29

Metals

Native Vegetation Clearing Permit (Purpose): Supporting Report

Life of Mine Tailings Storage Facility 4

Golden Grove Operations Pty Ltd

Table of Contents

FIGURES

TABLES

1. Introduction

1.1. Background

Talis Consultants was commissioned by 29Metals Limited (the Proponent) to prepare a Native Vegetation Clearing Permit (NVCP) application for clearing associated with the Golden Grove Mine.

Golden Grove Mine (the Project) is approximately 450 km northeast of Perth, 250 km east of Geraldton, and approximately 50 km southeast of Yalgoo, Western Australia. The Proponent operates the Project, which currently comprises two existing underground mines, a processing plant, waste rock landforms (WRLs), tailings storage facilities (TSFs), supporting infrastructure and several decommissioned open pits. The Project is located within the Shire of Yalgoo in the Midwest region of WA (Figure 1-1).

The Proponent mines a volcanic-hosted massive sulphide deposit to produce concentrate products of copper, zinc, gold, silver and lead. The Project is expected to deliver approximately 1.7 million tonnes per annum of these elements collectively for export over an estimated ten years. Mineral exploration in the Golden Grove Project Area (the Project Area) commenced in 1971 with the realisation of the potential for base metal sulfide deposits from outcrops of coarse pyroclastic rocks and gossan fragments. The Project has predominately been an underground operation with two separate underground portals, Scuddles and Gossan Hill, of which mining commenced in 1990 and 1998, respectively.

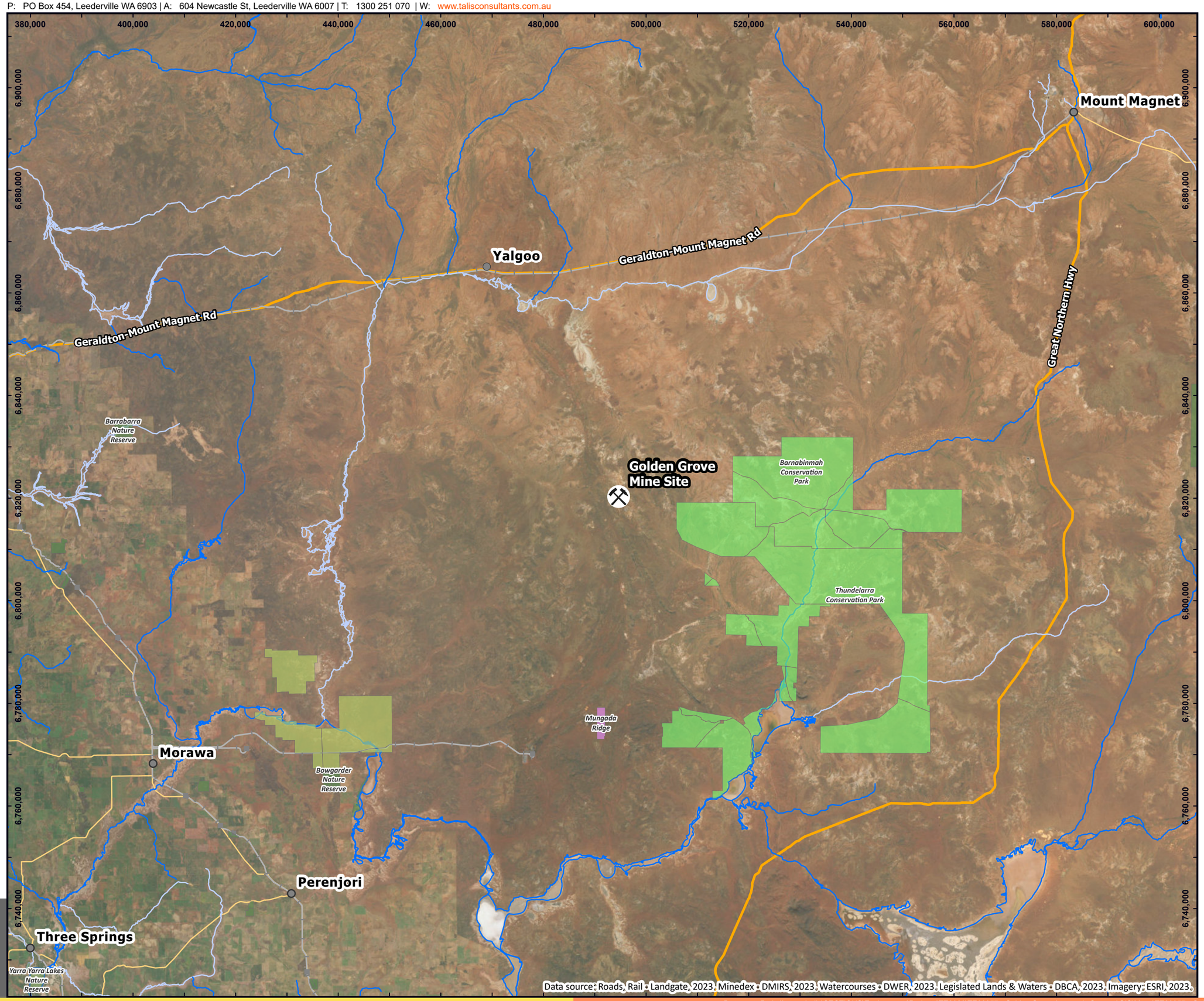
Mining recommenced at the Gossan Hill Open Pit in late 2011, with processing of Copper (II) Oxide ore in beginning in 2012. The Gossan Hill open pit was initially mined via conventional open-pit, drill and blast, and shovel and truck methods. Ores (including ore with high precision metal concentrate) were systematically stockpiled on the Run-of-Mine (ROM) pad prior to being loaded and transported via road-train to the Port of Geraldton for exportation to smelters in Asia and Europe for refining.

Additionally, the Proponent is currently developing plans for an additional underground mine (Gossan Valley), which is located approximately 10km from the current operations. Processing will be at the Golden Grove processing plant, with tailings expected to be stored at Golden Grove. Due to the limited storage capacity of the current TSF (TSF3), even without the addition of Gossan Valley, the Proponent will require commissioning of an additional TSF (TSF4).

To commission TSF4, an NVCP is required. The proposed development envelope (DE) for TSF4 is situated on the below list of tenements (Figure 1-2):

- M59/3;
- M 59/89;
- M 59/363; and
- M 59/90.

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



Data source: Roads, Rail - Landgate, 2023. Minedex - DMIRS, 2023. Watercourses - DWER, 2023. Legislated Lands & Waters - DBCA, 2023. Imagery: ESRI, 2023.

LEGEND

- Mine Site

Water Courses

- Major River
- Minor River

Legislated Lands and Waters

- Conservation Park
- National Park
- Nature Reserve
- Timber Reserve

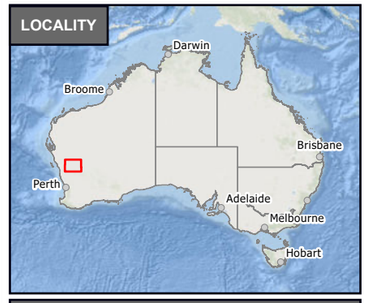
Rail Network

- Railway Stations
- Railway Lines

Western Australian Roads

- Freeway / Highway
- Main Road

LOCALITY



0 1,000 2,000 3,000 4,000 5,000 km

SITE LOCALITY

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N 0 10 20 30 Km

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:700,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

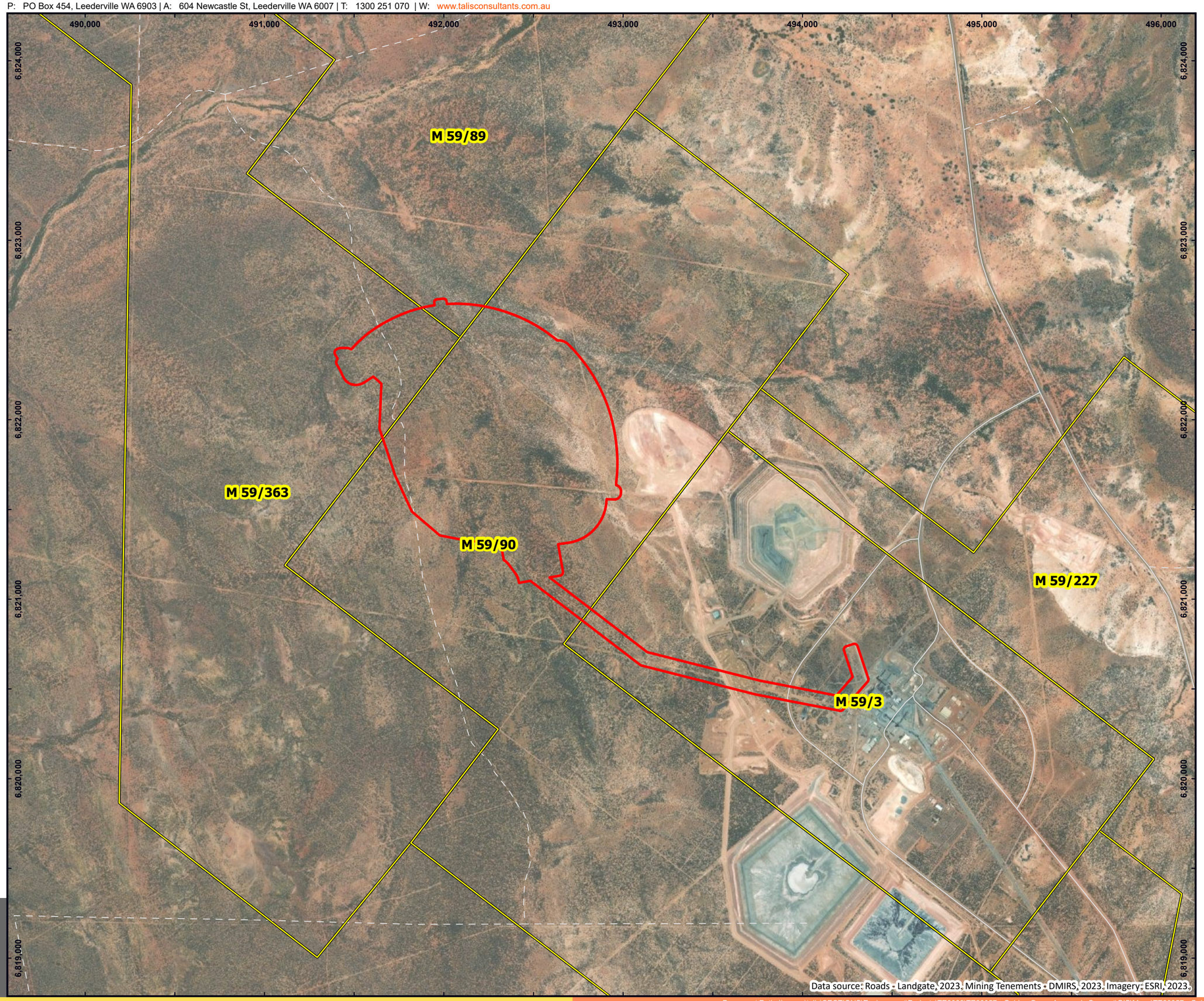
talis consultants

29 Metals Golden Grove

Figure 1-1

Document Path: \\server\talis\SECTIONS\Environment\Projects\TE2023\TE23057 - Golden Grove Approvals Support\GIS\Maps\TE23057 - Golden Grove Approvals Support\TE23057 - Golden Grove NCVP.aprx

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



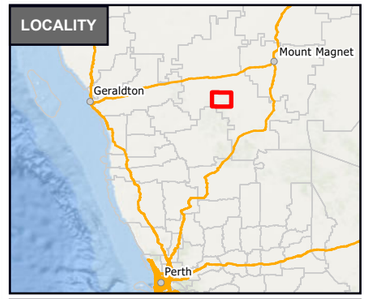
LEGEND

- Development Envelope
- Mining Tenements

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

SITE TENURE

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:20,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 1-2

Document Path: \\server\talis\SECTIONS\Environment\Projects\TE2023\TE23057 - Golden Grove Approvals Support\GIS\Maps\TE23057 - Golden Grove Approvals Support\TE23057 - Golden Grove NCVP.aprx

Under Section 51C of the *Environmental Protection Act 1986* (EP Act), the clearing of any native vegetation requires an approved clearing permit, unless an exemption applies. Exemptions for mining generally apply to areas of low impact mining and exploration, or for proposals that have already been assessed by the Environmental Protection Authority (EPA), Department of Water, Environment and Regulation (DWER) or Department of Mines, Industry Regulation and Safety (DMIRS) through a separate process. Sufficient exemptions do not apply for vegetation within the Project; a clearing permit is therefore required.

The NVCP application is to clear up to up to 143.5 hectares (ha) of native vegetation within the Development Envelope (DE) of approximately 187.7 ha.

1.2. Purpose of Clearing Permit Application

The purpose of this NVCP supporting document is to present the results of an assessment of the clearing aspects of this proposal against the ten clearing principles as outlined in the (then) Departments of Environment Regulation (DER)'s A guide to the assessment of applications to clear native vegetation (2014) under Part V Division 2 of the EP Act. This report identifies the potential environmental impacts associated with the proposal based on the best available data. This report and accompanying NVCP Purpose Permit application form will be submitted to DMIRS for assessment.

1.3. Proposed Timeframe

Clearing is proposed to commence in Q2 2024 with TSF4 expected to be in operation until 2035.

1.4. Responsible Applicant

Golden Grove Operations Pty Ltd (Golden Grove) are responsible for the implementation of the clearing described within this report. Correspondence relating to this NVCP application should be addressed to:

Callum Moore
HSEC Manager
29Metals Ltd
Level 2, 1100 Hay St, West Perth WA 6005
(08) 9956 4091

Callum.Moore@29metals.com

2. Site Overview

2.1. Climate

Golden Grove mine is situated within the Murchison region and Yalgoo bioregion, has a variable climate with characteristics of semi-arid and Mediterranean climates, and is prone to long periods of drought. Most rainfall occurs during the winter months, although more occasional major rainfall events, largely associated with tropical cyclone activity off the northwest shelf, occur in the summer months and can result in localised flooding.

The nearest BoM weather station to the Project is Morawa Airport (Station 8296). The annual average rainfall recorded at the Morawa Airport weather station is 286.6 mm.

Long-term monthly rainfall averages and temperature are shown in Figure 2-1 based on the Morawa Airport data between 1997-2022 (BoM, 2023).

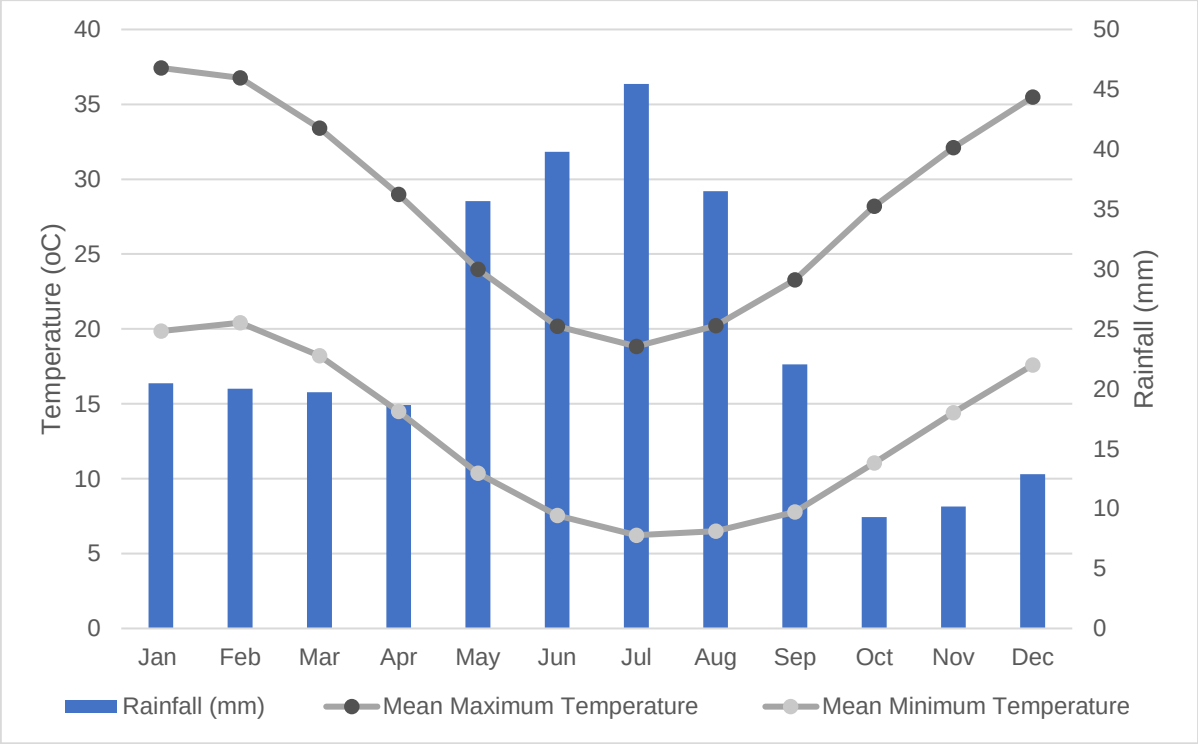


Figure 2-1: Long Term Monthly Rainfall and Evaporation

While the long-term average monthly rainfall totals are similar, in practice, the site often receives more rainfall in the winter months due to frontal systems from the southwest and occasionally high totals in the summer due to rain-bearing depressions (ex-tropical cyclones) from the north. Rainfall of more than 30 to 50 mm is likely to contribute to groundwater recharge if it occurs over a few successive days. Below that the rainfall contributes to soil moisture only.

On average, the evaporation rate is 2,583mm with monthly totals in the order of ten times the corresponding rainfall rates. This is typical for inland areas of WA and is responsible for the absence of permanent surface water in the region (GHD, 2020).

2.2. Topography

The area surrounding the Golden Grove mine site is of low to moderate relief with long ranges separated by extensive plains. Elevation is generally around 350 m above sea level with the highest point in the region being Minjar Hill to the west, approximately 380 m above sea level. The main feature of the operational tenements is Gossan Hill which is an isolated hill on the plain between a range to the west and breakaways in the east.

Golden Grove is located on a topographic divide with the majority of the mine infrastructure located in a wide shallow valley which drains to the south-west towards Minjar Hills. The valley is surrounded by a low ridge of volcanoclastic rocks and meta-sedimentary rock types. The geological formations in the project area are often intruded by dykes and sills of dolerite and dacite (URS, 2009).

2.3. Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into 89 bioregions based on major biological, geographical, and geological attributes. These bioregions are subdivided into 419 subregions as part of a refinement of the IBRA framework (Department of Climate Change, Energy, the Environment and Water, 2021).

The Project is located within the Yalgoo biogeographic subregion, which is characterised by open woodlands (principally *Callitris*, *Eucalyptus salubris*, Mulga and Bowgada) and scrubs on earth or sandy earth plains (CALM, 2002). The subregion represents the boundary between the Murchison and Southwestern bioregions with features of both bioregions represented in the Yalgoo subregion.

2.4. Geology

The Golden Grove mine area is underlain by Archaean rocks comprising metasediments and metavolcaniclastics sediments including banded iron formation with minor felsic volcanic's. The sequence is sub-vertically dipping and striking northwest to southeast. The succession has been intruded by Proterozoic dacite sills and dolerite dykes. The Archaean rocks form the eastern limb of a narrow north-northwest trending syncline, confined by granite to the east and west.

The Archaean bedrock is mantled by caprock and alluvium. The alluvium overlies low-lying parts of a palaeosurface that was previously of higher relief than the present-day topography. Alluvium infilling the palaeovalley is typically coarser grained in proximal areas such as the valley mid-slopes and finer rained in distal areas such as the valley floor. Alluvium observed in drill samples comprise gravelly, sandy, and silty loams.

Caprock is a calcreted and/or ferruginous (by iron oxide) surface that is variably cemented. Calcrete cemented caprock is massive and does not appear to be weathered or vuggy. The laterite cemented caprock is sometimes pisolitic and can be loose, sandy, and porous or cemented and vuggy. Lateritic caprock occurs in upper- to mid-slope areas while the calcrete-cemented caprock tends to occur in mid-slope to low-lying areas. Both grades downwards to uncemented saprolitic deposits which are clayey and silty.

At Golden Grove, strata bound sulfide-magnetite mineralisation occurs in a one km thick felsic volcanoclastics sequence, consisting of fine and coarse-grained pyroclastic rocks, volcanogenic sediments, and minor flow rocks (Frater, 1983). Outcropping occurs mainly at the site of mineralisation rather than in the surrounding countryside and, generally, ranges from negligible (over diabase) to 100 per cent (%) (over gossan and siliceous country rock).

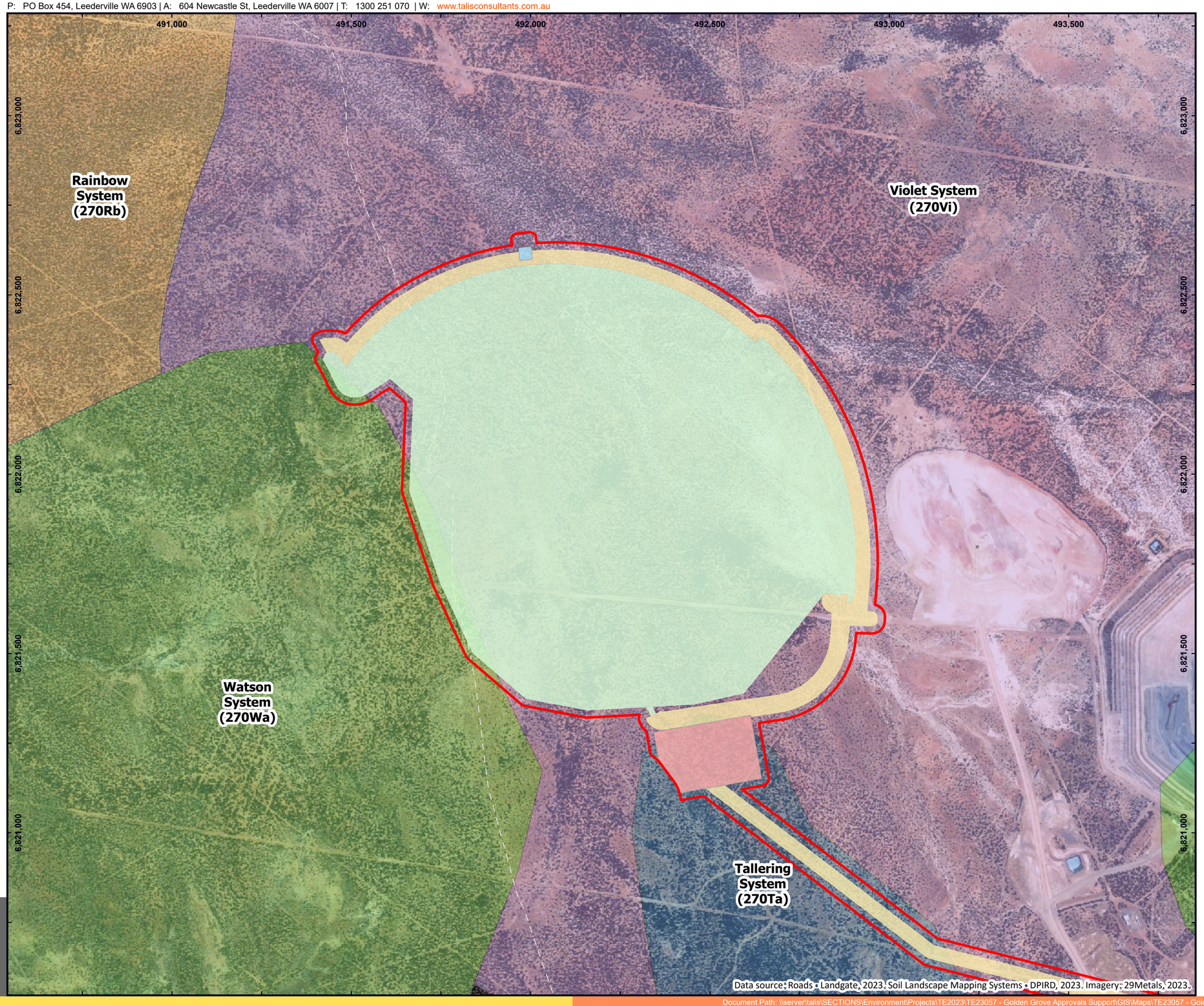
2.5. Soil Landscape Systems

Phoenix (2022) identified three land systems (Figure 2-2) that are located within the proposed TSF4 DE. These are summarised below in Table 2-1:

Table 2-1: Land Systems identified at the TSF DE (Phoenix, 2022)

Land System	Description	Area (ha)	% of DE
Tallering System	Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other *Acacia* shrublands.	11.78	6.7
Violet System	Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands.	156.53	89.1
Watson System	Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs.	7.47	4.2
Total		**175.77**	**100**

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



LEGEND

- Development Envelope

Proposed Disturbance

- Seepage Collection Pond
- TSF4
- Transport & Infrastructure Corridor
- Thickener Plant

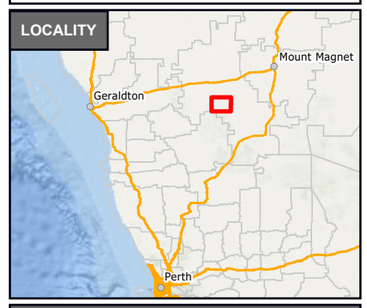
Soil Landscape Mapping - Systems

- Rainbow System (270Rb): Hardpan plains supporting mulga tall shrublands.
- Tallering System (270Ta): Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other acacia shrublands.
- Violet System (270Vi): Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands.
- Watson System (270Wa): Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs.

Western Australian Roads

- Other

LOCALITY



SOIL LANDSCAPE MAPPING SYSTEMS

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N
0 100 200 300 400 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:10,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 2-2

Document Path: \\server\talis\SECTIONS\Environment\Projects\TE2023\TE23057 - Golden Grove Approvals Support\GIS\Maps\TE23057 - Golden Grove Approvals Support\TE23057 - Golden Grove NCVP.aprx

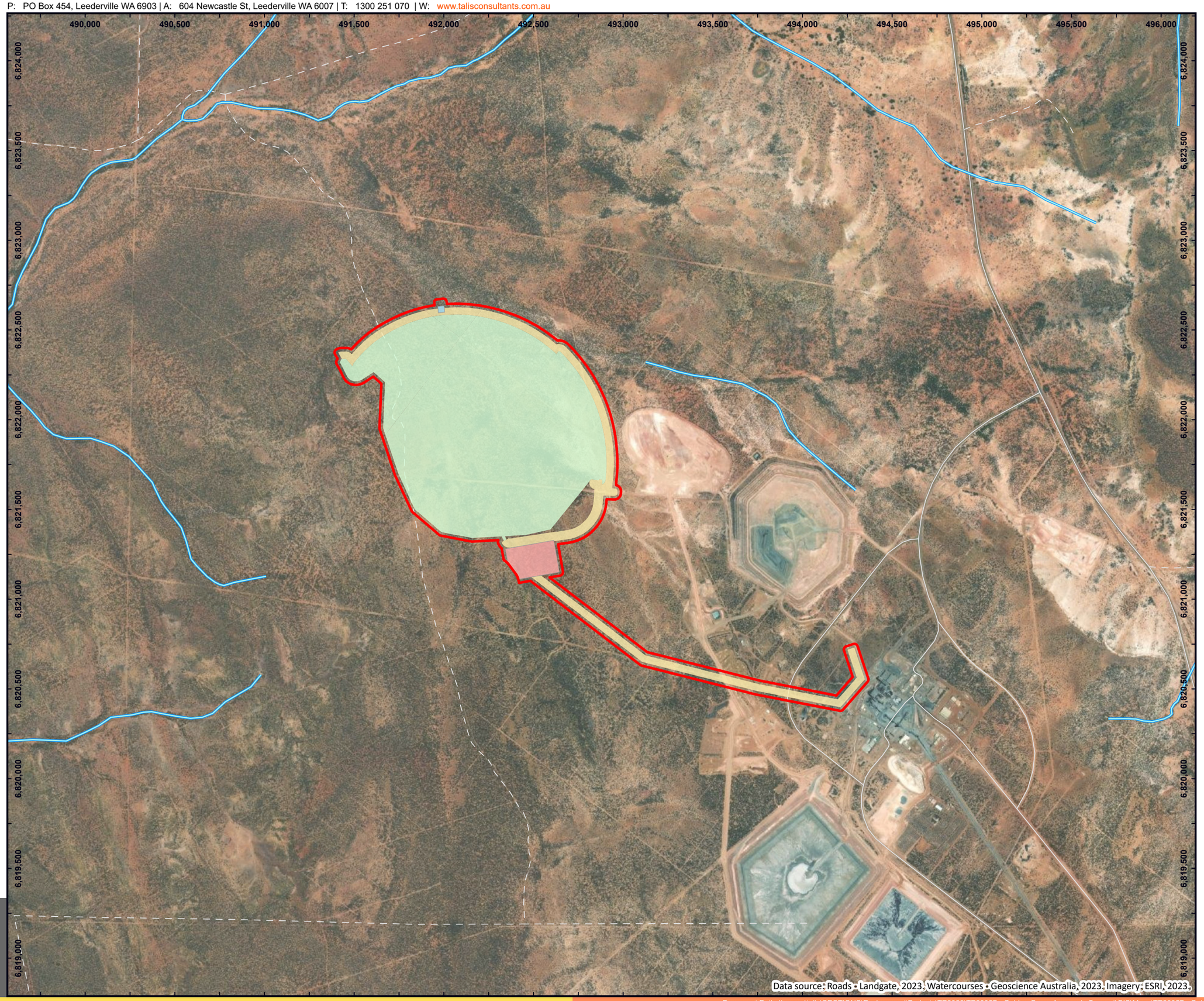
2.6. Hydrology and Wetlands

The Project is located on the semi-arid Murchison Region of WA, close to the Wheatbelt Region. Fluctuating rainfall patterns contribute to highly variable surface water flows, which only occur following intense rainfall events (AECOM, 2023). There are no permanent surface water bodies in the region and the Project is not located within any proclaimed Surface Water Areas (DWER, 2020). (Figure 2-3 and Figure 2-4).

Adjacent to the Project area, the central catchment divide runs north-west to south-east. The area contains well defined surface drainages in elevated areas, which become indistinct in low-lying areas where runoff disperses across the valley floors. The Non-Contributing catchment area created by the proposed TSF4 represents a very small (<6% by area) proportion of the total Cattle Creek watershed area at the downstream confluence point (AECOM, 2023).

There are no wetlands of national importance within or close to the DE or within the Shire of Yalgoo (Maia, 2022). No other wetlands occur in or close to the DE and no watercourses intersect the DE (Maia, 2022).

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



Data source: Roads - Landgate, 2023. Watercourses - Geoscience Australia, 2023. Imagery: ESRI, 2023.

LEGEND

- Development Envelope
- Watercourse

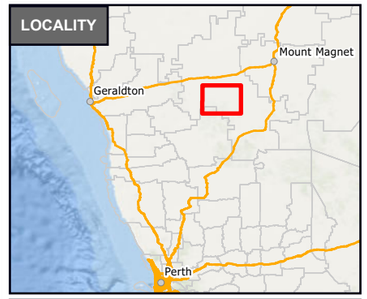
Proposed Disturbance

- Seepage Collection Pond
- TSF4
- Transport & Infrastructure Corridor
- Thickener Plant

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

REGIONAL SURFACE HYDROLOGY

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:20,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

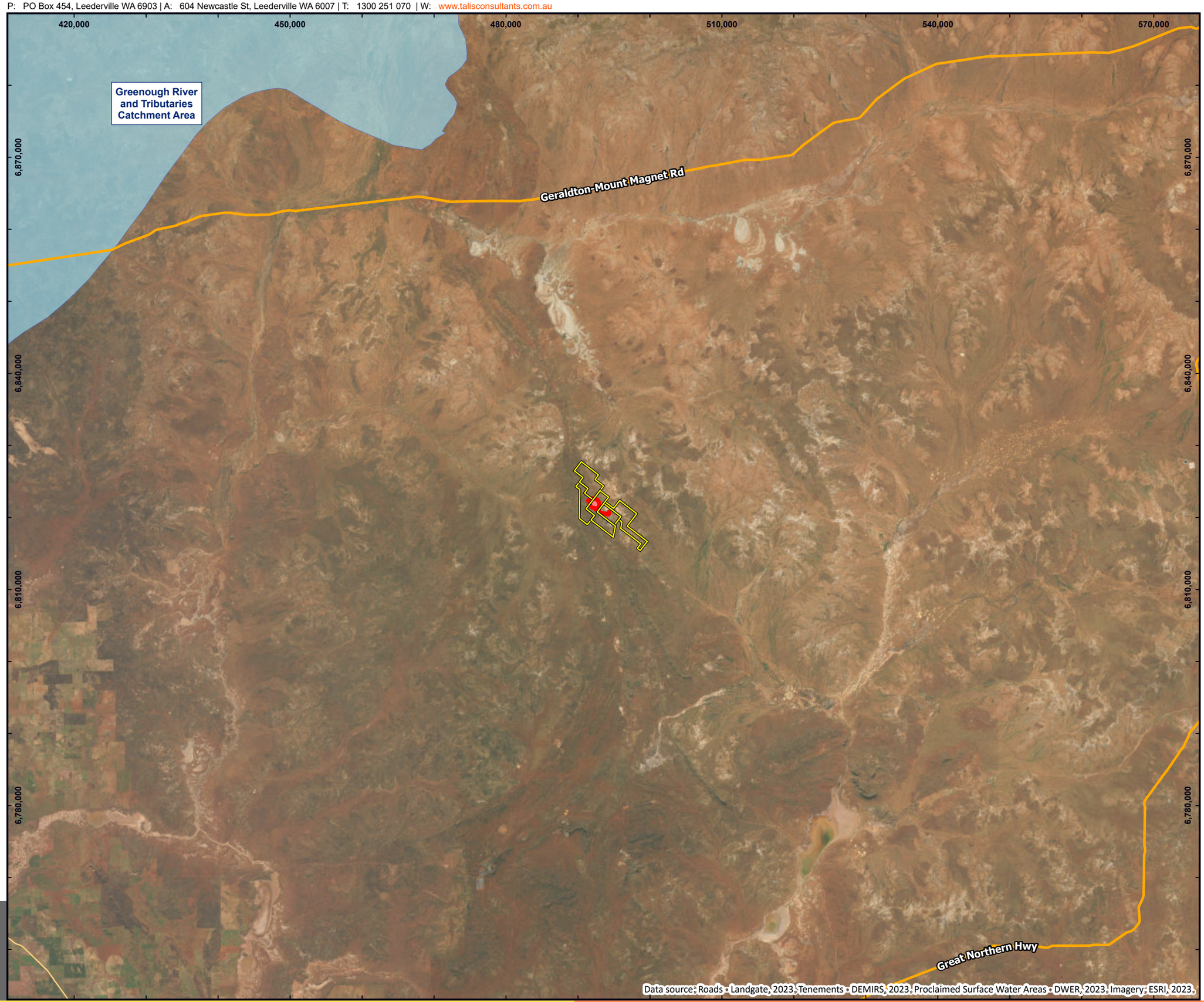
talis consultants

29 Metals Golden Grove

Figure 2-3

Document Path: \\server\talis\SECTIONS\Environment\Projects\TE2023\TE23057 - Golden Grove Approvals Support\GIS\Maps\TE23057 - Golden Grove Approvals Support\TE23057 - Golden Grove NCVP.aprx

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



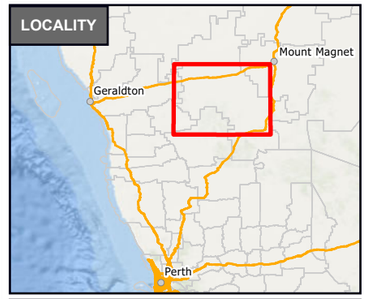
LEGEND

- Development Envelope
- Mining Tenements
- RIWI Act Proclaimed Surface Water Areas

Western Australian Roads

- Freeway / Highway
- Main Road

LOCALITY



0 100 200 300 400 500 km

PROCLAIMED SURFACE WATER AREAS

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N 0 5 10 15 20 Km

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:500,000

Prepared:	T Daymond	Date:	1/12/2023
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

talis consultants

29 Metals **Golden Grove**

Figure 2-4

Data source: Roads - Landgate, 2023. Tenements - DEMIRS, 2023. Proclaimed Surface Water Areas - DWER, 2023. Imagery: ESRI, 2023.

2.7. Conservation Features

None of the Project area lies in Department of Biodiversity, Conservation and Attractions (DBCA) Legislated Lands and Waters (Maia, 2022). The closest is a Timber Reserve, approximately 57 km south-west of the DE. Further, the DE does not lie in any DBCA Lands of Interest, and it does not fall in an Environmentally Sensitive Area (ESA). The closest ESA is approximately 35 km south-east of the DE (Maia, 2022). The DE is not in an EPA Redbook Recommended Conservation Reserves 1976-1991 area, the closest is Yarra Yarra Lake Conservation Park, more than 100 km south-west of the DE. The DE is not in a Schedule One Area (Maia, 2022).

3. Flora and Vegetation Assessment

Three flora and vegetation surveys have been undertaken by Maia Environmental Consultancy Pty Ltd (Maia) of the proposed DE for TSF4 over the period 2021 to 2022. Of these surveys, one was a targeted flora survey for *Petrophile vana*, a Priority 1 (P1) flora species. Other extensive flora and vegetation surveys have been conducted across the entirety of Golden Grove Mine tenements to inform other project approvals throughout the Project's history. The following summary and the assessment against the clearing principles is based on the most recent works completed by Maia in 2021 and 2022.

3.1. Desktop Assessment

The Department of Biodiversity, Conservation and Attractions' (DBCA) Threatened and Priority Flora List was searched in conjunction with WA Herbarium databases for information on vascular conservation significant flora species and introduced species that could potentially occur in the Project area (Maia, 2022). Results from reports of previous botanical surveys carried out within the Project area tenements were collated and added to the full list of search results for the desktop portion of the flora and vegetation assessment.

3.1.1. Flora Assessment

Fourteen (14) conservation significant flora were identified from database searches (Maia, 2022). Of these, three are listed as Threatened flora species under the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the WA *Biodiversity Conservation Act 2016* (BC Act). However, the three threatened species have not been noted in the area previously. Eleven Priority flora species were recorded: one P1, eight P3 species and two P4 species. All priority flora species have been previously recorded during earlier surveys, with *Acacia speckii*, in particular, being recorded in high numbers (Maia, 2022). Table 3-1 summarises the search results for conservation significant flora that could potentially occur within the proposed DE.

Table 3-1: Significant flora potentially occurring within the DE

Species	Conservation Status
Eucalyptus synandra	T (VU – EPBC & WA)
Gyrostemon reticulatus	T (CR – EPBC & WA)
Stylidium scintillans	T (VU – WA)
Chamelaucium sp. Yalgoo (Y. Chadwick 1816)	P1
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	P3
Drummondita fulva	P3
Grevillea globosa	P3
Micromyrtus trudgenii	P3
Persoonia pentasicha	P3
Polianthion collinum	P3
Psammomoya implexa	P3
Rhodanthe collina	P3
Acacia speckii	P4
Haegiela tatei	P4

Note: T = Threatened, CR = Critical, VU = Vulnerable, P1, P3, P4 = Priority One, Three and Four.

Weeds

No weed species listed on any of the national weed lists or under the *Biosecurity Agriculture Management Act 2007* (BAM Act) were listed in the database and literature search results (Maia, 2022). A total of 22 general weed species were collated from the search results, 17 of which have been recorded during earlier surveys for Golden Grove mine tenements (Maia, 2022).

3.1.2. Vegetation Assessment

Broad Vegetation Types

Mapping of pre-European broad vegetation within Western Australia was completed on a broad scale (1:1,000,000) by Beard (1976). These vegetation types were later re-assessed by Shepherd et. al (2002) with some larger vegetation units divided into smaller units. Together, this pre-European database contains a total of 819 vegetation types within Western Australia.

Three of Beard's pre-European vegetation associations are mapped within the DE:

- 202 Open Shrubland: Wattle, teatree and other *Melaleuca* spp.;
- 361 Open Shrubland: Wattle with York gum, casuarina; and
- 420 Open Shrubland: Wattle, teatree and other *Melaleuca* spp.

Between 99.69% and 99.97% of the vegetation associations remain in the Yalgoo bioregion and Tallering subregion in the Shire of Yalgoo. Currently only 0.02% of the pre-European extent of vegetation association 420 is protected in the bioregion and subregion, and none of it in the Shire. Neither 202 or 361 is protected for conservation in the bioregion, subregion or Shire (Table 3-2) (Maia, 2022).

Table 3-2 Broad vegetation types (Government of Western Australia, 2019)

Vegetation Type	Pre-European Extent (ha)	Current Extent (ha)	Remaining (%)	Current Extent protected (IUCN 1-4) for conservation (%)
Representation across the Yalgoo Bioregion				
202	45,096.14	45,011.91	99.81	0
361	76,479.74	76,453.22	99.97	0
420	621,396.05	620,265.57	99.82	0.02
Representation across the Tallering Subregion				
202	45,096.14	52,004.53	99.81	0
361	76,456.96	77,518.54	99.97	0
420	615,816.17	549,363.07	99.82	0.02
Representation across the Shire of Yalgoo				
202	52,004.53	51,900.75	99.80	0
361	77,518.54	77,492.03	99.97	0
420	549,363.07	548,343.13	99.81	0

Ecological Communities

Information on significant ecological communities that could potentially occur within the proposed DE was gathered from the State's Threatened and Priority Ecological Community database or the Department pf Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool. No Threatened Ecological Communities (TECs) were listed in the proposed DE.

Approximately 58% of the DE area was identified as occurring within the boundaries of the Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) P1 Priority Ecological Community (PEC) (Maia, 2022). The PEC is mostly associated with areas mapped as the Tallering and Watson land systems, with other land systems falling under the outer edges of these areas (e.g., the Violet land system) (Maia, 2022). See Figure 3-1 for more detail.

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au

490,000 491,000 492,000 493,000 494,000 495,000 496,000

6,824,000 6,823,000 6,822,000 6,821,000 6,820,000 6,819,000

Unique Occurance ID: 2587

Unique Occurance ID: 5257

Unique Occurance ID: 5258

LEGEND

- Development Envelope

Proposed Disturbance

- Seepage Collection Pond
- TSF4
- Transport & Infrastructure Corridor
- Thickener Plant

Survey Areas

- Maia Survey (2021 & 2022)

Priority Ecological Communities

- Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) (P1)

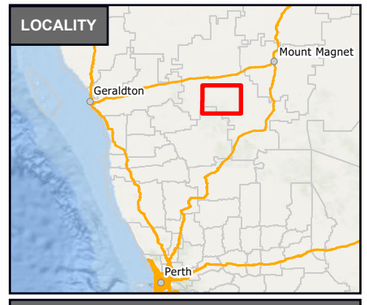
Threatened and Priority Fauna

- Threatened species

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

THREATENED & PRIORITY ECOLOGICAL COMMUNITIES

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N 0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:20,000

Prepared:	T Daymond	Date:	1/12/2023
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 3-1

Data source: Roads - Landgate, 2023. PECs, Fauna - DBCA, 2023. Imagery: ESRI, 2023.

3.2. Field Survey Assessment

Maia surveyed the DE for the Project in November 2021, covering 254.54 ha. The 2021 survey ran over four days, with analysis of rainfall data indicating the vegetation would likely be in average condition for the time of year (Maia, 2022). Survey methodology was developed to comply with the *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessments* (EPA, 2016) and the report was provided in 2022. The data available is considered robust and is supported by an earlier survey of the DE conducted by Maia in August 2020 (report provided 2021).

3.2.1. Vegetation Assessment

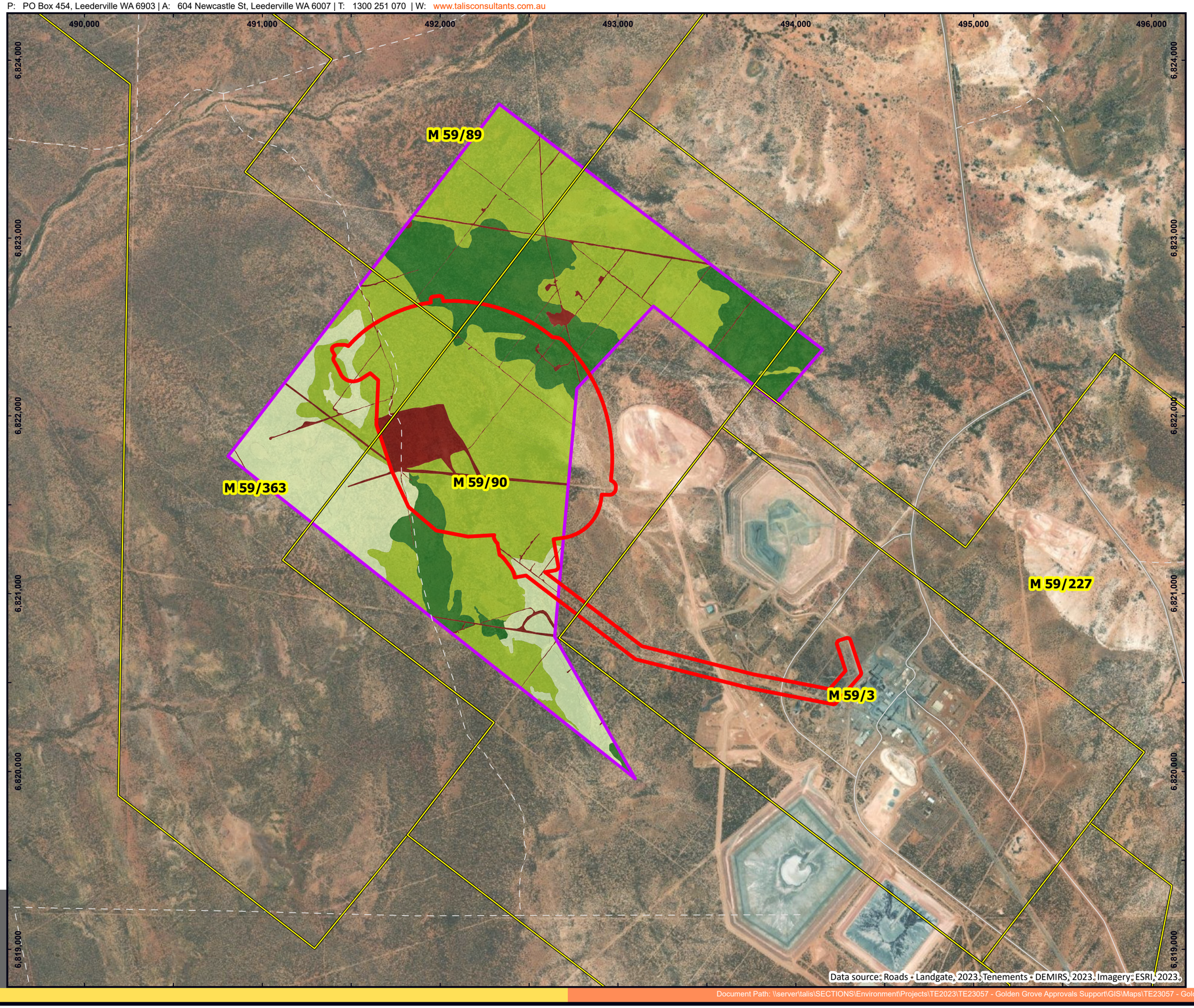
Vegetation Condition

Vegetation condition within the survey ranged from Excellent to Completely degraded. The dominant vegetation condition was Excellent to Very Good, with just over 50% of the survey area falling within this category (Maia, 2022). Degraded to Completely Degraded areas comprised only 6% of the survey area and causal factors noted were works removing all native vegetation (Maia, 2022). Further details on vegetation condition recorded for the survey area are included in Figure 3-2 and Table 3-3 .

Table 3-3: Vegetation Condition

Vegetation Condition	Area (ha)/Cover (%)	Comments
Excellent	81.78/17.95	Areas where there are few to no obvious signs of disturbance.
Excellent to Very Good	245.02/53.77	Some signs of low-level disturbance, e.g., off-road driving and litter.
Very Good	101.51/22.28	Moderate signs of disturbance from grazing and exploration activities were noted in these areas, or areas were directly adjacent to major infrastructure areas.
Degraded to Completely Degraded	27.39/6.00	Areas cleared for drill lines, roads, tracks, and pits.

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



LEGEND

- Development Envelope
- Mining Tenements
- Maia Survey (2021 & 2022)

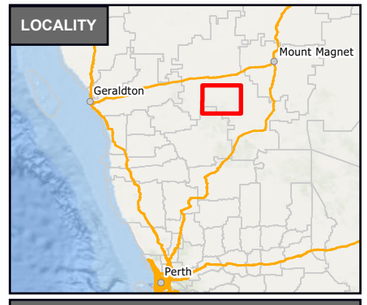
Vegetation Condition

- Degraded to Completely Degraded
- Excellent
- Excellent to Very Good
- Very Good

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

VEGETATION CONDITION

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N 0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:20,000

Prepared:	T Daymond	Date:	1/12/2023
Reviewed:	J Kirke	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 3-2

Data source: Roads - Landgate, 2023. Tenements - DEMIRS, 2023. Imagery: ESRI, 2023.

Document Path: \\server\talis\SECTIONS\Environment\Projects\TE2023\TE23057 - Golden Grove Approvals Support\GIS\Maps\TE23057 - Golden Grove Approvals Support\TE23057 - Golden Grove NCVP.aprx

Vegetation Types

Seven vegetation types were mapped in the Maia survey area, with Mixed Tall Open Shrubland (MTSL 2) comprising 41% of the total surveyed area (>188 ha) (Maia, 2022). Table 3-4 details a broad floristic composition, habitat, associated species and average vegetation condition for each of the mapped vegetation types.

The P1 flora species *Petrophile vana* was recorded in two of the vegetation types; ATSL (1) and MTSL (1). P4 *Acacia speckii* was recorded in four: ATSL (3), ATSL (4), MTSL (1) and MTSL (2).

A portion of all seven of the vegetation types occur within the boundaries of the Minjar and Chulaar Hills P1 PEC (Maia, 2022).

Table 3-4: Vegetation Type Description

Code	Broad floristic formation	Coverage of survey area (%)	Area (ha)	Vegetation type and associated information	
ALWL	Acacia Low Woodland	2.19	9.97	**Vegetation Type:** Low Open Woodland of *Acacia aptaneura* with a mixed Tall Sparse Shrubland mainly of *Acacia aptaneura, A. caesaneura* (narrow phyllode variant), *A. ramulosa* var. *ramulosa* and Sparse Shrubland of *Eremophila latrobei* subsp. *latrobei*	**Associated Species:** *Cheilanthes adiantoides, Grevillea obliquistigma, Mirbelia* sp. *Bursarioides* (T.R. Lally 760), *Philotheca sericea, Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Thryptomene decussata*
				Habitat: Banded iron formation (BIF) ridges and outcrops	**Vegetation Condition:** Excellent; grazing, exploration activities, animal tracks – trampled vegetation.
ATSL (1)	Acacia Tall Sparse Shrubland to Open Shrubland	2.21	10.05	**Vegetation Type:** Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa* and *A. aulocophylla* with a Sparse Mixed Shrubland of *Thryptomene costata, Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Philotheca brucei* subsp. *brucei.*	**Associated Species:** *Aluta aspera subsp. Hesperia, Alyxia buxifolia, Calytrix uncinate, Dodonaea viscosa subsp. Mucronate, Eeremophila exilifolia, E. latrobei subsp. latrobei, Petrophile vana* (P1), *Philotheca sericea, Stylidium .longibracteatum*
				Habitat: Hill slopes and crests with a surface layer of laterite and BIF rocks and boulders.	**Vegetation Condition:** Excellent; exploration activities.
ATSL (2)	Acacia Tall Sparse Shrubland to Open Shrubland	13.55	61.77	**Vegetation Type:** Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa, A. effusifolia* and/or *A. caesaneura* (narrow phyllode variant) with a mixed Open Shrubland mainly of *Eremophila forrestii* subsp. *forrestii, E. latrobei* subsp. *latrobei* and *Philotheca sericea* and Isolated Low Trees of *Acaia caesaneura* (narrow phyllode variant).	**Associated Species:** *Acacia exocarpoides, Eremophila clarkei, Philotheca brucei* subsp. *brucei, Ptilotus obovatus, P. schartzii, Sid asp*. Golden calyces glabrous (H.N. Foote 32), *Thryptomene decussata.*
				Habitat: Hill slopes, crests and outcropping with a surface layer of ironstone and/or BIF gravel, rocks and boulders.	**Vegetation Condition:** Excellent; exploration and pastoral activities, grazing, animal tracks -trampled vegetation.
ATSL (3)	Acacia Tall Sparse Shrubland	12.51	57.01	**Vegetation Type:** Mixed Acacia Tall Sparse Shrubland mainly of *Acacia grasbyi, A. umbraculiformis* and *A. ramulosa* var. *ramulosa* with a mixed Sparse Low Shrubland mainly of *Eremophila punica, Philotheca brucei* subsp. *brucei* and *Ptilotus obovatus.*	**Associated Species:** *Acacia caesaneura* (narrow phyllode variant), *A. speckii* (P4), *Aluta aspera* subsp. *hesperia, Eremophila compacta, E. latrobei* subsp. *latrobei, Grevillea pityophylla, Mirbelia* sp. Bursarioides (T.R. Lally 760), *Ptilotus obovatus, P. schwartzii, Thryptomene costata, T. decussata.*
				Habitat: Stony plains, hill slopes and minor depressions with a surface layer of weathered ironstone and laterite gravel and occasionally with granite surface plates and rocks.	**Vegetation Condition:** Excellent to Very Good; tracks, exploration activities and weeds.
ATSL (4)	Acacia Tall Open Shrubland	3.9	17.79	**Vegetation Type:** Mixed Acacia Tall Open Shrubland mainly of *Acacia ramulosa* var. *ramulosa, A. caesaneura* and *A. umbraculiformis* with a mixed Open Shrubland mainly of *Thryptomene costata, Aluta aspera* subsp. *hersperia* and *Eremophila forrestii* subsp. *forrestii.*	**Associated Species:** *Acacia caesaneura* (narrow phyllode variant), *A speckii* (P4)*, Eremophila latrobei* subsp. *latrobei, Mirbelia* sp. Bursarioides (T.R. Lally 760), *Philotheca brucei* subsp. *brucei, P. sericea, Thryptomene decussata*.
				Habitat: Hill slopes with a surface layer of BIF and ironstone stones	**Vegetation Condition:** Very good; exploration and mining activities and grazing.
MTSL (1)	Mixed Tall Open Shrubland	18.38	83.74	**Vegetation Type:** Mixed Tall Open Shrubland mainly of *Acacia burkittii, A. ramulosa* var. *ramulosa* and *Hakea recurve* subsp. *arida* with Isolated mixed Low	**Associated Species:**

Code	Broad floristic formation	Coverage of survey area (%)	Area (ha)	Vegetation type and associated information	
				Shrubs mainly of *Solanum lasiophyllum, Maireana villosa* and *Ptilotus obovatus*.	*Acacia tetragonaphylla, Eremophila eriocalyx, Eremophila granitica, Hakea recurve* subsp. *arida, Maireana carnosa, Petrophile vana* (P1), *Solanum lasiophyllum, Vincetoxicum lineare.*
				Habitat: Hardpan plains and broad drainage flats with a surface layer of ironstone gravel.	**Vegetation Condition:** Very Good; grazing, exploration and mining activities, animal tracks – trampled vegetation.
MTSL (2)	Mixed Tall Open Shrubland	41.25	188	**Vegetation Type:** Tall Open mixed Shrubland mainly of *Acacia ramulosa* var. *ramulosa, Acacia sibina* and *Grevillea obliquistigma* subsp. *obliquistigma* with a mixed Open Shrubland mainly of *Acacia exocarpoides, Eremophila forrestii* subsp. *forrestii* and *Aluto aspera* subsp. *hesperia.*	**Associated Species:** *Acacia caesaneura* (narrow phyllode variant), *A. effusifolia, A. tetragonophylla, A. speckii* (P4), *Eremophila latrobei* subsp. *latrobei, Monachather paradoxus, Ptilotus obovatus, Solanum lasiophyllum.*
				Habitat: Hill slopes with a surface layer of laterite gravel.	**Vegetation Condition:** Excellent to Very Good; exploration and pastoral activities and grazing.

Groundwater Dependent Vegetation

No GDV identified by national assessment occurs in the DE. No large drainage lines or wetlands, which could indicate the potential for GDV, are present within the surveyed area (Maia, 2022).

Vegetation of Conservation Significance

The DE is not in or close to a federally listed TEC. No TECs protected by the BC Act are listed for the Yalgoo bioregion (Maia, 2022).

Approximately 58% (108.96 ha) of the 187.7 ha DE falls within the Minjar and Chulaar Hills vegetation complexes (banded ironstone formation) P1 PEC. The PEC area includes sections of the land systems it relates to as well as a buffer around those land systems. This buffer is on average 500 m wide. It is estimated that 30% of the DE is over what is likely to be the actual PEC and 25% is over its buffer (Maia, 2022). An estimated 108.96 ha of the PEC falls within the proposed DE, with 75.9% of the proposed area to be cleared (143.5 ha) mapped as the P1 PEC.

The Minjar and Chulaar Hills P1 PEC is mapped over approximately 25,154 ha, comprising of 7,909 ha of the Tallering LS, 523 ha of the Violet LS and 2,270 ha of the Watson LS (Maia, 2022). All the seven vegetation types mapped within the survey area either wholly or partially fall within the boundaries of the Minjar and Chulaar Hills P1 PEC (Maia, 2022).

The proposed clearing of 143.5 ha will result in the removal of the 108.96 ha of the PEC that falls within the DE. This comprises 0.43% of the total mapped PEC.

3.2.2. Flora Assessment

A record of 117 taxa was obtained in the DE, 32% were annual species and the remaining 68% were perennial (Maia, 2022). The number of taxa recorded was similar to data obtained from earlier surveys of surrounding areas (based on area surveyed) (Maia, 2022). No inconsistencies with the recorded floristic composition of the area with the Yalgoo bioregion were noted. Figure 3-3 maps the priority flora identified during the field survey.

Threatened Flora

No threatened flora protected by the EPBC Act or the BC Act were located in the DE (Maia, 2022).

Priority Flora

Two priority flora species were recorded in the DE – *Petrophile vana* (P1) and *Acacia speckii* (P4). *Petrophile vana* was recorded at two locations and *Acacia speckii* at 68 (Maia, 2022). *Petrophile vana* had not been recorded in the 2020 survey of the proposed TSF4 DE conducted by Maia, nor in any earlier flora surveys conducted by other consultants across the Golden Grove Mine. *Acacia speckii* was noted in the 2020 Maia survey.

Acacia speckii has been recorded extensively in, around and north of the DE in previous flora surveys and the 2021 survey by Maia recorded 86 plants (Maia, 2022). From available records, it is estimated that here are 122 discrete populations of *A. speckii* within WA, with one population occurring within the survey area. If the entire DE were to be cleared, the impact to the total known populations would be less than 0.82% (Maia, 2022)

At the time of the 2021 survey, there were only five *Petrophile vana* records listed in FloraBase, and these are in the Murchison and Yalgoo bioregions (Maia, 2022). It was estimated from current records, that there are currently 179 *P. vana* plants in WA and 13 populations (Maia, 2022). Using this data, clearing of the entire DE would result in a <1.1% impact to individual *P. vana* plants and a <15% impact to populations (Maia, 2022).

