RED DIRT METALS LIMITED

Mt Ida Lithium Project -

Native Vegetation Clearing Permit Application: Supporting Document

220057-MIG-MTIDA-NVCP

Rev: 0

March 2023

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Acronyms

Acronym	Meaning
BC Act	Western Australian Biodiversity Conservation Act 2016
CAM	Central Amphibolite
CGR	Copperfield Granite
BoM	Bureau of Meteorology
DAM	Dick Amphibolite
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environment Regulation
DMIRS	Department of Mines, Industry Resources and Safety
DPIRD	Department of Primary Industries and Regional Development
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ha	Hectare
IBRA	Interim Biogeographic Regionalisation for Australia
Km	Kilometres
MAN	Anorthosite
MCP	Mine Closure Plan
MIG	Mt. Ida Gold Pty Ltd
MUR	Murchison Bioregion
MUR01	Eastern Murchison Subregion
NVCP	Native Vegetation Clearing Permit
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
Project	Mt. Ida Lithium Project
RDM	Red Dirt Metals Limited
ROM Pad	Run of Mine Pad
SDP	Surface Disturbing Permit
TAM	Timoni Amphibolite
TEC	Threatened Ecological Community
UUM	Unexpected Ultramafic
WRL	Waste Rock Landform

1 INTRODUCTION

The Mt Ida Lithium Project (Project) is being developed by Mt Ida Gold Pty Ltd (MIG) a wholly owned subsidiary of Red Dirt Metals Limited (RDM).

The Project is located approximately 100km northwest of Menzies, in the Murchison Region (MUR) of Western Australia (Figure 1-1). Green Values Australia (Green Values) was commissioned by MIG to prepare an *Environmental Protection Act 1986* (EP Act) Part V Native Vegetation Clearing Permit (NVCP) application to the Department of Mines, Industry Regulation and Safety (DMIRS) to seek approval for clearing native vegetation on mining tenements M29/165 and M29/2 to facilitate the Project's resource development. This document has been prepared to support the NVCP application, which seeks approvals for clearing of up to 246 hectares (ha) of native vegetation within a 544 ha proposed Purpose Permit Area (Figure 1-2). All mining tenements are held by MIG.

The application for the NVCP (Purpose Permit) is based primarily on the findings of the *Reconnaissance Flora and Vegetation Survey of the Mt Ida Lithium Project, May 2022* (Native Vegetation Solutions, 2022) and the *Vertebrate Fauna Reconnaissance Survey and Risk Assessment, May 2022* (Terrestrial Ecosystems, 2022). The survey area for both reports was 617.73 ha (Appendix A and Appendix B) and includes historical mining areas that have been severely degraded due to previous mining activity by other responsible companies.

1.1 Document Purpose

The purpose of this document is to provide the necessary information and justification, as prescribed within the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* to seek approval under Part V of the EP Act for the clearing of Native Vegetation. This document has been prepared to support a NVCP application to DMIRS by MIG, to clear up to 246 ha within a 544 ha Purpose Permit Area located on tenements M29/165 and M29/2.

This NVCP document is structured to provide the following information:

- Description and map of the proposed Purpose Permit Area proposed for clearing in regard to location, size and purpose.
- Site overview, with a brief description of local climate, biogeographic region, geology, land use and land systems, soils, hydrology, and hydrogeology.
- Description of the proposed Purpose Permit Area to be cleared in regard to vegetation type, condition and representation in a regional context.
- Presence of significant flora species, including within the proposed Purpose Permit Area.
- Description of broad fauna habitat within the proposed Purpose Permit Area and

- Discussion of proposed vegetation clearing in relation to the EP Act *Schedule 5 – Principles for clearing native vegetation*.

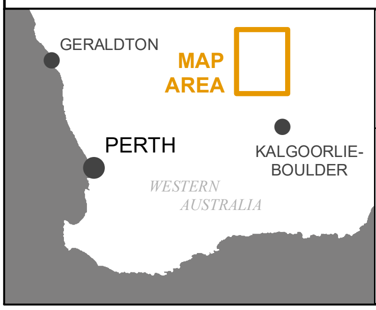

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Figure 1.1:
Mt Ida Lithium Project
regional location

0 10 20
Kilometres
GCS GDA 1994

Legend

- Proposed purpose permit area
- Locality
- Minor Road
- Principal Road

Scale 1: @ A4	Author: J. Webster
Date: 2/03/2023	Drawn: L. Weggelaar

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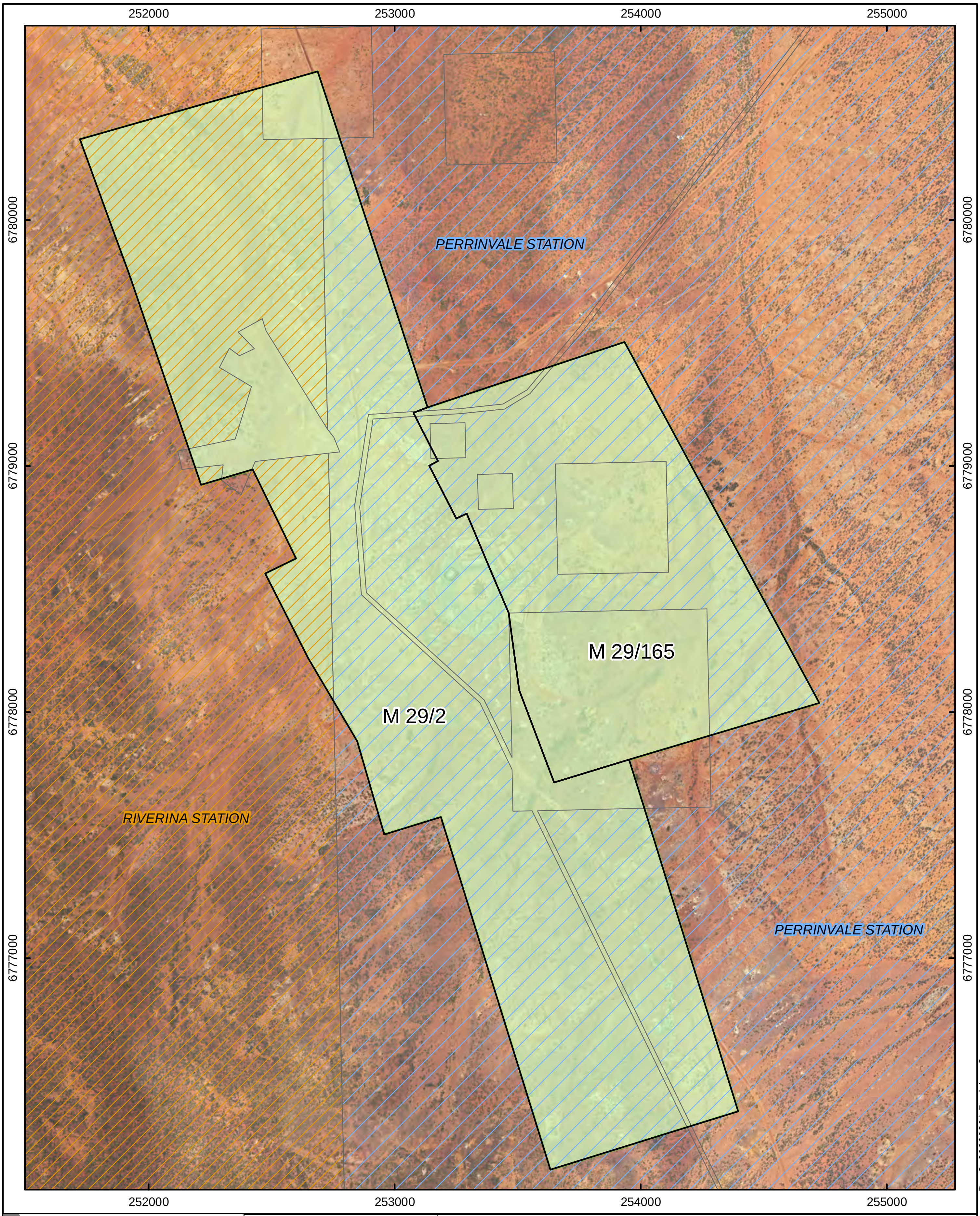

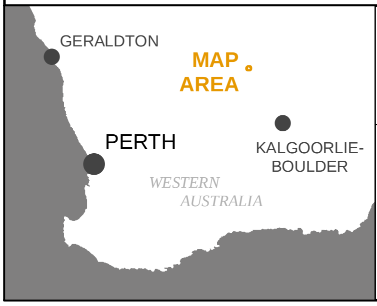

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Figure 1-2:
Mt Ida Lithium Project
proposed Purpose Permit Area
and mining tenements

Legend
- Proposed purpose permit area
- Mt Ida Gold mining tenement
- Perrinvale Station
- Riverina Station

0 0.25 0.5
Kilometres
GDA 1994 MGA Zone 51

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Date: 2/03/2023	Drawn: L. Weggelaar

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2 BACKGROUND

The proposed Purpose Permit lies within two tenements (M29/165 and M29/2) held by MIG.

Table 2-1: MIG tenements within the proposed Purpose Permit Area

Tenement	Area (ha)	Granted	Expires	Holder
M29/0165	160.25	December 20, 1994	December 20, 2036	Mt Ida Gold Pty Ltd
M29/0002	383	December 18, 1982	December 21, 2024	Mt Ida Gold Pty Ltd

2.1 Contact Details

Company Details:

Name: David Flanagan (Executive Chairman), Red Dirt Metals Limited

Trading Name: Red Dirt Metals Limited

ABN/ACN: 671 072 44039/107 244 039

Postal Address: Suite 4, 6 Centro Avenue, Subiaco, W.A, 6008

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Authorised Person & Contact Person: Claire McGuire, Snr ESG Advisor

Email: c.mcguire@reddirtmetals.com.au

Mobile: 0402 0489 23

2.2 Land Holder Authorisation

The Mt Ida Lithium Project (Project) is being developed by Mt Ida Gold Pty Ltd (MIG) a wholly owned subsidiary of Red Dirt Metals Limited (RDM). A corporate structure is shown as Figure 2-1.

RDM is a company incorporate and domiciled in Australia whose shares are publicly listed on the ASX (ASX Code: RDT). Both tenements under this application are held solely by MIG. Tenement summary reports are attached as Appendix 4.

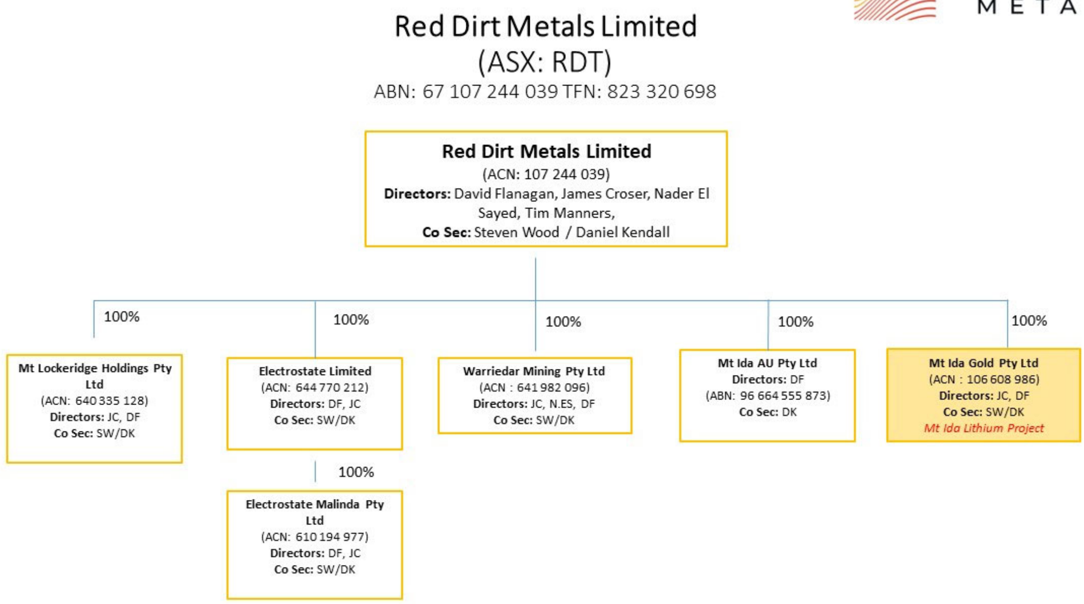


Figure 2-1: Red Dirt Metals corporate structure

3 PROPOSED ACTIVITIES

3.1 Description of Proposed Activities

The proposed Project involves the development of a new mining void area to allow the extraction of spodumene (lithium ore). Ore extracted from the open pit will be crushed via a mobile crushing and screening plant. The ore will be transported to port via road train as a spodumene Direct Shipping Ore (DSO) product. The Project will consist of a mining void area containing two open cut mining pits, a waste rock landform (WRL) and supporting mining infrastructure. The main activities that will require vegetation clearing are listed below:

- an updated mining void area containing two open pits.
- infrastructure including workshops, administration.
- expansion to camp facilities and access roads
- construction of a WRL
- laydown area and run of mine pads (ROMs)
- topsoil stockpiles
- abandonment bunds
- turkey's nest.

An indicative project layout is provided as Figure 3-1.

Conventional drill and blast methods will be used to release ore and waste from the pits. Ore and waste will be extracted using excavators and dump trucks. Ore will be placed at ROMs to be established adjacent to the pits and waste will be placed on WRLs. A hydrogeological assessment recently undertaken indicates that dewatering will not be required as the proposed pits will be between 70-90m in depth and will sit above the water table (Appendix 3). Abandonment bunds will be built progressively during construction activities including around the open pits in accordance with relevant regulations by removing vegetation (if present) within the bund footprint area by dozer to the width of the abandonment bund. Dump trucks will be used to place inert rock material to create the bund.

3.2 Estimated Vegetation Disturbance Requirements

MIG proposes that up to 246 ha of native vegetation will be cleared within the 544 ha Purpose Permit Area to allow the works listed in Section 3.1 to occur. The proposed site layout is shown in Figure 1-2.

Due to past mining activities, there is existing infrastructure and associated ground disturbance on site, covering approximately 60 ha. A summary of current and proposed clearing per tenement is included as Table 3-1.

Table 3-1: Existing and Planned Clearing by Tenement

	Area (ha)
Total native vegetation in permit area	484
Total existing disturbance in permit area	60
Proposed purpose permit area	544

3.3 Indicative Time

MIG proposes to commence vegetation clearing in Q4 2023. Clearing activities will be implemented progressively over the life of the mine.

3.4 Method of Vegetation Clearing

MIG will ensure all clearing and ground disturbance is carried out in accordance with their Ground Disturbance Procedure (Red Dirt Metals Ltd 2022). Noting this, the following methods of vegetation clearing will be implemented during the construction phase of the Project:

- Prior to clearing, a project-specific internal Surface Disturbance Permit (SDP) will be completed and signed off by the Environmental Department.
- Clearing areas will be delineated in accordance with the project-specific internal SDP, the clearing boundary will be surveyed and demarcated with survey pegs and flagging tape.
- Vegetation will be removed prior to topsoil stripping. Vegetation will generally be cleared 'blade up' with bulldozers or graders within the proposed Purpose Permit Area. Diggers and loaders may be used around drainage lines as required.
- Vegetation will typically be stripped and stored to the side of each disturbed are for use in rehabilitation works. Areas with thicker vegetation may need to have the vegetation pushed into piles and mulched.
- An average topsoil salvage depth of 0.2 m of the soil profile within the proposed disturbance areas will be stripped (where possible) and placed in stockpiles (paddock dumped not greater than 2 m in height with adequate distance between them to create a series of mounds and troughs).
- Subsoil may also be stripped and stockpiled separately to ensure adequate capping material and growth medium is collected.
- Any (non-vegetative) surface litter or waste present will be collected and stockpiled in the allocated landfill area.
- Machinery operators will aim to minimise the frequency and intensity of disturbance, so they do not compromise the structural integrity of the soils. Handling of topsoil will be minimised as much as possible especially when wet.
- Soil stripping is planned to occur as close as possible to the time when the proposed mining is scheduled to commence.

3.5 Operational Controls

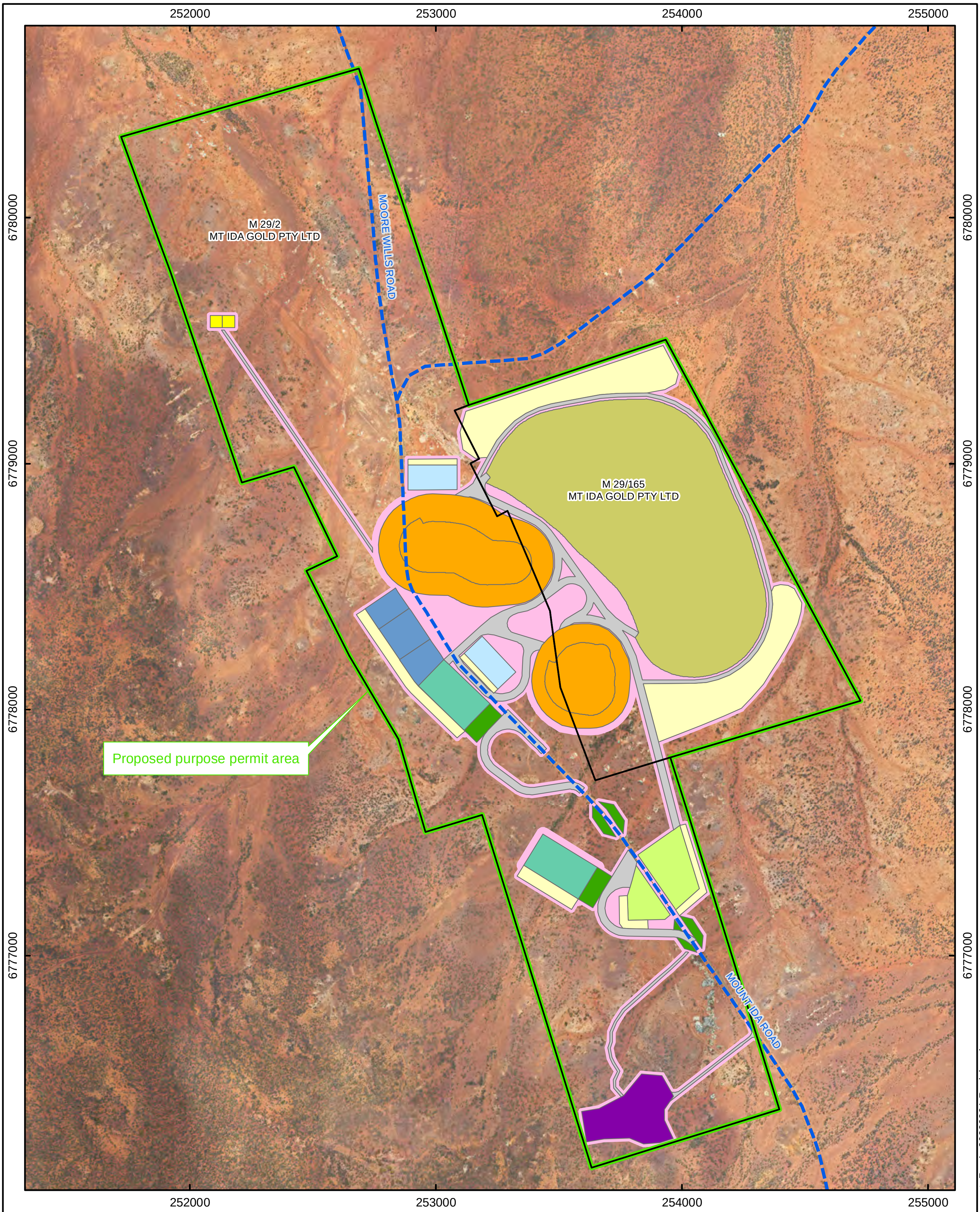
Flora and vegetation assessments (Appendix 1) identified a significant amount of introduced species over the tenement area. Weed identification is further covered in Section 5.1.3 of this document.

To minimise the further spread of weed species, MIG and any contractors commissioned by MIG will complete a Weed, Seed, and Hygiene Certificate prior to arrival upon site and adhere to hygiene procedures to minimise the risk of spreading or introducing weeds within the proposed Purpose Permit Area.

Further controls will be placed on vehicles leaving site if the vehicle is considered to have traversed weed-impacted areas. Weed management will be outlined in the operational Environmental Management Plan for the Project.

3.6 Rehabilitation and Maintenance

In areas where topsoil has been disturbed it will be spread back over the area and rehabilitated according to the specifications of MIG's Mine Closure Plan (MCP) and seeded with local native species. Rehabilitation monitoring will be undertaken on all substantial rehabilitation areas within one year of seeding to determine whether germination and establishment has been successful. Ongoing monitoring will determine if further management measures are required, including re-seeding or other interventions.



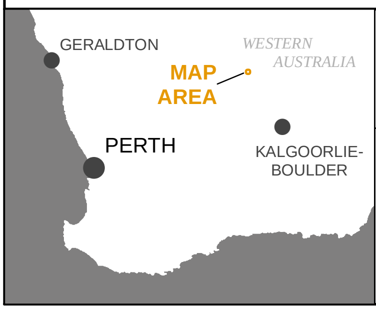


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Figure 3-1:
Indicative project layout

0 250 500
Metres
GDA 1994 MGA Zone 51

Legend

- Proposed purpose permit
- Live tenement
- Existing track
- Buffer
- Dam: fresh water
- Laydown or hardstand area
- Low-grade ore stockpile (Class
- Magazine
- Village
- Mining void (with a depth of at least 5m) - below ground-water level
- Run-of-mine (ROM) pad
- Topsoil stockpile
- Transport or service infrastructure corridor
- Waste dump or overburden stockpile (Class 2)
- Workshop

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Date: 2/03/2023	Drawn: L. Weggelaar

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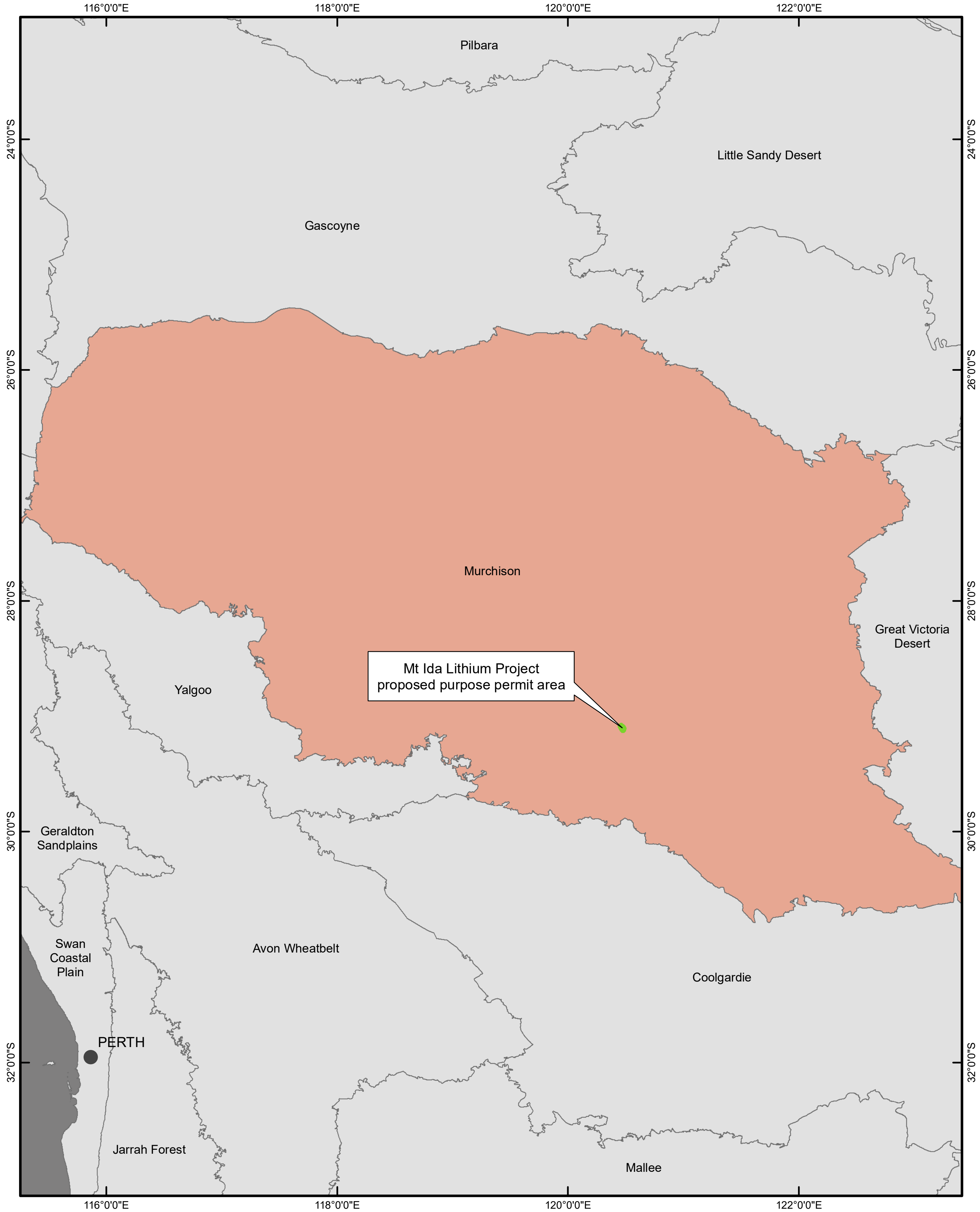
4 SITE OVERVIEW

4.1 Biogeographic Location

The proposed Purpose Permit Area lies within the Eastern Murchison (MUR01) subregion of the Murchison (MUR) bioregion (Figure 4-1) as outlined by the Interim Biogeographic Regionalisation for Australia (IBRA). The Eastern Murchison subregion covers over 7 million hectares and is described as internally draining, with extensive areas of elevated red desert sandplains with minimal dune development (Native Vegetation Solutions, 2022). The bioregion includes broad plains with red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga woodlands often with ephemerals, hummock grasslands, saltbush shrublands and halosarcia shrublands (Cowan et al. 2001). The region also contains several Salt Lake systems, such as Lake Ballard.



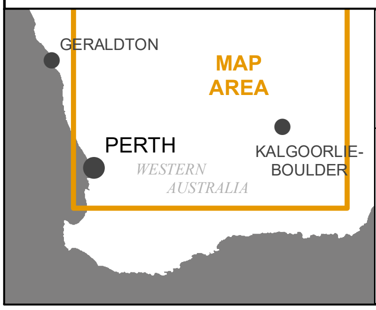


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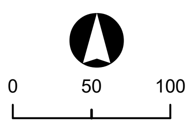
Figure 4-1:
Location of the proposed Purpose Permit Area within the Murchison bioregion



GCS GDA 1994

Legend
- Proposed purpose permit area
- IBRA bioregion - Murchison
- IBRA bioregion

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Date: 2/03/2023	Drawn: L. Weggelaar

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4.2 Climate

The climate within the proposed Purpose Permit Area is classified as Arid and characterised by low rainfall, hot dry summers, and mild winters. Rainfall is evenly distributed between the summer and winter months, however thunderstorm activity in summer months results in slightly larger monthly averages. Evaporation exceeds rainfall in all months and averages over 3,000 mm per year. The highest mean maximum and minimum temperatures from Menzies meteorological station (No. 012052), which is located 85km to the southeast, are in January with an average 35.1°C and 19.7°C, respectively (Bureau of Meteorology, 2022). The lowest mean daily maximum and minimum temperatures occur in July (**Error! Reference source not found.**).

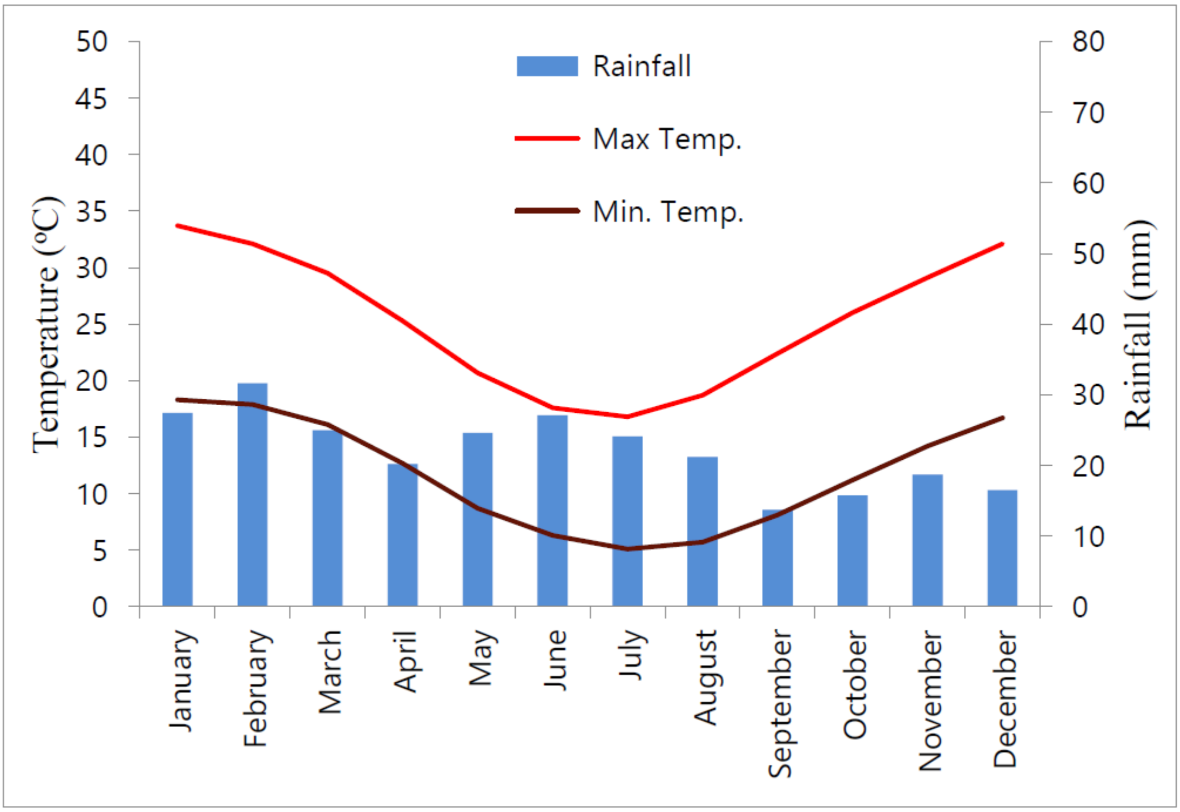


Figure 4-2: Monthly Weather for Menzies meteorological station (No. 012052). Source: BOM, 2022

4.3 Land Use

A combination of land uses with a range of different stakeholders are present in the proposed Purpose Permit Area. The principal land uses in the area involve mining and pastoral activities.

The Perrinvale and Riverina stations underly the mining tenements.

Other land uses include recreational prospecting, transport, and tourism. Numerous small and abandoned mines and open shafts are evident throughout the landscape. The proposed Purpose Permit Area has been subject to previous mining exploration and operational activity.

4.4 Conservation Reserves and Environmentally Sensitive Areas

The proposed Purpose Permit Area does not overlap with any Environmentally Sensitive Areas (ESAs). The area does contain four 'C' Class or Common Reserves (Department of Water and Environment Regulation (DWER), 2022). Common reserves are a form of tenure of Crown land, reserves tenure usually apply to land that (a) holds intrinsic community value or is of high conservation value that should be preserves and maintained for the benefit of future generations; or (b) for core business/service delivery needs of general sector State agencies and local governments (Government of Western Australia). The common reserves in the area include a waterway, historic mechanics institute and explosive magazine (Table 4-1).

In January 2023, RDM obtained consent to mine within the reserve areas (Appendix 5), this update is also reflected on the tenement conditions M29/2 and M29/165.

The nearest ESA is Lake Ballard, which is nationally important wetland located approximately 40km southeast from the proposed Purpose Permit Area. Lake Ballard is a large intermittent Salt Lake, it is usually a dry saline basin which fills approximately once every five years. When full, Lake Ballard is an important breeding ground for several water bird species most notably the endemic Banded Stilt (*Cladorhynchus leucocephalus)*, a nomadic wading bird which travels vast distances to breed in shallow saline lakes (DoEE, 2019).

Table 4-1: Reserves located within the survey area

Reserve Number	Class	Purpose	Responsible Agency
R 12922	C	Waterway	Water Corporation
R 11674	C	Waterway	Water Corporation
R 12369	C	Mechanics Institute	Department of Planning, Lands and Heritage
R 23378	C	Explosives magazine	DMIRS

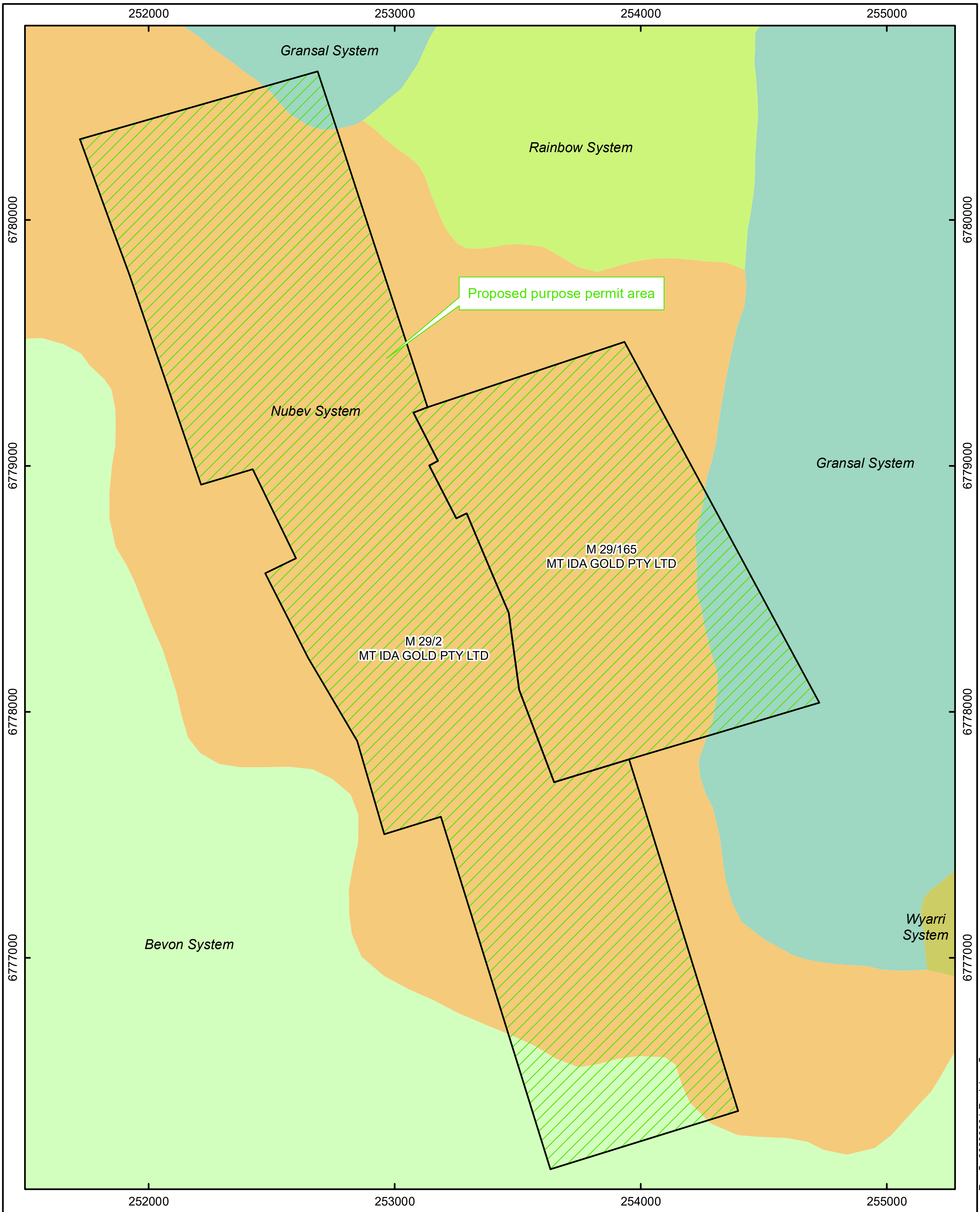
4.5 Land Systems and Soils

Land systems are defined as an area or group of areas throughout which there is a recurring pattern of topography, soils, and vegetation (Tille 2006). An assessment of land systems provides an indication of the occurrence and distribution of vegetation types (Purdie et al. 2004). The proposed

Purpose Permit Area contains the Nubev System (90.7%), the Gransal System (5.0%) and the Bevon System (4.4%) (Table 4-2; Figure 4-3).

Table 4-2: Extent of land systems within the proposed Purpose Permit Area

		Extent within the Purpose Permit Area	
Land System	**Description**	**Extent (ha)**	**Proportion (%)**
Nubev System	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands.	492.8	90.6
Gransal System	Stony plains and low rises based on granite supporting mainly halophytic low shrublands.	26.9	5.0
Bevon System	Irregular low ironstone hills with stony lower slopes supporting mulga shrublands.	23.8	4.4



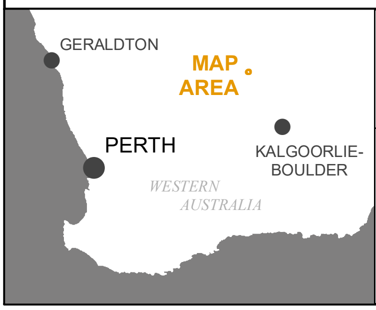


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Figure 4-3:
Land Systems of the
proposed Purpose Permit Area

0 0.25 0.5
Kilometres
GDA 1994 MGA Zone 51

Legend

Proposed purpose permit area
Mt Ida Gold mining tenement

Land systems
Bevon System
Gransal System
Nubev System
Rainbow System
Wyarri System

Scale 1: @ A4	Author: J. Webster
Date: 2/03/2023	Drawn: L. Weggelaar

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4.5.1 Soil Characteristics

A baseline soil and landform assessment for the project was completed by Mine Earth in February 2023, and is attached as Appendix 6.

The soils of the Eastern Goldfields have also been described in general terms by Beard (1978). They typically comprise sandy loams, although skeletal stony soils occur on the rocky ridges, sands occur in the dunes, and sandy clays occur in the bottomlands. Depressions throughout the Eastern Goldfields are generally saline, and large areas of alkaline soils occur where parent materials are close to the surface.

The proposed Purpose Permit Area consists of Unit BE3 and is within the Salinaland Plains Zone (Figure 4-4). The Salinaland Plains Zone is defined as broken slopes and ridges characterized by breakaways, generally on gneissic granites and allied rocks; iron-stone gravel pavement variably present: chief soils seem to be shallow earthy loams (Um5.3) with some shallow (Gn2.12) soils, both underlain by a red-brown hardpan. Associated are a variety of (Dr1) soils, such as (Dr1.32), (Dr1.42), and (Dr1.82), and (Dr1.73) on outwash areas below the breakaways. These soils are often only 6-15 in. deep; some (Um5.11) and (Gc1.12) soils on calcrete (kunkar) platforms between shallow drainage-ways on the outwash areas below the breakaways; some (Um) and (Dr2.32) soils on pediments; and much mottled- and pallid-zone material along the slope of the breakaway with some block laterite (Australian Soil Resource Information System, 2022).

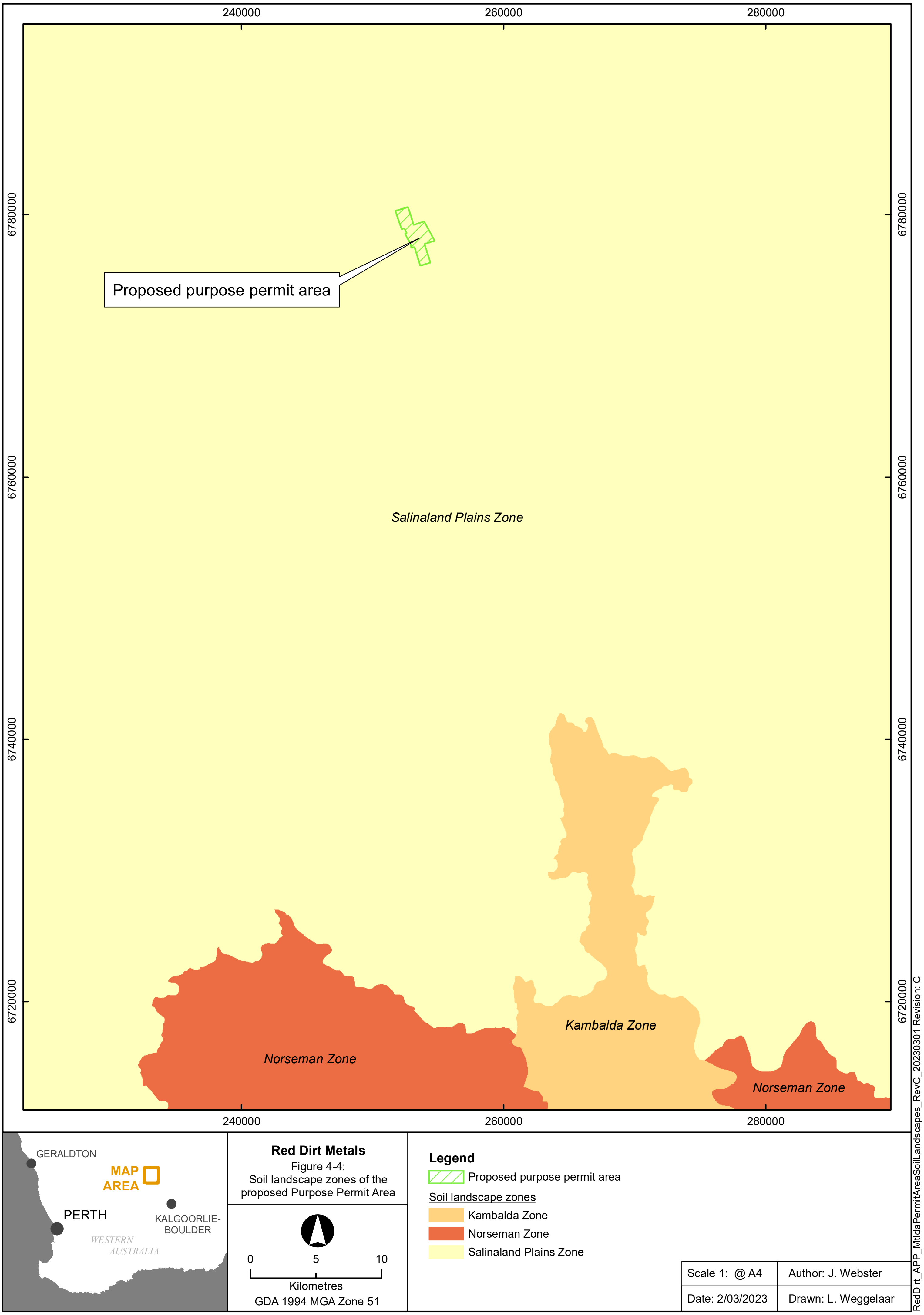


Figure 4-4: Soil landscape zones of the proposed Purpose Permit Area

4.6 Geology

4.6.1 Local Geology

The Permit Area intersects six geological units (Figure 4-5) and are described below.

The Copperfield Granite (CGR). CGR is an extensive granitoid, which forms the core to the Kurrajong Anticline.

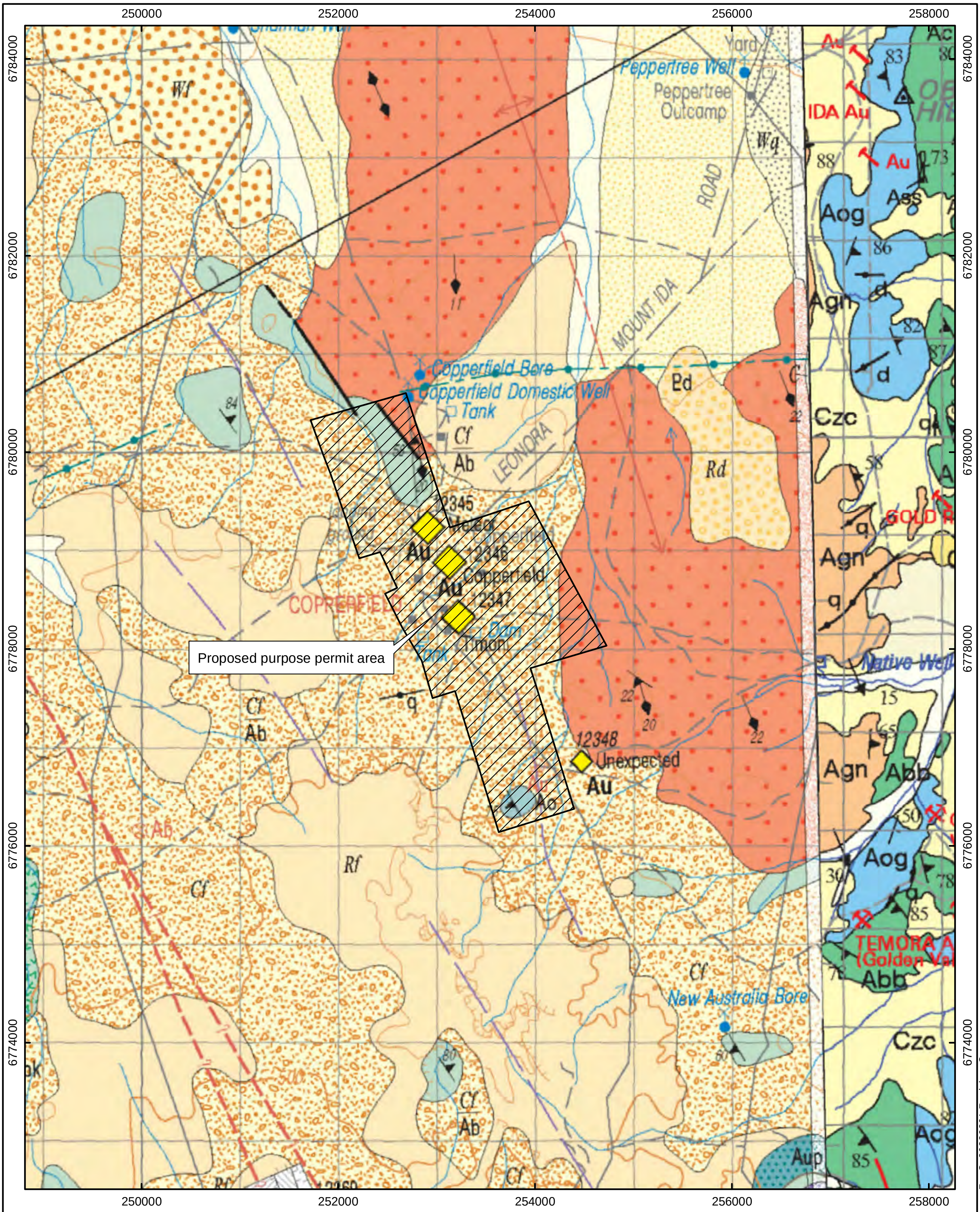
The Dick Amphibolite (DAM). A fine to medium grained amphibolite with a 'sparkly hornfels' character, akin to many mafic rocks observed in close proximity to large granitoids in the Yilgarn. Variations in colour and grainsize are observed in outcrop and on drill heaps, suggesting that DAM is a composite of at least 2 different mafic units, although this has not been tested. The unit is approximately 100m thick.

