGAGAGTTATTGGAGATGATCAAATTTATAATGTTATTGTAAGTCTCATGCTTTTGTGA
TGATTTTTTTTATGGTTATGCCGATTATAATTGGGGGGTTTGGTAATTGATTAGTTCCTTTGATGATTGGGGC
TCCTGATATAGCATTTCCTCGAATAAATAATTTGAGTTTTTGGTTACTTCCTCCTTCTTTTTTTTTTATTATTA
GCTTCTTCTGTTGTTGAGAGTGGAGTTGGGACGGGGTGAAGTGTCTATCCGCCACTAGCTTCAAGTTTGTTC
ATGGTGGACCGGCTGTTGATTTAGCTATTTTTTCTTTCATTTAGCCGGGGCTTCTTCTATTTTAGGAGCTAT
TAATTTTATTACAACGTGATTAATATGCCGAGCTTATGGAATGATTTTGAACGGATGCCGTTGTTTGTGTGG
TCTGTGGTTTTAACGGCTATTTTGTATTATTATCTCTG
```