Following provision of this information, the Proponent commissioned a second, targeted flora survey for *Petrophile vana* in December 2022. The survey was conducted within the proposed TSF4 infrastructure footprint and outside this footprint around the *P. vana* locations identified in the 2021 survey (Maia, 2023). 99 new *P. vana* plants were recorded at four locations, two within the TS4 DE and two outside. 97 of the *P.* vana individuals occur in the western most corner of the TSF DE (Maia, 2023). It is highly likely that further surveys in suitable habitat in the surrounding area will result in more plants being located (Maia, 2023).

Weeds

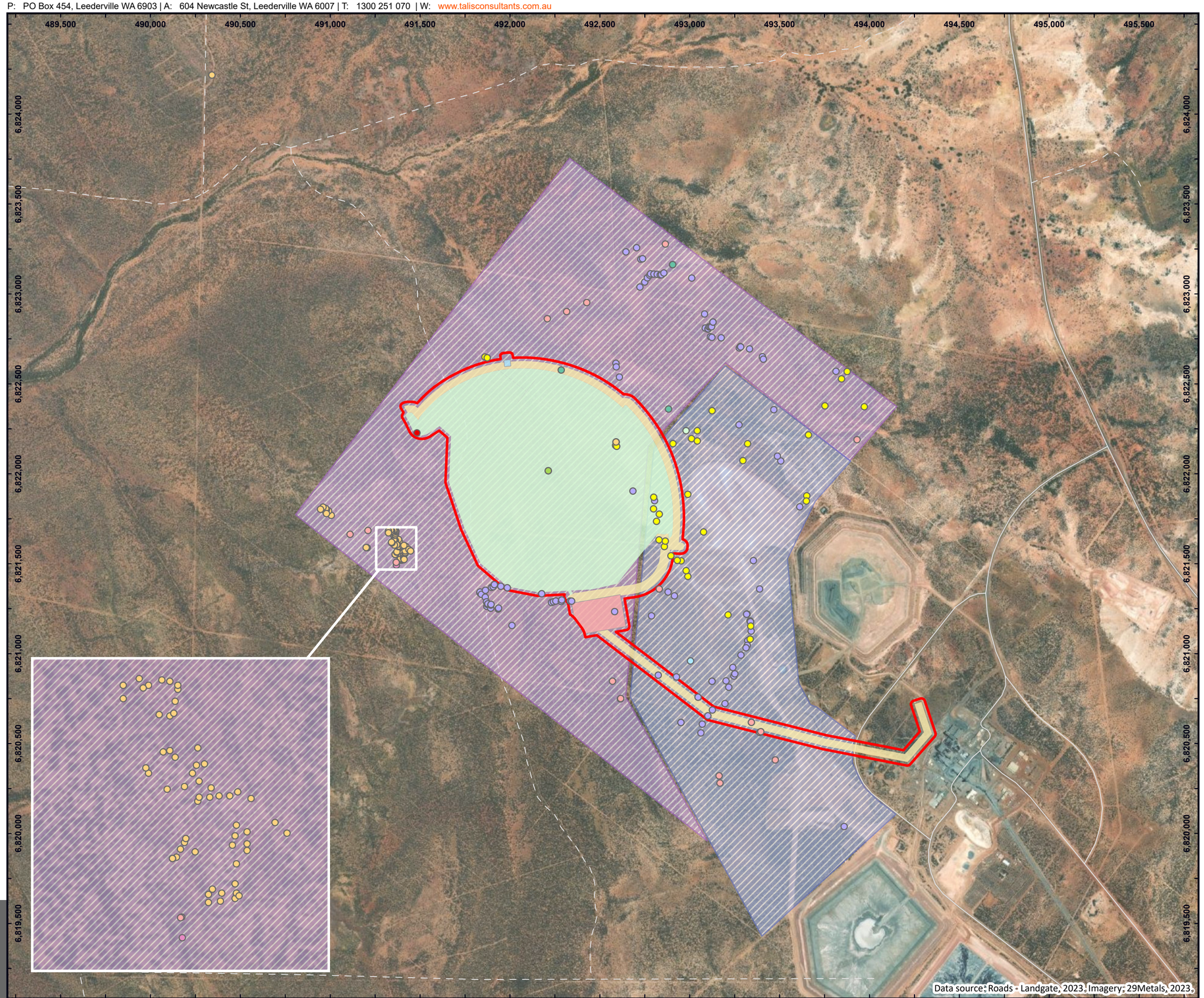
No weeds on any of the national weed's lists were recorded in the DE and no plant species declared as pests in WA were recorded in the survey area (Maia, 2022).

Six environmental weed species were recorded in the DE:

- *Aira caryophyllea;*
- *Cusuta epithymum;*
- *Hypochaeris glabra;*
- *Mesembryanthemum nodiflorum;*
- *Pentameris airoides;* and
- *Sonchus oleraceus.*

All are noted as having rapid invasiveness, with *Aira caryophyllea* and *Mesembryanthemum nodiflorum* rated as having high ecological impact as well as rapid invasiveness (Maia, 2022).

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au



LEGEND

- Development Envelope

Proposed Disturbance

- Seepage Collection Pond
- TSF4
- Transport & Infrastructure Corridor
- Thickener Plant

Flora Surveys

- Acacia speckii
- Brachychiton gregorii
- Cleretum papulosum subsp. papulosum
- Mesembryanthemum nodiflorum
- Santalum spicatum
- Aira caryophyllea
- Cuscuta epithymum
- Hypochaeris glabra
- Pentameris airoides
- Petrophile vana
- Sonchus oleraceus

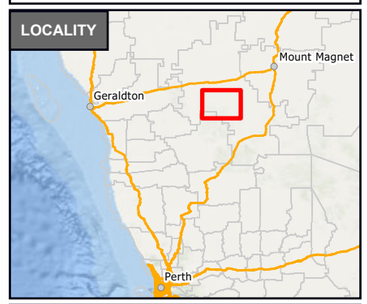
Survey Areas

- Maia Survey (2020)
- Maia Survey (2021 & 2022)

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

FLORA SURVEYS

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N

0 200 400 600 800 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:20,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 3-3

Data source: Roads - Landgate, 2023. Imagery: 29Metals, 2023.

4. Terrestrial Fauna Assessment

The most recent fauna survey for the DE is by Pheonix Environmental Sciences (2022). Pheonix also conducted a fauna survey of the DE in 2021. The following assessment is based on Pheonix's 2022 survey, with the 2021 survey used for comparison and validation of the species diversity.

4.1. Desktop Assessment

Searches of several biological databases were undertaken to identify and prepare lists of significant fauna that may occur within the DE. A literature search was also conducted for reports on biological surveys conducted within 40 km of the DE to build on the lists developed from database searches (Pheonix, 2022).

4.1.1. Vertebrate Fauna

The desktop review identified records of 253 vertebrate taxa – 7 frogs, 52 reptiles, 170 birds and 24 mammals (Phoenix, 2022). Twenty significant vertebrate species were identified as potentially occurring within the DE, seven of which are listed as Threatened, Conservation Dependent or Specially Protected under the EPBC Act and/or BC Act. Eight avifauna species are listed as Migratory under the EPBC and BC Act and three species are listed as Priority by the DBCA (Phoenix, 2022). A full list of the significant species and their conservation status is detailed in Table 4-1.

Table 4-1: Likelihood of occurrence for significant vertebrate fauna identified in the desktop review

Species	Common Name	Likelihood of occurrence	Conservation status		
			EPBC Act	BC Act	DBCA List
Reptiles					
Cyclodomorphus branchialis	Gilled Slender Bluetongue skink	Possible	-	VU	-
Egernia stokesii badia	Western Spiny-tailed Skink	Unlikely	EN/VU	EN/VU	-
Birds					
Actitis hypoleucos	Common sandpiper	Recorded	MIG	MIG	-
Apus pacificus	Fork-tailed Swift	Unlikely	MIG	MIG	-
Calidris acuminata	Sharp-tailed Sandpiper	Possible	CR/MIG	CR	-
Calidris ferruginea	Curlew Sandpiper	Unlikely	CR/MIG	CR	-
Calidris melanotos	Pectoral Sandpiper	Possible	MIG	MIG	-
Falco peregrinus	Peregrine Falcon	Unlikely	-	OS	-
Gelochelidon nilotica	Gull-billed Tern	Unlikely	-	MIG	-

Species	Common Name	Likelihood of occurrence	Conservation status		
			EPBC Act	BC Act	DBCA List
Ixobrychus dubius	Australian Little Bittern	Unlikely	-	-	P4
Leipoa ocellata	Malleefowl	Unlikely	VU	VU	-
Motacilla cinerea	Grey Wagtail	Unlikely	MIG	MIG	-
Oxyura australis	Blue-billed Duck	Unlikely	-	-	P4
Pezoporus occidentalis	Night Parrot	Unlikely	EN/CR	EN/CR	-
Rostratula australis	Australian Painted Snipe	Unlikely	EN	EN	-
Thinornis rubricollis	Hooded Plover	Unlikely	-	-	P4
Tringa nebularia	Common Greenshank	Unlikely	MIG	MIG	-
Tyto novaehollandiae subsp. Novaehollandiae	Masked Owl (southwest)	Unlikely	-	-	P3
Mammals					
Dasyurus geoffroii	Chuditch	Unlikely	-	-	P3
Bettongia leseur graii	Boodie	Unlikely	EX	EX	-
Notamacropus Irma	Western Brush Wallaby	Unlikely	-	-	P4
Leporillus apicalis	Lesser Stick-nest Rat	Unlikely	EX	EX	-

Note: MIG = Migratory, EX = Extinct, CR = Critically endangered, EN = Endangered, VU = Vulnerable

4.1.2. Short Range Endemic (SRE) Invertebrate Fauna

The desktop review identified records of 63 potential SRE taxa, with no records of SRE species having been previously recorded within the DE (Phoenix, 2022). These records confirm the results of the desktop review for SREs completed by Phoenix in 2021.

Of the 63 potential SRE taxa, only seven are named species. The remaining 56 comprise taxa named to morphospecies codes as applied by the WA Museum or are not identified to confirmed species level (i.e. “sp.” or “cf.”) (Phoenix, 2022). The results are dominated by trap-door spiders (39 taxa) and Millipedes (10 taxa) and the majority of sourced records are from SRE surveys of banded iron formations for mining tenements (Phoenix, 2022).

4.2. Field Survey Assessment

Pheonix conducted a terrestrial fauna survey for the DE in November 2021. A total of 12 survey sites were sampled and field methods for the fauna survey included:

- Habitat assessment;
- Active diurnal searches;
- Avifauna surveys;
- Mallefowl habitat assessment;
- SRE invertebrate sampling; and
- Targeted searches for *Idiosoma clypeatum* in suitable habitat.

4.2.1. Habitat Types

Two broad fauna habitat types were identified in the DE:

- Mulga shrublands on hills and plains (MHP); and
- Mulga shrublands on BIF (MBIF).

MHP comprised 91.5% (417 ha) of the study area and MBIF 3.7% (16.9 ha). The remaining portion of the survey area was designated as cleared or otherwise disturbed (4.6%; 21.1 ha) (Phoenix, 2022).

MHP is subdivided further into three habitat types to recognise the variations in topography, soils, and vegetation structures:

- Tall mulga shrublands on gentle hillslopes (MHS; 106.3 ha, 23.3%);
- Mulga shrublands on undulating stony plains (MUP; 242.0 ha; 53.1%); and
- Tall mulga shrublands on laterite plains (MLP; 68.7 ha; 3.7%).

The MHP habitat types are consistent with the adjacent MHP habitat identified in the 2021 Phoenix survey of adjacent areas. No habitat types were considered locally or regionally important (Phoenix, 2022).

All 12 sites were assessed as to whether they were suitable habitat to support Malleefowl, with 6 sites being deemed suitable to support. Five of these sites were located in MLP habitat and one in MUP (Figure 4-1) (Phoenix, 2022).

One habitat was identified within the study area as being potentially suitable habitat for SRE invertebrates – Tall mulga shrubland on low BIF ridgeline.

P: PO Box 454, Leederville WA 6903 | A: 604 Newcastle St, Leederville WA 6007 | T: 1300 251 070 | W: www.talisconsultants.com.au

490,000 490,500 491,000 491,500 492,000 492,500 493,000 493,500 494,000 494,500 495,000 495,500

6,823,500 6,823,000 6,822,500 6,822,000 6,821,500 6,821,000 6,820,500 6,820,000 6,819,500

Site05 Site06 Opp007 Site07 Site07 02 Site10 Site09 03 19 17 Site11 04 16 18 Site12 08 Mound002 Site02 05 Site02 Opp002 Site04 Site03 06 07 23 Mound001 Site08 Site08 09 Opp003 24 Site01 Site01 13 MFchick 01 Opp001 15 Site01 25 14 21 22 20

Site08 Site08

Opp005 Opp006 Mound001 Opp004

Data source: Roads - Landgate, 2023. Imagery: ESRI, 2023.

LEGEND

- Development Envelope
- Survey Area (Pheonix 2021)

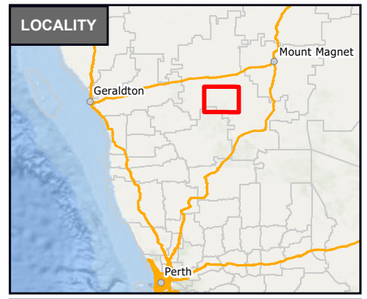
Proposed Disturbance

- Seepage Collection Pond
- TSF4
- Transport & Infrastructure Corridor
- Thickener Plant

Western Australian Roads

- Minor Road
- Other

LOCALITY



0 100 200 300 400 500 km

FAUNA SURVEY AREA

Golden Grove Approvals
LOM TSF4 NVCP

29Metals

N 0 200 400 600 m

Coordinate System: GDA2020 MGA Zone 50
Scale @ A3: 1:18,000

Prepared:	E Jackson	Date:	1/12/2023
Reviewed:	J Ritschny	Revision:	A
Project:	TE23057		

talis consultants

29 Metals Golden Grove

Figure 4-1

4.2.2. Recorded Species

A total of 38 terrestrial vertebrate species representing 29 families and 36 genera were recorded in the DE during the field surveys. Of the 38 species, 37 were native and one was an introduced species (Pheonix, 2022). The recorded species by Group are as follows:

- Amphibians: 0;
- Reptiles: 5;
- Birds: 28; and
- Mammals: 5 (including 1 introduced).

4.2.3. Conservation Significant Species

One Threatened fauna species was recorded in the survey area, as well as further evidence of historical and recent presence of the species. A Malleefowl chick, listed as Vulnerable under EPBC and BC Acts was sighted on two occasions at one of the 12 survey sites. This survey site was not within the proposed DE. Three old, severely degraded Malleefowl mounds were recorded within the survey area, as well as one track sequence. None of the mounds or the track sequence were within the proposed DE.

Malleefowl chicks are known to disperse great distances after emerging from the nest mound. There are no active mounds within the study area, but there are several known active mounds within 1-2 km from which it is likely the chick has dispersed (Phoenix, 2022). The tracks indicate that adult birds may use the area for foraging (Phoenix, 2022). It is noted that it is unlikely that the small portion of MBR within the study area contains specific value to Malleefowl, and that the local population has dispersed to more suitable nesting habitat outside the DE in response to disturbance from proximal mining activities (Phoenix, 2022).

No SRE specimen were recorded in the DE and targeted searches for *Idiosoma clypeatum* did not reveal any burrows of the species (Phoenix, 2022).

5. Environmental Management Measures

5.1. Avoid

The TSF4 design minimises the clearing of the P1 flora *Petrophile vana* identified within the development envelope and the Mine layout has been designed to avoid all Malleefowl mounds. Further, the Proponent has committed to only undertake clearing activities where it is absolutely necessary for the operations and/or progression of the Project.

5.2. Mitigation

The Proponent has developed plans and procedures which outline environmental management measures that minimise impacts of clearing but still allow for safe and productive operations on site. These documents include, but are not limited to:

- Land and Biodiversity Management Plan;
- Malleefowl Management Plan; and
- Land Clearing and Rehabilitation Procedure.

Details on key management measures committed to by the Proponent are outlined further in the subsections below.

5.2.1. Fauna

Key management measures relating to fauna have been identified for the Project through relevant risk assessments. The primary concern within the Project area is the presence of Malleefowl and the mitigation of any impacts to the species and their habitat. Measures to be implemented during the clearing process are outlined below (not exhaustive):

- Conduct pre-clearing fauna surveys to no Malleefowl or mounds are present;
- Speed limits during operations and construction to reduce incidence of fauna strikes;
- A spotter is to be present during clearing to look out for signs of Malleefowl; and
- Implement the Malleefowl Management Plan.

5.2.2. Flora

Key management measures relating to flora and native vegetation have been identified for the Project through relevant risk assessments. The primary concern within the Project area is the presence of a P1 PEC and a few species of Priority flora. Measures to be implemented during the clearing process are outlined below (not exhaustive):

- All clearing activities proposed will be undertaken in accordance with the internal clearing permitting process;
- Clearing will be in accordance with the Golden Grove Land Clearing and Rehabilitation Procedure;
- Areas to be cleared will be pegged and demarcated, then inspected to ensure clearing boundary is within approved areas;
- All personnel working on site will be inducted on the presence of a PEC and priority flora on site and the need to protect these communities/plants;
- Protected flora will be clearly demarcated with signage to prevent incidents;
- No clearing will be conducted during windy conditions to reduce dust deposition on adjacent native vegetation; and
- Induction will address that there is no driving on unauthorised areas and off pre-cleared tracks.

Golden Grove has an Environmental Management System for the Golden Grove Mine, as required by the current *Mining Proposal Statutory Guidelines* (DMIRS, 2020).

5.3. Rehabilitation

The Golden Grove Land Clearing and Rehabilitation Procedure sets out the requirements for rehabilitation works at Golden Grove Mine. As the proposed area to be cleared for this NVCP is to be utilised for a TSF, there is no current plan for the area's rehabilitation. TSF4 is expected to be operational for 11 years, until 2035. Rehabilitation considerations have been at a conceptual level, with detailed rehabilitation and closure requirements for the area addressed in the Mine Closure Plan supporting the LOM TSF4 Mining Proposal submitted to DMIRS on 3 November 2023.

An overview of general management measures that will be implemented to reduce the risk of poor or failed rehabilitation are listed below:

- Removal of approximately top 100 mm of soil as growth medium (topsoil) material and stockpile;
- Topsoil stockpiles will not exceed 2 m in height;
- Where applicable, retain vegetation for reuse;
- Undertake rehabilitation trials;
- Light ripping to break any surface crusting;
- All hardstand areas of compacted soils will be deep ripped; and
- Undertake progressive rehabilitation of disturbed areas where practicable.

6. Assessment Against the Ten Clearing Principles

The proposed clearing activities have been assessed against the ten clearing principles as defined in the Department of Environment Regulation (DER) Guide to Assessment: Clearing of Native Vegetation under the EP Act, considering the current extent and condition of the native vegetation on the site. This assessment is presented in Table 6-1.

Table 6-1: Assessment Against the Ten Clearing Principles

Principle	Assessment
Principle (a) – Native vegetation should not be cleared if it comprises a high level of biological diversity.	**Assessed Outcome:** Within the clearing area there are no threatened flora or threatened ecological communities. There are several priority flora populations and part of the proposed clearing area intersects a P1 PEC. The priority flora identified are locally common, with the TSF4 design stage not predicted to impact the identified populations. Approximately 0.5% of the P1 PEC will be impacted by the proposed clearing works, with a portion of this comprising the 500 m buffer for the community, rather than the PEC itself. The proposed clearing area of up to 143.5 ha is not considered to comprise a high level of biological diversity according to field work conducted by Maia (Maia, 2021, 2022, b). Therefore, the proposed clearing is unlikely to be at variance with this Principle. Refer to Section 3 and Section 4 for further detail.
Principle (b) – Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to Western Australia.	**Assessed Outcome:** Based on the gathered information (Section 4), none of the identified species in the proposed clearing area are considered solely dependent on any of the terrestrial habitat types identified. Disturbance within the proposed clearing area is unlikely to significantly impact any of the species listed due to the presence of similar habitat within the vicinity of the area. The DE is not considered necessary for the maintenance of a significant habitat for fauna indigenous to Western Australia and therefore the proposed clearing of up to 143.5 ha is unlikely to be at variance with this Principle.
Principle (c) – Native vegetation should not be cleared if it includes, or is necessary for the continued existence of rare flora.	**Assessed Outcome:** No Threatened Flora were identified by Maia during surveys in 2021 and 2022 (Maia, 2021, 2022, 2023). No Threatened flora were considered likely to be present. Two priority flora species were identified during surveys: *Petrophile vana* (P1) and *Acacia speckii* (P4) (Maia, 2022). *Acacia speckii* has been recorded extensively in, around, and north of the current survey area in previous flora surveys. It is estimated that there are 122 discrete populations in WA, with one population occurring within the survey area (Maia, 2022). A targeted flora survey identified 99 *Petrophile vana* plants within the survey area. It is estimated from current records that clearing of the entire survey area would result in a 1.1% impact to individual *P. vana* plants.

Principle	Assessment
	Furthermore, 97 of the 99 identified *P. vana* plants occur in the western corner of the survey area which will not be impacted during the design stage of the TSF (Maia, 2023). Given the abundance of the priority species in the local area and the limited impact clearing of the proposed area will have on their total known distributions, the proposed clearing of up to 143.5 ha is unlikely to be at variance with this principle.
Principle (d) – Native vegetation should not be cleared if it comprises the whole or a part of or is necessary for the maintenance of a Threatened Ecological Community (TEC).	**Assessed Outcome:** No Threatened Ecological Communities were identified by Maia during the commissioned studies (2021, 2022). The Minjar and Chulaar Hills P1 PEC was identified within the survey area, with the PEC intersecting approximately 55% of the area surveyed. The proposed clearing of 143.5 ha will only remove 0.43% (108.96 ha) of the total area mapped for the PEC (25,154 ha). Further, the PEC polygon includes sections of the land systems it relates to as well as a buffer around those land systems. It is estimated that of the 55% of the PEC within the survey area, 30% is the actual PEC and 25% is over its buffer. Therefore, of the 0.43% of the PEC proposed to be cleared, a portion of this is likely to be the buffer. Given the minimal clearing of the PEC and no presence of TECs within the proposed clearing footprint, the clearing of up to 143.5 ha is unlikely to be at variance with this principle.
Principle (e) – Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	**Assessed Outcome:** The development envelope is mapped within vegetation associations 202, 361 and 420 which are described as open shrublands. The EPA's Guidance Statement No. 33 has identified a minimum threshold of retention of 30% of pre-European extent of each community (Environmental Protection Authority, 2008). 202, 361 and 420 are well above this threshold, representation of these associations within the shire of Yalgoo are 99.8%, 99.97% and 99.81%, respectively. The percentages of remaining vegetation for vegetation association 202, 361 and 420 are well above the threshold value of 30%, making the proposed clearing unlikely to be at variance with this Principal.
Principle (f) – Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	**Assessed Outcome:** The Project is located in the semi-arid Murchison Region of WA. There are no permanent surface water bodies within the region and the Project is not located within any proclaimed Surface Water Areas. No wetlands of national importance are within or close to the DE or within the Shire of Yalgoo. No other wetlands occur in or close to the DE and no watercourses intersect the DE. It is therefore unlikely that the clearing of up to 143.5 ha is at variance with this Principle.
Principle (g) – Native vegetation should not be cleared if the clearing of the	**Assessed Outcome:** The (then) DER has defined land degradation as including the following (Department of Environment Regulation, 2014): • The clearing of vegetation;

Principle	Assessment
vegetation is likely to cause appreciable land degradation.	• Decline in vegetation condition; • Soil erosion and soil acidity (caused by wind and water erosion due to vegetation clearing); • Salinity; or • Waterlogging/flooding. The land use surrounding the Project is mostly undisturbed, except for existing roads, mining landforms and access tracks. While clearing of vegetation for mine site development will directly impact native vegetation, development plans for TSF4 have included measures to minimise and mitigate impacts to surface water and risk of sedimentation downstream. The works associated with the clearing are unlikely to cause appreciable land degradation that is different or more significant than what has already occurred within the Project tenements and the surrounding area to date. Therefore, the proposed clearing is unlikely to be at variance with this principle.
Principle (h) – Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	**Assessed Outcome:** The Project is not located within any Environmentally Sensitive Areas (ESA) and there are no ESAs located within a 30 km radius of the Site (Department of Water and Environmental Regulation, 2018a). The site is not located within any DBCA Managed Lands (Department of Biodiversity Conservation and Attractions, 2019). The proposed clearing is not likely to have an impact on the environmental values of any adjacent or nearby conservation areas considering where it is located and the proximity of conservation areas. There are no nearby or adjacent conservation areas or ESA's within the nearby vicinity of the proposed clearing, therefore it is unlikely the Proposal is at variance with this Principle.
Principle (i) – Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	**Assessed Outcome:** No permanent surface water features were observed in the survey area. Clearing and/or construction should not impact on drainage or surface water quality, given the lack of surface water structures within the DE and provided sediments are controlled during construction and operation by implementing standard management procedures. Surface water management measures to be implemented have been identified in the LOM TSF4 Mining Proposal. Further, changes to stream flow characteristics, erosion risk, and surface water quality have been identified as being primarily associated with rare 1% AEP events and are not predicted to have significant long-term impacts on the environment (AECOM, 2023). Groundwater drawdown impacts are unlikely to be problematic as no vegetation complexes in the clearing area are considered to be groundwater dependent (Section 3.2.1).

Principle	Assessment
	The proposed clearing is not within a Proclaimed Surface Water Area (PSWA), nor is it likely to affect the quality of surface or groundwater, making it unlikely to be at variance with this Principle.
Principle (j) – Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	**Assessed Outcome:** The surface water assessment by AECOM (2023) did not identify the DE as being within a flood risk area. A diversion channel is proposed to divert surface water away from around the TSF embankments and maintain downstream flows. The incidence of flooding in the DE is not anticipated to be exacerbated by clearing of the vegetation due to the fact that the DE occurs on free draining soils and is relatively flat in terrain. The minor drainage lines that flow through the DE would not carry a high volume of surface water during annual rainfall events (AECOM, 2023). The proposed clearing is unlikely to cause, or exacerbate, the incidence of flooding therefore it is unlikely to be at variance with this principle.

7. Summary of Assessment

The assessment concludes that the clearing of up to 143.5 ha of native vegetation for the construction of the TSF4 for the Golden Grove Mine is not at variance with nine of the Clearing Principles. Where the development envelope intersects with a P1 PEC, the clearing may be at variance with Principle (d). However, this is not considered to be a significant impact as the proposed clearing removes < 1 % of the current mapped extent of the PEC, and a portion of this will include the buffer of the PEC (approximately 500 m wide).

8. References

AECOM, 2023. TSF4 Project Surface Water Assessment. Golden Grove Mine. Oct 2023.

Beard, J.S., 1976. *Vegetation survey of Western Australia [1:1 000 000] vegetation series.*

BoM, 2023. Monthly rainfall. Morawa Airport. Climate data online. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=008296

DCCEEW, 2021. Australia's bioregions IBRA. https://www.dcceew.gov.au/environment/land/nrs/science/ibra/australias-bioregion-framework

DWER, 2022. Surface Water Proclamation Areas. WA.gov.au online. https://www.wa.gov.au/system/files/2022-11/Proclaimed-surface-water-areas-map.pdf

Environmental Protection Authority, 2016. *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessments.*

Maia, 2022. 29 Metals Golden Grove. Tailings Storage Facility 4 (TSF4) Option B Regional Flora and Vegetation Reconnaissance and Targeted Flora Surveys, November 2021. Maia Environmental Consultancy.

Maia, 2023. 29 Metals Golden Grove: *Petrovile vana* Targeted Survey, December 2022. Maia Environmental Consultancy.

Phoenix, 2021. Terrestrial fauna survey for the TSF4 Project. Prepared for EMR Golden Grove Pty Ltd.

Phoenix, 2022. Basic Terrestrial Fauna Survey for the TSF4 Project. Prepared for 29 Metals Pty Ltd. October 2022.

Shephard, D.P., G.R. Beeston and A.J.M Hopkins, 2002. *Native Vegetation in Western Australia: extent, type and status.*

9. Appendices

9.1. Appendix A Flora And Vegetation Survey Report (Maia, 2022)

9.2. Appendix B Targeted Flora Survey Report (Maia, 2023)

9.3. Appendix C Terrestrial Fauna Survey (Phoenix, 2022)

maia
Environmental Consultancy

29 METALS Golden Grove: Tailings Storage Facility 4 (TSF4) Option B Regional Flora and Vegetation Reconnaissance and Targeted Flora Surveys, November 2021




21 February 2022

Version 1

maia.net.au

This document describes the results of combined vegetation and flora reconnaissance and targeted flora surveys carried out by Maia Environmental Consultancy (Maia) at 29 Metals Golden Grove's (29MGG) Tailings Storage Facility 4 (TSF4) Option B Regional project area in early November 2021.

Photographs on front page taken in the TSF4 general area.

Maia Environmental Consultancy Pty Ltd

ABN 25 141 503 184

PO Box 1213

Subiaco WA 6904

Document Prepared By: TR, EK, SH, CC, DF

Document Reviewed By: CC

Document Version: Draft

Document Reference Number: 2121V1

Date: 21 February 2022

Table of Contents

Tables

MAPS

Acronyms and Abbreviations

BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
BIF	Banded iron-formation
BoM	Bureau of Meteorology
CSF	Conservation significant flora
DAWE	Department of Agriculture, Water and Environment (Federal)
DBCA	Department of Biodiversity Conservation and Attractions
DEC	Former Department of Environment and Conservation (current DBCA)
DIWA	Directory of Important Wetlands in Australia
DotE	Former Department of the Environment (current DAWE)
DPaW	Former Department of Parks and Wildlife (current DBCA)
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally sensitive area
ESCAVI	Executive Steering Committee for Australian Vegetation Information
Fl, Fr	Flowering, fruiting
GDA94	Geocentric Datum of Australia, 1994
GDE	Groundwater dependent ecosystem
GoWA	Government of Western Australia
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for Conservation of Nature
LS	Land system
M-t	Medium-term
Maia	Maia Environmental Consultancy Pty Ltd
MGA50	Map Grid of Australia zone 50
MVT	Maia Vegetation Type
NVE	Native vegetation extent
NVIS	National Vegetation Information System
OppColl	Opportunistic collection
P (1-4)	Priority (1 to 4) flora species
PEC	Priority ecological community
PMST	Protected Matters Search Tool
sp.	Species -single
spp.	Species - multiple
subsp.	Subspecies

Survey Area	Tailings Storage Facility 4 (TSF4) Option B Regional
T	Threatened flora species
TEC	Threatened ecological community
TPFL	Threatened and Priority Flora database
TSF	Tailings storage facility
VA	Vegetation association
var.	Variety
VSA	Vegetation system association
WA	Western Australia
WAH / WA Herb	Western Australian Herbarium
WAOL	Western Australian Organism List
WEC	Woodman Environmental Consultiing
WoNS	Weed of National Significance
*****	After species indicates a weed species
?	Queried / unconfirmed genus or species
29MGG	29 Metals Golden Grove

Summary

Background and Methods

- 29 Metals Golden Grove (29MGG) plans to extend its tailings storage facility (TSF) to a new area, area 4 (TSF4) Option B Regional. The 29MGG project area is in the Shire of Yalgoo, in the Mid-West Region of Western Australia (WA). Maia Environmental Consultancy Pty Ltd (Maia) was engaged by 29MGG to carry out a combined reconnaissance and targeted flora survey over the proposed TSF4 Option B Regional area i.e., the Survey Area, which is approximately 50 km south south-east of Yalgoo and covers 455.72 ha.
- A desktop assessment was carried out before the survey, and the combined reconnaissance and targeted flora survey was carried out in late November 2021 (spring).

Desktop Study Results

- The closest Threatened flora species record for a species listed under the *Biodiversity Conservation Act 2016* (BC Act) is approximately 2.5 km to the east of the Survey Area – *Stylidium scintillans* (Vulnerable). None of the other threatened flora species listed in the search results have been found in the Golden Grove area previously. *Acacia speckii* (Priority (P) Four) has been located previously in the Survey Area and surrounds.
- No weeds on any of the national weed lists have been recorded in the area previously. Twenty-two general weed species have been recorded in the search area and 17 of them have records in 29MGG's project area.
- The Survey Area does not lie in an area indicated as a threatened ecological community (TEC). Approximately 55% of the Survey Area lies within the boundaries of a polygon mapped as the 'Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)' P1 priority ecological community (PEC).
- The Survey Area does not lie in a Schedule One area, in DBCA Lands of Interest or DBCA Legislated Lands and Waters. No environmentally sensitive area (ESA) occurs within the Survey Area and neither do any significant water bodies or wetlands. No groundwater dependent ecosystems are thought to occur in the local or wider area (based on a national assessment).
- The remaining Yalgoo extent of the two land systems (LS) and three vegetation system associations (VSA) in the Survey Area is more than 97%. The remaining extent in the Survey Area is more than 92%.

Survey Results - Flora

- One hundred and seventeen (117) taxa from 67 genera and 29 families were recorded in the Survey Area (68% perennial and 32% annual). The flora of the Survey Area is typical of the area and the habitats assessed, and species richness is similar to that recorded previously in the Survey Area and surrounds.
- No threatened flora species protected by the federal (*Environment Protection and Biodiversity Conservation Act 1999)* EPBC Act, or the WA BC Act were located in the Survey Area. Two priority flora species were recorded in the Survey Area – *Petrophile vana* (P1; two plants) and *Acacia speckii*(P4; 86 plants).
- No regional endemic species, range extension species or novel species were located in the Survey Area.
- No nationally or WA listed weed species were located in the Survey Area; however, six general weed species were recorded: *Aira caryophyllea (*Silvery Hairgrass), *Cuscuta epithymum* (Lesser Dodder), *Hypochaeris glabra* (Smooth Catsear), *Mesembryanthemum nodiflorum* (Slender Iceplant), *Pentameris airoides* (False Hairgrass) and *Sonchus oleraceus* (Common Sowthistle).

Survey Results - Vegetation

- Seven vegetation types were mapped over the Survey Area: one, Acacia low woodland, two Acacia tall sparse to open shrublands, one Acacia tall sparse shrubland, one Acacia tall open shrubland and two mixed tall open shrublands.
- The dominant vegetation type mapped over the Survey Area was MTSL (2) (Mixed Tall Open Shrubland, mapped over 41% of the Survey Area on hill slopes with a surface layer of laterite). The least extensive were ALWL (Acacia Low Woodland, mapped over 2% of the Survey Area on BIF ridges and outcrops), ATSL (1) (Acacia Tall Sparse Shrubland to Open Shrubland, mapped over 2% of the Survey Area on hill slopes and crests with laterite and banded iron formation (BIF) rocks and boulders), and ATSL (4) (Acacia Tall Open Shrubland, mapped over 4% of the Survey Area on hillslopes with surface of BIF and ironstone stones).

- Vegetation condition in the Survey Area was mapped as Excellent (18%), Excellent to Very Good (54%), Very Good (22%), and Degraded to Completely Degraded (6%).

Ecological Communities and Sheet Flow Dependent Vegetation

- The occurrences of the 'Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)' P1 PEC adjacent to and to the south of the Survey Area are associated (mostly) with areas mapped as the Tallering and Watson land systems (LS). The PEC polygons placed around these LS also include a buffer. About 30% of the Survey Area lies over Tallering and Watson LS polygons and 25% over the PEC buffer (the Violet LS).
- Some of the mulga vegetation on the undulating and gently inclined lower plains of the Violet LS could depend on sheet flow of water across the hardpan plains.

Conservation Significance

- Two priority flora species were recorded in the Survey Area – *Petrophile vana* (P1) and *Acacia speckii*(P4).
- *Petrophile vana* (P1) was recorded in two vegetation types - ATSL (1) and MTSL (1) - and *Acacia speckii* (P4) was recorded in four - ATSL (3), ATSL (4), MTSL (1) and MTSL (2). Many *A. speckii* have been recorded outside the Survey Area on 29MGG tenements and beyond, and Maia knows of 122 populations of this species in WA; one population occurs in and around the Survey Area. This is the first time that *Petrophile vana* has been recorded in the Golden Grove project area and the closest record is 36 km to the east. Maia knows of only 13 populations of *Petrophile vana* in WA, and two of the 13 are in the Survey Area.
- Very small sections of the Survey Area were mapped as ALWL (2% of it), ATSL (1) (2% of it) and ATSL (4) (4% of it). While small areas of ATSL (1) and ATSL (4) were mapped in an adjacent TSF4 area surveyed in 2020, ALWL was not mapped in that area, and neither was it mapped in other areas to the east. All of ALWL, some of ATSL (1), ATSL (2) and ATSL (4) are mapped within the boundaries of the Tallering LS section of the PEC, while the remainder of ATSL (1), and much of the remaining areas of ATSL (2) and ATSL (4) are mapped mostly within the boundaries of the Watson LS within the PEC polygon. Therefore, these vegetation types, plus MTSL (1) in which the P1 *Petrophile vana* was found, are viewed as locally more significant than the others. While the P4 species *Acacia speckii* occurs in other vegetation types, it is relatively common in the local and regional area.
- Based on the similarity of the species occurring in ATSL (1) to the species occurring where the threatened species *Stylidium scintillans* has been located previously in and around the 29MGG project area, ATSL (1) could be potential habitat for *S. scintillans*. However, *S. scintillans* has not been located previously on slopes of BIF hills in the Golden Grove project area, it has been found on lower hills with no outcropping BIF to the east of the main range of hills.

Recommendations

- Impact to the vegetation of the PEC should be avoided, particularly to the vegetation within the Tallering and Watson LS. An approximately 500 m wide buffer is placed around the mapped boundary of these land systems and is included in the PEC polygon. The north-eastern 45% of the Survey Area lies outside of this buffer, and that section of the Survey Area is less significant with respect to the PEC; however, the P1 *Petrophile vana* is in that section.
- Direct impact to the vegetation of the Survey Area should be minimised as much as possible and vegetation clearing boundaries visibly identified before any clearing starts.
- Direct impact to the P1 *Petrophile vana* should be avoided and direct impact to the P4 *Acacia speckii* minimised.
- As *Petrophile vana* is a P1 species and has not been recorded in the Golden Grove area previously (the closest record is 36 km away), a follow-up targeted survey should be carried out to locate any more plants in and around any areas to be impacted. All plants located should be buffered to prevent direct impact to them.
- 29M should employ good weed management practices to prevent the introduction of new weeds or the spread of existing weed species into and away from the selected area.
- Impact to the *Santalum spicatum* (Sandalwood) located in the Survey Area should be avoided whenever possible, as Sandalwood is a valuable resource. Necessary permits should be applied for if it is to be harvested.

29 Metals Golden Grove: Tailings Storage Facility 4 (TSF4) Option B Regional

Flora and Vegetation Reconnaissance and Targeted Flora Surveys, November 2021

1 Introduction

1.1 Scope of Work

29 Metals Golden Grove (29MGG) plans to extend its tailings storage facility (TSF) to a new area, area 4 (TSF4) Option B Regional in the Golden Grove project area (tenements M59/89, M59/90 and M59/3636). The 29MGG project area is in the Shire of Yalgoo in the Mid-West Region of Western Australia (WA).

Maia Environmental Consultancy Pty Ltd (Maia) was engaged by 29MGG to carry out combined flora and vegetation reconnaissance and targeted flora surveys over a polygon within which the new TSF4 area is to be located. The polygon is referred to as the Survey Area in this report and it is shown on **Figure 1**.

This report presents the results of a desktop study carried out before going to site and the results of the field survey; it also presents a brief discussion of the significance of the flora and vegetation of the Survey Area.

1.2 Survey Area Location and Size

The centre of the Survey Area is about 50 kilometres (km) south south-east of the town of Yalgoo and the polygon to be surveyed covers approximately 456 hectares (ha).

2 Background Information

2.1 Bioregional Setting

Information on the bioregion, subregion, geology, land systems, pre-European vegetation, protected and significant areas, watercourses and wetlands and groundwater dependent ecosystems (GDE) is summarised in **Figures 2 to 7**.

Background information on the Survey Area

Figure 1: General location of the Survey Area (within red circle) in the Yalgoo Bioregion

Background information on the Survey Area

The Survey Area is in the Tallering subregion of the Yalgoo IBRA Bioregion (Department of the Environment (DotE) (2012)).

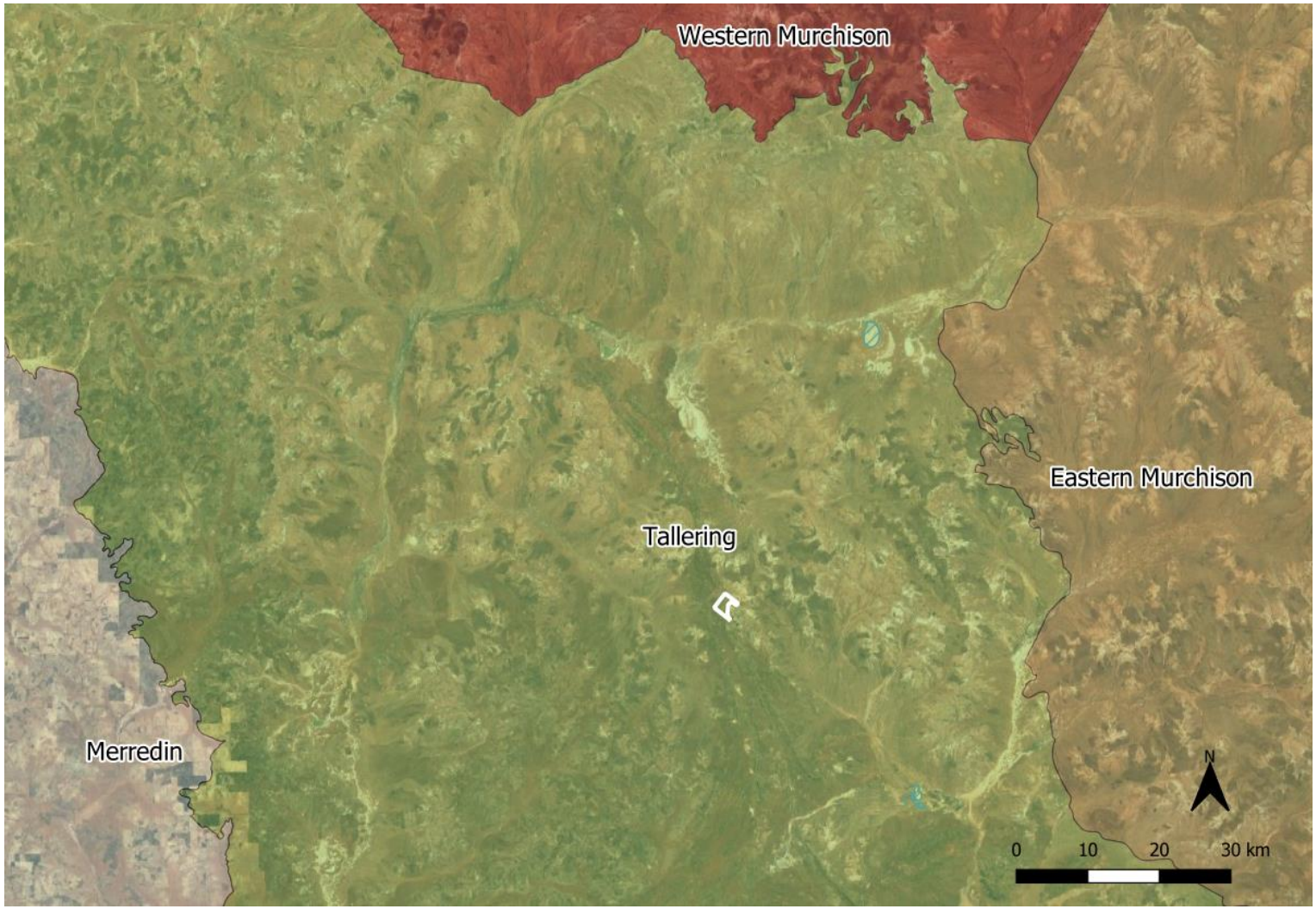
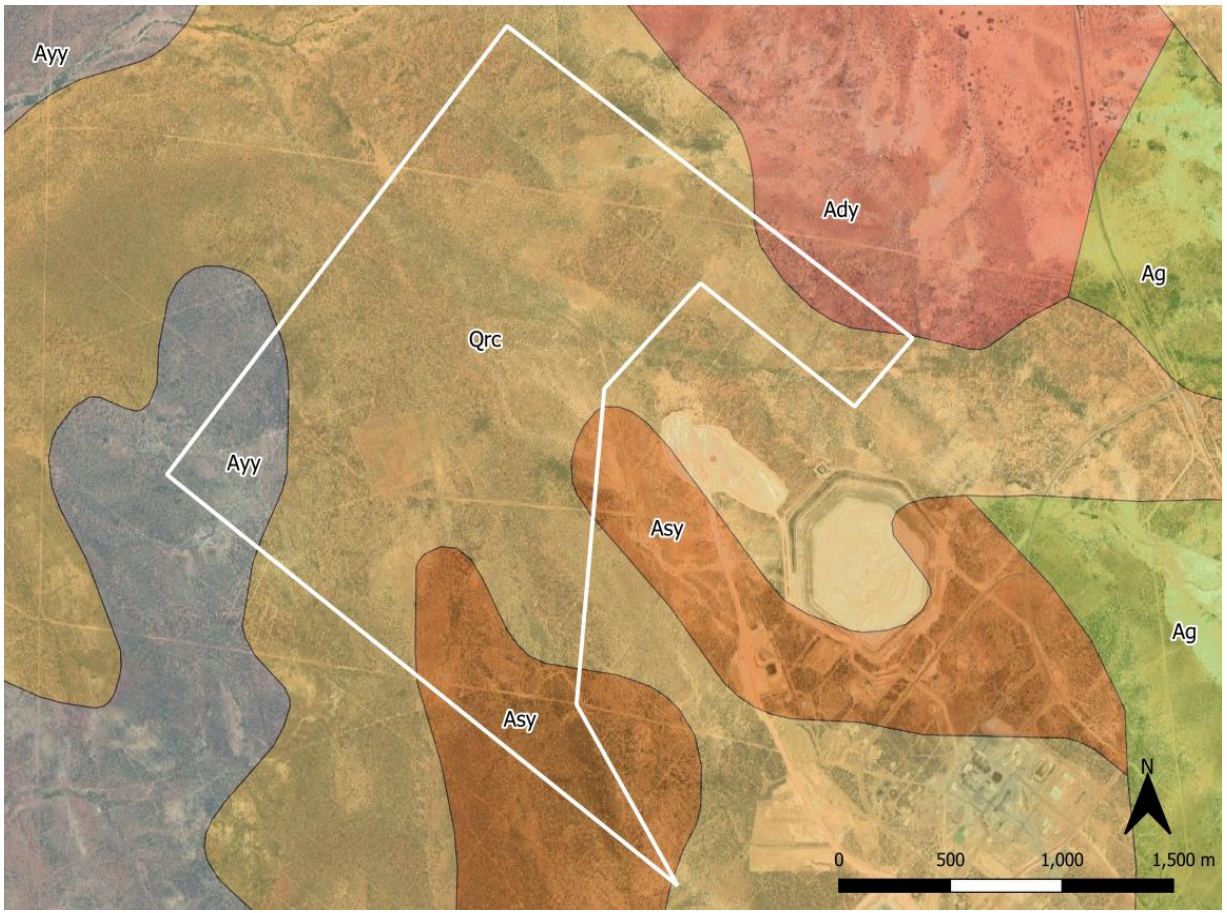


Figure 2: IBRA subregions and the Survey Area

Background information on the Survey Area

Four surface geological units are mapped in the Survey Area, and they are described below right (Stewart et al., 2008).

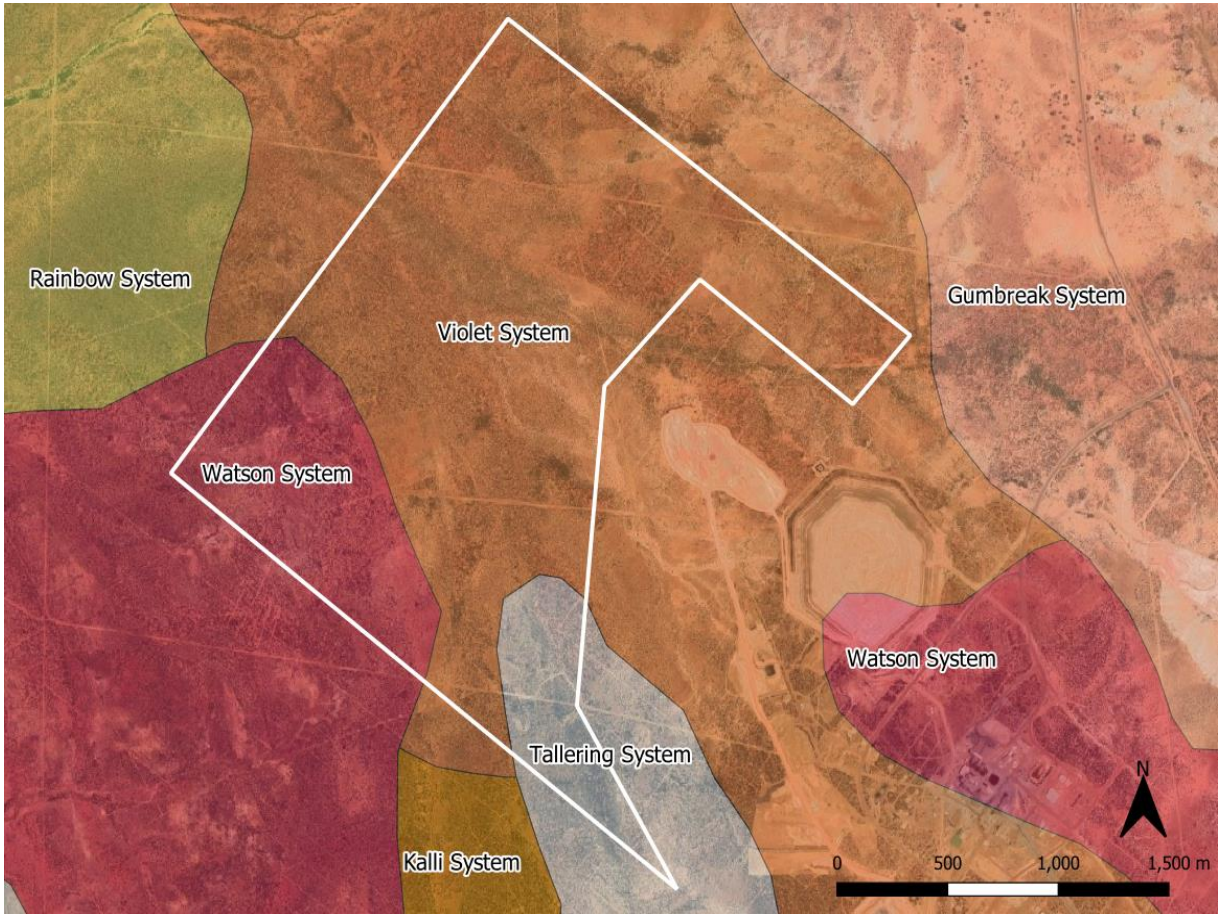


Ady	Mafic intrusive rocks, medium to coarse-gr layered mafic to ultramafic intru metadolerite; medium to coarse-g metagabbro, dolerite and granophyre, ultramafic bases.
Asy	Conglomerate, chert, small amounts volcaniclastic rocks, sandstone, qua siltstone, phyllite, schist, pelite, shale. In former Hatfield Formation.
Ayy	Metasandstone, metashale, metasilt metaconglomerate and meta-volcanicl pelitic schists, phyllite, fuchsitic quartzit clasts quartzite and felsic volcanic quartzite; pelitic and psammitic gneiss.
Qrc	Colluvium, sheetwash, talus; gravel pied and aprons over and around bedrock; cl sand with sheet and nodular kankar; alluvi aeolian sand-silt-gravel in depressions and valleys in Canning Basin; local calcrete, rew laterite.

Figure 3: Surface geology and the Survey Area

Background information on the Survey Area

Three Land systems are mapped in the Survey Area; they are described in the right panel, below (Department of Primary Industries and Rural Development (DPIRD) (2019a))

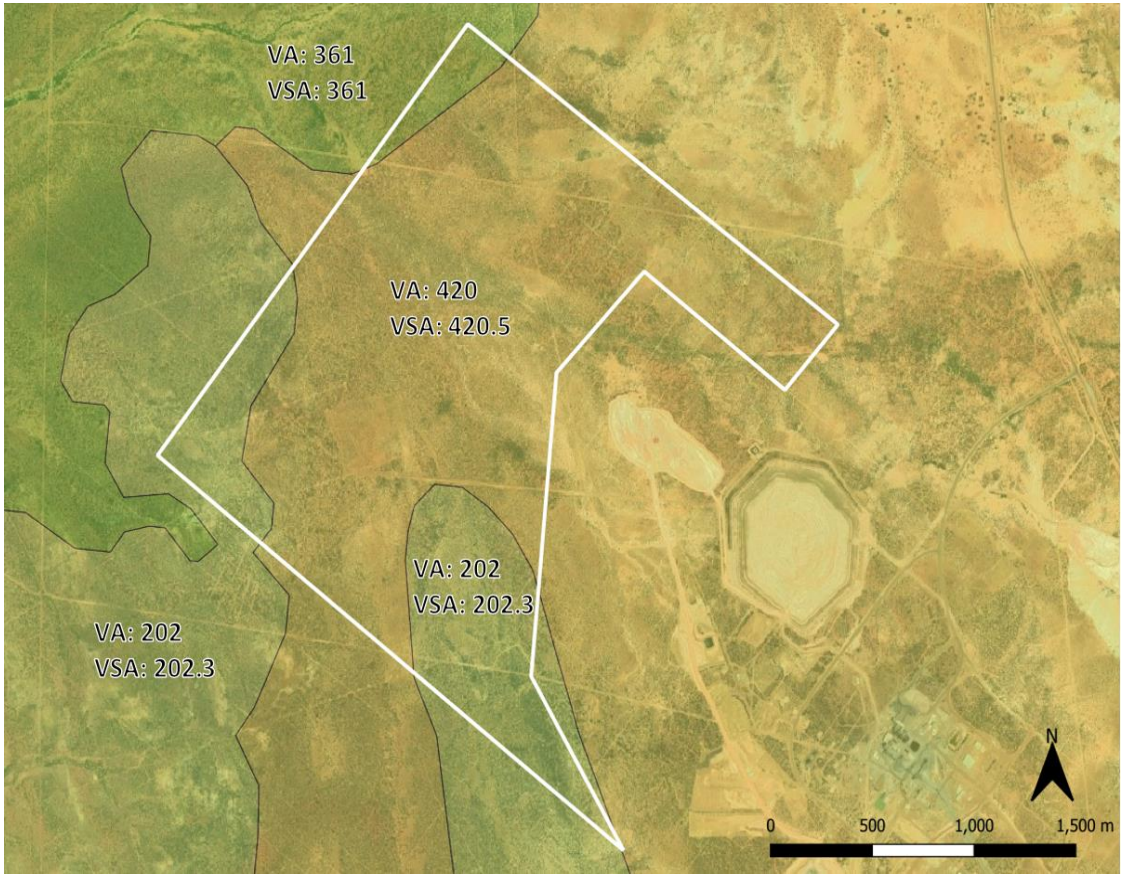


Tallering	Prominent ridges and hills of band ironstone, dolerite and sediment rocks supporting bowgada and oth acacia shrublands.
Violet	Gently undulating gravelly plains greenstone, laterite and hardpan, w low stony rises and minor saline plai supporting groved mulga and bowga shrublands and occasionally chenop shrublands.
Watson	Hills, rises and gravelly plains sedimentary rocks supporting bowga shrublands with non-halophy undershrubs.

Figure 4: Soil-landscape systems and the Survey Area

Background information on the Survey Area

Three of Beard's pre-European vegetation associations (VAs) and vegetation system associations (VSAs) are mapped in the Survey Area - VA 202 and VSA 202.3, VA 361 and VSA 361, and VA 420 and VSA 420.2 (DPIRD, 2019b). The Environmental Protection Authority's (EPA) broad principles for the protection of native terrestrial vegetation and flora indicate that biodiversity should be maintained at sustainable levels. This generally means that ecological communities should be retained at an overall level of at least 30% of the original extent of the ecological community in each region. This level is the threshold level below which species loss appears to accelerate exponentially at an ecosystem level. A level of 10% of the original extent is regarded as being a level representing "endangered" (Environmental Protection Authority (EPA, 2000)). The pre-European extent of the VAs and VSAs in the Yalgoo Bioregion, the Tallering Subregion, the Shire of Yalgoo, and the Survey Area, along with the current extent, the percentage remaining, and the current extent protected for conservation in those areas is listed in **Table 1**.



VA: 202 VSA: 202.3	Wattle, teatree *Melaleuca* spp
VA: 361 VSA: 361	Wattle with York gum, *loxophleba*, *Allocasuari*
VA: 420 VSA: 420.5	Wattle, teatree *Melaleuca* spp.

Between 99.69% and 99.97% of the VAs and VSAs remain in the Yalgoo bioregion and Tallering subregion and the Shire of Yalgoo. Currently only 0.02% of the pre-European extent of VA 420 and VSA 420.5 is protected in the bioregion and subregion and none of it in the Shire. None of the two other VAs or VSAs is protected for conservation in the bioregion, subregion or Shire (GoWA, 2019).

Figure 5: Pre-European vegetation associations and system associations and the Survey Area

Background information on the Survey Area

None of the Survey Area lies in Department of Biodiversity, Conservation and Attractions (DBCA) Legislated Lands and Waters (DBCA, 2021a). The closest is a Timber Reserve, approximately 57 km south-west of the Survey Area. Further, the Survey Area does not lie in any DBCA Lands of Interest - (DBCA, 2021b), nor does it fall in an Environmentally Sensitive Area (ESA); the closest is approximately 35 km south-east of the Survey Area (Department of Water, Environment and Regulation (DWER), 2020a). The Survey Area is not in an EPA Redbook Recommended Conservation Reserves 1976-1991 area; the closest is Yarra Yarra Lake Conservation Park, more than 100 km south-west of the Survey Area (DBCA, 2020a). The Survey Area is not in a Schedule One Area (DWER, 2020b).