The Anorthosite (MAN). MAN is interpreted to be a single sill, with a thickness of ~300m. It consists of an anorthosite upper portion, (i.e.,>90% plagioclase, var. labradorite) to the west, and a gabbro-anorthosite lower portion (~50-80% plagioclase).

Central Amphibolite (CAM). The Central amphibolite may be equivalent to DAM, with the anorthosite intruded into it.

The Unexpected Ultramafic (UUM). The highly magnetic character of UUM means that it can be traced on aeromagnetic images over the strike length of the lease. Earlier reports suggest that UUM increases in thickness to the south, where it hosts the Unexpected Lode.

The Timoni Amphibolite (TAM). The TAM hosts the 250,000oz Timoni Lode, as well as the Federation Lode ~300m to the west. The TAM has been previously interpreted to consist of sedimentary and volcanic amphibolites.



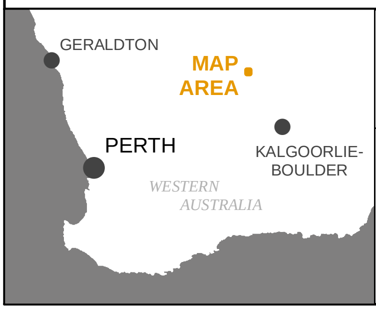


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Figure 4-5:
Local geology of the proposed Purpose Permit Area

0 0.5 1
Kilometres
GDA 1994 MGA Zone 51

Legend

Proposed purpose permit

DMIRS 100k Geological Mosaic
http://gissdi.dmp.wa.gov.au/gisexternal/services/External/Imagery_External/MapServer/WmsServer?request=GetLegendGraphic%26version=1.3.0%26format=image/png%26layer=35
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4.7 Surface Water and Hydrology

A surface water assessment titled Mt Ida Lithium Project Hydrological Assessment was completed by Advisian in February 2023.

The proposed Purpose Permit Area is located within the Lake Raeside catchment. The ground surface slopes gently to the north where a network of ephemeral creeks form. There are no permanent water courses or other surface water features in the area. A small dry watercourse trends north easterly across the proposed Purpose Permit Area. Stream flow occurs only after heavy storms or after persistent low intensity rainfall.

Surface drainage is generally contained in the local creek systems, which eventually flow in years of high rainfall to the salt lakes of Lake Raeside to the north-east and Lake Ballard to the south-east. These lakes are located approximately 40km from the proposed Purpose Permit Area and due to distance and infiltration only the high rainfall events and years reach the regional lakes. Disturbance in the proposed Purpose Permit Area is unlikely to have significant impact on the regional drainage systems.

4.8 Hydrogeology

A baseline groundwater assessment titled *Hydrogeological Study and Water Supply Options Analysis* was completed for the Project by Advisian in August 2022.

The proposed Purpose Permit Area is located within an area underlain by weathered and fractured Archaean basement (Yilgarn Craton) which comprises granitoid and greenstone rocks. They are overlain by alluvium, colluvium, calcrete, lake deposits and paleochannel deposits.

Regional groundwater primarily occurs in the top part of the weather profile which is typically less than 40 m thick. The regolith regime mapping, as proxy of the weathering profile, comprises exposed bedrock (basement outcrops), residual units (e.g., lateritic cap on top of saprolite profile) and unconsolidated Tertiary and Quaternary sediments (alluvial, eolian, colluvial, lacustrine) which also include significant Tertiary paleochannel fill. Fresh basement rock contains minor groundwater in fractures, the occurrence of which generally reduces with depth.

Groundwater flow directions are inferred to follow topographic trends in the area i.e., from elevated areas to low-lying areas. The main aquifer system, the basal paleochannel sand drains the Archaean basement. The groundwater in paleochannel flows eastwards in the Raeside paleochannel, however flow gradients are considered to be low.

5 ENVIRONMENTAL VALUES

This section contains information about the environmental characteristics of the proposed Purpose Permit Area, specifically relating to flora, vegetation, and terrestrial fauna values, that may be relevant to this NVCP application. The assessment against the ten clearing principles has also taken into regard the geological, soil characteristics, and hydrogeology to inform the impact predictions.

5.1 Flora

5.1.1 Survey Objective, Area, and Timing

A reconnaissance flora survey was conducted by Native Vegetation Solutions (NVS) in May 2022. The survey area was 617.4 ha which encompassed and extended beyond the proposed Purpose Permit Area (Figure 5-1). The objective of the survey was to understand the flora and vegetation values of the survey area, including a literature review and a search of the relevant databases, characterising the flora, delineating vegetation units, and providing an assessment of the significance of the flora and vegetation.

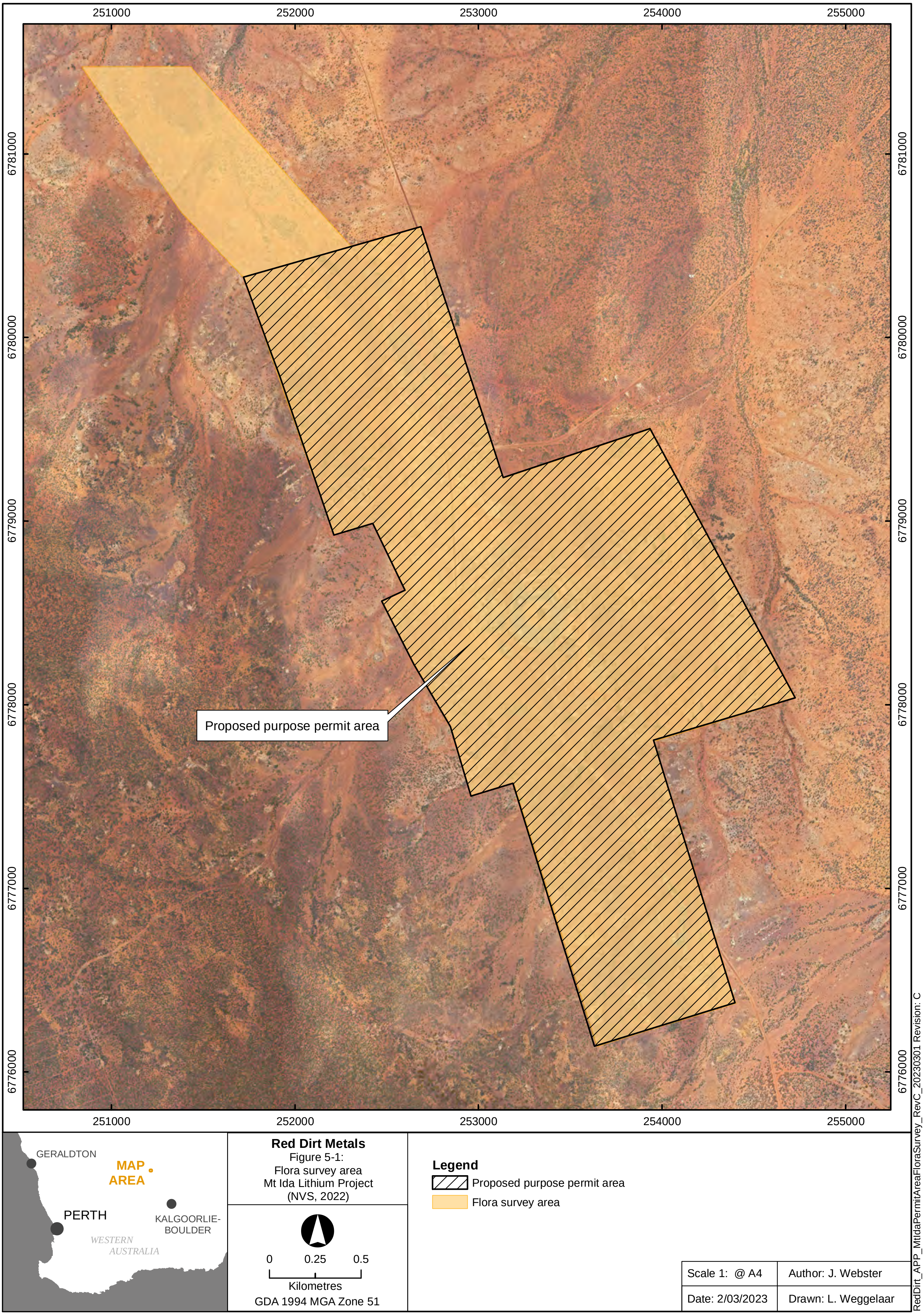
5.1.2 Flora of Significance

No Priority Flora or Threatened Flora were recorded in the survey area.

The Department of Biodiversity, Conservation and Attractions (DBCA) database searches revealed no Threatened and four Priority Flora species to occur within a 10km radius of the Survey area (Figure 5-2). The closest Priority Flora was located approximately 180 metres west of the survey area.

5.1.3 Introduced Flora

Seven weed species was recorded within the survey area, *Sonchus oleraceus* (Common Sowthistle), *Salvia verbenaca* (Wild Sage), *Lysimachia arvensis* (Pimpernel), *Carthamus lanatus* (Saffron Thistle), *Oncosiphon suffruticosum* (Calomba Daisy), *Cylindropuntia imbricata* (Devil's Rope) and *Opuntia stricta* (Common Prickly Pear). Two of these species are considered Declared Pests (DPIRD, 2022); Devil's Rope and Common Prickly Pear. Both species are classified as s22(2), under the BAM Act 2007, with a C3 Management requirement that states some form of management activities should be applied to alleviate the harmful impact of the organism, reduce the numbers or distribution or prevent/contain the spread of the organism.



Red Dirt Metals
Figure 5-1:
Flora survey area
Mt Ida Lithium Project
(NVS, 2022)

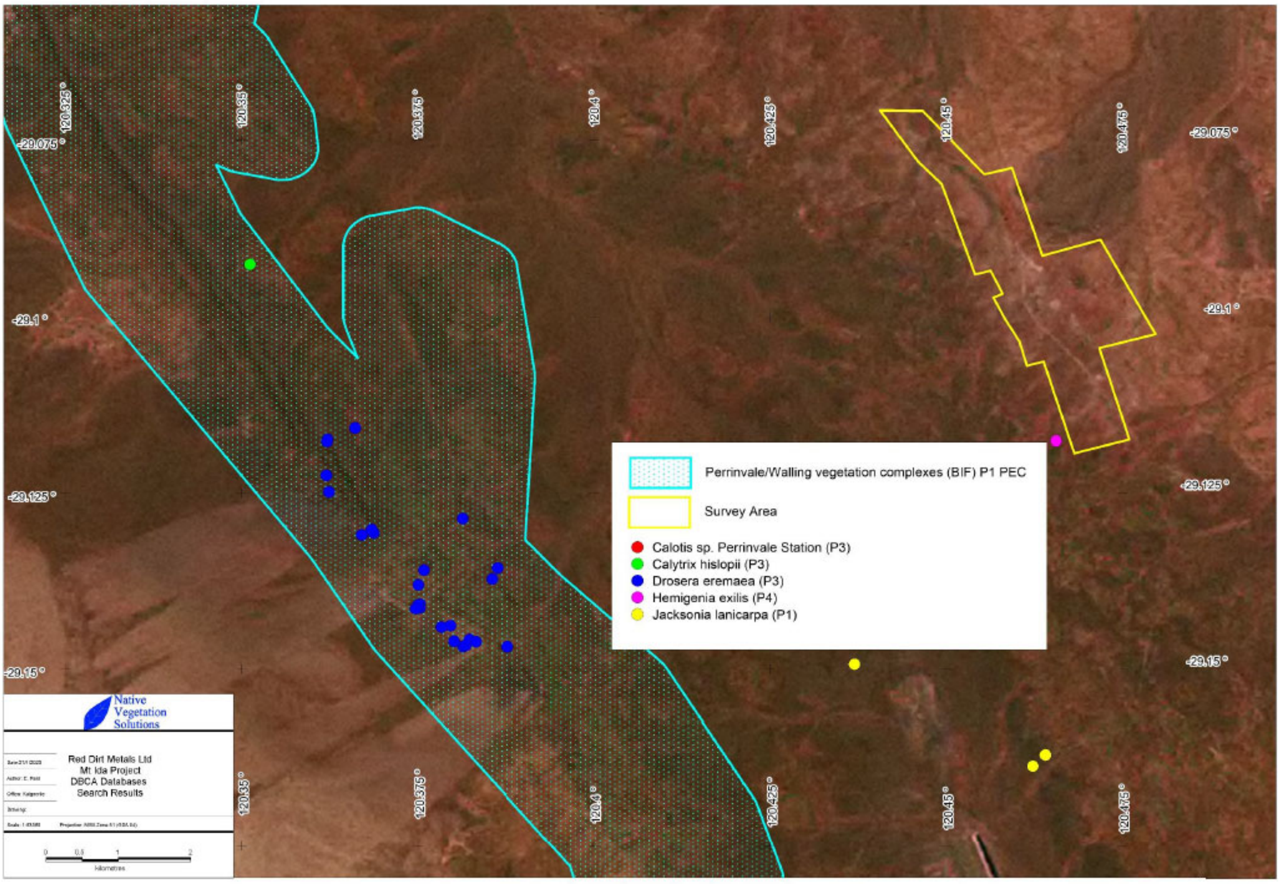


Figure 5-2: DBCA Threatened Flora Database Search Results (Source: NVS, 2022)

5.2 Vegetation

5.2.1 Vegetation Types

A total of 25 Families, 48 Genera and 87 Species were recorded within the survey area. Eight major vegetation groups were recorded in the survey area (

Figure 5-3). All vegetation types are common, widespread, and well represented in the Eastern Murchison subregion (NVS, 2022).

Table 5-1: Vegetation Group Summary (NVS, 2022)

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total within indicative disturbance footprint (ha)	Representative Photograph
A	Mulga over *Maireana sedifolia* and sclerophyll shrubland	168.6	27.3	155.1	72.0	
B	Creekline Vegetation	64.2	10.4	55.7	30.9	

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total within indicative disturbance footprint (ha)	Representative Photograph
C	Mulga Woodland	66.6	10.8	57.7	32.4	
D	Open chenopod shrubland with occasional Mulga overstory	207.6	33.6	183.7	65.6	

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total within indicative disturbance footprint (ha)	Representative Photograph
E	Acacia burkitti shrubland	26.32	4.26	18.8	0.3	
F	*Hakea preissii* over open chenopod shrubland	15.8	2.6	6.4	0.3	

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total within indicative disturbance footprint (ha)	Representative Photograph
G	*Acacia quadrimarginea* over *Eremophila platycalyx* and Senna shrubland over laterite hills	5.2	0.8	5.2	2.2	
H	Mulga over Ironstone outcrops	2.0	0.3	2.0	0.0	

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total within indicative disturbance footprint (ha)	Representative Photograph
N/A	Existing Disturbance	61.5	10.0	59.8	42.2	
TOTAL		617.8	100%	**544**	**245.9**	

5.2.2 Vegetation of Significance

There was no vegetation of significance mapped within, or adjacent to, the proposed Purpose Permit Area and no vegetation types were analogous to any known Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs). The Perrinvale/Walling vegetation complexes PEC, listed as P1 under the Western Australian Biodiversity Conservation Act 2016 (BC Act), is located approximately 6 km west from the proposed Purpose Permit Area (Figure 5-2) and will not be impacted by this proposal.

5.2.3 Vegetation Condition

Vegetation condition in the survey area ranged from 'Completely Degraded' to 'Very Good' condition (Figure 5-4). Evidence of extensive historic exploration and mining activities (by others) as well as a number of access roads and gazetted roads were identified throughout the survey area.

Overall, most of the survey area was classified as 'Good.' Areas which were affected by historic exploration and mining were deemed to be in 'Degraded' condition.

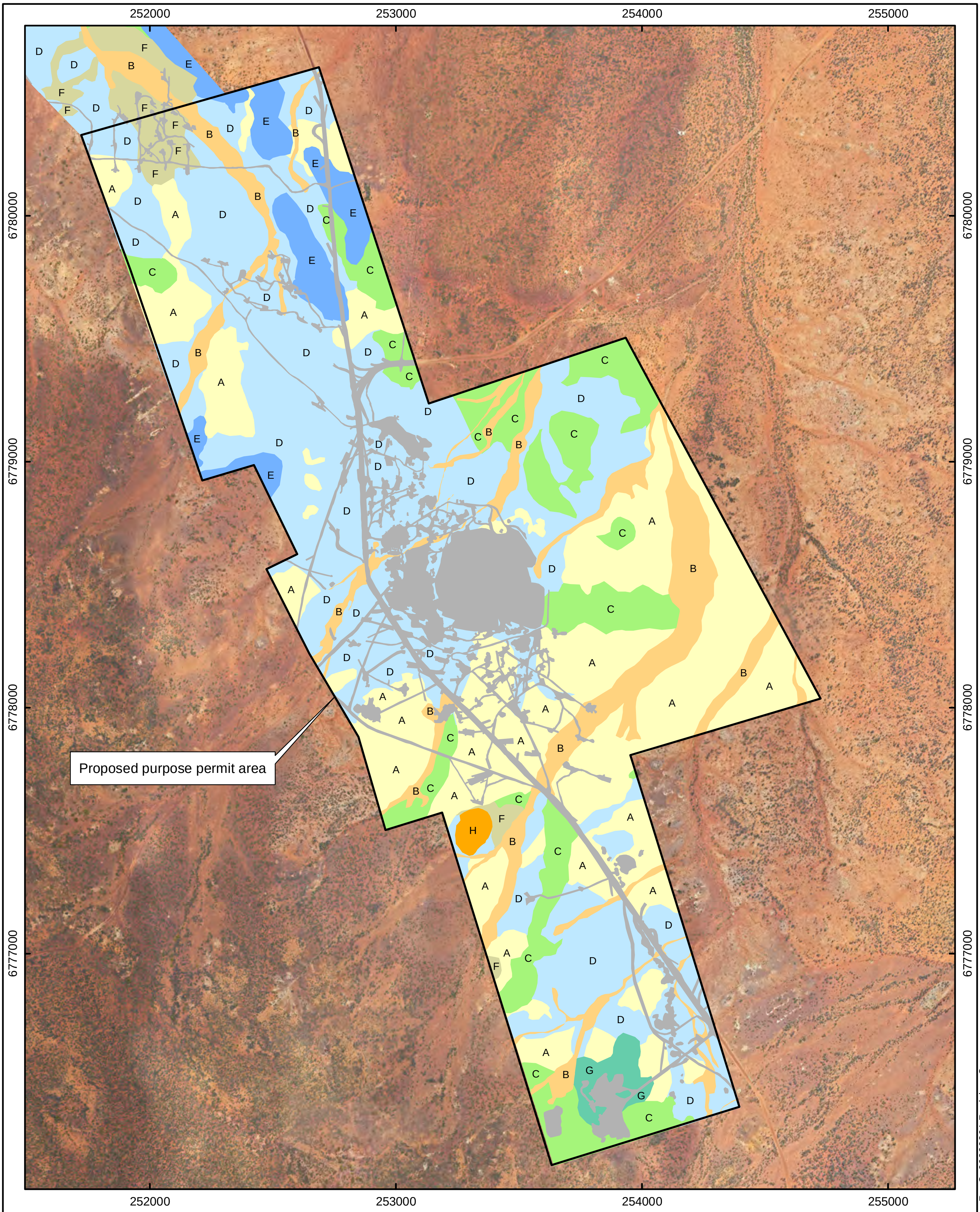
5.2.4 Pre-European Vegetation

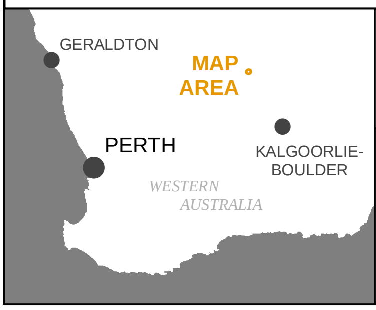
The proposed Purpose Permit Area is situated within two vegetation units defined by Beard (1990). The vegetation units identify the pre-European extent of vegetation. The national objectives and targets for biodiversity conservation recognise that the retention of 30% of more of the pre-clearing extent of Beard's vegetation associations is necessary for biological diversity. The extent of the two Beard vegetation units within the survey area is less than 1% of the total area for each scale, with the exception of Beard Association 39 at the Shire scale, which cover 1.27% of the total area (Table 5-2). The development of the project will not trigger any national objectives for biodiversity conservation.

The implementation of this proposal will not have a detrimental effect on Pre-European vegetation associations.

Table 5-2: Extent of Beard Associations within survey area

Beard Vegetation Association	Description	Extent (ha)	Proportion of Survey Area (%)	Scale			
				WA extent	By IBRA Region (MUR)	By IBRA Sub-region (MUR1)	By Shire (Menzies)
39	Shrublands; mulga scrub.	587.6	95.1	<1%	<1%	<1%	1.27%
18	Low woodland; mulga (Acacia aneura).	30.1	4.9	<1%	<1%	<1%	<1%





Red Dirt Metals

Figure 5-3:
Vegetation Groups relevant to the proposed Purpose Permit Area (NVS, 2022)

0 0.25 0.5
Kilometres
GDA 1994 MGA Zone 51

Legend

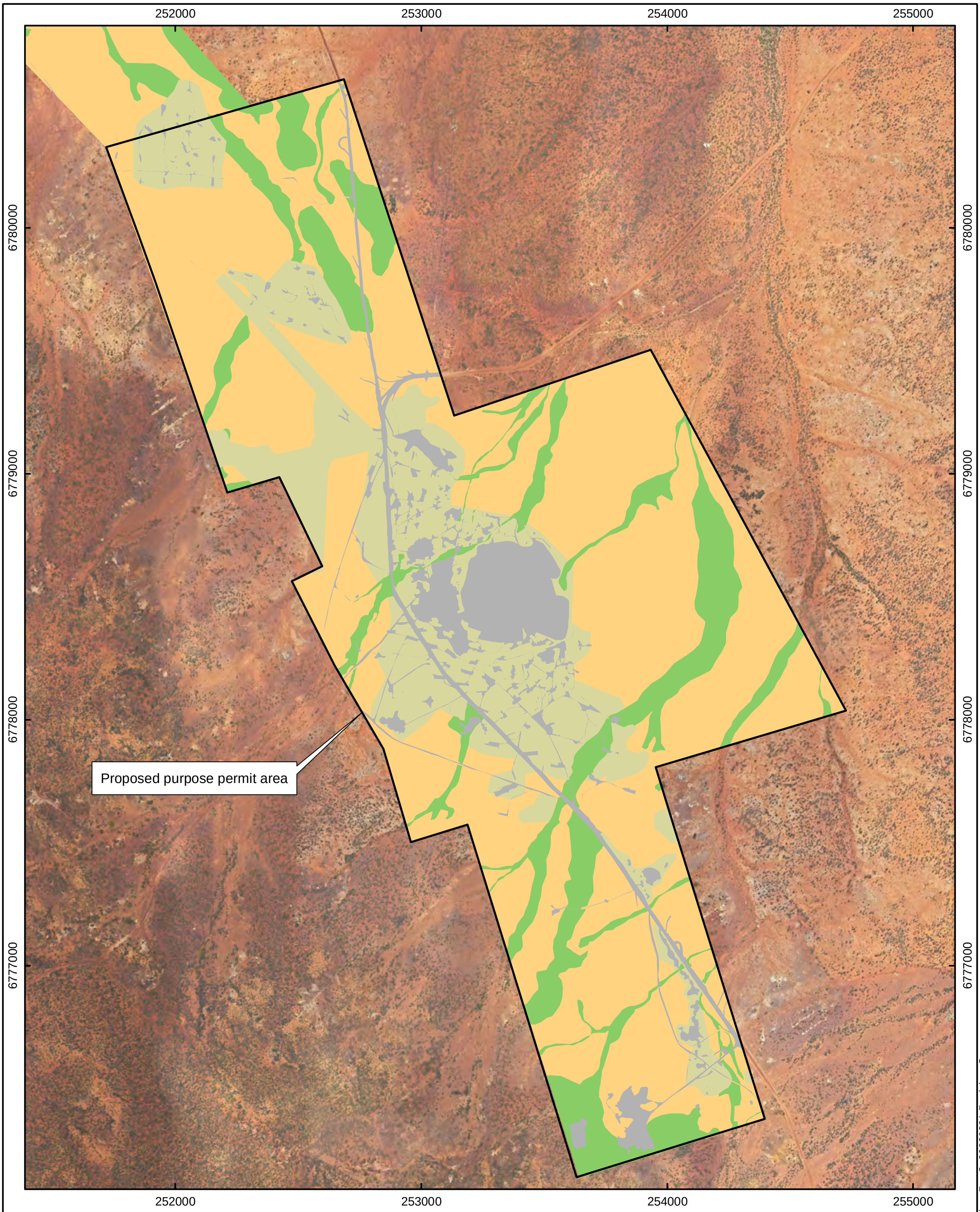
Proposed purpose permit area

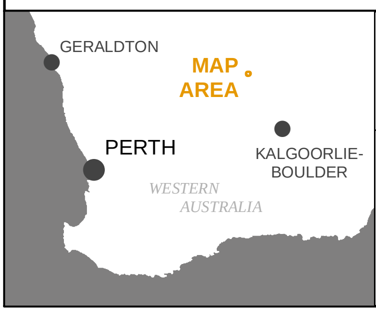
Vegetation groups

- A
- B
- C
- D
- E
- F
- G
- H
- Existing disturbance

Scale 1: @ A4	Author: J. Webster
Date: 2/03/2023	Drawn: L. Weggelaar

RedDirt_APP_MtIdaPermitAreaVegGroups_RevC_20230301 Revision: C





Red Dirt Metals

Figure 5-4:
Vegetation Condition of the proposed Purpose Permit Area (NVS, 2022)

0 0.25 0.5
Kilometres
GDA 1994 MGA Zone 51

Legend

Proposed purpose permit area

Vegetation condition

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

Scale 1: @ A4	Author: J. Webster
Date: 2/03/2023	Drawn: L. Weggelaar

RedDirt_APP_MtIdaPermitAreaVegCondition_RevC_20230301 Revision: C

5.3 Terrestrial Fauna

A *Vertebrate Fauna Reconnaissance survey and risk assessment* was undertaken in August 2022 by Terrestrial Ecosystems. The survey area was 617.7 ha which encompassed and extended beyond the proposed Purpose Permit Area.

5.3.1 Survey Objective and Methods

The objective of the survey was to undertake a basic fauna risk assessment and a search of the Project for Malleefowl (*Leipoa ocellata*) and their mounds. The purpose of the fauna risk assessment was to determine the potential impacts of disturbance activities on the vertebrate fauna assemblage in the proposed Purpose Permit Area.

The assessment involved a search of online databases including *the Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to identify species potentially occurring in the area and a survey to search for Malleefowl and their mounds and to identify available fauna habitat types.

5.3.2 Fauna Habitats

One broad fauna habitat was identified from fauna habitat assessments within the proposed Purpose Permit Area (Figure 5-5). This habitat was described as mixed mulga, acacia, and chenopod shrubland. The density of trees and shrubs varies across the area with denser vegetation evident along drainage lines. Disturbed areas are largely devoid of terrestrial vertebrate fauna.

5.3.3 Fauna Assemblage

Fauna survey data provided by Cowan and How (2004), and Dell and How (1988) provide an indication of the vertebrate fauna assemblage for the proposed Purpose Permit Area. Due to sparse vegetation, there is very little leaf litter on the ground indicating a limited vertebrate fauna assemblage with few individuals being present.

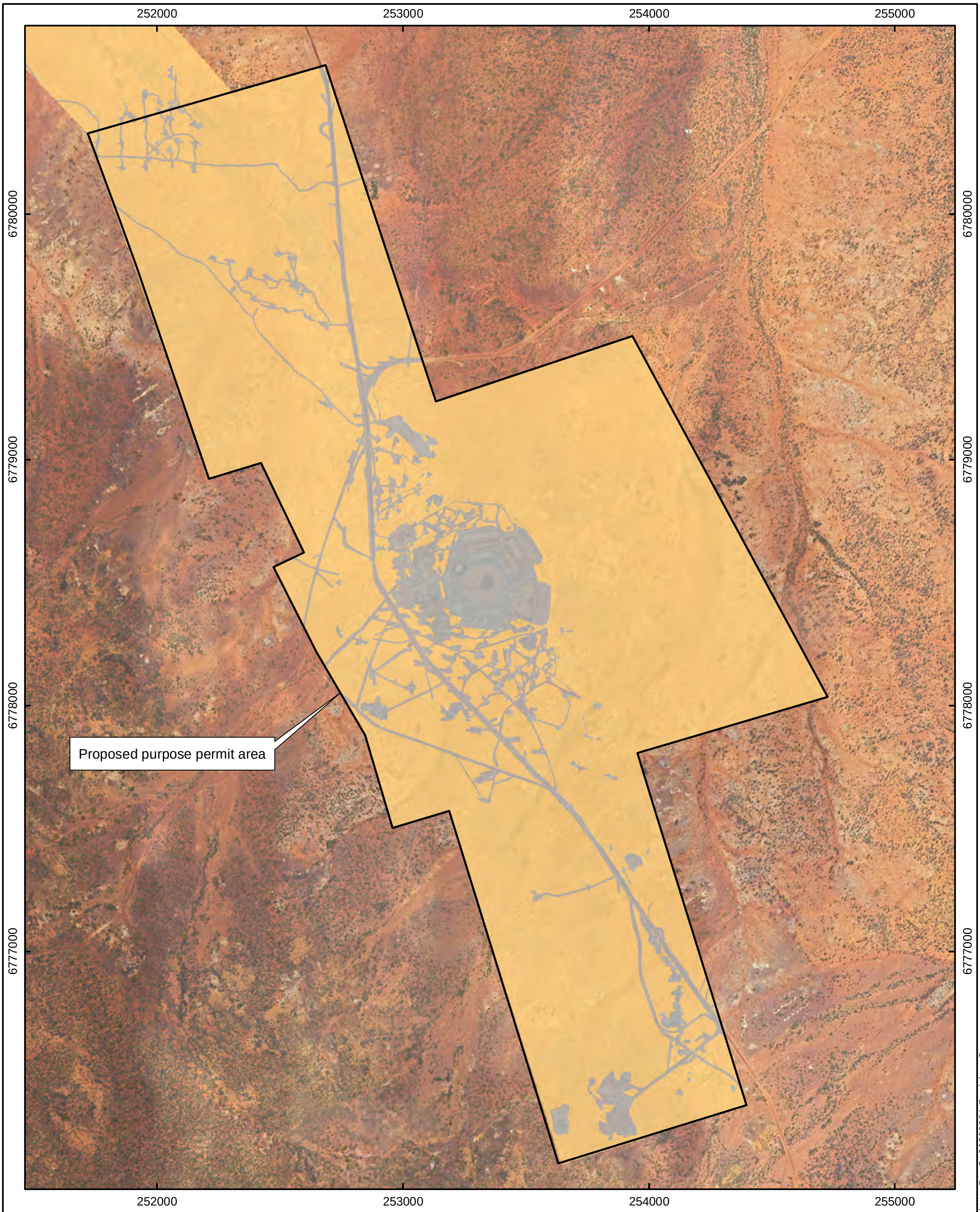
5.3.4 Fauna of Significance

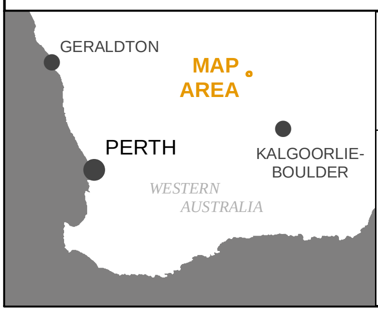
Conservation significant species identified in the database searches are outlined in Table 5-3 below.

No threatened species of fauna were identified from the survey effort.

Table 5-3: Conservation species recorded in database searches (Terrestrial Ecosystems, 2022)

Species	DBCA Schedule/ Priority	Status under Commonwealth EPBC Act	Likelihood to occur in the proposed Purpose Permit Area
Night Parrot (Pezoporus occidentalis)	Critically Endangered	Endangered	Highly unlikely to occur in the proposed Purpose Permit Area
Sandhill Dunnart (Sminthopsis psammophila)	Endangered	Endangered	Highly unlikely to occur in the proposed Purpose Permit Area
Malleefowl (Leipoa ocellata)	Vulnerable	Vulnerable	Highly unlikely to occur in the proposed Purpose Permit Area
Chuditch (Dasyurus geoffroii)	Vulnerable	Vulnerable	Highly unlikely to occur in the proposed Purpose Permit Area
Grey Falcon (Falco hypoleucos)	Vulnerable	Vulnerable	Highly unlikely to occur in the proposed Purpose Permit Area
Princess Parrott (Polytelis alexandrae)	Vulnerable	Vulnerable	May infrequently be seen in the proposed Purpose Permit Area
Fork-tailed Swift (Apus pacificus)	Migratory	Migratory	May infrequently be seen in the proposed Purpose Permit Area
Grey Wagtail (Motacilla cinerea)	Migratory	Migratory	Highly unlikely to occur in the proposed Purpose Permit Area
Peregrine Falcon (Falco peregrinus)	Other	-	May infrequently be seen in the proposed Purpose Permit Area
Woma (Aspidites ramsayi)	Priority 1	-	Highly unlikely to occur in the proposed Purpose Permit Area
Mulgara (Dasycercus blythi)	Priority 4	Vulnerable	Highly unlikely to occur in the proposed Purpose Permit Area
Central Long-eared Bat (*Nyctophilus* major tor)	Priority 3	-	Highly unlikely to occur in the proposed Purpose Permit Area





Red Dirt Metals

Figure 5-5:
Fauna habitat types within the proposed Purpose Permit Area

0 0.25 0.5
Kilometres
GDA 1994 MGA Zone 51

Legend

Proposed purpose permit area

Fauna habitat

Disturbed

Mixed mulga, acacia and chenopod shrubland

Scale 1: @ A4	Author: J. Webster
Date: 2/03/2023	Drawn: L. Weggelaar

RedDirt_APP_MtIdaPermitAreaFaunaHabitats_RevC_20230301 Revision: C

6 ENVIRONMENTAL MANAGEMENT MEASURES AND REHABILITATION

6.1 Approved Policies and Planning Instruments

The clearing of native vegetation in Western Australia is regulated under Part V of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. In addition to the matters required to be considered in accordance with s. 51O of the EP Act, MIG has also had regard for the below statutes, polices and guidelines:

- Environmental Protection Act 1986 (WA) (EP Act)
- Biodiversity Conservation Act 2016 (WA) (BC Act)
- Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)
- Soil and Land Conservation Act 1945
- Rights in Water and Irrigation Act 1914
- Aboriginal Heritage Act 1972
- Aboriginal Cultural Heritage Act 2021
- WA Environmental Offsets Policy (Government of Western Australia 2011)
- A guide to the assessment of applications to clear native vegetation: Under Part V Division 2 of the *Environmental Protection Act 1986* (Department of Environmental Regulation 2014)
- Procedure: Native vegetation clearing permits (Department of Water and Environmental Regulation 2021)
- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (Environmental Protection Authority 2016)
- Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (Environmental Protection Authority 2020b).

6.2 Management Measures – Avoidance

MIG is committed to appropriately managing its activities and ensuring any potential impacts to the environment are avoided where possible. Clearing has been minimised by utilising existing disturbed area. Where practical, existing disturbed areas will be utilised for haul/access roads and associated infrastructure to minimise clearing requirements.

In addition, MIG are committed to undertaking all compliance monitoring and reporting stipulated by applicable laws and regulations, and the operation will require all employees to exercise appropriate environmental practices. Environmental management includes:

- identifying risk and hazards
- operational environmental management plans
- training and competencies
- monitoring programs
- auditing and inspections
- incident investigation
- reporting requirements.

6.3 Management Measures – Minimisation

6.3.1 Land Clearing and Flora Management

MIG will ensure all clearing and ground disturbance is carried out in accordance with their Ground Disturbance Procedure. The following actions will be implemented to minimise and manage land disturbance impacts:

- Prior to clearing, an internal Surface Disturbance Permit (SDP) will be completed and signed off by the relevant Environment Department.
- The disturbance permit will identify any conditions that apply to the clearing area (including any protected areas / species to be avoided where practicable).
- The clearing area will be delineated on foot and marked with survey pegs and flagging tape to ensure only the surveyed area is cleared.
- Clearing will not be undertaken until construction / mining is imminent, minimising erosion and dust risks.
- Environmental awareness training will be completed by personnel involved in clearing activities (including identification of flora and fauna of conservation significance).
- A spotter will be used during clearing of external boundaries to ensure clearing remains within approval boundaries.
- Fire management practices will be implemented.
- No burning of vegetation spoil will occur on site.
- All cleared vegetation will be stockpiled for later use in rehabilitation activities.

6.3.2 Weed Management

MIG will aim to prevent the introduction and spread of weeds in the proposed Purpose Permit Area as far as practicable. The following management measures will be implemented to minimise the risk of introducing flora into the proposed Purpose Permit Area:

- Weed, Seed and Hygiene Certificates will be presented as verification prior to mobilisation.

- All vehicles and equipment will be cleaned before mobilisation to the proposed Purpose Permit Area, to remove all dirt and vegetative materials.
- Vehicle and equipment washdown will only occur at an appropriate facility.
- Off-road vehicle use will be strictly controlled with no driving permitted off designated roads.
- Any new weed outbreaks will be recorded in the MIG's Incident Reporting system and managed in accordance with site environmental procedures.
- Any vehicles that may have traversed weed impact areas will be cleaned prior to leaving site.

6.4 Fauna Management

MIG will aim to ensure fauna species are not adversely affected by clearing, including both by direct impacts and impacts to habitat. The following management measures will be implemented to minimise the potential impacts on fauna:

- Pre-clearance surveys within the specified clearing areas will be undertaken in the morning of clearing to search for the presence of significant fauna species.
- No clearing at night will occur to avoid impacting nocturnal species.
- Awareness training will outline the appropriate behaviour and responses in the event of contact with native fauna.
- Native fauna will not be captured, fed, harmed, or disturbed. If relocation is required, site environmental department will be contacted.
- All significant fauna deaths will be reported through the company incident reporting system.
- An SDP will be required for all clearing.
- Open excavations will be monitored regularly to ensure that any trapped fauna is rescued and released as quickly as possible.
- Water holding infrastructure, including any turkey's nests, will have fauna egress matting installed.
- Rehabilitation will be conducted progressively where possible.
- No pets or other animals will be brought to the project site.
- All bores and drill holes will be capped.

6.4.1 Dust Management

MIG will aim to minimise fugitive dust emissions and other air quality issues created during Project construction and operation by:

- Using water to suppress dust emission from unsealed roads, stockpiles and work areas as required.

- Ensure that any saline water used is only sprayed within the haul roads and cleared infrastructure footprints, dribble bars will be used where required.
- Implement water truck operating procedures and train water cart operators so that personnel are aware of the potential impacts of saline water on vegetation.

- Reducing vehicle speeds as appropriate if dust emission from roads is visually excessive.
- Where possible, operational activities will be scheduled to avoid high winds that may generate excessive dust.
- Report and respond to any community complaints regarding dust emissions that are deemed excessive as an incident.

6.4.2 Soil and Topsoil Management

Topsoil is an important resource for rehabilitation of disturbed sites, which need to be managed effectively. Incorrect management of topsoil can impact upon the soil structure and decrease its usefulness in rehabilitation. Topsoil will be managed by:

- Stockpiling vegetation, topsoil, and subsoil as per the SDP.
- Stripping topsoil to the required depth (average salvage depth of 0.2m).
- Not using topsoil for construction of windrows bulk fill or in surface water management.
- Not using saline water for dust suppression during topsoil / subsoil harvesting or rehandling.
- Not storing materials or equipment on topsoil stockpiles.
- Marking out stockpile locations on maps and recording them in a GIS database, along with volumes.
- Implement weed, seed, and hygiene requirements.

6.4.3 Water Management

The proposed Purpose Permit Area is not located within any major drainage lines or watercourses; therefore, clearing is not expected to impact surface water flow. Additionally, the proposed clearing is not located in proximity to any public drinking water source areas. Surface water management measures will be implemented if required to divert surface water flow from mining infrastructure. MIG will aim to minimise impacts on the quality of surface water and will avoid unnecessary disturbance to natural surface drainage. General recommendations for surface water management that will be considered for all mine infrastructure areas include:

- Implement erosion and sediment management measures where there is a risk of:
  - discharge of runoff from the mine occurring to downstream environments; and/or
  - discharge of sediment laden runoff.

- Installation of culverts and road drainage options where there are risks of modification to downstream flow, particularly for linear infrastructure developments.
- Construction and / or maintenance of roadside drainage so that runoff from the haul road will be contained during rainfall events.

Clearing is unlikely to impact on groundwater quality provided that groundwater contamination from the use of hydrocarbons and chemicals will be actively managed as detailed in Section 6.4.4.

6.4.4 Hydrocarbon Management

MIG will actively manage the storage and use of hydrocarbon in machinery and vehicles to minimise and contain spills and uncontrolled releases to prevent impacts to vegetation, soil and/or water. Increased vehicle activity during construction and operation may result in hydrocarbon spills; however, MIG aims to minimise such occurrences by ensuring that:

- Hazardous materials are approved prior to site entry.
- Hydrocarbons and chemicals are safely stored.
- Hydrocarbons and other hazardous wastes are collected, treated, transported, and disposed of in an environmentally sound manner, in accordance with regulatory and legislative requirements.
- Effective spill clean-up material is readily available at each work site and on all mobile service trucks or vehicles, and where hydrocarbons and chemicals are stored, dispensed and / or used.

6.5 Management Measures – Rehabilitation

A Mining Proposal is being prepared for the Project and mine closure activities will be captured in the Mine Closure Plan (MCP) submitted with the Mining Proposal. All clearing activities outlined in this NVCP will be addressed in the MCP. Rehabilitation of the Project will be conducted at the end of the project life including legacy mining activities. Progressive rehabilitation will occur during the life of the Project. Ongoing monitoring will be implemented during, and post, the life of the Project to ensure legal obligations and closure objectives are met. Rehabilitation activities will aim to meet post closure land use objectives. MIG will:

- Continue to consult with key stakeholders throughout the life of the Project and at closure.
- Ensure the rehabilitated land surfaces are safe and stable.
- Undertake rehabilitation tasks detailed in the MCP.

7 ASSESSMENT AGAINST THE 10 CLEARING PRINCIPLES

7.1 Scale of the Proposed Clearing

The proposed Purpose Permit Area covers an area of 544 ha of native vegetation of which 86 ha (16%) is in 'Good to Very Good' condition; 302ha (56%) is in 'Good' condition; 94 ha (17.4%) is in 'Degraded' condition; and 60 ha (11%) is in 'Completely Degraded' condition (NVS, 2022)(Table 7-1). NVS (2023) identified eight (8) vegetation units that would occur within the permit area. Indicative disturbance is provided in Table 7-2.