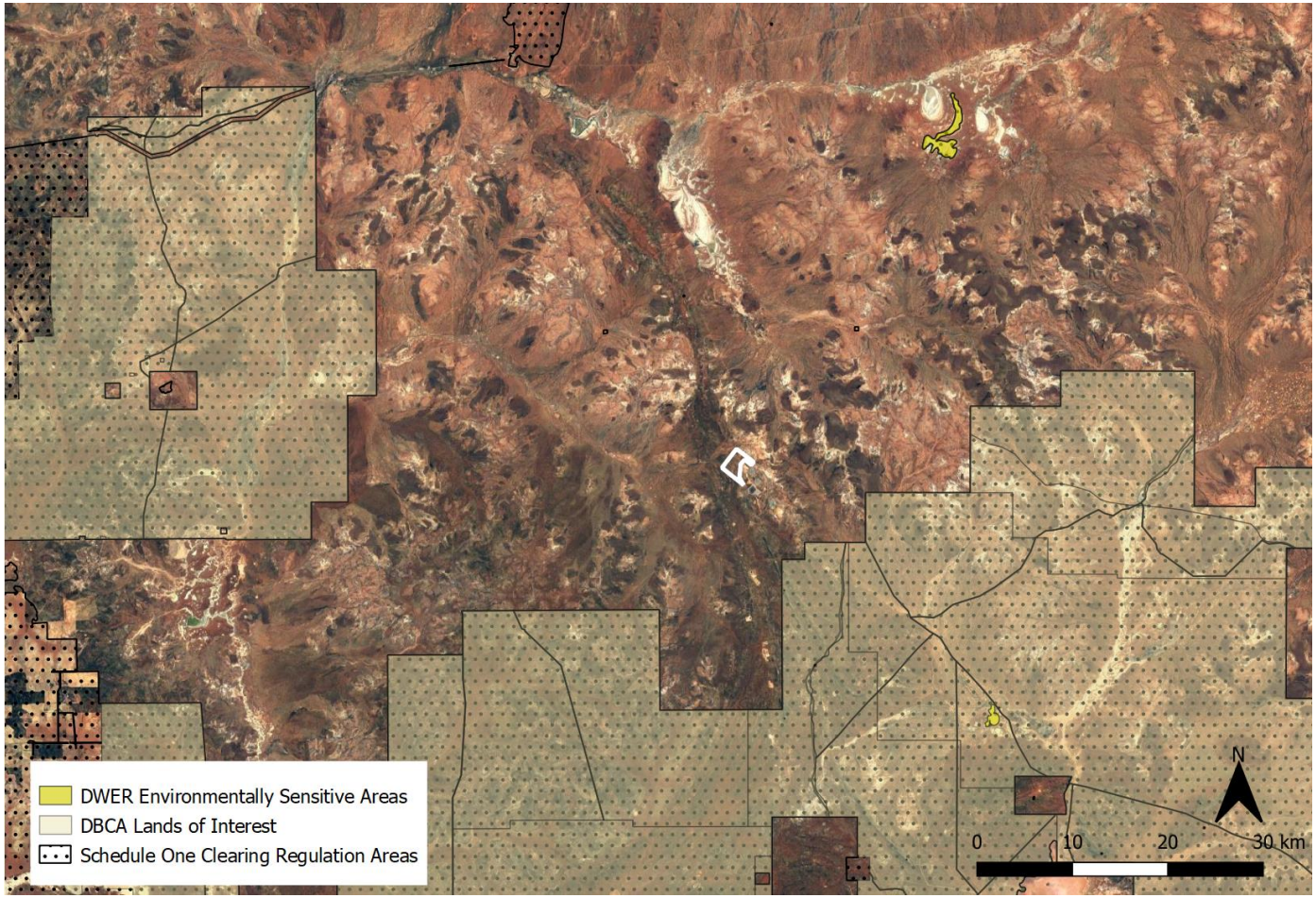


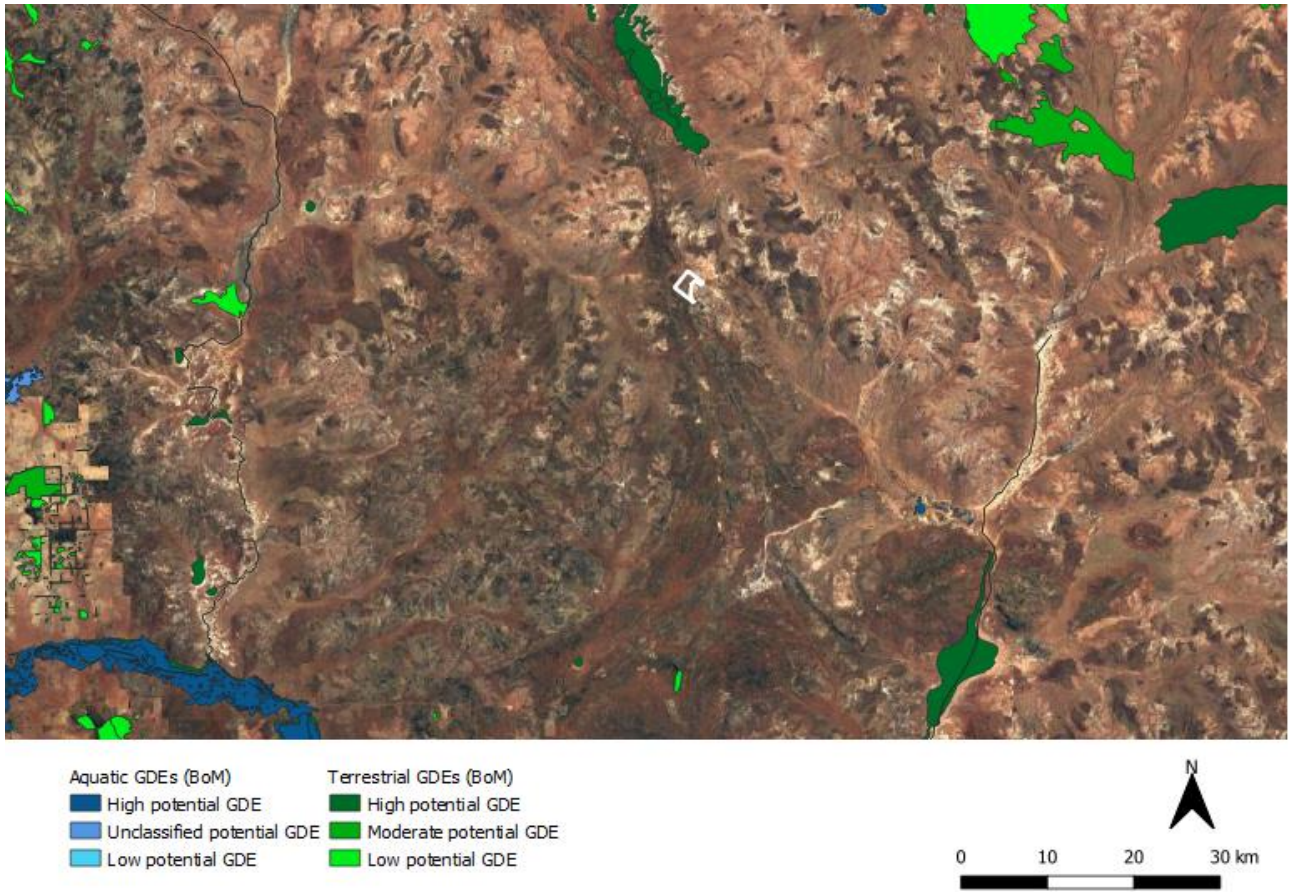
Figure 6: Protected and significant areas and the Survey Area

Background information on the Survey Area

Australia currently has 66 Wetlands of International Importance listed under the Ramsar Convention, and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a framework for protecting Ramsar Sites in accordance with the Ramsar Convention (DAWE, 2021a). None of these wetlands occur in or close to the Survey Area (DBCA, 2020b). Currently, 120 nationally important wetlands are listed in WA (including Ramsar wetlands) (DAWE, 2021b), and none of them are in the Survey Area or in the Shire of Yalgoo (DBCA, 2020c).

The closest Directory of Important Wetlands in Australia (DIWA) wetland is Thundelarra Lignum Swamp, approximately 35 km to the south-east of the Survey Area.

No other wetlands occur in or close to the Survey Area and no watercourses intersect the Survey Area.



Smith et al. (2006) defined groundwater dependent ecosystems (GDEs) as ecosystems that rely wholly or partially on groundwater to maintain an adequate level of ecosystem function and maintenance of community composition over multiple generations of the longest-lived species within the community. The Groundwater Atlas (BoM, 2021a) indicates the potential for GDEs to occur in an area (based on a national rather than detailed local assessment). No aquatic or terrestrial groundwater dependent ecosystems (GDE) are mapped in or close to the Survey Area (Bureau of Meteorology (BoM), 2020a; 2020b).

Figure 7: Groundwater dependent ecosystems (national assessment) and the Survey Area

Table 1: Pre-European vegetation associations and system associations

	Yalgoo Bioregion	Tallering Subregion	Shire of Yalgoo
Vegetation associations (VA)			
Pre-European extent (ha)			
202	45,096.14	45,096.14	52,004.53
361	76,479.74	76,456.96	77,518.54
420	621,396.05	615,816.17	549,363.07
Current extent (ha)			
202	45,011.91	45,011.91	51,900.75
361	76,453.22	76,430.44	77,492.03
420	620,265.57	614,685.69	548,343.13
Remaining (%)			
202	99.81	99.81	99.80
361	99.97	99.97	99.97
420	99.82	99.82	99.81
Current extent of VA protected (IUCN 1-4) for conservation (proportion of pre-European extent) (%)			
202	0	0	0
361	0	0	0
420	0.02	0.02	0
Source: GoWA (2019).			

	Yalgoo Bioregion	Tallering Subregion	Shire of Yalgoo
Vegetation system associations (VSA)			
Pre-European extent (ha)			
202.3	45,020.68	45,020.68	42,727.07
361	76,456.96	76,456.96	77,518.54
420.5	455,831.59	455,831.59	326,780.46
Current extent (ha)			
202.3	44,936.45	44,936.45	42,642.84
361	76,430.44	76,430.44	77,492.03
420.5	454,715.08	454,715.08	325,768.27
Remaining (%)			
202.3	99.81	99.81	99.80
361	99.97	99.97	99.97
420.5	99.76	99.76	99.69
Current extent of VSA protected (IUCN 1-4) for conservation (proportion of pre-European extent) (%)			
202.3	0	0	0
361	0	0	0
420.5	0.02	0.02	0
Source: GoWA (2019).			

This page is intentionally blank.

3 DESKTOP ASSESSMENT

3.1 FLORA

Appendix 1 provides information on conservation significance of flora and vegetation and **Appendix 2** information on the classification of weeds.

3.1.1 Conservation Significant Flora

Search results from DBCA's Threatened and Priority Flora List (TPFL) and WA Herbarium (WAHerb) databases (DBCA search reference #14-0420FL) were used to collate information on vascular conservation significant flora (CSF) species that could potentially occur in the Survey Area.

Searches using the EPBC Act Protected Matters Search Tool (PMST) (Department of Agriculture, Water and the Environment (DAWE) (2021c), search reference PMST_ZJZMOB and NatureMap (DBCA, 2007-) were also carried out by buffering the following coordinates by 20 km: 116° 55' 13''E, 28° 43' 38'' S (search carried out before the NatureMap site closed down).

The results from reports on botanical surveys previously carried out on 29MGG's project area tenements were also used; all CSF species from these reports were already in the DBCA, EPBC Act PMST and NatureMap search results, and therefore they are not listed separately in the collated results.

The search results are listed in **Table 15, Appendix 3**.

3.1.1.1 THREATENED FLORA

Three Threatened (T) flora species (or their habitats) protected by the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or the WA *Biodiversity Conservation Act 2016* (BC Act) were listed in the search results (**Table 15, Appendix 3**); *Eucalyptus synandra, Gyrostemon reticulatus* and *Stylidium scintillans.* These three species have not been in the Survey Area previously. The closest currently known Threatened flora species population is a *Stylidium scintillans* (listed as Vulnerable) population approximately 2.5 km to the east of the northern corner of the Survey Area (**Map 1, Section 11**).

3.1.1.2 PRIORITY FLORA

Eleven Priority (P) flora species have records within the search area previously (**Table 15, Appendix 3**): one P1, eight P3 species and two P4 species. *Acacia speckii* has been recorded in high numbers in sections of the Survey Area during past surveys (Yilgarn Traders, 2008a, b, c; Yilgarn Traders, 2009) and between 3.8 km and 10 km north of the Survey Area (WEC, 2014).

3.1.2 `Weeds

The EPBC Act PMST (DAWE, 2021c, search reference PMST_ZJZMOB) and NatureMap (DBCA, 2007-) results also list weed species that could potentially occur in the Survey Area or have been recorded in the vicinity previously. Weed data was also collated from any botanical surveys carried out within the search area. The results are listed in **Table 16, Appendix 3**. The results from surveys carried out within the search area are included in **Table 16** only when a species not already in the NatureMap search results was located.

3.1.2.1 WEEDS OF NATIONAL INTEREST AND DECLARED PEST PLANTS

No weed species listed on any of the national weeds lists (weeds AUSTRALIA, 2021) were in the database and literature search results (**Table 16, Appendix 3**), and no weed species listed under the BAM Act were listed in the database and literature search results (DPIRD, 2020c).

3.1.2.2 ENVIRONMENTAL WEEDS

A list of 22 weed species was collated from the database and literature search results.

The Midwest Region species prioritisation process 2014 impact and invasiveness ratings spread sheet lists 324 weed species for which impact and invasiveness has been rated, and a further seven weed species that have been listed as priority alert species (Department of Parks and Wildlife (DPaW), 2014).

The ecological impact and invasiveness rankings for the 22 general weed species identified from the database and literature searches are listed in **Table 16 (Appendix 3)**. Four of the species listed have high ecological impact and rapid invasiveness ratings (shaded pink): *Aira caryophyllea*, *Cenchrus ciliaris*, *Mesembryanthemum nodiflorum* and *Raphanus raphanistrum*.

Seventeen of the 22 species have been recorded during surveys carried out at Golden Grove for 29MGG (bold in **Table 16,** column 1), and three of the 17 have high ecological impact and rapid invasiveness ratings.

3.1.3 Sandalwood and Desert Kurrajong

Western Australian sandalwood (*Santalum spicatum*) is a slow-growing, long-lived small woody tree or shrub that occurs naturally throughout the southern part of WA and into South Australia. It is valuable and highly sought-after for the oils contained in the heartwood. Western Australian sandalwood is now unique as the world's largest and only remaining wild resource. It occurs over the southern two thirds of WA and in South Australia. The species originally occurred throughout the Wheatbelt but has been reduced to smaller fragmented populations by clearing for agriculture (DPaW, 2015). Sandalwood (*Santalum spicatum*) is a controlled species under the BC Act (if it has a diameter of greater than 25 mm at the smallest end when stripped of bark; or roots of sandalwood) and it cannot be taken from private land or from Crown land to be processed without a licence (flora taking (sandalwood licence) (GoWA, 2018)), unless an exemption applies. No *Santalum spicatum* has been recorded in the Survey Area previously (29MGG database, WEC 2013). Nine Sandalwood trees were found in a previous Maia survey to the east of and adjacent to the Survey Area (Maia, 2020c). Desert Kurrajong is known to have local significance and is long lived. It has not been found in the sections of the Survey Area assessed previously; however, one specimen was located in an adjacent area (Maia, 2020c).

3.2 VEGETATION

3.2.1 Vegetation Surveys Carried out in the Area Previously

Four companies have carried out surveys in the local area previously – Mattiske (1996), Yilgarn Traders (2008a, b and c; 2009), Woodman Environmental Consulting (WEC, 2013) and Maia (2020c) (**Figure 8**).

A section of the TSF3 area surveyed by Yilgarn Traders lies in the Survey Area and five vegetation associations were mapped in the area, they were described as:

- Drainage Line 4: Open mixed Acacia shrublands (*Acacia quadrimarginea, Acacia aneura* and *Acacia tetragonophylla* with *Senna* sp. Austin over *Eremophila* species)
- Drainage Line 5: Dense to mid-dense Acacia shrubland (*Acacia ramulosa*, *Acacia aneura* over *Eremophila forrestii* var. *forrestii* over dense annuals)
- Plains 8: Very open to open mixed shrublands (*Hakea preissii* and *Borya nitida* with scattered mixed *Acacia* species including *Acacia aulacophylla*, *Acacia grasbyi* and *Acacia ramulosa*)
- Plains 10: Very open to open Acacia shrubland (*Acacia ramulosa*, *Acacia aneura* and *Grevillea obliquistigma* over *Eremophila forrestii* var. *forrestii* and *Eremophila punicea*)

- Upper Plains 1: Mid-dense Acacia woodlands (*Acacia aneura* x *craspedocarpa* amongst *Acacia ramulosa* and *Acacia exocarpoides* over *Eremophila forrestii* var. *forrestii* with patches of *Aluta* heath).

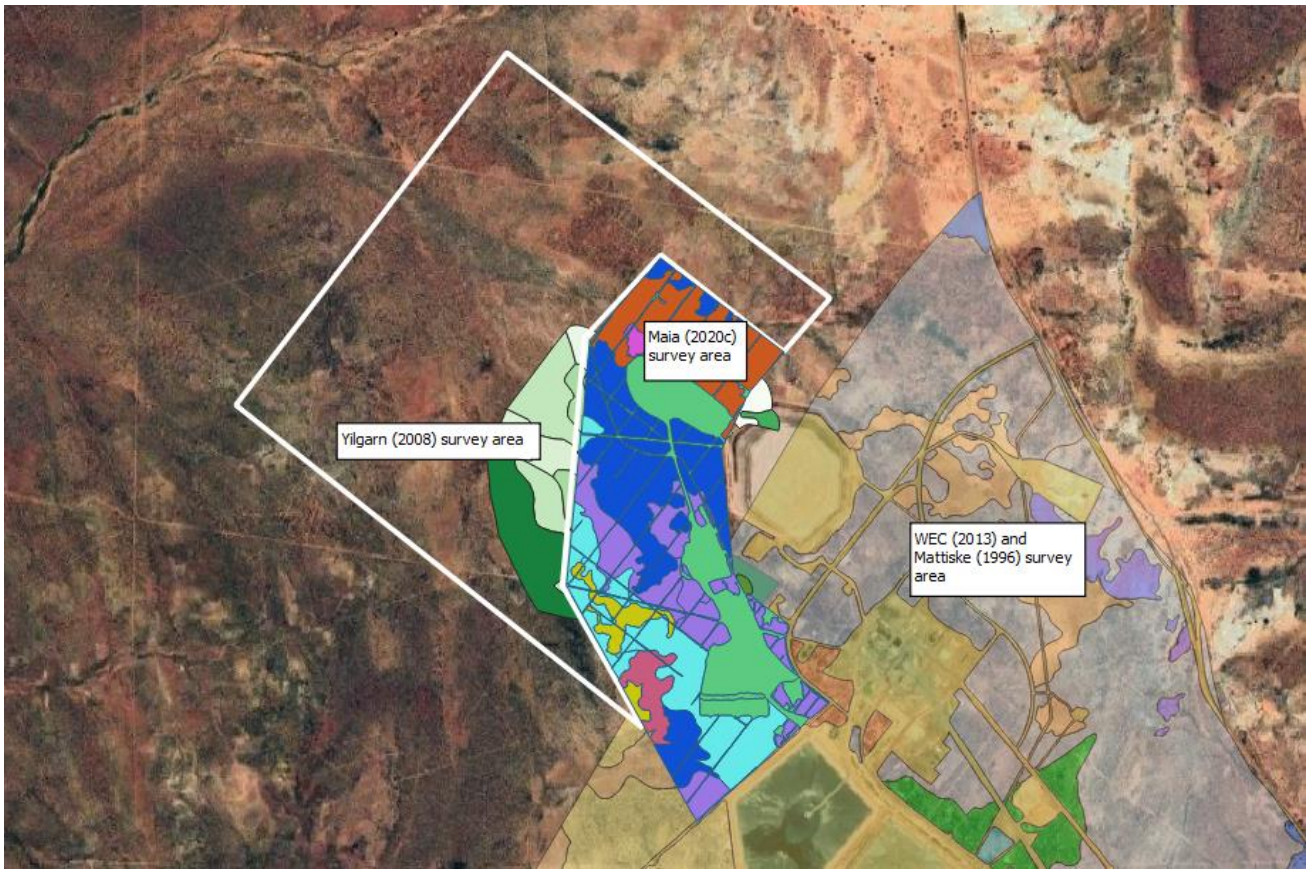


Figure 8: Previous surveys within or close to the Survey Area

3.2.2 Significant Ecological Communities

Information on significant ecological communities that could potentially occur in the Survey Area was gathered from an EPBC Act PMST search (DAWE, 2021c; search reference PMST_ZJZMOB), and a DBCA Ecological Communities search (search reference #10-0420EC). The DBCA Ecological Communities search results were checked for currency on National map (Threatened Ecological Communities (DBCA-038); National Map, 2021) by comparing the more recent NationalMap data set with the database search results: the communities in the vicinity of the Survey Area had not changed since the DBCA database search was carried out.

3.2.2.1 THREATENED ECOLOGICAL COMMUNITIES

No Threatened Ecological Communities (TECs) were listed in the PMST or DBCA search results. The Survey Area does not lie in or close to any of the current boundaries indicated for a known federally listed. No TECs currently protected by WA legislation are listed for the Yalgoo bioregion (DBCA, 2018).

3.2.2.2 PRIORITY ECOLOGICAL COMMUNITIES

The most recent Priority Ecological Community (PEC) list is dated July 15, 2021 (DBCA, 2021c) and lists 109 PECs for DBCA's Midwest Region. Approximately 55% of the Survey Area lies within the boundaries of a polygon mapped as the 'Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)' P1 PEC (**Map 2, Section 11**).

4 RAINFALL

29MGG record rainfall at Golden Grove and the medium-term (2013 to 2020) mean monthly total rainfall is listed in **Table 2** along with actual and mean annual rainfall (data supplied by 29MGG).

Total rainfall recorded at Golden Grove over the three months before the survey (August to October 2021) was 1 mm lower than the medium-term mean total for those same months (14.5 mm and 15.5 mm, respectively).

According to BoM's WA rainfall deciles map for 1 August 2021 to 31 October 2021, the Survey Area is in an area that received average rainfall over the three months before the survey (**Figure 9**, the approximate location of the Survey Area is indicated by the black dot).

Based on the rainfall data recorded over the three months before the survey, the medium-term rainfall records and BoM's rainfall deciles map, the vegetation in the Survey Area would likely have been in average condition, for the time of year, when the survey was carried out in November 2021.

Table 2: Golden Grove 2013 – 2020 medium-term mean monthly and mean annual total rainfall (mm), and actual monthly and annual rainfall January 2013 to October 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
M-t	24.5	30.7	29.5	24.6	24.9	26.4	25.4	31.7	9.3	5.5	7.4	10.6	250.6
2013	40.2	3.5	17.0	11.9	48.5	4.5	17.3	27.3	18.6	13.9	1.2	6.7	210.6
2014	24.0	23.5	28.0	53.5	73.5	7.4	12.2	22.6	30.4	10.0	5.0	5.5	295.6
2015	12.2	13.5	86.5	40.2	9.5	22.0	44.0	39.4	0.5	0	11.3	1.5	280.6
2016	75.9	0	48.8	37.5	35.5	40.5	29.8	31.5	4.8	2.0	1.0	14.2	321.5
2017	11.5	150.3	0	2.5	4.7	3.0	10.7	47.9	16.1	0.5	18.5	11.0	276.7
2018	29.5	7.4	16.0	2.3	14.3	26.3	37.8	30.4	0.8	15.5	12.5	17.0	209.8
2019	0	0	26.5	47.8	0	82.5	17.0	13.0	1.0	2.0	0	23.4	213.2
2020	3.0	47.5	13.0	1.5	13.5	24.8	34.0	41.8	1.8	0.4	10.0	5.5	196.8
2021	0	43.0	79.0	26.0	110.5	41.5	64.8	10.4	6.4	26.7	-	-	408.3

Note: M-t= medium-term (2013-2020). Orange cell indicates the three months before the survey. 2021 total rainfall is to end of October.

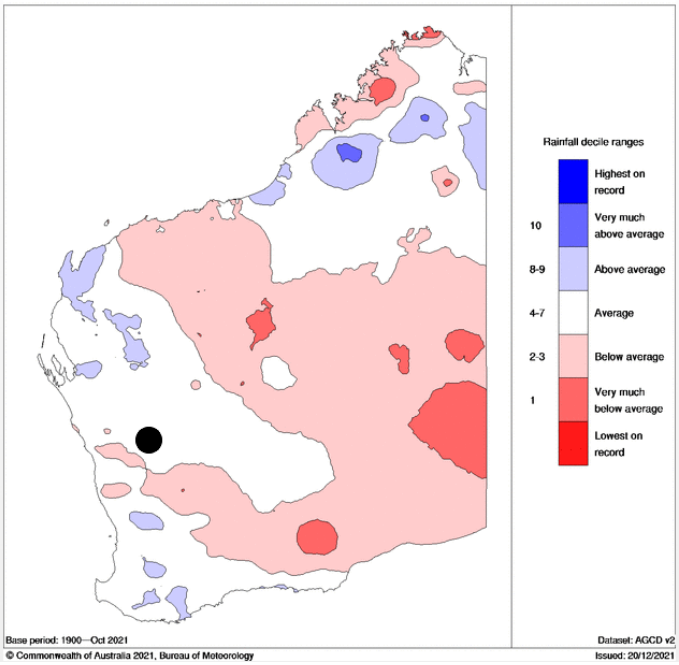


Figure 9: Western Australia three-month rainfall deciles, 1 August to 31 October 2021 (BoM 2021b). Black dot indicates general location of the Survey Area

5 METHODS – SURVEY, TAXONOMY AND VEGETATION MAPPING

5.1 FIELD SURVEY

The survey methodology was developed to comply with the following:

- Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016).

The survey was carried out by one botanist on November 5 to November 8, 2021, and the following was assessed:

- A representative number of relevé sites.
- An approximately 15 m wide band of vegetation while walking traverses in the Survey Area. Known or suspected CSF and weeds were targeted while walking the traverses and, if any were found, their location was recorded on a GPS and the number of plants was counted. Any additional taxa not already collected at the relevé sites were also collected while walking traverses.
- Any apparently different vegetation types, changes in vegetation condition or any disturbances to the vegetation were noted.

The following parameters were recorded at each relevé site:

- Location details including Global Positioning System (GPS) co-ordinates (GDA94) for the north-west corner of the relevé.
- Parameters such as soil description, topography and general habitat description, rock type and cover.
- At least one photograph across the relevé.
- Vegetation condition (using the scale and criteria for the Southwest and Interzone Botanical Provinces (as in EPA, 2016) (**Table 17, Appendix 4**).
- Notes on any disturbance apparent disturbance to the vegetation.
- Fire history.
- A description of the vegetation structure including the height, percentage cover and dominant species within each stratum.
- The name, height, percentage cover and any other significant recording details for any other species located at the relevé.

At least one specimen of each species encountered during the survey was collected and species were re-collected whenever flowering or fruiting material was located by the botanists.

5.2 TAXONOMY AND NOMENCLATURE

Plant specimens collected from the Survey Area were identified by Conrad Slee.

Species names used in this report are those adopted by the WA Herbarium, and they have been checked against current FloraBase records (WA Herbarium (WAH), 1998-). Undescribed taxa are referred to in the report and listed in the species list as “sp.” (species), subspecies as subsp. and varieties as var..

5.3 VEGETATION MAPPING

Aerial photography provided by 29MGG and captured in 2018 was used to map the vegetation types at a scale of between 1:500 and 1:10,000. Vegetation types were described according to the dominant genera in each structural class. Notes made by the botanist while carrying out the survey were used to delineate the boundaries of each vegetation type. Statistical analyses were not carried out to define the vegetation types of the Survey Area.

Vegetation types are described using the current National Vegetation Inventory System (NVIS) methodology at the association level (Level 5). At this level up to three strata and a maximum of three taxa per stratum are used to describe an association (Executive Steering Committee for Australian Vegetation Information (ESCAVI), 2003). The NVIS structural formation terminology is outlined in **Tables 18 to 20**, **Appendix 5**; it utilises growth forms (**Table 18**), height classes (**Table 19**) and foliage cover characteristics (**Table 20**).

6 Survey Results

6.1 Coverage Achieved over the Survey Area

Thirty-four relevés were assessed and about 36 km of traverses were walked through the Survey Area. An estimate of survey coverage achieved is listed in **Table 3**. The survey coverage achieved via traverses walked in the Survey Area was approximated by buffering traverses by 15 m. The information collected at each relevé is provided in **Table 21 (Appendix 6),** and relevé locations and traverses walked are shown on **Map 3, Section 11**.

Table 3: Survey coverage achieved

Attribute		Survey Area
Relevés (ha)		1.36
Traverses (ha)		36.36
Total area surveyed (ha)		37.72
Survey Area (ha)		455.72
Coverage achieved (%)		8.28

6.2 Flora

6.2.1 General Flora

Maia recorded 117 taxa in the Survey Area (**Table 22, Appendix 7**). The families and genera represented, the percentage of annual and perennial species and the percentage of the species list that were fertile when the survey was carried out are listed in **Table 4**.

There was one query taxa, *Grevillea*? *sarissa.*

Table 4: Flora information

Attribute	Number or percent
Families (#)	29
Genera (#)	67
Taxa (#)	117
Annual / perennial (%)	32 / 68
Flowering / fruiting / flowering and fruiting / fertile overall (%)	38 / 33 / 7/ 79

Maia (2020c) recorded 107 taxa in the earlier TSF4 survey area (255 ha), while Yilgarn Traders (2008a) recorded 79 species from the TSF3 footprint (169 ha) in June 2008, 96 vascular plants from the TSF3 Site A area (89 ha) (Yilgarn Traders, 2008c) and, 219 vascular plants from TSF3 footprint Site B&D and northern areas (630 ha) (Yilgarn Traders, 2009). WEC (2013) recorded 114 vascular flora taxa and two putative hybrids from 26 families and 53 genera during a survey over an approximately 2,952 ha area. The number of taxa recorded in the Survey Area is similar to or greater than that recorded in the surrounding areas (based on the area surveyed).

6.2.2 Conservation Significant Flora

6.2.2.1 THREATENED FLORA

- No threatened flora protected by the Federal EPBC Act or the WA BC Act were located in the Survey Area.

6.2.2.2 PRIORITY FLORA

Two priority flora species were recorded in the Survey Area – *Petrophile vana* (P1) and *Acacia speckii* (P4).

- *Petrophile vana* was recorded at two locations and *Acacia speckii* at 68. These species are described in **Table 5** and their locations are shown on **Map 4, Section 11**; their coordinates have been supplied to 29MGG electronically (they are not listed in this report).

Table 5: Conservation significant flora species located in the Survey Area

Species description and habitat	Photographs
***Petrophile vana* (P1) - Proteaceae** *P. vana* is a smooth-barked lower shrub growing to 1.5 m high Its leaves are alternate, stalk-less and inward-curled towards the branches. The flowers are stalk-less and grow in the leaf axils and they are white to cream in colour and are produced in September. *P. vana* grows on shallow, white, gritty clay-soil on laterite breakaway platforms and is only known to occur in the Murchison and Yalgoo bioregions (Cranfield & Macfarlane, 2007). Maia recorded two *P. vana* at two locations (one at each location).	 Photography by G. Cockerton. Image used with the permission of the Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions (https://florabase.dpaw.wa.gov.au/help/copyright). Accessed on Thursday, 9 December 2021.
***Acacia speckii* (P4) - Fabaceae** *A. speckii* is a bushy shrub or small tree growing to 3 m high (WAH, 1998-). The phyllodes have eight prominent nerves and the tips are pungent with a hard, brown tip. The flowers are yellow and globular and are produced from autumn to spring, and the pods are shallowly curved. *A. speckii* grows on rocky soils over granite, basalt or dolerite on rocky hills or rises (WAH, 1998-). Maia recorded 86 *Acacia speckii* at 68 locations in the Survey Area.	

Species description and habitat	Photographs
Photographs were taken by Maia and show the general growth habit of *A. speckii* (top) and a close-up of its phyllodes and flowers (bottom).	

6.2.3 Range Extensions

Species have a typical range which is indicated by their known distribution records. Sometimes species are recorded during a survey, which have not been located previously in the area; these species are described as range extensions. In many cases a range extension reflects a lack of surveys in a particular area or submissions of flora records to the WA Herbarium rather than a true range extension.

Using 100 km as the minimum distance from an existing record to define a range extension, no range extensions were recorded in the Survey Area.

6.2.4 Regional Endemics

Regional endemics are plants that are geographically restricted to a particular locality or region.

None of the species in the species list is endemic to the Yalgoo bioregion.

6.2.5 Queried Taxa

One taxon in the species list is queried and could not be determined to species level because the specimen was sterile – *Grevillea* ? *sarissa*. *Grevillea sarissa* is not a priority species and it occurs in the Yalgoo bioregion. There is one priority *Grevillea* that was listed in the background searches that occurs in the Yalgoo bioregion - *Grevillea globosa* (P3). *Grevillea globosa* has been located in the Gossan Valley Project area and it is known to Maia - the specimen collected was not *G. globosa* as the shrub was smaller than *G. globosa* and it was not growing in the correct habitat.

6.2.6 Taxa of Interest

Eleven *Santalum spicatum* trees were recorded from 10 locations in the Survey Area (**Map 4, Section 11**).

6.2.7 Introduced Flora

6.2.7.1 NATIONAL WEEDS LISTS

No weeds on any of the national weed's lists were recorded in the Survey Area.

6.2.7.2 PLANT PESTS DECLARED IN WESTERN AUSTRALIA

No plant species declared as a pest in WA were recorded in the Survey Area.

6.2.7.3 ENVIRONMENTAL WEEDS

Six environmental weed species, *Aira caryophyllea* (Silvery Hairgrass), *Cuscuta epithymum* (Lesser Dodder), *Hypochaeris glabra* (Smooth Catsear), *Mesembryanthemum nodiflorum* (Slender Iceplant), *Pentameris airoides* (False Hairgrass) and *Sonchus oleraceus* (Common Sowthistle), were recorded in the Survey Area and their locations are shown on **Map 5, Section 11**. The impact and invasiveness ratings for the species in DBCA's Midwest region is listed in **Table 6** (DPaW, 2014). *Aira caryophyllea* and *Mesembryanthemum nodiflorum* are rated as having high ecological impact and rapid Invasiveness.

Table 6: Environmental weed species recorded in the Survey Area

Species (Common name)	DPaW Midwest Prioritisation Rank (DPaW, 2014)	
	Ecological impact	Invasiveness
*Aira caryophyllea (*Silvery Hairgrass	High	Rapid
Cuscuta epithymum (Lesser Dodder)	Unknown	Rapid
Hypochaeris glabra (Smooth Catsear)	Low	Rapid
Mesembryanthemum nodiflorum (Slender Iceplant)	High	Rapid
Pentameris airoides (False Hairgrass)	Unknown	Rapid
Sonchus oleraceus (Common Sowthistle)	Unknown	Rapid

Note: rows highlighted orange = high ecological impact and rapid invasiveness species.

6.3 VEGETATION

6.3.1 Vegetation Types

Seven vegetation types were mapped over the Survey Area. The area and cover of each vegetation type is listed in **Table 7**. The vegetation types are described in **Table 8** and their distribution over the Survey Area is shown on **Map 6 (Section 11)**. Areas already cleared for roads, tracks, drill lines and existing mining areas are mapped as Disturbed. The vegetation condition noted in **Table 8** for each vegetation type uses the condition of the vegetation at the relevés assessed in each vegetation type. Whenever possible, relevés are sampled in intact / good condition vegetation, and so the average condition ratings in **Table 8** are different from those mapped across the whole of the Survey Area and discussed in **Table 9**.

The information collected at relevés is included as **Table 21, Appendix 6**.

Table 8 provides the following information on each vegetation type: its broad floristic formation; a detailed description; its habitat; the associated species; the relevés assessed in the vegetation type; and, the average vegetation condition (based on vegetation condition at relevés).

The vegetation type codes used include the first letter of the genus of the dominant taxon or taxa in the vegetation type, along with the first letters of the dominant stratum (e.g., ATSL is Acacia Tall Sparse to Open Shrubland) and the codes are suffixed by a number to distinguish between multiples of the vegetation type (e.g., ATSL (1), ATSL (2) etc., which have the same structure but different dominant species).

A vegetation type by species matrix is included as **Table 23**, **Appendix 8**.

The most widespread vegetation type is MTSL (2) – Mixed Tall Open Shrubland – mapped over 188 ha - and the least widespread are ALWL (Acacia Low Woodland) and ATSL (1) (Acacia Tall Sparse Shrubland to Open Shrubland) mapped over 9.97 ha and 10.05 ha respectively.

Table 7: Vegetation types, area and cover

Vegetation type code: broad floristic formation	Area (ha)	Cover (%)
ALWL: Acacia Low Woodland	9.97	2.19
ATSL (1): Acacia Tall Sparse Shrubland to Open Shrubland	10.05	2.21
ATSL (2): Acacia Tall Sparse Shrubland to Open Shrubland	61.77	13.55
ATSL (3): Acacia Tall Sparse Shrubland	57.01	12.51
ATSL (4): Acacia Tall Open Shrubland	17.79	3.9
MTSL (1): Mixed Tall Open Shrubland	83.74	18.38
MTSL (2): Mixed Tall Open Shrubland	188.00	41.25
Disturbed	27.39	6.01
Total area (ha) / Cover (%)	455.72	100

Table 8: Vegetation type descriptions

Code	Broad floristic formation, vegetation type and associated information		Photograph
ALWL	**Broad floristic formation**: Acacia Low Open Woodland **Vegetation type**: Low Open Woodland of *Acacia aptaneura* with a mixed Tall Sparse Shrubland mainly of *Acacia aptaneura*, *A. caesaneura* (narrow phyllode variant), *A. ramulosa* var. *ramulosa* and a Sparse Shrubland of *Eremophila latrobei* subsp. *latrobei*	**Associated species:** *Cheilanthes adiantoides*, *Grevillea obliquistigma*, *Mirbelia* sp. *Bursarioides* (T.R. Lally 760), *Philotheca sericea*, *Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Thryptomene decussata* **Relevés:** RA-01, RA-31	
	Habitat: BIF ridges and outcrops	**Vegetation condition:** Excellent: grazing, exploration activities, animal tracks - trampled vegetation.	
ATSL (1)	**Broad floristic formation**: Acacia Tall Sparse Shrubland to Open Shrubland **Vegetation type**: Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa* and *A. aulacophylla* with a Sparse Mixed Shrubland of *Thryptomene costata*, *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Philotheca brucei* subsp. *brucei*	**Associated species:** *Aluta aspera* subsp. *hesperia*, *Alyxia buxifolia*, *Calytrix uncinata*, *Dodonaea viscosa* subsp. *mucronata*, *Eremophila exilifolia*, *E. latrobei* subsp. *latrobei*, ***Petrophile vana* (P1)**, *Philotheca sericea*, *Stylidium longibracteatum* **Relevés:** RA-36, RA-39	
	Habitat: Hill slopes and crests with a surface layer of laterite and banded iron-formation (BIF) rocks and boulders.	**Vegetation condition:** Excellent: exploration activities	

Code	Broad floristic formation, vegetation type and associated information		Photograph
ATSL (2)	**Broad floristic formation**: Acacia Tall Sparse Shrubland to Open Shrubland **Vegetation type**: Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa*, *A. effusifolia* and / or A. caesaneura (narrow phyllode variant) with a mixed Open Shrubland mainly of *Eremophila forrestii* subsp. *forrestii*, *E. latrobei* subsp. *latrobei* and *Philotheca sericea* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)	**Associated species:** *Acacia exocarpoides*, *Eremophila clarkei*, *Philotheca brucei* subsp. brucei, *Ptilotus obovatus*, *P. schwartzii*, *Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Thryptomene decussata* **Relevés:** RA-06, RA-07, RA-18, RA-35	
	Habitats: Hill slopes, crests and outcropping with a surface layer of ironstone and / or BIF gravel, rocks and boulders.	**Vegetation condition:** Excellent: exploration and pastoral activities, grazing, animal tracks - trampled vegetation.	
ATSL (3)	**Broad floristic formation**: Acacia Tall Sparse Shrubland **Vegetation type**: Mixed Acacia Tall Sparse Shrubland mainly of *Acacia grasbyi*, *A. umbraculiformis* and *A. ramulosa* var. *ramulosa* with a mixed Sparse Low Shrubland mainly of *Eremophila punicea*, *Philotheca brucei* subsp. *brucei* and *Ptilotus obovatus*	**Associated species:** *Acacia caesaneura* (narrow phyllode variant), ***A. speckii* (P4)**, *Aluta aspera* subsp. *hesperia*, *Eremophila compacta*, *E. latrobei* subsp. *latrobei*, *Grevillea pityophylla*, *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Ptilotus obovatus*, *P. schwartzii*, *Thryptomene costata*, *T. decussata* **Relevés:** RA-14, RA-26, RA-40, RA-42	
	Habitats: Stony plains, hill slopes and minor depressions with a surface layer of weathered ironstone and laterite gravel and occasionally with granite surface plates and rocks.	**Vegetation condition:** Excellent to Very Good: tracks, exploration activities and weeds.	

Code	Broad floristic formation, vegetation type and associated information		Photograph
ATSL (4)	**Broad floristic formation**: Acacia Tall Open Shrubland **Vegetation type**: Mixed Acacia Tall Open Shrubland mainly of *Acacia ramulosa* var. ramulosa, *A. caesaneura* and *A. umbraculiformis* with a mixed Open Shrubland mainly of *Thryptomene costata*, *Aluta aspera* subsp. *hesperia* and *Eremophila forrestii* subsp. *forrestii*	**Associated species:** *Acacia caesaneura* (narrow phyllode variant), ***A. speckii*** **(P4)**, *Eremophila latrobei* subsp. *latrobei*, *Mirbelia* sp. Bursarioides (T.R. Lally 760), *Philotheca brucei* subsp. *brucei*, *P. sericea*, *Thryptomene decussata* **Relevés:** RA-03, RA-34	
	Habitat: Hill slopes with a surface layer of BIF and ironstone stones.	**Vegetation condition:** Very Good: exploration and mining activities and grazing.	
MTSL (1)	**Broad floristic formation**: Mixed Tall Open Shrubland **Vegetation type**: Mixed Tall Open Shrubland mainly of *Acacia burkittii, A. ramulosa* var. *ramulosa* and *Hakea recurva* subsp. *arida* with Isolated mixed Low Shrubs mainly of *Solanum lasiophyllum*, *Maireana villosa* and *Ptilotus obovatus*	**Associated species:** *Acacia tetragonophylla, Eremophila eriocalyx, Eremophila granitica, Hakea recurva* subsp. *arida*, *Maireana carnosa*, **Petrophile vana (P1)**, *Solanum lasiophyllum*, *Vincetoxicum lineare* **Relevés:** RA-10, RA-11, RA-12, RA-24, RA-43, RA-44, RA-47	
	Habitat: Hardpan plains and broad drainage flats with a surface layer of ironstone gravel.	**Vegetation condition:** Very Good: grazing, exploration and mining activities, animal tracks - trampled vegetation.	

Code	Broad floristic formation, vegetation type and associated information		Photograph
MTSL (2)	**Broad floristic formation**: Mixed Tall Open Shrubland **Vegetation type**: Tall Open mixed Shrubland mainly of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* and *Grevillea obliquistigma* subsp. *obliquistigma* with a mixed Open Shrubland mainly of *Acacia exocarpoides*, *Eremophila forrestii* subsp. *forrestii* and *Aluta aspera* subsp. *hesperia*	**Associated species:** *Acacia caesaneura* (narrow phyllode variant), *A. effusifolia*, *A. tetragonophylla*, ***A. speckii*** **(P4)**, *Eremophila latrobei* subsp. *latrobei*, *Monachather paradoxus*, *Ptilotus obovatus*, *Solanum lasiophyllum* **Relevés:** RA-05, RA-15, RA-16, RA-19, RA-22, RA-23, RA-29, RA-30, RA-32, RA-33, RA-38, RA-41, RA-49	
	Habitat: Hill slopes with a surface layer of laterite gravel.	**Vegetation condition:** Excellent to Very Good: exploration and pastoral activities and grazing.	

6.3.2 Vegetation Condition

Vegetation condition ratings (**Table 9**) were derived using a selection of different information (data collected at relevés and photo points, notes recorded while walking from site to site, any disturbance visible on aerial imagery, and any weeds located in the different areas); they are not the same as those in **Table 8**, which are based on vegetation condition noted at the relevés.

Vegetation condition is shown on **Map 7 (Section 11)**; the dominant vegetation condition rating for the Survey Area is Excellent to Very Good (approximately 54%). Areas mapped as Degraded to Completely Degraded cover approximately 6% of the Survey Area. Additional comments on vegetation condition and the Survey Area are included in **Table 9**.

Table 9: Vegetation condition

Vegetation condition	Area (ha) / cover (%) in the Survey Area	Vegetation types	Comments
Excellent	81.78 / 17.95	ALWL, ATSL (1), ATSL (2)	Areas where there are few to no obvious signs of disturbance.
Excellent to Very Good	245.02 / 53.77	ATSL (3), MTSL (2)	The majority of the Survey Area is mapped as Excellent to Very Good. There were some signs of low-level disturbance e.g., off-road driving and litter. Goat scats were also seen, but there were no obvious signs of grazing.
Very Good	101.53 / 22.28	ATSL (4), MTSL (1)	Moderate signs of disturbance from grazing and exploration activities were noted in these areas. Some old drill lines were also present and native vegetation had regrown in these areas. There were generally more weed species and goat and rabbit scats, goat tracks and rabbit burrows in these areas.
Degraded to Completely Degraded	27.39 / 6.00	Not applicable	Areas cleared for drill lines, roads, tracks and pits. Little to no native vegetation remains, and they have been mostly cleared but there is still the possibility of some level of regeneration.

7 Discussion

A discussion of the conservation significance of the flora and vegetation of the Survey Area follows. As per the vegetation and flora technical guidance (EPA, 2016), significance is assessed at both regional and local scales.

7.1 Flora of Conservation Significance

None of the following were recorded in the Survey Area when the survey was carried out in November 2021:

- Threatened flora species
- Regional endemic species
- New species
- Range extension species.

7.1.1 Priority Flora - Regional and Local Significance

The regional conservation significance of the *Petrophile vana and Acacia speckii* recorded in the Survey Area is indicated by their current priority ranks – P1 and P4. **Table 10** provides regional and local (Survey Area) information on the distribution and occurrence of *Petrophile vana* and *Acacia speckii* and **Map 8** shows their distribution.

Table 10: Distribution of *Petrophile vana* (Priority 1) and *Acacia speckii* (Priority 4)

Current distribution status
***Petrophile vana* (Priority 1)** FloraBase currently lists five *Petrophile vana* records and they are in the Murchison and Yalgoo bioregions (WAH, 1998). FloraBase records indicate that plant frequency ranges from one to 20 plants, and records with frequency information note that it is uncommon. One of the *P. vana* records is in Barnarbinmah Conservation Park and another is in Dalgaranga and Noongal Pastoral Leases (AVH, 2022). Maia recorded two plants in the Survey Area, one plant at each location (**Map 4, Section 11)**. *Petrophile vana* has not been recorded in or close to the Survey Area previously, the closest record (one plant) is approximately 36 km to the east-northeast in Barnarbinmah Conservation Park. Maia estimates the number of *P. vana* plants in WA to be 179 (DBCA search #14-0420FL, 14 plants; Ecologia 2010, 163 plants; current survey 2 plants (re DBCA search reference #14-0420FL; no new records have been listed on FloraBase since the search was carried out)) and 13 populations (populations identified by buffering plant locations by 500 m following DBCA's method). Using these numbers Maia estimates that if all of the Survey Area were to be cleared impact to *P. vana* plants would be 1.1% and impact to populations would be 15.4%.
***Acacia speckii* (Priority 4)** FloraBase currently lists 39 *Acacia speckii* records and they are in the Murchison, Yalgoo and Gascoyne bioregions (WAH, 1998-). FloraBase records describe plant frequency as isolated to common and plant numbers associated with the records range from one plant up to one record with 220 plants. Some of the records are in ex Barnong Pastoral Lease and also in Narloo, part Yuin and part Twin Peaks Pastoral Leases (AVH, 2022). Both Yilgarn Traders (2008a, 2009) and WEC (2013 & 2014) recorded many *Acacia speckii* in, around and to the north of the current Survey Area, and Maia recorded 87 plants in the adjacent TSF4 area surveyed (Maia, 2020c); it is therefore locally common. Eighty-six *Acacia speckii* plants were located in the current Survey Area and their locations are shown on **Map 4, Section 11**. The total number of *A. speckii* located in the Survey Area previously cannot be calculated - either because many of the records in 29MGG database have no plant numbers associated with them, or because population boundaries are available but not plant locations within the boundaries. The *Acacia speckii* records currently known to Maia have a wide distribution in WA, and they comprise 122 discrete populations (when populations are identified by buffering plant locations by 500 m following DBCA's method). One population occurs in the Survey Area and surrounds and if all of the plants in the Survey Area were to be impacted part of that one population would be affected: one population comprises 0.82% of the populations known to Maia.

7.2 Vegetation - Regional and Local Distribution

Regional significance of the vegetation of the Survey Area is discussed using land systems (LS) and Beard's vegetation system associations (VSA) occurring in the Survey Area and their representation in the Yalgoo bioregion. Local significance of the vegetation mapped in the Survey Area is discussed using the vegetation types mapped by Maia.

7.2.1 Land Systems

Three land system are mapped in the Survey Area –Tallering, Violet and Watson. The number of bioregions and subregions they are mapped in, and the originally mapped area of each LS is listed in **Table 11**, along with their extent, distribution and protection in the Yalgoo bioregion and in the local area (the Survey Area). Their bioregional extents are shown on **Map 9 (Section 11)**.

The three LS have more than 97% of their original mapped extent remaining in the Yalgoo bioregion and they have a limited (Tallering and Watson) or moderate (Violet) distribution, as the Tallering and Watson LS are mapped in two bioregions (two subregions) and the Violet LS in four bioregions (five subregions) respectively.

Approximately 93% (Violet), 95% (Watson) and 96% (Tallering) of the original mapped extent of the three LS remains in the local area (Survey Area).

7.2.2 Vegetation System Associations

The number of bioregions and subregions in which VSAs 202.3, 361 and 420.5 occur is listed in **Table 11** along with their extent, distribution, and protection in the Yalgoo bioregion and in the local area.

More than 99% of VSAs 202.3, 361 and 420.5 remains in the Yalgoo bioregion. Approximately 99% of the originally mapped extent of VSA 361 currently remains in the Survey Area, 97% of VSA 202.3 and 93% of VSA 420.5. The VSAs occur in two bioregions (and two subregions)(VSA 202.3 and 361) and three bioregions (and four subregions)(VSA 420.5). The bioregional extent of the VAs and VSAs are shown on **Map 9 (Section 11)**.

Desmond and Chant (2011) list vegetation associations 202, 361 and 420 as having high reservation priority for the Yalgoo bioregion; however, either none (VA 202 and 361) or only 0.02% (VA 420) of their current extent is protected for conservation (IUCN I-IV) (**Table 11**).

7.2.3 Maia Vegetation Types

Seven vegetation types were mapped in the Survey Area and two of them over only 10 ha (2% of the Survey Area) – ALWL (9.97 ha) and ATSL (1) (10.05 ha); the other vegetation types were mapped over larger areas, the largest, MTSL (2), over 188 ha (41% of the Survey Area).

The P1 flora species *Petrophile vana* was recorded in two of the vegetation types - ATSL (1) and MTSL (1) – and the P4 *Acacia speckii* was recorded in four of them - ATSL (3), ATSL (4), MTSL (1) and MTSL (2).

Some of all seven of the vegetation types mapped in the Survey Area occur within the boundaries of the Minjar and Chulaar Hills P1 PEC. ALWL, ATSL (1), ATSL (2), ATSL (4) and MTSL (2) are mapped in the Tallering LS section of the PEC in the Survey Area and ATSL (1), ATSL (2), ATSL (4) and MTSL (2) in the Watson LS section; the other two vegetation types are in the PEC buffer - ATSL (3) and MTSL (1).

Very small sections of the Survey Area were mapped as ALWL (2% of it), ATSL (1) (2% of it) and ATSL (4) (4% of it). While small areas of ATSL (1) and ATSL (4) were mapped in an adjacent TSF4 area surveyed in 2020, ALWL was not mapped in that area, and neither was it mapped in other areas to the east. All of ALWL, some of ATSL (1), ATSL (2) and ATSL (4) are mapped within the boundaries of the Tallering LS section of the PEC, while the remainder of ATSL (1), and much of the remaining areas of ATSL (2) and ATSL (4) are mapped mostly within the boundaries of the

Watson LS within the PEC polygon. Therefore, these vegetation types, plus MTSL (1) in which the P1 *Petrophile vana* was found, are viewed as locally more significant than the others. While the P4 species *Acacia speckii* occurs in other vegetation types, it is relatively common in the local and regional area and the Survey Area population comprise about 0.8% of the populations known to Maia.

Areas were ATSL (1) is mapped could potentially be habitat for the threatened species *Stylidium scintillans*. This is based on the similarity of the species occurring in ATSL (1) to the species occurring where *S. scintillans* has been located previously in and around the 29MGG project area. However, *Stylidium scintillans* has not been located previously on slopes of the BIF hills in the Golden Grove project area, it has been found on lower hills, with no outcropping BIF, to the east of the main range. ATSL (1) is also one of the vegetation types in which the P1 *Petrophile vana* was located - the second was MTSL (1), which is mapped over a larger area (approximately 84 ha). ATSL (4) was mapped over approximately 18 ha and 23 *Acacia speckii* plants located by Maia were recorded in it.

Table 11: Regional and local pre-European or mapped extent, current extent and protection of the land systems and VSAs of the Survey Area

Unit		Number of bioregions (subregions)	Regional - Yalgoo bioregion				Local - Survey Area		
			Mapped (LS) or pre-European (VSA) extent (ha)	Current extent (ha)	Current extent remaining as a proportion of mapped or pre-European extent (%)	Current extent protected (IUCN I-IV) for conservation as a proportion of mapped or pre-European extent (%)	Mapped or pre-European extent (ha)	Current extent (ha)	Current extent remaining as a proportion of mapped or pre-European extent (%)
LS	**Tallering**	2 (2)	31,486	31,178	99.02	0	39.37	37.75	95.87
	Violet	4 (5)	18,583	18,108	97.45	0	332.05	310.38	93.48
	Watson	2(2)	14,892	14,635	98.27	0	84.30	80.20	95.14
VSA	**202.3**	2 (2)	45,021	44,936	99.81	0	100.82	98.29	97.49
	361	2(2)	76,456	76,430	99.97	0	11.95	11.84	99.08
	420.5	3 (4)	455,832	454,715	99.76	0.02	342.94	318.9	92.78

Note: LS = land system, VSA = vegetation system association. Pre-European and current extent of VSAs in the Yalgoo bioregion from GoWA, 2019. All areas (ha) have been rounded up or down to nearest whole number. The method used to determine originally mapped and current LS extents is described below.

Notes re methods used to determine mapped, pre-European and current extents in Table 12:

Yalgoo bioregion (regional), methods for determining originally mapped and current extent of land systems: The original mapped extent of the land systems was determined by intersecting the land systems shapefiles (DPIRD, 2019a) with IBRA subregions (DotE, 2012); the current extent was determined by intersecting the resultant layer with Native Vegetation Extent (NVE) (DPIRD, 2020a).

Survey Area (local), methods for determining mapped and current extent of land systems: The originally mapped extent of land systems was determined by intersecting the land systems shapefile (DPIRD, 2019a) with Maia Vegetation Types (MVTs) mapped in the Survey Area – areas mapped as disturbed (degraded to completely degraded) were included in the calculations as well as native vegetation. To determine the current extent, the land systems shapefiles were intersected with MVTs and only native vegetation was included in the calculations (areas mapped as degraded to completely degraded were excluded).

Survey Area (local), methods used to determine pre-European and current extent of VSAs: pre-European extent of VSAs was calculated by intersecting pre-European vegetation shapefiles (DPIRD, 2019b) with MVTs mapped in the Survey Area (areas mapped as degraded to completely degraded were included in the calculations as well as with native vegetation). The current extent in the Survey Area was calculated by intersecting the pre-European vegetation shapefiles with MVTs, including only native vegetation in the calculations (degraded to completely degraded were not used).

This page is intentionally blank.

7.3 Significant Vegetation

Significant vegetation is defined in EPA Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016) as vegetation:

- being identified as threatened or priority ecological communities
- restricted distribution
- degree of historical impact from threatening processes
- a role as a refuge
- providing an important function required to maintain ecological integrity of a significant ecosystem.

These dot points are discussed with respect to the vegetation of the Survey Area in the following sections.

7.3.1 Threatened and Priority Ecological Communities

The Survey Area is not in or close to a federally listed TEC (DAWE, 2020b). No TECs protected by the BC Act are listed for the Yalgoo bioregion (DBCA, 2018).

Approximately 55% (249.59 ha) of the 455.72 ha Survey Area is covered by polygons indicating occurrences of the 'Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)' P1 PEC (**Map 2, Section 11**). The PEC within the Survey Area and to the west and the south of it are associated mostly with areas mapped as the Tallering LS and Watson LS, with other land systems falling under the outer edges e.g., the Violet LS in the Survey Area.

The PEC polygons include the sections of the land systems they relate to as well as a buffer around those land systems (approximately 500 m wide but sometimes wider or narrower). About 9% (39.37 ha) of the Survey Area lies over the Tallering LS, 25% (113.76 ha) lies over the Violet LS and 21% (96.46 ha) over the Watson LS i.e., about 30% of the Survey Area is over what is likely to be the actual PEC and 25% is over its buffer.

The Minjar and Chulaar Hills P1 PEC is mapped over approximately 25,154 ha, and about 7,909 ha of it comprises the Tallering LS, 523 ha the Violet LS and 2,270 ha the Watson LS.

Either sections of or all of the seven vegetation types mapped in the Survey Area occur within the boundaries of the Minjar and Chulaar Hills P1 PEC. Five of them are mapped in the Tallering LS section of the PEC in the Survey Area – ALWL, ATSL (1), ATSL (2), ATSL (4) and MTSL (2) – and ALWL is mapped only in the Tallering LS in the Survey Area. Four of the seven vegetation types are mapped in the Watson LS section of the PEC - ATSL (1), ATSL (2), ATSL (4) and MTSL (2), while five are mapped in the Violet LS within the PEC polygon (and presumably the buffer for it) – ATSL (2), ATSL (3), ATSL (4), MTSL (1) and MTSL (2). Areas outside the boundary of the PEC are mapped as ATSL (3), MTSL (1) and MTSL (2).

7.3.2 Restricted Distribution, Historical Impact and Refugia

The land systems and vegetation system associations of the Survey Area are not restricted to the local area, as they occur in the wider Tallering subregion in the Yalgoo bioregion or in the Yalgoo and neighbouring bioregions. The vegetation associations and system associations of the Survey Area have not been historically cleared / impacted, as their current remaining extent in the Yalgoo bioregion, Tallering subregion and Shire of Yalgoo is more than 99% (**Table 1**). Similarly, more than 97% of the land systems of the Survey Area currently remains in the Yalgoo bioregion (**Table 11**). Locally, between 92% and 99% of the VSAs remain in the Survey Area and between 93% and 96% of the LS (**Table 11**).

The main sections of the hills of the Tallering that occur in the Survey Area (and to a lesser degree the Watson LS) extend for many kilometres to the south and southeast of the Survey Area and therefore the small sections of the hills that occur in the Survey Area are unlikely to act as refugia.

7.3.3 Ecosystems at Risk, Groundwater Dependent Ecosystems and Sheet Flow Dependent Vegetation

Ten 'other ecosystems at risk' relating to vegetation are listed for the Yalgoo bioregion (Desmond and Chant, 2011), and plant assemblages dominated by *Acacia grasbyi* (miniritchie) is one of the 10.

Acacia grasbyi was recorded in the Survey Area, it was a dominant species in two of the three relevés at which it was recorded (**Table 21**).

No terrestrial GDE identified by national assessment occurs in the Survey Area. No large drainage lines or wetlands (which could indicate the potential for a GDE) occur in the Survey Area.

Five of the Survey Area acacias are mulga species: *A. caesaneura* (narrow phyllode variant), *A. craspedocarpa* (hybrid), *A. aptaneura, A. aneura* and *A. pteraneura* (Maslin and Reid, 2012; **Table 22, Appendix 7**). The level to gently undulating plains with mantles of abundant ironstone and quartz pebbles and cobbles and level to gently inclined lower plains with mantles of ironstone pebbles of the Violet LS can be subject to sheet flow (Payne et al., 1998). Alteration to sheet flow in these areas could affect the health of the mulga, particularly down slope of structures altering the sheet flow (Payne et al., 1998). The Violet LS is mapped over approximately 68% of the Survey Area.

8 Project Team, Licences and Limitations

8.1 Project Team and Licences

The survey was carried out and the report prepared by the ecologists listed in **Table 12**.

Table 12: Project team

Botanist	Flora licence number
Christina Cox (report)	Not applicable
Rochelle Haycock (report)	Not applicable
Scott Hitchcock (survey and report)	FB62000064
Eva Karikis (report)	Not applicable
Dominic Fabry (report)	Not applicable
Conrad Slee (plant taxonomy)	Not applicable

8.2 Survey Limitations

Technical Guidance, Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016) states that any survey-specific issues / limitations should be addressed in a limitations section and that the limitations should be addressed as standard, whether they were a limitation of survey or not. **Table 13** addresses any survey-specific issues / limitations.

Table 13: Survey limitations

Limitation	Comment
Availability of contextual information at a regional and local scale	**No limitation** A desktop study was carried out to gather background information at a regional and local scale. A number of surveys have been conducted within and around the Survey Area including detailed/Level 2 surveys - Markey and Dillon (2008; 2011); Meissner and Coppen (2014); Patrick (2002)); WEC (2008; 2012), Animal Plant Mineral (APM) (2017), and Maia (2020b). Several reconnaissance/Level 1 and targeted flora surveys have been carried out over some of 29MGG's tenements over the past 25 years e.g., Mattiske (1996 and 2004), Yilgarn Traders (2007; 2008a, 2008b and 2008c; 2009), Yilgarn Consulting (2010 and 2011), WEC (2013) and Maia (2020a and 2020c). Pre-European vegetation mapping and land systems mapping is also available for the Survey Area. The results of searches of DBCA's threatened flora and ecological community databases carried out for the wider project area in 2020, and searches over the buffered Survey Area were carried out using the EPBC Act Protected Matters Search Tool and NatureMap.
Competency /experience of the team carrying out the survey, including experience in the bioregion surveyed	**No limitation** Scott Hitchcock has more than 16 years of experience in carrying out botanical surveys in WA, including in the Yalgoo bioregion. One specimen for most of the uncommon taxa encountered during the survey were collected for formal identification by a taxonomist. The specimens were identified by Conrad Slee, a botanist with more than 22 years of experience in the taxonomy of the flora of the WA.
Proportion of flora recorded and/or collected, any identification issues	**No limitation** One hundred and seventeen (117) taxa from 29 families and 67 genera were recorded: 32% of the 117 taxa were annual and 68% perennial, and 79% of the taxa in the species list was identified from specimens with reproductive material (flowers / fruit or both). The identity of one specimen could not be confirmed– *Grevillea ?sarissa* - because the material was sterile. The proportion of the flora collected and identified based on sampling, survey time, area surveyed, and the intensity of survey effort was good. The number of taxa recorded in the current Survey Area is similar to that recorded during other surveys carried out in and around the Survey Area.
Was the appropriate area fully surveyed (effort and extent)	**No limitation** A flora and vegetation reconnaissance survey combined with a targeted flora survey (targeting conservation significant taxa, novel taxa and weeds) was carried out over the Survey Area. One botanist carried out the survey over three days. Thirty-four relevés were assessed (1.4 ha) and 36.4 ha were assessed via traverses walked over the Survey Area. Overall, 8.2% (37.7 ha) of the Survey Area was assessed.
Access restrictions within the survey area	**No limitation** There were no access problems. The Survey Area was accessed by walking from existing tracks running through the Survey Area.
Survey timing, rainfall, season of survey	**No limitation** The flora and vegetation survey was conducted in early November 2021 (mid-spring). Total rainfall recorded at Golden Grove over the three months before the survey was 3 mm less than the medium-term (2013 – 2021) average total for those three months. BoM's rainfall deciles map shows the Survey Area is in a section of WA that received below average rainfall from Aug to Oct 2021 (BoM, 2020c). Based on this information, the flora and vegetation should have been in below average condition when the survey was carried out in November 2021. However, approximately 32% of the species recorded in the Survey Area were annual species and 78% of the flora taxa recorded were fertile when the survey was carried out. The species list for the August 2020 area surveyed to the east of and adjacent to the current Survey Area comprised 18% annual species and 82% perennial, and 76% of the species list was identified from fertile material. The November survey therefore

Limitation	Comment
	captured more annual species and more species that were fertile than the August survey in the previous year.
Disturbances (fire, flood, accidental human intervention etc.)	**No limitation**
	No disturbances were evident or noted by the botanist carrying out the survey. No floods, severe storms or fires had occurred in the weeks or months before the survey was carried out.

9 Summary - Main Results and Recommendations

9.1 Flora

- One hundred and seventeen (117) taxa from 67 genera and 29 families were located in the Survey Area.
- No threatened flora species was located in the Survey Area.
- One P1 species – *Petrophile vana* - and one P4 species – *Acacia speckii* - were located by Maia. Two *Petrophile vana* plants and 86 *Acacia speckii*. Other *Acacia speckii* plants have been recorded previously in the Survey Area.
- No weed species on any of the national weed lists were located in the Survey Area; six general weed species were located – *Aira caryophyllea (*Silvery Hairgrass), *Cuscuta epithymum* (Lesser Dodder), *Hypochaeris glabra* (Smooth Catsear), *Mesembryanthemum nodiflorum* (Slender Iceplant), *Pentameris airoides* (False Hairgrass) and *Sonchus oleraceus* (Common Sowthistle). *Aira caryophyllea* and *Mesembryanthemum nodiflorum* are rated as having high ecological impact and rapid Invasiveness.

9.2 Vegetation

- Seven vegetation types were mapped in the Survey Area – one Acacia low woodlands, two Acacia tall sparse to open shrublands, one Acacia tall sparse shrubland, one Acacia tall open shrubland and two mixed tall open shrublands.
- The condition of the vegetation in the Survey Area was mapped as Excellent (17.95%), Very Good (53.77%), Good (22.28%), and the remainder (6%) as Degraded to Completely Degraded.
- ALWL, ATSL (1) and ATSL (4) were the least widespread vegetation types mapped in the Survey Area (mapped over 2%, 2%% and 4% respectively), while the most widespread was MTSL (2), mapped over 41%.
- The remaining extent of the two land systems and three vegetation system associations mapped in the Survey Area is more than 97% in the Yalgoo bioregion. Between 92% and 99% of the VSAs and LS currently remain in the Survey Area.

9.3 Ecological Communities and Other Significant Areas

- None of the Survey Area lies in a TEC. Approximately 55% of the Survey Area lies over an area mapped as a PEC – the 'Minjar and Chulaar Hills vegetation complexes (banded ironstone formation)' P1 PEC. The occurrences of this PEC adjacent to and to the south of the Survey Area are associated primarily with areas mapped as the Tallering LS with some areas of the Watson LS. The PEC polygons placed around occurrences of both of these land systems include the land system as well as a buffer. About 30% of the Survey Area lies over the Tallering and Watson LS, while 25% of it lies over the PEC buffer (which is over the Violet LS).
- The Survey Area does not lie in any DBCA Legislated Lands and Waters or DBCA Lands of Interest.
- The Survey Area is not in an ESA or a Schedule One area. No significant wetlands occur in the Survey Area. No non-perennial watercourses, no lakes, waterholes, water points or springs cross or occur in or close to the Survey Area.
- No GDEs (aquatic or terrestrial) are thought to occur in the local or wider area (based on national assessment).
- The level to gently undulating plains with mantles of abundant ironstone and quartz pebbles and cobbles and level to gently inclined lower plains with mantles of ironstone pebbles of the Violet LS can be subject to sheet

flow. Alteration to sheet flow in these areas could affect the health of the mulga, particularly down slope of structures altering the sheet flow.

9.4 Recommendations

- Impact to the vegetation of the PEC should be minimised, particularly to the vegetation within the Tallering and Watson land systems. An approximately 500 m wide buffer has been placed around the mapped boundary of these land systems and is included in the PEC polygon. The northeastern 45% of the Survey Area lies outside of this buffer, and that section of the Survey Area is less significant with respect to the PEC; however, one of the P1 *Petrophile vana* plants is in that section.
- Direct impact to the vegetation of the Survey Area should be minimised as much as possible and vegetation clearing boundaries visibly identified before any clearing starts.
- The area selected for the new TSF should avoid impact to the P1 *Petrophile vana* and minimise impact to the P4 *Acacia speckii* as much as possible.
- Two *Petrophile vana* plants and 86 *Acacia speckii* were recorded by Maia in the Survey Area, and many more *A. speckii* have been recorded in the areas that were not traversed by Maia.
- As *Petrophile vana* is a P1 species and has not been recorded in the Golden Grove area previously (the closest record is 36 km away), a follow-up targeted survey should be carried out to locate any more plants of this significant species.
- 29MGG's weed management practices should avoid the introduction of new weed species to the area and prevent the spread of existing weed species into and away from the Survey Area.
- Impact to the *Santalum spicatum* (Sandalwood) located in the Survey Area should be avoided if possible. Sandalwood is a valuable resource and necessary permits should be applied for if it is to be harvested.
- Should sheet flow of water across the stony plains be impeded by infrastructure, it could affect the health of any mulga down slope of the disturbance.

10 References

Animal Plant Mineral (APM) (2017). Mt Mulgine Project Biological Survey, Rothsay, WA. Prepared on behalf of Tungsten Mining NL, February 2017.

Australasian Virtual Herbarium (AVH) (2022). Available: avh.chah.org.au/. Accessed: February 2022.

Bureau of Meteorology (BoM) (2020a). Aquatic groundwater-dependent ecosystems [shapefile]. Available: http://www.bom.gov.au/water/groundwater/gde/map.shtml.

BoM (2020b). Terrestrial groundwater-dependent ecosystems [shapefile]. Available: http://www.bom.gov.au/water/groundwater/gde/map.shtml.

BoM (2021a). National Groundwater Dependent Ecosystems (GDE) Atlas. Bioregional Assessment Source Dataset. Viewed 19 January 2022, http://www.bom.gov.au/water/groundwater/gde/map.shtml

BoM (2021b). Three-monthly rainfall deciles for Western Australia. Available: http://www.bom.gov.au/jsp/awap/rain/index.jsp?colour=colour&time=history%2Fwa%2F20200201202004 30&step=2&map=decile&period=3month&area=wa.

Cranfield, R.J. & Macfarlane, T.D. (2007). A new species of *Petrophile* (Proteaceae) from south-western Australia. Nuytsia 17: 153-158.

Department of Agriculture, Water and the Environment (DAWE) (2021a). Wetlands of international importance (Ramsar wetlands). Available: https://www.awe.gov.au/environment/epbc/what-is-protected/wetlands#:~:text=The%20EPBC%20Act%20enhances%20the%20management%20and%20protection%20of%20Australia's%20Ramsar%20wetlands.&text=The%20EPBC%20Act%20also%20establishes,through%20nationally%20consistent%20management%20principles.

DAWE (2021b). Directory of Important Wetlands in WA. Available: https://www.environment.gov.au/cgi-bin/wetlands/list.pl.

DAWE (2021c). Protected Matters Search Tool. Report by Coordinates. Available: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst-coordinate.jsf.

Department of Agriculture, Water and the Environment (DAWE) (2021a). Threatened species under the EPBC Act. Available: https://www.environment.gov.au/biodiversity/threatened/species

DAWE (2021b). Threatened ecological communities. Available: https://www.environment.gov.au/biodiversity/threatened/communities.

Department of Biodiversity, Conservation and Attractions (DBCA) (2007-). NatureMap: Mapping Western Australia's Biodiversity. Department of Biodiversity, Conservation and Attractions. Currently not available, searches were carried out before the site closed down.

DBCA (2018). List of Threatened Ecological Communities Endorsed by the Minister for the Environment. Department of Biodiversity Conservation and Attractions. 28 June 2018. Available: https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/threatened_ecological_communities_endorsed_by_the_minister_for_the_environment_june_2018.pdf.

DBCA (2019a). Biodiversity Conservation Act and Regulations. Available: https://www.dpaw.wa.gov.au/plants-and-animals/biodiversity-conservation-act-regulations.

DBCA (2019b). Conservation Codes for Western Australian Flora and Fauna. January 3, 2019. Available: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation%20code%20definitions.pdf.

DBCA (2020a). EPA Redbook Recommended Conservation Reserves 1976-1991 (DBCA-029) [shapefile] (last updated on 24/07/2020). Available: https://catalogue.data.wa.gov.au/dataset/epa-redbook-recommended-conservation-reserves-1976-1991.

DBCA (2020b). Ramsar sites (DBCA-010) [shapefile] (last updated on 20/08/2020). Available: https://catalogue.data.wa.gov.au/dataset/ramsar-sites

DBCA (2020c). Directory of Important Wetlands in Australia (DBCA-045) [shapefile] (last updated on 24/07/2020). Available: https://catalogue.data.wa.gov.au/dataset/directory-of-important-wetlands-in-western-australia.

DBCA (2021a). DBCA - Legislated Lands and Waters (DBCA-011) [shapefile]. (last updated on 11/11/2021). Available: https://catalogue.data.wa.gov.au/dataset/dbca-legislated-lands-and-waters.

DBCA (2021b). DBCA – Lands of Interest (DBCA-012) [shapefile]. (last updated on 11/11/2021). Available: https://catalogue.data.wa.gov.au/dataset/dbca-lands-of-interest.

DBCA (2021c). Priority Ecological Communities for Western Australia, Version 30. Species and Communities Program, Department of Biodiversity, Conservation and Attractions. 15 July 2021.

DBCA (2021d). How does Parks and Wildlife Service manage weeds? Available: https://www.dpaw.wa.gov.au/plants-and-animals/plants/weeds/156-how-does-dpaw-manage-weeds.

Department of Environment and Conservation (DEC) (2013). Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. January 2013. Available: https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf.

Department of Parks and Wildlife (DPaW) (2014). Species-led ecological impact and invasiveness ranking summary results by region. Midwest Region ecological impact and invasiveness ratings from the Department of Parks and Wildlife Midwest Region Species Prioritisation Process 2014.

DPaW (2015). Review of the Sandalwood (Limitation of Removal of Sandalwood) Order 1996. Available: https://www.dpaw.wa.gov.au/images/documents/plants-animals/licences-permits/Flora/sandalwood_oic_review_report_may_2015.pdf.

Department of Primary Industries and Regional Development (DPIRD) (2019a). Soil Landscape Mapping - Rangelands (DPIRD-063) [shapefile]. Available: https://catalogue.data.wa.gov.au/dataset/soil-landscape-mapping-rangelands.

DPIRD (2019b). Pre-European Vegetation (DPIRD-006) [shapefile]. Available: https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006.

DPIRD (2020a). Native Vegetation Extent (DPIRD-005) [shapefile]. Available: https://catalogue.data.wa.gov.au/dataset/native-vegetation-extent.

DPIRD (2020b). Western Australian Organism List. Available: https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol.

DPIRD (2020c). Western Australian Organism List. Available: https://www.agric.wa.gov.au/organisms.

Department of the Environment (DotE) (2012). Interim Biogeographic Regionalisation for Australia (Subregions - States and Territories) v. 7 (IBRA) [shapefile]. Available: http://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7B1273FBE2-F266-4F3F-895D-C1E45D77CAF5%7D.

Department of Water and Environmental Regulation (DWER) (2020a). Clearing Regulations - Environmentally Sensitive Areas (DWER-046) [shapefile]. 2 November 2020. Available: https://catalogue.data.wa.gov.au/dataset/clearing-regulations-environmentally-sensitive-areas-dwer-046.

DWER (2020b). Clearing Regulations - Schedule One Areas (DER-057) [shapefile]. Available: https://catalogue.data.wa.gov.au/dataset/clearing-regulations-schedule-one-areas-dwer-057.

Desmond, A., and Chant, A. (2011). Yalgoo (YAL). Available: https://www.dpaw.wa.gov.au/images/documents/about/science/projects/waaudit/yalgoo_p656-667.pdf.

Ecologia Environment (2010). Oakajee Port and Rail, OPR Rail Development Vegetation and Flora Assessment. May 2010.

Environmental Protection Authority (EPA) (2000). Environmental Protection of Native Vegetation in Western Australia - Clearing of Native Vegetation, with Particular Reference to the Agriculture Area. Position Statement No. 2. December, 2000.

EPA (2016). Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment. Environmental Protection Authority, December 2016.

Executive Steering Committee for Australian Vegetation Information (ESCAVI) (2003). Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0. Department of the Environment and Heritage, Canberra.

Geoscience Australia (2020). Digital elevation model (DEM) (SRTM-derived 1 second DEM version 1.0). Available: Elvis (fsdf.org.au).

Government of Western Australia (GoWA) (2016). Biodiversity Conservation Act 2016. Available: https://www.legislation.wa.gov.au/legislation/statutes.nsf/aspassed_2016.html.

GoWA (2018). Biodiversity Conservation Amendment Regulations 2018. Western Australian Government Gazette, No. 141, 17 September 2018.

GoWA (2019). 2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of April 2019. WA Department of Biodiversity, Conservation and Attractions, Perth. Available: https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics.

Maia Environmental Consultancy Pty Ltd (Maia) (2020a). EMR Golden Grove: Southern Leases Area (Thundelarra and Bassendean) Level 1 Reconnaissance and Targeted Flora Survey, April 2020. Version 1, 6 July 2020.

Maia Environmental Consultancy Pty Ltd (Maia) (2020b). EMR Golden Grove: Gossan Valley Study Area, Detailed Flora and Vegetation Assessment and Stylidium scintillans census. Version 1, 23 August 2020.

Maia Environmental Consultancy Pty Ltd (Maia) (2020c). EMR Golden Grove: Tailings Storage Facility 4 (TSF4) Survey Area, Flora and Vegetation Reconnaissance and Targeted Flora Surveys, August 2020.

Markey, A.S. & Dillon, S.J. (2008). Flora and Vegetation of the Banded Ironstone Formations of the Yilgarn Craton: the central Tallering System. *Conservation Science W. Aust.* 7 (1): 121-149.

Markey, A.S. & Dillon, S.J. (2011). Flora and Vegetation of the Banded Ironstone Formations of the Yilgarn Craton: Yalgoo. *Conservation Science W. Aust.* 8 (1): 113-136.

Maslin, Bruce R. and Reid, Jordan E. (2012). A taxonomic revision of Mulga (*Acacia aneura* and its close relatives: Fabaceae) in Western Australia. Nuytsia 22(4): 129-267.

Mattiske Consulting (Mattiske) (1996). Flora and vegetation of Golden Grove Project, Murchison Zinc Company Pty Ltd. Prepared for John Consulting Services, December 1996.

Mattiske (2004). Priority flora search - Gossan Hill and Surrounds. Prepared for Newmont Golden Grove Operations, February 2004.

Meissner, R.A., and Coppen, R. (2014). Flora and Vegetation of the greenstone ranges of the Yilgarn Craton: Warriedar Fold Belt, *Conservation Science W. Aust.*, Vol. 9, No. 2, pp. 153-167.

National map (2021). Available: https://nationalmap.gov.au/.

Patrick, S. (2002). Flora and vegetation of Burnerbinmah Station: a study of the plant communities in the Mulga shrublands of the Murchison Region, Western Australia. *Conservation Science W. Aust.* 4 (3): 72-93.

Payne, A. L., Van Vreeswyck, A. M. E., Pringle, H. J. R., Leighton, K. A. and Hennig, P. (1998). An inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area, Western Australia. Technical Bulletin No. 90, Agriculture Western Australia.

Smith, P. L., Williams, R. M., Hamilton, S. and Shaik, M. (2006). A risk-based approach to groundwater management for terrestrial groundwater dependant ecosystems. Murray Darling Basin Conference. Dept. Natural Resources NSW.

Stewart, A.J., Sweet, I.P., Needham, R.S., Raymond, O.L., Whitaker, A.J., Liu, S.F., Phillips, D., Retter, A.J., Connolly, D.P., and Stewart, G. (2008). Surface geology of Australia 1:1,000,000 scale, Western Australia [Digital Dataset]. Canberra: The Commonwealth of Australia, Geoscience Australia. Available: http://www.ga.gov.au. Accessed and downloaded through Landgate (March, 2012).

weedsAustralia (2021). Weeds of National Significance (WONS). Available: https://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html.

Western Australian Herbarium (WAH) (1998-). FloraBase – the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. Available: https://florabase.dpaw.wa.gov.au/. Accessed: January and February 2022.

Woodman Environmental Consulting (WEC) (2008). Gindalbie Metals Ltd: Karara – Mungada Project Survey Area Flora and Vegetation. May 2008.

WEC (2012). Regional Flora and Vegetation of the Karara to Minjar Block. Prepared for Karara Mining Limited, June 2012.

WEC (2013). Minerals and Metals Group Limited, Golden Grove Open Pit Expansion Project, Baseline Flora and Vegetation Assessment. August 2013.

WEC (2014). Minerals and Metals Group Limited, Conservation Significant Flora Survey, Northern Leases - Golden Grove. July 2014.

Yilgarn Consulting (2010). Golden Grove Targeted Searches for Conservation Significant Flora - Southern Leases & Gossan Hill South. Prepared for Minerals and Metals Group, December 2010.

Yilgarn Consulting (2011). Golden Grove Targeted Searches for Threatened Flora '*Stylidium* sp. Yalgoo' & Gossan Valley Vegetation and Flora Survey. Prepared for Minerals and Metals Group, November 2011.

Yilgarn Traders (2007). Golden Grove - Southern Leases Vegetation Association Mapping. Prepared for Oxiana Golden Grove, December 2007.

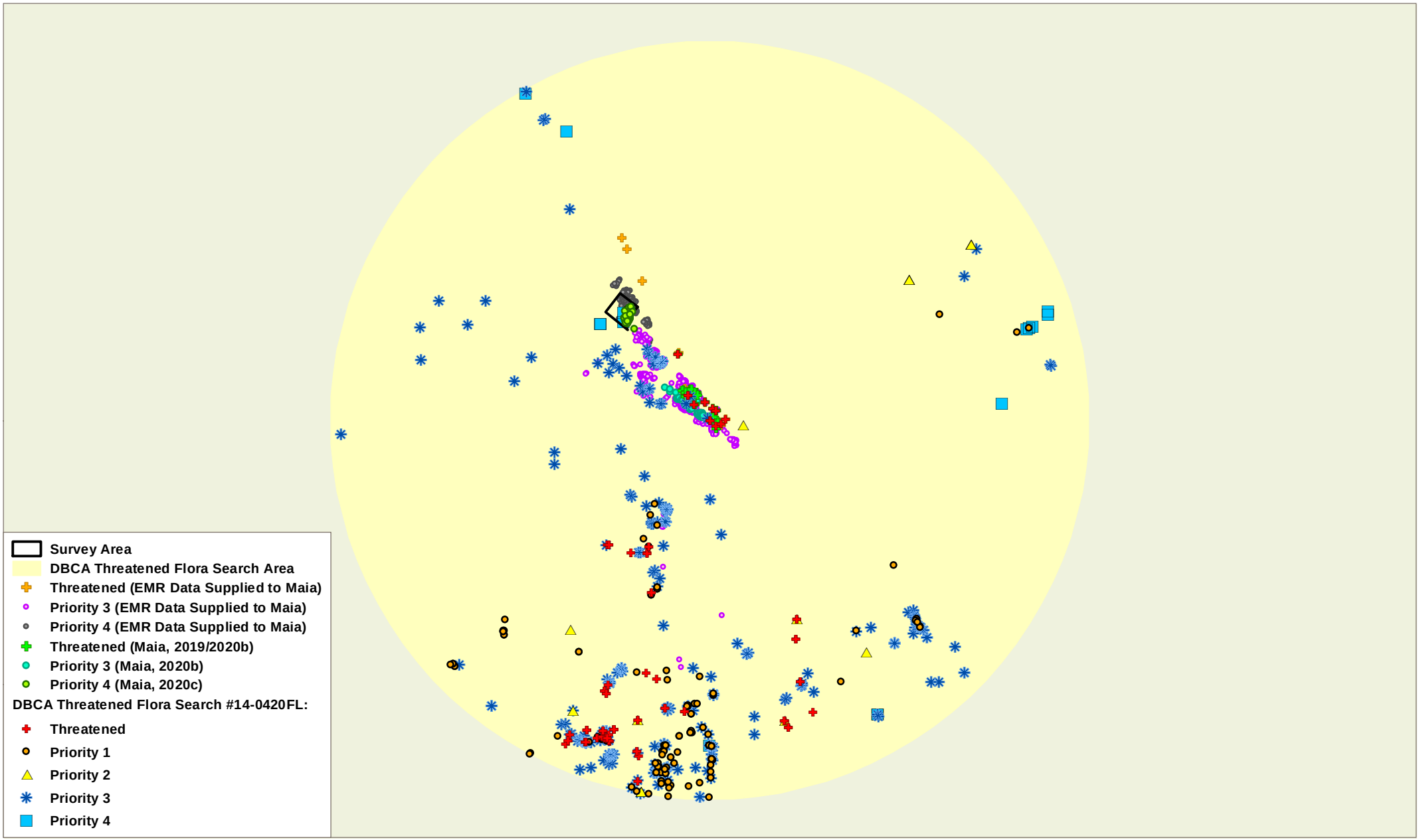
Yilgarn Traders (2008a). Golden Grove - Flora survey & vegetation mapping for TSF3 footprint. Prepared for Oxiana Golden Grove, June 2008.

Yilgarn Traders (2008b). Banded Iron Formation Hills - Buffer zone for the proposed TSF3 site. Prepared for OzMinerals Golden Grove, August 2008.

Yilgarn Traders (2008c). Golden Grove - Flora Survey and Vegetation Mapping for TSF3 footprint - Site A. Prepared for OzMinerals Golden Grove, December 2008.

Yilgarn Traders (2009). Golden Grove - Flora Survey and Vegetation mapping for TSF3 footprint - Site B & D and northern areas. Prepared for OzMinerals Golden Grove, February 2009.

11 MAPS



Conservation Significant Flora -
Selected Database and Literature Searches

maia

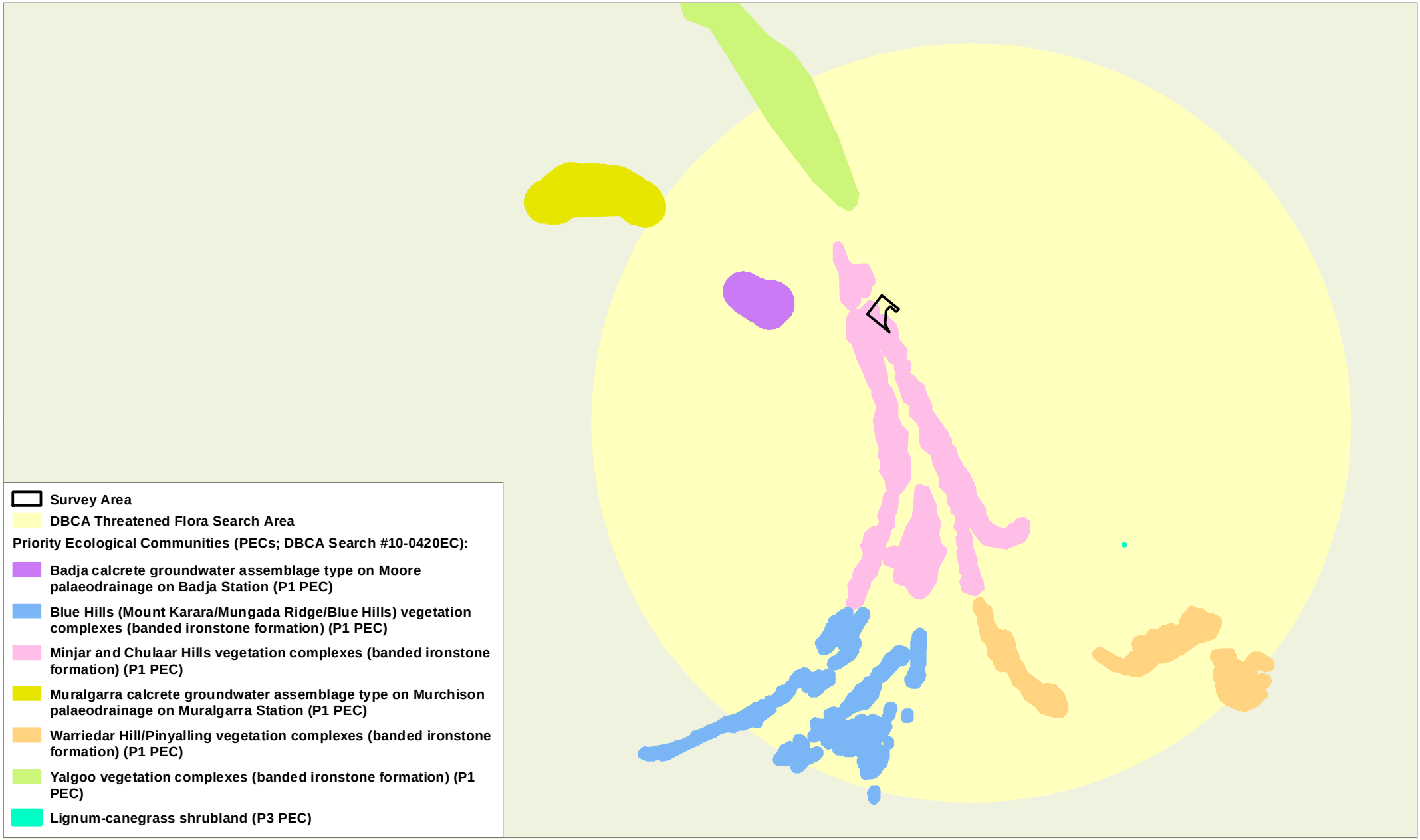
N

0 10

Kilometres

Datum: GDA94, MGA 50

Map: 1
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4



Location Map

Significant Ecological Communities - DBCA Database Search

maia

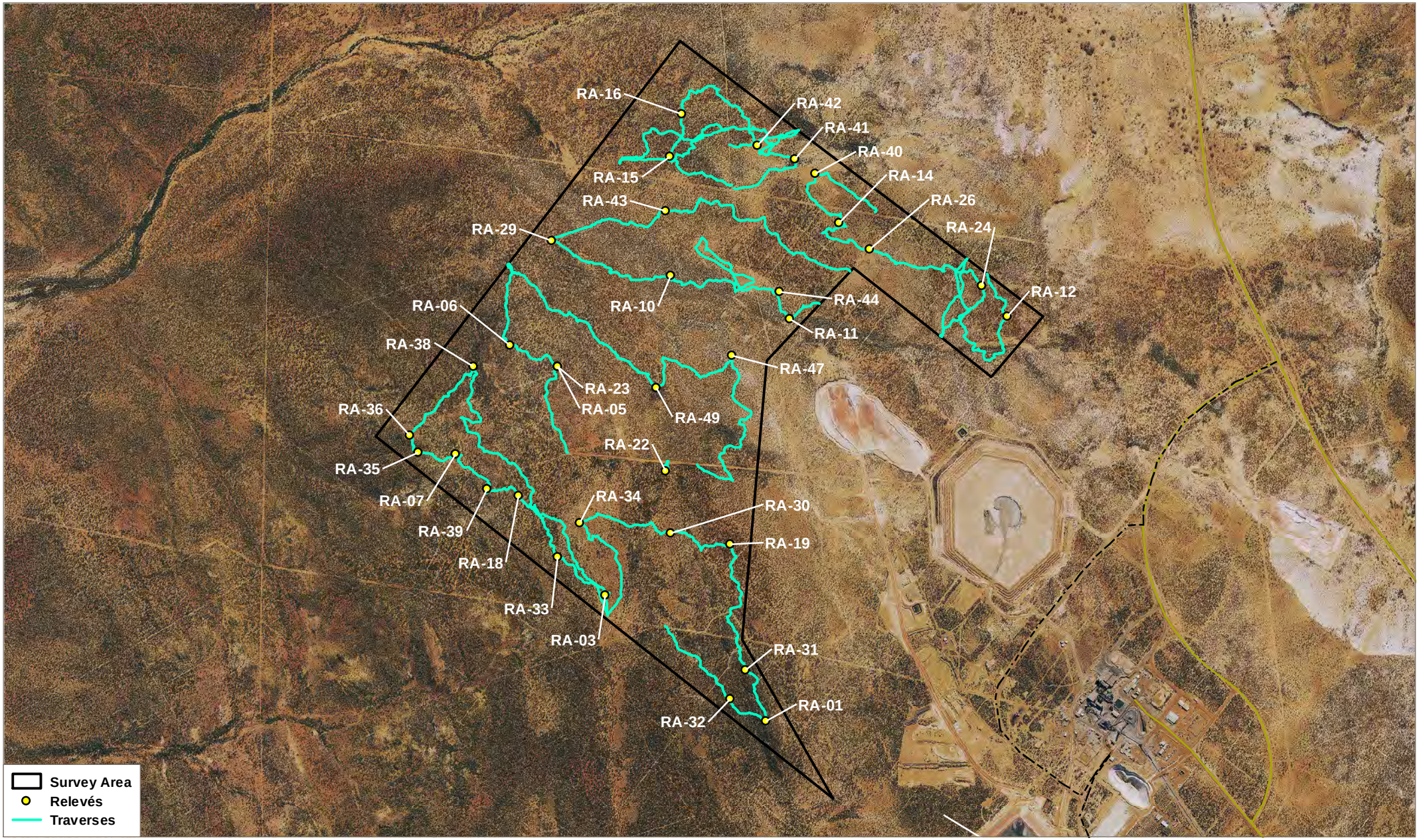
N

0 10

Kilometres

Datum: GDA94, MGA 50

Map: 2
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4



Location Map

Road Network (Main Roads, 20190516)

Tracks

Relevés and Traverses

maia

N

0 0.5

Kilometres

Datum: GDA94, MGA 50

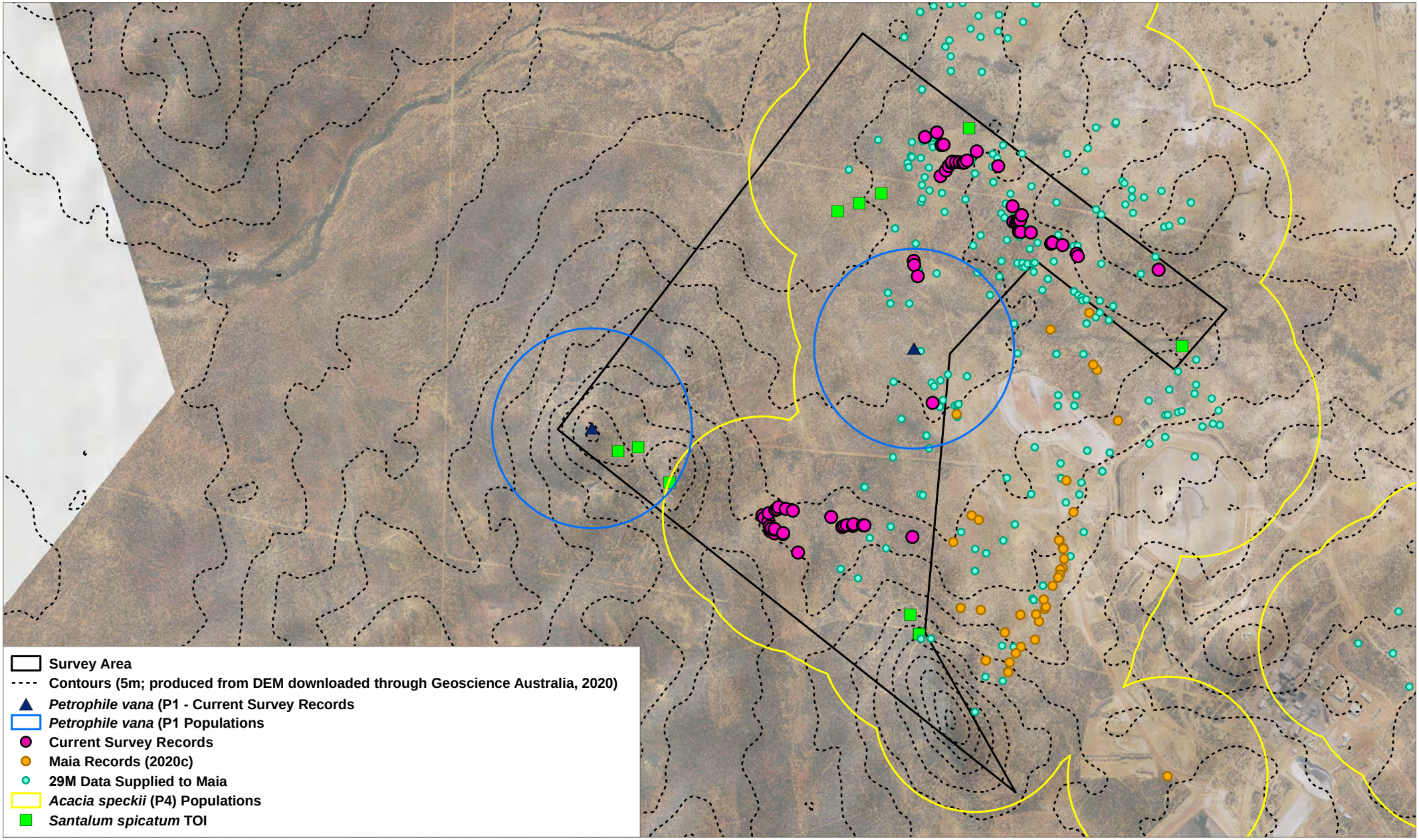
Map: 3

Prepared for: 29 Metals

Drawn by: RH

Date: 1/02/2022

Version: 1 **Size:** A4



Location Map

Hillshade (Geoscience Australia, 2020; QGIS, 2020)

Conservation Significant Flora and Taxon of Interest

maia

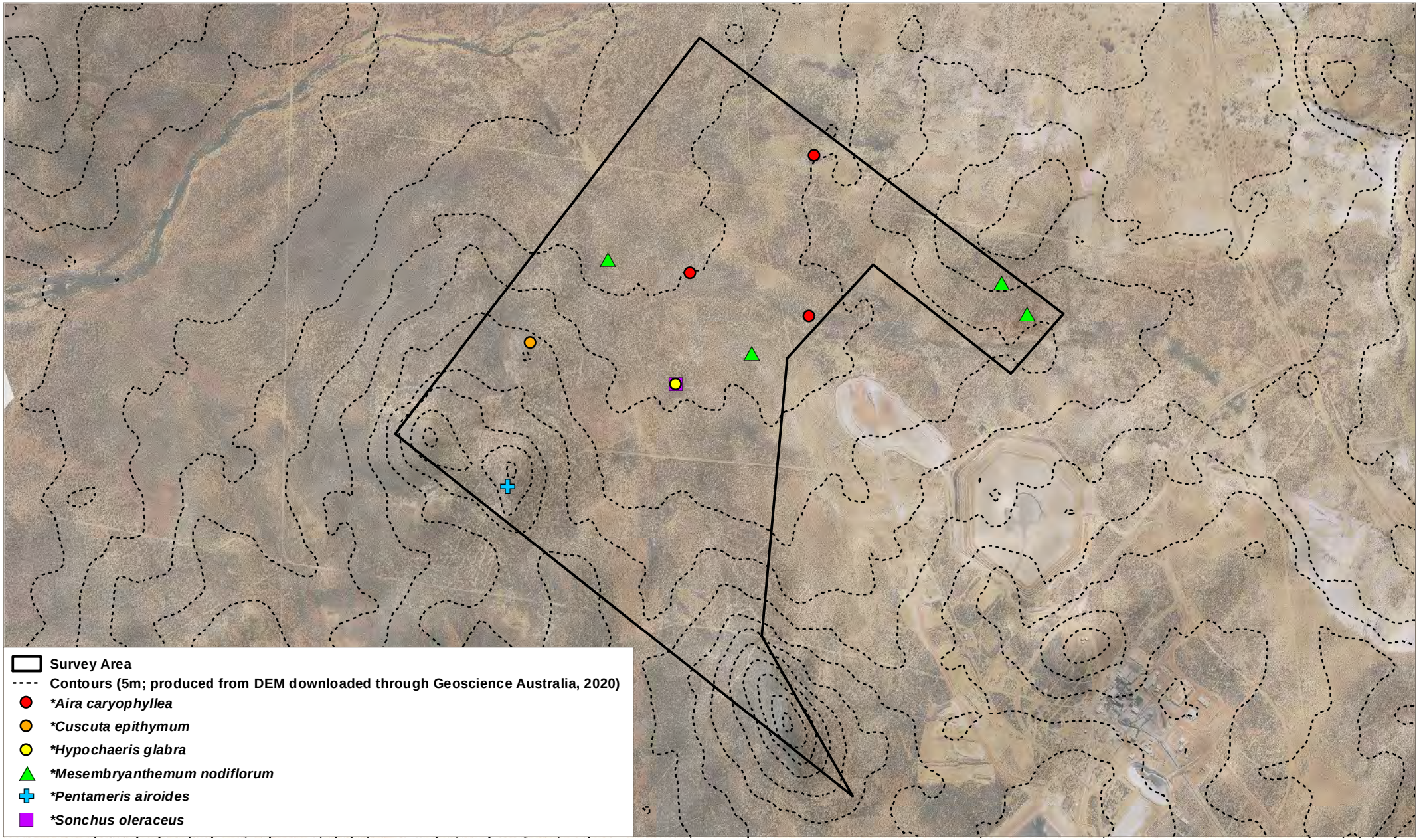
N

0 0.5

Kilometres

Datum: GDA94, MGA 50

Map: 4
Prepared for: 29 Metals
Drawn by: RH
Date: 8/02/2022
Version: 2 **Size:** A4



Location Map

Hillshade (Geoscience Australia, 2020; QGIS, 2020)

Weeds

maia

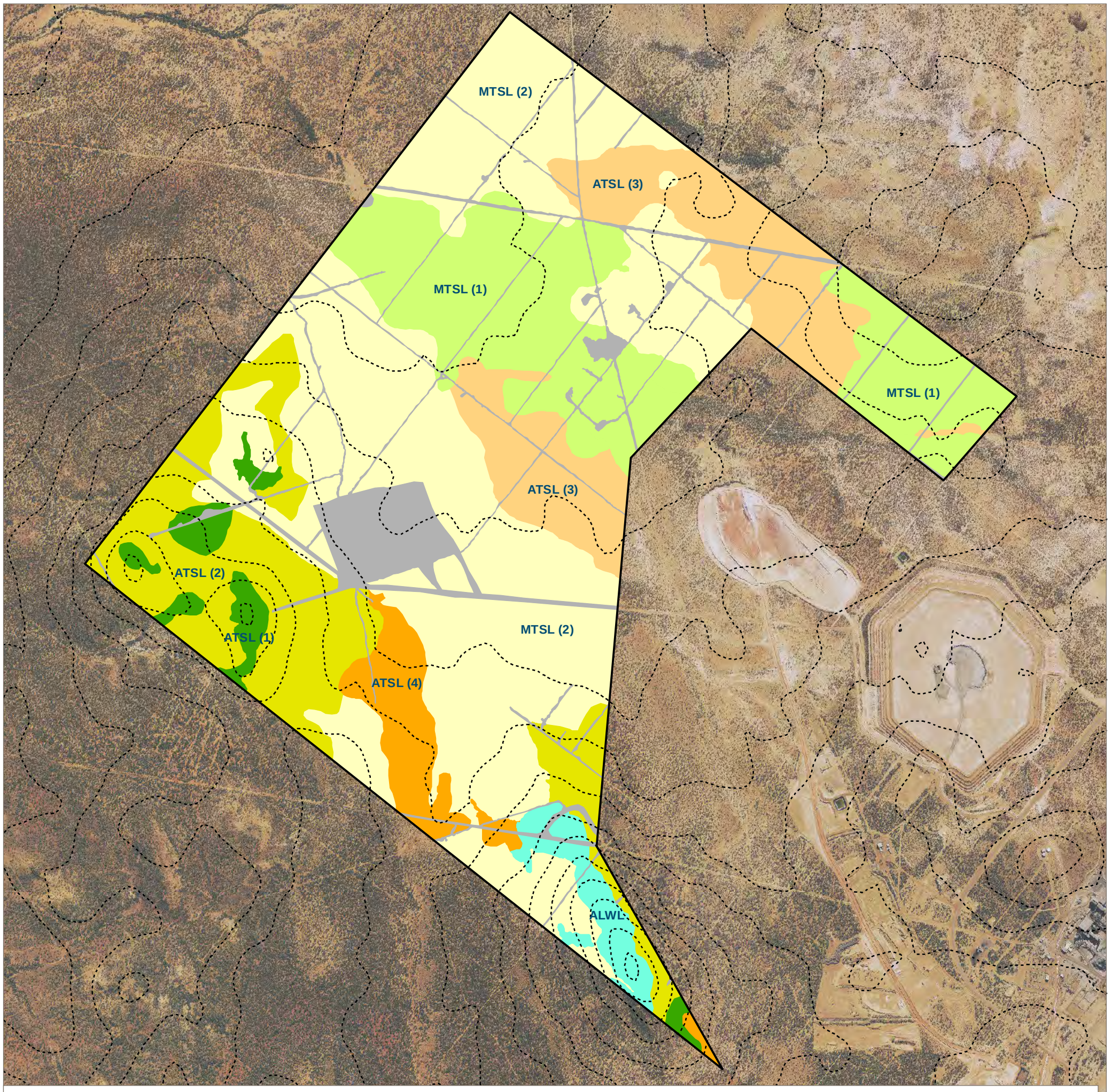
N

0 0.5

Kilometres

Datum: GDA94, MGA 50

Map: 5
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4



Survey Area

Maia Vegetation Types:

ALWL	Low Open Woodland of *Acacia aptaneura* with a mixed Tall Sparse Shrubland mainly of *Acacia aptaneura*, *A. caesaneura* (narrow phyllode variant), *A. ramulosa* var. *ramulosa* and a Sparse Shrubland of *Eremophila latrobei* subsp. *latrobei*
ATSL (1)	Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa* and *A. aulacophylla* with a Sparse Mixed Shrubland of *Thryptomene costata*, *Mirbelia* sp. Bursarioides (T.R. Lally 760) and *Philotheca brucei* subsp. *brucei*
ATSL (2)	Tall Sparse Shrubland to Tall Open Shrubland of *Acacia ramulosa* var. *ramulosa*, *A. effusifolia* and / or *A. caesaneura* (narrow phyllode variant) with a mixed Open Shrubland mainly of *Eremophila forrestii* subsp. *forrestii*, *E. latrobei* subsp. *latrobei* and *Philotheca sericea* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)
ATSL (3)	Mixed Tall Open Shrubland mainly of *Acacia burkittii*, *A. ramulosa* var. *ramulosa* and *Hakea recurva* subsp. *arida* with Isolated mixed Low Shrubs mainly of *Solanum lasiophyllum*, *Maireana villosa* and *Ptilotus obovatus*
ATSL (4)	Mixed Acacia Tall Open Shrubland mainly of *Acacia ramulosa* var. *ramulosa*, *A. caesaneura* and *A. umbraculiformis* with a mixed Open Shrubland mainly of *Thryptomene costata*, *Aluta aspera* subsp. *hesperia* and *Eremophila forrestii* subsp. *forrestii*
MTSL (1)	Mixed Tall Open Shrubland mainly of *Acacia burkittii*, *A. ramulosa* var. *ramulosa* and *Hakea recurva* subsp. *arida* with Isolated mixed Low Shrubs mainly of *Solanum lasiophyllum*, *Maireana villosa* and *Ptilotus obovatus*
MTSL (2)	Tall Open mixed Shrubland mainly of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* and *Grevillea obliquistigma* subsp. *obliquistigma* with a mixed Open Shrubland mainly of *Acacia exocarpoides*, *Eremophila forrestii* subsp. *forrestii* and *Aluta aspera* subsp. *hesperia*
Disturbed	

Contours (5m; produced from DEM downloaded through Geoscience Australia, 2020)

maia

Location Map

Maia Vegetation Types

N

0 0.4

Kilometres

Datum: GDA 1994, MGA 50

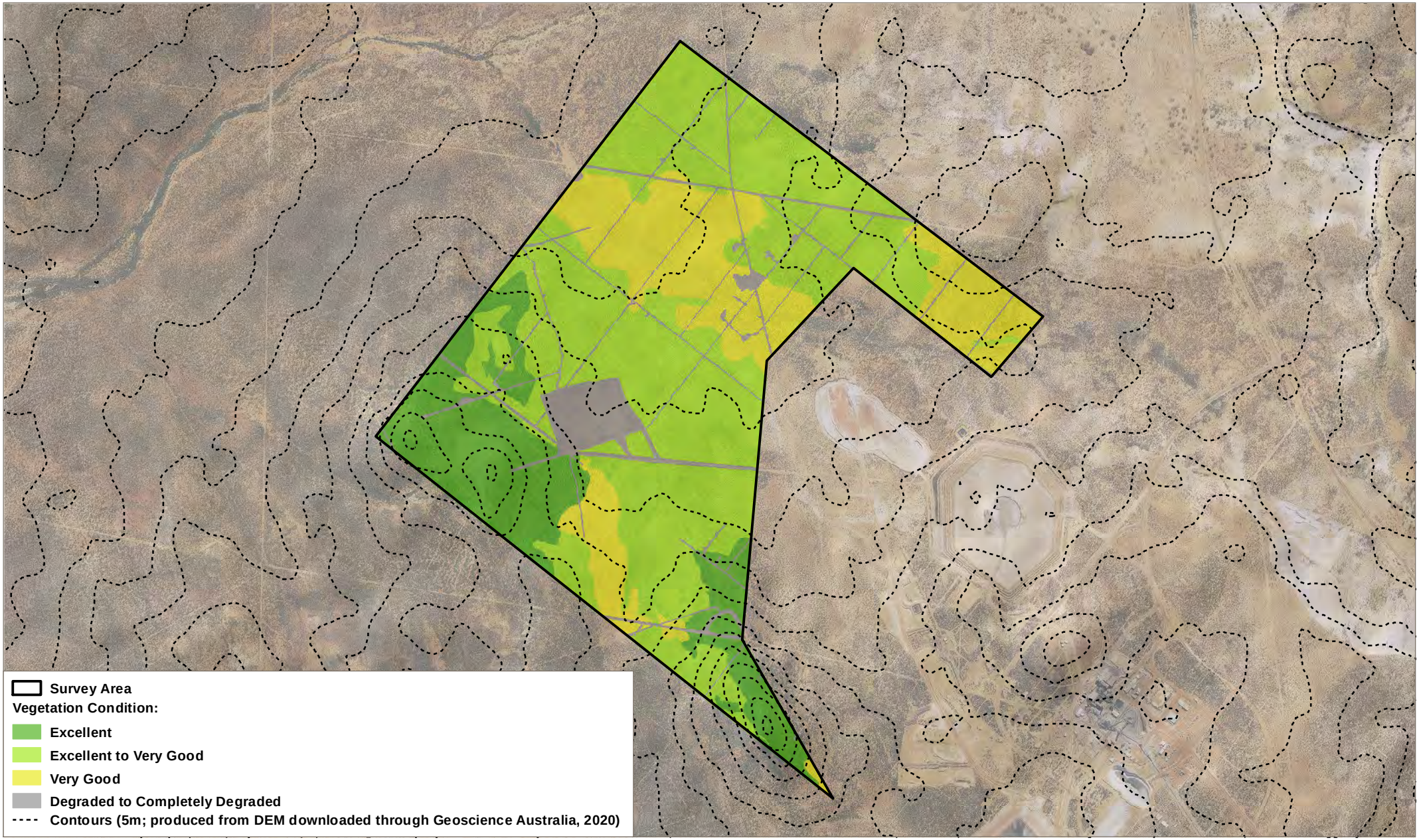
Map: 6

Prepared for: 29 Metals

Drawn by: RH

Date: 1/02/2022

Version: 1 **Size:** A3



Hillshade (Geoscience Australia, 2020; QGIS, 2020)

Vegetation Condition

maia

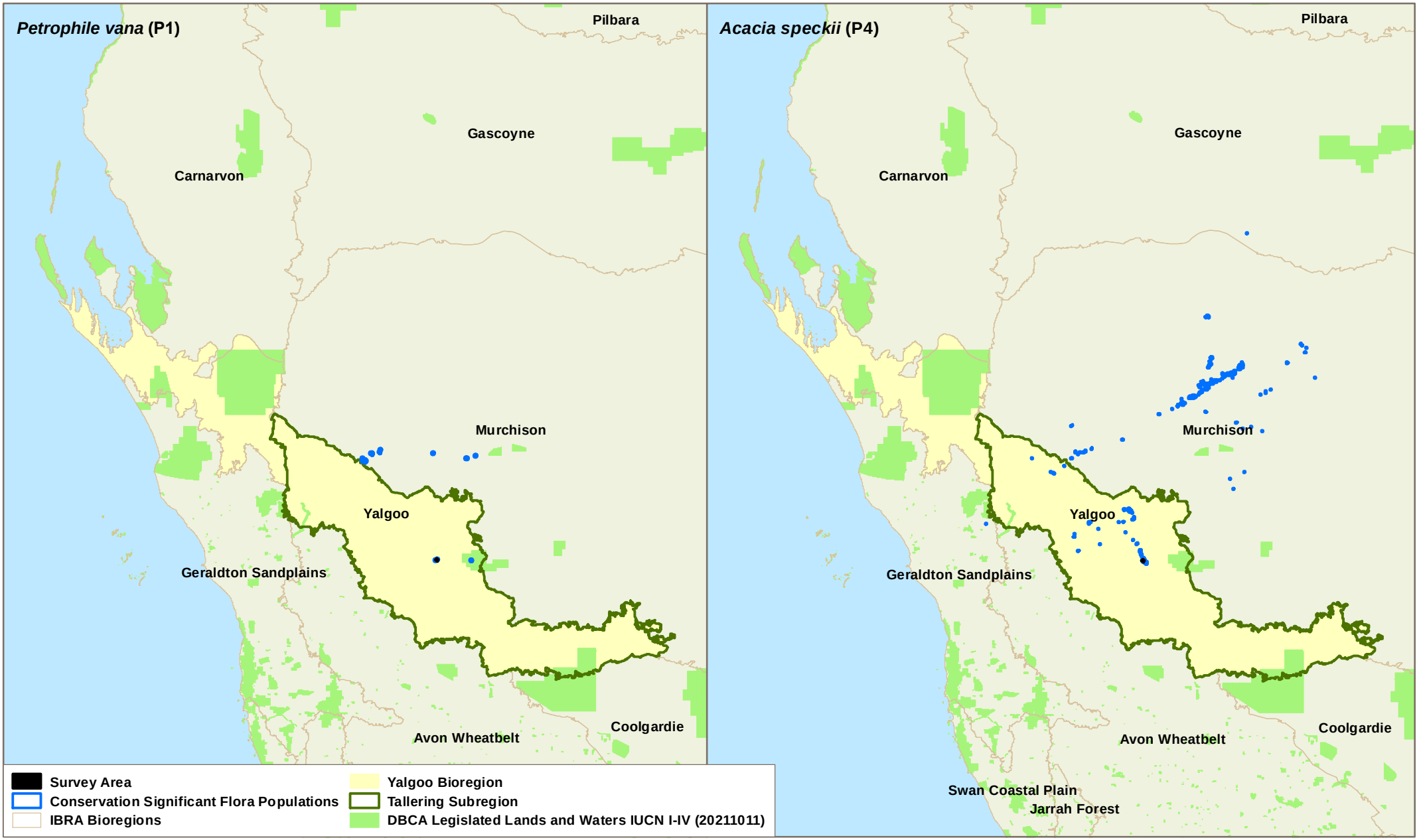
N

0 0.5

Kilometres

Datum: GDA94, MGA 50

Map: 7
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4



Location Map

Conservation Significant Flora - Distribution in WA

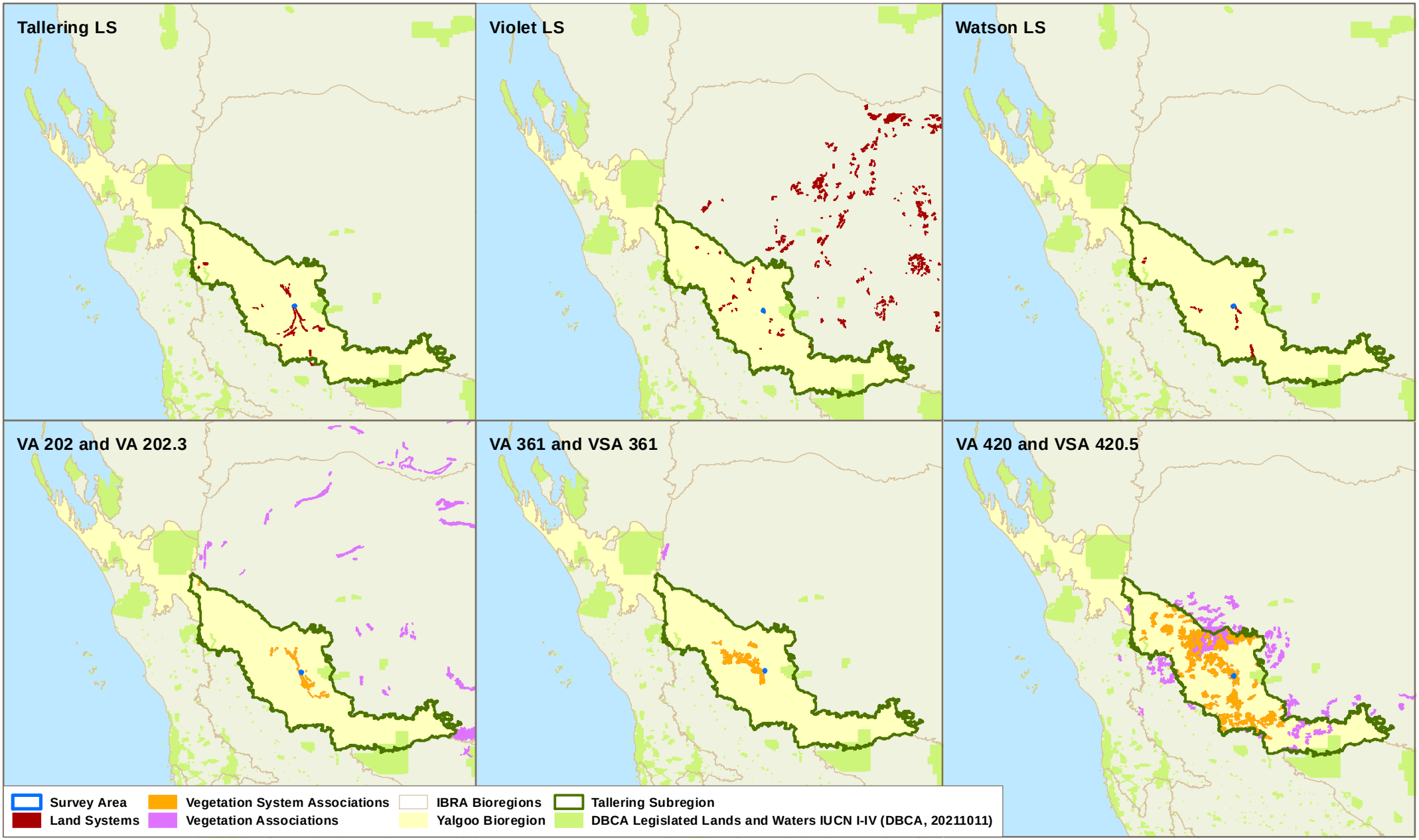
N

0 50

Kilometres

Datum: GDA94, MGA 50

Map: 8
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4



Distribution of Land Systems (LS), Vegetation Associations (VA) and Vegetation System Associations (VSA) (Pre-European Extent) in the Yalgoo Bioregion

maia

N

Datum: GDA 1994, MGA 50

Map: 9
Prepared for: 29 Metals
Drawn by: RH
Date: 1/02/2022
Version: 1 **Size:** A4

This page is intentionally blank.

APPENDIX 1: CONSERVATION SIGNIFICANCE (FLORA AND ECOLOGICAL COMMUNITIES)

Threatened Flora

Some flora species can be protected by Australian Government legislation (*Environment Protection and Biodiversity Conservation Act 1999*, EPBC Act) or by WA legislation (*Biodiversity Conservation Act 2016*, BC Act) (DAWE, 2021a; GoWA, 2016). Species specially protected by these acts are referred to as threatened species and can be listed as critically endangered, endangered or vulnerable.