Table 7-1: Vegetation condition and habitats which will be cleared within the proposed Purpose Permit Area

Vegetation Condition	Extent (ha)	Proportion of proposed Purpose Permit Area (%)
Good to Very Good	86	16
Good	302	56
Degraded	94	17
Completely Degraded	60	11

Table 7-2: Vegetation units within the proposed Purpose Permit Area and indicative disturbance

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total indicative disturbance (ha)
A	Mulga over *Maireana sedifolia* and sclerophyll shrubland	168.6	27.3	155.1	72.0
B	Creekline Vegetation	64.2	10.4	55.7	30.9
C	Mulga Woodland	66.6	10.8	57.7	32.4
D	Open chenopod shrubland with occasional Mulga overstory	207.6	33.6	183.7	65.6
E	Acacia burkitti shrubland	26.32	4.26	18.8	0.3
F	*Hakea preissii* over open chenopod shrubland	15.8	2.6	6.4	0.3
G	*Acacia quadrimarginea* over *Eremophila platycalyx* and Senna shrubland over laterite hills	5.2	0.8	5.2	2.2

Veg ID	Vegetation Group	Total Survey Extent (ha)	Proportion of Survey Area (%)	Total within permit area (ha)	Total indicative disturbance (ha)
H	Mulga over Ironstone outcrops	2.0	0.3	2.0	0.0
N/A	Existing Disturbance	61.5	10.0	59.8	42.2
TOTAL		617.8	100%	**544**	**245.9**

7.2 Assessment Against the 10 Clearing Principles

The proposed clearing works were assessed against the 10 clearing principles for native vegetation as listed in *Schedule 5 of the EP Act* (Table 7-3). The 10 clearing principles stipulate when native vegetation should not be cleared. The proposal to clear native vegetation for MIG's Mt Ida Lithium Project is considered in terms of these principles, in accordance with Department of Environmental Regulation (2014) (now Department of Water and Environment Regulation) assessment guidelines. As detailed design has progressed, an Indicative Footprint has been delineated to accommodate the mining infrastructure and is 246 ha within the 544 ha Purpose Permit Area. Clearing will not extend beyond the proposed Purpose Permit Area and MIG commits to avoiding and minimising impacts to significant flora as far as practicable. The following sections address each of the 10 clearing principles as specified in *Schedule 5 of the EP Act*. These assessments have been made using information obtained from existing surveys and reports commissioned by MIG.

Table 7-3: Assessment against the 10 clearing principles of clearing native vegetation within the proposed Purpose Permit Area.

Clearing Principle	Justification of Variance	Variance
Principle (a) Native vegetation should not be cleared if it compromises a high level of biological diversity.	The proposed Purpose Permit Area is 544 ha in area, of which 483 ha (89%) contains remnant vegetation. No Priority or Threatened flora species were recorded during the NVS (2022) reconnaissance survey. No PECs or TECs are known to occur within the proposed Purpose Permit Area. One PEC, the Perrinvale/Walling vegetation complexes, listed as P1 under the BC Act, is located more than 6km away from the proposed Purpose Permit Area and not be impacted by DSO Operations. No significant fauna was recorded within the proposed Purpose Permit Area. One broad fauna habitat was identified from fauna habitat assessments with the proposed Purpose Permit Area and is described as mixed mulga, acacia, and chenopod shrubland. Overall, it is considered that the fauna habitat, biological diversity and occurrence of significant species within, and adjacent to, the proposed Purpose Permit Area is widespread throughout the surrounding region and not considered restricted to the area of proposed clearing.	Unlikely to be at variance.
Principle (b) Native vegetation should not be cleared if it compromises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	The proposed Purpose Permit Area contains one broad habitat: mixed mulga, acacia, and chenopod shrubland. More than 200 species of vertebrate fauna were identified as part of the Desktop Assessment including seven conservation significant species. Of the conservation significant species, three were identified as infrequently occurring in the proposed Purpose Permit Area, comprising the Princess Parrott (*Polytelis alexandrae*), Fork-tailed Swift (*Apus pacificus*) and Peregrine Falcon (*Falco peregrinus*). The remaining species were considered as Highly Unlikely to occur based on unsuitable habitat as well as the proposed Purpose Permit Area occurring outside the known species range. It is unlikely that significant fauna and their habitats are restricted to within the proposed Purpose Permit Area; therefore, clearing of native vegetation is unlikely to fragment, restrict or isolate any populations of significant fauna species.	Unlikely to be at variance.
Principle (c) Native vegetation should not be cleared if it includes or is necessary for the continued existence of rare flora.	No significant flora was recorded within the proposed Purpose Permit Area or were considered to have the potential to occur. Two individual BC-Act listed *Hermigenia exilis* (P4) was recorded adjacent to the proposed Purpose Permit Area. This species was not detected during the recent surveys conducted by NVS (2022). Therefore, it is considered unlikely that *Hermigenia exilis* is not found to be within the proposed Purpose Permit Area.	Not at Variance

<table>
<tr><th>Clearing Principle</th><th>Justification of Variance</th><th>Variance</th></tr>
<tr><td>Principle (d)
Native vegetation should not be cleared if it compromises the whole or a part of or is necessary for the maintenance of a Threatened ecological community</td><td>No TECs were found to have buffers that overlap the proposed Purpose Permit Area.</td><td>Not at Variance</td></tr>
<tr><td>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.</td><td>The proposed Purpose Permit Are is situated within two vegetation associations being vegetation association 39 (Shrublands; mulga scrub) and vegetation association 18 (Low woodland; mulga (Acacia aneura)).
The significance of clearing a particular vegetation association can be determine by comparing current and pre-European extents (Table 7-4). Vegetation associations retaining less than 30% of their pre-European extent generally experience accelerated species loss at an ecosystem level and are regarded as being ‘vulnerable’, while vegetation types retaining less than 10% of their original extent are regarded as being ‘endangered’. The current extent of the vegetation associations is above the 30% threshold across all three scales of assessment (bioregion, subregion, LGA). In addition, given the small are of the proposed purpose Permit Area, it is unlikely that additional clearing will significantly reduce the overall extends.

Table 7-4: pre-European extent of vegetation associations in the proposed Purpose Permit Area
<table>
<tr><th>Beard Vegetation Association</th><th>Scale</th><th>Pre-European Extent (ha)</th><th>Pre-European Extent Remaining (%)</th></tr>
<tr><td rowspan="3">39</td><td>Bioregion (MUR)</td><td>1,148,400</td><td>99.10</td></tr>
<tr><td>Subregion (MUR01)</td><td>711,328</td><td>98.68</td></tr>
<tr><td>LGA (Shire of Menzies)</td><td>46,182</td><td>99.77</td></tr>
<tr><td>18</td><td>Bioregion</td><td>12,403,172</td><td>99.68</td></tr>
</table></td><td>Not at Variance</td></tr>
</table>

Clearing Principle	Justification of Variance	Variance
	<table><tr><td></td><td>(MUR)</td><td></td><td></td></tr><tr><td></td><td>Subregion (MUR01)</td><td>10,269,896</td><td>99.66</td></tr><tr><td></td><td>LGA (Shire of Menzies)</td><td>2,010,840</td><td>99.94</td></tr></table>	
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.	No wetlands of international or national significance are located within the vicinity of the proposed Purpose Permit Area. Lake Ballard is a listed Environmentally Sensitive Area and a nationally important wetland. However, it is considered unlikely that the native vegetation to be cleared will impact Lake Ballard or other surrounding wetlands and watercourses.	Not at Variance
Principle (g) Native vegetation should not be cleared if the clearing of vegetation is likely to cause appreciable land degradation.	The proposed Purpose Permit Area is located predominantly within the Nubev System (92%) which consists of gently undulating stony plains, minor limonitic low rises and drainage floors. This land system may be prone to land degradation as a result of clearing, presenting as salinisation and soil erosion. However, the small scale of clearing, proposed management measures and rehabilitation commitments means it is considered unlikely that the proposed clearing will result in salinisation or soil erosion.	Not at Variance
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.	The proposed Purpose Permit Are does not overlap any ESAs. The nearest ESA is Lake Ballard which is located approximately 40 km from the proposed Purpose Permit Area.	Not at Variance
Principle (i)	The proposed Purpose Permit Area is not located within any major drainage lines or watercourses. Therefore, clearing is not expected to impact surface water flow and/or water quality within any watercourse. Additionally, the	Not at Variance

Clearing Principle	Justification of Variance	Variance
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.	proposed clearing is not located in proximity to any public drinking water source areas. Surface water management measures will be implemented if required to divert surface water flow away from mining infrastructure and avoid unnecessary disturbance to natural surface drainage. Clearing is unlikely to impact on groundwater quality provided that groundwater contamination from the use of hydrocarbons and chemicals will be actively managed.	
Principle (j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	The proposed Purpose Permit Area is not located within any major drainage lines or watercourses. Therefore, clearing is not expected to alter the hydrological regime of the area leading to an increase in the frequency or intensity of flooding.	Not at Variance

8 STAKEHOLDER CONSULTATION

MIG understands that stakeholders are an integral part of day-to-day operations and long-term operational strategy. In recognition of this, MIG will ensure that any communication with stakeholders will be undertaken in accordance with the following principles:

- consultation is undertaken in a timely manner.
- consultation is sincere and meaningful.
- consultation ensures that all affected parties are included, and the information provided is easily accessible.
- consultation is responsive and any concerns raised will be dealt in accordance with MIG's internal procedures.

A stakeholder engagement register will be developed and updated regularly to record all stakeholder consultations.

Table 8-1: Stakeholder consultation undertaken for the proposed Purpose Permit Area

Date	Group	Consultation Type	Action
16/2/2022	Zenith Holdings	Email	Notification of proposed drill program to be undertaken on Riverina and Perrinvale pastoral stations
3/1/2022	DoW	Phone call	Discussion regarding requirements for a GWL
17/6/2022	Albury Lynch	Site Visit	Cultural Awareness Training and Heritage Assessment
27/7/2022	Aurenne	Meeting	Meeting with Environmental Department to discuss upcoming plans and synergies for environmental knowledge
29/7/2022	Perrinvale and Riverina Tenements	Email	Notification of POW being submitted for drilling on these pastoral stations
15/9/2022	Perrinvale	In person	Ricki (station owner) reached out to RDT for assistance to assist with improving his water bore pad
14/10/2022	Sturt Meadows	Email	Email to Sturt Meadows notifying of proposed PoW
18/11/2022	Sturt Meadows	Email and Phone Call	Discussion regarding water licence and application to search for water
6/12/2022	DMIRS	Meeting	Approvals discussion for DSO submission and road realignment
12/12/2022	Shire of Menzies	Meeting	Discussion on Mt Ida - Sandstone Road realignment
4/1/2023	DMIRS	Email	Follow up on tenement conditions for consent to mine on M29/2 and M29/165
12/1/2023	Shire of Menzies	Email	Request of traffic counter of Mt Ida - Sandstone Road
12/1/2023	Sturt Meadows	Email	Discussion regarding access to water

Date	Group	Consultation Type	Action
17/1/2023	DPLH	Email	Follow up phone call for the removal and exemption of tenement conditions
1/2/2023	Juno Minerals	Meeting	Meeting to discuss options of movement of Mt Ida Road within the boundaries of Juno Minerals
14/2/2023	Perrinvale Pastoralist	Phone call	Discussion regarding water access
14/2/2023	Shire of Menzies	Meeting	Discussion between RDT and CEO - Rob Stewart on road realignment and DSO project plan
1/3/2023	Aurenne	Meeting	Project Update and company synergies for both Projects

9 CONCLUSION

MIG proposes to clear no more than 246 ha of native vegetation with a 544 ha Purpose Permit Area as part of the development of the Project. The proposed clearing is not at Variance to EP Act Schedule 5 clearing principles (c), (d), (e), (f), (g), (h), (i) and (j). Clearing is unlikely to be at variance to EP Act Schedule 5 clearing principle (a) or (b) based on the small scale of clearing, proposed management measures and rehabilitation commitments.

Development of the Project will result in the loss of some vegetation and terrestrial fauna habitat. However, the fauna habitat is regionally widespread and is not considered restricted to the area of clearing. Similarly, a significant extent of the vegetation association is present elsewhere. Finally, an absence of conservation significant species within the proposed Purpose Permit Area indicates the proposed clearing will not affect the conservation values for vegetation, flora, or fauna.

10 REFERENCES

Advisian, (2022). Mt Ida Lithium Gold Project Hydrogeological Study & Water Supply Options Analysis. Advisian Pty Ltd. Level 14, 240 St Georges Terrace, Perth WA, 6000.

ASRIS, (2022). Atlas of Australian Soils, https://www.asris.csiro.au/ Accessed: 12/12/2022

Beard, J. S. (1975). The Vegetation Survey of Western Australia. 30(3): 179-187.

Beard, J.S., (1990), Plant Life of Western Australia, Kangaroo Press Pty Ltd, NSW

BOM, (2022), *Climate Data Online*, Bureau of Meteorology, http://www.bom.gov.au/climate/averages/. Accessed: 12/12/2022

Cowan, M. 2001. Murchison 1 (MUR1 - East Murchison subregion). Pages 466-479 *in* N. L. McKenzie, J. E. May, and S. McKenna, editors. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth.

Cowan, M. A., and R. A. How. 2004. Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. Records of the Western Australian Museum 22:91-100.

Dell, J., R. A. How, A. V. Milewski, and G. J. Keighery. 1988. The biological survey of the eastern goldfields of Western Australia Part 5: Edjudina - Menzies Study Area. Records of the Western Australian Museum **Supplement No. 31**:38-69.

DoEE (2019) Directory of Important Wetlands in Australia – Information Sheet. Lake Ballard – WA058. Department of the Environment and Energy

DPIRD, (2022), *Declared Plants Database,* Department of Primary Industries and Regional Development, Western Australia https://www.agric.wa.gov.au/pests-weeds-diseases/weeds/declared-plants Accessed: 2/08/2022

DWER, (2022), Clearing Permit System Map Viewer, Department of Water and Environmental Regulation https://cps.dwer.wa.gov.au/main.html Accessed: 12/12/2022.

Government of Western Australia. (2022). Crown Land Reserves. https://www.wa.gov.au/organisation/department-of-planning-lands-and-heritage/crown-land-reserves. Accessed 06/02/2023

Native Vegetation Solutions. (2022). Reconnaissance Flora and Vegetation Survey of the Mt Ida Lithium – Gold Project. Native Vegetation Solutions, PO Box 41, Kalgoorlie.

Purdie, B. R., Tille, P. J. and Schoknecht, N. R. (2004). Soil-landscape mapping in south-Western Australia: an overview of methodology and outputs. Department of Agriculture and Food, Western Australia, Perth, Perth, W.A.

Terrestrial Ecosystems. (2022). Vertebrate fauna reconnaissance survey and risk assessment Mt Ida Lithium Gold Project. Terrestrial Ecosystems, 10 Houston Place, Mt Claremont, Wa, 6010

Tille, P. (2006). Soil-landscapes of Western Australia's Rangelands and Arid Interior. Department of Agriculture and Food Resource Management Technical Report 313.

11 APPENDICES

Appendix 1: Reconnaissance Flora and Vegetation Survey

Native Vegetation Solutions

Reconnaissance Flora and Vegetation Survey of the Mt Ida Lithium Project-

January 2023

Prepared for
Mt Ida Gold Pty Ltd
under

Red Dirt Metals Ltd

FINAL V2.0
January 2023

Prepared by:
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Appendices

Figures

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1 INTRODUCTION

Mt Ida Gold Pty Ltd (Mt Ida Gold) is a subsidiary company of Red Dirt Metals Ltd (ASX: RDT) who are focused on the evaluation and development of the recently discovered Mt Ida Lithium province in Western Australia's Eastern Goldfields region and is the owner of its Mt Ida Lithium Project.

Native Vegetation Solutions (NVS) was supplied with a survey area located approximately 100 km Northwest of Menzies, in the Murchison Region (MUR) of Western Australia (Figure 1).

The Mt Ida Lithium Project (Mt Ida Project or the Project) comprises of 29 tenements in the historical Mt Ida gold mining district, located approximately 100 km north-west of Menzies in the WA Goldfields. The Project tenements cover an area of 167 km^2 and include the historic Timoni Gold Mine and others, which have produced over 300,000 oz gold at 17.2 g/t head grade.

Mt Ida Gold are undertaking studies and planning to commence a Direct Shipping Ore (DSO) operations at the Mt Ida Lithium Project in Q4-2023 and require a flora and vegetation reconnaissance survey to determine any impact of flora and vegetation

The total survey area received from RDT covered approximately 617.73 ha. The survey area lies within Mining Tenements M29/165, M29/2 and Exploration Tenement E29/640. Actual disturbance footprints are not yet defined; however, clearing required within the boundary of the survey area is anticipated to be less than the total survey area.

This report will encompass results of the reconnaissance flora and vegetation survey within the Mt Ida Project survey area.

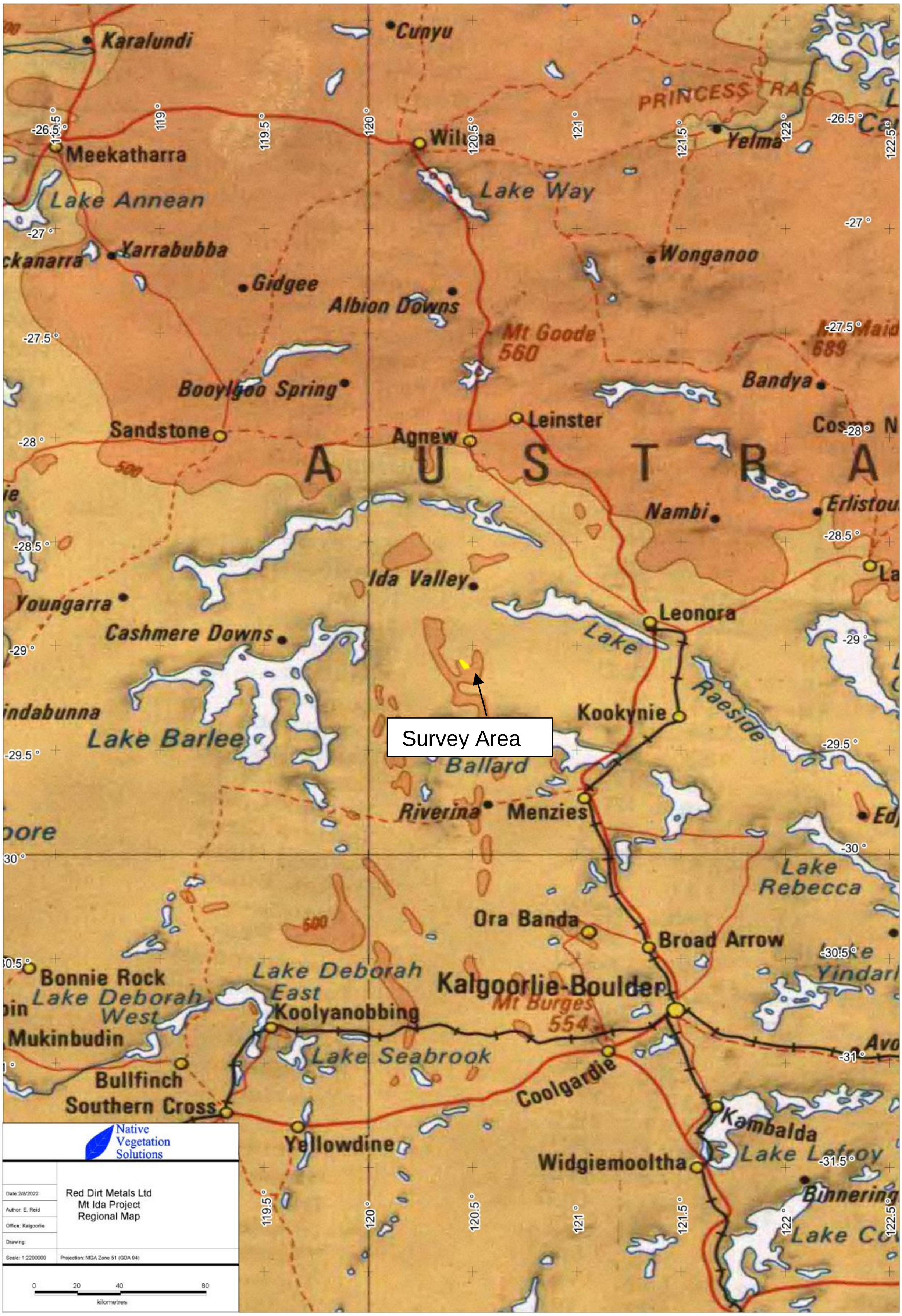


Figure 1: Regional map of survey location

1.1 Objectives

The objective of this report is to document the results of the flora and vegetation component of a reconnaissance assessment conducted in accordance with:

- Environmental Factor Guideline- Flora and Vegetation (EPA, 2016); and
- Technical Guidance- Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016a).

A reconnaissance assessment has two components:

1). Desktop study which includes a literature review and a search of the relevant databases;
2). Reconnaissance survey of the survey area to verify the desktop survey, to define vegetation units present in the area, search for species of conservation significance and to determine potential sensitivity to impact.

As part of the reporting for the reconnaissance assessment, NVS has conducted a flora and vegetation survey which includes broad-scale vegetation mapping and vegetation condition mapping of the survey area.

The scope of work for the reconnaissance flora and vegetation survey was to:

- conduct a desktop study that includes a literature review and search of the relevant databases;
- describe the vegetation associations in the survey area;
- prepare an inventory of species occurring in the survey area;
- identify any vegetation communities or flora species of conservation significance;
- map broad-scale vegetation groups found within the survey area, including vegetation condition; and
- provide recommendations, including the management of perceived impacts to flora and vegetation within the survey area.

1.2 Geology and Vegetation

The survey area lies in the Murchison (MUR) bioregion, more specifically the Eastern Murchison (MUR01) subregion. The Eastern Murchison subregion covers over 7 million hectares and contains the northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. The landscape is characterised by extensive areas of elevated red desert sandplains with minimal dune development and internal drainage. The occluded Paleodrainage system generates Salt lake systems. Other features include broad plains of red-brown soils, breakaway complexes, and red sandplains. Mulga woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and *Tecticornia* shrublands dominate the vegetation (CALM, 2002)

1.3 Climate

The climate is classified as Arid with 200-300 mm of rainfall, sometimes in summer but usually in winter (CALM, 2002). The nearest official meteorological weather station with the most complete and up to date temperature information is Bulga Downs (station number 012239), which is located approximately 95.5 km northwest of the survey area.

1.3.1 Temperature

Mean annual minimum temperature at Bulga Downs is 13.6°C and mean annual maximum temperature is 29.0°C (BOM, 2022). The coldest temperatures are attained in July (mean minimum temperature 4.8°C), the hottest is January (mean maximum temperature 37.9°C) and diurnal temperature variations are relatively consistent throughout the year (Figure 2).

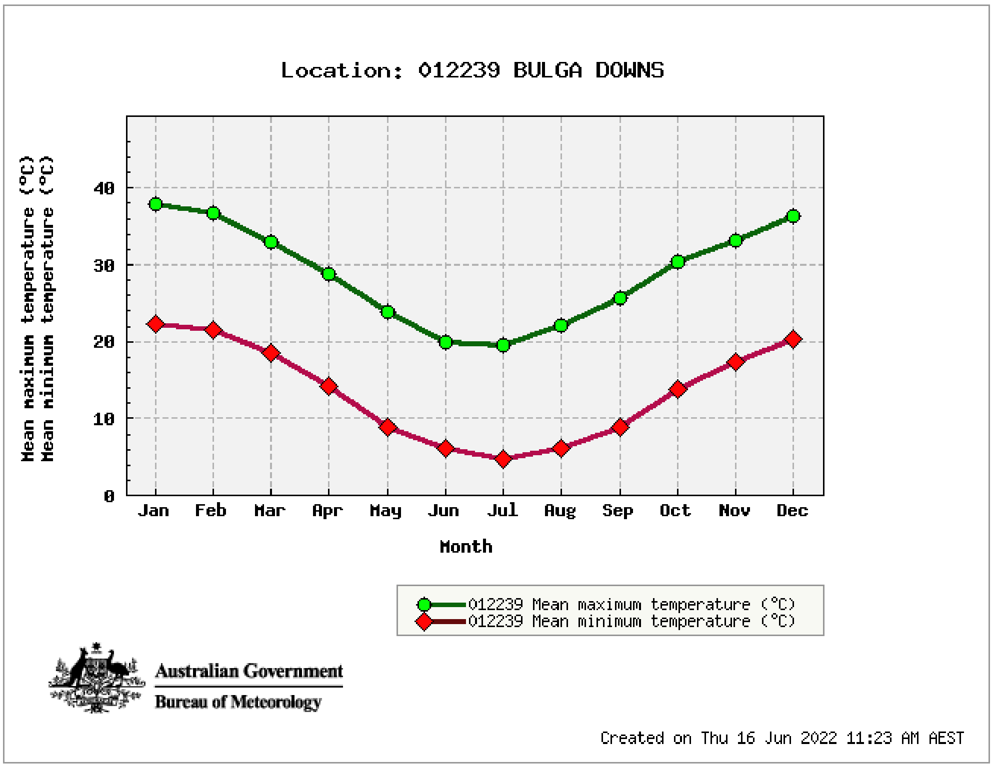


Figure 2: Mean temperature ranges for Bulga Downs weather station

1.3.2 Rainfall

The annual average rainfall at Bulga Downs is 236.6 mm, which falls (>1 mm) on an average of 11 rain-days (BOM, 2022). Larger rainfall events occur from January to March and May to July (Figure 3). Prior to the survey in 2022, rainfall in March exceeded monthly averages while rainfall for all other months remained below monthly averages (BOM, 2022).

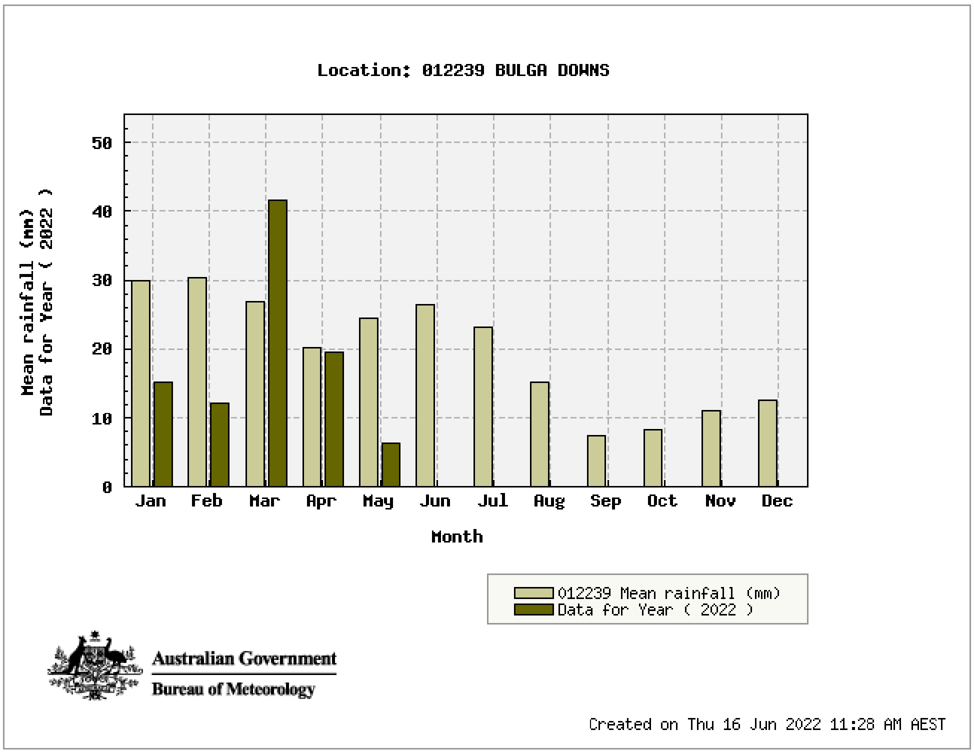


Figure 3: Monthly and mean rainfall for Bulga Downs weather station

2. ASSESSMENT METHODOLOGY

2.1 Personnel and Reporting

The following personnel were involved in the Reconnaissance flora and vegetation survey:

- Mr Eren Reid (*BSc- Biological Science),* Principal Botanist, Native Vegetation Solutions, undertook the survey, vegetation mapping, data collation, field identification of flora, preparation and review of the report. Mr Eren Reid has over 18 years' experience in botanical surveys throughout the Murchison Region and over a variety of environments across Western Australia.
- Ms Adele Thomasz (*BSc*- Conservation and Wildlife Biology), Native Vegetation Solutions, data collation and preparation of the report. Adele Thomasz has over 5 years' experience working in the conservation sector and one year specifically working on botanical survey reporting; and
- Mr Frank Obbens (*BSc*), Consultant Botanist, Bushtech Consultancy, undertook identification of unknown samples collected in the field. Mr Frank Obbens has over 22 years' experience offering botanical identification and conducting taxonomic investigations to consultancies and industry.

2.2 Preliminary Desktop Study

A preliminary assessment of the survey area and its potential constraints was undertaken by reviewing relevant government agency managed databases (Sections 2.2.1 to 2.2.6, and Appendices 1 & 2) and consulting with government agencies where necessary. The following sections provide a summary of desktop searches undertaken for the project.

2.2.1 Known Previous Flora and Vegetation Surveys

Four Level 2 Flora and Vegetation Surveys and several Targeted Flora Surveys were completed near the Mt Ida Project Area from 2007 to 2012. The list of these reports below have been referenced for this report. The locations of these survey areas occur approximately 12km to the southwest of the current survey area;

- PAA, (2007), *Vegetation Survey and Rare Flora Search of the Mt Mason and Mt Ida Exploration Project- May 2007*, Unpublished Report Prepared by Paul Armstrong and Associates for Jupiter Mines Ltd
- PAA, (2008), Level 2 Vegetation Survey and Rare Flora Search of the Mt Mason and Mt Ida Exploration Projects- Conducted May to September 2007, (Including Addendums 1 to 6), Unpublished Report Prepared by Paul Armstrong and Associates for Jupiter Mines Ltd
- OES, (2010), *Mt Ida Level 2 Flora and Vegetation Survey- September 2010*, Unpublished Report prepared by Outback Ecology Services for Jupiter Mines Ltd
- NVS, (2012), *Level 2 Flora and Vegetation Survey of the Mt Ida Project, Part 1- November 2011*, Unpublished Report Prepared by Native Vegetation Solutions for Jupiter Mines Ltd
- NVS, (2012), *Level 2 Flora and Vegetation Survey of the Mt Mason Project, Part 1- October 2011*, Unpublished Report Prepared by Native Vegetation Solutions for Jupiter Mines Ltd
- NVS, (2012), *Level 2 Flora and Vegetation Survey of the Mt Mason Project, Part 2- March 2012*, Unpublished Report Prepared by Native Vegetation Solutions for Jupiter Mines Ltd
- NVS, (2013), *Level 1 Flora and Vegetation Survey of the Proposed Mount Mason Haul Road- May 2012*, Unpublished Report Prepared by Native Vegetation Solutions for Jupiter Mines Ltd

2.2.2 *Environment Protection and Biodiversity Conservation Act* Protected Matters

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* Protected Matters Search tool was utilised to provide results for matters of National Environmental Significance within the survey area using the survey area as the search criteria with a 3 km buffer (DAWE, 2022).

2.2.3 Threatened Flora and Communities

The Threatened and Priority Flora Database managed by the Department of Biodiversity, Conservation and Attractions (DBCA) was searched for threatened and priority flora within a 10km radial area of the survey area (DBCA, 2022a).

The Threatened and Priority Ecological Communities (TECs and PECs) database was searched to determine the presence of PECs or TECs (DBCA, 2022), with Geographic Information System (GIS) data supplied for assessment, within a 20 km radial area of the survey area.

2.2.4 Environmentally Sensitive Areas (ESAs) and Conservation Reserves

The Department of Water and Environmental Regulation (DWER, 2022) Clearing Permit System Map Viewer was used to determine the location of any ESAs and Conservation Reserves.

2.2.5 Vegetation Type, Extent and Status

Vegetation extent and status data was sourced from the Department of Agriculture and Food (DAFWA) report and its associated GIS file (Shepherd *et al*, 2002). This data comprises Beard's Pre-European vegetation groups.

DBCA's Statewide Vegetation Statistics (DBCA, 2019) was also referenced for the current extent of Beard's Vegetation Groups. The purpose of examining this information is to determine if the survey area lies within any vegetation groups defined by Beard that may have been subjected to widescale clearing for European settlement. The national objectives and targets for biodiversity conservation recognise that the retention of 30% or more of the pre-clearing extent of a Beard vegetation association is necessary if Australia's biological diversity is to be protected.

2.2.6 Wetlands

The potential of wetlands within the project area was determined by examining DWER's Clearing Permit System Map Viewer (DWER, 2022).

2.2.7 Dieback

Under normal circumstances Dieback is only considered a potential issue for any project if the project area lies within the Southwest Land Division and the mean annual rainfall of the area is greater than 400 mm. There is no record of *Phytophthora cinnamomi* (Dieback*)* establishing in natural ecosystems in regions receiving <400mm rainfall per annum (CALM, 2003).

However, as indicated within the more recent Dieback guidelines (DBCA, 2020), other species of *Phytophthora* may persist east of the 400mm isohyet in unusually wet conditions. It is therefore recommended to conduct a risk assessment as per these guidelines.

2.3 Site Investigation

A site visit of the Mt Ida Project survey area was carried out by Botanist Eren Reid from Native Vegetation Solutions on the 9th of May 2022 and 26th January 2023 to examine the flora and vegetation groups contained within the survey area. A total of 20 hours was spent on site traversing the survey area, by Yamaha Viking and on foot.

The survey was conducted in accordance with relevant Environmental Protection Authority's (EPA's) Statements and Technical Guidance (Section 1.1).

The EPA uses the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for Environmental Impact Assessment (EIA) decision making in relation to the conservation of biodiversity. Given the scale and nature of the proposed disturbance as well as the existing disturbance, and that the survey area is located within the Murchison (MUR) IBRA region, a reconnaissance flora and vegetation survey was deemed adequate.

2.3.1 Licenses

Field work was conducted under Scientific License FB62000171, held by Mr Eren Reid with expiry 08/10/2022.

2.3.2 Field Methods

Prior to the field work, the aerial photography was examined and representative sample sites for relevés were chosen to provide coverage over all viable vegetation types.

In the field, 20m x 20m relevé sites were established at these sites, taking into account representation of surrounding vegetation and vegetation boundaries. Relevé sites are represented in Appendix 4.

Each relevé site was captured on a TwoNav Aventura GPS at ±4m accuracy, using Universal Transverse Mercator location on GDA94 datum. Digital photographs were taken of each representative vegetation group present in the survey area.

Data collected at each relevé included:

- Photograph of representative vegetation group:
- GPS Location:
- Species Present;
- Population Count/Estimate of Conservation Significant Flora (if present);
- Disturbance Level; and
- Vegetation Condition

Specimens of taxa not recognised by the Botanist were collected and pressed along with specimens of taxa recognised as, or thought to be, conservation-significant species.

The vegetation structure was assessed using the method developed by Muir (1977). Definitions of the vegetation structure are presented in.

The condition of each relevé was assessed using the method developed by Keighery (1994). Definitions of the condition scale are presented in Appendix 3.

Vegetation groups were mapped using the methods listed in section 2.3.4 below.

Opportunistic sampling of plant taxa and vegetation group mapping was also utilised in the survey area between relevé sampling points, via wandering traverses. Smaller singular relevé sites were also utilised as opportunistic sample sites to collect flora specimens and assist in mapping vegetation groups.

All sample sites and GPS tracks are included in Appendix 4.

2.3.3 Post-Field Methods

Unknown specimens collected in the field were identified post field work by Frank Obbens (Bushtech Consultancy) and Eren Reid (NVS) with reference to published keys, WAHERB reference herbarium and information published on Florabase (WAHERB, 2022). Threatened flora range extensions and new locations were submitted to the Western Australian Herbarium (WAHERB) as per the EPA Technical Guidelines (EPA 2016a).

Species information was transferred into Microsoft Excel® worksheets representing presence/absence of species per vegetation group.

2.3.4 Mapping

Vegetation mapping was produced via GPS recorded information in the field, cross-referenced with vegetation descriptions made in the field, overlaid on aerial imagery of the survey area. The GPS utilised (TwoNav Aventura GPS) displayed aerial imagery, hence real-time mapping of vegetation groups was available during field work.

Vegetation Health Condition was assessed in the field with reference to Keighery (1994).

GPS tracks and waypoints recorded during field work are presented in Appendix 4.

2.3.5 IBSA Data Package

The Environmental Protection Authority (EPA), Department of Water and Environmental Regulation (DWER) and Department of Mines, Industry Regulation and Safety (DMIRS) require Index of Biodiversity Surveys for Assessments (IBSA) Data Packages to be submitted to support assessment and compliance under the *Environmental Protection Act 1986.*

An IBSA data package is a single file in .zip format, containing:

- one Metadata and Licensing Statement in .pdf format;
- one survey report in .pdf format;
- one plain-text survey report in .txt format; and
- a set of electronic data files, comprising:
    - one survey details spatial dataset in shapefile (.shp, etc.) or MapInfo (.tab, etc.) format; and
    - one or more survey data spatial datasets, as required, in shapefile (.shp, etc.) or MapInfo (.tab, etc.) format.

The IBSA Data package for this survey will be submitted via the DWER IBSA Submission Portal.

2.4 Nomenclature And Taxonomy

Nomenclature follows that used by the WAHERB.

The WAHERB has updated its sequence and arrangement of collections to conform to the systematic sequence of the Angiosperm Phylogeny Group (APGIII), with the result that many Families and Genera have been moved or renamed. This report attempts to follow those changes in relation to species recorded during this survey. Definitions of Threatened Flora are also included in Section 6 below.

2.5 Limitations

Table 1 lists potential limitations that may have affected the survey.

Table 1: List of potential survey limitations

Potential Limitations	Constraint (Y/N)	Comment
Competency and experience of the consultants undertaking the survey	N	Experienced and competent personnel conducted the survey. Eren Reid has over 18 years' experience in botanical surveys throughout the Murchison Region and over a variety of environments across Western Australia.
Scope	N	The Scope of work was adequately defined. Vascular flora species were the focus of the survey and were thoroughly sampled.
Proportion of flora identified during survey	N	As the survey was planned to target species of conservation significance and flora within a defined survey area, a complete census of the species present was attempted (Approx. 95%). Sufficient identifications were made to allow vegetation descriptions to be made.
Sources of information	N	Threatened and Priority Flora GIS information was available from DBCA.
Proportion of the task achieved	N	All tasks completed.
Timing/Season	N	The reconnaissance flora and vegetation survey was conducted in Autumn 2022. Flowering annual species were present within the survey area, suggesting recent above average rainfall in February 2022 was sufficient for the period of survey. Additional field work was completed in January 2023, which consisted of expanding the already known vegetation groups.
Disturbance in survey area	N	Extensive disturbance (historical mining access tracks and exploration) was observed within the survey area, however, did not compromise the results of the survey as these areas were avoided whilst collecting data.
Intensity of survey effort	N	The survey intensity is considered to have been sufficient for a reconnaissance survey according to EPA (2016) guidelines. Areas most likely to contain threatened and priority species were targeted. Vegetation mapping sites were selected to provide adequate coverage of the survey area.
Resources	N	Resources, in terms of time, equipment, support and personnel were adequate to undertake and complete the reconnaissance survey.
Access problems	N	All the areas in need of survey were easily accessible from existing tracks, or by foot.
Availability of contextual information on the region	N	Contextual information regarding vegetation and flora of the Murchison bioregion is readily available. Adequate information was able to be accessed from available databases.

3. RESULTS

3.1 Preliminary Desktop Assessment

3.1.1 EPBC Act Protected Matters

Results of the EPBC Protected Matters search tool are included in Appendix 1. The results revealed that the Mt Ida Project survey area could possibly contain suitable habitat for the weed species *Carrichtera annua* (Ward's Weed) and *Cenchrus ciliaris* (Buffel grass) (DAWE, 2022a).

Carrichtera annua was introduced into Australia from the eastern Mediterranean, and is now widespread throughout South Australia, the Interior, and Western Australia (Lamp & Collet, 1989). This species is not listed as a declared plant by DPIRD (2022), however according to the EPBC search tool this invasive weed species is considered a threat to the rangeland biodiversity within the Southern Australian Sheep and Cattle Grazing Land Management Zone (DAWE, 2022a).

Cenchrus ciliaris is native to Africa and India, was widely planted in Western Australian pastoral regions as a pasture grass, and has become a widespread weed of roadsides, creeklines, river edges and most vegetation types from Geraldton to the Pilbara, Kimberley and adjacent desert (Hussey, 2007). In the Murchison region it often colonises roadside table drains, excluding native everlastings. It seriously alters the fire characteristics of invaded plant cover by generating highly flammable fuel that is prone to more frequent fires.

The EPBC Protected Matters report indicated no TECs or Commonwealth Reserves within the requested survey area.

3.1.2 Threatened Flora and Communities

The DBCA database searches revealed a potential for no Threatened and four Priority Flora species to occur within a 10km radius of the survey area (DBCA, 2022a). No known locations of Threatened or Priority Flora occur within the survey area, with the closest Priority Flora located approximately 180 metres west of the survey area.

Results of the threatened flora database search are included in Appendix 2 which includes the likelihood of each species to occur within the survey area.

The PEC/TEC search (DBCA, 2022) revealed that no PECs or TECs fall within the survey area. One Priority 1 Ecological Community falls within a 20 km radius of the survey area; Perrinvale/Walling vegetation complexes (Banded ironstone formation); and is located approximately 6 km to the west of the survey area. There are no TECs within 20 km of the survey area.

Threatened and Priority Flora species occurring within a 10 km radius and TEC/PEC's within a 20 km radius of the survey area are displayed in Appendix 4.

3.1.3 Environmentally Sensitive Areas and Conservation Reserves

No ESA's are located within the survey area. However, the area does contain four 'C' Class Reserves (Purpose: Common) (DWER, 2022). Reserve details are listed in Table 2 below and displayed in Appendix 1.

Table 2: Reserves located within the survey area

Reserve Number	Class	Purpose	Responsible Agency
R 12922	C	Waterway	Water Corporation
R 11674	C	Waterway	Water Corporation
R 12369	C	Mechanics Institute	Department of Planning, Lands and Heritage
R 23378	C	Explosives magazine	DMIRS

3.1.4 Land Systems

As part of the Rangeland resource surveys, the Department of Agriculture mapped the Land Systems of Western Australia (DPIRD, 2017). The Land Systems occurring within the survey area are listed in 3 below and displayed in Appendix 4.

Table 3: Land Systems occurring within the survey area (DPIRD, 2017)

Land System	Description	Extent of Survey Area (ha)	% Of Survey Area (%)
Nubev System	Gently undulating stony plains, minor limonitic low rises and drainage floors supporting mulga and halophytic shrublands.	567.17	91.82%
Gransal System	Stony plains and low rises based on granite supporting mainly halophytic low shrublands.	26.97	4.37%
Bevon System	Irregular low ironstone hills with stony lower slopes supporting mulga shrublands.	23.59	3.82%

3.1.5 Vegetation Type, Extent and Status

Two vegetation units defined by Beard (1990) were identified as part of the desktop assessment. The vegetation units identify the Pre-European extent of vegetation, as mapped by Beard (1990). The national objectives and targets for biodiversity conservation recognise that the retention of 30% or more of the pre-clearing extent of Beard's vegetation associations is necessary if Australia's biological diversity is to be protected.

Information relating to known Beard (1990) vegetation units within the survey area has been summarised in Table 4, Table 5 and Table 6 below. This information has been compiled through both desktop assessments and the site visit.

The extent of the two Beard vegetation units within the survey area at all scales is less than 1% of the total area at each scale, with the exception of Beard Association 39 at the Shire scale, which covers 1.27% of the total area (Table 4). All scales are above the 30% threshold at a State, bioregional and subregional level (Table 5 and Table 6).

Table 4: Extent of Beard Associations within the survey area

Beard Vegetation Association	Extent within survey area (ha)	% of survey area (%)	By Association WA	By Association WA	By IBRA Region *(MUR)*	By IBRA Sub-region *(MUR01)*	By Shire *(Shire of Menzies)*
39	587.62	95.13	<1%	<1%	<1%	<1%	1.27%
18	30.10	4.87	<1%	<1%	<1%	<1%	<1%

Table 5: Summary of information regarding Pre-European and current vegetation extent of Vegetation Association 39 within the survey area

Factor	Value				
Beard Vegetation Association*	39				
Vegetation Association Description*	Shrublands; mulga scrub				
Pre-European Extent (ha)	Scale				
	By Association (WA)	By Association (WA)	By IBRA Region (MUR)	By IBRA Sub-region (MUR01)	By Shire (Shire of Menzies)
	4,856,768*	6,613,567.48**	1,148,400.30**	711,328.84**	46,182.99**
% Pre-European Extent Remaining	100.00%*	99.83%**	99.10%**	98.68%**	99.77%**
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DBCA, (2019)
***Source: Field Assessment

Table 6: Summary of information regarding Pre-European and current vegetation extent of Vegetation Association 18 within the survey area

Factor	Value				
Beard Vegetation Association*	18				
Vegetation Association Description*	Low woodland; mulga (*Acacia aneura*)				
Pre-European Extent (ha)	Scale				
	By Association (WA)	By Association (WA)	By IBRA Region (MUR)	By IBRA Sub-region (MUR01)	By Shire (Shire of Menzies)
	22,029,557*	19,892,306.46**	12,403,172.30**	10,269,896.44**	2,010,840.87**
% Pre-European Extent Remaining	100.00%*	99.75%**	99.68%**	99.66%**	99.94%**
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DBCA, (2019)
***Source: Field Assessment

3.1.6 Wetlands

The DWER Clearing Permit System Map Viewer revealed no waterbodies within the survey area (DWER, 2022).

3.1.7 Dieback

The survey area lies south of the 26^{th} parallel, however receives average annual rainfall of 236.6 mm. There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving less than 400mm rainfall per annum (CALM, 2003).

However, as indicated within the more recent Dieback guidelines (DBCA, 2020), other species of *Phytophthora* may persist east of the 400mm isohyet in unusually wet conditions. It is therefore recommended to conduct a risk assessment as per these guidelines.

Additionally, all measures should be taken to prevent any possible soil contamination (seeds of non-native species *etc*.) which poses a risk in the survey area during seasonally favourable conditions.

3.2 Field Assessment

3.2.1 Threatened Flora

No Priority Flora or Threatened Flora were recorded in the survey area.