On 1 January 2019, the BC Act and *Biodiversity Conservation Regulations 2018* replaced both the *Wildlife Conservation Act 1950* and the *Sandalwood Act 1929* and their associated regulations (DBCA, 2019a; GoWA, 2016 and 2018). The new BC Act and regulations provide greater protection for threatened species and ecological communities.

Priority Flora

Possible threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Flora List under Priorities (P) 1, 2, 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species list for other than taxonomic reasons, are placed in Priority 4 and require regular monitoring (DBCA, 2019b).

Threatened Ecological Communities

Some ecological communities are protected by Australian Government legislation (the EPBC Act) based on the perceived levels of threat to the community or species population at a national level. They are listed as threatened ecological communities – TECs – and can be listed as critically endangered, endangered or vulnerable (DAWE, 2020c). The communities are listed by state on the DAWE website.

In WA, the BC Act provides for the statutory listing of TECs by the Minister. The new legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs. These TECs are listed as presumed totally destroyed, critically endangered, endangered or vulnerable (DBCA, 2018; Department of Environment and Conservation (DEC), 2013).

Priority Ecological Communities

Ecological communities with insufficient information available to be considered a TEC, or which are rare but not currently threatened are placed on a priority list and are referred to as priority ecological communities (PECs; DBCA, 2020f). Definitions, categories and criteria for threatened and priority ecological communities can be found on the DBCA's website (DEC, 2013).

APPENDIX 2: WEEDS

Weeds of National Interest

A number of lists of weeds of national interest are currently recognised. A number of lists and strategies have been created that identify plants of particular concern or plants that have been through an assessment process (weedsAustralia, 2021). Weeds lists include: Weeds of National Significance (WoNS), Species Targeted for Biological Control, Species permitted entry into Australia, Priority list of exotic weeds, National Environmental Alert List, Sleeper Weeds, Species targeted for eradication and State and territory noxious weed lists (weedsAustralia, 2021).

Declared Pests

To protect WA agriculture DPIRD regulates harmful plants under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DPIRD, 2020b). Under the Biosecurity and Agriculture Management Regulations 2013, declared pests can be assigned to one of three control categories and these are explained in **Table 14**.

Table 14: Control categories for declared pests (DPIRD, 2020b)

Category (C)	Definition
C1 (Exclusion)	Organisms which should be excluded from part or all of Western Australia.
C2 (Eradication)	Organisms which should be eradicated from part or all of Western Australia.
C3 (Management)	Organisms that should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism.
Unassigned	Unassigned: Declared pests that are recognised as having a harmful impact under certain circumstances, where their subsequent control requirements are determined by a Plan or other legislative arrangements under the Act.

DBCA Weed Prioritisation Process

The DBCA prioritises weeds in each region based on their invasiveness, ecological impact, potential and current distribution and feasibility of control. The resulting priorities focus on weeds considered to be high impact, rapidly invasive and still at a population size that can feasibly be eradicated or contained to a manageable size (DBCA, 2021d).

Summaries of the species' ecological impact and invasiveness rankings are provided to help landholders, community groups and private enterprises manage weeds that might impact on the natural environment (DBCA, 2021d). Most recent species-led ecological impact and invasiveness ranking summary results are available for the different government regions in WA.

APPENDIX 3: DATABASE AND LITERATURE SEARCH RESULTS

Table 15: Conservation significant flora

Species	Conservation code	EPBC Act Protected Matters Search Tool	NatureMap (DBCA, 2007-)	DBCA search results	
				TPFL	WAHERB
Eucalyptus synandra	T (VU - EPBC & WA)	•			
Gyrostemon reticulatus	T (CR - EPBC & WA)	•			
Stylidium scintillans	T (VU - WA)		•	•	•
Chamelaucium sp. Yalgoo (Y. Chadwick 1816)	P1		•	•	
Calotis sp. Perrinvale Station (R.J. Cranfield 7096)	P3		•		•
Drummondita fulva	P3		•		•
Grevillea globosa	P3		•		•
Micromyrtus trudgenii	P3		•	•	•
Persoonia pentasticha	P3		•		•
Polianthion collinum	P3		•	•	•
Psammomoya implexa	P3		•		•
Rhodanthe collina	P3		•	•	•
Acacia speckii	P4		•		•
Haegiela tatei	P4		•	•	•

Note: T = Threatened, CR = Critical, VU = Vulnerable, P1, P3 and P4 = Priority One, Three and Four. NatureMap data was collated before the site shut down.

Table 16: Weeds

Species	DPaW (2014) Ratings		PMST	NM	Mattiske 1996	Yilgarn Consulting, 2011	Maia, 2020b	Maia, 2020c
	Ecological Impact	Invasiveness						
Aira caryophyllea	H	R					•	
Bromus rubens	U	R		•				
Cenchrus ciliaris	H	R	•					
Cirsium vulgare	N/A				•			
Cleretum papulosum and *C. papulosum* subsp. *papulosum*	U	R		•				•
Cucumis myriocarpus* subsp. *myriocarpus	U	R					•	
Cuscuta epithymum	U	R		•			•	
Cuscuta planiflora	U	R				•		
Hypochaeris glabra	L	R		•	•		•	
Lamarckia aurea	U	R		•				
Lolium rigidum	U	R			•			
Mesembryanthemum nodiflorum	H	R		•		•	•	•
Parentucellia latifolia	M	R				•		
Pentameris airoides* and *P. airoides* subsp. *airoides	U	R			•	•	•	
Raphanus raphanistrum	H	R			•			
Rostraria pumila	U	U					•	
Rumex hypogaeus	L	R			•		•	
Schismus arabicus	M	M					•	
Sisymbrium orientale	U	U			•			
Sonchus oleraceus	U	R			•	•	•	
Spergula pentandra	L	R		•		•	•	
Vulpia muralis	U	R		•				

Note: rows highlighted pink = high ecological impact and rapid invasiveness species; species in bold font in column 1 = those recorded during surveys carried out at Golden Grove and surrounds for 29MGG.

APPENDIX 4: VEGETATION CONDITION

Table 17: Vegetation condition scale (EPA, 2016)

Vegetation condition	South-West and Interzone Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact, and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.

APPENDIX 5: NATIONAL VEGETATION INFORMATION SYSTEM VEGETATION CLASSIFICATION

Table 18: NVIS growth forms and descriptions

Growth form	Description
Tree	Woody plants, more than 2m tall with a single stem or branches well above the base.
Tree Mallee	Woody perennial plant usually of the genus *Eucalyptus*. Multi-stemmed with fewer than 5 trunks of which at least 3 exceed 100 mm at breast height (1.3 m). Usually 8 m or more in height.
Shrub	Woody plants multi-stemmed at the base (or within 200 mm from ground level) or if single stemmed, less than 2 m in height.
Mallee Shrub	Commonly less than 8 m tall, usually with 5 or more trunks, of which at least 3 of the largest do not exceed 100 mm at breast height (1.3 m).
Heath Shrub	Shrub usually less than 2 m, with sclerophyllous leaves having high fibre: protein ratios and with an area of nanophyll or smaller (less than 225 sq. m.). Often a member of the following families: Epacridaceae, Myrtaceae, Fabaceae and Proteaceae. Commonly occur in nutrient-poor substrates.
Chenopod Shrub	Single or multi-stemmed, semi-succulent shrub of the family Chenopodiaceae exhibiting drought and salt tolerance.
Samphire Shrub	Genera (of Tribe Salicornioideae, viz: *Halosarcia*, *Pachycornia, Sarcocornia*, *Sclerostegia*, *Tecticornia* and *Tegicornia*) with articulate branches, fleshy stems and reduced flowers within the Chenopodiaceae family, succulent chenopods. Also genus *Suaeda*.
Tussock Grass	Forms discrete but open tussocks usually with distinct individual shoots, or if not, then forming a hummock. These are common agricultural grasses.
Hummock Grass	Coarse xeromorphic grass with a mound-like form often dead in the middle; genera are *Triodia* and *Plectrachne*.
Sedge	Herbaceous, usually perennial erect plant generally with a tufted habit and of the families Cyperaceae (true sedges) or Restionaceae (node sedges).
Rush	Herbaceous, usually perennial erect monocot that is neither a grass nor sedge. For the purposes of NVIS, rushes include the monocotyledon families Juncaceae, Typhaceae, Liliaceae, Iridaceae, Xyridaceae and the genus *Lomandra* (i.e. "graminoid" or grass-like genera).
Forb	Herbaceous or slightly woody, annual or sometimes perennial plant (usually a
Grass-tree	Australian grass trees. Members of the family Xanthorrhoeaceae.
Cycad	Members of the families Cycadaceae and Zamiaceae.

Table 19: Height classes defined for the NVIS

Height classes	Height range (m)	Tree	Shrub, heath shrub, chenopod shrub, samphire shrub, cycad, grass-tree	Tree mallee, mallee shrub	Tussock grasses, sedges, rushes and forbs
8	**>30**	tall			
7	**10-30**	mid		tall	

Height classes	Height range (m)	Tree	Shrub, heath shrub, chenopod shrub, samphire shrub, cycad, grass-tree	Tree mallee, mallee shrub	Tussock grasses, sedges, rushes and forbs
6	**<10**	low		mid	
5	**<3**			low	
4	**>2**		tall		tall
3	**1-2**		mid		tall
2	**0.5-1**		low		mid
1	**<0.5**		low		low

Table 20: NVIS structural formation terminology

Growth Form	Height (m)	Foliage Cover (%)					
		>70	**30-70**	**10-30**	**2-10**	**<2 (isolated)**	**<2 (isolated clump)**
Tree	**<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	**<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
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
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

Source: **Tables 18 to 20** from ESCAVI (2003).

APPENDIX 6: RELEVÉ SITE INFORMATION

Table 21: Information collected at relevé sites

Relevé: RA-01	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492764	mE	6820346	mN	
Habitat:	Low ridge gentle (ridgetop)					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	BIF stones (60%), BIF boulders (10%)					
Mapped as:	**ALWL**					
Vegetation association:	Open Low Woodland of *Acacia aptaneura* with a Sparse Tall Shrubland of *Acacia aptaneura*, *Acacia caesaneura* (narrow phyllode variant) and *Acacia ramulosa* var. *ramulosa* with Sparse Mid Shrubland of *Eremophila latrobei* subsp. *latrobei* and Sparse Low Shrubland of *Eremophila latrobei* subsp. *latrobei*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aptaneura, Acacia ramulosa var. ramulosa, Cheilanthes adiantoides, Eremophila latrobei subsp. latrobei, Goodenia mimuloides, Grevillea obliquistigma, Mirbelia sp. Bursarioides (T.R. Lally 760), Philotheca deserti, Philotheca sericea, Sida sp. Golden calyces glabrous (H.N. Foote 32), Solanum lasiophyllum, Thryptomene decussata, Waitzia acuminata var. acuminata*					

Relevé: RA-03	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491959	mE	6820976	mN	
Habitat:	Hill gentle (upperslope)					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	Ironstone gravel (40%), Ironstone stones (20%)					
Mapped as:	**ATSL (4)**					
Vegetation association:	Open Low Shrubland of *Thryptomene costata* with Sparse Tall Shrubland of *Acacia umbraculiformis* and Sparse Mid Shrubland of *Thryptomene costata*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aneura, Acacia ramulosa* var. *ramulosa, Acacia umbraculiformis, Calocephalus multiflorus, Eremophila compacta, Eriachne pulchella* subsp. *pulchella, Goodenia mimuloides, Ptilotus gaudichaudii, Ptilotus obovatus, Ptilotus schwartzii, Thryptomene costata, Waitzia acuminata* var. *acuminata*					

Relevé: RA-05	Described by: SH			Date: 8/11/2021		Photo:
Location (GDA94):	MGA50	491718	mE	6822121	mN	
Habitat:	Hill very gentle east facing slope (footslope)					
Soil:	Orange sandy-clay surface crust (20%)					
Rocks:	Granitic rocks stones (40%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* with Sparse Mid Shrubland of *Philotheca brucei*, *Eremophila georgei* and Sparse Low Shrubland of *Ptilotus obovatus*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia exocarpoides, Acacia ramulosa* var. *ramulosa, Acacia sibina, Acacia tetragonophylla, Calocephalus multiflorus, Eremophila georgei, Eremophila latrobei* subsp. *latrobei, Erodium cygnorum, Erymophyllum glossanthus, Goodenia mimuloides, Goodenia rosea, Grevillea obliquistigma, Panaetia lessonii, Philotheca brucei, Ptilotus obovatus, Ptilotus schwartzii, Solanum lasiophyllum, Thysanotus manglesianus, Waitzia acuminata* var. *acuminata*					

Relevé: RA-06	Described by: SH			Date: 8/11/2021		Photo:
Location (GDA94):	MGA50	491483	mE	6822228	mN	
Habitat:	Hill gentle north-east facing slope (upperslope)					
Soil:	Orange sandy-loam surface crust (5%)					
Rocks:	BIF stones (40%), Granitic rocks stones (10%), Jaspalite stones (10%)					
Mapped as:	**ATSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia caesaneura* (narrow phyllode variant) with Sparse Mid Shrubland of *Thryptomene decussata*, *Philotheca sericea* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia assimilis* subsp. *assimilis, Acacia caesaneura* (narrow phyllode variant), *Acacia ramulosa* var. *ramulosa,* ***Cuscuta epithymum****, *Gnephosis arachnoidea, Goodenia mimuloides, Philotheca sericea, Rhodanthe citrina, Solanum lasiophyllum, Thryptomene decussata, Waitzia acuminata* var. *acuminata*					

Relevé: RA-07	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491210	mE	6821685		
Habitat:	Hill gentle east facing slope (upperslope)					
Soil:	Orange sandy-clay surface crust (30%)					
Rocks:	Ironstone boulders (10%), Ironstone stones (45%)					
Mapped as:	**ATSL (2)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia exocarpoides* with Sparse Mid Shrubland of *Philotheca brucei*, *Eremophila latrobei* subsp. *latrobei* with Sparse Low Shrubland of *Eremophila latrobei* subsp. *latrobei* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia exocarpoides*, *Acacia ramulosa* var. *ramulosa*, *Acacia caesaneura* (narrow phyllode variant), *Dodonaea petiolaris*, *Philotheca brucei*, *Philotheca deserti*, *Philotheca sericea*, *Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Ptilotus obovatus*, *Ptilotus schwartzii*, *Eremophila clarkei*, *Eremophila forrestii* subsp. *forrestii*, *Eremophila latrobei* subsp. *latrobei*, *Goodenia mimuloides*, *Calocephalus multiflorus*, *Waitzia acuminata* var. *acuminata*					

Relevé: RA-10	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492285	mE	6822577	mN	
Habitat:	Drainage lines					
Soil:	Orange-white sandy-clay surface crust (40%)					
Rocks:	Laterite gravel (2%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla*, *Acacia burkittii* with Open Forbland of *Erymophyllum glossanthus* with Sparse Mid Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla* and *Acacia burkittii* and Sparse Low Shrubland of *Eremophila granitica*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, off track driving					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla,* ***Aira caryophyllea****, Calocephalus multiflorus, Comesperma integerrimum, Eremophila eriocalyx, Eremophila granitica, Erymophyllum glossanthus, Gnephosis arachnoidea, Goodenia mimuloides, Goodenia rosea, Hakea recurva* subsp. *arida, Lawrencella rosea, Maireana carnosa, Maireana planifolia, Panaetia lessonii, Ptilotus obovatus, Vincetoxicum lineare*					

Relevé: RA-11	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492882	mE	6822360	mN	
Habitat:	Drainage lines					
Soil:	Orange-white sandy-clay surface crust (40%)					
Rocks:	Laterite gravel (2%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla*, *Acacia burkittii* with Open Forbland of *Erymophyllum glossanthus* with Sparse Mid Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla*, *Acacia burkittii* and Sparse Low Shrubland of *Eremophila granitica*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, off track driving					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla,* ***Aira caryophyllea****, Calocephalus multiflorus, Eremophila eriocalyx, Eremophila granitica, Erymophyllum glossanthus, Gnephosis arachnoidea, Gnephosis tenuissima, Grevillea ?sarissa, Hakea recurva* subsp. *arida, Lawrencella rosea, Panaetia lessonii, Ptilotus obovatus, Vincetoxicum lineare*					

Relevé: RA-12	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	493971	mE	6822373	mN	
Habitat:	Hill very gentle (hilltop)					
Soil:	Orange sandy-loam surface crust (5%)					
Rocks:	Ironstone stones (40%), Quartz stones (5%), Granitic rocks stones (5%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Forbland of *Maireana carnosa*, *Erymophyllum glossanthus* with Open Mid Shrubland of *Acacia burkittii*, *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla* with Open Low Shrubland of *Ptilotus obovatus* and Sparse Tall Shrubland of *Acacia burkittii*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Aristida contorta, Austrostipa elegantissima, Calocephalus multiflorus, Eremophila oppositifolia* subsp. *angustifolia, Erymophyllum glossanthus, Gnephosis arachnoidea, Maireana carnosa, Maireana georgei, Maireana planifolia, Maireana thesioides, Maireana tomentosa* subsp. *tomentosa, Maireana villosa,* ***Mesembryanthemum nodiflorum****, Ptilotus obovatus, Scaevola spinescens, Senna artemisioides* subsp. *petiolaris, Solanum lasiophyllum*					

Relevé: RA-14	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	493129	mE	6822844	mN	
Habitat:	Low hill very gentle (hilltop)					
Soil:	Orange sandy-loam loose soil (5%), surface crust (5%)					
Rocks:	Laterite gravel (30%), Ironstone stones (15%)					
Mapped as:	**ATSL (3)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia caesaneura* (narrow phyllode variant), *Acacia umbraculiformis* with Sparse Mid Shrubland of *Acacia ramulosa* var. *ramulosa* and Sparse Low Shrubland of *Eremophila exilifolia*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia effusifolia, Acacia grasbyi, Acacia ramulosa* var. *ramulosa, Acacia umbraculiformis, Actinobole uliginosum, Aluta aspera* subsp. *hesperia, Calandrinia translucens, Calocephalus multiflorus, Chthonocephalus pseudevax, Eremophila exilifolia, Eremophila latrobei* subsp. *latrobei, Goodenia mimuloides, Lobelia winfridae, Panaetia lessonii, Ptilotus gaudichaudii, Ptilotus schwartzii, Waitzia acuminata* var. *acuminata*					

Relevé: RA-15	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492282	mE	6823173	mN	
Habitat:	Sandy plain					
Soil:	Orange sand loose soil (20%), surface crust (10%)					
Rocks:	0					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* with Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia craspedocarpa* (hybrid), *Acacia effusifolia, Acacia ramulosa* var. *ramulosa, Acacia sibina, Acacia tetragonophylla, Calocephalus multiflorus, Comesperma integerrimum, Eremophila compacta, Eremophila forrestii* subsp. *forrestii, Eremophila granitica, Erodium cygnorum, Erymophyllum glossanthus, Goodenia mimuloides, Grevillea pityophylla, Hakea recurva* subsp. *arida, Lawrencella rosea, Panaetia lessonii, Ptilotus benlii, Rytidosperma caespitosum*					

Relevé: RA-16	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492343	mE	6823385	mN	
Habitat:	Hardpan plain					
Soil:	Orange sand loose soil (10%), surface crust (20%)					
Rocks:	Granitic rocks gravel (2%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia effusifolia*, *Acacia sibina* with Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant) and Isolated Low Shrubs of *Eremophila forrestii* subsp. *forrestii*, *Eremophila granitica*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia effusifolia, Acacia sibina, Acacia tetragonophylla, Calandrinia eremaea, Calocephalus multiflorus, Eremophila forrestii* subsp. *forrestii, Eremophila granitica, Erodium cygnorum, Erymophyllum glossanthus, Goodenia mimuloides, Grevillea obliquistigma, Lawrencella rosea, Monachather paradoxus, Panaetia lessonii, Ptilotus obovatus, Waitzia acuminata* var. *acuminata*					

Relevé: RA-18	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491524	mE	6821476	mN	
Habitat:	Hill gentle east facing slope (upperslope)					
Soil:	Orange sandy-clay surface crust (30%)					
Rocks:	Ironstone gravel (10%), Ironstone stones (15%)					
Mapped as:	**ATSL (2)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia exocarpoides* with Sparse Mid Shrubland of *Philotheca brucei*, *Eremophila forrestii* subsp. *forrestii*, *Eremophila clarkei* with Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia exocarpoides, Acacia ramulosa* var. *ramulosa, Calocephalus multiflorus, Eremophila clarkei, Eremophila forrestii* subsp. *forrestii, Eremophila latrobei* subsp. *latrobei, Goodenia mimuloides, Mirbelia* sp. *Bursarioides* (T.R. Lally 760), *Philotheca brucei, Ptilotus obovatus, Ptilotus schwartzii, Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Waitzia acuminata* var. *acuminata*					

Relevé: RA-19	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492582	mE	6821234	mN	
Habitat:	Hill very gentle (footslope)					
Soil:	Orange sandy-clay surface crust (20%), loose soil (5%)					
Rocks:	Ironstone stones (10%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia aptaneura*, *Grevillea obliquistigma* with Open Mid Shrubland of *Acacia ramulosa* var. *ramulosa*, *Eremophila forrestii* subsp. *forrestii* and Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aptaneura, Acacia caesaneura* (narrow phyllode variant), *Acacia exocarpoides, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Calocephalus multiflorus, Erymophyllum glossanthus, Goodenia mimuloides, Grevillea obliquistigma, Monachather paradoxus, Panaetia lessonii, Ptilotus obovatus, Solanum lasiophyllum, Vincetoxicum lineare*					

Relevé: RA-22	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492260	mE	6821599	mN	
Habitat:	Stony plain					
Soil:	Orange sandy-clay surface crust (20%), loose soil (5%)					
Rocks:	Laterite gravel (40%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina* with Sparse Mid Shrubland of *Eremophila forrestii* subsp. *forrestii* and Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, pastoral activities					
Fire age:	0					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia effusifolia, Acacia ramulosa* var. *ramulosa, Acacia sibina, Acacia tetragonophylla, Austrostipa elegantissima, Calocephalus multiflorus, Eremophila compacta, Eremophila forrestii* subsp. *forrestii, Eremophila latrobei* subsp. *latrobei, Erymophyllum glossanthus, Gnephosis arachnoidea, Goodenia mimuloides, Grevillea obliquistigma, Ptilotus benlii, Solanum lasiophyllum, Waitzia acuminata* var. *acuminata*					

Relevé: RA-23	Described by: SH			Date: 8/11/2021		Photo:
Location (GDA94):	MGA50	491718	mE	6822121	mN	
Habitat:	Hill very gentle east facing slope (footslope)					
Soil:	Orange sandy-clay surface crust (20%)					
Rocks:	Granitic rocks stones (20%), laterite gravel (20%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia sibina*, *Acacia effusifolia* with Sparse Mid Shrubland of *Eremophila forrestii* subsp. *forrestii*, *Eremophila georgei* with Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii* and Isolated Mallee Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia effusifolia, Acacia ramulosa* var. *ramulosa, Acacia sibina, Acacia tetragonophylla, Calocephalus multiflorus, Eremophila georgei, Erodium cygnorum, Erymophyllum glossanthus, Goodenia mimuloides, Goodenia rosea, Grevillea obliquistigma, Monachather paradoxus, Panaetia lessonii, Ptilotus schwartzii, Solanum lasiophyllum, Teucrium teucriiflorum, Waitzia acuminata* var. *acuminata*					

Relevé: RA-24	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	493844	mE	6822528	mN	
Habitat:	Hill very gentle (hilltop)					
Soil:	Orange sandy-loam surface crust (5%)					
Rocks:	Granitic rocks stones (40%), ironstone stones (15%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Forbland of *Maireana carnosa*, *Erymophyllum glossanthus* with Open Mid Shrubland of *Acacia burkittii*, *Senna artemisioides* subsp. *petiolaris*, *Acacia tetragonophylla* with Open Low Shrubland of *Senna artemisioides* subsp. *petiolaris* and Sparse Tall Shrubland of *Acacia burkittii*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Calocephalus multiflorus, Erymophyllum glossanthus, Maireana carnosa, Maireana thesioides, Maireana villosa,* ***Mesembryanthemum nodiflorum****, *Ptilotus obovatus, Scaevola spinescens, Senna artemisioides* subsp. *petiolaris*					

Relevé: RA-26	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	493281	mE	6822708	mN	
Habitat:	Low hill very gentle (upperslope)					
Soil:	Orange sandy-loam loose soil (5%), surface crust (5%)					
Rocks:	Granitic rocks stones (70%)					
Mapped as:	**ATSL (3)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia umbraculiformis*, *Acacia ramulosa* var. *ramulosa* with Sparse Low Shrubland of *Eremophila compacta* and Isolated Mid Shrubs of *Aluta aspera* subsp. *hesperia* subsp. *hesperia*, *Thryptomene decussata*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia ramulosa* var. *ramulosa,* ***Acacia speckii*** **(P4)**, *Acacia umbraculiformis, Actinobole uliginosum, Aluta aspera* subsp. *hesperia, Calandrinia eremaea, Calandrinia translucens, Calocephalus multiflorus, Chthonocephalus pseudevax, Cryptandra imbricata, Eremophila compacta, Eremophila latrobei* subsp. *latrobei, Lobelia winfridae, Mirbelia* sp. *Bursarioides* (T.R. Lally 760), *Panaetia lessonii, Philotheca brucei, Ptilotus obovatus, Ptilotus schwartzii, Solanum lasiophyllum, Thryptomene decussata*					

Relevé: RA-29	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	491688	mE	6822752	mN	
Habitat:	Stony plain					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	Ironstone stones (30%), granitic rocks stones (1%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia sibinaina* with Open Forbland of *Goodenia* sp. (dead) and Sparse Low Shrubland of *Ptilotus obovatus*, *Eremophila clarkei*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia ramulosa* var. *ramulosa, Acacia sibina, Calocephalus multiflorus, Eremophila clarkei, Eremophila granitica, Eremophila latrobei* subsp. *latrobei, Erodium cygnorum, Erymophyllum glossanthus, Gnephosis arachnoidea, Goodenia mimuloides, Goodenia rosea, Hakea recurva* subsp. *arida, Lawrencella rosea, Maireana carnosa, Maireana georgei, Maireana thesioides, Maireana tomentosa* subsp. *tomentosa, Maireana villosa, Monachather paradoxus, Panaetia lessonii, Ptilotus obovatus, Sclerolaena densiflora, Teucrium teucriiflorum, Waitzia acuminata* var. *acuminata*					

Relevé: RA-30	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492285	mE	6821290	mN	
Habitat:	Stony plain					
Soil:	Orange sandy-clay surface crust (10%), loose soil (5%)					
Rocks:	Ironstone stones (40%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Mid Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia effusifolia* with Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, ***Acacia speckii (P4)*** and Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia effusifolia, Acacia ramulosa* var. *ramulosa,* ***Acacia speckii*** **(P4)**, *Acacia umbraculiformis, Calandrinia translucens, Calocephalus multiflorus, Eremophila compacta, Eremophila glandulifera, Eremophila latrobei* subsp. *latrobei, Eremophila punicea, Erymophyllum glossanthus, Goodenia mimuloides, Lobelia winfridae, Monachather paradoxus, Panaetia lessonii, Persoonia manotricha, Prostanthera campbellii, Ptilotus obovatus, Sida* sp. dark green fruits (S. van Leeuwen 2260), *Solanum lasiophyllum, Vincetoxicum lineare*					

Relevé: RA-31	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492662	mE	6820604	mN	
Habitat:	Low ridge gentle east facing slope (upperslope)					
Soil:	Orange sandy-clay surface crust (30%)					
Rocks:	BIF boulders (60%), BIF stones (15%)					
Mapped as:	**ALWL**					
Vegetation association:	Open Low Woodland of *Acacia aptaneura* with Sparse Tall Shrubland of *Acacia aptaneura*, *Acacia caesaneura* (narrow phyllode variant) with Sparse Mid Shrubland of *Philotheca sericea*, *Eremophila latrobei* subsp. *latrobei* and Sparse Low Shrubland of *Eremophila latrobei* subsp. *latrobei*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aptaneura, Acacia caesaneura* (narrow phyllode variant), *Acacia umbraculiformis, Cheilanthes adiantoides, Eremophila forrestii* subsp. *forrestii, Eremophila latrobei* subsp. *latrobei, Euphorbia boophthona, Goodenia mimuloides, Grevillea obliquistigma, Mirbelia* sp. *Bursarioides* (T.R. Lally 760), *Persoonia manotricha, Philotheca sericea, Ptilotus obovatus, Ptilotus schwartzii, Sida* sp. Golden calyces glabrous (H.N. Foote 32), *Thryptomene decussata, Waitzia acuminata* var. *acuminata*					

Relevé: RA-32	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	492582	mE	6820458	mN	
Habitat:	Stony plain					
Soil:	Orange sandy-clay surface crust (10%), loose soil (5%)					
Rocks:	Ironstone stones (40%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia effusifolia* with Sparse Low Shrubland of *Eremophila forrestii* subsp. *forrestii*, *Aluta aspera* subsp. *hesperia* and Isolated Mid Shrubs of *Acacia effusifolia*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia effusifolia, Acacia umbraculiformis, Calandrinia translucens, Calocephalus multiflorus, Eremophila latrobei subsp. latrobei, Erymophyllum glossanthus, Goodenia mimuloides, Grevillea obliquistigma, Lobelia winfridae, Monachather paradoxus, Panaetia lessonii, Persoonia manotricha, Ptilotus obovatus, Sida* sp. dark green fruits (S. van Leeuwen 2260), *Solanum lasiophyllum, Vincetoxicum lineare, Waitzia acuminata* var. *acuminata*					

Relevé: RA-33	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491721	mE	6821170	mN	
Habitat:	Hill gentle (upperslope)					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	Ironstone gravel (40%), Ironstone stones (20%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Low Shrubland of *Aluta aspera* subsp. *hesperiaera*, *Eremophila latrobei* subsp. *latrobei*, *Eremophila forrestii* subsp. *forrestii* with Sparse Tall Shrubland of *Acacia aptaneura*, *Grevillea obliquistigma* with Sparse Mid Shrubland of *Grevillea obliquistigma*, *Aluta aspera* subsp. *hesperiaera* and Isolated Low Trees of *Acacia aptaneura*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aptaneura, Acacia umbraculiformis, Aristida contorta, Calocephalus multiflorus, Eremophila forrestii* subsp. *forrestii, Eremophila latrobei* subsp. *latrobei, Goodenia mimuloides, Grevillea obliquistigma, Philotheca sericea, Ptilotus obovatus, Ptilotus schwartzii, Waitzia acuminata* var. *acuminata*					

Relevé: RA-34	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491832	mE	6821338	mN	
Habitat:	Hill gentle south facing slope (footslope)					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	Granitic rocks stones (40%), Ironstone gravel (20%)					
Mapped as:	**ATSL (4)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia umbraculiformis* with Sparse Mid Shrubland of *Thryptomene costata* and Sparse Low Shrubland of *Thryptomene costata*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia ramulosa* var. *ramulosa, Acacia speckii* P4, *Acacia tetragonophylla, Acacia umbraculiformis, Calocephalus multiflorus, Eremophila clarkei, Eremophila compacta, Eremophila latrobei* subsp. *latrobei, Goodenia mimuloides, Mirbelia* sp. *Bursarioides* (T.R. Lally 760)*, Ptilotus gaudichaudii, Ptilotus obovatus, Ptilotus schwartzii, Thryptomene costata, Waitzia acuminata* var. *acuminata*					

Relevé: RA-35	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491021	mE	6821691	mN	
Habitat:	Hill gentle west facing slope (hilltop)					
Soil:	Orange sandy-clay surface crust (5%)					
Rocks:	Ironstone boulders (10%), Ironstone stones (45%)					
Mapped as:	**ATSL (2)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia assimilis* subsp. *assimilis*, *Acacia caesaneura* (narrow phyllode variant) with Sparse Mid Shrubland of *Philotheca sericea*, *Eremophila latrobei* subsp. *latrobei*, *Aluta aspera* subsp. *hesperia* with Sparse Low Shrubland of *Eremophila latrobei* subsp. *latrobei*, *Philotheca sericea* and Isolated Low Trees of *Acacia caesaneura* (narrow phyllode variant)					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia assimilis* subsp. *assimilis, Acacia caesaneura* (narrow phyllode variant), *Acacia exocarpoides, Acacia ramulosa* var. *ramulosa, Calocephalus multiflorus, Eremophila latrobei* subsp. *latrobei, Goodenia mimuloides, Philotheca sericea, Ptilotus schwartzii, Thryptomene decussata, Waitzia acuminata* var. *acuminata*					

Relevé: RA-36	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	490979	mE	6821779	mN	
Habitat:	Low ridge gentle (hilltop)					
Soil:	Orange sandy-clay surface crust (5%)					
Rocks:	Ironstone boulders (60%), Ironstone stones (10%)					
Mapped as:	**ATSL (1)**					
Vegetation association:	Open Low Shrubland of *Calytrix uncinata*, *Dodonaea petiolaris* with Open Forbland of *Stylidium longibracteatum* and Sparse Tall Shrubland of *Acacia aulacophylla*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aulacophylla, Acacia pteraneura, Aluta aspera* subsp. *hesperia, Calocephalus multiflorus, Calytrix uncinata, Cheiranthera simplicifolia, Dodonaea petiolaris, Eremophila exilifolia, Eriachne pulchella* subsp. *pulchella, Goodenia mimuloides, Gunniopsis rubra,* ***Petrophile vana*** **(P1)**, *Ptilotus schwartzii, Rhodanthe citrina, Stylidium longibracteatum*					

Relevé: RA-38	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491299	mE	6822123	mN	
Habitat:	Depression					
Soil:	Orange sandy-clay surface crust (10%)					
Rocks:	Ironstone gravel (60%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Tall Shrubland of *Acacia ramulosa* var. *ramulosa* with Open Mid Shrubland of *Eremophila georgei* and Sparse Low Shrubland of *Eremophila georgei*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia caesaneura* (narrow phyllode variant), *Acacia exocarpoides, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Actinobole uliginosum, Eremophila forrestii* subsp. *forrestii, Eremophila georgei, Gnephosis arachnoidea, Goodenia mimuloides, Grevillea obliquistigma, Maireana carnosa, Philotheca brucei, Ptilotus benlii, Ptilotus obovatus, Senna artemisioides subsp. petiolaris, Solanum lasiophyllum, Waitzia acuminata* var. *acuminata*					

Relevé: RA-39	Described by: SH			Date: 7/11/2021		Photo:
Location (GDA94):	MGA50	491368	mE	6821508	mN	
Habitat:	Low ridge gentle (hilltop)					
Soil:	Orange sandy-clay surface crust (5%)					
Rocks:	Ironstone boulders (60%), ironstone stones (10%)					
Mapped as:	**ATSL (1)**					
Vegetation association:	Open Low Shrubland of *Calytrix uncinata*, *Dodonaea viscosa* subsp. *mucronata* with Open Forbland of *Stylidium longibracteatum* and Sparse Tall Shrubland of *Acacia aulacophylla*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia aulacophylla, Alyxia buxifolia, Calocephalus multiflorus, Calytrix uncinata, Dodonaea viscosa* subsp. *mucronata, Eremophila exilifolia, Eremophila latrobei* subsp. *latrobei, Erymophyllum glossanthus, Gunniopsis rubra, Panaetia lessonii,* ***Pentameris airoides****, Philotheca brucei, Philotheca deserti, Philotheca sericea, Rhodanthe citrina, Solanum lasiophyllum, Stylidium longibracteatum*					

Relevé: RA-40	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	493011	mE	6823088	mN	
Habitat:	Low hill very gentle					
Soil:	Orange sandy-loam loose soil (5%), surface crust (5%)					
Rocks:	Laterite gravel (40%)					
Mapped as:	**ATSL (3)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia grasbyi* with Sparse Low Shrubland of *Eremophila compacta*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Rytidosperma caespitosum, Grevillea pityophylla, Acacia grasbyi,* ***Acacia speckii (P4)****, Acacia umbraculiformis, Thryptomene decussata, Verticordia interioris, Ptilotus obovatus, Ptilotus schwartzii, Calandrinia eremaea, Calandrinia translucens, Nicotiana rosulata, Eremophila compacta, Eremophila latrobei* subsp. *latrobei, Actinobole uliginosum, Calocephalus multiflorus, Chthonocephalus pseudevax*					

Relevé: RA-41	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492905	mE	6823163	mN	
Habitat:	Depression					
Soil:	Orange-white sandy-clay surface crust (50%), loose soil (1%)					
Rocks:	Laterite gravel (10%)					
Mapped as:	**MTSL (2)**					
Vegetation association:	Open Tall Shrubland of *Acacia ramulosa* var. *ramulosa* with Open Low Shrubland of *Eremophila compacta*, *Eremophila latrobei* subsp. *latrobei*, and Sparse Mid Shrubland of *Philotheca brucei*, *Eremophila latrobei* subsp. *latrobei*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, grazing					
Fire age:	None evident					
Species:	*Acacia effusifolia, Acacia ramulosa* var. *ramulosa, Acacia sibina,* ***Aira caryophyllea****, Calocephalus multiflorus, Eremophila clarkei, Eremophila exilifolia, Eremophila granitica, Eremophila latrobei* subsp. *latrobei, Erymophyllum glossanthus, Goodenia mimuloides, Grevillea extorris, Grevillea obliquistigma, Lawrencella rosea, Panaetia lessonii, Philotheca brucei, Ptilotus obovatus, Solanum lasiophyllum*					

Relevé: RA-42	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492720	mE	6823228	mN	
Habitat:	Low hill very gentle					
Soil:	Orange sandy-loam loose soil (5%), surface crust (5%)					
Rocks:	Laterite gravel (30%)					
Mapped as:	**ATSL (3)**					
Vegetation association:	Sparse Tall Shrubland of *Acacia grasbyi with* Sparse Low Shrubland of *Eremophila compacta*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia grasbyi, Acacia umbraculiformis, Actinobole uliginosum, Calandrinia eremaea, Calandrinia translucens, Calocephalus multiflorus, Chthonocephalus pseudevax, Eremophila compacta, Grevillea pityophylla, Panaetia lessonii, Ptilotus obovatus, Ptilotus schwartzii, Rytidosperma caespitosum*					

Relevé: RA-43	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492260	mE	6822900	mN	
Habitat:	Hardpan plain					
Soil:	Orange sandy-clay surface crust (15%)					
Rocks:	Ironstone gravel (10%), Granitic rocks stones (1%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Open Forbland of *Erymophyllum glossanthus*, *Calocephalus multiflorus*, *Calandrinia eremaea* with Sparse Mid Shrubland of *Acacia ramulosa* var. *ramulosa*, *Acacia burkittii* with Sparse Low Shrubland of *Grevillea pityophylla*, *Ptilotus obovatus* and Isolated Tall Shrubs of *Acacia burkittii*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, grazing					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Calandrinia eremaea, Calocephalus multiflorus, Eremophila eriocalyx, Eremophila granitica, Erymophyllum glossanthus, Goodenia mimuloides, Goodenia rosea, Lawrencella rosea, Maireana carnosa, Panaetia lessonii, Ptilotus obovatus, Vincetoxicum lineare*					

Relevé: RA-44	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	492830	mE	6822498	mN	
Habitat:	Hardpan plain					
Soil:	Orange sandy-clay surface crust (40%)					
Rocks:	Laterite gravel (10%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Open Forbland of *Goodenia* sp. (dead) with Sparse Tall Shrubland of *Acacia ramulosa* var. *ramulosa* and Sparse Low Shrubland of *Ptilotus obovatus*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities, grazing					
Fire age:	None evident					
Species:	*Acacia ramulosa* var. *ramulosa, Calocephalus multiflorus, Eremophila granitica, Erodium cygnorum, Erymophyllum glossanthus, Gnephosis arachnoidea, Grevillea pityophylla, Hakea recurva* subsp. *arida, Lawrencella rosea, Panaetia lessonii, Ptilotus obovatus, Waitzia acuminata* var. *acuminata*					

Relevé: RA-47	Described by: SH			Date: 6/11/2021		Photo:
Location (GDA94):	MGA50	#N/A	mE	#N/A	mN	
Habitat:	Alluvial plain very gentle					
Soil:	Orange-white sandy-clay surface crust (60%)					
Rocks:	Ironstone stones (5%), quartz stones (5%), granitic rocks stones (5%)					
Mapped as:	**MTSL (1)**					
Vegetation association:	Forbland of *Maireana carnosa*, *Erymophyllum glossanthus*, with Open Mid Shrubland of *Acacia burkittii*, *Acacia ramulosa* var. *ramulosa*, *Acacia tetragonophylla* with Open Low Shrubland of *Ptilotus obovatus*, *Eremophila compacta* and Sparse Tall Shrubland of *Acacia burkittii*					
Vegetation condition:	Excellent					
Disturbances:	Exploration activities					
Fire age:	None evident					
Species:	*Acacia burkittii, Acacia ramulosa* var. *ramulosa, Acacia tetragonophylla, Aristida contorta, Austrostipa elegantissima, Calandrinia eremaea, Calocephalus multiflorus, Comesperma volubile, Eremophila granitica, Eremophila latrobei* subsp. *latrobei, Erymophyllum glossanthus, Gnephosis arachnoidea, Goodenia mimuloides, Maireana carnosa, Maireana villosa,* ***Mesembryanthemum nodiflorum****, **Petrophile vana*** **(P1)**, *Pogonolepis muelleriana, Ptilotus obovatus, Solanum lasiophyllum*					

Relevé: RA-49	Described by: SH			Date: 8/11/2021		Photo:
Location (GDA94):	MGA50	492213	mE	6822017	mN	
Habitat:	Depression					
Soil:	Orange sandy-clay surface crust (20%)					
Rocks:	0					
Mapped as:	**MTSL (2)**					
Vegetation association:	Tall Shrubland of *Acacia sibina*, *Acacia ramulosa* var. *ramulosa*, *Grevillea obliquistigma* with Forbland of mixed dead herbs with Sparse Mid Shrubland of *Eremophila georgei* and Isolated Low Trees of *Acacia aptaneura*					
Vegetation condition:	Very good					
Disturbances:	Exploration activities, grazing, weeds					
Fire age:	None evident					
Species:	*Acacia aptaneura, Acacia ramulosa* var. *ramulosa, Acacia sibina, Aristida contorta, Calandrinia translucens, Calocephalus multiflorus, Dianella revoluta* var. *revoluta, Eremophila forrestii* subsp. *forrestii, Eremophila georgei, Eremophila punicea, Erodium cygnorum, Erymophyllum glossanthus, Euphorbia boophthona, Feldstonia nitens, Gilberta tenuifolia, Gilruthia osbornei, Gnephosis arachnoidea, Gnephosis tenuissima, Grevillea obliquistigma,* ***Hypochaeris glabra****, *Isoetopsis graminifolia, Lawrencella rosea, Lemooria burkittii, Monachather paradoxus, Myriocephalus guerinae, Olearia humilis, Olearia pimeleoides, Panaetia lessonii, Ptilotus obovatus, Rhodanthe citrina, Rhodanthe maryonii, Rhodanthe spicata, Rhodanthe stricta, Sida* sp. dark green fruits (S. van Leeuwen 2260)*, Solanum lasiophyllum,* ***Sonchus oleraceus****, *Trachymene ornata, Waitzia acuminata* var. *acuminata*					

Note: P1= Priority One species, P4 = Priority Four species, * after a species indicates a weed species, subsp. = subspecies, var. = variety, sp. = species. ? = query species.

APPENDIX 7: SPECIES LIST

Table 22: Species list

Family	Taxa	Flowering / Fruiting	Relevé	OppColl
Aizoaceae	*Gunniopsis rubra*	Fr	✓	
Aizoaceae	***Mesembryanthemum nodiflorum**	Fr	✓	✓
Amaranthaceae	*Ptilotus benlii*	Fl	✓	
Amaranthaceae	*Ptilotus gaudichaudii*	Fl	✓	
Amaranthaceae	*Ptilotus obovatus*	FlFr	✓	✓
Amaranthaceae	*Ptilotus schwartzii*	Fl	✓	
Apocynaceae	*Alyxia buxifolia*	Fl	✓	
Apocynaceae	*Vincetoxicum lineare*		✓	
Araliaceae	*Trachymene ornata*	Fr	✓	
Asparagaceae	*Thysanotus manglesianus*	Fl	✓	
Asteraceae	*Actinobole uliginosum*	Fl	✓	
Asteraceae	*Calocephalus multiflorus*	Fl	✓	
Asteraceae	*Chthonocephalus pseudevax*		✓	
Asteraceae	*Erymophyllum glossanthus*	FlFr	✓	
Asteraceae	*Feldstonia nitens*	Fl	✓	
Asteraceae	*Gilberta tenuifolia*		✓	
Asteraceae	*Gilruthia osbornei*		✓	
Asteraceae	*Gnephosis arachnoidea*	FlFr	✓	
Asteraceae	*Gnephosis tenuissima*		✓	
Asteraceae	***Hypochaeris glabra**	Fl	✓	
Asteraceae	*Isoetopsis graminifolia*	Fl	✓	
Asteraceae	*Lawrencella rosea*	Fl	✓	
Asteraceae	*Lemooria burkittii*	Fl	✓	
Asteraceae	*Myriocephalus guerinae*	FL	✓	
Asteraceae	*Olearia humilis*	FL	✓	
Asteraceae	*Olearia pimeleoides*	FL	✓	
Asteraceae	*Panaetia lessonii*	FL	✓	
Asteraceae	*Pogonolepis muelleriana*	FlFr	✓	
Asteraceae	*Rhodanthe citrina*	Fl	✓	
Asteraceae	*Rhodanthe maryonii*	Fl	✓	
Asteraceae	*Rhodanthe spicata*	Fl	✓	
Asteraceae	*Rhodanthe stricta*	Fl	✓	
Asteraceae	***Sonchus oleraceus**		✓	
Asteraceae	*Waitzia acuminata* var. *acuminata*	Fl	✓	
Campanulaceae	*Lobelia winfridae*	Fl	✓	
Chenopodiaceae	*Maireana carnosa*	Fr	✓	
Chenopodiaceae	*Maireana georgei*	Fr	✓	
Chenopodiaceae	*Maireana planifolia*	Fr	✓	
Chenopodiaceae	*Maireana thesioides*		✓	
Chenopodiaceae	*Maireana tomentosa* subsp. *tomentosa*		✓	
Chenopodiaceae	*Maireana villosa*	Fr	✓	
Chenopodiaceae	*Sclerolaena densiflora*	Fr	✓	
Convolvulaceae	***Cuscuta epithymum**	FlFr	✓	
Euphorbiaceae	*Euphorbia boophthona*	Fr	✓	

Family	Taxa	Flowering / Fruiting	Relevé	OppColl
Fabaceae	*Acacia aneura*	Fr	✓	
Fabaceae	*Acacia aptaneura*	Fr	✓	
Fabaceae	*Acacia assimilis* subsp. *assimilis*		✓	
Fabaceae	*Acacia aulacophylla*	Fr	✓	
Fabaceae	*Acacia burkittii*	Fr	✓	
Fabaceae	*Acacia caesaneura* (narrow phyllode variant)	Fr	✓	
Fabaceae	*Acacia craspedocarpa* (hybrid)	Fr	✓	
Fabaceae	*Acacia effusifolia*	Fr	✓	
Fabaceae	*Acacia exocarpoides*	Fr	✓	
Fabaceae	*Acacia grasbyi*	Fr	✓	
Fabaceae	*Acacia pteraneura*		✓	
Fabaceae	*Acacia ramulosa* var. *ramulosa*	Fr	✓	
Fabaceae	*Acacia sibina*	Fr	✓	
Fabaceae	***Acacia speckii* (P4)**	Fr	✓	✓
Fabaceae	*Acacia tetragonophylla*	Fr	✓	
Fabaceae	*Acacia umbraculiformis*		✓	
Fabaceae	*Mirbelia sp. Bursarioides* (T.R. Lally 760)	Fl	✓	
Fabaceae	*Senna artemisioides* subsp. *petiolaris*	Fr	✓	
Fabaceae	*Senna sp. Austin* (A. Strid 20210)			✓
Geraniaceae	*Erodium cygnorum*	Fr	✓	
Goodeniaceae	*Goodenia mimuloides*	Fl	✓	
Goodeniaceae	*Goodenia rosea*	Fl	✓	
Goodeniaceae	*Scaevola spinescens*		✓	
Hemerocallidaceae	*Dianella revoluta* var. *revoluta*		✓	
Lamiaceae	*Prostanthera campbellii*	Fr	✓	
Lamiaceae	*Teucrium teucriiflorum*		✓	
Malvaceae	*Sida sp. dark green fruits* (S. van Leeuwen 2260)	Fl	✓	
Malvaceae	*Sida sp. Golden calyces glabrous* (H.N. Foote 32)	Fl	✓	
Myrtaceae	*Aluta aspera* subsp. *hesperia*		✓	
Myrtaceae	*Calytrix uncinata*	Fl	✓	
Myrtaceae	*Thryptomene costata*	Fl	✓	
Myrtaceae	*Thryptomene decussata*	Fl	✓	
Myrtaceae	*Verticordia interioris*	FlFr	✓	✓
Pittosporaceae	*Cheiranthera simplicifolia*	Fr	✓	
Poaceae	****Aira caryophyllea***	Fr	✓	
Poaceae	*Aristida contorta*		✓	
Poaceae	*Austrostipa elegantissima*	Fr	✓	
Poaceae	*Eriachne pulchella* subsp. *pulchella*		✓	
Poaceae	*Monachather paradoxus*	Fr	✓	
Poaceae	****Pentameris airoides***	Fr	✓	
Poaceae	*Rytidosperma caespitosum*	Fr	✓	
Polygalaceae	*Comesperma integerrimum*	Fl	✓	
Polygalaceae	*Comesperma volubile*		✓	
Portulacaceae	*Calandrinia eremaea*	Fl	✓	
Portulacaceae	*Calandrinia translucens*	Fl	✓	
Proteaceae	*Grevillea ?sarissa*		✓	
Proteaceae	*Grevillea extorris*	Fr	✓	
Proteaceae	*Grevillea obliquistigma* subsp. *obliquistigma*	Fr	✓	
Proteaceae	*Grevillea pityophylla*	FlFr	✓	

Family	Taxa	Flowering / Fruiting	Relevé	OppColl
Proteaceae	*Hakea recurva* subsp. *arida*		✓	
Proteaceae	*Persoonia manotricha*	Fl	✓	
Proteaceae	***Petrophile vana* (P1)**	Fr	✓	
Pteridaceae	*Cheilanthes adiantoides*		✓	
Rhamnaceae	*Cryptandra imbricata*		✓	
Rutaceae	*Philotheca brucei subsp. brucei* subsp. *brucei*	Fr	✓	
Rutaceae	*Philotheca deserti*	Fl	✓	
Rutaceae	*Philotheca sericea*	Fl	✓	
Sapindaceae	*Dodonaea petiolaris*	Fr	✓	
Sapindaceae	*Dodonaea viscosa* subsp. *mucronata*		✓	
Scrophulariaceae	*Eremophila clarkei*	Fl	✓	
Scrophulariaceae	*Eremophila compacta*	Fl	✓	
Scrophulariaceae	*Eremophila eriocalyx*	Fl	✓	
Scrophulariaceae	*Eremophila exilifolia*	Fl	✓	
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*	FlFr	✓	
Scrophulariaceae	*Eremophila georgei*	Fr	✓	
Scrophulariaceae	*Eremophila glandulifera*	Fr	✓	
Scrophulariaceae	*Eremophila granitica*	Fr	✓	✓
Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*	Fl	✓	
Scrophulariaceae	*Eremophila oppositifolia* subsp. *angustifolia*		✓	
Scrophulariaceae	*Eremophila punicea*	Fl	✓	
Solanaceae	*Nicotiana rosulata*	Fl	✓	
Solanaceae	*Solanum lasiophyllum*	Fl	✓	
Stylidiaceae	*Stylidium longibracteatum*	Fl	✓	

Note: OppColl = opportunistic collection, Fl = flowering material, Fr = fruiting material, subsp. = subspecies, var. = variety, sp. = species. ? = query species, * a weed species, P1= Priority One species, P4= Priority Four species. Nomenclature based on current WA Herbarium terminology and confirmed on FloraBase (WAH, 1998-).

APPENDIX 8: SPECIES BY VEGETATION TYPE MATRIX

Table 23: Species and vegetation type matrix

Family	Taxa	ALWL	ATSL (1)	ATSL (2)	ATSL (3)	ATSL (4)	MTSL (1)	MTSL (2)
Aizoaceae	*Gunniopsis rubra*		X					
Aizoaceae	***Mesembryanthemum nodiflorum****						X	
Amaranthaceae	*Ptilotus benlii*							X
Amaranthaceae	*Ptilotus gaudichaudii*				X	X		
Amaranthaceae	*Ptilotus obovatus*	X		X	X	X	X	X
Amaranthaceae	*Ptilotus schwartzii*	X	X	X	X	X		X
Apocynaceae	*Alyxia buxifolia*		X					
Apocynaceae	*Vincetoxicum lineare*						X	X
Araliaceae	*Trachymene ornata*							X
Asparagaceae	*Thysanotus manglesianus*							X
Asteraceae	*Actinobole uliginosum*				X			X
Asteraceae	*Calocephalus multiflorus*		X	X	X	X	X	X
Asteraceae	*Chthonocephalus pseudevax*				X			
Asteraceae	*Erymophyllum glossanthus*		X				X	X
Asteraceae	*Feldstonia nitens*							X
Asteraceae	*Gilberta tenuifolia*							X
Asteraceae	*Gilruthia osbornei*							X
Asteraceae	*Gnephosis arachnoidea*			X			X	X
Asteraceae	*Gnephosis tenuissima*						X	X
Asteraceae	***Hypochaeris glabra****							X
Asteraceae	*Isoetopsis graminifolia*							X
Asteraceae	*Lawrencella rosea*						X	X
Asteraceae	*Lemooria burkittii*							X
Asteraceae	*Myriocephalus guerinae*							X
Asteraceae	*Olearia humilis*							X
Asteraceae	*Olearia pimeleoides*							X
Asteraceae	*Panaetia lessonii*		X		X		X	X
Asteraceae	*Pogonolepis muelleriana*						X	
Asteraceae	*Rhodanthe citrina*		X	X				X

Family	Taxa	ALWL	ATSL (1)	ATSL (2)	ATSL (3)	ATSL (4)	MTSL (1)	MTSL (2)
Asteraceae	*Rhodanthe maryonii*							X
Asteraceae	*Rhodanthe spicata*							X
Asteraceae	*Rhodanthe stricta*							X
Asteraceae	*Sonchus oleraceus*							X
Asteraceae	*Waitzia acuminata* var. *acuminata*	X		X	X	X	X	X
Campanulaceae	*Lobelia winfridae*				X			X
Chenopodiaceae	*Maireana carnosa*						X	X
Chenopodiaceae	*Maireana georgei*						X	X
Chenopodiaceae	*Maireana planifolia*						X	
Chenopodiaceae	*Maireana thesioides*						X	X
Chenopodiaceae	*Maireana tomentosa* subsp. *tomentosa*						X	X
Chenopodiaceae	*Maireana villosa*						X	X
Chenopodiaceae	*Sclerolaena densiflora*							X
Convolvulaceae	***Cuscuta epithymum****			X				
Euphorbiaceae	*Euphorbia boophthona*	X						X
Fabaceae	*Acacia aneura*				X	X		
Fabaceae	*Acacia aptaneura*	X						X
Fabaceae	*Acacia assimilis* subsp. *assimilis*			X				
Fabaceae	*Acacia aulacophylla*		X					
Fabaceae	*Acacia burkittii*						X	
Fabaceae	*Acacia caesaneura* (narrow phyllode variant)	X		X	X			X
Fabaceae	*Acacia craspedocarpa* (hybrid)							X
Fabaceae	*Acacia effusifolia*				X			X
Fabaceae	*Acacia exocarpoides*			X				X
Fabaceae	*Acacia grasbyi*				X			
Fabaceae	*Acacia pteraneura*		X					
Fabaceae	*Acacia ramulosa* var. *ramulosa*	X		X	X	X	X	X
Fabaceae	*Acacia sibina*							X
Fabaceae	***Acacia speckii* (P4)**				X	X	X	X
Fabaceae	*Acacia tetragonophylla*				X	X	X	X
Fabaceae	*Acacia umbraculiformis*	X			X	X		X
Fabaceae	*Mirbelia* sp. Bursarioides (T.R. Lally 760)	X		X	X	X		
Fabaceae	*Senna artemisioides* subsp. *petiolaris*						X	X

Family	Taxa	ALWL	ATSL (1)	ATSL (2)	ATSL (3)	ATSL (4)	MTSL (1)	MTSL (2)
Fabaceae	*Senna* sp. Austin (A. Strid 20210)							
Geraniaceae	*Erodium cygnorum*						X	X
Goodeniaceae	*Goodenia mimuloides*	X	X	X	X	X	X	X
Goodeniaceae	*Goodenia rosea*						X	X
Goodeniaceae	*Scaevola spinescens*						X	
Hemerocallidaceae	*Dianella revoluta* var. *revoluta*							X
Lamiaceae	*Prostanthera campbellii*							X
Lamiaceae	*Teucrium teucriiflorum*							X
Malvaceae	*Sida* sp. dark green fruits (S. van Leeuwen 2260)							X
Malvaceae	*Sida* sp. Golden calyces glabrous (H.N. Foote 32)	X		X				
Myrtaceae	*Aluta aspera* subsp. *hesperia*		X		X			
Myrtaceae	*Calytrix uncinata*		X					
Myrtaceae	*Thryptomene costata*				X	X		
Myrtaceae	*Thryptomene decussata*	X		X	X			
Myrtaceae	*Verticordia interioris*				X			
Pittosporaceae	*Cheiranthera simplicifolia*		X					
Poaceae	***Aira caryophyllea****						X	X
Poaceae	*Aristida contorta*						X	X
Poaceae	*Austrostipa elegantissima*						X	X
Poaceae	*Eriachne pulchella* subsp. *pulchella*		X		X	X		
Poaceae	*Monachather paradoxus*							X
Poaceae	***Pentameris airoides****		X					
Poaceae	*Rytidosperma caespitosum*				X			X
Polygalaceae	*Comesperma integerrimum*						X	X
Polygalaceae	*Comesperma volubile*						X	
Portulacaceae	*Calandrinia eremaea*				X		X	X
Portulacaceae	*Calandrinia translucens*				X			X
Proteaceae	*Grevillea* ?*sarissa*						X	
Proteaceae	*Grevillea extorris*							X
Proteaceae	*Grevillea obliquistigma*	X						X
Proteaceae	*Grevillea pityophylla*				X		X	X
Proteaceae	*Hakea recurva* subsp. *arida*						X	X
Proteaceae	*Persoonia manotricha*	X						X

Family	Taxa	ALWL	ATSL (1)	ATSL (2)	ATSL (3)	ATSL (4)	MTSL (1)	MTSL (2)
Proteaceae	***Petrophile vana* (P1)**		X				X	
Pteridaceae	*Cheilanthes adiantoides*	X						
Rhamnaceae	*Cryptandra imbricata*				X			
Rutaceae	*Philotheca brucei* subsp. *brucei*		X	X	X			X
Rutaceae	*Philotheca deserti*	X	X	X				
Rutaceae	*Philotheca sericea*	X	X	X				X
Sapindaceae	*Dodonaea petiolaris*		X	X				
Sapindaceae	*Dodonaea viscosa* subsp. *mucronata*		X					
Scrophulariaceae	*Eremophila clarkei*			X	X	X		X
Scrophulariaceae	*Eremophila compacta*				X	X		X
Scrophulariaceae	*Eremophila eriocalyx*						X	
Scrophulariaceae	*Eremophila exilifolia*		X		X			X
Scrophulariaceae	*Eremophila forrestii* subsp. *forrestii*	X		X				X
Scrophulariaceae	*Eremophila georgei*							X
Scrophulariaceae	*Eremophila glandulifera*							X
Scrophulariaceae	*Eremophila granitica*						X	X
Scrophulariaceae	*Eremophila latrobei* subsp. *latrobei*	X	X	X	X	X	X	X
Scrophulariaceae	*Eremophila oppositifolia* subsp. *angustifolia*						X	
Scrophulariaceae	*Eremophila punicea*							X
Solanaceae	*Nicotiana rosulata*				X			
Solanaceae	*Solanum lasiophyllum*	X	X	X	X		X	X
Stylidiaceae	*Stylidium longibracteatum*		X					

Note: sp. = species, subsp. = subspecies, var. = variety, ? = query species, * indicates a weed species, P1 = a Priority One species, P4 a Priority Four species. Nomenclature based on current WA Herbarium terminology and confirmed on FloraBase (WAH, 1998-).


maia

maia
Environmental Consultancy

29Metals Golden Grove: Petrophile vana Targeted Survey, December 2022




17 July 2023

Version 1

maia.net.au

This document describes the results of a survey targeting *Petrophile vana* over selected areas in and around 29Metals' Golden Grove (29MGG) project area. The survey was carried out by Maia Environmental Consultancy Pty Ltd (Maia) in December 2022.