3.2.2 Vegetation Type, Extent and Status

A total of 25 Families, 51 Genera and 96 Species were recorded within the survey area. Eight major vegetation groups were recorded in the survey area and range from Completely Degraded to Very Good condition (using the scale of Keighery 1994, see Appendix 3). Existing disturbance within the survey area is comprised of historic mining areas, exploration activities, and access roads.

No unique or restricted vegetation communities were identified, and all vegetation types/communities are common, widespread and well represented in the Eastern Murchison subregion.

The summary of vegetation groups contained within the survey area is summarised in

Table 7 below. Maps of the survey area can be seen in Appendix 4.

Table 7: Vegetation Group Summary

Vegetation Group	Veg Group Code	Families	Genera	Species	Area (ha)	Percentage of survey area (%)
Mulga over *Maireana sedifolia* and sclerophyll shrubland	A	18	27	42	168.58	27.29
Creekline Vegetation	B	19	29	45	64.19	10.39
Mulga woodland	C	12	20	39	66.60	10.78
Open chenopod shrubland with occasional Mulga overstorey	D	15	25	34	207.57	33.60
Acacia burkittii shrubland	E	14	22	30	26.32	4.26
*Hakea preissi*i over open chenopod shrubland	F	11	19	28	15.77	2.55
Acacia quadrimarginea over Eremophila platycalyx and Senna shrubland over laterite hills	G	9	14	22	5.20	0.84
Mulga over Ironstone outcrops	H	10	11	16	2.04	0.33
Existing Disturbance	N/A	N/A	N/A	N/A	61.46	9.95
	Total	25*	51*	96*	617.73#	100.00#

Note: * Within total survey area (not sum of column)
Sum of column

The Mt Ida Project vegetation groups are described in more detail below.

3.2.2.1 Mulga over *Maireana sedifolia* and sclerophyll shrubland (A)

This Scrub (Muir, 1977) consisted of 18 Families, 27 Genera and 42 Species. The vegetation group was approximately 168.58 ha which makes up 27.29% of the survey area.

Figure 4: Vegetation Group A within the survey area

3.2.2.2 Creekline vegetation (B)

This Scrub (Muir, 1977) consisted of 19 Families, 29 Genera and 45 Species. The vegetation group was approximately 64.19 ha which makes up 10.39% of the survey area.

Figure 5: Vegetation Group B within the survey area

3.2.2.3 Mulga woodland (C)

This Open Scrub (Muir, 1977) consisted of 12 Families, 20 Genera and 39 Species. The vegetation group was approximately 66.60 ha which makes up 10.78% of the survey area.

Figure 6: Vegetation Group C within the survey area

3.2.2.4 Open chenopod shrubland with occasional Mulga overstorey (D)

This Open Low Scrub B (Muir, 1977) consisted of 15 Families, 25 Genera and 34 Species. The vegetation group was approximately 207.57 ha which makes up 33.60% of the survey area.

Figure 7: Vegetation Group D within the survey area

3.2.2.5 Acacia burkittii shrubland (E)

This Scrub (Muir, 1977) consisted of 14 Families, 22 Genera and 30 Species. The vegetation group was approximately 26.32 ha which makes up 4.26% of the survey area.

Figure 8: Vegetation Group E within the survey area

3.2.2.6 Hakea preissii over open chenopod shrubland (F)

This Low Scrub A (Muir, 1977) consisted of 11 Families, 19 Genera and 28 Species. The vegetation group was approximately 15.77 ha which makes up 2.55% of the survey area.

Figure 9: Vegetation Group F within the survey area

3.2.2.7 Acacia quadrimarginea over Eremophila platycalyx and Senna shrubland over laterite hills (G)

This Low Scrub A (Muir, 1977) consisted of 9 Families, 14 Genera and 22 Species. The vegetation group was approximately 5.20 ha which makes up 0.84% of the survey area.

Figure 10: Vegetation Group G within the survey area

3.2.2.8 Mulga over Ironstone outcrops (H)

This Low Scrub A (Muir, 1977) consisted of 10 Families, 11 Genera and 16 Species. The vegetation group was approximately 2.04 ha which makes up 0.33% of the survey area.

Figure 11: Vegetation Group H within the survey area

3.2.2.9 Existing Disturbance

Existing disturbance within the survey area consisted of historic mining areas, exploration clearing and access roads and was approximately 61.46 ha which makes up 9.95% of the survey area.

Figure 12: Existing disturbance within the survey area

3.2.3 Weeds

Seven weed species was recorded within the survey area, *Sonchus oleraceus* (Common Sowthistle), *Salvia verbenaca* (Wild Sage), *Lysimachia arvensis* (Pimpernel), *Carthamus lanatus* (Saffron Thistle), *Oncosiphon suffruticosum* (Calomba Daisy), *Cylindropuntia imbricata* (Devil's Rope) and *Opuntia stricta* (Common Prickly Pear). Two of these species are considered Declared Pests (DPIRD, 2022); Devil's Rope and Common Prickly Pear. Both of these species are classified as s22(2), under the BAM Act 2007, with a C3 Management requirement that states the organism should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution or prevent/contain the spread of the organism. This management requirement applies to the whole of the state of WA.

3.2.4 Vegetation Condition

Evidence of extensive historic exploration and mining activities was observed during the field assessment. A number of access roads and gazetted roads also run through the survey area.

Overall, the condition of the vegetation was determined to range from "Completely Degraded" to "Very Good" with most of the area falling into the "Good" Category. Areas which were affected by historic exploration and mining were deemed in "Degraded" condition. A map of the vegetation condition within the survey is depicted in Appendix 4.

4. DISCUSSION

The field assessment established that the condition of the vegetation in the proposed disturbance area ranged from "Completely Degraded" to "Very Good" with most of the area falling into the "Good" Category. Areas which were affected by historic exploration and mining were deemed in "Degraded" condition. No areas of vegetation were assessed to be in "Pristine" condition.

Seven weed species was recorded within the survey area, *Sonchus oleraceus* (Common Sowthistle), *Salvia verbenaca* (Wild Sage), *Lysimachia arvensis* (Pimpernel), *Carthamus lanatus* (Saffron Thistle), *Oncosiphon suffruticosum* (Calomba Daisy), *Cylindropuntia imbricata* (Devil's Rope) and *Opuntia stricta* (Common Prickly Pear). Two of these species are considered Declared Pests (DPIRD, 2022); Devil's Rope and Common Prickly Pear. Both of these species are classified as s22(2), under the BAM Act 2007, with a C3 Management requirement that states the organism should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution or prevent/contain the spread of the organism. This management requirement applies to the whole of the state of WA.

No Priority or Threatened Flora were recorded in the survey area.

No TECs or PECs were recorded in the survey area.

No unique or restricted vegetation communities were identified, and all vegetation types/communities are common, widespread and well represented in the Eastern Murchison subregion.

Any proposed disturbance/clearing of vegetation will result in a loss of species. However, given the size of the area and the extent of the Beard (1990) vegetation association elsewhere, the impact on the vegetation and its component flora will not affect the conservation values of either, or create fragmentation or patches of remnant vegetation.

The following recommendations arise from the reconnaissance flora survey:

- Weed control measures should be implemented during and following earthworks; and
- Dust control measures should be implemented during earthworks.

5. REFERENCES

Beard, J.S., (1990), *Plant Life of Western Australia*, Kangaroo Press Pty Ltd, NSW

BOM, (2022), *Climate Data Online*, Bureau of Meteorology, http://www.bom.gov.au/climate/averages/
Accessed: 16/06/2022

CALM, (2002), *A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002- Murchison (MUR01 Eastern Murchison synopses)*, Department of Conservation and Land Management

CALM, (2003), *Phytophthora cinnamomi and Diseases Caused by It, Volume 1-Management Guidelines,* Department of Conservation and Land Management
https://library.dbca.wa.gov.au/FullTextFiles/021873.pdf
Accessed: 21/05/2022

DAWE, (2022*), Interim Biogeographic Regionalisation for Australia* (IBRA), Department of Agriculture, Water and the Environment, Australian Government
https://www.environment.gov.au/land/nrs/science/ibra
Accessed: 17/06/2022

DAWE (2022a), *Protected Matters Search Tool*, Department of Agriculture, Water and the Environment, Australian Government
http://www.environment.gov.au/epbc/protected-matters-search-tool
Accessed: 16/06/2022

DBCA, (2019), *2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report)- Current as of March 2019,* WA Department of Biodiversity, Conservation and Attractions, Perth
https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics
Accessed: 17/06/2022

DBCA, (2022), *TEC/PEC Database Results Ref:06_0522EC,* Department of Biodiversity, Conservation and Attractions

DBCA, (2022a), *Threatened Flora Database Results Ref: 07_0522FL,* Department of Biodiversity, Conservation and Attractions

DPIRD, (2017), *NRInfo Digital Mapping*, Department of Primary Industries and Regional Development
https://maps.agric.wa.gov.au/nrm-info/
Accessed: 17/06/2022

DPIRD, (2022), *Declared Plants Database,* Department of Primary Industries and Regional Development, Western Australia
https://www.agric.wa.gov.au/pests-weeds-diseases/weeds/declared-plants
Accessed: 2/08/2022

DWER, (2022), Clearing Permit System Map Viewer, Department of Water and Environmental Regulation
https://cps.dwer.wa.gov.au/main.html
Accessed: 16/06/2022

EPA, (2016), *Environmental Factor Guideline: Flora and Vegetation,* Environmental Protection Authority, Western Australia

EPA, (2016a), *Technical Guidance- Flora and Vegetation Surveys for Environmental Impact Assessment,* Environmental Protection Authority, Western Australia

Hussey, B.M.J., (2007), *Western Weeds- A Guide to the Weeds of Western Australia*, Weeds Society of Western Australia

Keighery, B.J., (1994), *Bushland Plant Survey; A guide to plant community survey for the Community,* Wildflower Society of Western Australia (Inc.) Nedlands

Lamp, C.A. and Collet, F., (1989), *Field Guide to Weeds in Australia,* Inkata Press

Muir, B.G., (1977), Biological Survey of the Western Australian Wheatbelt. Pt. 2. Vegetation and habitat of the Bendering Reserve. Records of the Western Australian Museum Supplement 3

Shepherd, D.P., Beeston, G.R. and Hopkins, A.J.M., (2002), *Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit Report*, Technical Report 250, Department of Agriculture Western Australia

WAHERB, (2022), *Florabase- the Western Australian Flora*, Department of Parks and Wildlife
http://florabase.dpaw.wa.gov.au/
Accessed 19/06/2022

6. GLOSSARY

Acronyms:

BOM	Bureau of Meteorology, Australian Government
BSc	Bachelor of Science
CALM	Department of Conservation and Land Management (now DBCA)
CPS	Clearing Permit System (DWER)
DBCA	Department of Biodiversity, Conservation and Attractions, Western Australia
DMIRS	Department of Mines, Industry Regulation and Safety, Western Australia
DOTEE	Department of the Environment and Energy, Australian Government
DPAW	Department of Parks and Wildlife, Western Australia (now DBCA)
DPIRD	Department of Primary Industries and Regional Development, Western Australia
DRF	Declared Rare Flora (now classed as Threatened Flora)
DWER	Department of Water and Environmental Regulation, Western Australia
EPA	Environmental Protection Authority, Western Australia
EP Act	Environmental Protection Act 1986, Western Australia
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth Act)
ESA	Environmentally Sensitive Area
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
IBRA	Interim Biogeographic Regionalisation for Australia, DOTEE
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union
km	Kilometres
m	Metres
MUR	Murchison Bioregion (IBRA)
MUR01	Eastern Murchison Subregion (IBRA)
NVS	Native Vegetation Solutions
PEC	Priority Ecological Community, Western Australia
Ramsar	A wetland site designated of international importance under the Ramsar Convention (UNESCO)
TEC	Threatened Ecological Community
UNESCO	United Nations Educational, Scientific and Cultural Organization
WA	Western Australia
WAHERB	Western Australian Herbarium (DBCA)

Definitions:

DBCA (2019) Conservation Codes for Western Australian Flora and Fauna. Department of Biodiversity, Conservation and Attractions, Western Australia, January 2019: -

T Threatened species:

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN Endangered species

Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species:

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018.*

P Priority Species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or 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 or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

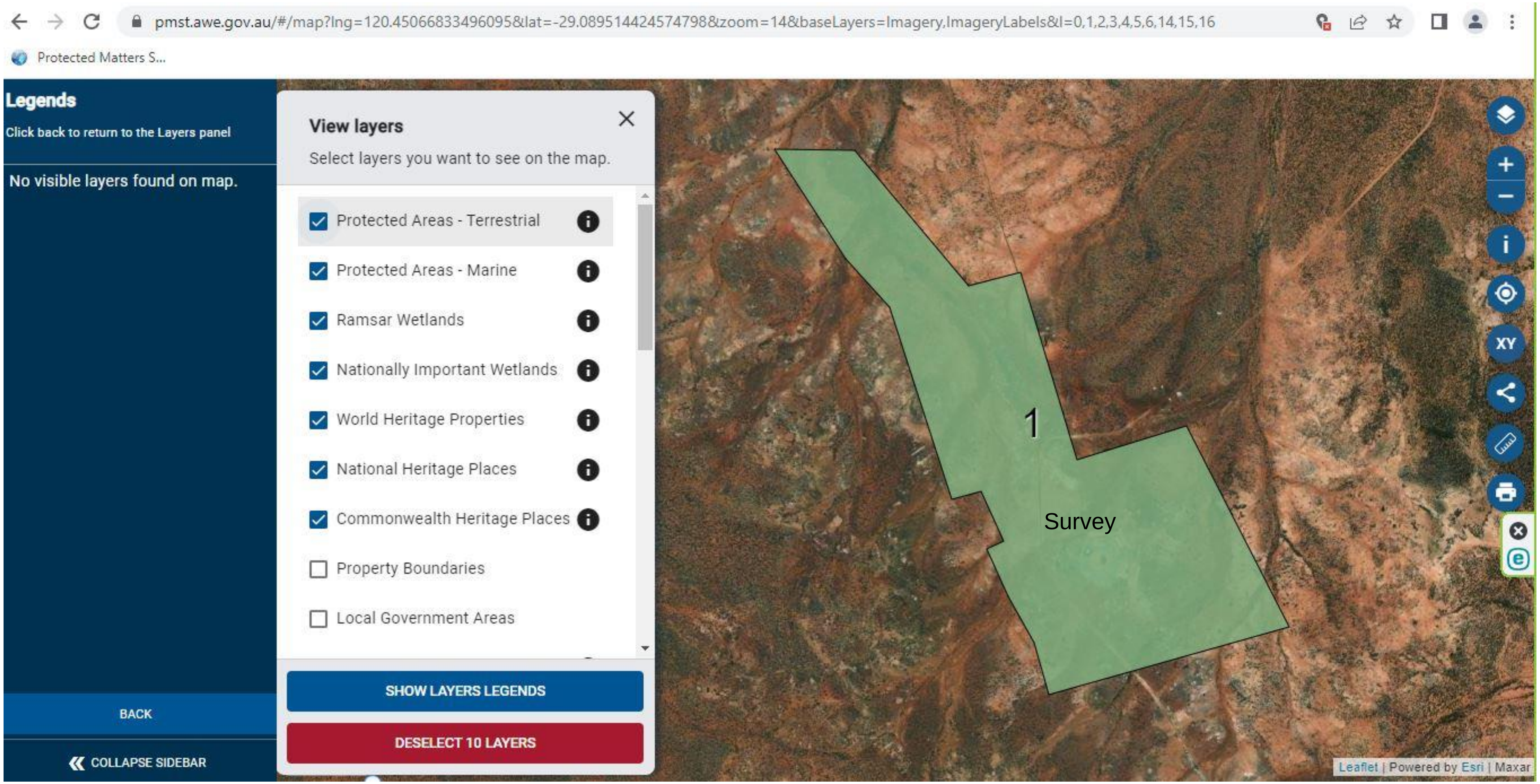
Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix 1: Relevant Government Database Search Results



The EPBC Protected Matters Search Tool showing no TECs or Commonwealth Reserves within the survey area (DAWE, 2022a)

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

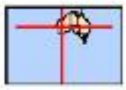
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 16/06/22 12:34:41

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 3.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	4
Listed Migratory Species:	5

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	7
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	10
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area

Extra Information

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

29.07002 120.44652, 29.07901 120.45933, 29.08923 120.47163, 29.10229 120.47926, 29.10678 120.48124, 29.09403 120.45409, 29.07036 120.44101, 29.07002 120.44652

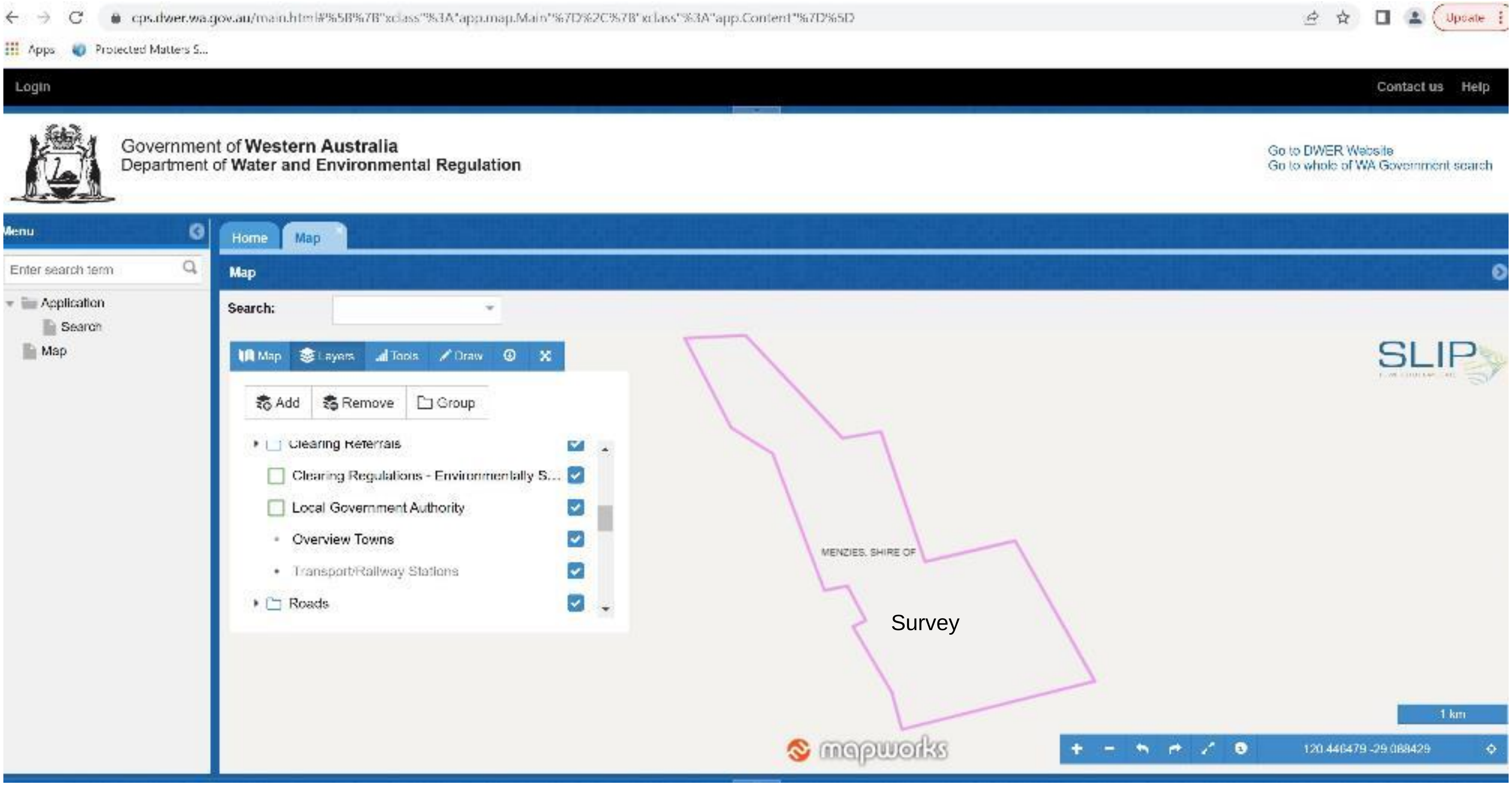
Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

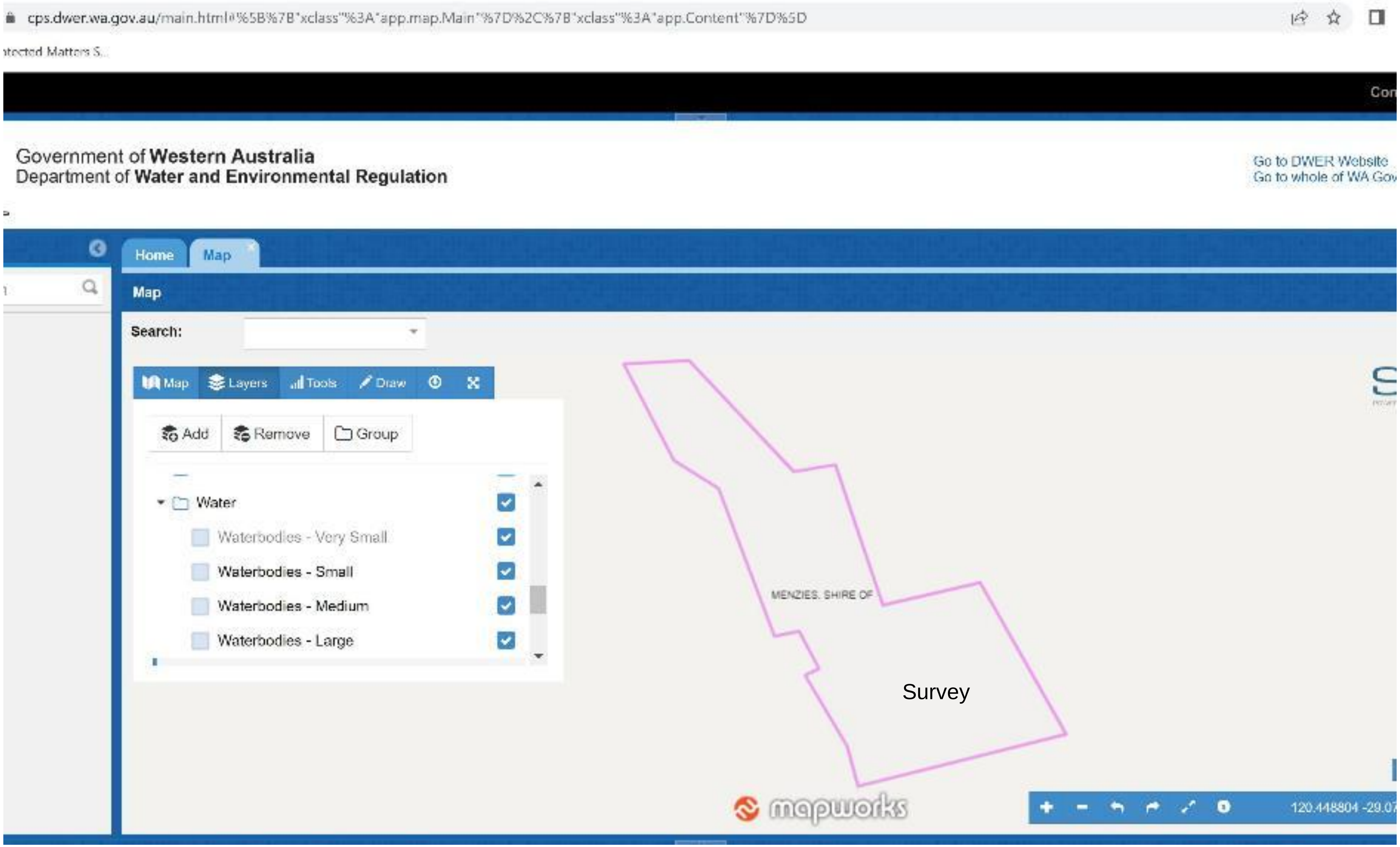
- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

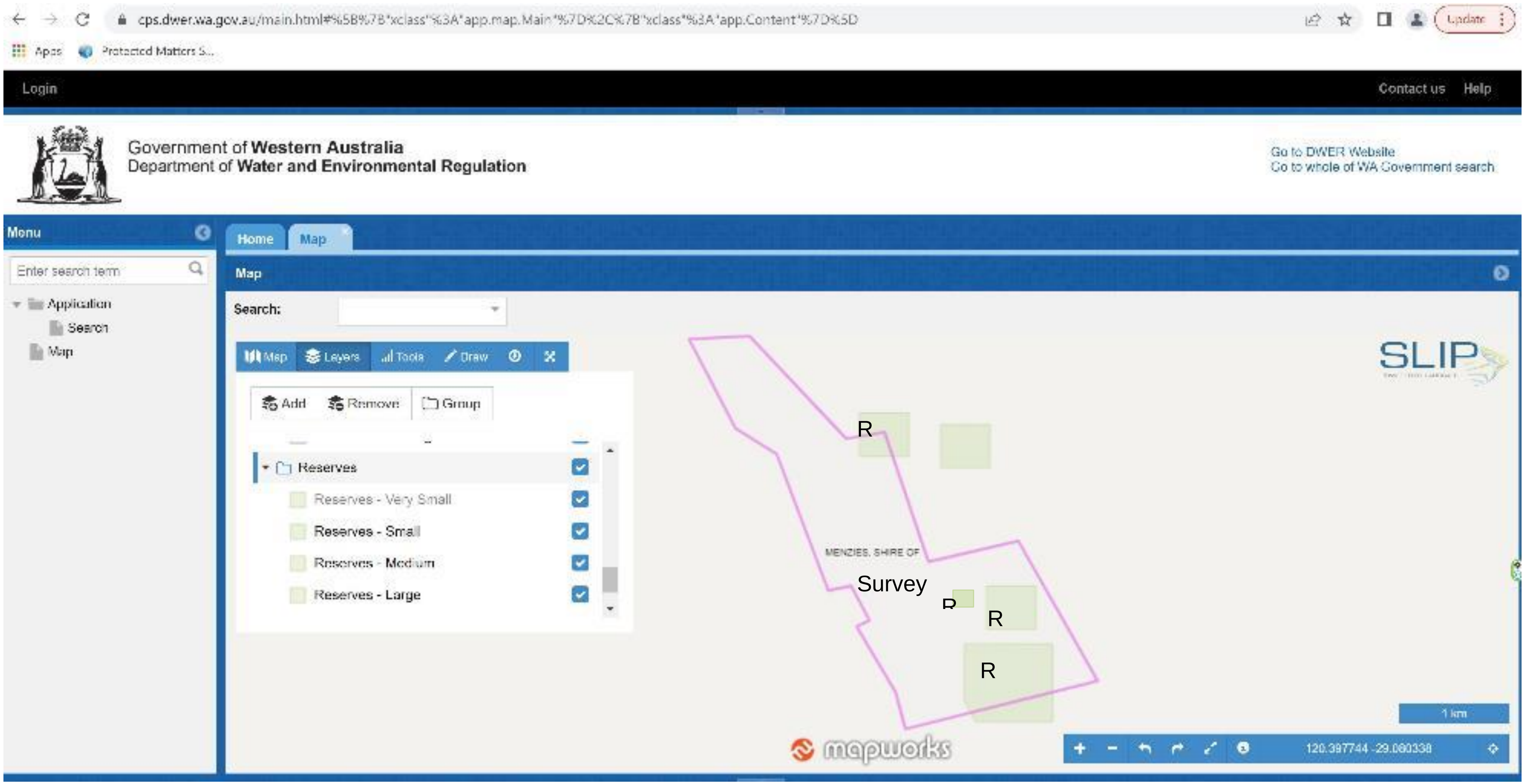
Please feel free to provide feedback via the Contact Us page.



DWER's Clearing Permit System Map Viewer showing no ESA's (dark green shaded areas) within the survey area (DWER, 2022)



DWER Clearing Permit System Map Viewer showing no waterbodies within the survey area (DWER, 2022)



DWER Clearing Permit System Map Viewer showing Class C reserves within the survey area (DWER, 2022)

Appendix 2: Threatened Flora Databases Search Results

GIS information provided in the Search results (Reference: 07_0522FL) listed the following species within a 10km radius of the survey area (DBCA, 2022a):

Taxon	**Conservation Code**	**Comment (Post field work)**
Calotis sp. Perrinvale Station	P3	Unlikely- No suitable habitat
Calytrix hislopii	P3	Unlikely- No suitable habitat
Drosera eremaea	P3	Unlikely- No suitable habitat
Hemigenia exilis	P4	Unlikely- No suitable habitat
Jacksonia lanicarpa	P1	Unlikely- No suitable habitat

Appendix 3: Vegetation Definitions

Vegetation Condition Definitions (Keighery, 1994)

Pristine (1). Pristine or nearly so, no obvious signs of disturbance.

Excellent (2). Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.

Very Good (3). Vegetation structure altered, obvious signs of disturbance.
For example, disturbance to vegetation structure caused by repeating fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good (4). Vegetation structure significantly altered by very obvious signs of multiple disturbance.
Retains basic vegetation structure or ability to regenerate it.
For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

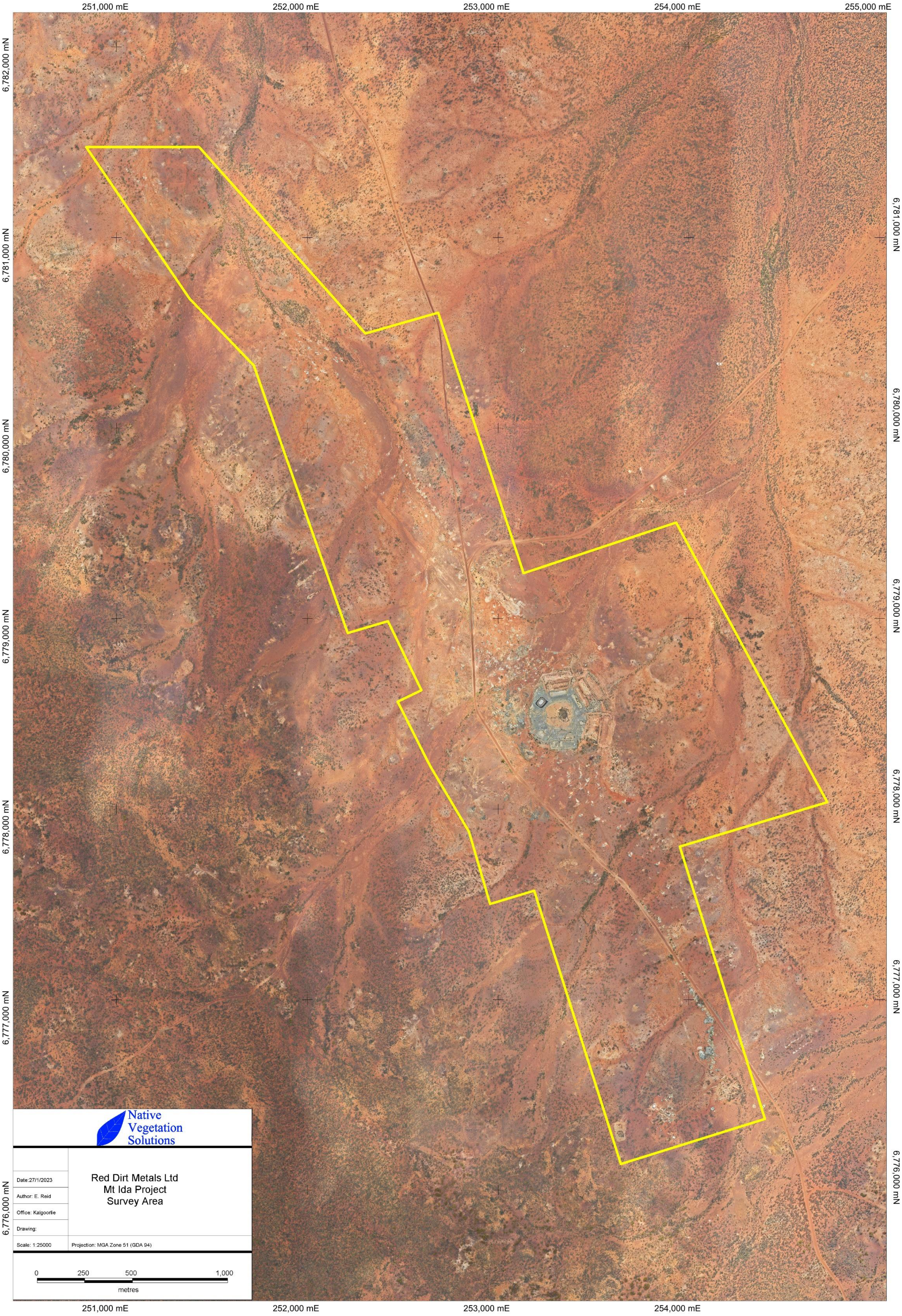
Degraded (5). Basic vegetation structure severely impacted by disturbance.
Scope for regeneration but not to a state approaching good condition without intensive management.
For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (6). 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 compromising weed or crop species with isolated trees or shrubs.

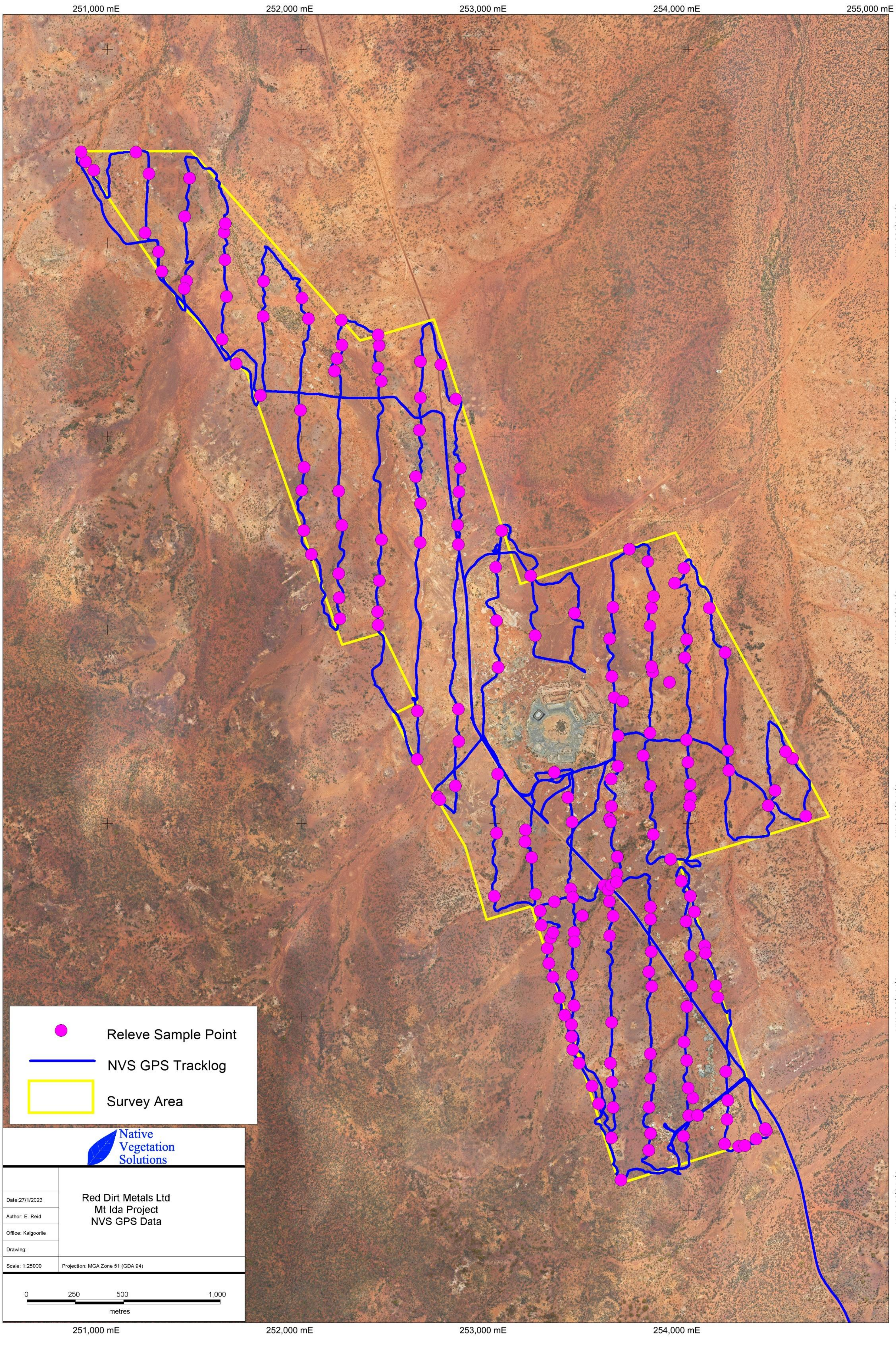
Vegetation Structure Definitions (Muir, 1977)

Life Form/Height Class	Canopy Cover			
	Dense 70-100% d	Mid-Dense 30-70% c	Sparse 10-30% i	Very Sparse 2-10% r
T Trees>30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
M Trees 15-30m	Dense Forest	Forest	Woodland	Open Woodlnd
LA Trees 5-15m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
LB Trees<5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
KT Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
KS Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
S Shrubs>2m	Dense Thicket	Thicket	Scrub	Open Scrub
SA Shrubs 1.5-2.0m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
SB Shrubs 1.0-1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
SC Shrubs 0.5-1.0m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
SD Shrubs 0.0-0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
P Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
H Hummock Grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
GT Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
GL Bunch grass <0.5m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
J Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
VT Sedges >0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
VL Sedges <0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
X Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverwort	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