Photographs on cover page taken in the areas surveyed by Maia.

Maia Environmental Consultancy Pty Ltd

ABN 25 141 503 184

PO Box 1213

Subiaco WA 6904

Document Prepared By: RW, EK, SH and CC

Document Reviewed By: CC

Document Revision Number: Version 1

Document Reference Number: 2215V1

Date: 17 July 2023

CONTENTS

TABLES

FIGURES

MAPS

ACRONYMS AND ABBREVIATIONS

29MGG	29Metals Golden Grove
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
BIF	Banded ironstone formation
BOM	Bureau of Meteorology
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DMIRS	Department of Mines, Industry Regulation and Safety
DMP	Department of Mines and Petroleum
DPIRD	Department of Primary Industries and Regional Development
Ecologia	Ecologia Environment
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre
m	Metre
mm	Millimetre
Maia	Maia Environmental Consultancy Pty Ltd
MCA	Multi-criteria analysis
P	Priority
P1	Priority 1 species
P4	Priority 4 species
PEC	Priority ecological community
spp.	Multiple species
TFS	Targeted flora survey
TSF	Tailings storage facility
VA	Vegetation association
VSA	Vegetation system association
WA	Western Australia
WAH	Western Australian Herbarium

SUMMARY

29Metals Golden Grove (29MGG) plans to extend its tailings storage facility (TSF) to a new area, area 4 (TSF4) Option B Regional in the Golden Grove project area. The 29MGG project area is in the Shire of Yalgoo in the Midwest Region of Western Australia (WA), approximately 50 km south south-east of Yalgoo.

Maia Environmental Consultancy Pty Ltd (Maia) was engaged by 29MGG to carry out a targeted flora survey (TFS) for *Petrophile vana,* a Priority (P) 1 flora species. The TFS was conducted in selected areas in the TSF4 polygon as well as potential habitat around the polygon (breakaways, exposed laterite and ridges). The areas searched are referred to as the survey areas in this report.

The survey was conducted by two botanists between December 13 and 16, 2022.

The following dot points include the main findings from the survey:

- Ninety-nine (99) new *Petrophile vana* plants were found in and around the TSF4 polygon – 97 in the western corner of the polygon and one plant at two locations away from the polygon.
- The *Petrophile vana* at the two original TSF4 locations were checked during the survey and the eastern location was not *P. vana* but a similar looking plant; therefore 98 *P. vana* have been located within the TSF4 polygon to date.
- Before this survey 14 *Petrophile vana* populations were known to Maia; with the removal of one of the two TSF4 populations and the addition of two new populations outside the TSF4 polygon, Maia now knows of 15 *P. vana* populations and one of them is in the TSF4 polygon. If the whole of this population were to be impacted by clearing for the new TSF4 area the impact to the populations known to Maia would be 7%.
- As the *P. vana* plants are in the western corner of the polygon, they could be avoided, and as they lie within the buffer for a P1 priority ecological community that intersects that section of the TSF4 polygon, the area should be avoided.

29Metals Golden Grove: Petrophile vana Targeted Survey, December 2022

1 INTRODUCTION

In November 2021 Maia Environmental Consultancy Pty Ltd (Maia) carried out a reconnaissance survey for 29Metals Golden Grove (29MGG) over a proposed new tailings storage facility (TSF), area 4 (TSF4) Option B Regional polygon (**Map 1**, **Section 9**; Maia, 2022). Two priority (P) flora species were recorded in the area surveyed – *Petrophile vana* (P1; two plants, one plant at each location) and *Acacia speckii* (P4; a total of 86 plants at 68 locations). Many *A. speckii* have been recorded outside the TSF4 polygon on 29MGG tenements and beyond, and Maia estimated that there are 122 populations of this species in Western Australia (WA), including the one population in the area surveyed. However, this is the first time that *Petrophile vana* has been recorded in the Golden Grove project area - the closest record known to Maia is 36 km to the east.

As this was the first time *Petrophile vana* had been recorded in the Golden Grove project area, and because the plants could potentially be impacted by development of the new TSF facility, Maia was engaged by 29MGG to conduct a *Petrophile vana* targeted flora survey (TFS) in areas around the *P. vana* located in the TSF4 area, and also in potential *P. vana* habitat outside the TSF4 area. The areas selected for survey are shown on **Map 1, Section 9**. The centre of the survey areas is about 50 kilometres (km) south south-east of the town of Yalgoo.

This short report includes brief background information on the habitat in which *Petrophile vana* has been located before this survey, description of the methods used to carry out the TFS and the results of the survey.

2 *PETROPHILE VANA* – SELECTION OF POTENTIAL HABITAT FOR SURVEY

Potential *Petrophile vana* habitat outside the TSF4 polygon was identified before going to site using habitat information from the areas where the *Petrophile vana* records known to Maia are located. These records are from Florabase (Western Australian Herbarium (WAH), 1998-), Maia's 2021 survey results (Maia, 2022) and an Ecologia survey report (Ecologia, 2010). There could be other records that are not on Florabase (like some of the Ecologia records), and in other reports but Maia has not been able to find any more.

From the Florabase, Maia and Ecologia data Maia has *Petrophile vana* records for 24 locations in the Murchison and Yalgoo bioregions (**Map 2, Section 9**); when each location is buffered by 500 metres (m) to identify populations there are 14 discrete populations. The habitats where the 24 *Petrophile vana* records occur indicate that it grows on breakaways, rocky outcrops and associated rocky ridges. The elevation, pre-European vegetation system association, soil land system and surface geology unit (1:1 000 000, 1: 250 000 and 1:100 000) associated with each record was noted and that data was used to try to find a pattern in the 24 locations (**Table 7, Appendix 1**).

The *Petrophile vana* records occur at similar elevations (between 300 – 550 m, with most occurring between 350 – 400 m) and in pre-European vegetation system associations with a similar structure (scrub, open scrub or sparse shrub / scrub with open woodland or scattered trees, dominated by *Acacia* species). However, soil land systems and surface geology mosaics were not the same at the different locations; although, the 1:1 000 000 surface geology was the same at 17 of the 24 records (Ag - Undifferentiated felsic intrusive rocks). Based on this brief analysis, areas to be searched for *Petrophile vana* were selected using elevation and vegetation system association data. The areas selected before going to the field (i.e., the preliminary survey areas) both within and outside the TSF4 area are shown on **Maps 1 and 2, Section 9**.

3 AREAS SELECTED FOR SURVEY – BIOPHYSICAL ATTRIBUTES

The preliminary survey areas are all in the Tallering subregion of the Yalgoo bioregion (**Map 2, Section 9**) (Department of Climate Change, Energy, the Environment and Water (DCCEEW), 2022).

They lie in three of the pre-European vegetation associations (VAs) / system associations (VSAs) mapped in the Yalgoo bioregion (**Map 3D, Section 9**) (Department of Primary Industries and Regional Development (DPIRD), 2021): 202/202.3; 361/361 and 420/420.5. Most of the areas are in VA/VSA 420/420.5.

The structural and floristic descriptions for each VA are listed in **Table 1**.

Table 1: Structural and floristic descriptions for the vegetation system associations in the survey areas

Vegetation association (VA) (where)	Description	
	Structural	Floristic
202 (areas inside and outside TSF4 polygon)	Scrub, open scrub or sparse scrub	Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.
361 (areas outside TSF4 polygon)	Scrub with open woodland or scattered trees	Wattle with York gum, casuarina, mulga *Acacia* spp. with *Eucalyptus loxophleba*, *Allocasuarina* spp., *Acacia aneura*
420 (areas inside and outside TSF4 polygon)	Scrub, open scrub or sparse scrub	Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.

Note: VA 361 occurs within the TSF4 polygon, but no traverses were placed in it; spp. = multiple species.

The survey areas intersect seven soil land systems (**Table 2; Map 3C, Section 9**) (DPIRD, 2022). The Tallering, Violet and Watson land systems are in areas assessed both inside and outside the TSF4 polygon, while the Gumbreak, Kalli, Rainbow and Wiluna land systems are only in the areas assessed outside the TSF4 polygon.

Table 2: Land systems in the survey areas

Land system (where)	Description
Tallering (areas inside and outside TSF4 polygon)	Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other *Acacia* shrublands.
Violet (areas inside and outside TSF4 polygon)	Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands.
Watson (areas inside and outside TSF4 polygon)	Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs.
Gumbreak (areas outside TSF4 polygon)	Low granite breakaways with extensive lower saline alluvial plains, supporting halophytic low shrublands.
Kalli (areas outside TSF4 polygon)	Elevated gently undulating red sandplains edged by stripped surfaces on laterite and granite, supporting acacia tall shrublands with wanderrie grass understoreys.
Rainbow (areas outside TSF4 polygon)	Hardpan plains supporting mulga tall shrublands.

Land system (where)	Description
Wiluna System (areas outside TSF4 polygon)	Low greenstone hills with occasional lateritic breakaways and broad stony slopes, lower saline stony plains and broad drainage tracts; supporting sparse mulga and other *Acacia* shrublands with patches of halophytic shrubs.

Note: the Tallering land system occurs inside the TSF4 polygon, but none of the preliminary survey areas were placed in it before going to site.

Four surface geological units mapped at a scale of 1:1 000 000 are in the TSF4 polygon (Ady, Asy, Ayy and Qrc). Five units occur in the areas selected for survey outside the TSF4 polygon - Ady, Ag, Asy, Ayy and Qrc (**Table 3; Map 3B, Section 9**) (Stewart et al., 2008).

Table 3: 1:1 000 000 surface geology in the survey areas

Code (where)	Description
Asy (areas inside and outside TSF4 polygon)	Conglomerate, chert, small amounts felsic volcaniclastic rocks, sandstone, quartzite, siltstone, phyllite, schist, pelite, shale. Includes former Hatfield Formation.
Ayy (areas inside and outside TSF4 polygon)	Metasandstone, metashale, metasiltstone, metaconglomerate and meta-volcaniclastics, pelitic schists, phyllite, fuchsitic quartzite with clasts quartzite and felsic volcanic rock; quartzite; pelitic and psammitic gneiss.
Qrc (areas inside and outside th TSF4 polygon)	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.
Ady (areas inside and outside TSF4 polygon)	Mafic intrusive rocks, medium to coarse-grained; layered mafic to ultramafic intrusions; metadolerite; medium to coarse-grained metagabbro, dolerite and granophyre, local ultramafic bases.
Ag (areas outside TSF4 polygon)	Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.

Note: while Ady occurs within the TSF4 polygon, no preliminary survey areas were aligned in it before going to site.

More detailed (1:250 000) surface geology mapping exists for WA, and seven geological units are mapped in the TSF4 polygon - Age, Asp, Aso, Czl, Qcg, Qcs and Qs. Four other units are mapped in areas selected to be surveyed outside the TSF polygon – Ab, Abg, Ae and Czs (**Table 4; Figure 1**) (Department of Mines, Industry Regulation and Safety (DMIRS), 2018).

Table 4: 1:250 000 surface geology in the survey areas

Code (where)	Description
Aso (inside TSF4 polygon, no traverses in it)	Oligomictic conglomerate with deeply weathered rocks.
Czl (inside TSF4 polygon only)	Quartz-kaolin grit, cemented limonite gravel with deeply weathered rocks.
Age (areas inside and outside TSF4 polygon, no traverses inside)	Medium, even-grained granite to trondhjemite with deeply weathered rocks.
Asp (areas inside and outside TSF4 polygon)	Siltstone, shale, phyllite, minor schist with deeply weathered rocks.
Qcg (areas inside and outside TSF4 polygon)	Quartz-kaolin grit, cemented limonite gravel.
Qcs (areas inside and outside TSF4 polygon)	Colluvium – rock fragments, gravel, sand and silt.

Code (where)	Description
Qs (areas inside and outside TSF4 polygon; no traverses inside TSF4)	Sand – alluvial, eolian, eluvial, on Qcf.
Ab (areas outside TSF4 polygon)	Mafic volcanic rocks with minor mafic and ultramafic intrusive rocks, minor felsic rocks with deeply weathered rocks.
Abg (areas outside TSF4 polygon)	Mafic rocks – coarse-grained; gabbro to diorite and granophyre.
Ae (areas outside TSF4 polygon)	Serpentinite – after peridotite with deeply weathered rocks.
Czs (areas outside TSF4 polygon)	Sandplain – red, brown, buff and yellow sand.

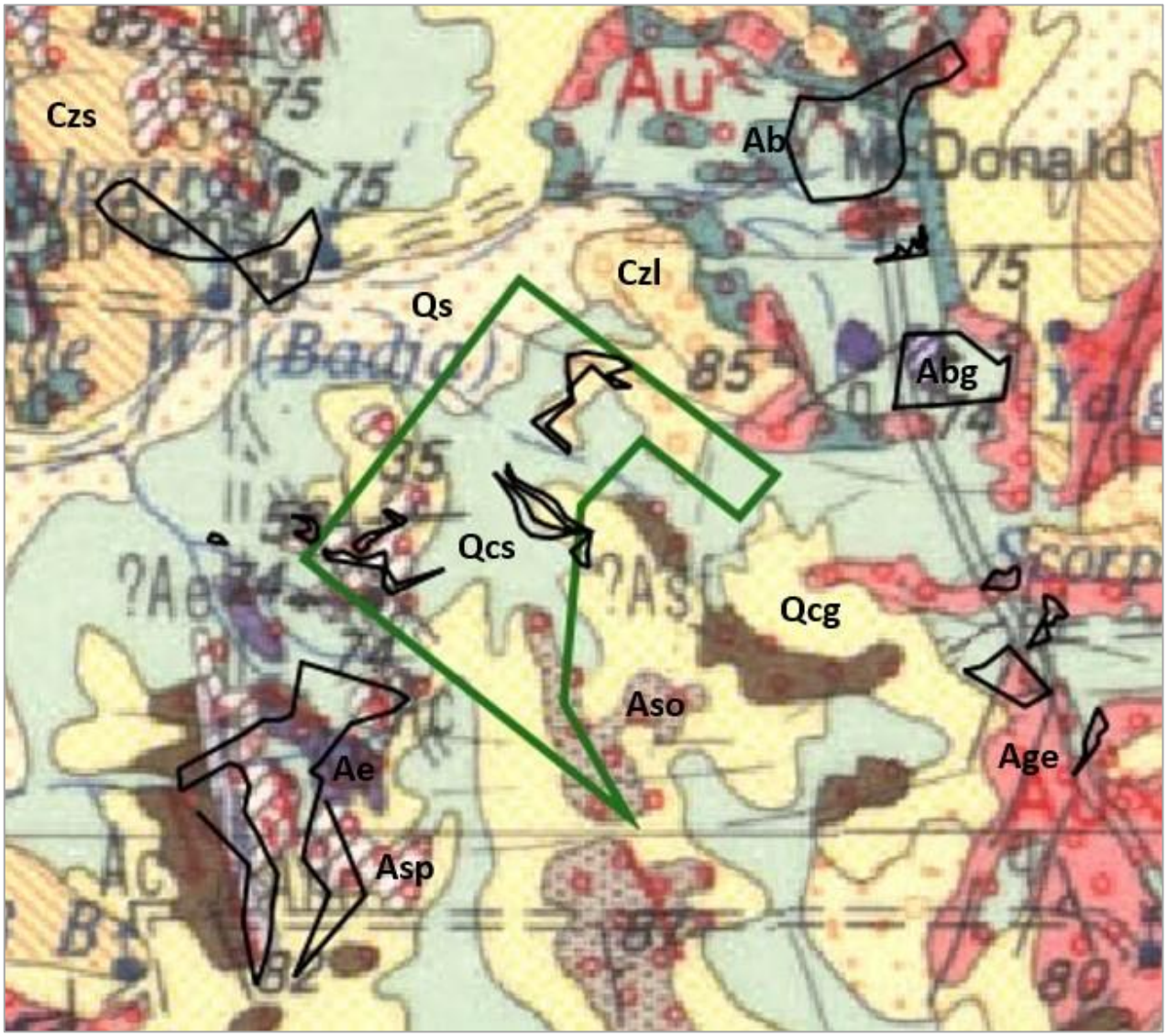


Figure 1: 1:250 000 surface geology of the survey areas (black lines) and TSF4 polygon (green) (DMIRS, 2018)

Detailed surface geology mapping (1:100 000) exists for some parts of WA and the survey areas lie within the Badja map area (Department of Mines and Petroleum (DMP), 2016). Nine geological units are mapped in the TSF4 polygon (A, AGLm-smb, AMUgm-xf-s, APOmib, C, Cf, Cttci, Rrf and Wf) and another five occur in the areas selected for survey outside the polygon – AANWmog, AmapsYYO, AmhsYYO, ASDB-xmg-mog and ATHgn-mgg (**Table 5; Map 3A, Section 9**) (DMP, 2016).

Table 5: 1: 100 000 surface geology and the survey areas

Code (where)	Description
AGLm-smb (inside TSF4 only)	Conglomerate, metamorphosed and strongly foliated; contains mafic and granitic clasts (no traverses aligned in it).
AMUgm-xf-s (inside TSF4 only)	Minjar Member: felsic volcaniclastic rocks and fine-grained siliciclastic sedimentary rocks; minor amygdaloidal basalt; metamorphosed (no traverses aligned in it).
APOmib (inside TSF4 only)	Metamorphosed banded iron-formation and minor banded chert; typical granular texture with magnetite and quartz grains 0.5 to 1.5 mm in size (no traverses aligned in it).
Cttci (inside TSF4 only)	Talus from banded iron-formation and chert; locally cemented (no traverses aligned in it).
A (inside and outside TSF4)	Clay, silt, sand, and gravel in channels and on floodplains.
C (inside and outside TSF4)	Colluvium derived from different rock types; includes gravel, sand, and silt (no traverses aligned in it inside TSF4).
Cf (inside and outside TSF4)	Ferruginous gravel and reworked ferruginous duricrust.
Rrf (inside and outside TSF4)	Ferruginous duricrust, massive to rubbly; includes iron-cemented reworked products.
Wf (inside and outside TSF4)	Clay, silt, and sand with abundant ferruginous grit.
AANWmog (outside TSF4)	Metagabbro; locally with layers of metaleucogabbro, metagabbronorite, metadolerite and minor metapyroxenite; includes amphibole-porphyroblastic metagabbro and metadolerite; typically weakly schistose.
AmapsYYO (outside TSF4)	Chlorite–tremolite(–talc) schist derived from peridotite.
AmhsYYO (outside TSF4)	Interlayered psammite and pelite; schistose.
ASDB-xmg-mog (outside TSF4)	Metagranite to metagranodiorite with locally abundant decametre to hectometre scale rafts of metagabbro; locally foliated.
ATHgn-mgg (outside TSF4)	Gnows Nest Granodiorite: metamorphosed granodiorite to tonalite with K-feldspar phenocrysts up to 8 mm in 4–6 mm matrix.

4 Survey Methods

The survey was carried out by two botanists between December 13 and 16, 2022. Florabase records note that flowering *Petrophile vana* specimens have been collected between September 10 and November 01 (WAH, 1998-). The *P. vana* that Maia located in late November 2021 were fruiting, and so any plants could still have fruit on them in mid-December.

Within the TSF4 polygon the botanists walked traverses around the *Petrophile vana* plants located in 2021 and in other areas that looked like prospective habitat. Some of the prospective habitat was in the preliminary survey areas selected before going to site and some of it was not. Outside the TSF4 polygon the botanists visited the preliminary *P. vana* survey areas selected before going to the field and they also walked traverses in areas where the habitat appeared to be most similar to that where *P. vana* was found within the TSF4 polygon. They walked traverses along breakaways and exposed laterite / weathered rocky areas (**Map 4, Section 9**). When found, *P. vana* locations were recorded on a Global Positioning System (GPS) and the plants were counted. Six *P. vana* specimens were collected for post-survey confirmation by a taxonomist at the WA Herbarium.

5 RAINFALL DECILES

According to the Bureau of Meteorology's (BOM's) WA rainfall deciles map for 1 September 2022 to 30 November 2022, the areas surveyed were in an area that received above average rainfall over the three months before the December 2022 survey (**Figure 2**, the approximate location of the areas surveyed is shown by the black dot) (BOM, 2022). Based on this rainfall deciles data, the vegetation in the areas searched would likely have been in above average condition for the time of year.

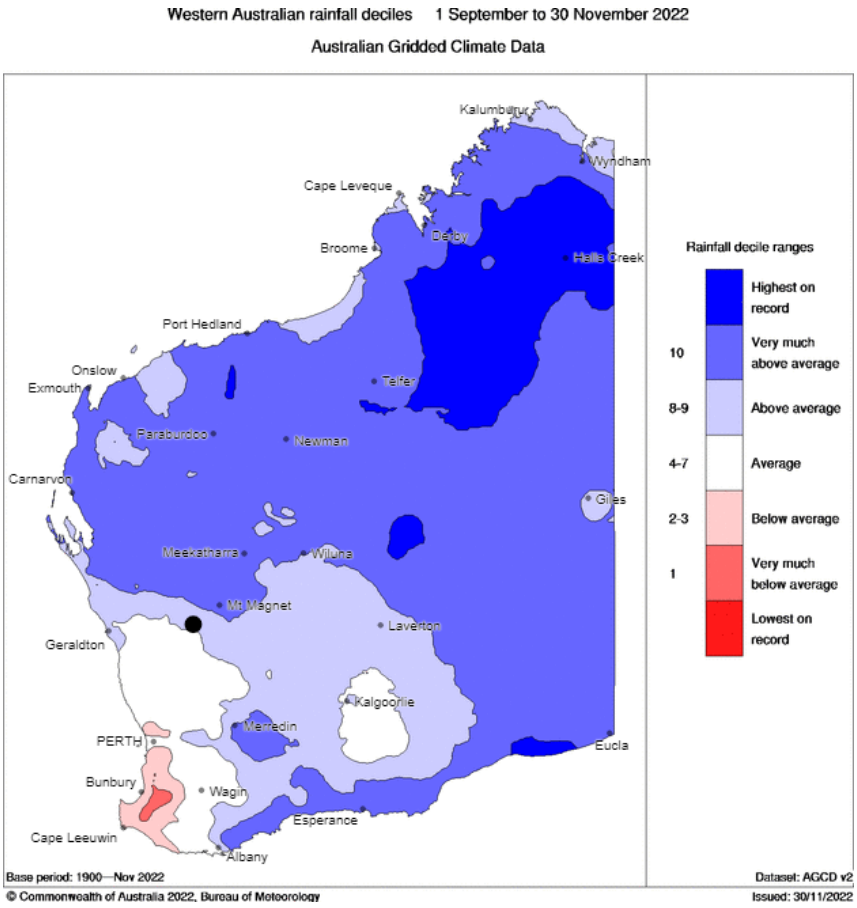


Figure 2: Western Australian rainfall deciles, 1 September to 30 November 2022 (BOM, 2022) (black dot indicates approximate location of the survey areas)

6 RESULTS AND DISCUSSION

Ninety-nine (99) new *Petrophile vana* plants were recorded at four locations - two locations within the TSF4 polygon and two outside (**Map 4, Section 9**). **Figure 3** shows one of the two original plants located by Maia in November 2021 along with the plants located in December 2022. The eastern-most of the two November 2021 TSF4 plants was revisited and the plant checked; however, it was not *P. vana* but a similar looking *Grevillea* species. Because of this there is now only one 2021 survey *P. vana* plant in the TSF4 polygon. However, 97 additional *P. vana* plants were located around the original plant in the western corner of the TSF4 polygon. Only one plant was recorded at two locations in the areas surveyed outside the TSF4 polygon.

Using a buffer of 500 m around each of the Florabase, Ecologia and Maia records (2021 and 2022 surveys) to identify discrete populations, 15 *Petrophile vana* populations are now known to Maia and one of them is in the TSF4 polygon. The TSF4 population lies within the buffered extent of a priority ecological community (PEC) – the Minjar and

Chulaar Hills vegetation complexes (banded ironstone formation - BIF) P1 PEC. The buffer over the western corner of the TSF4 polygon is associated with an occurrence of the Watson land system (**Figure 4**).

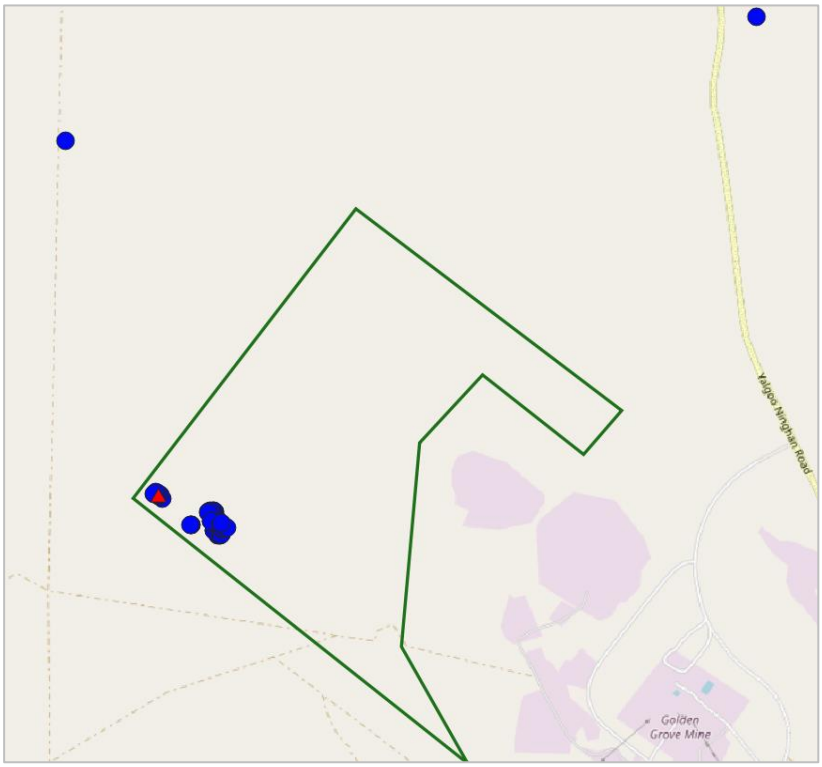


Figure 3: *Petrophile vana* locations – original (red triangle) and new (blue circles) records within and outside the TSF4 area (green polygon)

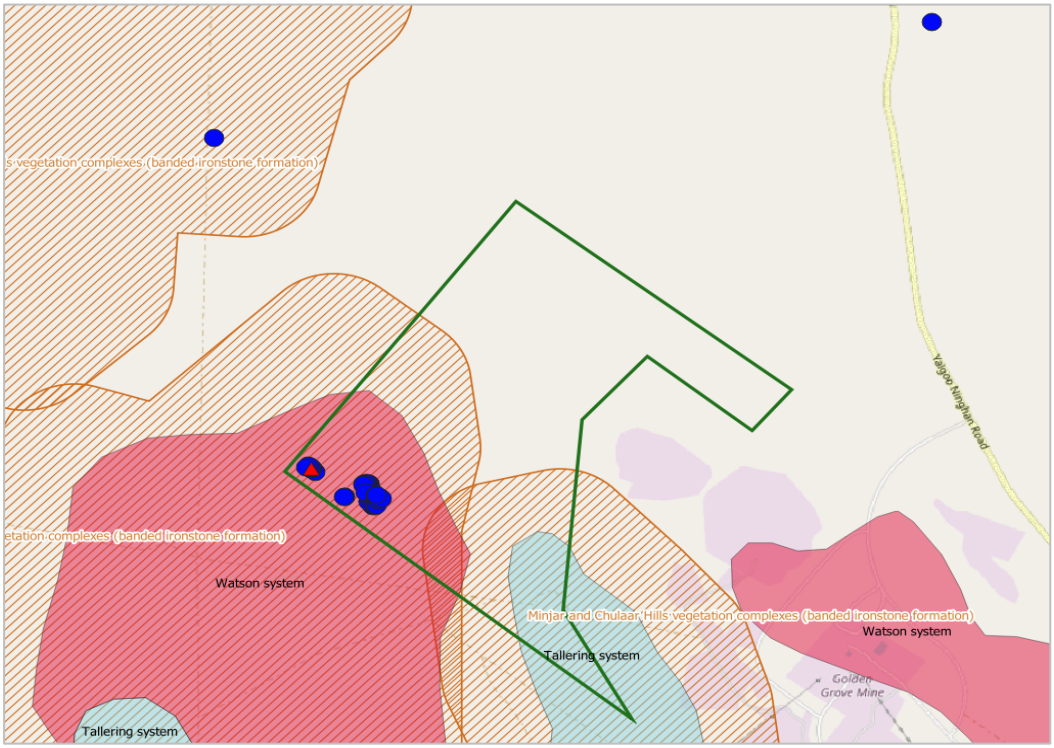


Figure 4: *Petrophile vana* locations and the Minjar and Chulaar Hills vegetation complexes (BIF) P1 PEC buffers (orange hatching)

Because only two *Petrophile vana* plants were located in the areas selected for survey outside the TSF4 polygon, Florabase records, Ecologia 2010 records and Maia 2021 and 2022 surveys records were used in a multi-criteria spatial analysis using the Multi-Criteria Analysis Shell (MCAS-S) program (Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (2022)). The program was used to combine a number of relevant environmental spatial layers to highlight areas that could potentially be *P. vana* habitat.

A multi-way coincidence count comparison model was used, and the following environmental variables were used in the final model:

- Elevation (continuous variable)
- Soil type (categorical variable)
- Major vegetation group pre 1970 (categorical variable), and
- Slope relief (categorical variable).

A multi-way coincidence count comparison model models the number of input criteria that are met in a particular area and presents the results using a colour scale: red = very high coincidence (all four criteria are met), yellow = high coincidence (three criteria are met), green = moderate coincidence (two criteria are met), blue = low coincidence (one criterion is met), and purple = very low coincidence (none of the criteria are met). Therefore, a red area means that there is high elevation (between 300 and 550 m), the soil type is either 'sand, loams or red duplex', the pre 1970 vegetation is '*Acacia* or other shrublands' and the slope relief is either 'very gentle or undulating plains and rises'.

The *Petrophile vana* locations known to Maia were then overlaid on the MCAS-S analysis output map to see how many of them occurred in areas where there was a very high coincidence score for the four environmental variables used in the analysis (**Figure 5**).

The *Petrophile vana* population in the TSF polygon is in an area modelled as having a high coincidence i.e., three of the four environmental criteria are met (the area does not meet the pre 1970 vegetation requirements). The areas outside the TSF4 polygon where the two *P. vana* plants / populations were recorded in December 2022 are modelled as a very high coincidence area, as all four environmental criteria are met.

Seven of the 12 other populations are in very high coincidence areas, two are in a high coincidence area, one is in a moderate coincidence area and two are in low coincidence areas. Therefore most (80%) of the *P. vana* populations lie in areas of very high or high coincidence for the four environmental variables used in the assessment. **Figure 6** zooms in on the results of the MCAS-S assessment around the TSF4 area, and the very high coincidence areas to the north, east and south could indicate areas where there could be potential *P. vana* habitat.

This is a high-level assessment and more detailed low-level habitat modelling could further define areas of potential *P. vana* habitat.

Ninety-nine (99) new *Petrophile vana* plants were located during the TFS; however, 97 of them were in the TSF4 polygon and only two were found in the areas searched outside the polygon. It is highly likely that further surveys in suitable habitat in the surrounding area will result in more plants being located.

The plants in the TSF4 polygon are all in its western corner and could be avoided if 29MGG didn't use that section of the polygon. As the western and south-western parts of the polygon are overlapped by buffers in place around a P1 PEC (Minjar and Chulaar Hills vegetation complexes (BIF)), impact to those areas should be avoided anyway. The plants are all in a part of the Watson land system that the P1 PEC buffer in the western corner is associated with.

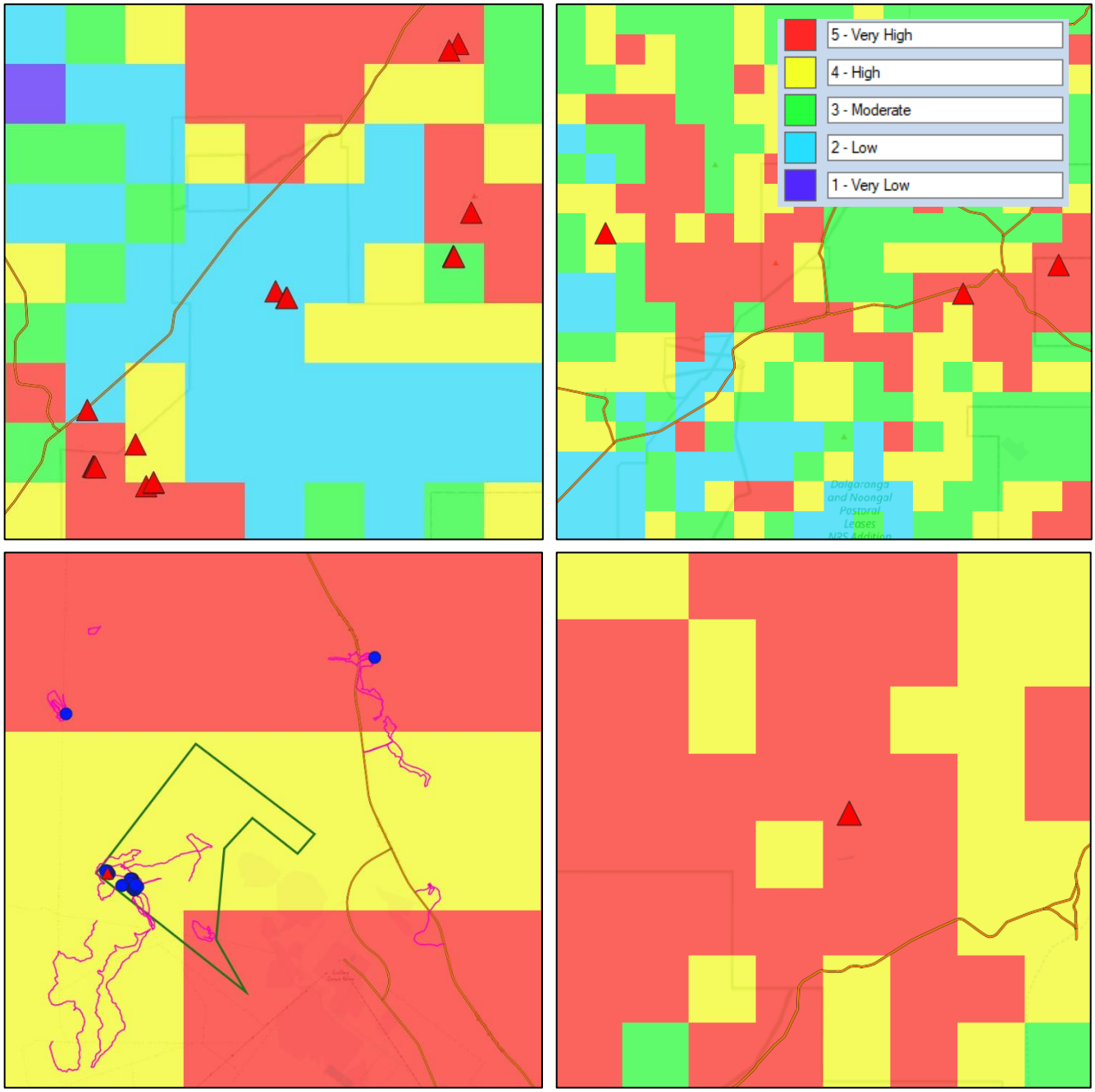


Figure 5: MCAS-S coincidence assessment with *Petrophile vana* locations pre (red triangles) and post December 2022 survey (blue circles)

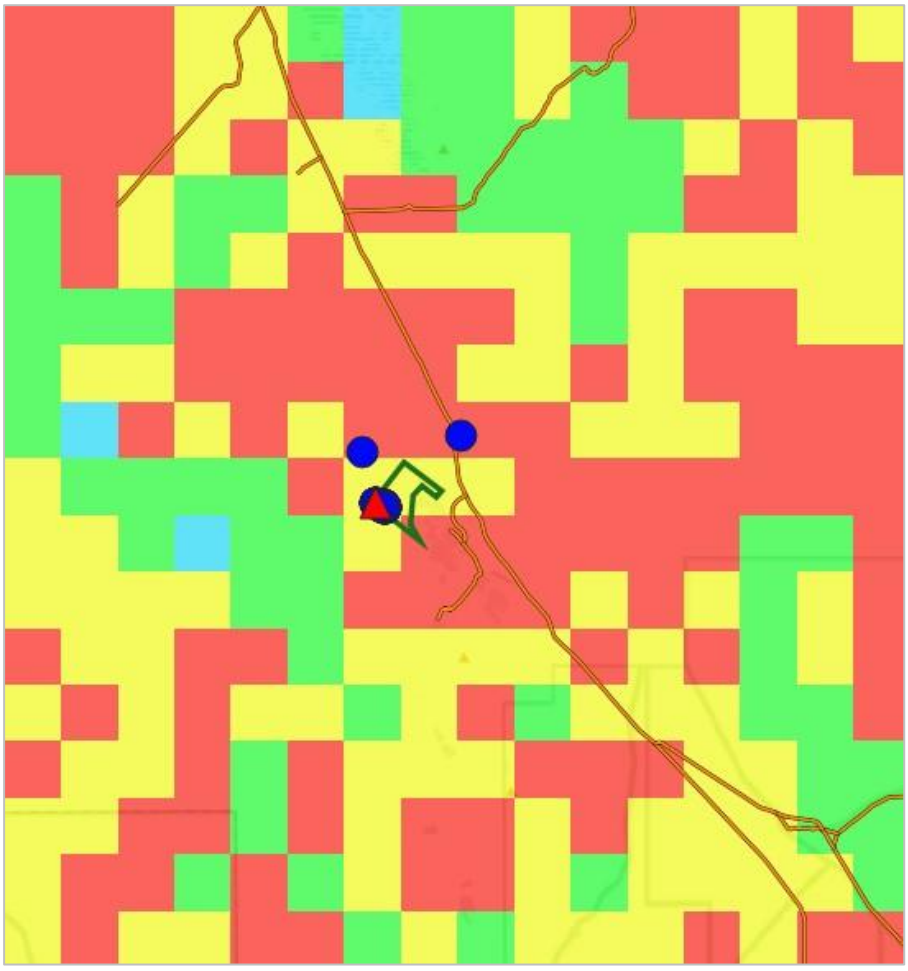


Figure 6: MCAS-S assessment results in and around the TSF4 polygon (dark green outline)

7 PROJECT TEAM

The survey and reporting tasks conducted for this project were undertaken by the botanists listed in **Table 6.**

Table 6: Project Team

Project team			
Name	**Qualification**	**Role**	**DBCA flora license number (expiry)**
Christina Cox	PhD	Report	Not applicable
Scott Hitchcock	BSc.	Botanist – survey and report	FB62000064-2 (30/04/2023)
Eva Karikis	BSc.	Botanist – survey and report	FB62000324 (21/03/2024)
Ryan Woodhouse	BSc.	Botanist – report	Not applicable
M. Hislop (WA Herbarium) confirmed the identity of the six *Petrophile vana* specimens collected from the areas surveyed.			

8 REFERENCES

Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) (2022). Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S), Version 4. Available: https://www.agriculture.gov.au/abares/aclump/multi-criteria-analysis.

Bureau of Meteorology (BOM) (2022). Recent and historical rainfall maps. Three-monthly rainfall deciles for Western Australia. 1 September 2022 – 30 November 2022. Available: http://www.bom.gov.au/climate/maps/rainfall/?variable=rainfall&map=decile&period=3month&region=wa&year=2022&month=11&day=30. Accessed: January 2023.

Department of Climate Change, Energy, the Environment and Water (DCCEEW) (2022). Interim Biogeographic Regionalisation for Australia, Version 7. 419 subregions. Available: https://www.dcceew.gov.au/sites/default/files/env/pages/5b3d2d31-2355-4b60-820c-e370572b2520/files/ibra-subregions.pdf. Accessed: 13rd December 2022.

Department of Mines and Petroleum (DMP) (2016). 1:100 000 geological map – BADJA (2240), first edition.

Department of Mines, Industry Regulation and Safety (DMIRS) (2018). Interactive geological map (GeoVIEW.WA). 1:250k Geology Mosaic of Western Australia, 2018. GDA94 Available: https://geoview.dmp.wa.gov.au/geoview/?Viewer=GeoVIEW&extent=110.724924327559,-29.0053888045655,127.992790301503,-20.2944653323595. Accessed: 15th December 2022.

Department of Primary Industries and Regional Development (DPIRD) (2021). Pre-European Vegetation – Western Australia (DPIRD-006) [shapefile]. Available at: https://data-downloads.slip.wa.gov.au/DPIRD-006/Shapefile. Accessed: 14th December 2022.

DPIRD (2022). Soil Landscape Mapping – Best Available (DPIRD-027) [shapefile]. Available: https://data-downloads.slip.wa.gov.au/DPIRD-027/Shapefile. Accessed: 14th December 2022.

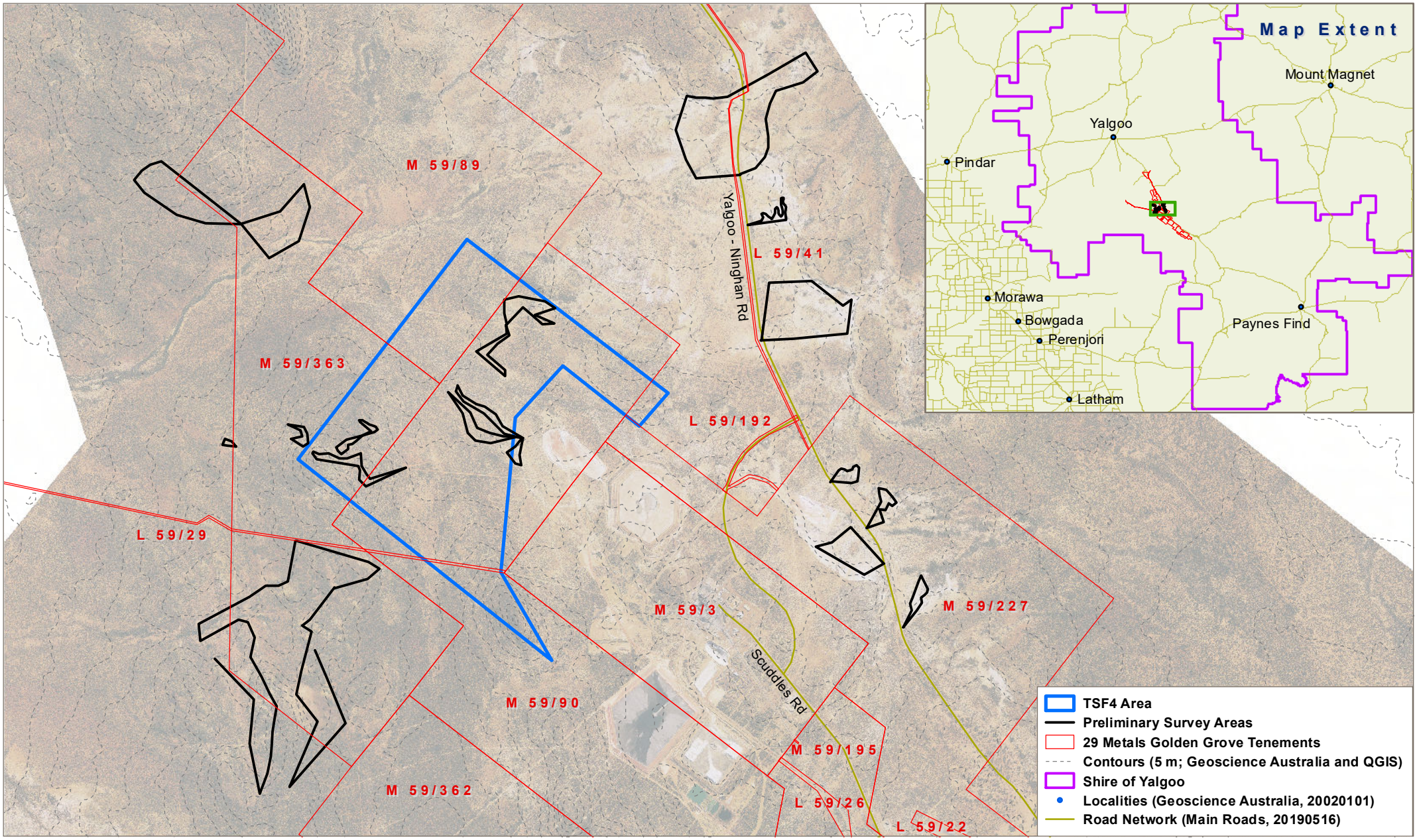
Ecologia Environment (Ecologia) (2010). Oakajee Port and Rail, OPR Rail Development Vegetation and Flora Assessment, May 2010.

Maia Environmental Consultancy Pty Ltd (Maia) (2022). 29 Metals Golden Grove: Tailings Storage Facility 4 (TSF4) Option B Regional. Flora and Vegetation Reconnaissance and Targeted Flora Surveys, November 2021. Version 1, February 21, 2022.

Stewart, A.J., Sweet, I.P., Needham, R.S., Raymond, O.L., Whitaker, A.J., Liu, S.F., Phillips, D., Retter, A.J., Connolly, D.P., and Stewart, G. (2008). Surface geology of Australia 1:1,000,000 scale, Western Australia [Digital Dataset]. Canberra: The Commonwealth of Australia, Geoscience Australia. Available: http://www.ga.gov.au. Accessed and downloaded through Landgate (March, 2012).

Western Australian Herbarium (WAH) (1998–). Florabase—the Western Australian Flora. Department of Biodiversity, Conservation and Attractions. Available: https://florabase.dpaw.wa.gov.au/.

9 MAPS



Location Map

The TSF4 Polygon and Preliminary Survey Areas

maia

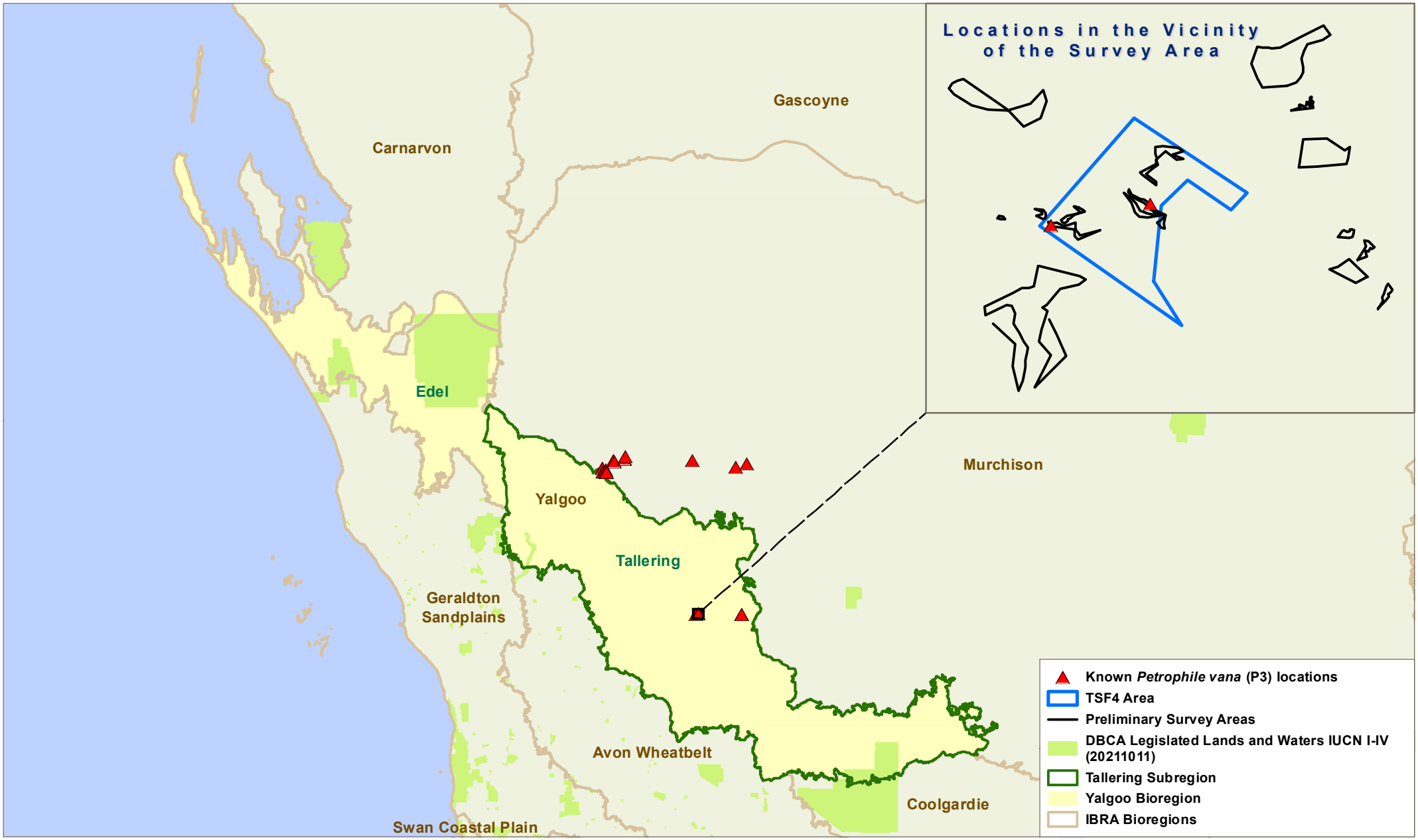
N

0 1

Kilometres

Datum: GDA 1994, MGA 50

Map: 1 **Version:** 1
Prepared for: 29MGG
Drawn by: RH
Date: 1/02/2023
Project: 2215 **Size:** A4



***Petrophile vana* (P1) Known Records**

maia

N

0 60

Kilometres

Datum: GDA 1994, MGA 50

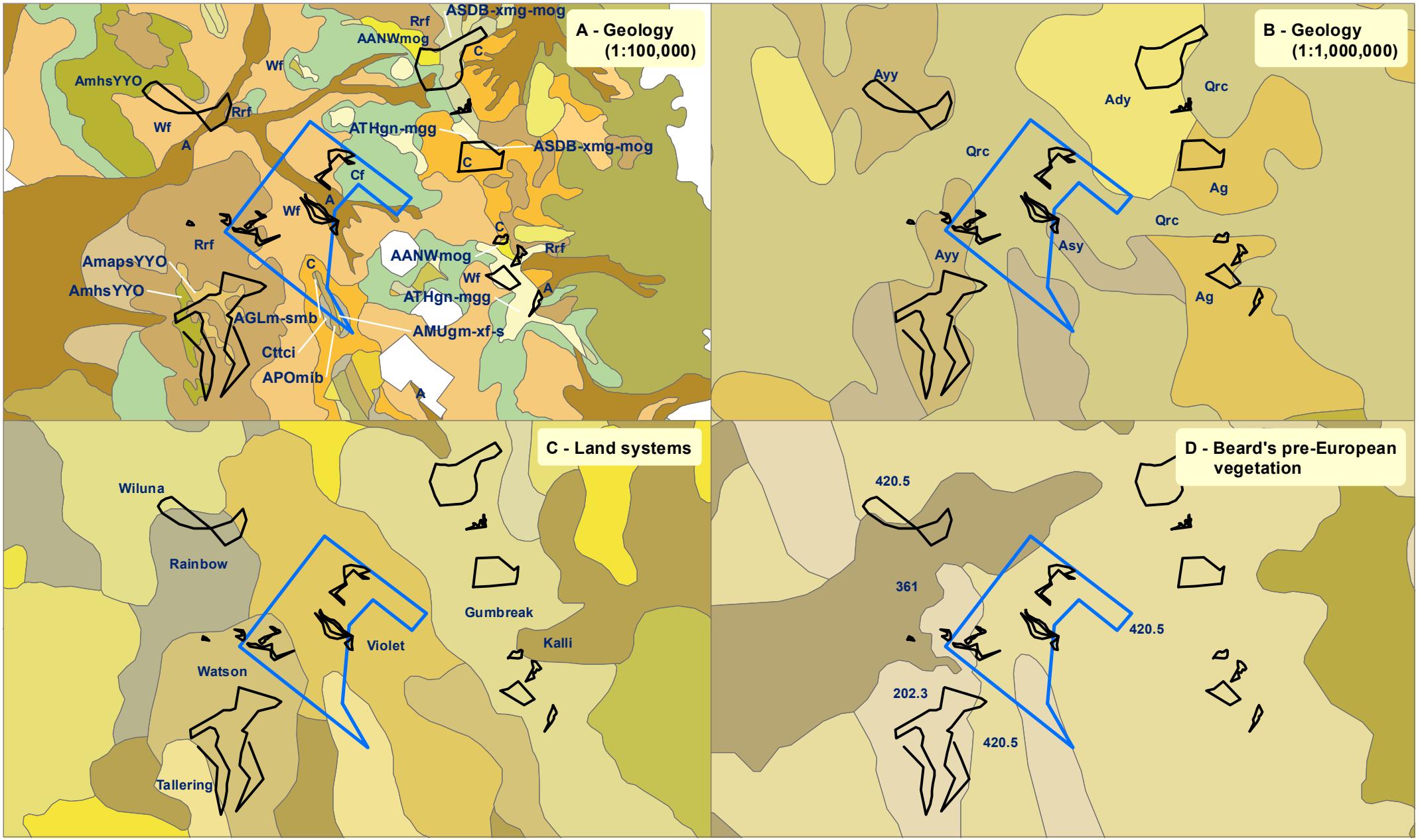
Map: 2 **Version:** 1

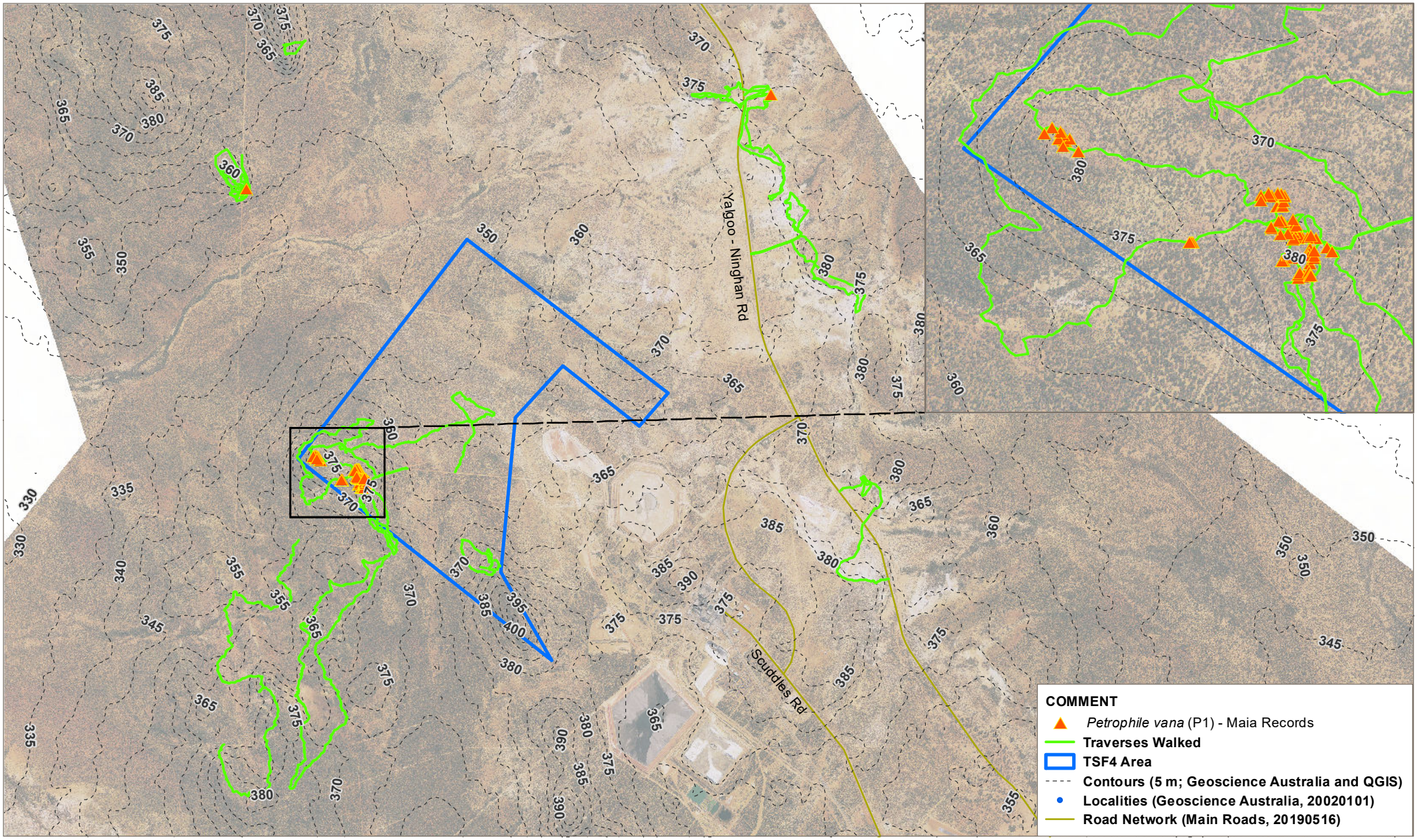
Prepared for: 29MGG

Drawn by: RH

Date: 1/02/2023

Project: 2215 **Size:** A4


A - Geology (1:100,000)
ASDB-xmg-mog
Rrf
AANWmog
C
Wf
AmhsYYO
Rrf
Wf
A
ATHgn-mgg
ASDB-xmg-mog
C
Cf
A
Wf
C
Rrf
AANWmog
Rrf
AmapsYYO
C
Wf
AmhsYYO
ATHgn-mgg
A
AGLm-smb
AMUgm-xf-s
Cttci
APOmib
A
B - Geology (1:1,000,000)
Ayy
Ady
Qrc
Qrc
Ag
Qrc
Asy
Ayy
Ag
C - Land systems
Wiluna
Rainbow
Gumbreak
Violet
Kalli
Watson
Tallering
D - Beard's pre-European vegetation
420.5
361
420.5
202.3
420.5
Location Map
Karratha
Newman
Wiluna
Geraldton
Perth
Preliminary Survey Areas
TSF4 Area
Geology, Land Systems and Beard's Pre-European Vegetation (Vegetation System Associations)
maia
N
Datum: GDA 1994, MGA 50
Map: 3 Version: 1
Prepared for: 29MGG
Drawn by: RH
Date: 1/02/2023
Project: 2215 Size: A4



Location Map

- Karratha
- Newman
- Wiluna
- Geraldton
- Perth

Traverses Walked, Contours and Maia *Petrophile vana* (P1) Records

maia

N

0 1

Kilometres

Datum: GDA 1994, MGA 50

Map: 4 **Version:** 1
Prepared for: 29MGG
Drawn by: RH
Date: 1/02/2023
Project: 2215 **Size:** A4

APPENDIX 1: *PETROPHILE VANA* HABITAT DATA

This page is intentionally blank.