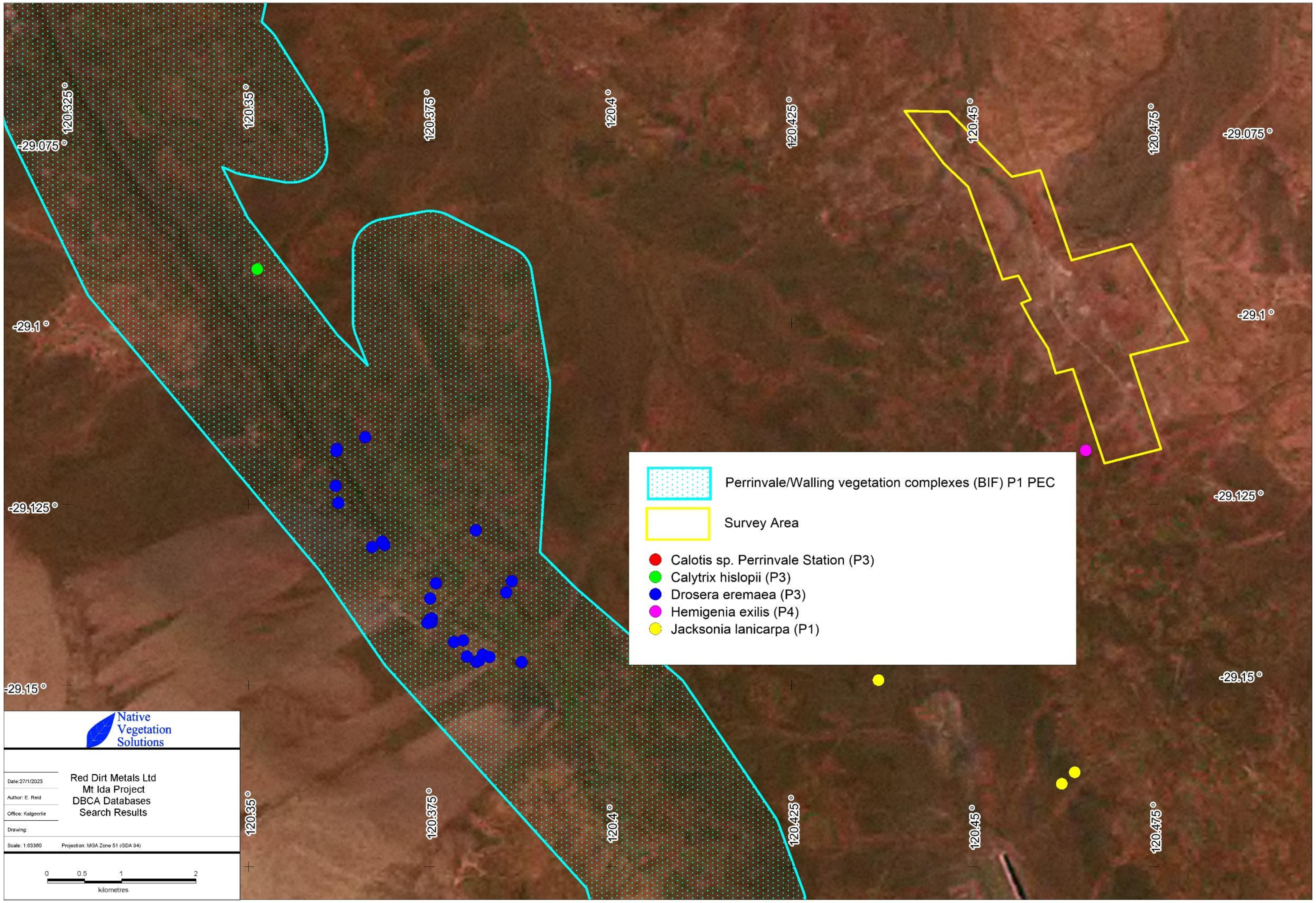
Appendix 4: Vegetation Mapping



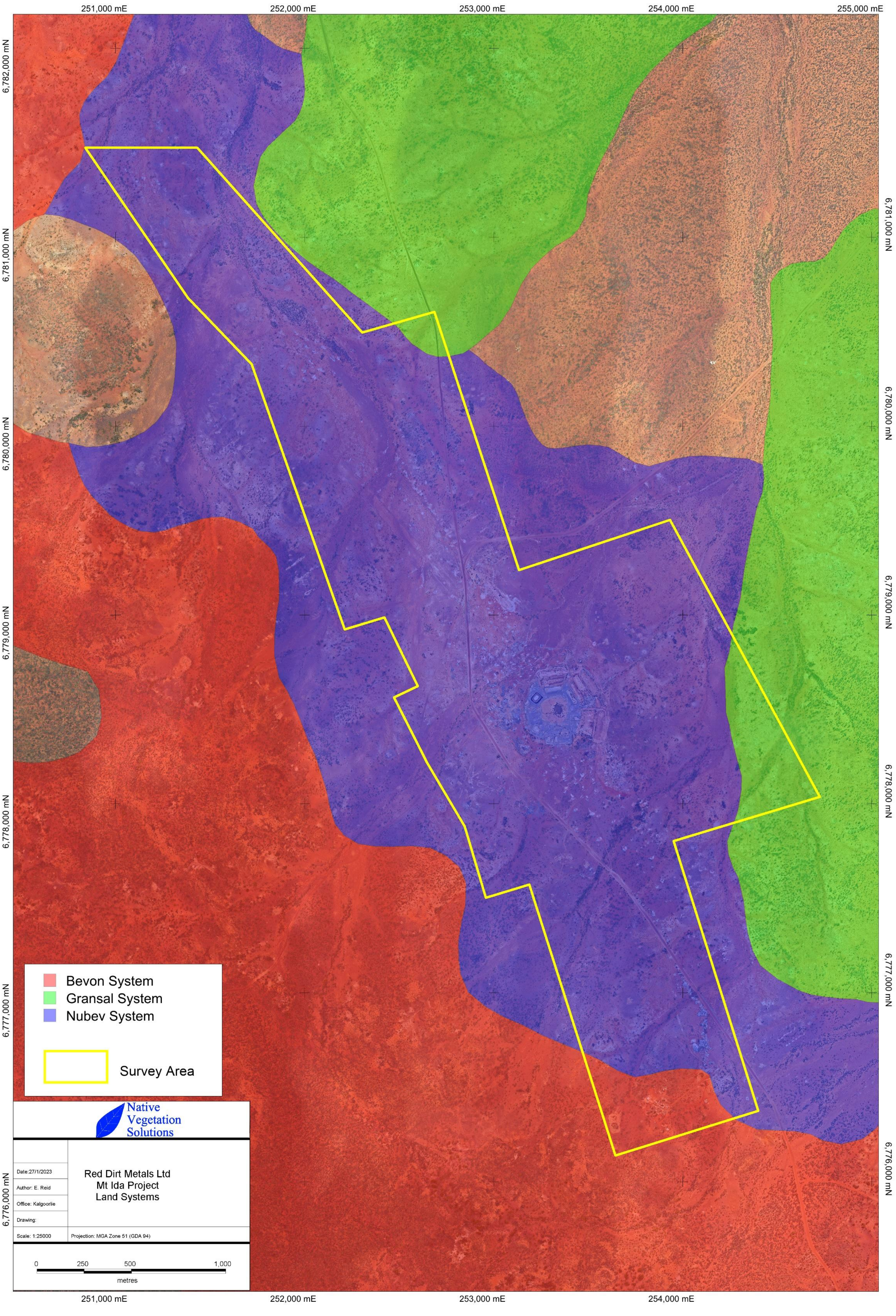
Map 1: Mt Ida Project Survey Area



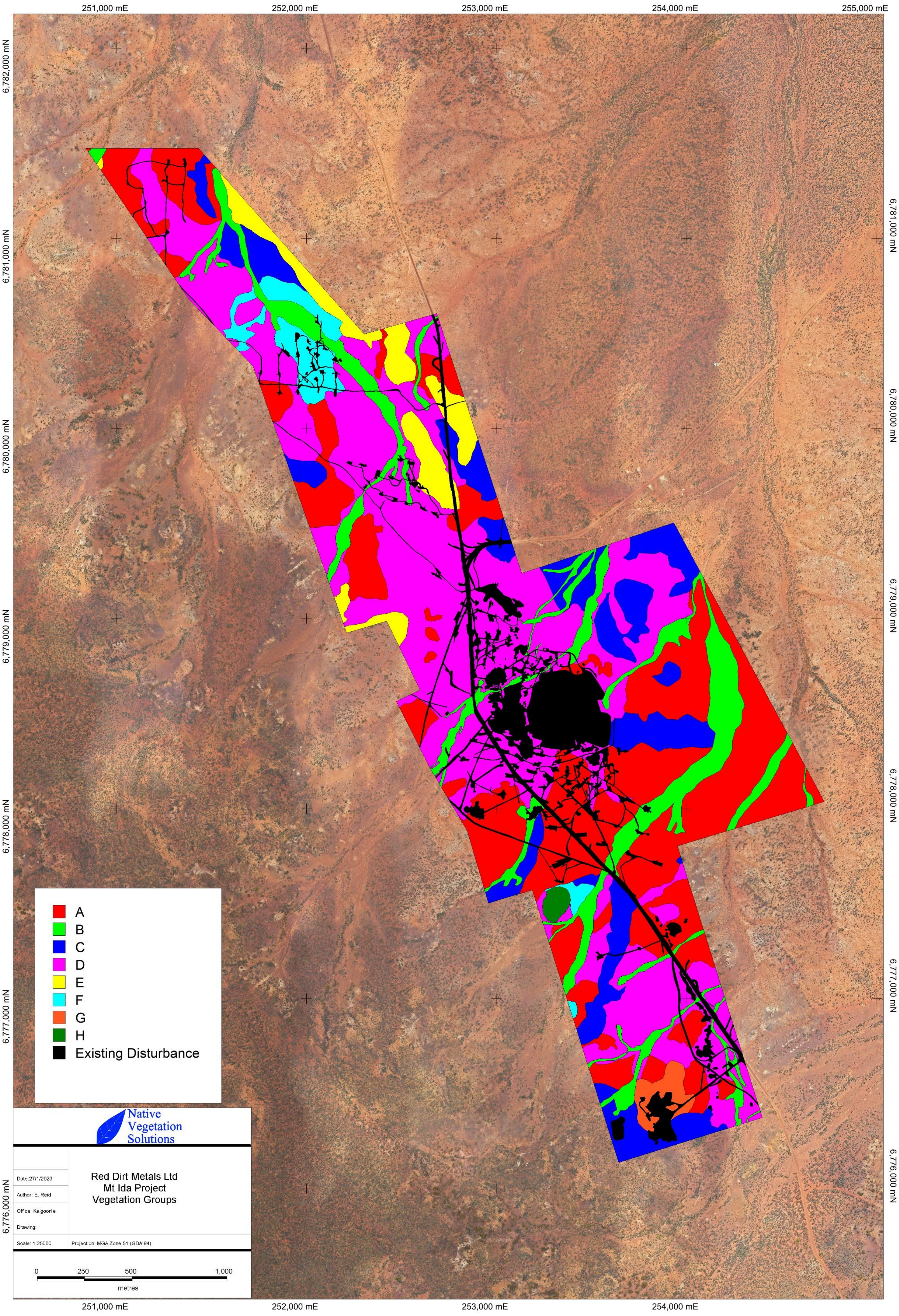
Map 2: NVS GP Data



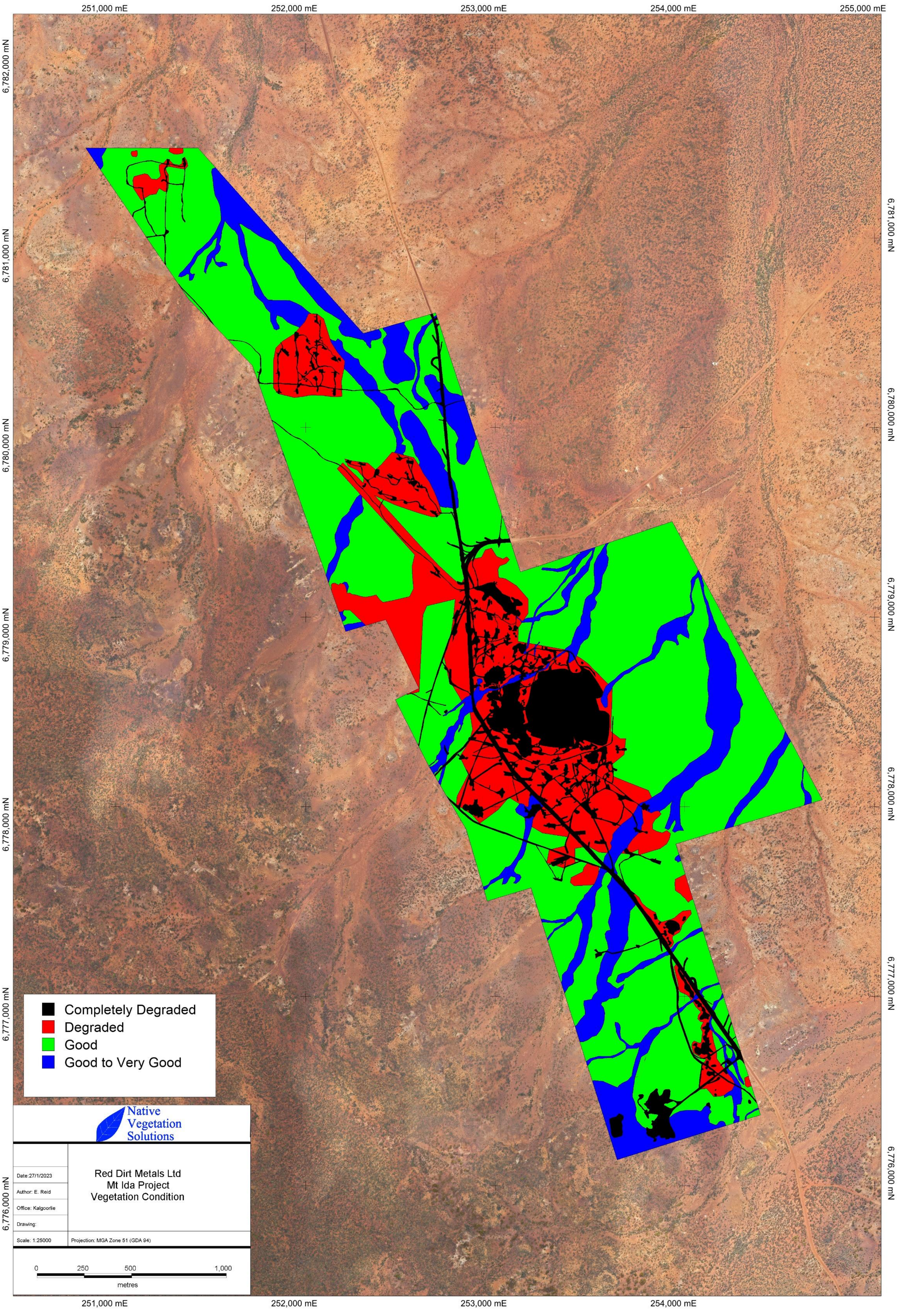
Map 3: DBC Databases Search Results



Map 4: Land Systems



Map 5: Vegetation Groups



Map 6: Vegetation Condition

Appendix 5: Species List

Species List per Vegetation Group

Family	Genus	Species	A	B	C	D	E	F	G	H
Amaranthaceae	*Ptilotus*	*Ptilotus aervoides*							*	
Amaranthaceae	*Ptilotus*	*Ptilotus obovatus*	*	*	*	*	*	*	*	*
Amaranthaceae	*Ptilotus*	*Ptilotus roei*							*	
Apocynaceae	*Alyxia*	*Alyxia buxifolia*			*					
Apocynaceae	*Leichhardtia*	*Leichhardtia australis*		*	*		*		*	
Asteraceae	*Brachyscome*	*Brachyscome ciliaris*				*		*		
Asteraceae	*Calotis*	*Calotis hispidula*							*	
Asteraceae	*Carthamus*	*Carthamus lanatus**	*			*				
Asteraceae	*Cratystylis*	*Cratystylis subspinescens*		*						
Asteraceae	*Gnephosis*	*Gnephosis tenuissima*	*							
Asteraceae	*Oncosiphon*	*Oncosiphon suffruticosum**				*		*		
Asteraceae	*Rhodanthe*	*Rhodanthe charsleyae*							*	
Asteraceae	*Rhodanthe*	*Rhodanthe chlorocephala* subsp. *splendida*							*	
Asteraceae	*Siemssenia*	*Siemssenia capillaris*				*	*	*	*	
Asteraceae	*Sonchus*	*Sonchus oleraceus**		*		*				
Cactaceae	*Cylindropuntia*	*Cylindropuntia imbricata**		*						
Cactaceae	*Opuntia*	*Opuntia stricta**	*	*		*				*
Casuarinaceae	*Casuarina*	*Casuarina pauper*	*							*
Chenopodiaceae	*Atriplex*	*Atriplex bunburyana*		*	*					
Chenopodiaceae	*Atriplex*	*Atriplex stipitata*	*	*						
Chenopodiaceae	*Atriplex*	*Atriplex vesicaria*	*	*	*					
Chenopodiaceae	*Enchylaena*	*Enchylaena tomentosa* var. *tomentosa*	*	*	*		*			
Chenopodiaceae	*Maireana*	*Maireana carnosa*	*							
Chenopodiaceae	*Maireana*	*Maireana georgei*	*	*	*				*	
Chenopodiaceae	*Maireana*	*Maireana glomerifolia*				*		*		
Chenopodiaceae	*Maireana*	*Maireana pyramidata*	*	*	*	*	*	*		*
Chenopodiaceae	*Maireana*	*Maireana sedifolia*	*				*			*
Chenopodiaceae	*Maireana*	*Maireana tomentosa*								*
Chenopodiaceae	*Maireana*	*Maireana trichoptera*	*			*	*	*		
Chenopodiaceae	*Maireana*	*Maireana triptera*	*		*	*	*	*	*	*
Chenopodiaceae	*Rhagodia*	*Rhagodia eremaea*	*							
Chenopodiaceae	*Sclerolaena*	*Sclerolaena densiflora*	*			*		*		
Chenopodiaceae	*Sclerolaena*	*Sclerolaena diacantha*	*	*	*	*	*	*		
Chenopodiaceae	*Sclerolaena*	*Sclerolaena eriacantha*		*		*		*	*	
Chenopodiaceae	*Sclerolaena*	*Sclerolaena eurotioides*							*	
Chenopodiaceae	*Tecticornia*	*Tecticornia disarticulata*				*		*		*
Colchicaceae	*Wurmbea*	*Wurmbea densiflora*			*	*		*		
Fabaceae	*Acacia*	*Acacia aneura*	*	*	*				*	*
Fabaceae	*Acacia*	*Acacia burkittii*		*			*		*	
Fabaceae	*Acacia*	*Acacia caesaneura*			*					
Fabaceae	*Acacia*	*Acacia craspedocarpa*	*	*	*	*		*		
Fabaceae	*Acacia*	*Acacia hemiteles*		*						
Fabaceae	*Acacia*	*Acacia incurvaneura*	*	*	*					
Fabaceae	*Acacia*	*Acacia mulganeura*	*		*					*
Fabaceae	*Acacia*	*Acacia oswaldii*	*							
Fabaceae	*Acacia*	*Acacia pteraneura*		*						
Fabaceae	*Acacia*	*Acacia quadrimarginea*			*		*		*	
Fabaceae	*Acacia*	*Acacia ramulosa* var. *ramulosa*		*	*					
Fabaceae	*Acacia*	*Acacia sibirica*	*	*	*		*			
Fabaceae	*Acacia*	*Acacia tetragonophylla*	*	*	*	*		*		*
Fabaceae	*Senna*	*Senna artemisioides* subsp. ×*artemisioides*		*	*	*	*	*	*	
Fabaceae	*Senna*	*Senna artemisioides* subsp. ×*sturtii*				*		*		
Fabaceae	*Senna*	*Senna artemisioides* subsp. *filifolia*	*	*	*		*			
Fabaceae	*Senna*	*Senna cardiosperma*							*	
Fabaceae	*Senna*	*Senna glutinosa* subsp. *chatelainiana*			*					
Fabaceae	*Senna*	*Senna* sp. Meekatharra			*					
Frankeniaceae	*Frankenia*	*Frankenia ?setosa*	*							
Geraniaceae	*Erodium*	*Erodium cygnorum*	*	*						
Goodeniaceae	*Goodenia*	*Goodenia havilandii*	*	*	*	*	*	*		
Goodeniaceae	*Scaevola*	*Scaevola spinescens*	*	*	*		*			*
Haloragaceae	*Haloragis*	*Haloragis trigonocarpa*	*	*			*			
Lamiaceae	*Salvia*	*Salvia verbenaca**	*	*		*				
Lamiaceae	*Teucrium*	*Teucrium racemosum*		*						

Family	Genus	Species	A	B	C	D	E	F	G	H
Lamiaceae	_Teucrium_	_Teucrium teucriiflorum_			*					
Malvaceae	_Abutilon_	_Abutilon otocarpum_		*						
Malvaceae	_Abutilon_	_Abutilon oxycarpum_			*					
Malvaceae	_Brachychiton_	_Brachychiton gregorii_			*					
Malvaceae	_Sida_	_Sida calyxhymenia_	*						*	
Malvaceae	_Sida_	_Sida ectogama_		*	*		*			
Malvaceae	_Sida_	_Sida fibulifera_				*		*		
Malvaceae	_Sida_	_Sida_ sp. Golden calyces glabrous			*					
Myrtaceae	_Eucalyptus_	_Eucalyptus lucasii_		*						
Myrtaceae	_Eucalyptus_	_Eucalyptus salubris_				*				
Pittosporaceae	_Pittosporum_	_Pittosporum angustifolium_		*						
Poaceae	_Aristida_	_Aristida contorta_	*			*	*	*	*	
Poaceae	_Austrostipa_	_Austrostipa nitida_					*		*	*
Poaceae	_Enneapogon_	_Enneapogon caerulescens_	*			*		*		
Poaceae	_Enteropogon_	_Enteropogon ramosus_		*		*		*		
Poaceae	_Eriachne_	_Eriachne pulchella_ subsp. _pulchella_	*		*	*	*	*		
Poaceae	_Monachather_	_Monachather paradoxus_		*			*			
Primulaceae	_Lysimachia_	_Lysimachia arvensis_*	*			*				
Proteaceae	_Hakea_	_Hakea preissii_	*	*		*	*	*		*
Proteaceae	_Hakea_	_Hakea recurva_ subsp. _recurva_				*		*		
Pteridaceae	_Cheilanthes_	_Cheilanthes sieberi_ subsp. _sieberi_		*	*					
Sapindaceae	_Dodonaea_	_Dodonaea lobulata_	*		*		*			*
Scrophulariaceae	_Eremophila_	_Eremophila forrestii_ subsp. _forrestii_		*	*		*			
Scrophulariaceae	_Eremophila_	_Eremophila glutinosa_		*	*					
Scrophulariaceae	_Eremophila_	_Eremophila latrobei_ subsp. _latrobei_				*	*	*		
Scrophulariaceae	_Eremophila_	_Eremophila metallicorum_		*	*	*		*		
Scrophulariaceae	_Eremophila_	_Eremophila oldfieldii_ subsp. _angustifolia_	*	*	*		*			*
Scrophulariaceae	_Eremophila_	_Eremophila pantonii_	*		*					
Scrophulariaceae	_Eremophila_	_Eremophila platycalyx_ subsp. _Granites_	*						*	
Scrophulariaceae	_Myoporum_	_Myoporum montanum_					*			
Solanaceae	_Solanum_	_Solanum lasiophyllum_	*	*		*	*	*	*	
Thymelaeaceae	_Pimelea_	_Pimelea microcephala_		*						
Zygophyllaceae	_Roepera_	_Roepera eremaea_					*			

Appendix 2: Vertebrate Fauna Reconnaissance Survey and Risk Assessment

Vertebrate fauna reconnaissance survey and risk assessment

Mt Ida Lithium Gold Project

Prepared for: Mt Ida Gold Pty Ltd

Version 1. January, 2023

RECORD OF DISTRIBUTION

No. of copies	Report File Name	Report Status	Date	Prepared for:	Initials
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EXECUTIVE SUMMARY

Mt Ida Gold Pty Ltd (Mt Ida Gold) is a subsidiary company of Red Dirt Metals Ltd (ASX: RDT) who is focused on the evaluation and development of the recently discovered Mt Ida Lithium province in Western Australia's Eastern Goldfields region and is the owner of its Mt Ida Lithium Gold Project.

Mt Ida Gold is planning to further explore and ultimately mine the areas adjacent to the historical Mt Ida Mine that was closed in 2008. The project area is ~85km north-west of Menzies and ~85 km west-south-west of Leonora. The project area is ~617ha and is reported to contain lithium, gold and copper deposits.

Terrestrial Ecosystems was commissioned by Mt Ida Gold to undertake a Basic fauna risk assessment and a search of the project area for Malleefowl (*Leipoa ocellata*) and their mounds. The purpose of this fauna assessment was to provide information to the Department of Mines, Industry Regulation and Safety (DMIRS) and / or the Environmental Protection Authority (EPA) on the potential impacts on the vertebrate fauna assemblage in the project area to enable the proposed development to be adequately assessed. The methodology broadly follows that described in the Environmental Protection Authority (EPA; 2020) *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment*.

The project area contains one broad fauna habitat of mixed mulga, acacia and chenopod shrubland. As with most areas in the Goldfields the density of trees and shrubs varies appreciably across the project area with denser vegetation along the drainage lines. Some of the project area is highly disturbed or cleared and is therefore devoid of terrestrial vertebrate fauna.

Clearing native vegetation and developing a mine is likely to result in the loss of a small number of vertebrate fauna that are unable to move away during the clearing process. The few larger animals, such as goannas, and most of the birds will move into adjacent areas once clearing commences.

Impacts on vertebrate fauna associated with clearing vegetation and development in the project area in a local context will be low and, in a landscape, or bioregional context are very low.

There are no threatened species of fauna in the project area. As the proposed project is unlikely to significantly impact on a conservation significant vertebrate fauna a referral under the *EPBC Act 1999* is not recommended.

1. INTRODUCTION

1.1 BACKGROUND

Mt Ida Gold Pty Ltd (Mt Ida Gold) is planning to further explore and ultimately mine the areas adjacent to the historical Mt Ida Mine that was closed in 2008. The project area incorporates the pit and waste dumps from previous mining activity. The project area is ~85km north-west of Menzies and ~85 km west of Leonora (Figure 1).

The project area assessed in this report comprises a single area (~617ha; Figure 2) and is reported to contain lithium, gold, and copper deposits.

1.2 PROJECT OBJECTIVES AND SCOPE OF WORKS

Terrestrial Ecosystems was commissioned by Mt Ida Gold to undertake a basic fauna risk assessment and a search of the project area for Malleefowl (*Leipoa ocellata*) and their mounds. The purpose of this fauna risk assessment was to provide information to the Department of Mines, Industry Regulation and Safety (DMIRS) and / or the Environmental Protection Authority (EPA) on the potential impacts on the vertebrate fauna assemblage in the project area to enable the proposed development to be adequately assessed. The methodology broadly follows that described in the Environmental Protection Authority (EPA; 2020) *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment*.

A Basic fauna risk assessment involves undertaking a desktop review and site visit. The objectives of this fauna risk assessment were to:

- provide an indication of the vertebrate fauna assemblage (reptiles, amphibians, mammals and birds) on and near the project area so that potential impacts on the fauna and fauna assemblage might be adequately assessed;
- identify the presence and/or potential risk of impacts on species of conservation significance that are present or likely to be present in the project area;
- assess the impact and environmental risks associated with the proposed development on the fauna assemblage;
- determine if any additional surveys are required to assess the potential impact on fauna assemblages in the project area, in particular, impacts on species of conservation significance; and
- make recommendations that avoid, mitigate or minimise potential impacts on resident fauna.

To achieve these objectives, Terrestrial Ecosystems:

- searched the Commonwealth Government's online database of matters of national environmental significance (MNES) to identify species potentially occurring within the area that are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC 1999*) or international migratory bird agreements (JAMBA/CAMBA);
- searched Terrestrial Ecosystems' database (which includes data from the Atlas of Living Australia and Western Australian Museum (WAM) collection) to identify potential vertebrate fauna within the area;
- reviewed previous fauna surveys conducted near the project area;
- undertook a search of the project area for Malleefowl and their mounds and to identify available fauna habitat types;
- discussed the likelihood of species listed under the *EPBC Act* and the Western Australian *Biodiversity Conservation Act 2016* (*BC Act 2016*) being present in the project area; and
- provided management recommendations to avoid, mitigate and minimise potential impacts on the fauna in the project area.

2. EXISTING ENVIRONMENT

2.1 LOCATION OF PROJECT AREA

The project area is in the Murchison 1 (MUR1 – East Murchison subregion) IBRA bioregion. Cowan (2001) described the East Murchison IBRA subregion as internally draining, with extensive areas of elevated red desert sandplains with minimal dune development. The bioregion includes broad plains with red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga woodlands often with ephemerals, hummock grasslands, saltbush shrublands and halosarcia shrublands.

The threatening processes for conservation significant fauna were listed by Cowan (2001) as foxes and cats. In addition, cattle grazing and mining activity over many years have significantly degraded small parcels of land dotted throughout the landscape.

2.2 LAND USE HISTORY

The dominant land uses for the bioregion are native pasture to support grazing on native pasture, unallocated crown land, and to a much lesser extent mining (Cowan 2001).

2.3 CLIMATE

The project area is characterised as semi-arid. Menzies, which is 85km to the southeast, has an annual rainfall of 254mm, although this varies considerably from year-to-year. The highest mean maximum and minimum temperatures in Menzies are in January with an average of 35.1°C and 19.7ºC, respectively (Bureau of Meteorology 2022). The lowest mean daily maximum and minimum temperatures occur in July (Chart 1). Rainfall is spread over the year with summer thunderstorms and winter rains resulting from low pressure cells moving in an easterly direction.

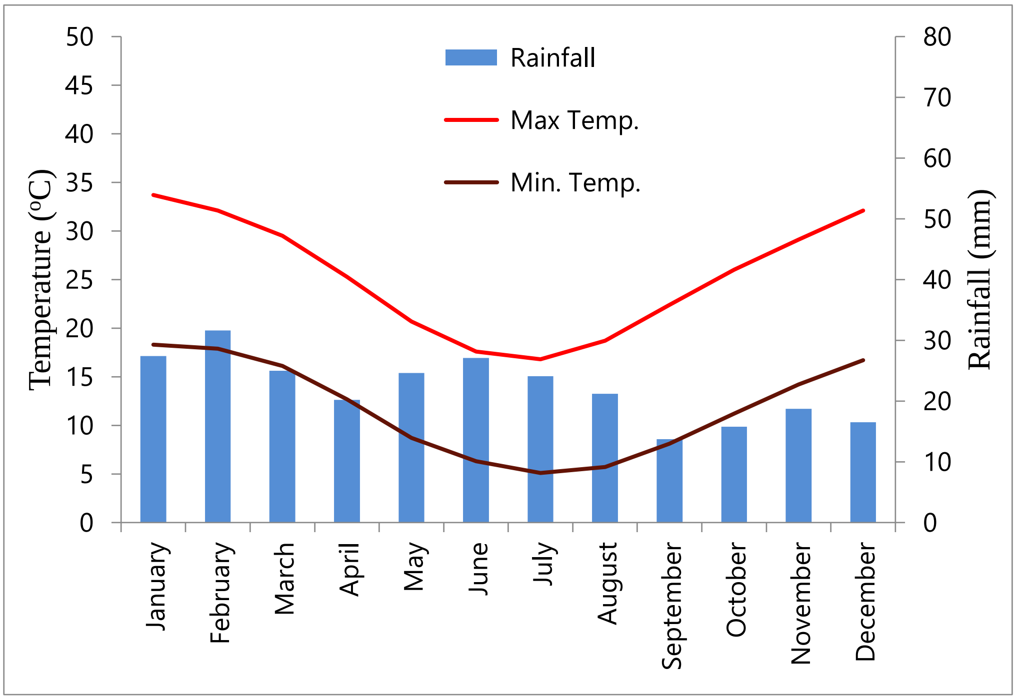


Chart 1. Monthly weather for Menzies

2.4 REGIONAL BIOLOGICAL FAUNA CONTEXT OF PROJECT AREA

Numerous vertebrate fauna surveys have been undertaken near the project area. These include:

- Bell, D.T., Bell, R.C. and Loneragan, W.A. (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia* 90, 219-227.
- Cowan, M.A. and How, R.A. (2004) Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. *Records of the Western Australian Museum*, 22, 91-100.
- Dell, J and How, R.A. (1988) Vertebrate fauna. In: The biological Survey of the Eastern Goldfields of Western Australia, Part 5, Edjudina - Menzies Study Area. *Records of the Western Australian Museum*, Supplement No 31., pp. 38-77.
- Keith Lindbeck and Associates (2012) *Central Yilgarn Iron Project (CYIP) Fauna Assessment Mt Mason*, Unpublished report for Jupiter Mines Ltd, Perth.
- Keith Lindbeck And Associates (2013) *Mt Mason Project and Proposed Haul Rd Targeted EPBC Fauna Survey*, unpublished report for Jupiter Mines Ltd, Perth.
- Ninox Wildlife Consulting (2006) *A vertebrate fauna assessment of the Tarmoola area*. Unpublished report for St Barbara Limited, Lower King WA.

Data in the Atlas of Living Australia, which includes data from the Western Australian Museum collection, have also been added to the information contained in Appendix B, and the compilation of the species lists for the project area.

The most useful and representative data for the project area is the information in the Cowan and How (2004) and Dell and How (1988) reports. The Cowan and How (2004) data come from two surveys in the Goongarrie National Park and the data from Dell and How (1988) are part of the WAM series of surveys of the Goldfields, and in this case the Edjudina – Menzies area. The data from the Atlas of Living Australia is more comprehensive, but includes historical inforamtion, therefore species that are locally extinct.

2.4.1 Fauna species at risk

In the now dated Cowan (2001) report, fauna species identified as being at risk in the East Murchison subregion as Bilby (*Macrotis lagotis*), Marsupial Mole (*Notoryctes typhlops*), Mulgara (*Dasycercus cristicauda*), Malleefowl (*Leipoa ocellata*), Princess Parrot (*Polytelis alexandrae*), Slender-billed Thornbill (*Acanthiza iredalei iredalei*), Giant Desert Skink (*Liopholis kintorei*) and Peregrine Falcon (*Falco peregrinus*).

Since then, the Grey Falcon (*Falco hypoleucos*), Night Parrot (*Pezoporus occidentalis*) and Sandhill Dunnart (*Sminthopsis psammophila*) have been added to the list.

This report assesses the potential for these species to be found in the project area and the potential impact that any proposed development might have on these species, and other conservation significant fauna.

3. METHODOLOGY

3.1 DATABASE SEARCHES

A search of the *EPBC Act 1999* online list of threatened species was undertaken to identify species of conservation interest to the Commonwealth Government under *EPBC Act* in the vicinity of the project area. In addition, a desktop search of the Terrestrial Ecosystems' fauna survey database was used to develop an appreciation of the vertebrate fauna assemblages near the project area.

Other more general texts were also used to provide supplementary information on vertebrates in the bioregion, including Tyler et al. (2000) for frogs; Storr et al. (1983, 1990, 1999, 2002) and Thompson and Thompson (2010) for reptiles; Johnstone and Storr (1998, 2004) for birds; and Van Dyck and Strahan (2008) for mammals.

Collectively these sources of information were used to create lists of species expected to utilise the project and adjacent areas. It should be noted that these lists will include species that have been recorded in the general region but are possibly vagrants and they will not generally be found in the project area due to a lack of suitable habitat. Vagrants can be recorded anywhere. Many of the bird, mammal, reptile and amphibian species have specific habitat requirements that may be present in the general area but not in the project area. Also, the ecology of many of these species is often not well understood and it can sometimes be difficult to indicate those species whose specific habitat requirements are not present in the project area. Consequently, many species will be included in the lists produced from database searches but will not be present in the actual project area.

There are errors in most databases, including Dandjoo, Atlas of Living Australia and the WA Museum (WAM) collection. These errors occur because of a misidentification of individuals, taxonomic name changes and incorrect coordinates being entered into the database. Terrestrial Ecosystems was unable to verify the primary records, so it has used the information provided. Readers should therefore appreciate that species lists and fauna surveys reported in the appendices may include these errors. These databases also contain historical records and therefore include species that are no longer present in the area (e.g. *Myrmecobius fasciatus*, *Bettongia lesueur* and *Macrotis lagotis*).

Because the project area is within 40km of Lake Ballard, numerous water birds are likely to be present in database searches, even though there is no available habitat for these species in the project area.

3.2 FAUNA HABITAT ASSESSMENT

A fauna habitat assessment was undertaken on 9 May 2022 for a portion of the project area. As the project design was modified slightly after the site assessment some additional areas were assessed using aerial photography and the flora and vegetation mapping provided by Native Vegetation Solutions. The May 2022 field assessment had two foci:

- assessing fauna habitat types and their condition; and
- assessing the possible presence of and recording evidence of conservation significant fauna so that mine planning can minimise potential impacts and mitigation and management strategies can be developed and implemented to reduce potential impacts.

The fauna habitat assessor stopped at multiple locations within the project area and recorded a suite of data about the fauna habitat and its condition. This information included a description of the habitat structure, habitat condition, landform, soils and vegetation and time since last fire. The following data were recorded at each location as part of the habitat assessment:

Observer's Name:	
Coordinates of the location as UTM (GDA94):	
Fire history – options	
☐ > 5 years	
☐ 1-5 years	
☐ < 1 year	
Landform – options	
☐ Beach	☐ Lower slope
☐ Clay plain	☐ Mid slope
☐ Cliff	☐ Ridge
☐ Creek line	☐ River
☐ Dam	☐ Rocky outcrop / breakaway
☐ Drainage line	☐ Salt lake
☐ Dune crest	☐ Sand dune
☐ Dune slope	☐ Sand plain
☐ Dune swale	☐ Stony plain
☐ Escarpment	☐ Swamp
☐ Flat	☐ Undulating
☐ Gorge	☐ Upper slope
☐ Gully	☐ Wetland
☐ Intertidal / mangrove	☐ Water hole
☐ Lake / lake edge	
Habitat quality – options	
☐ *High quality fauna habitat* – These areas closely approximate the vegetation mix and quality that would have been in the area prior to any disturbance. The habitat has connectivity with other habitats and is likely to contain the most natural vertebrate fauna assemblage.	
☐ *Very good fauna habitat* - These areas show minimal signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) and generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be minimally effected by disturbance.	
☐ *Good fauna habitat* – These areas showed signs of disturbance (e.g. grazing, clearing, fragmentation, weeds) but generally retain many of the characteristics of the habitat if it had not been disturbed. The habitat has connectivity with other habitats and fauna assemblages in these areas are likely to be affected by disturbance.	
☐ *Disturbed fauna habitat*– These areas showed signs of significant disturbance. Many of the trees, shrubs and undergrowth are cleared. These areas may be in the early succession and regeneration stages. Areas may show signs of significant grazing, containing weeds or have been damaged by vehicle or machinery. Habitats are fragmented or have limited connectivity with other fauna habitats. Fauna assemblages in these areas are likely to differ significantly from what might be expected in the area had the disturbance not occurred.	
☐ *Highly degraded fauna habitat* – These areas often have a significant loss of vegetation, an abundance of weeds, and a large number of vehicle tracks or are completely cleared. Limited or no fauna habitat connectivity. Fauna assemblages in these areas are likely to be significantly different to what might have been in the area pre-disturbance.	

Habitat structure – combined into habitat description			
Upper stratum			
☐	Tall open woodland	☐	Scattered tall trees
☐	Tall woodland	☐	Scattered trees
☐	Open woodland	☐	Scattered low trees
☐	Woodland	☐	Low closed forest
☐	Open forest	☐	Low open forest
☐	Closed forest	☐	Low woodland
☐	Tall closed forest	☐	Low open woodland
☐	Tall open forest		
Middle stratum			
☐	Shrubland	☐	Open heath
☐	Tall shrubland	☐	Low closed heath
☐	Tall open shrubland	☐	Low open heath
☐	Low shrubland	☐	Tall closed scrub
☐	Scattered low shrubs	☐	Tall open scrub
☐	Low open shrubland	☐	Scattered tall shrubs
☐	Scattered tall shrubs	☐	Open shrubland
☐	Closed heath	☐	Scattered shrubs
Lower stratum			
☐	Closed hummock grassland	☐	Closed tussock grassland / sedgeland / herbland
☐	Mid-dense hummock grassland	☐	Tussock grass land / sedgeland / herbland
☐	Hummock grassland	☐	Open tussock grassland / sedgeland / herbland
☐	Open hummock grassland	☐	Scattered tussock / grasses / sedges / herbs
☐	Scattered hummock grassland	☐	Very open tussock grassland / herbland
Soil Type – options			
☐	Sand	☐	Silty loam
☐	Loamy sand	☐	Sand clay loam
☐	Clayey sand	☐	Clay
☐	Clay loam	☐	Peat / organic
☐	Silty clay loam	☐	Stony
☐	Sandy loam		
Soil colour - options			
☐	Black	☐	Red
☐	Brown	☐	White
☐	Grey	☐	Yellow
☐	Orange		

Surface stones – options			
☐	None	☐	Boulders (>250mm)
☐	Pebbles (0-50mm)	☐	Rocks
☐	Cobbles (51-250)		

3.3 SURVEY AND REPORTING STAFF

Dr Scott Thompson undertook the site investigation, fauna habitat assessment and search for Malleefowl and their mounds. The survey was undertaken with the support from Eren Reid from Native Vegetation Solutions. Dr Graham Thompson drafted the report and Dr Scott Thompson reviewed the report before it was sent to the client. Both senior scientists have appropriate relevant post-graduate qualifications, extensive experience in conducting fauna assessments in the Goldfields, have published research articles on biodiversity, fauna assemblages, conservation significant species, survey strategies for Malleefowl, trapping techniques and temporal variations in trapped fauna assemblages based on Goldfields surveys and are therefore appropriately trained and experienced for the task of preparing this assessment (Table 1).

Table 1. Staffing

Name	Experience and qualifications	Tasks
Dr Scott Thompson	PhD, Certified Environmental Practitioner (Ecology Specialist), 20+ years of experience and a good familiarity with the vertebrate fauna in the Goldfields	Field work, fauna habitat mapping and reviewing report
Dr Graham Thompson	PhD, 20+ years of experience and a good familiarity with the vertebrate fauna in the Goldfields	Reporting

3.4 LIMITATIONS

This Basic vertebrate fauna risk assessment is based on information contained in the Commonwealth Government's online EPBC MNES online database and other published and unpublished fauna survey data for the bioregion and a site visit. It is acknowledged that multiple surveys conducted in different seasons, repeated over several years are necessary to fully appreciate the fauna assemblage in the project area.

The (EPA; 2020) *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* suggested that fauna surveys may be limited by many variables. Limitations associated with each of these variables are assessed in Table 2.

Table 2. Fauna survey limitations and constraints

Possible limitations	Constraint (yes/no); significant, moderate or negligible	Comment
Competency and experience of the consultant carrying out this assessment	No	The environmental scientists that undertook the site assessment, drafted, and reviewed this report are familiar with the vertebrate fauna of this bioregion.
Scope	No	All aspects of the scope of works have been addressed.
Proportion of fauna identified, recorded and/or collected	No	Not applicable.
Accuracy of previous survey work	Yes, negligible	Terrestrial Ecosystems has reported fauna survey data recorded by various authors but is not able to vouch for the accuracy of much of this information. It is acknowledged that the taxonomy of Western Australian vertebrates is continually being revised and the nomenclature of some of the species listed in the appendices may have changed since publication by the authors.
Sources of information	Yes, negligible	Vertebrate fauna information was available from on-line databases and unpublished and published reports of surveys conducted in the bioregion in a variety of habitat types. Many of these surveys employed a low level of trapping effort which significantly impacts on the capacity of these data to represent the fauna assemblages in the areas surveyed.
Proportion of the task achieved	No	All tasks completed.
Timing/weather/ season/ cycle	N/A	Weather was suitable for a site investigation.
Disturbances which affected results of the survey	No	Disturbance areas throughout the project area have been factored into this assessment.
Intensity of survey effort	N/A	
Completeness	No	All aspects of this assessment have been completed.
Resources	No	Adequate resources were available.
Remoteness and/or access problems	No	All areas could be accessed.
Availability of contextual information on the region	No	There are limited fauna survey data for areas around the project area, but the data from further afield is adequate to provide a list of species potentially in the project area.

4. RESULTS

4.1 FAUNA HABITAT

The project area supports one broad fauna habitat of mixed mulga, acacia and chenopod shrubland. As with most areas in the Goldfields the density of trees and shrubs varies appreciably across the project area with denser vegetation along the drainage lines. Some of the study area is highly disturbed or cleared and is therefore largely devoid of terrestrial vertebrate fauna. Plates 1-8 provide representative images of the fauna habitat types and disturbance.

Plate 1. Mixed mulga, acacia and chenopod shrubland

Plate 2. Mixed mulga, acacia and chenopod shrubland

Plate 3. Mixed mulga, acacia and chenopod shrubland

Plate 4. Mixed mulga, acacia and chenopod shrubland

Plate 5. Disturbed area **Plate 6. Disturbed area**

Plate 7. Disturbed area **Plate 8. Disturbed area**

The results of the rapid habitat assessment are provided in Appendix D. Images of the habitat at each of these assessment points provides a more comprehensive overview of the habitats in the project area and along the infrastructure corridors.

4.1.1 Anthropogenic disturbance

There is substantial evidence of previous exploration and mining activity in the project area including a substantial mining pit and the associated waste dumps. A considerable quantity of historical waste material has been left in parts of the project area. In addition more recent waste has been dumped into open pits.


Plate 9. Remains of a house

Plate 10. Remains of a house


Plate 11. Rubbish

Plate 12. Rubbish


Plate 13. Recently deposited waste

Plate 14. Disturbance and rubbish

4.2 BIOREGIONAL VERTEBRATE FAUNA

Appendix B provides a summary of the fauna survey data that are available near the project area. There are appreciable differences in the recorded fauna assemblages within and among fauna surveys shown in Appendix B. These differences are partially due to the low survey effort often deployed and they also reflect variations in soils and vegetation as well as temporal variations in the fauna assemblages.

Tables 3-7 provide a list of vertebrate species potentially found near the project area that have been compiled based on the fauna survey report results shown in Appendix B.

Table 3. Birds potentially found near the project area

Family	Species	Common Name
Casuariidae	*Dromaius novaehollandiae*	Emu
Anatidae	*Chenonetta jubata*	Australian Wood Duck
Megapodiidae	*Leipoa ocellata*	Malleefowl
Columbidae	*Phaps chalcoptera*	Common Bronzewing
	Ocyphaps lophotes	Crested Pigeon
	Geopelia cuneata	Diamond Dove
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo
Cuculidae	*Chrysococcyx osculans*	Black-eared Cuckoo
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar
Podargidae	*Podargus strigoides*	Tawny Frogmouth
Turnicidae	*Turnix velox*	Little Buttonquail
Ardeidae	*Egretta novaehollandiae*	White-faced Heron
Accipitridae	*Hieraaetus morphnoides*	Little Eagle
	Aquila audax	Wedge-tailed Eagle
	Circus assimilis	Spotted Harrier
	Accipiter fasciatus	Brown Goshawk
	Accipiter cirrocephalus	Collared Sparrowhawk
	Haliastur sphenurus	Whistling Kite
Cuculidae	*Heteroscenes pallidus*	Pallid Cuckoo
Strigidae	*Ninox boobook*	Southern Boobook
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher
Meropidae	*Merops ornatus*	Rainbow Bee-eater
Falconidae	*Falco cenchroides*	Nankeen Kestrel

Family	Species	Common Name
	Falco longipennis	Australian Hobby
	Falco berigora	Brown Falcon
Cacatuidae	*Eolophus roseicapilla*	Galah
	Nymphicus hollandicus	Cockatiel
Psittaculidae	*Neopsephotus bourkii*	Bourke's Parrot
	Barnardius zonarius	Australian Ringneck
	Psephotus varius	Mulga Parrot
	Melopsittacus undulatus	Budgerigar
Ptilonorhynchidae	*Chlamydera guttata*	Western Bowerbird
	Ptilonorhynchus maculata	Spotted Bowerbird
Climacteridae	*Climacteris affinis*	White-browed Treecreeper
	Climacteris rufus	Rufous Treecreeper
Maluridae	*Malurus pulcherrimus*	Blue-breasted Fairywren
	Malurus splendens	Splendid Fairywren
	Malurus leucopterus	White-winged Fairywren
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater
	Purnella albifrons	White-fronted Honeyeater
	Manorina flavigula	Yellow-throated Miner
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater
	Anthochaera carunculata	Red Wattlebird
	Gavicalis virescens	Singing Honeyeater
	Ptilotula ornata	Yellow-plumed Honeyeater
	Ptilotula plumula	Grey-fronted Honeyeater

Family	Species	Common Name
	Conopophila whitei	Grey Honeyeater
	Epthianura tricolor	Crimson Chat
	Epthianura aurifrons	Orange Chat
	Epthianura albifrons	White-fronted Chat
	Sugomel nigrum	Black Honeyeater
	Lichmera indistincta	Brown Honeyeater
	Nesoptilotis leucotis	White-eared Honeyeater
	Melithreptus brevirostris	Brown-headed Honeyeater
Pardalotidae	*Pardalotus striatus*	Striated Pardalote
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat
	Calamanthus campestris	Rufous Fieldwren
	Acanthiza iredalei	Slender-billed Thornbill
	Acanthiza apicalis	Inland Thornbill
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill
	Acanthiza uropygialis	Chestnut-rumped Thornbill
	Acanthiza robustirostris	Slaty-backed Thornbill
	Smicrornis brevirostris	Weebill
	Gerygone fusca	Western Gerygone
	Aphelocephala leucopsis	Southern Whiteface
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler
Cinclosomatidae	*Cinclosoma castanotum*	Chestnut Quail-thrush
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush
Campephagidae	*Coracina maxima*	Ground Cuckooshrike
	Coracina novaehollandiae	Black-faced Cuckooshrike
	Lalage tricolor	White-winged Triller
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird
Pachycephalidae	*Colluricincla harmonica*	Grey Shrikethrush
	Pachycephala inornata	Gilbert's Whistler

Family	Species	Common Name
	Pachycephala pectoralis	Golden Whistler
	Pachycephala rufiventris	Rufous Whistler
Artamidae	*Artamus personatus*	Masked Woodswallow
	Artamus superciliosus	White-browed Woodswallow
	Artamus cinereus	Black-faced Woodswallow
	Artamus cyanopterus	Dusky Woodswallow
	Cracticus torquatus	Grey Butcherbird
	Cracticus nigrogularis	Pied Butcherbird
	Gymnorhina tibicen	Australian Magpie
	Strepera versicolor	Grey Currawong
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail
	Rhipidura albiscapa	Grey Fantail
Monarchidae	*Grallina cyanoleuca*	Magpie-lark
Corvidae	*Corvus orru*	Torresian Crow
	Corvus bennetti	Little Crow
	Corvus coronoides	Australian Raven
Petroicidae	*Microeca fascinans*	Jacky Winter
	Petroica goodenovii	Red-capped Robin
	Melanodryas cucullata	Hooded Robin
	Drymodes brunneopygia	Southern Scrub-Robin
Locustellidae	*Cincloramphus cruralis*	Brown Songlark
	Cincloramphus mathewsi	Rufous Songlark
Hirundinidae	*Hirundo neoxena*	Welcome Swallow
	Petrochelidon ariel	Fairy Martin
	Petrochelidon nigricans	Tree Martin
	Cheramoeca leucosterna	White-backed Swallow
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird
Estrildidae	*Taeniopygia guttata*	Zebra Finch
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit

Table 4. Amphibians potentially found near the project area

Family	Species	Common Name
Limnodynastidae	*Neobatrachus kunapalari*	Wheatbelt Frog
	Neobatrachus sudelli	Sudell's Frog
	Neobatrachus sutor	Shoemaker Frog
	Neobatrachus wilsmorei	Plonking Frog
	Platyplectrum spenceri	Spencer's Burrowing Frog
Myobatrachidae	*Pseudophryne occidentalis*	Western Toadlet
Pelodryadidae	*Cyclorana maini*	Main's Frog
	Cyclorana occidentalis	Western Water-holding Frog
	Litoria moorei	Motorbike Frog

Table 5. Mammals potentially found near the project area

Family	Species	Common Name
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna
Bovidae	*Bos taurus*	Cow
	Capra hircus	Goat
	Ovis aries	Sheep
Camelidae	*Camelus dromedarius*	Dromedary
Suidae	*Sus scrofa*	Pig
Canidae	*Canis lupus*	Dingo
	Vulpes vulpes	Red Fox
Felidae	*Felis catus*	Cat
Molossidae	*Austronomus australis*	White-striped Freetail Bat
	Mormopterus planiceps	Southern Free-tail Bat
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat
	Nyctophilus geoffroyi	Lesser Long-eared Bat
	Nyctophilus major	Greater Long-eared Bat
	Scotorepens balstoni	Inland Broad-nosed Bat
	Vespadelus baverstocki	Inland Forest Bat
	Vespadelus finlaysoni	Finlayson's Cave Bat
Dasyuridae	*Antechinomys laniger*	Kultarr
	Ningaui ridei	Wongai Ningaui
	Ningaui yvonneae	Mallee Ningaui
	Pseudantechinus woolleyae	Woolley's False Antechinus
	Sminthopsis crassicaudata	Fat-tailed Dunnart
	Sminthopsis dolichura	Little Long-tailed Dunnart
	Sminthopsis hirtipes	Hairy-footed Dunnart
	Sminthopsis longicaudata	Long-tailed Dunnart
	Sminthopsis ooldea	Ooldea Dunnart
Macropodidae	*Osphranter robustus*	Euro
	Osphranter rufus	Red Kangaroo
Leporidae	*Oryctolagus cuniculus*	Rabbit
Muridae	*Mus musculus*	House Mouse
	Notomys alexis	Spinifex Hopping Mouse
	Notomys mitchellii	Mitchell's Hopping Mouse
	Pseudomys albocinereus	Ash-grey Mouse
	Pseudomys bolami	Bolam's Mouse
	Pseudomys hermannsburgensis	Sandy Inland Mouse

Table 6. Reptiles potentially found near the project area

Family	Species	Common Name
Agamidae	*Ctenophorus cristatus*	Crested Dragon
	Ctenophorus fordi	Mallee Dragon
	Ctenophorus infans	Ring-tailed Dragon
	Ctenophorus ornatus	Ornate Crevice Dragon
	Ctenophorus reticulatus	Western Netted Dragon
	Ctenophorus salinarum	Saltpan Dragon
	Ctenophorus scutulatus	Lozenge-marked Dragon
	Diporiphora amphiboluroides	Mulga Dragon
	Moloch horridus	Thorny Devil
	Pogona minor	Western Bearded Dragon
Carphodactylidae	*Nephrurus laevissimus*	Smooth Knob-tail
	Nephrurus vertebralis	Midline Knob-tail
	Underwoodisaurus milii	Barking Gecko
Diplodactylidae	*Diplodactylus granariensis*	Wheatbelt Stone Gecko
	Diplodactylus pulcher	Beautiful Gecko
	Lucasium maini	Main's Ground Gecko
	Rhynchoedura ornata	Beaked Gecko
	Strophurus assimilis	Goldfields Spiny-tailed Gecko
	Strophurus elderi	Jewelled Gecko
	Strophurus intermedius	Southern Spiny-tailed Gecko
	Strophurus strophurus	Western Spiny-tailed Gecko
	Strophurus wellingtonae	Western Shield Spiny-tailed Gecko
Elapidae	*Brachyurophis fasciolatus*	Narrow-banded Burrowing Snake
	Brachyurophis semifasciata	Half-girdled Snake
	Demansia psammophis	Yellow-faced Whipsnake
	Furina ornata	Orange-naped Snake
	Neelaps bimaculatus	Black-naped Burrowing Snake
	Suta monachus	Hooded Snake
	Pseudechis australis	Mulga Snake
	Pseudonaja mengdeni	Western Brown Snake
	Pseudonaja modesta	Ringed Brown Snake
	Simoselaps bertholdi	Jan's Banded Snake
	Suta fasciata	Rosen's Snake
Gekkonidae	*Gehyra punctata*	Spotted Dtella
	Gehyra purpurascens	Purplish Dtella
	Gehyra variegata	Variegated Gehyra
	Heteronotia binoei	Bynoe's Gecko
Pygopodidae	*Delma australis*	Marble-faced Delma
	Delma butleri	Unbanded Delma
	Delma nasuta	Sharp-snouted Delma
	Lialis burtonis	Burton's Legless Lizard
	Pygopus nigriceps	Western Hooded Scaly-foot
Pythonidae	*Antaresia stimsoni*	Stimson's Python
Scincidae	*Cryptoblepharus australis*	Inland Snake-eyed Skink
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink
	Ctenotus atlas	Southern Mallee Ctenotus
	Ctenotus brooksi	Wedgsnout Ctenotus
	Ctenotus leae	Orange-tailed Finesnout Ctenotus
	Ctenotus leonhardii	Leonhardi's Ctenotus
	Ctenotus schomburgkii	Barred Wedgesnout Ctenotus
	Ctenotus severus	Stern Ctenotus
	Ctenotus uber	Spotted Ctenotus
	Ctenotus xenopleura	Wide-striped Ctenotus
	Cyclodomorphus branchialis	Common Slender Bluetongue
	Cyclodomorphus melanops	Spinifex Slender Blue-tongue

Family	Species	Common Name
	Egernia depressa	Southern Pygmy Spiny-tailed Skink
	Egernia formosa	Goldfields Crevice Skink
	Lerista desertorum	Central Desert Robust Slider
	Lerista kingi	King's Slider
	Lerista lineopunctulata	Dotted-line Robust Slider
	Lerista macropisthopus	Unpatterned Robust Slider
	Lerista picturata	Southern Robust Slider
	Lerista timida	Timid Slider
	Liopholis inornata	Desert Skink
	Liopholis striata	Nocturnal Desert Skink
	Menetia greyii	Common Dwarf Skink

Family	Species	Common Name
	Morethia butleri	Woodland Morethia Skink
	Tiliqua occipitalis	Western Blue-tongued Lizard
Typhlopidae	*Anilios australis*	Austral Blind Snake
	Anilios bituberculatus	Prong-snouted Blind Snake
	Anilios hamatus	Pale-headed Blind Snake
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor
	Varanus giganteus	Perentie
	Varanus gouldii	Gould's Goanna
	Varanus panoptes	Yellow-spotted Monitor
	Varanus tristis	Black-headed Monitor

4.3 CONSERVATION SIGNIFICANT FAUNA

Conservation significant fauna are protected by the Commonwealth *EPBC Act 1999*, and this list includes species covered by international treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) and the Western Australia (WA) *BC Act 2016*. The WA *BC Act 2016* provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* that lists species under multiple categories. In addition, DBCA maintains a list of fauna that require monitoring under four priorities based on the current knowledge of their distribution, abundance and threatening processes. The *EPBC Act 1999* and *BC Act 2016* imply legislative requirements for the management of anthropogenic impacts to minimise the effects of disturbances on species and their habitats. Priority species have no statutory protection, other than the DBCA wishes to monitor potential impacts on these species. Environmental consultants and proponents of developments are encouraged to avoid and minimise impacts on these species. Definitions of the significant fauna under the WA *Wildlife Conservation Act* are provided in Appendix C.

Wetland, shorebirds and wetland migratory bird species present in the EPBC MNES online database search have been excluded from the following list and assessments as there is no suitable habitat for these species in the project area. There are no threatened species of fauna likely to be recorded in the project area. The following is an assessment of the likelihood of each of the species listed in Table 7 being found in the project area.

Table 7. Conservation species recorded in database searches for the region

Species	DBCA Schedule / Priority	Status under Commonwealth EPBC Act	Comment on the potential impact on species
Night Parrot (*Pezoporus occidentalis*)	Critically Endangered	Endangered	Highly unlikely to occur in the project area.
Sandhill Dunnart (*Sminthopsis psammophila*)	Endangered	Endangered	Highly unlikely to occur in the project area.
Malleefowl (*Leipoa ocellata*)	Vulnerable	Vulnerable	Highly unlikely to occur in the project area.
Chuditch (*Dasyurus geoffroii*)	Vulnerable	Vulnerable	Highly unlikely to occur in the project area.
Grey Falcon (*Falco hypoleucos*)	Vulnerable	Vulnerable	Highly unlikely to occur in the project area.
Princess Parrot (*Polytelis alexandrae*)	Vulnerable	Vulnerable	May infrequently be seen in the region, however, clearing vegetation and development is highly unlikely to impact on this species.
Fork-tailed Swift (*Apus pacificus*)	Migratory	Migratory	May infrequently be seen in the region, however, clearing vegetation and development is highly unlikely to impact on this species.
Grey Wagtail (*Motacilla cinerea*)	Migratory	Migratory	Highly unlikely to occur in the project area.
Peregrine Falcon (*Falco peregrinus*)	Other specially protected fauna		May infrequently be seen in the region, however, clearing vegetation and development is highly unlikely to impact on this species.
Woma (*Aspidites ramsayi*)	Priority 1		Highly unlikely to occur in the project area.
Mulgara (*Dasycercus blythi / cristicauda*)	Priority 4	Vulnerable	Highly unlikely to occur in the project area.
Central Long-eared Bat (*Nyctophilus major tor*)	Priority 3		Unlikely to occur in the project area.

Night Parrot (*Pezoporus occidentalis*) – Critically endangered under the WA *BC Act 2016* and endangered under the *EPBC Act 1999*

The Night Parrot is a small, arid-adapted, nocturnal, ground-feeding parrot (Johnstone and Storr 1998, Threatened Species Scientific Committee 2016). Its length is 22-25cm with a body mass of approximately 104g (Threatened Species Scientific Committee 2016), although it was suggested that they were semi-nomadic, the Night Parrots in south-western Queensland appear to be sedentary (Murphy 2015).

The Night Parrot was probably originally distributed over much of the semi-arid and arid Australia (Garnett *et al*. 2011, Threatened Species Scientific Committee 2016). Recordings in north-west and western Queensland in the early 1990-2000s were in a broad cross section of the habitats available (Cupitt and Cupitt 2008, Garnett *et al*. 2011, Boles *et al*. 2016). There have been recent sightings in the Pilbara in 1980, 2005 and 2017, central WA in 1979, north-eastern South Australia in 1979, western Queensland (including Pullen-Pullen-Mt Windsor-Diamantina population) in 1980, 1990, 1993, 2006 and 2013-17 (Davis and Metcalf 2008, Garnett *et al*. 2011, Charalambous 2016, Pickrell 2016, AG staff 2017, Palaszxzuk and Miles 2017, Rykers 2017, AG staff 2018), Pilbara in 2017 (Jones 2017), and the northern Goldfields (Jackett *et al*. 2017). Garnett *et al*. (2011) suggested that there were between 50-250 mature individuals in less than 5% of its previous range. Prior to 2007 there were very few records of the Night Parrot (Plate 15).

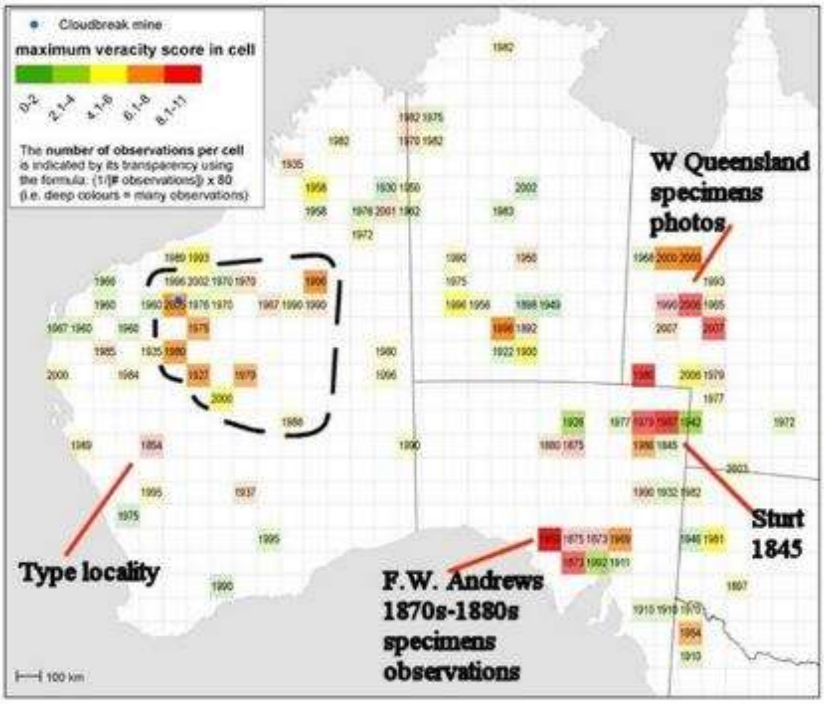


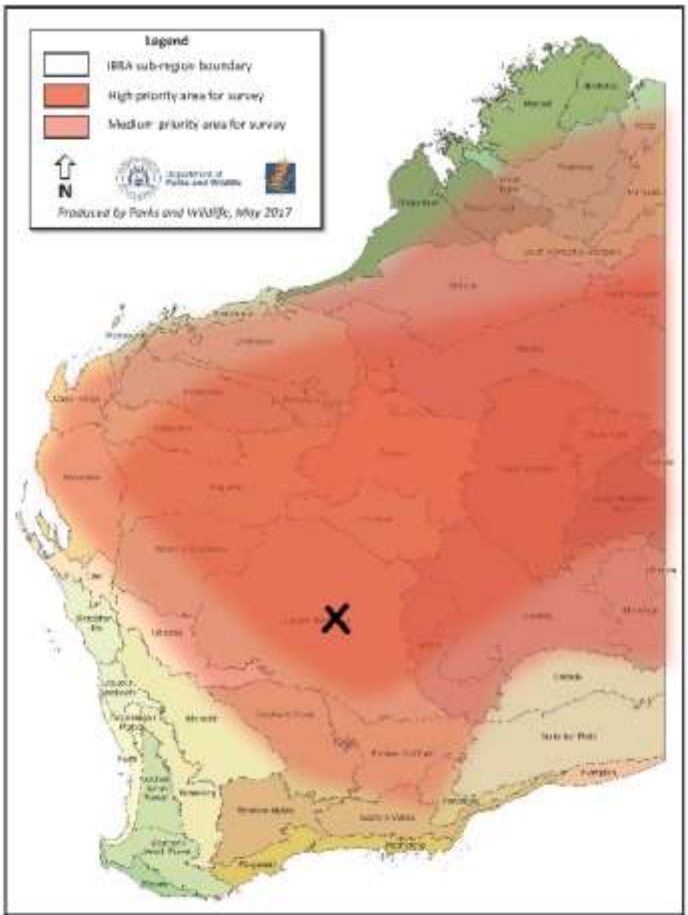
Plate 15. Map of historical Night Parrot records compiled by S. Murphy *et al.*, including records to 2007

(taken from https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals/night-parrot)

Wilson's (1937) summary of observations provided information on the early records of Night Parrots' preferred habitat and breeding sites. Recent information indicates its preferred habitat appears to be in Triodia grasslands, chenopod shrublands, shrubby samphire and floristically diverse habitats dominated by large-seeded species (Threatened Species Scientific Committee 2016, McCarthy 2017, Murphy *et al*. 2017b). At Pullen Pullen Reserve it nests in large, more or less ring-shaped Triodia, and the nest consists of a tunnel (25-30° and 0° to the ground; 20-33cm long) through an apron of dead spinifex leaves that leads to a chamber under a live hummock, with a shallow depression (3-4cm) excavated into the gravelly/sandy soil (Murphy *et al*. 2017a). In the northern Goldfields the nest was again in a spinifex hummock; it was circular, with an excavated depression (~1.5-2.0cm) in sandy substrate (Hamilton et al. 2017a, Jackett et al. 2017). The entrance tunnel was 62cm long, and was downward sloping (27°) with the entrance 28cm above the ground (Hamilton et al. 2017a). It has clutches of two to four sub-elliptical, white eggs with a lustrous appearance (Murphy *et al*. 2017a). Breeding followed significant rains in March for the observations in Pullen-Pullen Reserve and in April in the northern Goldfields (Hamilton et al. 2017a, Murphy et al. 2017a), but it is thought that breeding generally occurs between April and October (Murphy *et al*. 2017a).

Murphy *et al*. (2017b) placed a GPS tag on Night Parrots and reported that the two birds called at dusk from their diurnal roosts among spinifex hummocks and then flew to more floristically diverse habitats dominated by large-seeded, prolifically seeding species to feed.

The project area is within the medium priority search area for Night Parrots as indicated by the then Department of Parks and Wildlife (Plate 16; 2017). There is no spinifex present in the project area that is similar to that described as suitable habitat in the available reports (Department of Parks and Wildlife 2017, Hamilton et al. 2017b, Murphy et al. 2017b).



Priority areas for night parrot (*Pezoporus occidentalis*) surveys in Western Australia

Plate 16. Search areas for Night Parrot in Western Australia

Project area indicated as a black cross

The Night Parrot has been recorded in the northern goldfields and the record is thought to be about 340km north of the project area. Its recently reported preferred habitat is not present in the project area, therefore it is highly unlikely to be recorded in the project area.

Sandhill Dunnart (***Sminthopsis psammophila***) - *Endangered* under the *BC Act 2016* and *EPBC Act 1999*

The Sandhill Dunnart is a small, dasyurid with a body length of approximately 8-12 cm, and a tail length approximately 10-12 cm (Threatened Species Scientific Committee 2015). It has been recorded from numerous widely dispersed localities including the Great Victoria Desert and the Eyre Peninsula (Woinarski et al. 2014) and more recently in areas west of the Great Victoria Desert.

The Sandhill Dunnart's preferred habitat is sandy semi-arid and arid areas dominated by mature spinifex. They live in burrows dug under large spinifex hummocks as well as hollow logs and Hopping Mice burrows (Woinarski et al. 2014).

The project area is outside the Sandhill Dunnart's existing known extant geographic range, and the habitat that it has recently been recorded in is not present in the project area. The Sandhill Dunnart is highly unlikely to be present in the project area.

Malleefowl (*Leipoa ocellata*) – Vulnerable under the WA *BC Act 2016* and *EPBC Act 1999*

Malleefowl is a member of the family of birds (Megapodiidae) that builds a nest mound in which it incubates its eggs. This relatively large, mostly terrestrial bird nests in the same general area year-after-year, and will often use the same nest mound (Frith 1962, Priddel and Wheeler 2003). Outside the breeding period, birds will range over several square kilometres (Booth 1987, Benshemesh 2007). Chicks are independent from hatching and disperse widely, moving up to 2km per day (Benshemesh 2007) and do not appear to respond to habitat boundaries.

Malleefowl have been found in mallee regions of southern Australia from approximately the 26th parallel of latitude southwards. Malleefowl are mostly found in semi-arid and arid shrub lands and low woodlands dominated by mallee in the more temperate areas (Frith 1962, Parsons et al. 2008). Malleefowl are now only found throughout these regions in fragmented patches of dense vegetation due to clearing of habitat for agriculture, increased fire frequency, competition with exotic herbivores (sheep, rabbits, cattle, goats) and kangaroos, predation by foxes and cats, inbreeding as a result of fragmentation and possibly hunting for food.

Malleefowl build large mounds of sand, gravel and vegetation that can be 3-5m wide and over 1m high. This is mostly done between autumn and spring as a combined effort of the pair intending to use the mound. Once completed, the male then spends most of his time tending the mound, whereas, the female spends most of her time foraging.

The Malleefowl's wariness, cryptic habits and colouration make it difficult to reliably and accurately census their numbers. Brickhill (1985), Benshemesh and Emison (1996) and Priddel and Wheeler (2003) have all used the number of active mounds as a proxy of Malleefowl numbers. This is a relevant proxy, as it directly relates to the number of reproductively active birds, which is a good indicator of survival of the local population.

No Malleefowl or suitable habitat were recorded in the project area. The Malleefowl is therefore highly unlikely to be recorded in the project area.

Chuditch (*Dasyurus geoffroii*) – Vulnerable under the *BC Act 2016* and *EPBC Act 1999*

The Chuditch is the largest carnivorous marsupial in Western Australia (WA). It is usually active from dusk to dawn. Formally known from over 70% of Australia, the Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of south-west WA and other isolated areas (Serena and Soderquist 2008). Chuditch are solitary animals for most of their life and den in hollow logs, burrows, culverts, etc and have also been recorded in tree hollows and rock cavities. Chuditch are opportunistic feeders, and forage primarily on the ground at night. Their diet can include other mammals, birds, lizards, bird and reptile eggs but the majority is a mixture of large invertebrates (e.g. spiders, scorpions and crickets; Serena and Soderquist 2008).

Chuditch disappeared from the northern Goldfields a long-time ago, so it is highly improbable that they are present in the project area. The habitat in the project area is also unsuitable for this species.

Grey Falcon (*Falco hypoleucos*) – Vulnerable under the *BC Act 2016* and *EPBC Act 1999*.

This is Australia's rarest falcon, and it is mostly found in areas of less than 500mm rainfall north of latitude 26°S in Western Australia (Schoenjahn et al. 2019, Threatened Species Scientific Committee 2020). It is mostly found in timbered lowland plains, particularly *Acacia* shrublands that are crossed by tree-lined water courses (Threatened Species Scientific Committee 2020). However, this species has been observed in treeless areas and frequents tussock grassland and open woodland (Threatened Species Scientific Committee 2020).

This species was not seen during the site visit, has not been recorded in other fauna surveys near the project areas, and if it was present, would move away once disturbed.

Princess Parrot (*Polytelis alexandrae*) - Vulnerable under the *EPBC Act 1999* and Priority 4 species with DBCA

Very little is known about the Princess Parrot, even the exact extent of its geographical distribution. The species is found mostly in the inland arid areas of Australia, and in Western Australia in the Gibson, Little Sandy and Great Victoria Deserts (Johnstone and Storr 1998, Pavey et al. 2014), however, they occasionally occur in lightly wooded areas adjacent to the sandy deserts (Moriarty 1972). It is thought to be nomadic within the central desert regions of Australia, occupying arid shrub lands, particularly those dominated by Mulga, Desert Oak and spinifex. Due to the paucity of information on this species, accurate estimates of its population size are difficult, however, this species is probably threatened by habitat loss to agricultural practices and changes in fire regimes.

Dr S. Thompson sighted a single specimen of this parrot in a survey near the Wanjarri Nature Reserve in 2006. It is highly unlikely that Princess Parrots would be seen this far away from their normal habitat in the sandy deserts.

Fork-tailed Swift (*Apus pacificus*) - Migratory under the *EPBC Act 1999* and *BC Act 2016*

This species breeds in the northeast and mid-east Asia and winters in Australia and southern New Guinea. It is a visitor to most parts of Western Australia, beginning to arrive in the Kimberley in late September, in the Pilbara in November and in the southwest land division in mid-December, and leaving by late April. The Fork-tailed Swift is an almost exclusively aerial species, foraging and sleeping on the wing. It rarely comes to earth, usually only for breeding. It is common in the Kimberley, uncommon to moderately common near northwest, west and southeast coasts and rare to scarce elsewhere. It is rarely seen in the Goldfields.

Terrestrial Ecosystems' assessment is that the Fork-tailed Swift may infrequently be seen in the region, however, the proposed vegetation clearing is unlikely to significantly impact on this species as it will move away to other areas if it is disturbed.

Grey Wagtail (*Motacilla cinerea*) - Migratory species under the *EPBC Act 1999* and *BC Act 2016*

The Grey Wagtail is a small yellow breasted bird with a grey back and head. Johnstone and Storr (2004) reported this migratory species as breeding in Palearctic from western Europe and north-west Africa to eastern Asia and wintering in Africa, south-east Asia, Indonesia, the Philippines, New Guinea and Australia. Its preferred habitat in Australia is banks and rocks in fast-running fresh water including rivers, streams and creeks where it feeds on insects. The Atlas of Living Australia records two sightings on the south-coast of Western Australia and none around the project area.

It is highly unlikely to be seen in the project area due to a lack of suitable habitat.

Peregrine Falcon (*Falco peregrinus*) – Other specially protected species under the *BC Act 2016*

The Peregrine Falcon is uncommon, although widespread throughout much of Australia excluding the extremely dry areas and has a wide and patchy distribution. It shows habitat preference for areas near cliffs along coastlines, rivers and ranges and within woodlands along watercourses and around lakes. Nesting sites include ledges along cliffs, granite outcrops and quarries, hollow trees near wetlands and old nests of other large bird species. There is no evidence to suggest any change in status in the last 50 years. The Peregrine Falcon has been recorded in other fauna surveys in the region but was not recorded in the project area.

Terrestrial Ecosystems' assessment is that the Peregrine Falcon may infrequently be seen in the region, however, the proposed development is unlikely to significantly impact on this species as it will move away to other areas if it is disturbed.

Woma (southern form: *Aspidites ramsayi*) – Priority 1 with DBCA

This python was once common in a crescent shaped distribution from Shark Bay through the wheatbelt to Kitchener. The Western Australian Museum has records of them being caught in the vicinity of the Great Eastern Highway from around Southern Cross and east toward Coolgardie (Thompson and Thompson 2006). The published literature indicates that it is now only found around Shark Bay and east of Kalgoorlie.

There are no recent records for the Woma near the project area and the habitat is not suitable. The Woma is therefore highly unlikely to be present in the project area or impacted by future development.

Brush-tailed Mulgara (*Dasycercus blythi*) - Priority 4 with the DBCA

Woolley (2005) recognises two species of 'Mulgara'; *Dasycercus blythi* and *D. cristicauda*. *Dasycercus blythi* has a non-crested tail, two upper premolars and six nipples; *D. cristicauda* has a crested tail, three upper premolars and eight nipples. Both species potentially have overlapping distributions in arid Australia, but it is thought that *D. cristicauda* does not currently exist in Western Australia, although there are old records indicating its presence. Woolley (2005) suggested the common names for these two species be Brush-tailed Mulgara for *D. blythi* and Crest-tailed Mulgara for *D. cristicauda*. These two species can be sympatric in places, but probably utilise different parts of the habitat on a local scale when they are recorded in the same area. Currently, there are insufficient data to separate the spatial ecology, burrows and reproductive biology of these two species. Information that follows is based on what is known for 'Mulgara' without distinguishing between the species.

Adult males are typically heavier than females (Gibson and Cole 1992, Dickman *et al*. 2001, Körtner *et al*. 2007), with females growing to 80g and males to 147g (Masters 1998, Dickman *et al*. 2001). Gibson and Cole (1992) reported pouched young in the winter and spring with lactating females as late as December. Litter sizes averaged five, but ranged from 2-6 (Gibson and Cole 1992, Masters 1998), with a single litter being produced each year (Dickman *et al*. 2001). Woolley (2008a) reported *D. blythi* females to carry up to six young in central Australia when caught in September, and in captivity mating has been observed from mid-May to Mid-June and young have been born in June to August after a gestation of five to six weeks. The breeding biology is similar for *D. cristicauda,* but because females have eight nipples they can carry up to eight young (Woolley 2008b). Adult males mostly die after mating.

The Mulgara diet includes insects, arachnids and rodents as the main prey, but reptiles, centipedes and small marsupials are also consumed (Chen et al. 1998, Masters 1998, Contos and Letnic 2019).

The reported distribution of Mulgara in Western Australia includes much of the inland spinifex covered sandy desert and spinifex vegetated areas in the Pilbara and northern goldfields. Within these areas their distribution is patchy and it is most frequently confined to habitat dominated by mature spinifex (Gibson and Cole 1992, Masters 2003, Masters *et al*. 2003). Relative abundance seems to be positively associated with rainfall in the previous 12 to 24 months (Gibson and Cole 1992, Masters 1998, Dickman *et al*. 2001, Letnic and Dickman 2005). Significant population fluctuations appear to be a characteristic of the ecology of Mulgara (Manson 1994, Barrick Plutonic Gold Mine 2006). For example, Pearson (2003-04) reported significant fluctuations at Mt Keith with 99 being caught in 2001 and only 33 being caught in 2002 in a repeated survey. The recent burning of spinifex does not seem to be sufficient to cause Mulgara to move out of an area (Thompson and Thompson 2007).

Mulgara are generally sedentary in contrast with some other small dasyurids and have high site fidelity and a low propensity for dispersal once a home range has been established (Masters 1998, Dickman *et al*. 2001, Masters 2003). Masters (2003) indicated home ranges vary in size from 1.0 to 14.4ha (mean 6.5ha), with some overlap, however, Kortner *et al*. (2007) reported home ranges for males to average 25.5ha and for females to average 10.8ha. Burrows are mostly used by a single individual, but males and females have been found together in a single burrow during the breeding season (Masters 2003, Thompson and Thompson 2007). Kortner *et al*. (2007) reported that 10 of 68 burrows they monitored were used by multiple Mulgara and one individual returned to the same burrow on 32 of 52 days monitored. Masters (2003) reported individual's burrows in her study area were concentrated in a relatively small area, as the average maximum distance across a home range was about 440m. In the Pilbara, Thompson and Thompson (2007, 2008) reported catching nine Mulgara in an area of 22ha and 50 in 210ha, and about 200 trap-nights were required to catch each Mulgara in areas with a relatively high density.

Masters (2003) reported that both males and females use 2-9 burrows, but averaged about three, whereas Kortner *et al*. (2007) reported Mulgara used up to 15 burrows, with 47% of burrows used by an individual only once. Woolley (1990) described *D. cristicauda* burrows near Ayers Rock as having one large hole, around which there was loose soil, and either one or two smaller holes within 1m of the large hole. The tunnels to these pop holes were near vertical. Thompson and Thompson (2007) indicated that burrows in the Pilbara contained between two and nine entrances, tunnels were mostly on a single level and to a depth of about 300mm. Kortner *et al*. (Körtner *et al*. 2007) reported Mulgara burrows in the Uluru National Park varied in complexity, some with only a single entrance but others had multiple entrances. The lumen for a burrow entrance was typically an arch over a flat bottom with a height of 70-80mm, and a width of 80-100mm at the base. Internal tunnels were mostly 50-70mm wide. Masters (2008) suggested that the complexity of burrows varies geographically with those in central Australia having a single entrance with two or three side tunnels and pop holes, and those in Queensland having more than one entrance, deeper branching tunnels and numerous pop holes. This difference may have been due to differences in species that were not recognised until recently.

The habitat in the project area is not suitable for this species, so it is highly unlikely to be present.

Central Long-eared Bat (*Nyctophilus major tor*) – Priority 4 with DBCA

This species is probably the species referred to by Churchill (2008) as the Central Long-eared Bat (*Nyctophilu*s sp. 1). This species is distributed across the southern and central wheatbelt, southern part of the Great Victoria Desert and the Nullarbor coast. The project area is on the northern boundary of its known distribution. It roosts in tree cavities, foliage and under loose bark.

This bat may be present in the region, and if present in project area, it is unlikely to be significantly impacted by the development as it will readily move when disturbed, and they are likely to be in a similar abundance in adjacent areas.

4.3.1 Vertebrate fauna risk assessment

Fauna surveys to support environmental approval are part of the environmental risk assessment undertaken to consider what potential impacts a development might have on the biodiversity on a particular area and region. Potential impacts on fauna from the proposed development are identified and briefly described above. Tables 8, 9 and 10 provide a summary of the risk assessment associated with this project.

Any risk assessment is a product of the likelihood of an impact occurring and the consequences of that impact. Likelihood and consequences are categorised and described below. The assessed risk level (likelihood x consequences) is then calculated as the overall risk for the development. This is followed by an assessment of the acceptability of the risk associated with each of the impacts. Disturbances and vegetation clearing have an impact on the fauna at multiple scales – site, local, landscape and regional. Each of these is considered in the risk assessment. This assessment should be considered in the context of the summary in Table 10.

Table 8. Fauna impact risk assessment descriptors

Likelihood		
Level	Description	Criteria
A	Rare	The environmental event may occur, or one or more conservation significant species may be present in exceptional circumstances.
B	Unlikely	The environmental event could occur, or one or more conservation significant species could be present at some time.
C	Moderate	The environmental event should occur, or one or more conservation significant species should be present at some time.
D	Likely	The environmental event will probably occur, or one or more conservation significant species will be present in most circumstances.
E	Almost certain	The environmental event is expected to occur, or one or more conservation significant species is expected be present in most circumstances.
Consequences		
Level	Description	Criteria
1	Insignificant	Insignificant impact on fauna of conservation significance or regional biodiversity, and the loss of individuals will be insignificant in the context of the availability of similar fauna or fauna assemblages in the area.
2	Minor	Impact on fauna localised and no significant impact on species of conservation significance in the project area. Loss of species at the local scale.
3	Moderate	An appreciable loss of fauna in a regional context or a limited impact on species of conservation significance in the project area.
4	Major	Significant impact on conservation significant fauna or their habitat in the project area and/or regional biodiversity and/or a significant loss in the biodiversity at the landscape scale.
5	Catastrophic	Loss of species at the regional scale and/or a significant loss of species categorised as 'vulnerable' or 'endangered' under the EPBC Act (1999) at a regional scale.
Acceptability of Risk		
Level of risk	Management action required	
Low	No action required.	
Moderate	Avoid if possible, routine management with internal audit and review of monitoring results annually.	
High	Externally approved management plan to reduce risks, monitor major risks annually with external audit and review of management plan outcomes annually.	
Extreme	Unacceptable, project should be redesigned or not proceed.	

Table 9. Levels of acceptable risk

		Likelihood				
		Rare or very low (A)	Unlikely or low (B)	Moderate (C)	Likely (D)	Almost certain (E)
Consequence	Insignificant (1)	Low	Low	Low	Low	Low
	Minor (2)	Low	Low	Low	Moderate	Moderate
	Moderate (3)	Low	Moderate	Moderate	High	High
	Major (4)	Moderate	Moderate	High	High	Extreme
	Catastrophic (5)	Moderate	High	High	Extreme	Extreme

Table 10. A risk assessment of the impact of ground disturbance activity on fauna

			Before management				With management		
	Potential impacts		Inherent risk			Risk controls	Residual risk		
Factor			Likelihood	Consequence	Significance		Likelihood	Consequence	Significance
Fauna survey data	Inadequate survey data to adequately assess the risks	Unknown loss of fauna, fauna of conservation significance, and fauna assemblages, and an incomplete fauna assessment.	B	2	Low				
	Inadequacy of comparative data	Limits on the availability of comparative data reduced the capacity to assess the uniqueness of the fauna assemblages in the project area.	B	2	Low				
Clearing vegetation	Loss of fauna habitat – local scale	Loss of terrestrial fauna in the project area.	E	1	Low				
	Loss of fauna habitat – landscape scale	Loss of some fauna during vegetation clearing.	B	1	Low				
	Loss of fauna habitat – regional scale	Small loss of some fauna from the region.	B	1	Low				
	Loss of a threatened ecological fauna community	Loss of an undetected threatened ecological fauna community.	A	3	Low				
	Habitat fragmentation	Fauna movement restricted resulting in the death of fauna and a loss of biodiversity.	A	2	Low				
Death or loss of conservation significant fauna	Loss of a unique terrestrial fauna ecosystem	Loss of an ecosystem containing fauna with high species richness, high abundance and numerous top of the food chain predators.	A	2	Low				
	Night Parrot	Loss of a Night Parrot or small population of Night Parrots	A	3	Low				
	Sandhill Dunnart	Loss of a Sandhill Dunnart or small population of Sandhill Dunnarts	A	2	Low				
	Malleefowl	Loss of a Malleefowl or small population of Malleefowl	A	2	Low				
	Chuditch	Loss of a Chuditch or small population of Chuditch	A	2	Low				
	Grey Falcon	Loss of a Grey Falcon or small population of Grey Falcon	A	2	Low				
	Princess Parrot	Loss of a Princess Parrot or small population of Princess Parrot	A	2	Low				
	Fork-tailed Swift	Loss of a Fork-tailed Swift or small population of Fork-tailed Swift	A	2	Low				
	Grey Wagtail	Loss of a Grey Wagtail or small population of Grey Wagtail	A	2	Low				
	Peregrine Falcon	Loss of a Peregrine Falcon or small population of Peregrine Falcon	A	2	Low				
	Woma	Loss of a Woma or small population of Woma	A	2	Low				

			Before management				With management		
	Mulgara	Loss of a Mulgara or small population of Mulgara	A	2	Low				
	Central Long-eared Bat	Loss of a Central Long-eared Bat or small population of Central Long-eared Bat	A	2	Low				
Human impacts	Increase or spread of weeds	Changed vegetation and a resulting loss of fauna habitat.	E	2	Mod	Implementation of a weed management plan.	D	2	Low
	Road kills	Animals being killed by vehicles as they cross roads	E	1	Low	Limiting speeds	E	1	Low
	Increase in feral fauna; specifically the fox, wild dog and cat	Increased predation on the native fauna	C	3	Mod	Implementation of a feral animal control program(s)	C	2	Low
	Dust	Increased potential for dust	E	2	Mod	Implementation of a dust management plan.	C	2	Low

5. DISCUSSION

5.1 ADEQUACY OF THE FAUNA SURVEY DATA FOR FAUNA HABITATS REPRESENTED IN THE PROJECT AREA

The EPA's (2020) Technical Guidance on terrestrial fauna surveys indicated that the type of survey should be determined based on:

- level of existing regional knowledge;
- type and comprehensiveness of recent local surveys;
- degree of existing disturbance or fragmentation at the regional scale;
- extent, distribution and significance of habitats;
- significance of species likely to be present;
- sensitivity of the environment to the proposed activities; and
- scale and nature of impact.

Fauna survey data provided by Cowan and How (2004), and Dell and How (1988) provide an indication of the vertebrate fauna assemblage in the project. The project area is mostly sparely vegetated, and there is very little leaf litter on the ground indicating a limited vertebrate fauna assemblage with few individuals being present. A more detailed survey is unlikely to provide the environmental assessors with additional information or change the assessment.

5.1.1 Amphibians

Amphibians typically found in mulga woodlands in the Goldfields are listed in Table 4 in areas that form ponds of water after heavy rain. All the Limnodynastidae species are burrowing frogs and only come to the surface to feed and breed after substantial rain. *Pseudophryne occidentalis* finds shelter under rocks and in crevices during the dry periods and enters temporary ponds to breed after major rainfall events. All species have a wide-spread distribution in the Goldfields and are abundant. There are no conservation significant amphibians in the Goldfields.

5.1.2 Reptiles

Reptile species richness in the project area will be comparable with similar sparely vegetated mulga woodlands elsewhere in the bioregion. The list provided in Appendix A represents species likely to be found over a large area of diverse range of habitat types. Mulga woodlands would typically support up to 40 species of reptiles, but many of these would be in low abundance (see Table 6). Fauna habitats in the project area are likely to be similar to adjacent areas, so the loss of reptiles during vegetation clearing is unlikely to be significant in a bioregional context.

5.1.3 Birds

The number of birds and bird species in the northern Goldfields fluctuates based on seasons and recent rainfall. The project area is likely to support a similar assemblage to that present in the adjacent areas. Birds of conservation significance potentially found in the region include the Malleefowl, Peregrine Falcon, and Princess Parrot.

Malleefowl are present in the region but are not present in the project area. The Princess Parrot is nomadic and moves around the arid interior often in search of water and resources but is not regularly recorded this far away from the sandy deserts, so it is highly unlikely to be recorded in the project area. The Peregrine Falcon will normally have a very large home range in the Goldfields, and clearing a small section of the project area, particularly when similar habitat exists in the adjacent areas, is unlikely to significantly impact on this species.

It is Terrestrial Ecosystems' view that the proposed vegetation clearing, and the development and operating a mine in the project area are unlikely to significantly impact on the avian fauna of the bioregion.

5.1.4 Mammals

The number of small terrestrial mammals potentially caught in the project area would be low due the sparsely vegetated habitat. Although, records of Numbats (*Myrmecobius fasciatus*), Burrowing Bettongs (*Bettongia lesueur*) and Bilbies (*Macrotis lagotis*) are shown in the Atlas of Living Australia and Western Australian Museum records (Appendix B), they are no longer present in this area, having been predated on by foxes, cats and dogs many years ago. None of the mammals potentially found in the project area are of conservation significance. The loss of small mammals during vegetation clearing and the development and operating a mine in the project area are unlikely to significantly impact on the mammal fauna of the bioregion.

It was noted during the site visit that there was evidence of rabbits, donkeys, wild dogs and cattle in the project area and surrounds.

5.2 BIODIVERSITY VALUE OF THE PROJECT AREA

An ecological assessment of a site should consider its biodiversity value at the genetic, species and ecosystem levels, and its ecological functional value at the ecosystem level. There are inadequate data to assess the ecological value at the genetic level.

Fauna habitat types represented in the project area are abundant and in similar condition in adjacent areas. Therefore, the fauna assemblage that is present in the project area will also be present and abundant in the adjacent areas. The available fauna survey data (Appendix B) provides a good indication of the vertebrate fauna that are potentially in the project area.

5.2.1 Ecological functional value at the ecosystem level

Vertebrate species potentially in the project area are wide-ranging and have been recorded in various other fauna surveys in the bioregion (Appendix B). Much of the project area has been highly disturbed by historical mining or exploration activity, with the consequence that the project area will have a depleted vertebrate fauna assemblage. The most significant impact on vertebrate fauna in the project area and surrounds will have been feral cats, foxes and wild dogs. Historically, goats have heavily grazed some areas, and this would have impacted the vertebrate fauna assemblages, but the recent increase in the wild dog population has reduced the abundance of feral goats.

5.2.2 Maintenance of threatened ecological communities

No threatened ecological communities were identified in or near the project area.

5.2.3 Condition of fauna habitat

There are disused mining pits in the project area and multiple waste dumps, most of which have been poorly rehabilitated. There are substantial areas that have been explored, (i.e. clear drill lines, drill holes and bag farms) throughout the project area.

The impact of this disturbance over many years will have reduced the vertebrate terrestrial fauna assemblages in the project area.

5.2.4 Ecological linkages

The project area does not provide an important ecological linkage or terrestrial fauna movement corridor.

5.2.5 Abundance and distribution of similar habitat in the adjacent areas

The assessed project area is approximately 498ha. There is an abundance of similar habitat in adjacent areas and throughout the bioregion.

6. POTENTIAL IMPACTS

6.1 POTENTIAL IMPACTS ON FAUNA

Clearing of vegetation will potentially affect vertebrate fauna in the project area in numerous ways, including death/injury of fauna during vegetation clearing and impacts with vehicles and the loss of habitat.

Although there are anticipated short term impacts on the generic vertebrate fauna assemblage, they are not considered to result in significant impacts when considered in a bioregional context in the longer term.

6.2 DIRECT IMPACTS

6.2.1 Animal deaths during the clearing process and displacement of fauna

Clearing vegetation and activities associated with the proposed mining development will result in the loss of small fauna and those that retreat to burrows, such as reptiles and mammals. Nocturnal species are unlikely to be active when most of the land clearing and construction work is taking place which will inevitably result in these individuals being killed or injured in their burrows or as they attempt to escape. Larger terrestrial animals and avian species will most often move to adjacent areas. These species will be required to establish new activity areas and home ranges, and this could result in the temporary displacement of resident species, however, this loss of fauna is unlikely to have a significant impact when considered in a bioregional context.

6.2.2 Reduction or loss of activity areas and closure of burrows

Clearing vegetation and associated mine development activities are likely to destroy reptile and mammal burrows or foraging habitat that are currently in use or could be used again. Clearing vegetation that forms part of the activity area of individuals has the potential to force these animals into adjacent areas. These areas may offer fewer resources placing individuals under survival pressure. It could also cause individuals to move into the territories of other individuals increasing competition for resources. Forced relocations could increase the possibility of predation.

6.3 INDIRECT IMPACTS

6.3.1 Edge effects

In addition to the obvious impact of vegetation clearing there can be an equally significant or greater impact in the adjacent areas because of 'edge effects'. Edge effects can lead to the disruption of ecological processes such as predation and dispersal, animal movements and can change assemblage structure. The consequence is that the impact area will always be much larger than the cleared area.

However, the spareness of the vegetation is likely to cancel edge effects in the project area.

6.3.2 Habitat fragmentation

In addition to vegetation clearing, infrastructure including tracks, has the potential to fragment habitat. Cleared linear tracks of land are 'unnatural' in much of the habitat. These linear structures that partition existing activity areas, isolate sections of established communities and may alter long and medium-term patterns of movement around established home ranges particularly for small mammals and reptiles. A reduction in the population because of this infrastructure would be difficult to detect given our current knowledge of the spatial ecology for most of the small mammals known to be in the area.

As most of the tracks within the project area will be relatively narrow and in sparsely vegetated areas, so the potential impact associated with habitat fragmentation is likely to be very low.

6.3.3 Introduced fauna and weeds

An increase in habitat fragmentation and human activity is often associated with an increase in the abundance of introduced species such as the house mouse (*Mus musculus*), foxes (*Vulpes vulpes*), cat (*Felis catus*) and wild dogs (*Canis lupus*). This increase may be due to a decline in habitat health, increased road kills, poor disposal of waste and easier access to areas via tracks.

House mice, foxes, cats and wild dogs are known to be established in the area. In many situations they have become a 'naturalised' species in the Australian bush. Increases in fox, dog or cat numbers can have a detrimental impact on native fauna because they predate on and compete with native species, severely disrupting the natural balance. The cat is a particularly damaging predator on native fauna and any increase in their numbers could have a detrimental effect of local native fauna (Kinnear 1993, Bamford 1995); hence it is important to ensure that populations of the feral predators, such as cats under control.

Infrastructure known to support feral species, such as rubbish disposal sites and bins, should be managed to minimise increases in these populations.

Introduced plant species can successfully and rapidly invade areas of cleared native vegetation or otherwise disturbed by humans. Introduced plant species may replace native species that provide shelter or foraging areas for native fauna. There are existing cacti in the project area and these need to be actively managed (Plates 17-18). Major changes to the structure of vegetation will alter the fauna habitat and consequently may influence fauna species composition. Preparing and implementing a weed management plan will largely reduce their threat to native fauna species.

Plate 17. Cactus

Plate 18. Cactus

6.3.4 Road fauna deaths

An increase in road fauna deaths is likely to occur where new roads / tracks are constructed or upgraded affecting kangaroos, nocturnal birds and ground dwelling large carnivorous predators. Species such as goannas and raptors are attracted to carrion on road verges and therefore, there is an increased propensity for these species to be killed by vehicles.

6.3.5 Fire

Increased human activity is often associated with an altered fire regime which leads to a degradation of natural ecosystems. Fire has been identified as one of the threatening processes for some conservation significant species as several small mammal and bird species rely on long unburnt vegetation.

Large and widespread fires are unlikely to be a significant threat to native fauna species near the project area due to the sparseness of the vegetation.

6.3.6 Anthropogenic activity

Unnatural noises, vibrations, artificial light sources, and vehicle and human movement in an area may be sufficient to force individuals or fauna species to move from adjacent areas or alter their activity periods. This form of disturbance is likely to occur during the vegetation clearing and when mining activity commences. The overall impact is likely to be confined to a relatively small area and is unlikely to be a significant impact.