Table 7: *Petrophile vana* records (pre-December 2022 survey) habitat data

Maia record ID	Source	No. of plants	Elevation (m)	pre-European vegetation association (DPIRD, 2021)	Soil land system (DPIRD, 2022)	1:1M Surface geology (Stewart et al., 2008)	1:250k Surface geology (DMIRS, 2018)	1:100k Surface geology (DMP, 2016)
1	Ecologia, 2010	<2%	350-400 m	**326.2** - Scrub with open woodland or scattered trees - Wattle with York gum, casuarina, mulga *Acacia* spp. with *Eucalyptus loxophleba*, *Allocasuarina* spp. *Acacia aneura*.	**Challenge** - Gently undulating gritty and sandy surfaced plains, occasional granite hills, tors and low breakaways, supporting acacia shrublands and occasional halophytic shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Granite; even-grained with deeply weathered rocks.	
2	Ecologia, 2010	<2%	350-400 m					
3	Ecologia, 2010	22	350-400 m	**404** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Challenge** - Gently undulating gritty and sandy surfaced plains, occasional granite hills, tors and low breakaways, supporting acacia shrublands and occasional halophytic shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Granite; even-grained.	
4	Ecologia, 2010	17						
5	Ecologia, 2010	16						
6	Ecologia, 2010	1						
7	Ecologia, 2010	1	300-350 m	**326.2** - Scrub with open woodland or scattered trees - Wattle with York gum, casuarina, mulga *Acacia* spp. with *Eucalyptus loxophleba*, *Allocasuarina* spp. *Acacia aneura*.	**Yanganoo** - Almost flat hardpan wash plains, with or without small wanderrie banks and weak groving; supporting mulga shrublands and wanderrie grasses on banks	**Qrc** - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.	**Qb** - Sand - alluvial, eluvial and eolian.	
8	Ecologia, 2010	10	350-400 m	**326.2** - Scrub with open woodland or scattered trees - Wattle with York gum, casuarina, mulga *Acacia* spp. with *Eucalyptus loxophleba*, *Allocasuarina* spp. *Acacia aneura*.	**Challenge** - Gently undulating gritty and sandy surfaced plains, occasional granite hills, tors and low breakaways, supporting acacia shrublands and occasional halophytic shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Granite; even-grained with deeply weathered rocks.	
9	Ecologia, 2010	22						
10	Ecologia, 2010	17						
11	Ecologia, 2010	10	~350 m	**420** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Waguin** - Sandplains and stripped granite or laterite surfaces with low fringing breakaways and lower plains; supports bowgada and mulga shrublands with wanderrie grasses and minor halophytic shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Agp** - Granite; porphyritic with deeply weathered rocks and **Agn** - Migmatite of metamorphic and granitic rocks with deeply weathered rocks.	
12	Ecologia, 2010	14						
13	Ecologia, 2010	6						
14	Ecologia, 2010	6	350-400 m	**420** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Norie** - Granite hills with exfoliating domes and extensive tor fields, supporting acacia shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Granite; even-grained.	
15	Ecologia, 2010	13						
16	Ecologia, 2010	6						
17	Ecologia, 2010	1	350-400 m	**420** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Norie** - Granite hills with exfoliating domes and extensive tor fields, supporting acacia shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Granite; even-grained with deeply weathered rocks.	
18	Florabase	1	350-400 m	**404** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Kalli** - Elevated gently undulating red sandplains edged by stripped surfaces on laterite and granite, supporting acacia tall shrublands with wanderrie grass understoreys	**Qrc** - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.	**Agp** - Granite; porphyritic with deeply weathered rocks.	
19	Florabase	1	450-500 m	**2081.4** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Kalli** - Elevated gently undulating red sandplains edged by stripped surfaces on laterite and granite, supporting acacia tall shrublands with wanderrie grass understoreys	**Qrc** - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.	**Czs** - Sandplain.	
20	Florabase	1	450-500 m	**39.1** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Wiluna** - Low greenstone hills with occasional lateritic breakaways and broad stony slopes, lower saline stony plains and broad drainage tracts; supporting sparse mulga and other acacia shrublands with patches of halophytic shrubs	**Asy** - Conglomerate, chert, small amounts felsic volcaniclastic rocks, sandstone, quartzite, siltstone, phyllite, schist, pelite, shale. Include former Hatfield Formation.	**Ala** - Andalusite +- cordierite +- garnet +- staurolite bearing pelitic schist.	

Maia record ID	Source	No. of plants	Elevation (m)	pre-European vegetation association (DPIRD, 2021)	Soil land system (DPIRD, 2022)	1:1M Surface geology (Stewart et al., 2008)	1:250k Surface geology (DMIRS, 2018)	1:100k Surface geology (DMP, 2016)
21	Florabase	1	500-550 m	**39.1** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Kalli** - Elevated gently undulating red sandplains edged by stripped surfaces on laterite and granite, supporting acacia tall shrublands with wanderrie grass understoreys	**Ady** - Mafic intrusive rocks, medium to coarse-grained; layered mafic to ultramafic intrusions; metadolerite; Medium to coarse-grained metagabbro, dolerite and granophyre, local ultramafic bases.	**Abg** - Gabbro, medium to coarse-grained.	
22	Florabase	1	345-350 m	**326.3** - Scrub with open woodland or scattered trees - Wattle with York gum, casuarina, mulga *Acacia* spp. with *Eucalyptus loxophleba*, *Allocasuarina* spp. *Acacia aneura*.	**Sherwood** - Breakaways, kaolinised footslopes and extensive gently sloping plains on granite supporting mulga shrublands and minor halophytic shrublands	**Ag** - Undifferentiated felsic intrusive rocks, including monzogranite, granodiorite, granite, tonalite, quartz monzonite, syenogranite, diorite, monzodiorite, pegmatite. Locally metamorphosed, foliated, gneissic. Local abundant mafic and ultramafic inclusions.	**Age** - Adamellite to granodiorite - medium even-grained; includes minor xenoliths with granitoid rocks strongly foliated, lineated and/or recrystallized.	W - Clay, silt, and sand in extensive fans; local ferruginous gravel.
23	Maia, 2022 TSF4	1	380-385 m	**202.3** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Watson** - Hills, rises and gravelly plains on sedimentary rocks supporting bowgada shrublands with non-halophytic undershrubs	**Ayy** - Metasandstone, metashale, metasiltstone, metaconglomerate and meta-volcaniclastics, pelitic schists, phyllite, fuchsitic quartzite with clasts quartzite and felsic volcanic rock; quartzite; pelitic and psammitic gneiss	**Asp** - Siltstone, shale, phyllite, minor schist with deeply weathered rocks.	Rrf - Ferruginous duricrust, massive to rubbly; includes iron-cemented reworked products.
24*	Maia, 2022 TSF4	1	350-355 m	**420.5** - Scrub, open scrub or sparse scrub - Wattle, tea tree & other species *Acacia* spp. *Melaleuca* spp.	**Violet** - Gently undulating gravelly plains on greenstone, laterite and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands	**Qrc** - Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite.	**Qcg** - Quartz-kaolin grit, cemented limonite gravel.	A - Clay, silt, sand, and gravel in channels and on floodplains.

Note: * while this record was used in the preliminary habitat assessment, the plant was revisited during the December 2022 survey and it was not *P. vana*, but a similar looking species: it was not used in the follow-up habitat assessment carried out for this report; spp. = multiple species.

maia

PHOENIX
ENVIRONMENTAL SCIENCES

Terrestrial fauna survey for the TSF4 Project

Prepared for EMR Golden Grove Pty Ltd

March 2021

Final

Terrestrial fauna survey for the TSF4 Project

Prepared for EMR Golden Grove Pty Ltd

Version history

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
S. Pynt, J. Scanlon	J. Clark/M. Clunies-Ross	Draft for client comments	0.1	01-Feb-21	Stephen Neill
J. Scanlon	J. Clark	Final, client comments addressed	1.0	02-Mar-21	Stephen Neill

Phoenix Environmental Sciences Pty Ltd

2/3 King Edward Road OSBORNE PARK WA 6017

P: 08 6323 5410

E: admin@phoenixenv.com.au

Project code: 1348-GG-EMR-FAU

EXECUTIVE SUMMARY

EMR Golden Grove Pty Ltd (EMRGG) is seeking to develop the TSF4 Project (the Project), located ~120 km northeast of Morawa in the Shire of Yalgoo, Western Australia. Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by EMRGG to undertake a desktop review and a Level 1 single-phase terrestrial fauna survey of the 254 ha Project area in spring 2020 (August 24-28).

A search of the relevant databases combined with information from other surveys in the Yalgoo bioregion were used to determine the significant fauna potentially occurring in the study area and thus to design the field survey.

The field survey included an assessment of vertebrate fauna, short-range endemic (SRE) invertebrate and Malleefowl (*Leipoa ocellata*) habitat as well as targeted searches for evidence of Malleefowl, *Egernia stokesii badia* and *Idiosoma clypeatum*.

The study area comprises a single broad fauna habitat type (mulga shrubland on clay soils) which is widespread throughout the bioregion; it is subdivided for mapping purposes as follows:

- mulga shrubland on stony hill slopes (MHS)
- mulga shrubland on undulating plain (MUP)
- open mulga shrubland on laterite plain (MLP)
- mid mulga shrubland on hardpan clay (MHC)
- low open shrubland on plain (LOS)

Searches of the study area recorded no Malleefowl mounds, tracks, or other signs. Malleefowl habitat assessment using a scoring system on soil and vegetation attributes confirms largely low suitability, except for parts of habitat type MUP. It is concluded that the study area may be used infrequently by the population of Malleefowl resident in the broader area and thus the area does not require inclusion in the existing company management plan for the species (EMRGG 2017).

No evidence of *Egernia stokesii badia* or *Idiosoma clypeatum* was observed during the survey, nor were habitats considered prospective for SRE invertebrates.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

EMR Golden Grove Pty Ltd (EMRGG) is seeking to develop the TSF4 Project (the Project), located ~120 km northeast of Morawa, Western Australia (WA; Figure 1-1). The study area is in the Shire of Yalgoo and the Eremaean Botanical Province as defined by EPA (2016b).

In August 2020, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by EMRGG to undertake a desktop review and a Level 1 single-phase terrestrial fauna survey for the Project including targeted Malleefowl, *Egernia stokesii badia* and *Idiosoma clypeatum* searches.

Several previous fauna assessments have been conducted in the vicinity of the study area which provide contextual information:

Unpublished Reports for the Golden Grove Project.

- Ninox (1997)– Vertebrate Fauna of the Murchison Zinc Project Area. Not reviewed.
- Bamford (2007) – conducted a Level 1 assessment of Gossan Hill in accordance with EPA guidance 56 (EPA 2004) within a roughly 200 X 300 m survey area. Several significant fauna were identified as potentially occurring, *Cyclodomorphus branchialis* Gilled Slender Bluetongue (VU, BC Act), *Egernia stokesii badia* Western Spiny-tailed Skink (VU BC Act, EN EPBC Act), *Lerista eupoda* (P1), *Leipoa ocellata* Malleefowl (VU BC and EPBC Act), *Falco peregrinus* Peregrine Falcon (OS, BC Act), *Apus pacificus* Fork-tailed Swift (Mig.), *Sminthopsis longicaudata* Long-tailed Dunnart (P4), and several potential short-range endemic (SRE) invertebrates. The author noted that burrows of the Threatened trap-door spider *Idiosoma nigrum* (now *Idiosoma clypeatum*) were not detected in the survey.
- ENV (2008) – suitable habitat/assumed locations for *Egernia stokesii badia* mapped by ENV (map dated 2008) within part of tenements M59/91, M59/92, and M599/93.
- Coffey (2008) – undertook a Level 1 terrestrial fauna risk assessment for a proposed expansion of the tailings storage facilities. The survey found there were no active Malleefowl mounds, or nesting hollows for Major Mitchell's Cockatoo. Similarly the habitat was unsuitable for Western Spiny-tailed or Gilled Slender Bluetongue skinks.
- Central Regional TAFE (2017) – conducted a targeted survey for Malleefowl mounds in nearby tenements 59/195 and 59/227 (~5 km SE of the study area). No mounds were recorded; however, the report notes that several other surveys conducted for the Golden Grove mine site have recorded both active and inactive mounds in the general area.
- Phoenix (2020b) – terrestrial fauna survey for the Gossan Valley Project in parts of tenements M59/91, M59/92 and M59/93 (~6-13 km SE of the study area) recorded evidence of Malleefowl from recent scats, tracks, foraging evidence, and 11 mounds, two of which were previously known. None of the mounds within the Project area was currently active, and fresh Malleefowl evidence was concentrated in and around woodland habitat in the north-western part of the study area. No evidence of *Egernia stokesii badia* or *Idiosoma clypeatum* was observed during search transects, nor were habitats considered prospective for SRE invertebrates.
- Phoenix (2020a) – terrestrial fauna survey for the Bassendean Project in parts of tenements M59/93, M59/94, M59/143 and M59/2272 (~15-22 km SE of the study area) recorded evidence of Malleefowl (feathers) at a single site, but no mounds, tracks or foraging signs. Malleefowl habitat assessment using a scoring system on soil and vegetation attributes confirms largely low suitability. No evidence of *Egernia stokesii badia* or *Idiosoma clypeatum*

was observed during the survey, nor were habitats considered prospective for SRE invertebrates.

1.2 SCOPE OF WORK

This terrestrial fauna survey included:

- a desktop review of available technical reports and relevant databases to determine the potential fauna species and habitats within the study area
- a Level 1 reconnaissance field survey for terrestrial fauna within the study area
- a search of the Project area for presence of Malleefowl mounds, scats of *Egernia stokesii badia* in hollow-forming *Eucalyptus* trees, fallen logs and under bark, and the burrows of *Idiosoma clypeatum*
- maps showing species records and habitat for Threatened species
- a report detailing:
    - methods
    - results
    - assessment of significant species and habitats
    - a likelihood of occurrence assessment for significant species.

1.3 STUDY AREA

The study area is an irregular polygon approximately 3 km by 1 km (254.5 ha), occupying parts of tenements M59/90 and M59/03 (Figure 1-1). The study area is located adjacent to existing Project infrastructure and has undergone considerable disturbance by exploration and operations (tracks, drill pads, borrow pits, spoil heaps).

EMR Golden Grove
Golden Grove

Project No	1348
Date	16/12/2020
Drawn by	IN
Map author	JS

0 250 500
Meters

1:16,000 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_1_1_Project_location_study_area.mxd

Study area

Figure 1-1

Project location and study area

PHOENIX ENVIRONMENTAL SCIENCES

2 LEGISLATIVE CONTEXT

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

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

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

2.1 COMMONWEALTH

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

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

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

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

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

2.2 STATE

2.2.1 Threatened and Priority species

In WA, the BC Act provides for the listing of Threatened fauna species (Government of Western Australia 2018a, b)[2] in the following categories:

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

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

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

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

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

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

2.2.2 Critical habitat

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

2.2.3 Other significant fauna

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

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

- species with restricted distribution (see also section 2.2.4)
- species subject to a degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

2.2.4 Short-range endemic invertebrates

SRE fauna are defined as animals that display restricted geographic distributions, nominally less than 10,000 km^2, that may also be disjunct and highly localised (Harvey 2002). EPA (2016a) 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 that are generally at greater risk of changes in conservation status due to environmental change than other, more widely distributed taxa.

Short-range endemism in terrestrial invertebrates is believed to have evolved through two primary processes (Harvey 2002):

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

1. Relictual – where the drying climate reduced the area of suitable habitat available to a species, forcing a range contraction. Such habitats typically maintain historic mesic conditions (e.g. south-facing rock faces or slopes of mountains or gullies)
2. Habitat speciality – where species settled in particular isolated habitat types (e.g. rocky 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 (see for example Car & Harvey 2014; Rix *et al.* 2018).

There can be uncertainty in categorising a specimen as an SRE due to several 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 four categories which were adopted in this assessment: confirmed, potential, uncertain and not SRE. Confirmed SREs are taxa for which the distribution is known to be less than 10,000 km^2, the taxonomy is well known and the group is well represented in collections and/ or via comprehensive sampling (WAM 2013). 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.

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is located in the Tallering subregion (YAL02) of the Yalgoo bioregion (Figure 3-1) which is characterised by low woodlands to open woodlands of *Eucalyptus*, *Acacia* and *Callitris* on red sandy plains of the Western Yilgarn Craton and Southern Carnarvon Basin.

The Western Yilgarn Craton comprises mulga, *Callitris*, *Eucalyptus salubris*, and bowgada open woodlands and scrubs on earth to sandy-earth plains. The Southern Carnarvon Basin has a basement of Phanerozoic sediments. The subregion is particularly rich in ephemerals (Desmond & Chant 2001).

3.2 LAND SYSTEMS AND SURFACE GEOLOGY

The WA Department of Primary Industries and Regional Development undertakes land system mapping for WA using a nesting soil-landscape mapping hierarchy (Schoknecht & Payne 2011). While the primary purpose of the mapping is to inform pastoral and agricultural land capability, it is also useful for informing biological assessments. Under this hierarchy, land systems are defined as areas with recurring patterns of landforms, soils, vegetation and drainage (Payne & Leighton 2004).

The study area intersects two land systems (Table 3-1; Figure 3-2).

Table 3-1 Land systems and extent in study area

Land system	Description	Area (ha)	% of study area
Tallering	Prominent ridges and hills of banded ironstone, dolerite and sedimentary rocks supporting bowgada and other Acacia shrublands.	57.9	22.8
Violet	Gently undulating gravelly plains on greenstone, laterite, and hardpan, with low stony rises and minor saline plains; supporting groved mulga and bowgada shrublands and occasionally chenopod shrublands.	196.6	77.2
	Total	**254.5**	**100**

According to the Surface Geology of Australia 1:1,000,000 scale, WA database (Stewart *et al.* 2008), the study area intersects two geological formations (Table 3-2; Figure 3-2).

Table 3-2 Surface geology of the study area, extent by deposit type

Surface geology unit	Description	Area (ha)	% of study area
Pelitic and psammitic sedimentary rocks 74240 (Asy)	Conglomerate, chert, small amounts felsic volcaniclastic rocks, sandstone, quartzite, siltstone, phyllite, schist, pelite, shale; include former Hatfield Formation	80.6	31.7
Colluvium 38491 (Qrc)	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite	174.0	68.3
	Total	**254.6**	**100**

EMR Golden Grove
Golden Grove

Project No	1348
Date	16/12/2020
Drawn by	IN
Map author	JS

0 7.5 15
Kilometers

1:400,000 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_3_1_Ibra.mxd

Study area

Ibra region and subregion

Yalgoo, Tallering

Murchison, Eastern Murchison

Figure 3-1

Study area in relation to IBRA bioregions and subregions

PHOENIX ENVIRONMENTAL SCIENCES

EMR Golden Grove
Golden Grove

Project No	1348
Date	16/12/2020
Drawn by	IN
Map author	JS

0 250 500
Meters

1:14,000 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_3_2_Land_systems_surface_geol.mxd

Study area

Surface geology

Asy

Qrc

Land system

Tallering System

Violet System

Figure 3-2

Land systems and surface geology in the study area

PHOENIX ENVIRONMENTAL SCIENCES

3.3 CLIMATE AND WEATHER

The climate of the Tallering subregion is described as semi-arid to Mediterranean. Spatially averaged median (1890–2001) rainfall is 248 mm (Cowan 2001). Daily rainfall data documented at Golden Grove from 2017-2020 records mean annual total as 224 mm (EMRGG 2021) (Figure 3-3). The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and recent historic climate data is at Mount Magnet Aero (no. 007600, Latitude: -28.095 Longitude: 117.88), approximately 130 km northeast of the study area. Mount Magnet Aero records the highest mean maximum monthly temperature (38.0°C) in January (lowest in July, 18.9°C) and the lowest minimum mean monthly temperature (7.0°C) in July (highest in January, 23.5°C) (BoM 2020) (Figure 3-3). Average annual rainfall is 251.2 mm with February and March recording the highest monthly averages (35.4 mm and 35.3 mm respectively; Figure 3-3).

Daily mean temperatures at Mount Magnet Aero preceding the surveys were close to average in most months leading up to the survey, but mean daily maxima up to 4°C above average in September to December 2019 and June-July 2020 (Figure 3-3). Slightly warmer than average temperatures continued during the month of survey (mean daily minimum and maximum 9.8°C and 22.0°C, not shown in graph).

Records from Golden Grove show mixed results concerning average rainfall, with most months preceding the survey being below the average, while December 2019, February, June, and July 2020 saw above average rainfall. That being said, total rainfall for the year was 79% of the average for 2017-2020 (Figure 3-3). In the month of survey, 38.8 mm was recorded at Golden Grove between August 9 and 18 (EMRGG 2021). Accordingly, rainfall and temperatures in the lead-up to the survey were conducive for fauna activity.

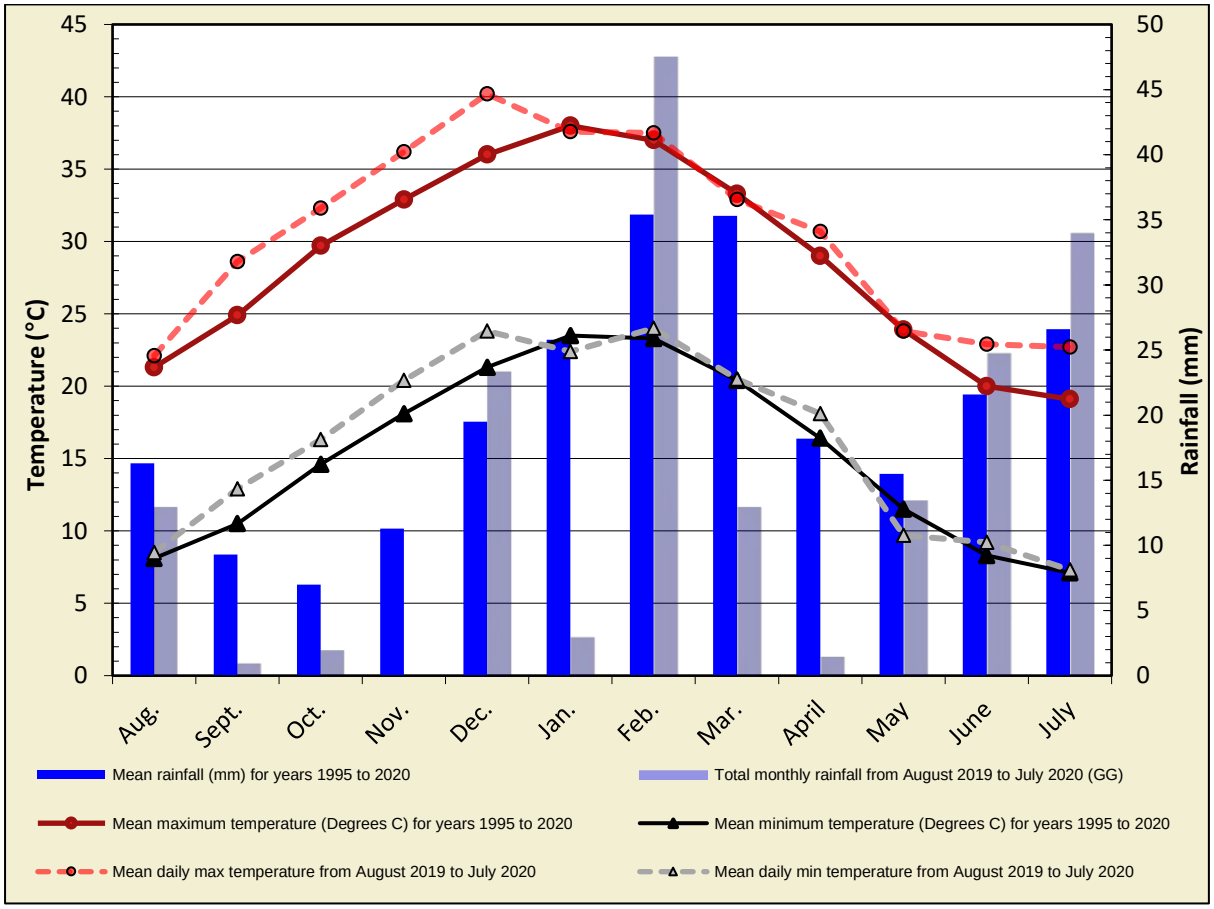


Figure 3-3 **Annual climate and weather data for Mount Magnet Aero (no. 007600) and mean monthly data for the 12 months preceding the survey (BoM 2020; EMRGG 2021)**

3.4 LAND USE

The Tallering subregion is sparsely populated and primary land uses include Production from relatively natural environments (Grazing native vegetation), Conservation and natural environments (Nature conservation and other minimal use) (ABARES 2018) and mining leases.

Table 3-3 Land use within the Tallering IBRA subregion (ABARES 2018)

Primary land use	Secondary landuse	Sum (ha)	Pct
Production from relatively natural environments	Grazing native vegetation	2,289,742.8	57.14%
Conservation and natural environments	Nature conservation	1,063,440.1	26.54%
Conservation and natural environments	Other minimal use	476,069.0	11.88%
Water	Lake	132,911.8	3.32%
Production from dryland agriculture and plantations	Cropping	41,173.1	1.03%
Water	River	1,547.1	0.04%
Intensive uses	Transport and communication	1,429.3	0.04%
Intensive uses	Mining	708.7	0.02%
Production from dryland agriculture and plantations	Land in transition	95.1	0.0024%
Intensive uses	Residential and farm infrastructure	75.8	0.0019%
Intensive uses	Services	31.5	0.0008%
Production from dryland agriculture and plantations	Plantation forests	29.1	0.0007%
Water	Water	12.4	0.0003%
Water	Reservoir/dam	11.4	0.0003%
Water	Marsh/wetland	5.1	0.0001%
	Total	**4,007,282.3**	**100.0%**

3.5 CONSERVATION RESERVES AND ESAS

The study area does not intersect any conservation reserves; the former Warriedar Station and Thundelarra Station Nature Reserves (gazettal in progress) extend to approximately 8 km southeast (Figure 1-1). No Environmental Sensitive Areas (ESAs) occur within the area of the desktop review.

4 METHODS

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

- EPA Environmental Factor Guideline: Terrestrial fauna (EPA 2016a)
- EPA Technical Guidance: Terrestrial fauna surveys (EPA 2016e)
- EPA Technical Guidance: Sampling methods for terrestrial vertebrate fauna (EPA 2016c)
- EPA Technical Guidance: Sampling of short-range endemic invertebrate fauna (EPA 2016d)

4.1 DESKTOP REVIEW

Searches of several biological databases were undertaken to identify and prepare lists of significant vegetation and fauna that may occur within the study area (Table 4-1). A literature search was conducted for accessible reports for biological surveys conducted within 40 km of the study area to build on the lists developed from the database searches (Table 4-2).

Some species not identified by automated database searches (due to geographically sparse but widespread records, or incomplete taxonomic updates on the NatureMap database) were considered to potentially occur based on distribution known from other sources and added manually.

Table 4-1 Database searches conducted for the desktop review

Database	Target group/s	Search coordinates and extent
Protected Matters Search Tool (DoEE 2020a)	Fauna of National Environmental Significance	-28.8099, 116.9875 with a buffer of 40 km
Threatened and Priority fauna Database (DBCA 2019b)	Threatened and Priority fauna	-28.8099, 116.9875 with a buffer of 40 km
NatureMap Database (DBCA 2019a)	Fauna records	-28.8099, 116.9875 with a buffer of 40 km
(ALA 2020)	Fauna records	-28.8099, 116.9875 with a buffer of 40 km
WA Museum Arachnid, Myriapod and Mollusca Database (WAM 2019)	Arachnid, myriapod and mollusc SREs	~500 km^2 search area encompassing the study area between 27.54216°S, 115.58416°E (northwest corner) and 29.41597°S, 118.4773°E (southeast corner)

Table 4-2 Survey reports included in the desktop review

Report author	Survey description	Project
Bamford (2007)	Desktop and Level 1 assessment	Golden Grove Gossan Hill
Central Regional TAFE (2017)	Targeted Malleefowl mound survey	Gossan Hill
Coffey (2008)	Fauna Assessment for a Proposed Third Tailings Storage Facility	Golden Grove
ENV (2008)	Golden Grove fauna assessment	Golden Grove
Phoenix (2020b)	Terrestrial fauna survey for the Gossan Valley Project	Gossan Valley

Report author	Survey description	Project
Phoenix (2020a)	Terrestrial fauna survey for the Bassendean Project	Bassendean
Woodman Environmental (2013)	Baseline Flora and Vegetation Assessment for Golden Grove Expansion Project	Golden Grove Project

4.2 FIELD SURVEY

Field survey of the TSF4 study area was conducted by Simon Pynt and Ryan Carter in August 2020 (Table 4-3).

Table 4-3 Survey dates

Survey type	Season	Dates
Level 1 Terrestrial fauna survey	Winter	24 – 28 August 2020

Field methods for this Level 1 survey included:

- terrestrial fauna and SRE habitat assessment (see 4.2.1.1)
- active searches (4.2.1.2)
- avifauna surveys (4.2.1.3)
- targeted searches for Malleefowl (4.2.1.4), *Egernia stokesii badia* and *Idiosoma clypeatum*.

4.2.1 Terrestrial fauna

4.2.1.1 Habitat assessment

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Habitats with the potential to support significant terrestrial fauna species were identified based on known habitats of such species within the Yalgoo bioregion. Tentative sites were selected for the terrestrial fauna survey to represent all habitat types. Final survey site selection was conducted after ground-truthing of site characteristics.

At the broadest scale, site selection considered aspect, topography, and land systems. At the finer scale, consideration was given to proximity to water bodies (drainage lines and creek), vegetation complexes and condition and soil type. Sites were primarily chosen to represent the best example of distinct habitats within the broader habitat associations of the study area with a focus on species of conservation significance identified in the desktop review. Habitat descriptions and characteristics were recorded at all survey sites (Figure 4-1; Table 4-4; Appendix 2).

Table 4-4 Terrestrial fauna survey effort

Site	Site type	Sample type (hours)	
		Birding	Foraging
001	Fauna site	0.67	0.67
002	Fauna site	1.00	1.00
003	Fauna site	0.67	0.67
004	Fauna site	0.87	0.87
005	Fauna site	0.64	0.64

Site	Site type	Sample type (hours)	
		Birding	Foraging
006	Fauna site	0.87	0.87
007	Fauna site	0.67	0.67
008	Fauna site	0.67	0.67
009	Fauna site	0.67	0.67
010	Fauna site	0.67	0.67
011	Fauna site	0.67	0.67
012	Fauna site	0.67	0.67
013	Fauna site	1.17	1.17
014	Fauna site	0.68	0.68
015	Fauna site	0.67	0.67
016	Fauna site	0.67	0.67
017	Fauna site	0.64	0.64
018	Fauna site	0.67	0.67
019	Fauna site	0.67	0.67
020	Fauna site	0.64	0.64
021	Fauna site	1.00	1.00
022	Fauna site	0.67	0.67
023	Fauna site	0.80	0.80
024	Fauna site	0.80	0.80
025	Fauna site	0.84	0.84
026	Fauna site	0.00	0.00
	Total	**18.66**	**18.66**

4.2.1.2 Active searches

Active diurnal searches were undertaken at 25 sites (Site 26 was a site description only) and primarily targeted herpetofauna and mammals from direct sightings and secondary evidence. Searches focused on significant species identified during experience in the area (Phoenix 2020a, b) and from the desktop review as potentially occurring within the study area.

Searches were undertaken in any observable microhabitats considered likely to support mammals, reptiles, and amphibians. Techniques included: raking leaf and bark litter, overturning logs, searching beneath the bark of trees, investigating dead trees and logs, investigating burrows, investigating infrastructure ruins or disused building materials such as tin piles and identifying any secondary evidence including tracks, diggings, scats, fur or sloughs (shed skins), predation or feeding sites, and fauna constructed structures such as Malleefowl mounds.

4.2.1.3 Avifauna surveys

Standardised twenty-minute, two-hectare avifauna surveys were not undertaken. Instead, birds were constantly recorded from sightings, calls or other evidence while foraging.

4.2.1.4 Malleefowl habitat assessment

Habitat was assessed for its suitability to support Malleefowl at 26 locations using attributes considered important to the species (Benshemesh 2007), whereby each attribute was recorded as present (1) or absent (0) and the total summed:

- sandy substrate
- canopy
- litter (distinct patches under vegetation, or continuous)
- level ground
- mallee present
- *Melaleuca* present
- Mulga present
- *Triodia* present.

Any location with a score of four or more was considered potential Malleefowl habitat, that is, 50% of the favourable attributes were present.

4.2.1.5 Likelihood of occurrence assessment

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

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

4.2.2 Survey personnel

The personnel involved in the survey, reporting and project management are listed in Table 4-5.

Table 4-5 Survey personnel

Name	Qualifications	Years' experience	Role/s
Simon Pynt	Ba.Sci. (Zoology)	12	Field surveys
Ryan Carter	Ba.Sci. (Cons.Biol.)	1	Field surveys
Dr John Scanlon	Ph.D. (Zoology)	30	Reporting
Jarrad Clark	B.Sci. (Env.Mgt.)	20	Project Management

EMR Golden Grove
Golden Grove

Project No	1348
Date	23/12/2020
Drawn by	IN
Map author	JS

0 250 500
Meters

1:14,100 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_4_1_Fauna_survey_sites.mxd

Study area

Fauna survey sites

Figure 4-1

Terrestrial fauna survey sites

PHOENIX ENVIRONMENTAL SCIENCES

5 RESULTS

5.1 DESKTOP REVIEW

5.1.1 Vertebrate fauna

The desktop review identified 235 vertebrate species based on external database records or (for species considered MNES) modelling within the desktop search extent; four additional species were recorded in recent surveys for Golden Grove projects (Phoenix 2020a, b). Many other species that have not yet been recorded in the vicinity may be expected to occur based on their broader distribution, which is sparsely sampled in collection and survey databases: 30 reptiles, eight birds and 15 mammal species (including one Priority species) are included in the regional fauna on this basis, for a total of 292 vertebrate species. The list comprised seven frogs, 80 reptiles, 169 birds (including two naturalised pigeon species) and 36 mammals (including six introduced, and two extinct) (Table 5-1; Appendix 3). A single Priority listed invertebrate, *Idiosoma clypeatum* (Northern shield-backed trap-door spider) is also listed here.

Twenty-two significant vertebrate species were identified in the desktop review, including nine species listed as Threatened, CD or SP under the EPBC Act and/or BC Act (Table 5-2). Seven avifauna species are listed as Migratory under the EPBC Act and BC Act (Table 5-2). A further six species are listed as Priority by DBCA (Table 5-2). Lesser Stick-nest Rat and the mainland subspecies of Boodie (both extinct) were also returned (DBCA 2019b; DoEE 2019; Phoenix 2020b).

Previous surveys adjacent to the study area (Central Regional TAFE 2017; Coffey 2008; ENV 2008; Ninox 1997) have recorded few significant species, predominantly old, inactive Malleefowl mounds. Of 21 mounds listed by Central Regional TAFE (2017), none are within the present study area, eight are less than 1 km outside, and the single mound recorded as active (when observed in 2008) is 1.3 km south of the study area. Additional inactive mounds, as well as tracks and other fresh sign of Malleefowl presence, were identified in recent surveys (Phoenix 2020a, b)(Figure 5-1).

Table 5-1 Summary of terrestrial fauna desktop results

Class	Introduced	Native	Total
Spiders	0	1	1
Amphibians	0	7	7
Reptiles	0	80	80
Birds	2	167	169
Mammals	6	30	36
Total	**8**	**285**	**293**

In terms of habitats described by other surveys, Coffey (2008) reported that of 12 vegetation associations previously described, from a fauna perspective the habitat realistically represented a single (variable) unit. Central Regional TAFE (2017) concluded that three vegetation types mapped by Woodman Environmental (2013) intersected with that study area (T4, T9 and T11). Type T9 dominated the study area:

"Tall shrubland of mixed *Acacia* species dominated by *Acacia aulacophylla* and *Acacia ramulosa* var. *ramulosa* [bowgada] over mid open shrubland of mixed species dominated by *Eremophila glutinosa*, *Eremophila latrobei* subsp. *latrobei*, *Mirbelia* sp. *bursarioides* (T.R. lally760), *Philotheca brucei* subsp.

brucei and *Philotheca sericea* on red-brown sandy clay or loams on lower slopes to crests with ironstone or granite outcropping" (Table 1 of Central Regional TAFE 2017).

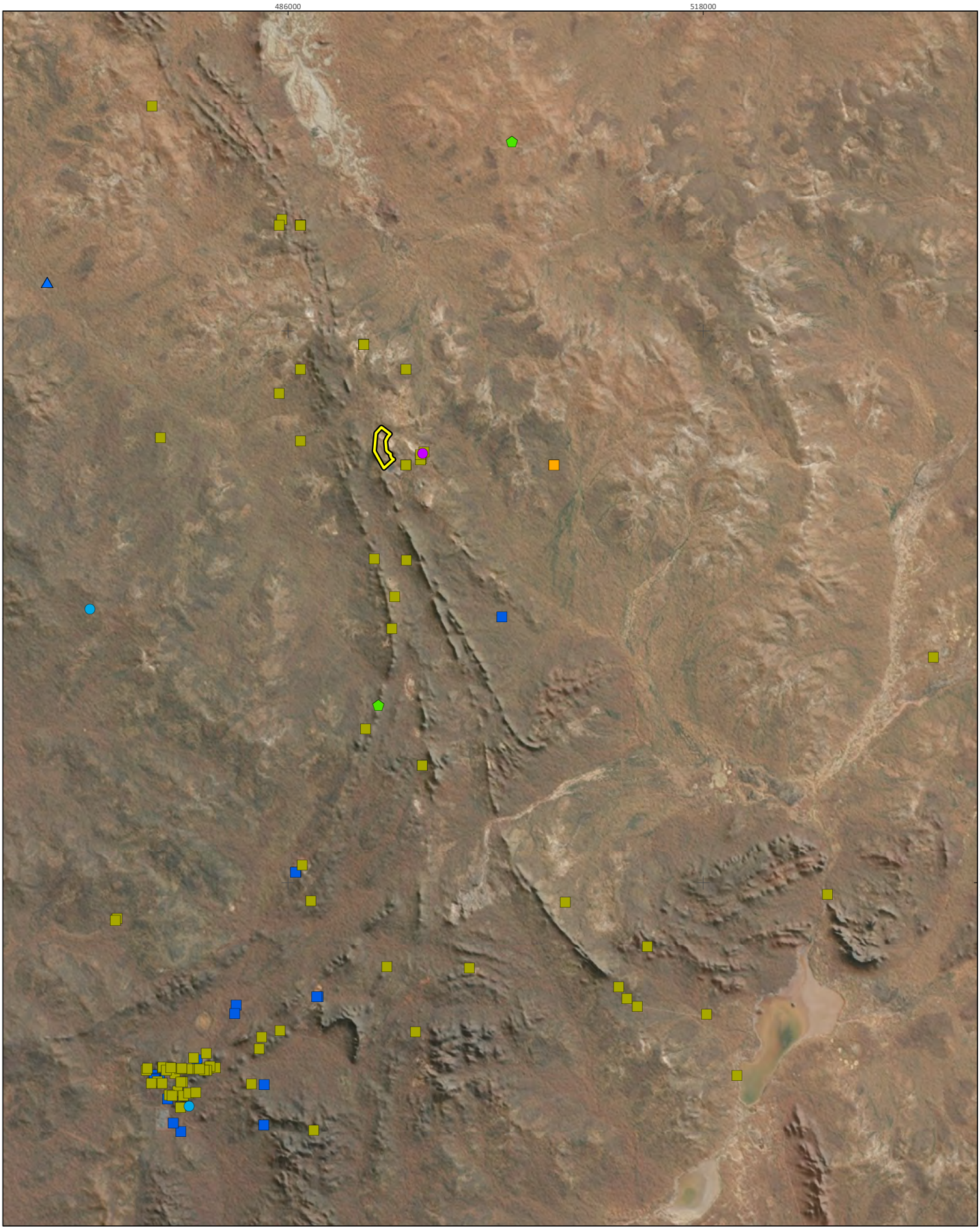
Bamford (2007) focused on describing significant fauna habitats, which included a gully on the south-eat of Gossan Hill and a restricted plain habitat of mixed woodland, to the west and south-west of Gossan Hill. They concluded that a regional approach to the protection of the hills in the area should be considered, due to the quantity of historic and future, cumulative impact of mining and exploration.

Table 5-2 Significant vertebrate fauna identified in the desktop review

Species (22)	Status	Proximity to study area (km)	Habitat
Reptiles (2)			
Cyclodomorphus branchialis Gilled Slender Bluetongue Skink	VU (BC Act)	12.4 E	Found in semi-arid shrublands on heavy soils, and also on banded ironstone hills. It has a restricted distribution in the south-west Murchison and the proposed Project area is within its known distribution (Storr *et al.* 1999; Wilson & Swan 2017).
Egernia stokesii badia Western Spiny-tailed Skink	EN/VU (EPBC Act; BC Act)	14.6 SE	Occurs in semi-arid scrubs and woodlands of the northern wheatbelt, sheltering in hollow logs and behind the bark of fallen trees in York Gum woodlands. It is also found in old buildings and under piles of timber, tiles or other building materials, and on granite boulder piles or outcrop with crevices (DoEE 2020b).
Birds (14)			
Leipoa ocellata Malleefowl	VU (EPBC & BC Acts)	<1 N,W,S	Malleefowl occur mainly in scrubs and thickets of mallee (*Eucalyptus* spp.), boree (*Melaleuca lanceolata*) and bowgada (*Acacia linophylla*), and other dense litter-forming shrublands including Mulga Shrublands (Johnstone and Storr, 2004). Nest mounds require sandy soil as well as abundant litter (Benshemesh 2007).
Oxyura australis Blue-billed Duck	P4 (DBCA list)	-	Endemic to Australia's temperate regions, inhabiting terrestrial wetlands (fresh or saline) with extensive bordering vegetation, including artificial wetland, such as sewage ponds (Birdlife Australia no date; del Hoyo *et al.* 2014).
Apus pacificus Fork-tailed Swift	Mig. (EPBC & BC Acts)	48.1 NW	Widespread migratory species that does not breed in Australia. It occurs in a wide range of dry or open habitats across most of WA and is uncommon to moderately common in the north-west (DoEE 2020b).
Ixobrychus dubius Australian Little Bittern	P4 (DBCA list)	-	Occurs in diverse freshwater swamp habitats, mainly where tall rushes, reeds, *Typha* (cumbungi), shrub thickets or other dense cover is inundated by at least 30 cm of water (Marchant & Higgins 1990).
Falco peregrinus Peregrine Falcon	OS (BC Act)	18.3 S	Preferred habitat includes cliffs and wooded watercourses. Nesting occurs mainly on cliff ledges, granite outcrops, quarries and in trees with old raven or Wedge-tailed Eagle nests (Johnstone & Storr 1998).
Rostratula australis Australian Painted Snipe	EN (EPBC & BC Acts)	-	Generally, inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*) (DoEE 2020b).

Species (22)	Status	Proximity to study area (km)	Habitat
Actitis hypoleucos Common Sandpiper	Mig. (EPBC & BC Acts)	-	Coastal and some inland wetlands including small ponds, large inlets, mudflats where they forage on the shore usually close to the vegetation (DoEE 2020b).
Calidris acuminata Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)	28.0 NW	Occurs on saline wetlands such as coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands (DoEE 2020b).
Calidris ferruginea Curlew Sandpiper	CR/Mig./CR (EPBC Act; BC Act)	-	Mainly occur on intertidal mudflats in sheltered coastal areas, also around non-tidal swamps, lakes, and lagoons near the coast. Less often inland around ephemeral and permanent lakes and waterholes, usually with bare edges of mud or sand (DoEE 2020b).
Calidris melanotos Pectoral Sandpiper	Mig. (EPBC & BC Acts)	-	Occurs on shallow fresh to saline wetlands, usually coastal or near-coastal but occasionally further inland. Prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation (DoEE 2020b).
Tringa nebularia Common Greenshank	Mig. (EPBC & BC Acts)	-	Mostly on the coast but sometimes inland; uses permanent and ephemeral terrestrial wetlands, including rivers and creeks (DoEE 2020b).
Pezoporus occidentalis Night Parrot	EN (EPBC & BC Acts)	-	Rare and cryptic species most frequently associated with *Triodia* hummock grass and chenopod shrubs (samphire, saltbush etc), particularly where these occur together as a mosaic or along a boundary (ecotone). Suitability of habitat is thought to depend on particular stages of regeneration after fire (DoEE 2018). There is one uncertain record from the vicinity of Lake Monger in 1961, all confirmed records are hundreds of km away (DBCA 2020).
Tyto novaehollandiae Masked Owl (southwest)	P3 (DBCA list)	2.3 E	Inhabits forests and woodlands, nests in tree hollows and forages close to nest (Higgins 1999). The southwestern population of this species is generally uncommon, and rarely recorded north of Yanchep.
Motacilla cinerea Grey Wagtail	Mig. (EPBC & BC Acts)	-	A rare vagrant, summer visitor mostly to northern WA (Nov-April), utilises a wide variety of habitats, mostly associated with running water and shorelines (DoEE 2020b).
Mammals (6)			
Dasyurus geoffroii Chuditch	VU (EPBC & BC Acts)	-	Formerly widespread in very diverse habitats, now mostly in Jarrah forest and woodland of the southwest, also heath and mallee habitats along the south coast; uses horizontal hollow logs or earth burrows as refugia and dens (DEC 2012a).
Sminthopsis longicaudata Long-tailed Dunnart	P4 (DBCA list)	54.1 W	Rare and patchily distributed in rocky areas of inland WA, occasionally locally common; occurs in rocky scree and plateau areas with open vegetation, but uses adjacent habitats for foraging and dispersal (Burbidge *et al.* 2008).

Species (22)	Status	Proximity to study area (km)	Habitat
Bettongia leseur graii Boodie	EX (EPBC & BC Acts)	8.7 SE	This subspecies is now extinct, and the species does not occur in mainland Australia except for reintroduced populations within fenced reserves. Old burrow complexes were located during a previous survey (Phoenix 2020b).
Notamacropus irma Western Brush Wallaby	P4 (DBCA list)	25.1 SW	Grazing species, occurs in open forest or woodland with low grasses and scrubby thickets, and also found in some areas of mallee and heathland (DEC 2012b). There are only two records from the Yalgoo IBRA Region representing the north-eastern limit of distribution, both since 2000 (DBCA 2020).
Nyctophilus major tor Central Long-eared Bat	P3 (DBCA list)	92.0 S	*Nyctophilus* species are insectivorous bats that catch prey in flight or by gleaning from surfaces (so that non-flying prey such as caterpillars may be eaten); *N. major tor* is poorly known but assumed similar to congeners in foraging ecology, as echolocation calls across WA *Nyctophilus* spp. are relatively uniform (Bullen & McKenzie 2002). Breeding sites are usually in tree hollows, and thus in trees usually over a century old (Abbott & Whitford 2001), but also roost amongst foliage and under loose bark; species used include *Eucalyptus rudis* and *Melaleuca raphiophylla* (Andrew 2015).
Leporillus apicalis Lesser Stick-nest Rat	EX (EPBC & BC Acts)	12.0 SE	Extinct. Old nests likely to be from this species were located in rock crevices in a breakaway during a previous survey (Phoenix 2020b).



EMR Golden Grove
Golden Grove

Project No	1348
Date	23/12/2020
Drawn by	IN
Map author	JS

0 7.5 15
Kilometers

1:379,500 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_5_1_Desktop_sig_vert_fauna.mxd

Study area

Significant fauna

- *Egernia stokesii badia* EN/VU (EPBC Act; BC Act)
- *Cyclodomorphus branchialis* VU (BC Act)
- *Leipoa ocellata*, VU (EPBC Act; BC Act)
- *Calidris acuminata*, Mig. (EPBC Act; BC Act)
- *Falco peregrinus*, OS (BC Act)
- *Tyto novaehollandiae*, P3 (DBCA list)
- *Notamacropus irma*, P4 (DBCA list)

Figure 5-1

Desktop records of significant vertebrate fauna

PHOENIX ENVIRONMENTAL SCIENCES

5.1.2 SRE invertebrate fauna

The desktop review identified records of 63 potential SRE taxa (Table 5-3; Figure 5-2). The desktop records indicate no SRE species have previously been recorded within the study area (Figure 5-2).

Of the 63 potential SRE taxa, seven are named species. The remaining 56 comprise taxa named only to morphospecies codes as applied by the WA Museum or are not identified to confirmed species level (i.e. “sp.” or “cf.”). These are often female or juvenile specimens and where not identified to species or morphospecies, may represent new species or other species listed in the same genus where records exist (Table 5-3).

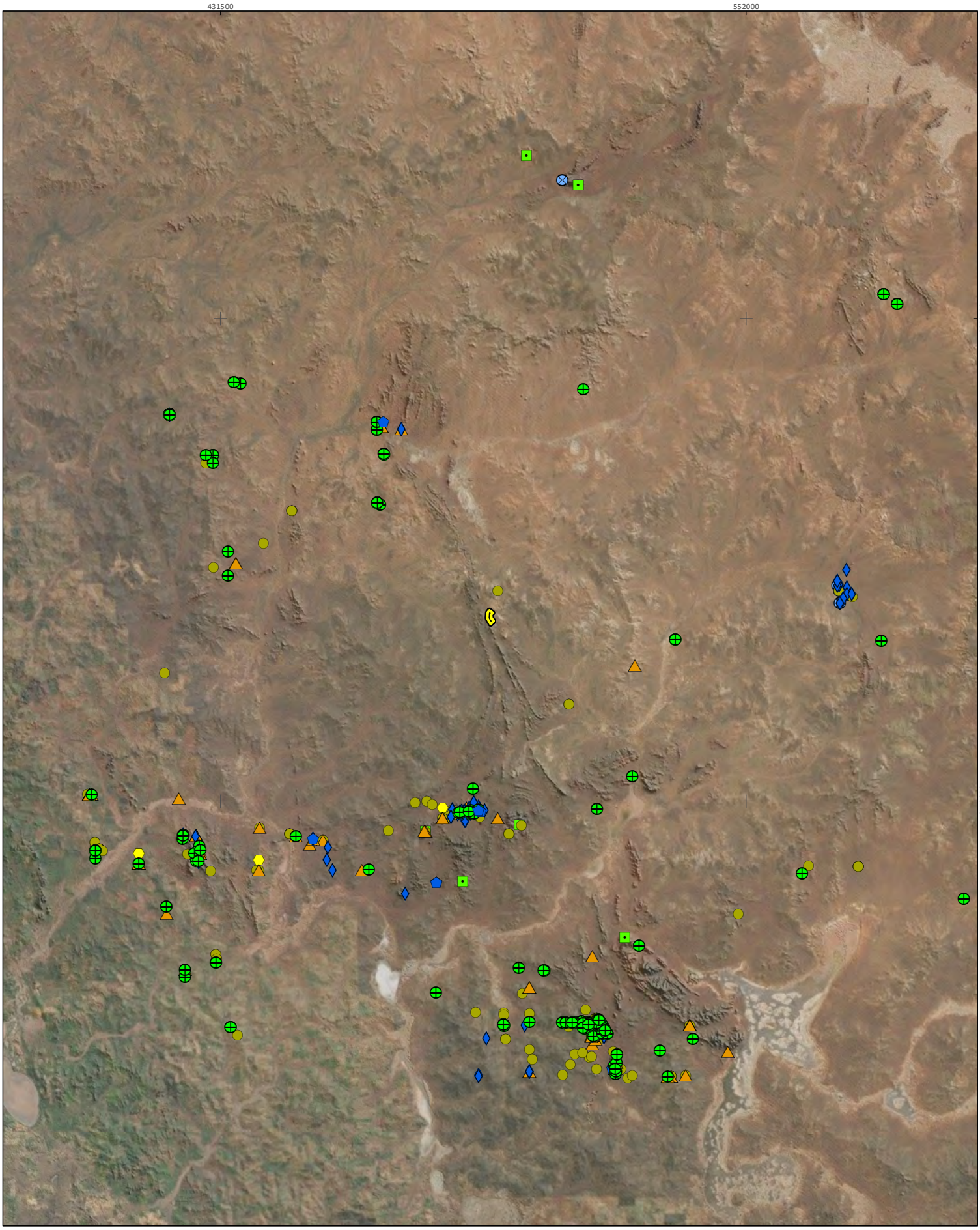
The assemblage is dominated by trap-door spiders (39 taxa), Millipedes (10 taxa) and Urodacidae scorpions (8 taxa). The majority of records are from SRE surveys of Banded Ironstone Formations related to mining tenements (e.g. Koolanooka, Mt Gibson).

Table 5-3 Priority invertebrate and SRE taxa identified in the desktop review

Higher taxon, family	Species	SRE category	Proximity to study area (km)	Habitat records
Gastropoda (Land snails) (4 taxa)				
Bothriembryontidae	*Bothriembryon* sp.	Potential	46.3	unknown
Camaenidae	cf. *Pleuroxia* sp.	Potential	99.6	sand stone - thicket of *Acacia* cf. *rostellifera*
Camaenidae	*Falspleuroxia* sp.	Potential	104.6	unknown
Camaenidae	*Pleuroxia* cf. *bethana*	Potential	147.4	unknown
Polydesmida (Millipedes) (10 taxa)				
Paradoxosomatidae	*Antichiropus* `bowgada`	Potential	99.4	unknown
Paradoxosomatidae	*Antichiropus* `charles darwin`	Potential	102.9	unknown
Paradoxosomatidae	*Antichiropus* `DIP068`	Potential	58.6	unknown
Paradoxosomatidae	*Antichiropus* `DIP146, karara`	Potential	49.7	unknown
Paradoxosomatidae	*Antichiropus* `hawotharra`	Potential	58.8	unknown
Paradoxosomatidae	*Antichiropus* `karara`	Potential	44.4	unknown
Paradoxosomatidae	*Antichiropus* `koolanooka`	Potential	83.0	unknown
Paradoxosomatidae	*Antichiropus alatus*	Potential	79.5	unknown
Paradoxosomatidae	*Antichiropus sagittulus*	Potential	102.6	unknown
Paradoxosomatidae	*Antichiropus westi*	Potential	93.6	unknown
Scorpiones (Scorpions) (8 taxa)				
Buthidae	*Isometroides* `laverton3`	Potential	93.8	unknown
Urodacidae	*Urodacus* `blue hills`	Potential	42.8	unknown
Urodacidae	*Urodacus* `gibson4`	Potential	92.7	unknown

Higher taxon, family	Species	SRE category	Proximity to study area (km)	Habitat records
Urodacidae	*Urodacus* `karara`	Potential	37.9	unknown
Urodacidae	*Urodacus* `koolanooka?`	Potential	84.2	unknown
Urodacidae	*Urodacus* `koolanooka`	Potential	43.3	unknown
Urodacidae	*Urodacus* `SCO020, gibson5`	Potential	96.7	unknown
Urodacidae	*Urodacus* `sp. indet. (laverton2 or laverton3?)`	Potential	85.3	unknown
Isopoda (Slaters) (2 taxa)				
Armadillidae	*Buddelundia labiata*	Potential	100.1	unknown
Philosciidae	*Laevophiloscia* cf. *yalgooensis*	Potential	79.3	unknown
Mygalomorphae (Trap-door spiders) (39 taxa)				
Actinopodidae	*Missulena* `MYG043`	Potential	102.6	unknown
Actinopodidae	*Missulena* `sp. B05`	Potential	101.8	unknown
Anamidae	*Aname* `Mt Gibson sp. 1`	Potential	97.7	unknown
Anamidae	*Aname* `Mt Gibson sp. 2`	Potential	94.7	unknown
Anamidae	*Aname* `MYG001 group, Mt Gibson 1`	Potential	92.8	unknown
Anamidae	*Aname* `MYG001 group, Mt Gibson 2`	Potential	94.6	unknown
Anamidae	*Aname* `MYG332`	Potential	93.2	unknown
Anamidae	*Aname* `MYG363`	Potential	94.7	unknown
Anamidae	*Aname* `salt lake survey sp. 1?`	Potential	66.4	unknown
Anamidae	*Kwonkan* `Mt Gibson sp. 1`	Potential	111.5	unknown
Anamidae	*Kwonkan* `MYG058`	Potential	93.7	unknown
Anamidae	*Kwonkan* `MYG439`	Potential	66.4	unknown
Anamidae	*Kwonkan* `salt lake survey sp. 1`	Potential	66.4	unknown
Anamidae	*Proshermacha* `MYG505`	Potential	104.6	unknown
Anamidae	*Teyl* `luculentus sp. group`	Potential	111.6	unknown
Anamidae	*Teyl* `MYG022`	Potential	92.8	unknown
Anamidae	*Teyl* `MYG345`	Potential	62.6	unknown

Higher taxon, family	Species	SRE category	Proximity to study area (km)	Habitat records
Anamidae	*Teyl* `MYG481`	Potential	108.7	unknown
Barychelidae	*Synothele* `impactspins`	Potential	97.0	unknown
Barychelidae	*Synothele* `Mt Gibson sp. 1`	Potential	111.3	unknown
Barychelidae	*Synothele* `sp. B05`	Potential	101.7	unknown
Euagridae	*Cethegus `sp. B02`*	Potential	104.6	unknown
Euagridae	*Cethegus* `sp. nov. (cf. ischnotheloides)`	Potential	93.4	unknown
Halonoproctidae	*Conothele* `MYG530`	Potential	86.0	unknown
Halonoproctidae	*Conothele* `MYG550`	Potential	89.0	unknown
Idiopidae	*Eucyrtops* `MYG148`	Potential	92.8	unknown
Idiopidae	*Eucyrtops* `MYG149`	Potential	111.5	unknown
Idiopidae	*Euoplos* `lochada`	Potential	70.5	unknown
Idiopidae	*Euoplos* `mt_gibson_hoggi_gp`	Potential	96.6	unknown
Idiopidae	*Euoplos* `pintharuka`	Potential	99.2	unknown
Idiopidae	*Euoplos* `sp. nov.`	Potential	85.8	unknown
Idiopidae	*Euoplos saplan*	Potential	105.7	unknown
Idiopidae	*Idiosoma clypeatum* (P3)	Widespread	9.7	Under mulga on creeklines or south-facing slopes of Banded Ironstone Formations (BIFs)
Idiopidae	*Idiosoma* `merkanooka` spp. group`	Potential	73.1	unknown
Idiopidae	*Idiosoma* `Mt Gibson sp. 1`	Potential	92.8	unknown
Idiopidae	*Idiosoma* `MYG641`	Potential	48.1	unknown
Idiopidae	*Idiosoma* `sp. 3`	Potential	111.3	unknown
Idiopidae	*Idiosoma* `sp. B04`	Potential	105.8	unknown
Idiopidae	*Idiosoma* `sp. B09 plug`	Potential	101.9	unknown
Idiopidae	*Idiosoma kopejtkaorum*	Potential	89.7	unknown



EMR Golden Grove
TSF4 Project

Project No	1348
Date	23/12/2020
Drawn by	IN
Map author	JS

0 10 20
Kilometers

1:1,128,500 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_5_2_Desktop_SRE_invertebrates.mxd

Study area

SRE taxa

- Centipede
- Millipede
- Mygalomorphae
- Opiliones
- Pseudoscorpion
- Scorpion
- Mollusca
- Slater

Figure 5-2

Desktop records of Priority and SRE invertebrates

PHOENIX ENVIRONMENTAL SCIENCES

5.2 FIELD SURVEY

5.2.1 Vertebrate fauna

5.2.1.1 Habitats

A single broad fauna habitat type in the study area ('mulga' shrubland on clay soils) is subdivided for the purpose of mapping as follows, recognising variation in topography, soils and vegetation structure (Table 5-4 ;Figure 5-3):

- Mulga on stony hill slopes (MHS)
- Mulga on undulating plain (MUP)
- Open mulga on laterite plain (MLP)
- Mid mulga on hardpan clay (MHC)
- Low open shrubland on plain (LOS)

These shrubland habitat types, comprising the whole uncleared portion of the study area, correspond to the habitat 'Shrubland on undulating plain (SUP)' in the nearby Gossan Valley survey (Phoenix 2020b), and are considered to largely match with vegetation association T9 as described by Woodman Environmental (2013). No habitat types were considered locally or regionally important.

Table 5-4 Extent and description of each fauna habitat in the study area

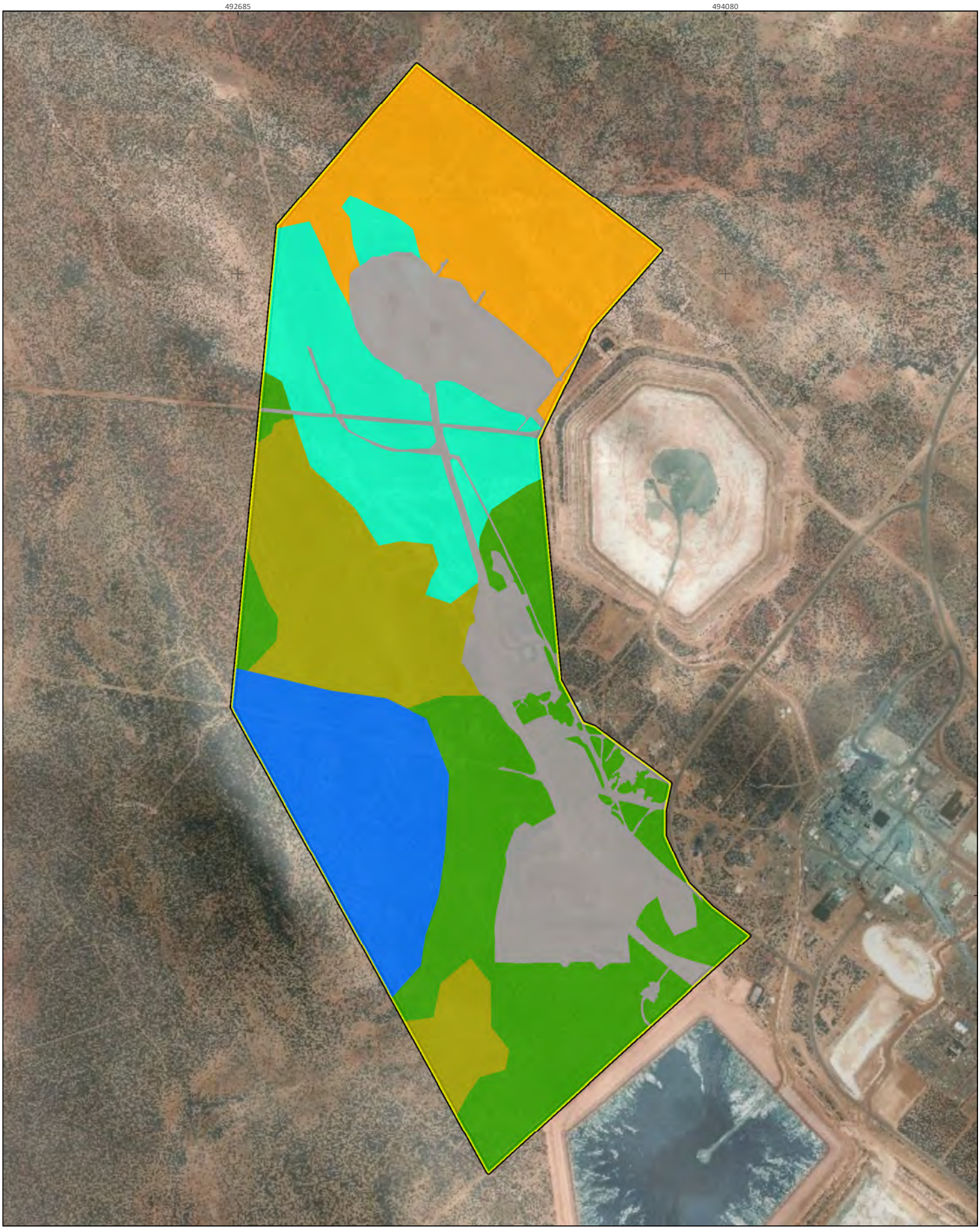
Habitat type details	Representative photograph
Mulga on stony hill slopes (MHS) Mid-tall mulga shrubland over mixed low shrubs on stony slope of low BIF range (365-390 m alt) **Sites**: 01, 13, 14, 15, 24, 25 **Area**: 31.9 ha, 12.5%	
Mulga on undulating plain (MUP) Mid-tall mulga shrubland over scattered low shrubs on undulating plain of clay loam soil (350-375 m alt); some habitat suitable for Malleefowl **Sites**: 20, 21, 22, 26 **Area**: 54.7 ha, 21.5%	

Habitat type details	Representative photograph
Open mulga on laterite plain (MLP) Open mid-tall mulga shrubland over sparse low shrubs on sandy clay plain with laterite (355-365 m alt) **Sites**: 09, 10, 11, 12 **Area**: 38.0 ha, 14.9%	
Mid mulga on hardpan clay (MHC) Mid mulga shrubland (some scattered taller mulga) over mixed low shrubs on rocky clay soils, mostly hardpan (350-360 m alt) **Sites**: 02, 03, 08, 16, 17, 18, 19 **Area**: 40.8 ha, 16.0%	
Low open shrubland on plain (LOS) Open to sparse low-mid shrubland on sandy clay plain (350-360 m alt), mulga scattered or absent **Sites**: 04, 05, 06, 07, 23 **Area**: 36.9 ha, 14.5%	
Cleared (roads, operations) **Sites:** N/A **Area**: 52.3 ha, 20.5%	n/a

The suitability for habitat to support Malleefowl was assessed at 26 locations (Table 5-5). The habitat was found to be suitable to support the species in two of the sites assessed (7.7%: shaded in table below), both in habitat type MUP (cf. Table 5-5).

Table 5-5 Malleefowl habitat assessment scores

Site	Habitat type	Malleefowl habitat	Score
01	MHS	No	2
02	MHC	No	2
03	MHC	No	3
04	LOS	No	2
05	LOS	No	2
06	LOS	No	2
07	LOS	No	3
08	MHC	No	2
09	MLP	No	2
10	MLP	No	2
11	MLP	No	2
12	MLP	No	2
13	MHS	No	2
14	MHS	No	1
15	MHS	No	1
16	MHC	No	3
17	MHC	No	3
18	MHC	No	3
19	MHC	No	2
20	MUP	No	3
21	MUP	No	2
22	MUP	Yes	5
23	LOS	No	3
24	MHS	No	3
25	MHS	No	1
26	MUP	Yes	5



EMR Golden Grove
Golden Grove

Project No	1348
Date	23/12/2020
Drawn by	IN
Map author	JS

0 250 500
Meters

1:14,100 (at A4) GDA 1994 MGA Zone 50

P:\GIS\Projects\GoldenGrove\1348-GOS-EMR-FAU\Mapping\MapDocuments\Figures\Figure_5_3_Habitat_Mapping.mxd

Study area

Fauna habitat

- Mulga on stony hill slopes (MHS)
- Mulga on undulating plain (MUP)
- Open mulga on laterite plain (MLP)
- Mid mulga on hardpan clay (MHC)
- Low open shrubland on plain (LOS)
- Cleared (roads, operations)

Figure 5-3

Fauna habitats of the study area

PHOENIX ENVIRONMENTAL SCIENCES

5.2.1.2 Assemblage

A total of 36 terrestrial vertebrate species representing 25 families and 31 genera were recorded in the study area during the field surveys (Table 5-6)

The assemblage included 34 native species and two introduced species.

Table 5-6 Number of vertebrate species recorded in survey in comparison to desktop results, by group

Class	Desktop			Field		
	Introduced	Native	Total	Introduced	Native	Total
Amphibia	0	7	7	0	0	0
Reptilia	0	80	80	0	4	4
Aves	2	167	169	0	28	28
Mammalia	6	30	36	2	2	4
Total	**8**	**284**	**292**	**2**	**34**	**36**

The recorded assemblage represents 12.3% of the species identified in the desktop review (Table 5-6). All of the species recorded had been identified in the desktop review.

5.2.1.3 Significant vertebrate fauna

No Threatened or Priority vertebrate fauna were recorded in the survey.

The likelihood of occurrence assessment (see section 4.2.1.5) for the remaining significant species identified in the desktop review (section 5.1.1) determined one (Malleefowl) is likely to occur in the study area, five may possibly occur and 16 are unlikely to occur (Table 5-7).

Table 5-7 Likelihood of occurrence for significant vertebrate fauna identified in the desktop review

Species (22)	Status	LOO	Comment
Reptiles (2)			
Cyclodomorphus branchialis Gilled Slender Blue tongue Skink	VU (BC Act)	Possible	Habitat suitable
Egernia stokesii badia Western Spiny-tailed Skink	EN/VU (EPBC Act; BC Act)	Unlikely	Suitable habitat absent
Birds (14)			
Leipoa ocellata Malleefowl	VU (EPBC & BC Acts)	Likely	Habitat suitable (MUP)
Oxyura australis Blue-billed Duck	P4 (DBCA list)	Unlikely	Suitable habitat absent
Apus pacificus Fork-tailed Swift	Mig. (EPBC & BC Acts)	Possible	Not limited by habitat
Ixobrychus dubius Australian Little Bittern	P4 (DBCA list)	Unlikely	Suitable habitat absent
Falco peregrinus	OS (BC Act)	Possible	Habitat suitable for foraging

Species (22)	Status	LOO	Comment
Peregrine Falcon			
Rostratula australis Australian Painted Snipe	EN (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Actitis hypoleucos Common Sandpiper	Mig. (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Calidris acuminata Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Calidris ferruginea Curlew Sandpiper	CR/Mig./CR (EPBC Act; BC Act)	Unlikely	Suitable habitat absent
Calidris melanotos Pectoral Sandpiper	Mig. (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Tringa nebularia Common Greenshank	Mig. (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Pezoporus occidentalis Night Parrot	EN (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Tyto novaehollandiae Masked owl (southwest)	P3 (DBCA list)	Unlikely	Suitable habitat absent
Motacilla cinerea Grey Wagtail	Mig. (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Mammals (6)			
Dasyurus geoffroii	VU (EPBC & BC Acts)	Unlikely	Suitable habitat absent
Sminthopsis longicaudata *Long-tailed Dunnart*	*P4 (DBCA)*	*Possible*	*Habitat suitable (especially MHS)*
Bettongia leseur graii	EX (EPBC & BC Acts)	Unlikely	Extinct
Notamacropus irma Western Brush Wallaby	P4 (DBCA list)	Unlikely	Suitable habitat absent
Nyctophilus major tor Central Long-eared Bat	P3 (DBCA list)	Possible	Habitat suitable for foraging
Leporillus apicalis Lesser Stick-nest Rat	EX (EPBC & BC Acts)	Unlikely	Extinct

5.2.2 SRE invertebrate fauna

No habitats were identified within the study area that are considered prospective for SRE invertebrates, that is, likely to give rise to short-range endemism. All habitats identified were minor variations of a single type which is regionally widespread. No Mygalomorphae spider burrows were observed during the survey. Consequently, no SRE specimens were obtained.

5.3 SURVEY LIMITATIONS

The limitations of the flora and vegetation survey and terrestrial fauna survey have been considered in accordance with EPA (2016b, e)(Table 5-8).

Table 5-8 Consideration of potential survey limitations

Limitations	Comments
Availability of contextual information at a regional and local scale	All previous survey data was made available
Competency/experience of the team carrying out the survey	All survey personnel have previous experience in the survey subregion and with Malleefowl surveys
Scope and completeness	There were no constraints on fulfilling the scope
Proportion of flora and fauna recorded and/or collected, any identification issues	Proportion of fauna recorded reasonable for level of survey; no identification issues
Access within the study area	There were no issues with access
Timing, rainfall, season	Time and weather did not impact on the survey work
Disturbance that may have affected the results of the survey	No disturbances impacted on the survey work

6 DISCUSSION

The vertebrate fauna of and adjacent to the Golden Grove (Gossan Hills) area has been surveyed on seven occasions since 1997 (Bamford 2007; Central Regional TAFE 2017; Coffey 2008; ENV 2008; Ninox 1997; Phoenix 2020a, b). Each of these surveys has largely concurred that the main environmental value supported with respect to terrestrial fauna is the presence of Malleefowl (VU).

The habitat scoring system used here indicates largely low suitability for Malleefowl in the TSF4 study area (sparse canopy and leaf litter cover, predominantly clay soils; see Table 5-5), except at some sites in habitat type MUP. No Malleefowl mounds, tracks, scats, or other evidence were recorded in the current survey. However, there are inactive and recently active mounds in the immediate vicinity (Figure 5-1), and the species is considered likely to occur at least intermittently within the study area.

Two EPBC listed reptile species, *Egernia stokesii badia* and *Cyclodomorphus branchialis*, were searched for and not located. The shrubland habitat of the study area does not appear to provide suitable hollows or logpiles for the large *Egernia* species: smaller-diameter hollows were provided by mulga stems, which were occupied by the similar but smaller species *Egernia depressa*. *Cyclodomorphus branchialis* has less specific habitat requirements (occurring in shrubland on heavy soils and on BIF hills) and is more difficult to detect when present; this species is considered to possibly occur.

Idiosoma clypeatum (P3) (previously *I. nigrum*) has been recorded extensively on BIF ridges approximately 4 km to the southwest. Searches in the study area failed to detect the species, or habitat similar to where it occurs, and it is considered absent. No other likely SRE invertebrate habitat was identified.

7 REFERENCES

ABARES. 2018. *Catchment Scale Land Use Mapping for Western Australia 2008-2017 in* Sciences, A. B. o. A. a. R. E. a., ed. Government of Western Australia.

Abbott, I. & Whitford, K. 2001. Conservation of vertebrate fauna using hollows in forests of south-west Western Australia: strategic risk assessment in relation to ecology, policy, planning, and operations management. *Pacific Conservation Biology* **7**: 240-255 https://doi.org/10.1071/PC020240.

ALA. 2020. *Atlas of Living Australia*. Available at: http://www.ala.org.au/

Andrew, D. 2015. *The complete guide to finding the mammals of Australia*. CSIRO Publishing, Clayton South, Vic.

Bamford. 2007. *Oxiana Golden Grove Gossan Hill: assessment of fauna values*. M.J. & A.R. Bamford Consulting Ecologists, Kingsley, WA. Unpublished report prepared for Enesar Consulting Pty Ltd.

Benshemesh, J. 2007. *National Recovery Plan for Malleefowl Leipoa ocellata*. South Australian Department of Environment and Heritage, South Australia.

Birdlife Australia. no date. *Reports and Conservation Statements*.

BoM. 2020. *Climate statistics for Australian locations*. Commonwealth of Australia, Bureau of Meterology. Available at: http://www.bom.gov.au/climate/data/

Bullen, R. D. & McKenzie, N. L. 2002. Differentiating Western Australian *Nyctophilus* (Chiroptera: Vespertilionidae) echolocation calls. *Australian Mammalogy* **23**: 89–93.

Burbidge, A. A., McKenzie, N. L. & Fuller, P. J. 2008. Long-tailed Dunnart, *Sminthopsis longicaudata*. *In:* Van Dyck, S. & Strahan, R. (eds) *Mammals of Australia*. Reed New Holland, Sydney, pp. 148-150.

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.

Central Regional TAFE. 2017. *Gossan Hill Targeted Malleefowl Survey*. Central Regional TAFE, Perth, WA. Unpublished report prepared for EMR Golden Grove.

Coffey. 2008. *Golden Grove Fauna Assessment for a Proposed Third Tailings Storage Facility*. Coffey environments, Perth, WA. Unpublished report to Oz Minerals Golden Grove.

Cowan, M. 2001. 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.

DBCA. 2019a. *NatureMap*. Department of Biodiversity, Conservation and Attractions. Available at: https://naturemap.dpaw.wa.gov.au/default.aspx

DBCA. 2019b. *Threatened and Priority Fauna database search*. Department of Biodiversity, Conservation and Attractions, Kensington, WA.

DBCA. 2020. *NatureMap*. Department of Biodiversity, Conservation and Attractions. Available at: https://naturemap.dpaw.wa.gov.au/default.aspx

DEC. 2012a. *Chuditch (Dasyurus geoffroii) national recovery plan*. Government of Western Australia, Department of Environment and Conservation, Australian Government.

DEC. 2012b. *Western Brush Wallaby Macropus irma (Jourdan, 1837)*. Department of Environment and Conservation, Kensington, WA.

del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. & de Juana, E. 2014. *Handbook of the Birds of the World Alive*. Lynx Edicions, Barcelona.

Desmond, A. & Chant, A. 2001. Carnarvon 2 (CAR2—Wooramel 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. 87–102.

DoEE. 2016. *Maps: Australia's bioregions (IBRA)*. Department of the Environment and Energy, Canberra, ACT. Available at: http://www.environment.gov.au/topics/land/national-reserve-system/science-maps-and-data/australias-bioregions-ibra

DoEE. 2018. *Species Profile and Threats Database*. Department of the Environment and Energy, Australian Government, Canberra, ACT. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DoEE. 2019. *Protected Matters Search Tool*. Department of the Environment and Energy, Canberra, ACT. Available at: http://www.environment.gov.au/epbc/protected-matters-search-tool

DoEE. 2020a. *Protected Matters Search Tool*. Department of the Environment and Energy, Canberra, ACT. Available at: http://www.environment.gov.au/epbc/protected-matters-search-tool

DoEE. 2020b. *Species Profile and Threats Database*. Department of the Environment and Energy, Australian Government, Canberra, ACT. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

EMRGG. 2017. *EMR Golden Grove Malleefowl Management Plan*. EMR Golden Grove Ltd.

EMRGG. 2021. *Weather Monitoring*.

ENV. 2008. *Golden Grove fauna assessment*. ENV. Unpublished report for Oxiana Ltd.

EPA. 2004. *Guidance for the assessment of environmental factors (in accordance with the Environmental Protection Act 1986). Terrestrial fauna surveys for environmental impact assessment in Western Australia. No. 56*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/EPADocLib/1850_GS56.pdf

EPA. 2016a. *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. 2016b. *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. 2016c. *Technical Guidance: Sampling methods for terrestrial vertebrate fauna*. Environmental Protection Authority, Perth, WA. Available at: http://epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Sampling-TV-fauna-Dec2016.pdf

EPA. 2016d. *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

EPA. 2016e. *Technical Guidance: Terrestrial fauna surveys*. Environmental Protection Authority, Perth, WA. Available at: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Terrestrial%20Fauna%20Surveys-Dec-2016.pdf

Government of Western Australia. 2018a. *Wildlife Conservation Act 1950 Wildlife Conservation (Rare Flora) Notice 2018*. Government Gazette, WA. Government of Western Australia, Perth, WA.

Government of Western Australia. 2018b. *Wildlife Conservation Act 1950, Wildlife Conservation (Specially Protected Fauna) Notice 2018*. Government Gazette, WA, Perth, WA.

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.

Higgins, P. J. (ed.) 1999. *Handbook of Australian, New Zealand and Antarctic birds. Volume 4: Parrots to Dollarbird*. Oxford University Press, Melbourne, Vic.

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

Marchant, S. & Higgins, P. J. 1990. *Handbook of Australian, New Zealand & Antarctic birds. Vol. 1, Ratites to ducks, P. AB*. Oxford University Press.

Ninox. 1997. *Vertebrate Fauna of the Murchison Zinc Project Area*. Ninox Wildlife Consulting. Unpublished Report for Murchison Zinc Golden Grove.

Payne, A. L. & Leighton, K. A. 2004. Land systems. *In:* van Vreeswyk, A. M. E., Payne, A. L., Leighton, K. A. & Hennig, P. (eds) *Technical Bulletin 9. An inventory and condition survey of the Pilbara region, Western Australia*. Department of Agriculture, Government of Western Australia, South Perth, WA, pp. 175–384.

Phoenix. 2020a. *Terrestrial fauna survey for the Bassendean Project*. Phoenix Environmental Sciences Pty Ltd, Osborne Park, WA. Unpublished report prepared for EMR Golden Grove Pty Ltd.

Phoenix. 2020b. *Terrestrial fauna survey for the Gossan Valley Project*. Phoenix Environmental Sciences Pty Ltd, Osborne Park, WA. Unpublished report prepared for ERM Golden Grove Pty ltd.

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.

Schoknecht, N. R. & Payne, A. L. 2011. *Land systems of the Kimberley region, Western Australia*. Department of Agriculture and Food, Western Australia, Perth.

Storr, G. M., Smith, L. A. & Johnstone, R. E. 1999. *Lizards of Western Australia, part 1: skinks*. Western Australian Museum, Perth, WA.

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

WAM. 2019. *WA Museum Arachnology/Myriapodology, Crustacea and Mollusca database*, Welshpool, WA.

Wilson, S. & Swan, G. 2017. *A Complete Guide to Reptiles of Australia*. New Holland, Sydney, NSW.

Woodman Environmental. 2013. *Baseline Flora and Vegetation Assessment for Golden Grove Expansion Project*. Woodman Environmental Consulting. Unpublished report for ERM Golden Grove.

Appendix 1 Survey site locations

Site	Site type	Site location	
		Latitude	Longitude
001	Fauna site	-28.742535	116.926286
002	Fauna site	-28.724334	116.930332
003	Fauna site	-28.7262	116.929578
004	Fauna site	-28.727648	116.928519
005	Fauna site	-28.731023	116.927094
006	Fauna site	-28.73393	116.929538
007	Fauna site	-28.734683	116.932087
008	Fauna site	-28.730547	116.934574
009	Fauna site	-28.738499	116.931098
010	Fauna site	-28.73679	116.928345
011	Fauna site	-28.734331	116.926648
012	Fauna site	-28.738807	116.926524
013	Fauna site	-28.741009	116.927491
014	Fauna site	-28.745961	116.92923
015	Fauna site	-28.743518	116.927783
016	Fauna site	-28.728492	116.931727
017	Fauna site	-28.727165	116.934631
018	Fauna site	-28.728775	116.936461
019	Fauna site	-28.726815	116.931867
020	Fauna site	-28.751171	116.932556
021	Fauna site	-28.748165	116.930243
022	Fauna site	-28.749038	116.935411
023	Fauna site	-28.735954	116.929815
024	Fauna site	-28.741124	116.930317
025	Fauna site	-28.743651	116.931067
026	Fauna site	-28.742332	116.933109

Appendix 2 Terrestrial fauna survey site descriptions

Site details			
Site	**01**	**Position (WGS84)**	-28.742535, 116.926286
Topography	hill slope	**Soil texture**	clay, rocks
Slope	gentle	**Rock type**	ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	24 Aug 2020	24 Aug 2020
1	Foraging	0.67	24 Aug 2020	24 Aug 2020
1	Site description	0.33	24 Aug 2020	24 Aug 2020

Site description - visit 1 (24 Aug 2020)

Mid - tall mulga shrubland over *Acacia* and mixed Myrtaceae scattered low shrubs on low BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, vehicle tracks		
Vegetation condition	Very Good	**Fire age**	not evident
Total veg. cover (%)	55	**Litter distribution**	under vegetation
Tree cover (%)	45	**Litter depth(cm)**	1
Shrub cover (%)	15	**Litter cover (%)**	30
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**02**	**Position (WGS84)**	-28.724334, 116.930332
Topography	plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	1.00	25 Aug 2020	25 Aug 2020
1	Foraging	1.00	25 Aug 2020	25 Aug 2020
1	Site description	0.50	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Open mid-tall mulga shrubland over mixed low shrubs on hard pan clay with BIF and quartz rocks. No leaf litter.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	not evident
Total veg. cover (%)	25	**Litter distribution**	none
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	10	**Litter cover (%)**	1
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**03**	**Position (WGS84)**	-28.7262, 116.929578
Topography	plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Tall mulga shrubland over mid mixed shrubs over scattered low shrubs on hard pan clay with BIF, quartz and ferrous rocks.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	not evident
Total veg. cover (%)	50	**Litter distribution**	none
Tree cover (%)	35	**Litter depth(cm)**	0
Shrub cover (%)	15	**Litter cover (%)**	1
Grass cover (%)	0		
Herb cover (%)	5		

Site details			
Site	**04**	**Position (WGS84)**	-28.727648, 116.928519
Topography	plain	**Soil texture**	sandy clay, clay
Slope	negligible	**Rock type**	ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.87	25 Aug 2020	25 Aug 2020
1	Foraging	0.87	25 Aug 2020	25 Aug 2020
1	Site description	0.43	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Low chenopod shrubland on sandy clay with some small quartz rocks.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	not evident
Total veg. cover (%)	10	**Litter distribution**	none
Tree cover (%)	1	**Litter depth(cm)**	0
Shrub cover (%)	10	**Litter cover (%)**	0
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**05**	**Position (WGS84)**	-28.731023, 116.927094
Topography	plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Open mid to tall mulga shrubland.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	15	**Litter distribution**	none
Tree cover (%)	5	**Litter depth(cm)**	0
Shrub cover (%)	10	**Litter cover (%)**	0
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**06**	**Position (WGS84)**	-28.73393, 116.929538
Topography	undulating plain	**Soil texture**	sandy clay, clay, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, quartz, calcrete
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.87	25 Aug 2020	25 Aug 2020
1	Foraging	0.87	25 Aug 2020	25 Aug 2020
1	Site description	0.43	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Scattered low mixed shrubs on sandy clay loam with calcrete.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	8	**Litter distribution**	none
Tree cover (%)	1	**Litter depth(cm)**	0
Shrub cover (%)	5	**Litter cover (%)**	0
Grass cover (%)	0		
Herb cover (%)	0.1		

Site details			
Site	**07**	**Position (WGS84)**	-28.734683, 116.932087
Topography	plain	**Soil texture**	sandy clay, silt
Slope	negligible	**Rock type**	ferrous - Ironstone, quartz, calcrete
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.00	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Mid mulga shrubland over scattered low shrubs on sandy clay with silt deposited from adjacent mine waste stockpile.

Habitat	shrubland		
Disturbance	current operations, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Good	**Fire age**	
Total veg. cover (%)	25	**Litter distribution**	none
Tree cover (%)	5	**Litter depth(cm)**	0
Shrub cover (%)	20	**Litter cover (%)**	0
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**08**	**Position (WGS84)**	-28.730547, 116.934574
Topography	undulating plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Mixed mid Acacia shrubland over mixed low shrubs on rocky clay.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	35	**Litter distribution**	under vegetation
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	20	**Litter cover (%)**	2
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**09**	**Position (WGS84)**	-28.738499, 116.931098
Topography	undulating plain	**Soil texture**	sand, clay loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Tall mulga shrubland over Acacia dominant, Eremophilla and other mixed shrubs on sandy clay loam with laterite.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	under vegetation
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	15	**Litter cover (%)**	5
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**10**	**Position (WGS84)**	-28.73679, 116.928345
Topography	undulating plain	**Soil texture**	sand, clay loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Tall mulga shrubland over mixed shrubs on sandy clay loam with laterite. Leaf litter under tall mulga.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	25	**Litter distribution**	under vegetation
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	15	**Litter cover (%)**	4
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**11**	**Position (WGS84)**	-28.734331, 116.926648
Topography	undulating plain	**Soil texture**	sand, clay loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Scattered mid mulga shrubland over sparse shrubs on lateritic clay loam and rocks.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	20	**Litter distribution**	under vegetation
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	10	**Litter cover (%)**	1
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**12**	**Position (WGS84)**	-28.738807, 116.926524
Topography	undulating plain	**Soil texture**	sand, clay loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	25 Aug 2020	25 Aug 2020
1	Foraging	0.67	25 Aug 2020	25 Aug 2020
1	Site description	0.33	25 Aug 2020	25 Aug 2020

Site description - visit 1 (25 Aug 2020)

Tall mulga shrubland over mixed shrubs on sandy clay loam with laterite. Leaf litter under tall mulga.

Habitat	shrubland		
Disturbance	exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	under vegetation
Tree cover (%)	15	**Litter depth(cm)**	0
Shrub cover (%)	15	**Litter cover (%)**	5
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**13**	**Position (WGS84)**	-28.741009, 116.927491
Topography	hill slope	**Soil texture**	sandy clay, loam, rocks
Slope	gentle	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	1.17	26 Aug 2020	26 Aug 2020
1	Foraging	1.17	26 Aug 2020	26 Aug 2020
1	Site description	0.58	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Mid-tall mulga shrubland over Acacia, Eremophilla and other mixed shrubs on mostly BIF, ferrous and quartz rocks on lower slope of BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	55	**Litter distribution**	under vegetation
Tree cover (%)	45	**Litter depth(cm)**	1
Shrub cover (%)	15	**Litter cover (%)**	10
Grass cover (%)	1		
Herb cover (%)	1		

Site details			
Site	**14**	**Position (WGS84)**	-28.745961, 116.92923
Topography	hill slope	**Soil texture**	clay loam, rocks
Slope	gentle	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	26 Aug 2020	26 Aug 2020
1	Foraging	0.67	26 Aug 2020	26 Aug 2020
1	Site description	0.33	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Low mid mulga shrubland over mixed low shrubs on rocky clay loam at lower slope of BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	20	**Litter distribution**	under vegetation
Tree cover (%)	10	**Litter depth(cm)**	0
Shrub cover (%)	10	**Litter cover (%)**	1
Grass cover (%)	0		
Herb cover (%)	0		

Site details			
Site	**15**	**Position (WGS84)**	-28.743518, 116.927783
Topography	hill slope	**Soil texture**	sandy clay, loam, rocks
Slope	gentle	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

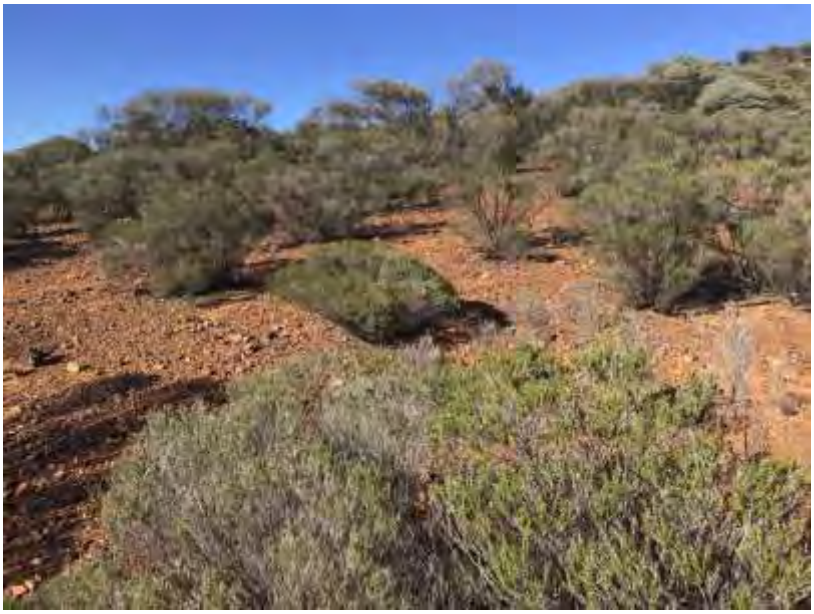
Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	26 Aug 2020	26 Aug 2020
1	Foraging	0.67	26 Aug 2020	26 Aug 2020
1	Site description	0.33	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Mulga shrubland over Myrtaceae dominant low mixed shrubs on rocky sandy clay loam on lower slope of BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	under vegetation
Tree cover (%)	10	**Litter depth(cm)**	0
Shrub cover (%)	20	**Litter cover (%)**	2
Grass cover (%)	0		
Herb cover (%)	1		



Site details			
Site	**16**	**Position (WGS84)**	-28.728492, 116.931727
Topography	undulating plain	**Soil texture**	clay loam
Slope	negligible	**Rock type**	ferrous - Ironstone, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	26 Aug 2020	26 Aug 2020
1	Foraging	0.67	26 Aug 2020	26 Aug 2020
1	Site description	0.33	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Mulga shrubland over Myrtaceae dominant low mixed shrubs on rocky sandy clay loam on lower slope of BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	under vegetation
Tree cover (%)	10	**Litter depth(cm)**	0
Shrub cover (%)	20	**Litter cover (%)**	2
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**17**	**Position (WGS84)**	-28.727165, 116.934631
Topography	undulating plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange, whitish	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	26 Aug 2020	26 Aug 2020
1	Foraging	0.67	26 Aug 2020	26 Aug 2020
1	Site description	0.33	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Mid mulga shrubland over mixed Acacia and Eremophila shrubs over mixed herbs on hard pan clay with small BIF, ferrous and quartz rocks.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	40	**Litter distribution**	transported
Tree cover (%)	25	**Litter depth(cm)**	1
Shrub cover (%)	20	**Litter cover (%)**	5
Grass cover (%)	0		
Herb cover (%)	5		

Site details			
Site	**18**	**Position (WGS84)**	-28.728775, 116.936461
Topography	plain	**Soil texture**	clay loam, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	26 Aug 2020	26 Aug 2020
1	Foraging	0.67	26 Aug 2020	26 Aug 2020
1	Site description	0.33	26 Aug 2020	26 Aug 2020

Site description - visit 1 (26 Aug 2020)

Mid mulga shrubland on hardpan clay with scattered small ferrous and BIF rocks.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	none
Tree cover (%)	5	**Litter depth(cm)**	0
Shrub cover (%)	30	**Litter cover (%)**	0
Grass cover (%)	1		
Herb cover (%)	1		

Site details			
Site	**19**	**Position (WGS84)**	-28.726815, 116.931867
Topography	undulating plain	**Soil texture**	clay, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	27 Aug 2020	27 Aug 2020
1	Foraging	0.67	27 Aug 2020	27 Aug 2020
1	Site description	0.33	27 Aug 2020	27 Aug 2020

Site description - visit 1 (27 Aug 2020)

Mulga shrubland over mixed low shrubs on hardpan clay.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	40	**Litter distribution**	under vegetation
Tree cover (%)	25	**Litter depth(cm)**	0
Shrub cover (%)	20	**Litter cover (%)**	2
Grass cover (%)	1		
Herb cover (%)	5		

Site details			
Site	**20**	**Position (WGS84)**	-28.751171, 116.932556
Topography	plain	**Soil texture**	sand, sandy clay, loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	27 Aug 2020	27 Aug 2020
1	Foraging	0.67	27 Aug 2020	27 Aug 2020
1	Site description	0.33	27 Aug 2020	27 Aug 2020

Site description - visit 1 (27 Aug 2020)

Mid mulga shrubland over scattered low shrubs on sandy clay loam.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	50	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	1
Shrub cover (%)	15	**Litter cover (%)**	10
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**21**	**Position (WGS84)**	-28.748165, 116.930243
Topography	undulating plain	**Soil texture**	sandy clay, loam, laterite
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	1.00	27 Aug 2020	27 Aug 2020
1	Foraging	1.00	27 Aug 2020	27 Aug 2020
1	Site description	0.50	27 Aug 2020	27 Aug 2020

Site description - visit 1 (27 Aug 2020)

Mulga shrubland over Myrtaceae dominant low mixed shrubs on rocky sandy clay loam on lower slope of BIF range.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	45	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	1
Shrub cover (%)	10	**Litter cover (%)**	10
Grass cover (%)	0		
Herb cover (%)	2		

Site details			
Site	**22**	**Position (WGS84)**	-28.749038, 116.935411
Topography	undulating plain	**Soil texture**	sandy loam, clay
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.67	27 Aug 2020	27 Aug 2020
1	Foraging	0.67	27 Aug 2020	27 Aug 2020
1	Site description	0.33	27 Aug 2020	27 Aug 2020

Site description - visit 1 (27 Aug 2020)

Mid mulga shrubland on sandy clay loam.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	45	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	1
Shrub cover (%)	10	**Litter cover (%)**	10
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**23**	**Position (WGS84)**	-28.735954, 116.929815
Topography	undulating plain	**Soil texture**	sandy clay
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.80	27 Aug 2020	27 Aug 2020
1	Foraging	0.80	27 Aug 2020	27 Aug 2020
1	Site description	0.40	27 Aug 2020	27 Aug 2020

Site description - visit 1 (27 Aug 2020)

Scattered low Acacia shrubs over scattered herbs on sandy clay loam.

Habitat	shrubland		
Disturbance	evidence of feral animals, vehicle tracks		
Vegetation condition	Good	**Fire age**	
Total veg. cover (%)	5	**Litter distribution**	none
Tree cover (%)	1	**Litter depth(cm)**	0
Shrub cover (%)	4	**Litter cover (%)**	0
Grass cover (%)	0		
Herb cover (%)	2		

Site details			
Site	**24**	**Position (WGS84)**	-28.741124, 116.930317
Topography	hill slope	**Soil texture**	clay, rocks
Slope	gentle	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.80	28 Aug 2020	28 Aug 2020
1	Foraging	0.80	28 Aug 2020	28 Aug 2020
1	Site description	0.40	28 Aug 2020	28 Aug 2020

Site description - visit 1 (28 Aug 2020)

Mid mulga shrubland over Acacia, Myrtaceae and Ereomophila low shrubs on low calcrete rise with BIF and quartz on clay.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	30	**Litter distribution**	under vegetation
Tree cover (%)	25	**Litter depth(cm)**	1
Shrub cover (%)	10	**Litter cover (%)**	5
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**25**	**Position (WGS84)**	-28.743651, 116.931067
Topography	hill slope	**Soil texture**	sandy clay, loam, rocks, laterite
Slope	gentle	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, quartz
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Birding	0.83	28 Aug 2020	28 Aug 2020
1	Foraging	0.83	28 Aug 2020	28 Aug 2020
1	Site description	0.42	28 Aug 2020	28 Aug 2020

Site description - visit 1 (28 Aug 2020)

Mid mulga shrubland over scattered low shrubs on sandy clay loam with small BIF and some quartz rocks and laterite.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	60	**Litter distribution**	transported
Tree cover (%)	55	**Litter depth(cm)**	1
Shrub cover (%)	5	**Litter cover (%)**	35
Grass cover (%)	0		
Herb cover (%)	1		

Site details			
Site	**26**	**Position (WGS84)**	-28.742332, 116.933109
Topography	undulating plain	**Soil texture**	clay loam, rocks
Slope	negligible	**Rock type**	ferrous - Ironstone, ferrous - Banded Iron Formation, calcrete
Soil colour	red–orange	**Rock cover (%)**	

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Date start	Date stop
1	Site description	0.00	28 Aug 2020	28 Aug 2020

Site description - visit 1 (28 Aug 2020)

Mid-tall mulga shrubland over scattered low shrubs on sandy clay loam.

Habitat	shrubland		
Disturbance	evidence of feral animals, exploration (drill pads and access tracks), vehicle tracks		
Vegetation condition	Very Good	**Fire age**	
Total veg. cover (%)	45	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	1
Shrub cover (%)	5	**Litter cover (%)**	10
Grass cover (%)	0		
Herb cover (%)	1		

Appendix 3 Vertebrate fauna desktop and field survey results

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Arachnids												
Idiopidae	*Idiosoma clypeatum*	Northern shield-backed trap-door spider	P3 (DBCA list)			1		1	10917			
Amphibians												
Hylidae	*Cyclorana platycephala*	Water-holding Frog			1							
Limnodynastidae	*Neobatrachus kunapalari*	Kunapalari Frog			1							
	Neobatrachus sutor	Shoemaker Frog			1							
	Neobatrachus wilsmorei	Plonking Frog			1							
	Platyplectrum spenceri	Centralian Burrowing Frog			1							
Myobatrachidae	*Pseudophryne guentheri*	Crawling Toadlet			1							
	Pseudophryne occidentalis	Western Toadlet			1			1				
Reptiles												
Cheluidae	*Chelodina steindachneri*	Flat-shelled Turtle			1							
Agamidae	*Amphibolurus longirostris*	Long-nosed Dragon										
	Ctenophorus maculatus	Spotted Military Dragon										
	Ctenophorus nuchalis	Central Netted Dragon			1			1				
	Ctenophorus ornatus	Ornate Crevice-Dragon			1							
	Ctenophorus reticulatus	Western Netted Dragon			1			1		1	1	
	Ctenophorus salinarum	Salt Pan Dragon			1							
	Ctenophorus scutulatus	Lozenge-marked Dragon			1			1		1	1	1
	Diporiphora amphiboluroides	Mulga Dragon			1							
	Moloch horridus	Thorny Devil			1							
	Pogona minor	Western Bearded Dragon			1			1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Gekkonidae	*Gehyra punctata*	Spotted Dtella			1							
	Gehyra variegata	Tree Dtella			1			1			1	1
	Heteronotia binoei	Bynoe's Gecko			1			1		1	1	1
Carphodactylidae	*Nephrurus vertebralis*	Midline Knob-tailed Gecko										
	Underwoodisaurus milii	Barking Gecko										
Diplodactylidae	*Crenadactylus ocellatus*	Clawless gecko										
	Diplodactylus granariensis	Western Stone Gecko										
	Diplodactylus pulcher	Fine-faced Gecko			1			1				
	Lucasium squarrosum	Mottled Ground Gecko			1							
	Oedura marmorata	Marbled Velvet Gecko										
	Rhynchoedura ornata	Western Beaked Gecko			1							
	Strophurus assimilis	Thorn-tailed Gecko										
	Strophurus michaelseni	Robust Striped gecko										
	Strophurus spinigerus	Soft Spiny-tailed Gecko										
	Strophurus	Western Spiny-tyailed gecko			1			1				
Pygopodidae	*Delma australis*	Marble-faced delma										
	Delma fraseri	Fraser's delma										
	Delma grayii	Side-barred Delma										
	Delma tincta	Excitable Delma										
	Lialis burtonis	Burton's Legless Lizard			1							
	Pygopus nigriceps	Western Hooded Scaly-foot			1			1				
Scincidae	*Cryptoblepharus buchananii*	Buchanan's Snake-eyed Skink						1				
	Cryptoblepharus plagiocephalus	Peron's Snake-eyed Skink			1					1		

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Ctenotus inornatus	Bar-shouldered Ctenotus			1							
	Ctenotus leonhardii	Leonhard's Ctenotus										
	Ctenotus mimetes	Checker-sided Ctenotus						1				
	Ctenotus pantherinus	Leopard Ctenotus										
	Ctenotus schomburgkii	Barred Wedge-snout Ctenotus			1			1				
	Ctenotus severus	Stern Ctenotus										
	Ctenotus uber	Spotted Ctenotus			1							
	Cyclodomorphus branchialis	Gilled Slender Bluetongue Skink	VU (BC Act)		1			1	2			
	Egernia depressa	Southern Pygmy Spiny-tailed Skink			1			1		1	1	1
	Egernia formosa	Goldfields Crevice-skink										
	Egernia stokesii badia	Western Spiny-tailed Skink	EN/VU (EPBC Act; BC Act)			1		1	1			
	Eremiascincus richardsonii	Broad-banded Sand Swimmer			1			1				
	Lerista gerrardii	Bold-striped Robust Slider						1				
	Lerista kingi	King's Three-toed Slider			1							
	Lerista macropisthopus	Unpatterned Robust Slider										
	Lerista nichollsi	Inland Broad-blazed Slider			1			1				
	Lerista timida	Timid Slider			1					1	1	
	Liopholis inornata	Desert Skink										
	Menetia greyii	Common Dwarf Skink			1							
	Morethia butleri	Woodland Morethia Skink			1						1	
	Morethia obscura	Shrubland Morethia Skink						1				
	Tiliqua occipitalis	Western Bluetongue										
	Tiliqua rugosa	Bobtail			1							

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor			1					1		
	Varanus giganteus	Perentie						1		1		
	Varanus gouldii	Bungarra or Sand Monitor			1							
	Varanus panoptes	Yellow-spotted Monitor			1			1		1	1	
	Varanus tristis	Racehorse Monitor								1		
Typhlopidae	*Anilos australis*	Southern Blindsnake										
	Anilios hamatus	Pale-headed Blindsnake										
	Anilios waitii	Beaked Blindsnake			1							
Pythonidae	*Antaresia perthensis*	Pygmy Python										
	Antaresia s. stimsoni	Stimson's Python										
Elapidae	*Acanthophis pyrrhus*	Desert Death Adder										
	Brachyurophis f. fasciolatus	Narrow-banded Snake										
	Brachyurophis semifasciatus	Southern Shovel-nosed Snake			1							
	Demansia psammophis reticulata	Yellow-faced Whipsnake										
	Furina ornata	Moon Snake									1	
	Neelaps bimaculatus	Black-naped Snake										
	Pseudechis australis	Mulga Snake										
	Pseudechis butleri	Spotted Mulga Snake			1			1		1		
	Pseudonaja mengdeni	Western Brown Snake			1							
	Pseudonaja modesta	Ringed Brown Snake			1			1				
	Simoselaps bertholdi	Jan's Banded Snake			1							
	Suta fasciata	Rosen's Snake			1			1				
	Suta monachus	Monk Snake			1					1		

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Birds												
Dromaiidae	*Dromaius novaehollandiae*	Emu			1			1		1	1	1
Megapodiidae	*Leipoa ocellata*	Malleefowl	VU (EPBC & BC Acts)		1	1		1	4	1	1	
Phasianidae	*Coturnix pectoralis*	Stubble Quail			1							
Anatidae	*Anas gracilis*	Grey Teal			1							
	Anas rhynchotis	Australasian Shoveler			1							
	Anas superciliosa	Pacific Black Duck			1			1				
	Aythya australis	Hardhead			1							
	Biziura lobata	Musk Duck			1							
	Chenonetta jubata	Australian Wood Duck			1			1				
	Cygnus atratus	Black Swan			1			1				
	Malacorhynchus membranaceus	Pink-eared Duck			1							
	Oxyura australis	Blue-billed Duck	P4 (DBCA list)		1							
	Stictonetta naevosa	Freckled Duck						1				
	Tadorna tadornoides	Australian Shelduck			1			1				
Podicipedidae	*Poliocephalus*	Hoary-headed Grebe			1							
	Tachybaptus novaehollandiae	Australasian Grebe			1			1				
Columbidae	*Columba livia*	Domestic Pigeon, Rock Dove		*		1						
	Geopelia cuneata	Diamond Dove			1			1				
	Ocyphaps lophotes	Crested Pigeon			1			1			1	
	Phaps chalcoptera	Common Bronzewing			1			1		1		
	Streptopelia senegalensis	Laughing Turtle-Dove		*	1	1						
Podargidae	*Podargus strigoides*	Tawny Frogmouth			1			1		1		

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Caprimulgidae	*Eurostopodus argus*	Spotted Nightjar			1			1		1		
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar			1			1				
Apodidae	*Apus pacificus*	Fork-tailed Swift	Mig. (EPBC & BC Acts)			1						
Ardeidae	*Ardea ibis*	Cattle Egret				1						
	Ardea modesta	Great egret				1						
	Ardea novaehollandiae	White-faced Heron			1							
	Ardea pacifica	White-necked Heron			1							
	Ixobrychus dubius	Australian Little Bittern	P4 (DBCA list)		1							
Threskiornithidae	*Platalea flavipes*	Yellow-billed Spoonbill										
	Threskiornis moluccus	Australian White Ibis			1							
	Threskiornis spinicollis	Straw-necked Ibis			1							
Accipitridae	*Accipiter cirrocephalus*	Collared Sparrowhawk			1			1				
	Accipiter fasciatus	Brown Goshawk			1							
	Aquila audax	Wedge-tailed Eagle			1			1				
	Circus assimilis	Spotted Harrier			1							
	Elanus caeruleus	Black-shouldered Kite			1							
	Haliastur sphenurus	Whistling Kite			1			1				
	Hamirostra isura	Square-tailed Kite										
	Hamirostra melanosternon	Black-breasted Buzzard										
	Hieraaetus morphnoides	Little Eagle			1							
Falconidae	*Falco berigora*	Brown Falcon			1			1		1		
	Falco cenchroides	Australian Kestrel			1			1		1		1
	Falco longipennis	Australian Hobby			1			1		1		

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Falco peregrinus	Peregrine Falcon	OS (BC Act)		1			1	1			
Rallidae	*Fulica atra*	Eurasian Coot			1							
	Porzana fluminea	Australian Spotted Crake			1							
Otididae	*Ardeotis australis*	Australian Bustard			1							
Burhinidae	*Burhinus grallarius*	Bush Stone-curlew			1			1				
Recurvirostridae	*Cladorhynchus leucocephalus*	Banded Stilt			1							
	Himantopus	Black-winged Stilt			1							
	Recurvirostra novaehollandiae	Red-necked Avocet			1							
Charadriidae	*Charadrius ruficapillus*	Red-capped Plover			1							
	Erythrogonys cinctus	Red-kneed Dotterel			1			1				
	Peltohyas australis	Inland Dotterel			1							
	Vanellus miles	Masked Lapwing			1							
	Vanellus tricolor	Banded Lapwing			1			1				
Rostratulidae	*Rostratula australis*	Australian Painted Snipe	EN (EPBC & BC Acts)			1						
Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	Mig. (EPBC & BC Acts)			1						
	Calidris acuminata	Sharp-tailed Sandpiper	Mig. (EPBC & BC Acts)		1	1			1			
	Calidris ferruginea	Curlew Sandpiper	CR/Mig./CR (EPBC Act; BC Act)			1						
	Calidris melanotos	Pectoral Sandpiper	Mig. (EPBC & BC Acts)			1						
	Tringa nebularia	Common Greenshank	Mig. (EPBC & BC Acts)			1						
Turnicidae	*Turnix varius*	Painted Button-quail			1							
	Turnix velox	Little Button-quail			1			1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Laridae	*Sterna hybrida*	Whiskered Tern			1							
Cacatuidae	*Cacatua leadbeateri*	Major Mitchell's Cockatoo			1							
	Cacatua roseicapilla	Galah			1			1		1	1	
	Cacatua sanguinea	Little Corella			1					1		
	Calyptorhynchus banksii	Red-tailed Black-Cockatoo			1			1				
	Nymphicus hollandicus	Cockatiel			1			1				1
Psittacidae	*Melopsittacus undulatus*	Budgerigar			1			1				
	Neophema bourkii	Bourke's Parrot			1							
	Neophema elegans	Elegant Parrot			1							
	Neophema splendida	Scarlet-chested Parrot								1		
	Parvipsitta porphyrocephala	Purple-crowned Lorikeet										
	Pezoporus occidentalis	Night Parrot	EN (EPBC & BC Acts)			1						
	Platycercus varius	Mulga Parrot			1			1		1		
	Platycercus zonarius	Australian Ringneck			1			1		1	1	1
	Polytelis anthopeplus	Regent Parrot			1							
Cuculidae	*Cacomantis pallidus*	Pallid Cuckoo			1			1				1
	Chrysococcyx basalis	Horsfield's Bronze Cuckoo			1							
	Chrysococcyx osculans	Black-eared Cuckoo			1	1		1				
Strigidae	*Ninox boobook*	Boobook Owl			1							
Tytonidae	*Tyto alba*	Barn Owl			1							
	Tyto novaehollandiae	masked owl (southwest)	P3 (DBCA list)		1			1				
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher			1			1				
	Todiramphus sanctus	Sacred Kingfisher			1			1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Meropidae	*Merops ornatus*	Rainbow Bee-eater			1	1		1		1		
Climacteridae	*Climacteris affinis*	White-browed Treecreeper			1			1			1	
	Climacteris rufus	Black-tailed Treecreeper			1							
Ptilonorhynchidae	*Ptilonorhynchus maculatus guttatus*	Western Bowerbird			1							
Maluridae	*Malurus lamberti*	Variegated Fairy-wren			1			1		1		
	Malurus leucopterus	White-winged Fairy-wren			1							
	Malurus splendens	Splendid Fairy-wren			1			1		1	1	1
Acanthizidae	*Acanthiza apicalis*	Broad-tailed Thornbill						1				1
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill			1			1				
	Acanthiza i. iredalei	Samphire Thornbill			1					1	1	1
	Acanthiza robustirostris	Slaty-backed Thornbill			1			1		1		
	Acanthiza uropygialis	Chestnut-rumped Thornbill			1			1		1	1	1
	Aphelocephala leucopsis	Southern Whiteface			1			1				
	Gerygone fusca	Western Gerygone			1			1		1		1
	Pyrrholaemus brunneus	Redthroat			1			1		1	1	1
	Smicrornis brevirostris	Weebill			1			1		1	1	
Pardalotidae	*Pardalotus striatus*	Striated Pardalote			1			1				
Meliphagidae	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater			1			1		1		1
	Anthochaera carunculata	Red Wattlebird			1			1				
	Certhionyx variegatus	Pied Honeyeater			1			1				
	Epthianura albifrons	White-fronted Chat			1			1				
	Epthianura aurifrons	Orange Chat			1							
	Epthianura tricolor	Crimson Chat			1			1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Gavicalis virescens	Singing Honeyeater			1					1	1	1
	Lacustroica whitei	Grey Honeyeater			1			1				
	Lichmera indistincta	Brown Honeyeater			1			1				
	Manorina flavigula	Yellow-throated Miner			1			1		1	1	
	Melithreptus brevirostris	Brown-headed Honeyeater										
	Nesoptilotis leucotis	White-eared Honeyeater										
	Ptilotula ornata	Yellow-plumed Honeyeater										
	Ptilotula penicillata	White-plumed Honeyeater			1							
	Ptilotula plumula	Grey-fronted Honeyeater										
	Purnella albifrons	White-fronted Honeyeater			1			1				
	Sugomel nigrum	Black Honeyeater			1							
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler			1			1		1	1	1
	Pomatostomus temporalis	Grey-crowned Babbler			1			1		1	1	
Cinclosomatidae	*Cinclosoma clarum*	Western Chestnut Quail-thrush			1			1		1		1
	Cinclosoma marginatum	Western Quail-thrush						1		1		
Psophodidae	*Psophodes occidentalis*	Western Wedgebill			1							
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella			1			1		1		
Campephagidae	*Coracina maxima*	Ground Cuckoo-shrike			1							
	Coracina novaehollandiae	Black-faced Cuckoo-shrike			1			1		1		
	Lalage tricolor	White-winged Triller			1							
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush			1			1		1		1
	Oreoica gutturalis	Crested Bellbird			1			1		1	1	1
	Pachycephala inornata	Gilbert's Whistler			1					1	1	1
	Pachycephala occidentalis	Western Golden Whistler			1							

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Pachycephala rufiventris	Rufous Whistler			1			1		1	1	1
Artamidae	*Artamus cinereus*	Black-faced Woodswallow			1			1		1	1	1
	Artamus cyanopterus	Dusky Woodswallow			1							
	Artamus minor	Little Woodswallow			1			1				
	Artamus personatus	Masked Woodswallow			1			1				
	Artamus superciliosus	White-browed Woodswallow			1			1				
Cracticidae	*Cracticus nigrogularis*	Pied Butcherbird			1			1		1		
	Cracticus tibicen	Australian Magpie			1			1			1	1
	Cracticus torquatus	Grey Butcherbird			1			1		1	1	1
	Strepera versicolor	Grey Currawong			1			1				
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird			1			1				
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail			1			1				1
	Rhipidura leucophrys	Willie Wagtail			1			1		1	1	1
Corvidae	*Corvus bennetti*	Little Crow			1			1				
	Corvus coronoides	Australian Raven			1			1				
	Corvus orru	Torresian Crow			1			1		1	1	
Monarchidae	*Grallina cyanoleuca*	Magpie-lark			1			1			1	1
Petroicidae	*Eopsaltria georgiana*	White-breasted Robin			1							
	Melanodryas cucullata	Hooded Robin			1			1		1		
	Microeca fascinans	Jacky Winter			1							
	Petroica goodenovii	Red-capped Robin			1			1		1		1
Acrocephalidae	*Acrocephalus australis*	Australian Reed Warbler			1							
Megaluridae	*Megalurus cruralis*	Brown Songlark			1							
	Megalurus gramineus	Little Grassbird			1			1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Megalurus mathewsi	Rufous Songlark			1							
Estrildidae	*Taeniopygia guttata*	Zebra Finch			1			1				
Hirundinidae	*Cheramoeca leucosterna*	White-backed Swallow			1			1		1		1
	Hirundo neoxena	Welcome Swallow			1			1				
	Petrochelidon ariel	Fairy Martin						1				
	Petrochelidon nigricans	Tree Martin						1				
Motacillidae	*Anthus australis*	Australian Pipit			1					1		1
	Motacilla cinerea	Grey Wagtail	Mig. (EPBC & BC Acts)			1						
Zosteropidae	*Zosterops lateralis*	Grey-breasted White-eye			1							
Mammals												
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna			1			1		1	1	
Dasyuridae	*Antechinomys laniger*	Kultarr			1			1				
	Dasyurus geoffroii	Chuditch	VU (EPBC & BC Acts)			1						
	Ningaui ridei	Wongai Ningaui			1							
	Pseudantechinus woolleyae	Woolley's Pseudantechinus			1			1		1		1
	Sminthopsis crassicaudata	Fat-tailed Dunnart										
	Sminthopsis dolichura	Little long-tailed Dunnart			1							
	Sminthopsis longicaudata	Long-tailed Dunnart	P4 (DBCA list)									
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum								1		
Potoroidae	*Bettongia lesueur graii*	Burrowing Bettong (mainland)	EX (EPBC & BC Acts)							1		
Macropodidae	*Macropus fuliginosus*	Western Grey Kangaroo										
	Macropus robustus	Euro						1		1	1	1

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
	Macropus rufus	Red Kangaroo			1			1				
Emballonuridae	*Taphozous hilli*	Hill's Sheathtail Bat										
Molossidae	*Austronomus australis*	White-striped Freetail Bat										
	Ozimops kitcheneri	Southwestern Freetail Bat										
	Ozimops petersi	Inland Freetail Bat										
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat						1				
	Chalinolobus morio	Chocolate Wattled Bat						1				
	Nyctophilus geoffroyi	Lesser Long-eared Bat						1				
	Nyctophilus major tor	Central Long-eared Bat	P3 (DBCA list)									
	Scotorepens balstoni	Inland Broad-nosed Bat										
	Vespadelus baverstocki	Inland Forest Bat										
	Vespadelus finlaysoni	Finlayson's Cave Bat			1							
Leporidae	*Oryctolagus cuniculus*	Rabbit		*		1		1		1	1	1
Muridae	*Leporillus apicalis*	Lesser Stick-nest Rat	EX (EPBC & BC Acts)		1							
	Mus musculus	House Mouse		*		1						
	Notomys alexis	Spinifex Hopping-mouse										
	Notomys mitchelli	Mitchell's Hopping-mouse										
	Pseudomys bolami	Bolam's Mouse										
	Pseudomys desertor	Desert Mouse										
	Pseudomys hermannsburgensis	Sandy Inland Mouse										
Bovidae	*Capra hircus*	Goat		*	1	1		1		1	1	1
Canidae	*Canis familiaris*	Dog		*		1				1	1	
	Vulpes	Red Fox		*		1		1				

Family / Higher order	Species	Common name	Status	Introduced	Desktop sources					PES 2019	PES 2020	This survey
					ALA	EPBC	ERMGG	NM	TFA			
Felidae	*Felis catus*	Cat		*		1		1		1	1