6.3.7 Dust

Dust generated from shifting topsoil and spoil and vehicle traffic can potentially degrade surrounding vegetation, reducing its ability to absorb sunlight and influencing photosynthetic rates. Degradation of these areas may potentially render habitat unsuitable for fauna. Dust suppression and management programs are an essential component of minimising impacts on fauna in areas adjacent to the mine. An effective dust management and monitoring program is required.

6.3.8 Uncapped drill holes

An ongoing potential risk to terrestrial fauna is the presence of uncapped drill holes within the project area. Small animals, particularly lizards and mammals, can become trapped in the drill holes and eventually die. Therefore drill holes that are open for periods of months or years can be particularly detrimental to small animal populations (Malnic 1997).

6.4 NATIVE VEGETATION CLEARING PRINCIPLES

The *Environmental Protection Act (1986)* provides criteria to judge the potential impact of a development on clearing native vegetation on flora and fauna. These criteria have been listed below with a response to indicate how clearing of the vegetation in the project area might be judged against these principles as they relate to fauna and fauna assemblages (Table 10). Where possible, native vegetation should not be cleared if any of the following principles are compromised.

Table 11. Assessment of impact using the native vegetation clearing principles

Principle	Response
It comprises a high level of biological diversity.	Clearing vegetation will not comprise a high level of biodiversity.
It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Clearing the vegetation will not result in the loss of significant habitat for indigenous fauna.
It includes, or is necessary for the continued existence or, rare flora.	N/A
It comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	The area does not contain a threatened ecological fauna community.
It is significant as a remnant of native vegetation in an area that has been extensively cleared.	The area is not a remnant.
It is growing in, or in association with, an environment associated with a watercourses or wetland.	The area does not contain a natural wetland.
The clearing of the vegetation is likely to cause appreciable land degradation.	N/A
The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Clearing of vegetation is unlikely to impact on the environmental values of the bioregion.
The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	N/A
The clearing of the vegetation is likely to cause, or exacerbate the incidence of flooding.	N/A

6.5 REFERRAL UNDER THE EPBC ACT

The proposed project is unlikely to significantly impact on a conservation significant vertebrate fauna species, so a referral under the *EPBC Act 1999* is not recommended.

7. SUMMARY

The total area assessed was approximately ~617ha and includes a substantial mining pit and associated waste dumps, and historical anthropogenic waste in numerous locations. The project area contains one broad fauna habitat of mixed mulga, acacia and chenopod shrubland. As with most areas in the Goldfields the density of trees and shrubs varies appreciably across the project area with denser vegetation along the drainage lines. Some of the study area is highly disturbed or cleared and provides no habitat value.

The project area currently does not provide an important ecological linkage or fauna movement corridor. Clearing native vegetation and development and operation of a mine is likely to result in the loss of a small number of vertebrate fauna that are unable to move away during the clearing process. The few larger animals, such as goannas, and most of the birds will move into adjacent areas once clearing commences.

The proposed vegetation clearing and mining operation may result in indirect impacts on the vertebrate fauna such as a reduction or loss of activity areas and closure of burrows, habitat fragmentation, increased presence of feral predators, road deaths and unnatural noises, vibrations, artificial light sources and vehicle and human movement in an area all of which may result in the death of animals or force some of them into adjacent areas.

Impacts on vertebrate fauna associated with clearing vegetation and the development and operation of a mine in the project area in a bioregional context will be very low.

There are no threatened species of fauna likely to be significantly impacted by clearing vegetation and the development and operation of a mine in the project area, therefore a referral under the *EPBC Act 1999* is not recommended.

8. MANAGEMENT STRATEGIES

The purpose of this section is to identify generic management and mitigation strategies to address the potential impacts of development in the project area.

8.1 INDUCTION AND AWARENESS

All contractors and staff involved in vegetation clearing, development and ongoing operations should be made aware of the possible presence and issues associated with terrestrial fauna in the area through the induction process.

8.2 DUST

Dust generated from the vegetation clearing, development and ongoing use of roads and tracks could potentially degrade surrounding vegetation, reducing its ability to absorb sunlight, and influencing photosynthetic rates. Degradation of these areas will potentially render habitat unsuitable for fauna. Dust suppression and management programs are an essential component of minimising disturbance impacts on fauna.

8.3 MINIMISING SECONDARY IMPACTS TO FAUNA AND FAUNA HABITAT

Pets and feral animals have the potential to impact on fauna. Pets should not be permitted on site and feral and pest fauna numbers monitored and controlled. To be effective, management of feral and pest species needs to be undertaken in collaboration with the landowner, pastoralist, and neighbouring tenement holders. All rubbish likely to attract animals should be suitably contained and disposed of so as not to encourage the feeding of fauna around the site.

Based on feral cat tracks and scats recorded in the study area it is highly probable that the study area currently supports a small population of feral cats. Reducing the impacts of feral cats will reduce the stress on fauna and fauna assemblages in the area. Wild dogs are also common in the area and will impacting on the local and regional vertebrate fauna assemblage.

Increased activity will result in increased traffic and a consequential increase in the fauna deaths on tracks and roads in the area. Limiting vehicle speed on access tracks can reduce collisions with fauna, particularly larger animals such as kangaroos and emus. Dead animals on the road also have the propensity to attract raptors, goannas and even cattle, which are then likely to be killed.

The following management recommendations will reduce potential impacts to fauna and fauna habitat:

- areas for clearing are minimised to reduce the loss of habitat and individual fauna;
- weed control measures are implemented during and post construction activities;
- control and reduction methods are implemented for feral and pest fauna;
- pets are not allowed on site; and
- driving restrictions are imposed on site to reduce vehicle speeds and reduce off-road driving.

9. REFERENCES

AG staff. 2017. Night parrot feather discovered in South Australia gives hope to ecologists. Australian Geographic **September**.

AG staff. 2018. Critically endangered night parrot fledging photographed on Queensland reserve. Australian Geographic **February**.

Bamford, M. J. 1995. Predation by feral cats upon lizards. The Western Australian Naturalist **20**:191-196.

Barrick Plutonic Gold Mine. 2006. Management Plan for the Protection of the Mulgara. Perth.

Bell, D. T., R. C. Bell, and W. A. Loneragan. 2007. Winter bird assemblages across an arid gradient in south-west Western Australia. Winter bird assemblages across an arid gradient in south-west Western Australia **90**:219-227.

Benshemesh, J. 2007. National Recovery Plan for Malleefowl. South Australia.

Benshemesh, J. S., and W. B. Emison. 1996. Surveying breeding densities of Malleefowl using an airborne thermal scanner. Wildlife Research **23**:121-141.

Boles, W. E., N. W. Longmore, and M. C. Thompson. 2016. A Recent Specimen of the Night Parrot *Geopsittacus occidentalis*. Emu **94**:37-40.

Booth, D. T. 1987. Home range and hatchling success of Malleefowl, *Leipoa ocellata* Gould (Megapodiidae), in Murray Mallee near Renmark, S.A. Australian Wildlife Research **14**:95-104.

Brickhill, J. 1985. An aerial survey of nests of Malleefowl *Leipoa ocellata* Gould (Megapodiidae) in central New South Wales. Australian Wildlife Research **12**:257-261.

Charalambous, S. 2016. First night parrot fledgling spotted in 100 years spotted in western Queensland. Australian Geographic **November**.

Chen, X., C. R. Dickman, and M. B. Thompson. 1998. Diet of the mulgara, *Dasycercus cristicauda* (Marsupialia: Dasyuridae), in the Simpson Desert, central Australia. Wildlife Research **25**:233-242.

Churchill, S. 2008. Australian Bats. Jacana Books, Crows Nest, NSW.

Contos, P., and M. Letnic. 2019. Diet of the crest-tailed mulgara (*Dasycercus cristicauda*) in the Strzelecki Desert. Australian Mammalogy.

Cowan, M. 2001. Murchison 1 (MUR1 - East Murchison subregion). Pages 466-479 *in* N. L. McKenzie, J. E. May, and S. McKenna, editors. A Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002. Department of Conservation and Land Management, Perth.

Cowan, M. A., and R. A. How. 2004. Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. Records of the Western Australian Museum **22**:91-100.

Cupitt, R., and S. Cupitt. 2008. Another recent specimen of the Night Parrot *Pezoporus occidentalis* from Western Queensland. Australian Field Ornithology **25**:69-75.

Davis, R. A., and B. M. Metcalf. 2008. The Night Parrot (*Pezoporus occidentalis*) in northern Western Australia: a recent sighting from the Pilbara region. Emu **108**:233-236.

Dell, J., R. A. How, A. V. Milewski, and G. J. Keighery. 1988. The biological survey of the eastern goldfields of Western Australia Part 5: Edjudina - Menzies Study Area. Records of the Western Australian Museum **Supplement No. 31**:38-69.

Department of Parks and Wildlife. 2017. Interim guideline for preliminary surveys of night parrot (*Pezoporus occidentalis*) in Western Australia. Perth.

Dickman, C. R., A. S. Haythornthwaite, G. H. McNaught, P. S. Mahon, B. Tamayo, and M. Letnic. 2001. Population dynamics of three species of dasyurid marsupials in arid central Australia: a 10 year study. Wildlife Research **28**:493-506.

Environmental Protection Authority. 2020. Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment. Western Australia.

Frith, H. J. 1962. The Mallee Fowl. Angus and Robertson, Sydney.

Garnett, S. T., J. K. Szabo, and G. Dutson. 2011. The Action Plan for Australian Birds 2010. CSIRO, Collingwood, Melbourne.

Gibson, D., and J. Cole. 1992. The Mulgara Mirage: A vanishing species, or just unknown? Wildlife Australia.

Hamilton, N., A. Burbidge, T. Douglas, and L. Gilbert. 2017a. Piecing the puzzle together: the fate of the Night Parrot nest found in Western Australia by Jackett et al. (2017). Australian Field Ornithology **34**:151-154.

Hamilton, N. A., M. Onus, B. Withnell, and K. Withnell. 2017b. Recent sightings of the Night Parrot *Pezoporus occidentalis* from Matuwa (Lorna Glen) and Milrose Station in Western Australia. Australian Field Ornithology **34**:71-75.

Jackett, N., B. Greatwich, G. Swann, and A. Boyle. 2017. A nesting record and vocalisations of the Night Parrot Pezoporus occidentalis from the East Murchison, Western Australia. Australian Field Ornithology **34**:144-150.

Johnstone, R. E., and G. M. Storr. 1998. Handbook of Western Australian Birds. Volume I - Non-Passerines (Emu to Dollarbird). Western Australian Museum, Perth.

Johnstone, R. E., and G. M. Storr. 2004. Handbook of Western Australian Birds. Volume II - Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth.

Jones, A. 2017. Night parrot sighting in Western Australia shocks birdwatching world. ABC News.

Keith Lindbeck and Associates. 2012. Central Yilgarn Iron Project (CYIP) Mt Mason Fauna Assessment. Perth.

Keith Lindbeck and Associates. 2013. Mt Mason Project and Proposed Haul Road Targeted EPBC Fauna Survey. Perth.

Kinnear, J. 1993. Masterly marauders: The cat and the fox. Landscope **8**:20-28.

Körtner, G., C. R. Pavey, and F. Geiser. 2007. Spatial ecology of the mulgara in arid Australia: impact of fire history on home range size and burrow use. Journal of Zoology **273**:350-357.

Letnic, M., and C. R. Dickman. 2005. The responses of small mammals to patches regenerating after fire and rainfall in the Simpson Desert, central Australia. Austral Ecology **30**:24-39.

Malnic, J. 1997. Uncapped drill holes are silent killers. Australia's Mining Monthly **March**:16.

Manson, J. 1994. The implications of home range variation between sexes and seasons in an arid dwelling dasyurid, the Mulgara *(Dasycercus cristicauda*). University of Western Australia, Perth.

Masters, P. 1998. The Mulgara *Dasycercus cristicauda* (Marsupialia: Dasyuridae) at Uluru National Park, Northern Territory. Australian Mammalogy **20**:403-407.

Masters, P. 2003. Movement patterns and spatial organisation of the mulgara, *Dasycercus cristicauda* (Marsupialia: Dasyuridae), in central Australia. Wildlife Research **30**:339-344.

Masters, P. 2008. Crest-tailed Mulgara. Pages 49-50 *in* S. Van Dyck and R. Strahan, editors. The Mammals of Australia. Reed New Holland, Sydney.

Masters, P., C. R. Dickman, and M. Crowther. 2003. Effects of cover reduction on Mulgara *Dasycercus cristicauda* (Marsupialia: Dasyuridae), rodent and invertebrate populations in central Australia: Implications for land management. Austral Ecology **28**:658-665.

McCarthy, M. 2017. Night parrot feather discovery proves Australia's most elusive bird is alive in South Australia. ABC News.

Moriarty, T. K. 1972. Birds of Wanjarri, W.A. (27°25'S, 120°40'E). Emu **72**:1-7.

Murphy, S. 2015. Shining a light: The research unlocking the secrets of the mysterious Night Parrot. Australian Birdlife **4**:30-35.

Murphy, S. A., J. J. Austin, R. K. Murphy, J. Silcock, L. Joseph, S. T. Garnett, N. P. Leseberg, J. E. M. Watson, and A. H. Burbidge. 2017a. Observations on breeding Night Parrots (*Pezoporus occidentalis*) in western Queensland. Emu **117**:107-113.

Murphy, S. A., J. Silcock, R. Murphy, J. Reid, and J. J. Austin. 2017b. Movements and habitat use of the night parrot *Pezoporus occidentalis* in south-western Queensland. Austral Ecology.

Ninox Wildlife Consulting. 2006. A Vertebrate Fauna Assessment of the Tarmoola Area. Perth.

Palaszxzuk, A., and S. Miles. 2017. New night parrot community discovered in central west Queensland.

Parsons, B. C., J. C. Short, and J. D. Roberts. 2008. Contraction in the range of Malleefowl (*Leipoa ocellata*) in Western Australia: a comparative assessment using presence-only and presence-absence datasets. Emu **108**:221-231.

Pavey, C. R., C. E. M. Nano, J. R. Cole, P. J. McDonald, P. Nunn, A. Silcocks, and R. H. Clarke. 2014. The breeding and foraging ecology and abundance of the Princess Parrot (*Polytelis alexandrae*) during a population irruption. Emu:NULL.

Pearson, D. 2003-04. Mulgaras and mining. Landscope **19**:26-31.

Pickrell, J. 2016. The night parrot's secret sanctuary. Australian Geographic **August**.

Priddel, D., and R. Wheeler. 2003. Nesting activity and demography of an isolated population of malleefowl (*Leipoa ocellata*). Wildlife Research **30**:451-464.

Rykers, E. 2017. Night parrot call recordings released online for first time. Australian Geographic **February**.

Schoenjahn, J., C. R. Pavey, and G. H. Walter. 2019. Ecology of the Grey Falcon *Falco hypoleucos* – current and required knowledge. Emu - Austral Ornithology **120**:74-82.

Serena, M., and T. Soderquist. 2008. Western Quoll. Pages 54-56 *in* S. van Dyck and R. Strahan, editors. The Mammals of Australia. Reed New Holland, Sydney.

Storr, G. M., and R. E. Johnstone. 1983. Part VI Amphibians and Reptiles. Pages 70-74 *in* N. L. McKenzie, editor. Wildlife of the Dampier Peninsula, south-west Kimberley, Western Australia. Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 1990. Lizards of Western Australia. III: Geckos and Pygopods. Western Australian Museum, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 1999. Lizards of Western Australia. I: Skinks. Western Australian Museum, Perth.

Storr, G. M., L. A. Smith, and R. E. Johnstone. 2002. Snakes of Western Australia. Western Australian Museum, Perth.

Thompson, G. G., and S. A. Thompson. 2007. Shape and spatial distribution of Mulgara (*Dasycercus cristicauda*) burrows, with comments on their presence in a burnt habitat and a translocation protocol. Journal of the Royal Society of Western Australia **90**:195-202.

Thompson, G. G., and S. A. Thompson. 2008. Abundance and spatial distribution of five small mammals at a local scale. Australian Mammalogy **30**:65-70.

Thompson, S. A., and G. G. Thompson. 2006. Reptiles of the Western Australian Goldfields. Goldfields Environmental Management Group, Kalgoorlie, WA.

Thompson, S. A., and G. G. Thompson. 2010. Terrestrial Vertebrate Fauna Assessments for Ecological Impact Assessment. Terrestrial Ecosystems, Perth.

Threatened Species Scientific Committee. 2015. Conservation Advice *Sminthopsis psammophila* sandhill dunnart. Canberra.

Threatened Species Scientific Committee. 2016. Conservation Advice *Pezoporus occidentalis* Night Parrot. Canberra.

Threatened Species Scientific Committee. 2020. Conservation Advice *Falco hypoleucos* Grey Falcon. Canberra.

Tyler, M. J., L. A. Smith, and R. E. Johnstone. 2000. Frogs of Western Australia. Western Australian Museum, Perth.

Van Dyck, S., and R. Strahan. 2008. The Mammals of Australia. Reed New Holland, Sydney.

Wilson, H. 1937. Notes on the Night Parrot, with references to recent occurrences. Emu **37**:79-87.

Woinarski, J. C. Z., A. A. Burbidge, and P. L. Harrison. 2014. The Action Plan for Australian Mammals 2012. CSRIO Publishing, Melbourne.

Woolley, P. A. 1990. Mulgaras, *Dasycercus cristicauda* (Marsupialia: Dasyuridae); their burrows, and records of attempts to collect live animals between 1966 and 1979. Australian Mammalogy **13**:61-64.

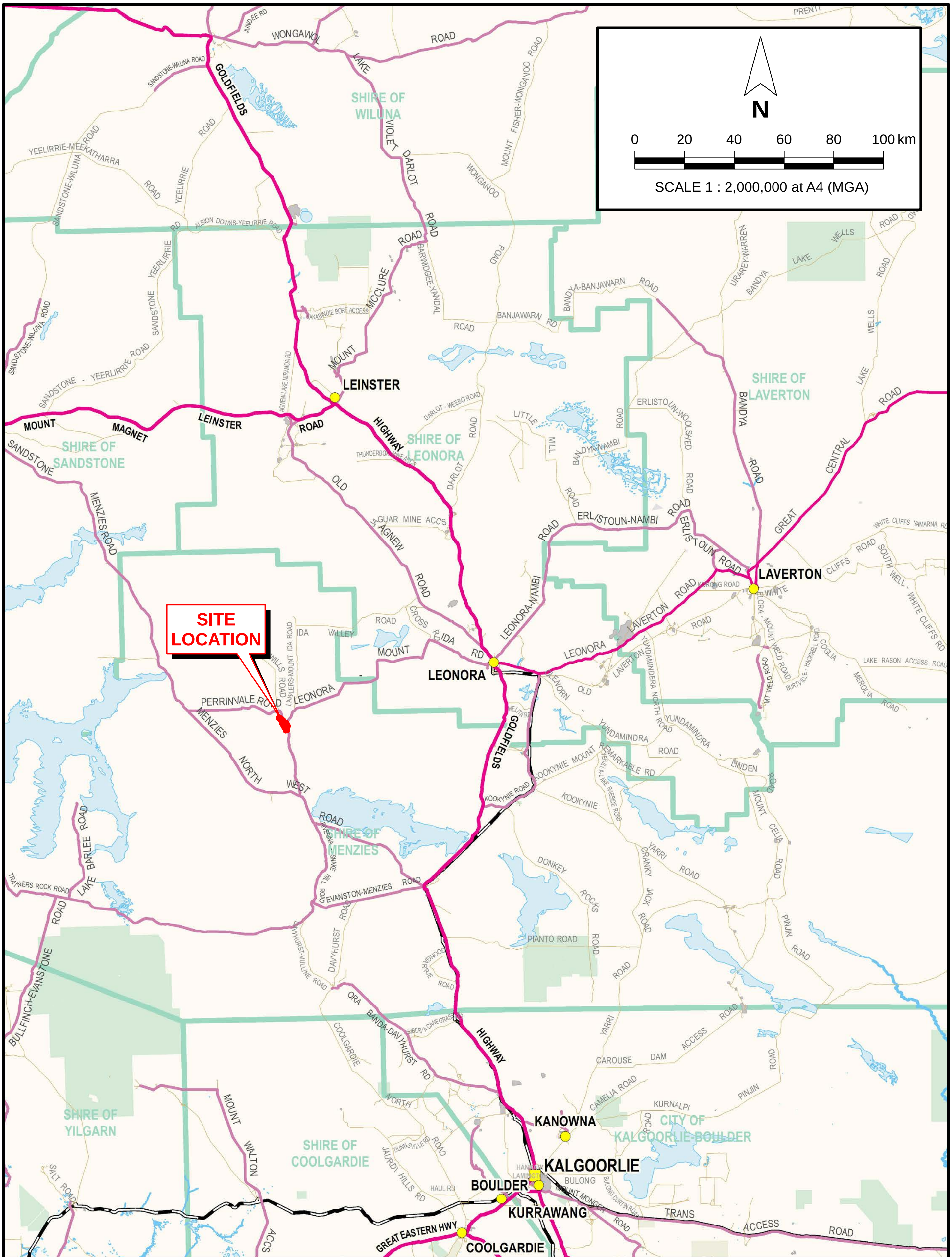
Woolley, P. A. 2005. The species of *Dasycercus* Peters, 1875 (Marsupialia: Dasyuridae). Memoirs of Museum Victoria **62**:213-221.

Woolley, P. A. 2008a. Brush-tailed Mulgara. Pages 47-48 *in* S. Van Dyck and R. Strahan, editors. The Mammals of Australia. Reed New Holland, Sydney.

Woolley, P. A. 2008b. Crest-tailed Mulgara. Pages 49-50 *in* S. Van Dyck and R. Strahan, editors. Mammals of Australia. Reed New Holland, Sydney.

Figures

Vertebrate fauna reconnaissance survey and risk assessment
Mt Ida Lithium Gold Project



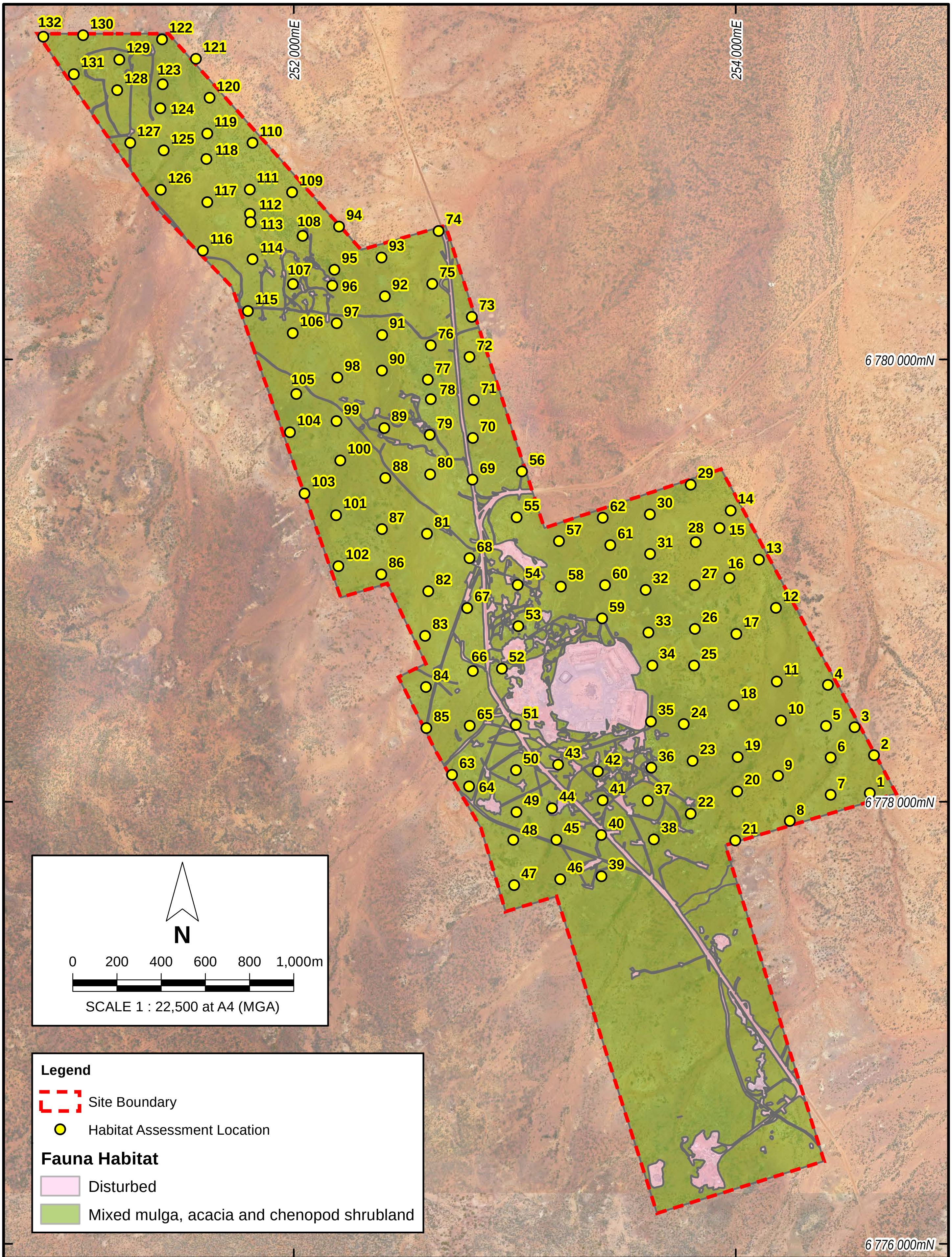
TERRESTRIAL ECOSYSTEMS

Mt Ida Gold Pty Ltd
VERTEBRATE FAUNA RECONNAISSANCE SURVEY AND RISK ASSESSMENT
MT IDA PROJECT

Figure 1

REGIONAL LOCATION

Drawn: S. Thompson | Date: 28 Jan 2023 | Job: 2022-0025



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TERRESTRIAL ECOSYSTEMS

Drawn: S. Thompson | Date: 28 Jan 2023

Mt Ida Gold Pty Ltd
VERTEBRATE FAUNA RECONNAISSANCE SURVEY AND RISK ASSESSMENT
MT IDA PROJECT

FAUNA HABITAT TYPES

Figure 2

Job: 2022-0025

Appendix A.
Results of the EPBC Act Protected Matters Search

Vertebrate fauna reconnaissance survey and risk assessment
Mt Ida Lithium Gold Project

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 19-Apr-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	10
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	13
Commonwealth Heritage Places:	None
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	5
Regional Forest Agreements:	None
Nationally Important Wetlands:	3
EPBC Act Referrals:	4
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Eleocharis papillosa Dwarf Desert Spike-rush [2519]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Myriophyllum lapidicola		
Chiddarcooping Myriophyllum [55940]	Endangered	Species or species habitat known to occur within area
Ricinocarpos brevis		
[82879]	Endangered	Species or species habitat known to occur within area
Tetratheca paynterae		
Paynter's Tetratheca [66451]	Endangered	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Unknown	
Commonwealth Land - [51796]	WA
Commonwealth Land - [52197]	WA
Commonwealth Land - [51756]	WA
Commonwealth Land - [51754]	WA
Commonwealth Land - [51755]	WA
Commonwealth Land - [51753]	WA
Commonwealth Land - [51751]	WA
Commonwealth Land - [51058]	WA
Commonwealth Land - [52213]	WA
Commonwealth Land - [51752]	WA
Commonwealth Land - [52232]	WA
Commonwealth Land - [51750]	WA
Commonwealth Land - [51984]	WA

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Thinornis cucullatus as Thinornis rubricollis Hooded Dotterel, Hooded Plover [87735]		Species or species habitat known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area overfly marine area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Bulga Downs & Cashmere Downs Pastoral leases portions	NRS Addition - Gazettal in Progress	WA
Credo	NRS Addition - Gazettal in Progress	WA
Goongarrie	National Park	WA
Mount Manning Range	Nature Reserve	WA
Unnamed WA46847	Nature Reserve	WA

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Lake Ballard	WA
Lake Barlee	WA
Lake Marmion	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
Ularring Hematite Project, WA	2012/6426	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Mt Mason Hematite DSO Project, 110kms northwest of Menzies, WA	2013/6870	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Mt Richardson Iron Ore Project and Northern Yilgarn Haul Road	2022/9152	Referral Decision	Referral Publication

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix B. Vertebrate Fauna Recorded in Biological Surveys in the Region

Vertebrate fauna reconnaissance survey and risk assessment
Mt Ida Lithium Gold Project

B.1 VERTEBRATE FAUNA ASSESSMENTS

		Surveys	A	B										C										D		E								F	G
Family	Species	Common names		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 22	Site 21a	Goongarrie NP	Site 12a	Mine (Tarmoola	Pipeline	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 9	Site 8	Unknown	Goongarrie
Amphibians																																			
Limnodynastidae	*Neobatrachus kunapalari*	Wheatbelt Frog	X																																
	Neobatrachus sudelli	Sudell's Frog	X																																
	Neobatrachus sutor	Shoemaker Frog	X											3	1	5	10																		
	Neobatrachus wilsmorei	Plonking Frog	X		3	2								1		11		2	2																
	Platyplectrum spenceri	Spencer's Burrowing Frog	X																																
Myobatrachidae	*Pseudophryne occidentalis*	Western Toadlet	X																																
Pelodryadidae	*Cyclorana maini*	Main's Frog	X																																
	Cyclorana occidentalis	Western Water-holding Frog	X																																
	Litoria moorei	Motorbike Frog	X																																
Reptiles																																			
Agamidae	*Ctenophorus cristatus*	Crested Dragon					5	1	1											5															
	Ctenophorus fordi	Mallee Dragon	X	22	42	2	15	2	2	6	9			43	26				2	16															
	Ctenophorus infans	Ring-tailed Dragon	X																																
	Ctenophorus ornatus	Ornate Crevice Dragon	X																																
	Ctenophorus pictus	Painted Dragon	X																																
	Ctenophorus reticulatus	Western Netted Dragon	X									1	2			2	1				4			X											
	Ctenophorus salinarum	Saltpan Dragon	X																																
	Ctenophorus scutulatus	Lozenge-marked Dragon	X		3	7	3		8			3	1													1	3	5	3	1					
	Ctenophorus vadnappa	Red-barred Dragon	X											3		2	1		7	3	2														
	Diporiphora amphiboluroides	Mulga Dragon																										2							
	Moloch horridus	Thorny Devil	X		1				1	1	2		1	1			1	2																	
	Pogona minor	Western Bearded Dragon	X	1	1	1	1		3	1	1		3	1	1	2		4	2	1	1						1		1						
Carphodactylidae	*Nephrurus laevissimus*	Smooth Knob-tail	X	18	18		2	1	1	12	9			18	18			1		2															
	Nephrurus vertebralis	Midline Knob-tail	X																																
	Underwoodisaurus milii	Barking Gecko	X									9																							
Diplodactylidae	*Diplodactylus granariensis*	Wheatbelt Stone Gecko	X			2	1	5	8	4	8	4						1	2	1	1														
	Diplodactylus pulcher	Beautiful Gecko	X						1			2	1														1			1					
	Lucasium maini	Main's Ground Gecko	X			1	2	2										3	1	2															
	Rhynchoedura ornata	Beaked Gecko	X		2	1	2	2	3	1				2		1		7	1	2															
	Strophurus assimilis	Goldfields Spiny-tailed Gecko	X							3																1									
	Strophurus elderi	Jewelled Gecko	X																																
	Strophurus intermedius	Southern Spiny-tailed Gecko	X														2																		

		Surveys	A	B										C										D		E								F	G
Family	**Species**	**Common names**		**GG26**	**GG27**	**GG29**	**GG28**	**GS28**	**GS29**	**GS26**	**GS27**	**GS30**	**GG30**	**Site 13**	**Site 3**	**Site 9**	**Site 9a**	**Site 12**	**Site 21**	**Site 22**	**Site 21a**	**Goongarrie NP**	**Site 12a**	**Mine (Tarmoola**	**Pipeline**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 9**	**Site 8**	**Unknown**	**Goongarrie**
	Strophurus wellingtonae	Western Shield Spiny-tailed Gecko	X																																
Elapidae	*Brachyurophis fasciolatus*	Narrow-banded Burrowing Snake	X								1																								
	Brachyurophis semifasciata	Half-girdled Snake								1		1																							
	Demansia psammophis	Yellow-faced Whipsnake	X				2																												
	Furina ornata	Orange-naped Snake	X																																
	Neelaps bimaculatus	Black-naped Burrowing Snake	X																																
	Suta monachus	Hooded Snake	X				1													1															
	Pseudechis australis	Mulga Snake	X																																
	Pseudonaja mengdeni	Western Brown Snake	X															1																	
	Pseudonaja modesta	Ringed Brown Snake	X		1		3							1						3															
	Simoselaps bertholdi	Jan's Banded Snake	X						1																										
Gekkonidae	*Gehyra punctata*	Spotted Dtella	X																																
	Gehyra purpurascens	Purplish Dtella	X				2													2															
	Gehyra variegata	Variegated Gehyra	X	1	1		3	4	6		2	3	1	1	1			2		4	2			X						1					
	Heteronotia binoei	Bynoe's Gecko	X										2								2										1				
Pygopodidae	*Delma australis*	Marble-faced Delma	X																																
	Delma butleri	Unbanded Delma	X	1			1																												
	Delma nasuta	Sharp-snouted Delma	X												1					1															
	Lialis burtonis	Burton's Legless Lizard																1																	
	Pygopus nigriceps	Western Hooded Scaly-foot	X			1												1	1																
Pythonidae	*Antaresia stimsoni*	Stimson's Python	X																																
Scincidae	*Cryptoblepharus australis*	Inland Snake-eyed Skink	X																																
	Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink	X			1	3				1		3						1	3	1														
	Ctenotus atlas	Southern Mallee Ctenotus	X	4	3	1	4	3	2	2	3			3	4					1															
	Ctenotus brooksi	Wedgsnout Ctenotus	X	17						3					24																				
	Ctenotus leae	Orange-tailed Finesnout Ctenotus	X																																
	Ctenotus leonhardii	Leonhardi's Ctenotus	X													5	9									1	8	2	1						
	Ctenotus schomburgkii	Barred Wedgesnout Ctenotus	X	4	9	3	5	5	1		1			9	4	1			3	5							1	1							
	Ctenotus severus	Stern Ctenotus	X																																
	Ctenotus uber	Spotted Ctenotus	X			1						1	6						1		1														
	Ctenotus xenopleura	Wide-striped Ctenotus	X																																
	Cyclodomorphus branchialis	Common Slender Bluetongue	X															1		2															
	Cyclodomorphus melanops	Spinifex Slender Blue-tongue				10	2		2			2																							
	Egernia depressa	Southern Pygmy Spiny-tailed Skink	X																2	1										3					
	Egernia formosa	Goldfields Crevice Skink	X										5																						
	Lerista desertorum	Central Desert Robust Slider	X																																
	Lerista kingi	King's Slider	X																																

		Surveys	A	B										C										D		E								F	G
Family	Species	Common names		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 22	Site 21a	Goongarrie NP	Site 12a	Mine (Tarmoola	Pipeline	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 9	Site 8	Unknown	Goongarrie
	Lerista lineopunctulata	Dotted-line Robust Slider	X																																
	Lerista macropisthopus	Unpatterned Robust Slider	X				1			2										1															
	Lerista picturata	Southern Robust Slider	X																																
	Liopholis inornata	Desert Skink	X	3	2	1		2		2	4			1	3			1	1		1														
	Liopholis striata	Nocturnal Desert Skink	X																																
	Menetia greyii	Common Dwarf Skink	X	1	2	1	1	1	1		1		1	2	1	1			1	2							1			3					
	Morethia butleri	Woodland Morethia Skink	X										2								2														
	Tiliqua occipitalis	Western Blue-tongued Lizard	X		1						1			1				1																	
Typhlopidae	*Anilios australis*	Austral Blind Snake	X						2	1																									
	Anilios bituberculatus	Prong-snouted Blind Snake						1																											
	Anilios hamatus	Pale-headed Blind Snake							1																										
Varanidae	*Varanus caudolineatus*	Stripe-tailed Monitor														1										3	2								
	Varanus giganteus	Perentie	X																																
	Varanus gouldii	Gould's Goanna	X			2		1								1	1		2		2			X											
	Varanus panoptes	Yellow-spotted Monitor	X																							1		2	1	2					
	Varanus tristis	Black-headed Monitor										1									3														
Birds																																			
Casuariidae	*Dromaius novaehollandiae*	Emu	X											8	2	1				3	1	1		X											
Anatidae	*Chenonetta jubata*	Australian Wood Duck																						X											
Megapodiidae	*Leipoa ocellata*	Malleefowl																																2	
Columbidae	*Phaps chalcoptera*	Common Bronzewing																		2	1	1	1												
	Ocyphaps lophotes	Crested Pigeon													2	6						1		X	X										
	Geopelia cuneata	Diamond Dove														1																			
Cuculidae	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo												6		1				2	2	1				1	2	2	1						
Cuculidae	*Chrysococcyx osculans*	Black-eared Cuckoo												3	4					6		1			X	1				1					
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar																		3		1						1							
Podargidae	*Podargus strigoides*	Tawny Frogmouth																		1		1													
Turnicidae	*Turnix velox*	Little Buttonquail												13	3							1													
Ardeidae	*Egretta novaehollandiae*	White-faced Heron																				1		X											
Accipitridae	*Hieraaetus morphnoides*	Little Eagle													1					2		1													
	Aquila audax	Wedge-tailed Eagle																				1		X											
	Circus assimilis	Spotted Harrier																	1			1													
	Accipiter fasciatus	Brown Goshawk																				1													
	Accipiter cirrocephalus	Collared Sparrowhawk																				1													
	Haliastur sphenurus	Whistling Kite																						X											
Cuculidae	*Heteroscenes pallidus*	Pallid Cuckoo																	4			1			X		1	2	2	1					

TERRESTRIAL ECOSYSTEMS

		Surveys	A	B										C										D		E								F	G
Family	**Species**	**Common names**		**GG26**	**GG27**	**GG29**	**GG28**	**GS28**	**GS29**	**GS26**	**GS27**	**GS30**	**GG30**	**Site 13**	**Site 3**	**Site 9**	**Site 9a**	**Site 12**	**Site 21**	**Site 22**	**Site 21a**	**Goongarrie NP**	**Site 12a**	**Mine (Tarmoola**	**Pipeline**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 9**	**Site 8**	**Unknown**	**Goongarrie**
Strigidae	*Ninox boobook*	Southern Boobook																				1													
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra																																	1
Alcedinidae	*Todiramphus pyrrhopygius*	Red-backed Kingfisher																				1													
Meropidae	*Merops ornatus*	Rainbow Bee-eater												3	1					5		1												7	
Falconidae	*Falco cenchroides*	Nankeen Kestrel																				1		X											
	Falco longipennis	Australian Hobby																		1		1		X											
	Falco berigora	Brown Falcon													2					2		1		X	X										
Cacatuidae	*Eolophus roseicapilla*	Galah																		4	62	1		X	X		2			2					
	Nymphicus hollandicus	Cockatiel																		11	4	1		X		13	3		21	3					
Psittaculidae	*Neopsephotus bourkii*	Bourke's Parrot																				1							5						
	Barnardius zonarius	Australian Ringneck														10			3			1		X	X	8	5	8	5	5					1
	Psephotus varius	Mulga Parrot												4	4	3			2			1		X											
	Melopsittacus undulatus	Budgerigar												1	6				38	27		1				10		20	15						
Ptilonorhynchidae	*Chlamydera guttata*	Western Bowerbird	X																								1								
	Ptilonorhynchus maculata	Spotted Bowerbird																						X											
Climacteridae	*Climacteris affinis*	White-browed Treecreeper	X																1		1	1			X										
	Climacteris rufus	Rufous Treecreeper	X																																
Maluridae	*Malurus pulcherrimus*	Blue-breasted Fairywren	X											15	9																				
	Malurus splendens	Splendid Fairywren	X											24								1		X	X	15	10	20	14	21					1
	Malurus leucopterus	White-winged Fairywren	X													17						1		X											
Meliphagidae	*Certhionyx variegatus*	Pied Honeyeater	X											2								1													
	Purnella albifrons	White-fronted Honeyeater	X											69	125	16			7	144	6	1	4												
	Manorina flavigula	Yellow-throated Miner	X													109			3	74		1		X	X			1	7						1
	Acanthagenys rufogularis	Spiny-cheeked Honeyeater	X											18	23	7			6	52	4	1		X	X	1	1	5	5	6					1
	Anthochaera carunculata	Red Wattlebird	X													1				5								2	5						1
	Gavicalis virescens	Singing Honeyeater	X											2		4				1		1		X	X	1	1	1	2	2					1
	Ptilotula ornata	Yellow-plumed Honeyeater	X																	230		1													
	Ptilotula plumula	Grey-fronted Honeyeater																		12															
	Conopophila whitei	Grey Honeyeater												2		1					17	1													
	Epthianura tricolor	Crimson Chat	X																								2								
	Epthianura aurifrons	Orange Chat	X																																
	Epthianura albifrons	White-fronted Chat	X																			1		X											
	Sugomel nigrum	Black Honeyeater	X											7	4																				
	Lichmera indistincta	Brown Honeyeater	X																			1		X											
	Nesoptilotis leucotis	White-eared Honeyeater	X											4																					1
	Melithreptus brevirostris	Brown-headed Honeyeater	X																	6		1													1
Pardalotidae	*Pardalotus striatus*	Striated Pardalote	X												1					2		1		X											1

		Surveys	A	B										C										D		E								F	G
Family	**Species**	**Common names**		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 22	Site 21a	Goongarrie NP	Site 12a	Mine (Tarmoola	Pipeline	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 9	Site 8	Unknown	Goongarrie
Acanthizidae	*Pyrrholaemus brunneus*	Redthroat	X											16	8				2		1	1					1			2					1
	Calamanthus campestris	Rufous Fieldwren																												1					
	Acanthiza iredalei	Slender-billed Thornbill	X																			1													1
	Acanthiza apicalis	Inland Thornbill	X											32	38				1	15	2	1	2		X	19	10	18	11	16					1
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	X											2		4				1				X	X		2								
	Acanthiza uropygialis	Chestnut-rumped Thornbill	X											23	3	27				46	10	1	2	X	X										1
	Acanthiza robustirostris	Slaty-backed Thornbill	X																							5	5	14	8	12					
	Smicrornis brevirostris	Weebill	X											50	36				2	269	2	1		X		2		10	5						
	Gerygone fusca	Western Gerygone	X																																
	Aphelocephala leucopsis	Southern Whiteface	X																		12	1		X	X										
Pomatostomidae	*Pomatostomus superciliosus*	White-browed Babbler	X											1							3	1			X		3								1
Cinclosomatidae	*Cinclosoma castanotum*	Chestnut Quail-thrush																		3															
	Cinclosoma castaneothorax	Chestnut-breasted Quail-thrush	X																																1
Campephagidae	*Coracina maxima*	Ground Cuckooshrike	X																	6		1													
	Coracina novaehollandiae	Black-faced Cuckooshrike	X												11	3				12		1		X	X			2							1
	Lalage tricolor	White-winged Triller	X											2		2				14	6	1													
Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	X											2								1													1
Oreoicidae	*Oreoica gutturalis*	Crested Bellbird	X											11	6	2				15	2	1	1	X	X	6	8	6	5	5					1
Pachycephalidae	*Colluricincla harmonica*	Grey Shrikethrush	X											6	16					17	1	1		X	X	2	2	2	1	3					1
	Pachycephala inornata	Gilbert's Whistler	X																																
	Pachycephala pectoralis	Golden Whistler	X																																
	Pachycephala rufiventris	Rufous Whistler	X												2					32	1	1		X	X	2		1							1
Artamidae	*Artamus personatus*	Masked Woodswallow	X											1	1					18		1													
	Artamus superciliosus	White-browed Woodswallow																				1													
	Artamus cinereus	Black-faced Woodswallow	X																		1	1		X	X										
	Artamus cyanopterus	Dusky Woodswallow	X																																
	Cracticus torquatus	Grey Butcherbird	X											2	2	1				8		1		X	X										1
	Cracticus nigrogularis	Pied Butcherbird	X											3	2	14				5	2	1		X			1	1	2	1					1
	Gymnorhina tibicen	Australian Magpie	X													5				2															
	Strepera versicolor	Grey Currawong	X													4				1	1	1				3	1	5	1	4					1
Rhipiduridae	*Rhipidura leucophrys*	Willie Wagtail	X													1				5		1		X	X										1
	Rhipidura albiscapa	Grey Fantail	X																	13		1				1									1
Monarchidae	*Grallina cyanoleuca*	Magpie-lark	X																					X											
Corvidae	*Corvus orru*	Torresian Crow	X																	2				X	X	3	2	4							
	Corvus bennetti	Little Crow	X													149				7		1				1		1	1						1
	Corvus coronoides	Australian Raven	X																																
Petroicidae	*Microeca fascinans*	Jacky Winter	X																	28		1													

		Surveys	A	B										C										D		E								F	G
Family	**Species**	**Common names**		GG26	GG27	GG29	GG28	GS28	GS29	GS26	GS27	GS30	GG30	Site 13	Site 3	Site 9	Site 9a	Site 12	Site 21	Site 22	Site 21a	Goongarrie NP	Site 12a	Mine (Tarmoola	Pipeline	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 9	Site 8	Unknown	Goongarrie
	Petroica goodenovii	Red-capped Robin	X											8		4				20	4	1		X	X		4	4	5	3					1
	Melanodryas cucullata	Hooded Robin	X												2					32	1	1													1
	Drymodes brunneopygia	Southern Scrub-Robin	X																																
Locustellidae	*Cincloramphus cruralis*	Brown Songlark	X																			1													
	Cincloramphus mathewsi	Rufous Songlark	X																		2	1													
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	X											2	1							1		X											
	Petrochelidon ariel	Fairy Martin	X												5							1													
	Petrochelidon nigricans	Tree Martin	X												7									X											
	Cheramoeca leucosterna	White-backed Swallow	X																			1		X											
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	X											3	1	4			1	5		1													1
Estrildidae	*Taeniopygia guttata*	Zebra Finch	X												4					2		1		X	X										
Motacillidae	*Anthus novaeseelandiae*	Australasian Pipit	X													2				4		1		X											
Mammals																																			
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	X																					X											
Bovidae	*Bos taurus*	Cow																						X											
	Capra hircus	Goat																						X											
	Ovis aries	Sheep														1	1		1					X											
Camelidae	*Camelus dromedarius*	Dromedary																		1															
Suidae	*Sus scrofa*	Pig	X																																
Canidae	*Canis lupus*	Dingo	X											1						1				X											
	Vulpes vulpes	Red Fox												1	1						1														
Felidae	*Felis catus*	Cat													1																				
Molossidae	*Austronomus australis*	White-striped Freetail Bat	X																	1						1	1	1	1	1					
	Mormopterus planiceps	Southern Free-tail Bat	X																																
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	X																							1	1	1	1	1					
	Nyctophilus geoffroyi	Lesser Long-eared Bat	X																																
	Nyctophilus major	Greater Long-eared Bat	X																																
	Scotorepens balstoni	Inland Broad-nosed Bat	X																							1	1	1	1						
	Vespadelus baverstocki	Inland Forest Bat	X																																
	Vespadelus finlaysoni	Finlayson's Cave Bat																								1	1	1	1	1					
Dasyuridae	*Antechinomys laniger*	Kultarr	X																																
	Ningaui ridei	Wongai Ningaui	X	1				4	3	5				1	3																				
	Ningaui yvonneae	Mallee Ningaui	X																																
	Pseudantechinus woolleyae	Woolley's False Antechinus																														1			
	Sminthopsis crassicaudata	Fat-tailed Dunnart	X	1					1						1		1																		
	Sminthopsis dolichura	Little Long-tailed Dunnart	X	1	1	1	1		1	2	2	12		3					1	1						1	2	3	4	3					

		Surveys	A	B										C										D		E								F	G
Family	**Species**	**Common names**		**GG26**	**GG27**	**GG29**	**GG28**	**GS28**	**GS29**	**GS26**	**GS27**	**GS30**	**GG30**	**Site 13**	**Site 3**	**Site 9**	**Site 9a**	**Site 12**	**Site 21**	**Site 22**	**Site 21a**	**Goongarrie NP**	**Site 12a**	**Mine (Tarmoola**	**Pipeline**	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 9**	**Site 8**	**Unknown**	**Goongarrie**
	Sminthopsis hirtipes	Hairy-footed Dunnart	X																																
	Sminthopsis longicaudata	Long-tailed Dunnart																										2							
	Sminthopsis ooldea	Ooldea Dunnart	X																																
Macropodidae	*Osphranter robustus*	Euro	X																1					X											
	Osphranter rufus	Red Kangaroo	X																					X											
Leporidae	*Oryctolagus cuniculus*	Rabbit													1									X											
Muridae	*Mus musculus*	House Mouse	X					1		2	4			4	2											4	2	2	23	10		1	2		
	Notomys alexis	Spinifex Hopping Mouse	X	9	3	1	1		2					2	9				2	1						5									
	Notomys mitchellii	Mitchell's Hopping Mouse	X	1											3				1																
	Pseudomys albocinereus	Ash-grey Mouse	X																																
	Pseudomys bolami	Bolam's Mouse	X																		3														
	Pseudomys hermannsburgensis	Sandy Inland Mouse	X		2				4	1				2	1											3		1	2	1					

A Atlas of Living Australia

B Cowan, M.A. and How, R.A. (2004) Comparisons of ground vertebrate assemblages in arid Western Australia in different seasons and decades. *Records of the Western Australian Museum*, 22, 91-100.

C Dell, J and How, R.A. (1988) Vertebrate fauna. In: The biological Survey of the Eastern Goldfields of Western Australia, Part 5, Edjudina - Menzies Study Area. *Records of the Western Australian Museum*, Supplement No 31, pp. 38-77.

D Ninox Wildlife Consulting (2006) *A vertebrate fauna assessment of the Tarmoola area*. Unpublished report for St Barbara Limited, Perth.

E Keith Lindbeck and Associates (2012) *Central Yilgarn Iron Project (CYIP) Fauna Assessment Mt Mason*, Unpublished report for Jupiter Mines Ltd, Perth.

F Keith Lindbeck And Associates (2013) *Mt Mason Project and Proposed Haul Rd Targeted EPBC Fauna Survey*, unpublished report for Jupiter Mines Ltd, Perth.

G Bell, D.T., Bell, R.C. and Loneragan, W.A. (2007) Winter bird assemblages across an arid gradient in south-west Western Australia. *Journal of the Royal Society of Western Australia* 90, 219-227.

Appendix C.

Definitions of Significant Fauna under the WA *Biodiversity Conservation Act 2016* and Priority Species

Vertebrate fauna reconnaissance survey and risk assessment
Mt Ida Lithium Gold Project

ATTACHMENT C
DEFINITIONS OF SIGNIFICANT FAUNA UNDER THE WA BIODIVERSITY CONSERVATION ACT 2016

Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such. 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 *Biodiversity Conservation Act 2016*. Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T Threatened Species

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

[1] The definition of flora includes algae, fungi and lichens

[2] Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

EN Endangered species

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU Vulnerable species

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct Species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

EW Extinct in the wild species

Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the pwild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially Protected Species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory birds protected under an international agreement

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependant fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or 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 or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations

P1	**Priority 1: Poorly-known species**

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

P2	**Priority 2: Poorly-known species**

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

P3	**Priority 3: Poorly-known species**

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

P4	**Priority 4: Rare, Near Threatened and other species in need of monitoring**

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

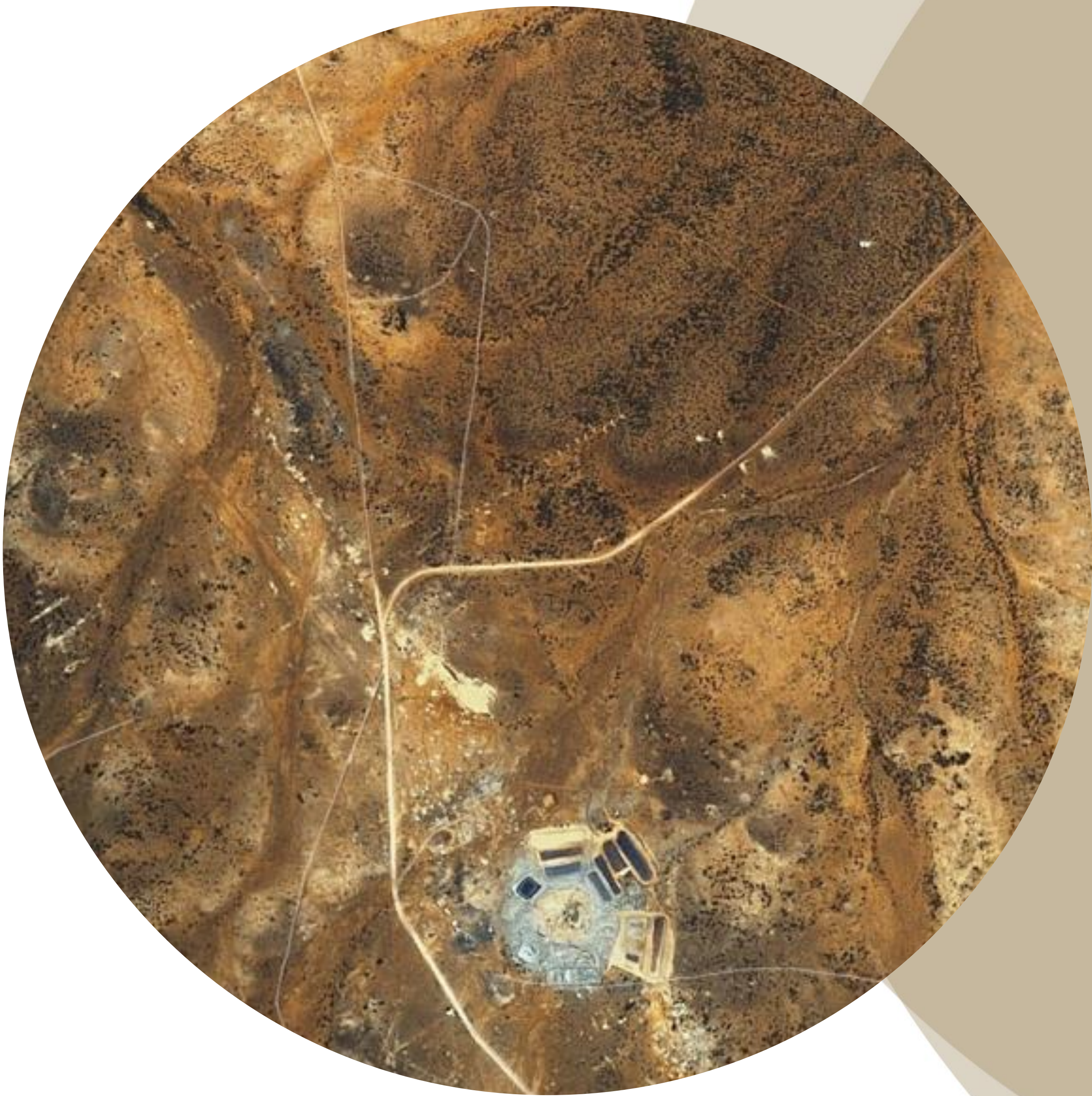
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix D.
Fauna habitat assessments

Vertebrate fauna reconnaissance survey and risk assessment
Mt Ida Lithium Gold Project

Appendix 3: Hydrogeological Study & Water Supply Options Analysis



Mt Ida Lithium-Gold Project

Hydrogeological Study & Water Supply Options Analysis

Mt Ida Gold Pty Ltd

10th August 2022

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PROJECT 311012-01455 - Mt Ida Lithium-Gold Project - Hydrogeological Study & Water Supply Options Analysis

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Executive summary

The Mt Ida Lithium-Gold Project (Mt Ida Project or the Project) consists of 29 tenements in the historical Mt Ida gold mining district, located approximately 100 km north-west of Menzies in the Goldfields region of Western Australia. The Project tenements cover an area of 167 km^2 and include the historic Timoni Gold Mine and others, which have produced over 300,000 oz gold at 17.2 g/t head grade.

Mt Ida Gold Pty Ltd (Mt Ida Gold) expect to commence a Prefeasibility Study (PFS) for the Mt Ida Project and require a baseline groundwater assessment with identification of potential water supply options. Further studies may be required in future, including a surface water baseline assessment and drafting of a preliminary water supply strategy.

The process water demand is in development, however preliminary estimates suggest a demand of between 1.5 and 2 GL/year over a 5 to 7 year period (i.e up to 7.5 to 17 GL for life of the Project). Availability of process water is the subject of this study.

Water quality requirements for the process are yet to be confirmed, however fresher water is preferred if/whenever available.

Advisian was engaged to complete a Hydrogeological Study & Water Supply Options Analysis for Mt Ida Gold. The scope of study included a baseline hydrogeological study focused on a high-level conceptual understanding and description of the hydrogeological conditions on site and within a broader region. The regional-scale characterisation is necessary due to the need to identify water supply options for the Project which are unlikely to be met from the Project tenement area. The baseline study will be used to inform the requirements of the PFS.

The review of the existing information from publicly available sources identified the potential target areas which are all situated outside of the current Mt Ida Project within a 50 km radius. The following prospective areas for water supply were identified:

- Calcrete body (C1) approximately 20 km north of the Project. Surface area is 2,880 hectares (ha), assumed saturation 5 m and assumed specific yield of 0.1. It is currently under third party miscellaneous licence. Likely to be stygofauna constrained.
- Raeside Paleochannel North – Lake Raeside (P1), paleochannels are generally most reliable aquifers in this area. A typical borefield would be installed over a 15 km length of paleochannel for the assumed demand of 1.5 GL/yr. The section of paleochannel directly north of the Project is already under third party miscellaneous licence. The target area would therefore be west of that specific tenement.
- Raeside Paleochannel West – Lake Barlee (P2), unexplored section, not under mining or miscellaneous licences.
- Rebecca Paleochannel – Lake Ballard (P3/P4), P3 similar considerations and assumptions as for P1. There has been more systematic drilling associated with third party miscellaneous licence with drilling depths over 70 m directly south of the Mt Ida tenement. An alternative or a parallel option is P4, a secondary trunk paleochannel.
- BIF and chert ridges (S1/S2) (potential) structurally controlled aquifers, part of the greenstone belts to the west of the Project. There are two options, either 5 km or 30 km from the Mt Ida Project tenements. BIF mineralisation (with chert occurrence) is known to be associated with groundwater

occurrence in similar arid settings, however its groundwater prospects in this area have not been explored. Probably a viable aquifer if BIF were structurally emplaced in a bathtub-like structure, surrounded by less permeable basement rocks.

Each of the identified options, if chosen, will require a site-specific hydrogeological investigation to confirm capacity and sustainability of the resource. The paleochannel sources are currently considered the most viable due to their historical use in the wider Goldfields area.

Due to the distances associated with the Project, engineering and water infrastructure considerations will be reviewed including but not limited to distance, topography and tenure access.

Acronyms and abbreviations

Acronym/abbreviation	Definition
AHD	Australian Height Datum
BIF	Banded Iron Formation
DOW	Department of Water (predecessor of DWER)
DWER	Department of Water and Environment Regulation
DWIR	Information system of DWER
GDA94	Geocentric Datum of Australia 1994
GeoVIEW	Information system of Department of Mines, Industry Regulation and Safety (WA)
GL	Gigalitre
GL/yr	Gigalitre per year
kL/d	Kilolitre per day
mg/L	Milligram per litre
SRTM	Shuttle Radar Topography Mission (elevation model)
SWOT	Strengths, Weaknesses, Opportunities, and Threats (assessment technique)
TDEM	Time-Domain Electromagnetic Method

1 Introduction

1.1 Project background

The Mt Ida Lithium-Gold Project (Mt Ida Project or the Project) consists of 29 tenements in the historical Mt Ida gold mining district, located approximately 100 km north-west of Menzies in the WA Goldfields. The Project tenements cover an area of 167 km^2 and include the historic Timoni Gold Mine and others, which have produced over 300,000 oz gold at 17.2 g/t head grade.

Mt Ida Gold Pty Ltd (Mt Ida Gold) expect to undertake a Prefeasibility Study (PFS) for the Mt Ida Project and require a baseline groundwater assessment with identification of potential water supply options. Further studies may be required in future, including a surface water baseline assessment and drafting of a preliminary water supply strategy.

The process water demand is in development, but preliminary estimates suggest a demand of between 1.5 and 2 GL/year over an approximate 5 to 7 year period (i.e up to 7.5 to 17 GL for life of mine). Availability of process water is the subject of this study, it is understood potable water supply is met from existing sources.

Water quality requirements for the process are to be confirmed, however fresher water is preferred if/whenever available.

Advisian was engaged to complete a Hydrogeological Study & Water Supply Options Analysis for Mt Ida Gold. This report presents the results of the study. Scope of this assessment

The scope of work includes the following:

- Characterisation of the baseline (regional) hydrogeology,
- Investigation of viable sources of water for both beneficial and non-beneficial users within the local and regional areas, including (but not limited to) the private, industrial and agricultural sectors,
- Investigation and reporting on other user licence limits, allocations and usage,
- Investigation and reporting on potential water source options for use within the Mt Ida Lithium-Gold Project,
- Investigation and reporting on water abstraction sources, locally and regionally, and the impact on confined and unconfined aquifers,
- Identification of potential bores and ownership, and
- Identification of local and regional aquifers and assessment of their associated availability/capacity to meet the Project water demands.

1.2 Approach

This baseline groundwater assessment focuses on a high-level conceptual understanding and description of the hydrogeological conditions on site and within a broader region. The regional-scale characterisation is necessary due to the need to identify water supply options for the Project which are unlikely to be met from the mining tenement area.

This includes:

- A review of existing hydrogeological information, reports and studies available for the region:
  - Regional and site geology, including the existing geological model (Leapfrog or similar),
  - Geomorphological setting, land use and land systems,
  - Regional aquifers systems,
  - Aquifer hydraulic parameters,
  - Groundwater recharge and discharge processes,
  - Regional groundwater bore and monitoring data (groundwater bores, water levels, abstraction rates, water quality, including WIN database search),
  - Groundwater flow directions and water levels of individual aquifers systems (where appropriate),
  - Stored groundwater volume estimates, and
  - Indications or evidence of surface water groundwater interaction.
- A review of environmental receptors and third-party users
  - Identification of existing users, groundwater licensing information for the region, and current and likely future allocations, and
  - Identification/confirmation of likely environmental receptors, including groundwater dependent ecosystems (GDEs) and potential stygofauna occurrence constraints.
- Development of hydrogeological conceptualisation based on collated and reviewed information, including production of maps and schematic cross-sections illustrating relevant subsurface conditions,
- Identification of options to secure water supply from groundwater resources, their strengths, weaknesses, opportunities, and threats (SWOT),
- A description of the likely key groundwater infrastructure that would be required for the Project,
- A description of preliminary risk identification and impact assessment as well as likely mitigation measures, and
- Identification of key information gaps to be addressed by the PFS.

2 Description of environment

2.1 Project area

The Mt Ida Project is situated in Goldfields area of Western Australia, approximately 560 km north-east of Perth, 85 km north-west of Menzies and 75 km west of Goldfields Highway (State Route M91) that runs in the north-south direction from Kalgoorlie to Leinster. Mt Ida Project tenure includes a total of 3,445 hectares held by Mt Ida Gold Pty Ltd.

The Project area shown in a regional setting is on Figure A-1 (Appendix A). The map grid of the Project is GDA94 Zone 51.

2.2 Area geomorphology and regional geology

The region topography is closely related to the underlying geology. Undulating sandplain areas with occasional granite outcrops are intersected by northerly trending ridges of the greenstone belts. Low-lying valleys carry alluvial sediments and playa lakes. The playa lakes are dry, inundated only during larger rainfall events or rare cyclonic occurrences.

The Mt Ida Project is situated close to the catchment divide running east-west and crossing the perpendicular divide running south north. The elevated areas are surrounded by paleodrainages running the south and north in the east-west direction – Lake Raeside and Lake Ballard (Figure A-2, Appendix A).

The Lake Raeside turns southwards to the west of the Project area, underlying the Lake Barlee.

Secondary offshoots from the Lake Raeside paleochannel abut the northern perimeter of Mt Ida. The southernmost extent of the Mt Ida tenure lies next to the Lake Ballard paleochannel. Its secondary offshoot wraps around the southern half of the tenement on the eastern side and intrudes into the middle section of the tenement (although its extent there would probably have to be proven there).

Topographic elevations of the Project span between 390 m AHD in the south to over 500 m AHD in the middle of the tenement. The ridge to the west of the tenement rises up to 560 m AHD, while paleochannel valleys elevations are 365 m AHD to 400 m AHD (Figure A-2, Appendix A).

The project is underlain by an assemblage of mafic and ultramafic rocks, acid volcanic rocks and volcanic sediments. Banded iron formation (BIF) and chert are resistant to weathering and therefore often form notable ridges in the area. Older greenstones are intruded by younger granitoid rocks.

Most of the Archaean rocks have a weathered profile resulting from chemical breakdown of rock matrix. The thickness of the weathered zone varies but is typically up to 50 m in greenstones. The weathering sequence in both greenstones and granitoids consists of the upper lateritic duricrust over a variable thickness of saprolite kaolinic clay that sharply morphs into fresh, bedrock with sparse fracturing.

Typical regolith regimes and thicknesses from publicly available mapping in the region around the Mt Ida Project are shown on Figure A-3 and A-4 (Appendix A).

Tertiary paleochannel sediments usually contain a large thickness of alluvial or lacustrine clay that overlays a basal fluvial sand. More recent alluvial colluvial sediments top the Tertiary sequence and can be sometimes calcretised.

The basal sand can be up to 40 m thick and 100 to 1,000 m in width, which can vary along the axis of the paleochannel. The paleochannel sand is understood to be continuous along the main drainage trunks but may be missing or minor in upper reaches of secondary tributaries or at intersections with greenstones.

Minor sand lenses can occur within the clay profile above the basal sand.

Calcrete occurs at the margins of playa lakes and in some tributaries of the main paleodrainages. An example of the latter is situated approximately 20 km to the north of the Mt Ida Project, on the margin of the Raeside paleochannel. It covers an area of over 2,800 hectares, however its thickness is unknown although it typically is less than 10 m (Figure A-5).

2.3 Climate

The region's climate is characterized by low rainfall, hot dry summers and mild winters. Rainfall is evenly distributed between the summer and winter months, however thunderstorm activity in summer months results in slightly larger monthly averages. The mean annual rainfall from Menzies meteorological station (number 012052) is 254 mm, with monthly averages provided in Table 2-1 over a period from 1896 to 2019:

Table 2-1 Average monthly rainfall

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
23.1	32.5	26.7	20.9	25.2	27.4	22.6	19.5	10.4	11.3	14.7	15.4

Evaporation exceeds rainfall in all months and averages over 3,000 mm per year. Evaporation rate peaks during the summer months of January and February and lowest during the winter months of June and July.

An order of magnitude difference between rainfall and evaporation is related to the relatively low groundwater recharge rate and often high groundwater salinity.

2.4 Regional hydrogeology

2.4.1 Aquifer systems

The area is underlain by weathered and fractured Archaean basement (Yilgarn Craton) which comprises granitoid and greenstone rocks. They are overlain by alluvium, colluvium, calcrete, lake deposits and paleochannel deposits.

Groundwater regionally primarily occurs in the top part of the weathering profile which is typically less than 40 m thick. The regolith regime mapping, as proxy of the weathering profile, shown in Figure A-3 (Appendix A) comprises exposed bedrock (basement outcrops), residual units (e.g. lateritic cap on top of saprolite profile) and unconsolidated Tertiary and Quaternary sediments (alluvial, eolian, colluvial, lacustrine) which also include significant Tertiary paleochannel fill.

Fresh basement rock contains minor groundwater in fractures, the occurrence of which generally reduces with depth.

The old drainages are filled with alluvial and lacustrine deposits with thickness of up to 100 m. A typical cross section through a paleochannel setting is shown in Figure 2-2.

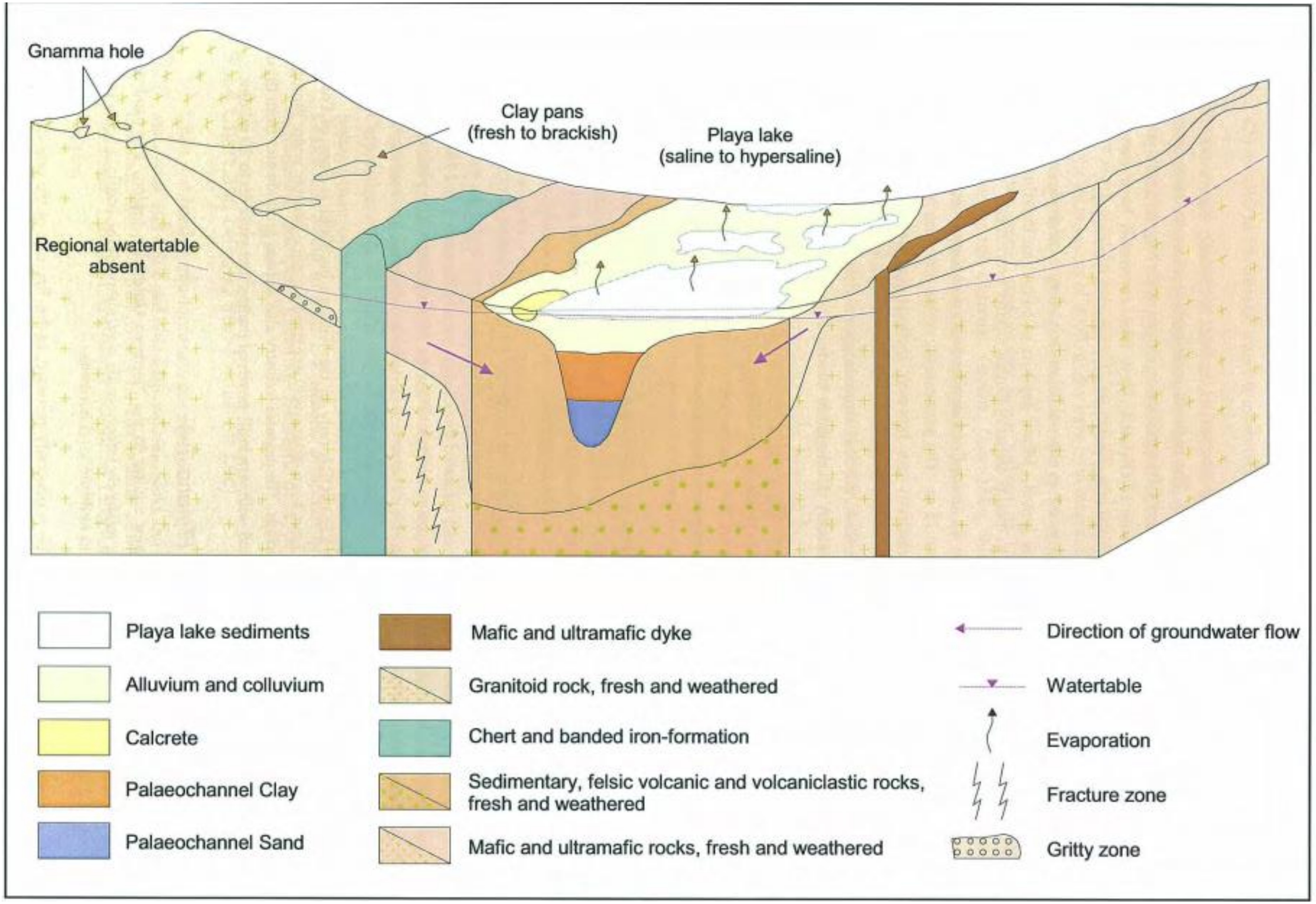


Figure 2-1 Schematic section of groundwater occurrence (after Johnson, 2004)

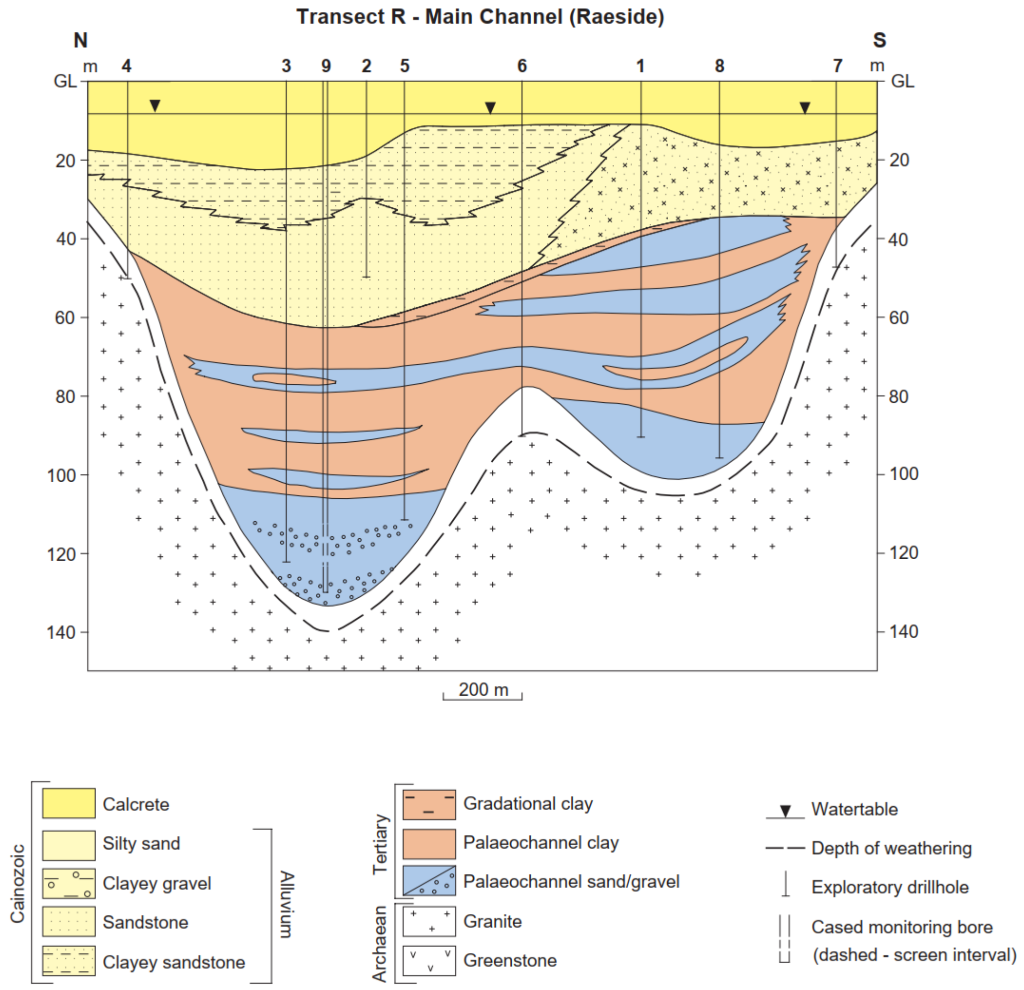


Figure 2-2 Hydrogeological cross-section through main Raeside paleochannel (after Johnson et al, 1999)

The key characteristics of major aquifer systems are summarized in Table 2-2:

Table 2-2 Major aquifer systems

Aquifer system	Description	Yield (kL/d)	Salinity (mg/L)
Alluvial	Unconfined aquifer, shallow groundwater level, variable but typically low hydraulic conductivity and yields. The latter tend to be larger at the base of greenstone ridges. Covers relatively small areas, often with thin saturation, which are consequently economically not viable. Recharged by episodic rainfall events (the typical recharge rate is 1% of annual rainfall or less). Has relatively low hydraulic permeability. Recharges, through vertical leakage, the underlying paleochannel and fractured rock aquifers.	50 to 600	1,000 to 4,000 but may be hypersaline near salt lakes

Aquifer system	Description	Yield (kL/d)	Salinity (mg/L)
Calcrete	A localised aquifer system with high permeability and storage. The saturated thickness is between 5 to 10 m. Recharged by direct rainfall and from surface runoff during larger rainfall events.	100 to 4,400	2,000 to 6,000
Paleochannel	Confined aquifer at the base of the paleochannel alluvial/lacustrine sequence (Figure 2-2, Appendix A). Paleochannels have developed in area's low-lying areas that form regional drainages (Figure A-3, Appendix A). The sand at the base of the paleochannel is continuous in major trunks, but can occasionally be absent where the paleochannel crosses greenstone belts. The secondary trunks may contain lesser thickness of basal sands. The long-term pumping can induce leakage from surrounding weathered bedrock.	300 to 700 (occasionally larger)	Hypersaline (over 100,000)
Fractured rock	Generally an assemblage of unconfined aquifers developed in fractured systems which can be enhanced by chemical dissolution. Occurrence and nature of fractured rock aquifers are influenced by structural geological features. The zone of oxidation (weathering) is deepest along mineralised ore zone zones and shear zones. Fractured rock aquifer consist of weathered bedrock (saturated thickness is 40 m), fractured oxidised bedrock (20 m thick) and fractured fresh bedrock (30 m thick)	Highly variable, but relatively low around Mt Ida	1,000 to 10,000

Spatial distribution of typical aquifer systems associated with the paleodrainages is presented in Figure A-5 (Appendix A). It shows an interpreted paleochannel width of paleochannel, with main and secondary trunks and occurrences of outcropping calcrete.

2.4.2 Groundwater flow directions and water levels

Groundwater flow directions are inferred to follow topographic trends in the area. This would mean that groundwater flows from elevated areas to low-lying areas. These patterns fractured rocks can be more complex and controlled by structural geological features.

The main aquifer system, the basal paleochannel sand drains the Archaean basement. The groundwater in paleochannel flows eastwards in the Raeside paleochannel, however flow gradients are considered to be low. Simple groundwater flow calculations indicate flows of 0.02 GL/yr in the Raeside paleochannel. This groundwater throughflow is relatively small in relations to total storage of water in the basal sand.

Depth to groundwater ranges from shallow (i.e. several metres below ground level in low-lying areas (alluvia, calcrete) to several tens of metres in elevated areas (Figure 2-2, Appendix A).

2.4.3 Groundwater recharge and discharge processes

Alluvial and bedrock aquifers are periodically recharged through direct rainfall infiltration following larger rainfall events, including cyclones. The recharge rate is inferred to be low, around 1% of mean annual rainfall.

Local recharge of the paleochannel aquifer occurs through tributaries of paleochannels and from leakage from the fractured basement and the overlying clays.

Groundwater discharge from the paleochannels occurs at the salt lakes through evaporation in distant areas of the Eucla Basin.

2.4.4 Existing hydrogeological bores and third-party users

Regional groundwater bore and monitoring data locations (groundwater bores, water levels, abstraction rates, water quality, including WIN database search) are shown in Figure A-6 (Appendix A). The records are often quite old (spanning from 1970s) or of unknown date.

In general, there are sufficient water supplies for potable purposes for the initial mine development sourced from fresher alluvial and fractured rock aquifers (or calcrete where available). This also applies for stock watering and limited irrigation activities (mainly horticultural on calcrete aquifers). Most bores for pastoral users are less than 30 m deep and are typically completed as windmills which yield up to 30 kL/d.

Pastoral stations usually rely on rainwater tanks for potable use but are supplemented by groundwater. This is evident from a number of relatively shallow bores and wells in the area (Figure A-6, Appendix A).

Potable water supply for the town of Leonora is obtained from the Station Creek borefield operated by the Water Corporation (DOW, 2010). The borefield accesses groundwater from alluvium, minor calcrete and fractured rock aquifers, from 12 production bores, that are between 30 and 70 m deep. The allocation, licensed by the DWER, is 0.6 GL/yr.

2.4.5 Groundwater volume estimates

Groundwater volume estimates, where available were adopted from Johnson et al (1999).

The groundwater volume estimates in the alluvial aquifers may be comparatively high but due to low permeability are not readily accessible for larger abstraction.

The largest calcrete body situated 23 km to the north of the Mt Ida Project tenement is estimated to store 34 GL of groundwater, with up to 1.1 GL/yr (Johnson et al, 1999) recharging into the system annually. This estimate is however not based on detailed investigations.

Within the most prospective aquifer, the basal paleochannel sand, the estimated storage is 1.7 GL/km of main trunk paleochannel, and 0.8 GL/km of secondary trunk paleochannel. A typical spacing of production bores in paleochannel aquifers is up to 1,000 m, with individual bore yields in the range of 4 to 8 L/s. A line of bores stretching over 10 to 20 km along the paleochannel would be needed to provide 1 to 2 GL/yr.

No estimates are currently available for fractured rock aquifer in the Mt Ida area.

2.4.6 Surface water groundwater interaction

Surface water groundwater interaction occurs in the low-lying areas (alluvial sediments) in the form of surface water contributing to groundwater recharge following the larger rainfall events or groundwater discharging into lakes and subsequently being removed by evaporation. Calcrete often develops at the margins of alluvial plains. Due to its higher permeability calcrete is able to accept direct rainfall and any surface runoff generated by larger rainfall events and recharge local groundwater systems.

Groundwater discharge into lakes from water stored in paleochannels occurs in areas remote from the Mt Ida Project.

2.4.7 Groundwater salinity and quality

Due to prevalence of evaporation over rainfall, groundwater can be quite saline and often hypersaline (Figure A-7, Appendix A).

Salinity of shallow aquifers (alluvial, calcrete) is usually fresh to brackish due to more readily available and regular recharge from larger rainfall events.

Groundwater in paleochannels is hypersaline, typically over 100,000 mg/L in paleochannels. Secondary trunks may carry less saline water but it is likely to be in tens of thousands of mg/L.

All shallow aquifers have relatively high concentrations of nitrate (generally more than 30 mg/L).

2.4.8 Environmental receptors

There are currently no identified environmental receptors or protected flora communities within the Mt Ida Project tenements. It is anticipated that lake systems, developed over paleochannels, may host fringing vegetation communities that are partly or fully dependent on groundwater.

Stygofauna is a recognised environmental receptor of calcrete aquifers but may also be identified in other aquifer types. Any groundwater exploration is usually complemented with stygofauna survey.

Figures A-2 and A-6 (Appendix A) also shows several soaks and rockholes (Weanne Soak, Larinsa Soak, The Fountain Spring rockhole, Mick Gnanma Rockhole, Dorina Gnanma Rockhole) in the Mt Ida region, however their environmental status is currently unknown.

3 Water supply option assessment

3.1 Introduction

Water supply options from groundwater sources typically target alluvial and paleochannel deposits in the region. A number of these options are currently under miscellaneous licence but not under water licence within 50 km from the Mt Ida project.

Groundwater licences were granted to users neighbouring the Mt Ida Project tenement, however these target the fractured rock aquifer. More details on these licences are provided in Section 3.3.

The supply options for the Mt Ida project were evaluated based on geological (and/or hydrogeological) considerations and current tenures. Less emphasis, at this stage, is given to water engineering issues, such as the need for pipeline(s) and the conditions the terrain configuration may have on those issues.

3.2 Groundwater supply options

Potential groundwater sources have been identified in several aquifer systems occurring typically several tens of kilometres away from the Project. There are currently no constraints from existing licences other than fractured rock aquifer, since the closest licensed areas in alluvial and paleochannel aquifers are over 100 km away (see Section 3.3).

Some of the areas of the potential water supply options are however already allocated under miscellaneous licences (e.g. Figure A-9, Appendix A).

Potential target options that have been identified are described in Table 3-1 and spatially shown on Figure A-10 (Appendix A).

Table 3-1 Identified water source options

Option	Description	Volume (GL)	Renewable (GL/yr)	Salinity (mg/L)	Availability
C	**Calcrete -** approximately 20 km north of the Project. Surface area is 2,880 hectares, assumed saturation 5 m and assumed specific yield of 0.1. It is currently under third party miscellaneous licence (Juno Minerals Pty Ltd). Likely to be stygofauna constrained.	14	**0.5**	3,000 to 5,000 (based on two bore records)	**Not likely** (would be subject to water trading or other commercial agreement)
P1	**Raeside Paleochannel North** – Lake Raeside, paleochannels are generally most reliable aquifers in this area. A typical borefield would be installed over 15	25	Confined aquifer, theoretically possible to	Paleochannel sand assumed to be over 100,000 mg/L, however samples are not available.	**Likely** (possible cumulative effects if resource developed in the neighbouring

Option	Description	Volume (GL)	Renewable (GL/yr)	Salinity (mg/L)	Availability
	km for the assumed demand of 1.5 GL/yr. The section of paleochannel directly north of the Project is already under third party miscellaneous licence (Juno Minerals). The target area for the Mt Ida Project would therefore be west of that specific tenement. The latter would probably have been the best supply option for Mt Ida project		obtain **1.5** GL/yr	Shallow samples from alluvium have fresher water (but minor yields)	miscellaneous tenement)
P2	**Raeside Paleochannel West** – Lake Barlee, an unexplored section, also no mining or miscellaneous licences. An upgradient location, so the available volume may be smaller. .	20	Confined aquifer, theoretically possible to obtain **1.5** GL/yr.	Assumed in the range of 20,000 to over 100,000 mg/L, no samples available. May be slightly fresher than the downgradient sections	**Likely** no major constraints
P3/P4	**Rebecca Paleochannel** – Lake Ballard, P3 similar considerations and assumptions as for P1. There has been more systematic drilling associated with third party miscellaneous licence with drilling depths over 70 m directly south of the Mt Ida tenement (Figure A-5, Appendix A). An alternative or a parallel option, P4 (Figure A-10, Appendix A)	25	Confined aquifer, theoretically possible to obtain **1.5** GL/yr	Paleochannel sand has TDS over 100,000 mg/L, confirmed by sampling. P3 option may have fresher groundwater. Shallow samples from alluvium have fresher water (but insufficient yields)	**Likely** (possible cumulative effects if resource also developed in the neighbouring miscellaneous tenement). P3 viability (and existence of paleochannel has to be proved), but if it is it may have fresher groundwater (10,000 to 50,000 mg/L)
S1/S2	**BIF and chert** structurally controlled (potential) aquifers, part of the greenstone belts to the west of the Project. There are two options, either 5 km or 30 km to the west. BIF mineralisation (with chert occurrence) is known to be associated with groundwater occurrence in similar arid settings, however its	22.5 (each)	**0.45** (each)	3,000 to 10,000 (based on two bore records in the vicinity). May be fresher f substantial permeability and yield proved.	**Unexplored/Licensed**. The S1 option that is 5 km west is partly under third party mining tenement (Figure A-10, Appendix A) and under an existing water licence (Hawthorn Resources).

Option	Description	Volume (GL)	Renewable (GL/yr)	Salinity (mg/L)	Availability
	groundwater prospects in this area have not been explored. It would be a viable aquifer if BIF were structurally emplaced in a bath-tub like structure, surrounded by less permeable basement rocks. Assumptions: area of 1,500 ha, 50 m saturation, specific yield 0.03. The S1 option is already licensed (Hawthorn Resources)				
F1	**Fractured rock** aquifer – individual, often pastoral bores, can support minor supplies for camp purposes, or initial developments but not a viable source in terms of volumes required for processing. Most bores drilled into the fractured rock would yield water, typically less than 5,000 kL/d. Typically shallow and fresher water quality. Surveys as far as in 1950 found that yields of existing wells within the 15 km radius of Mt Ida did not exceed 0.1 L/s.	Less than 0.1	**Less than 0.1**	1,000 to 3,000, a viable source for minor camp related purposes	**Not likely** for processing, only for minor camp uses. Mostly already licensed around Mt Ida Project perimeter

This summary (Table 3-1) indicates that paleochannel sand aquifers are likely to be the most viable source of water for processing, to be able to secure 1.5 to 2.0 GL/yr. The lack of structural geology and hydrogeological information does not allow to further evaluate the viability of a special fractured rock aquifer developed along the BIF and chert formation (S1, S2) which form prominent geomorphological features in the area.

Salinity of paleochannel sands is high, assumed to be over 100,000 mg/L.

Shallow groundwater sources (both alluvial and fractured rock), with drilled depth typically less than 30 m are abundant and often with fresher water quality (1,000 to 10,000 mg/L), but their yields are do not match likely processing requirements.

On-site groundwater sources, e.g. from existing underground workings or possibly from future dewatering were discounted for the purposes of this assessment as they are unlikely to significantly contribute to meeting the potential demand.

3.3 Groundwater allocation and licensing constraints and opportunities

Water licensing information was sourced from DWER, a snapshot as of the 25th of July 2022 is provided. Details of water licences within 100 km from the Mt Ida Project are presented in Appendix B.

All paleochannel targets identified in Section 3.2 appear to be currently unlicensed.

Several water licences are in place around the Mt Ida Project tenement, primarily to the west and south. Minor volumes (0.05 to 0.2 GL/yr) are allocated to be sourced from the fractured rock aquifer, however these would be considered unsatisfactory for the Mt Ida Project processing needs and consequently are not a targeted water resource for the Project.

The summary of water licences within 50 km from the Mt Ida Project is available in Table 3-2:

Table 3-2 Current water licences within 50 km from the Mt Ida Project (25th July 2022)

Licence Number	Holder	Tenements	Allocation (GL/yr)
154581	International Petroleum Limited	M29/2 Mt Ida Project	0.003
154584	International Petroleum Limited	M29/2 Mt Ida Project	0.52
180490	Carnegie Gold Pty Ltd	M30/255; M30/103; M30/256	0.895
203577	Barry James Donkin	P29/2432; M29/425; P29/2431	0.00005
204119	MGK Resources Pty Ltd	M29/150; M29/421; M29/151; P29/2521; L29/139; E29/921-I; E29/1016; E29/790; E29/1007; E29/1014	0.0015
204350	Michael Francis Crowley	M29/143	0.0015
205691	Red Dirt Mining Pty Ltd	P30/1144; P30/1125; M30/99; M30/256; M30/157; M30/91	0.5
206344	Juno Minerals Limited	M29/408-I; M29/414-I; G29/22; G29/23; L29/100	0.82
207385	Atlas Iron Pty Ltd	E29/510-I	0.1

The current holders of two of these licences with larger allocations in the immediate vicinity of the Mt Ida Project tenements belong to International Petroleum Ltd (licence number 154584) and Juno Minerals Ltd (licence number 206344).

Miscellaneous licences, among other purposes, can be used for water supply infrastructure, such as installation of borefields or delivery infrastructure such as pipelines.

Current miscellaneous licences in the Mt Ida Project area cover the Raeside paleochannel (including calcrete) and Rebecca paleochannel directly north and south, respectively (Figure A-9, Appendix A). The proposed target areas in these paleochannels are proposed in recognition of these existing miscellaneous licences.

Opportunities for licensing negotiations (water trading) are available for a large calcrete body (shown on Figure A-5, Appendix A), developed approximately 23 km to the north of the northern end of the Mt Ida Project tenement. Calcrete is assumed to hold substantial volumes of water and is relatively close to the Mt Ida Project's tenement. The S1 option, a BIF/chert prospect 5 km to the west of the Mt Ida Project, is already licensed (licence number 207385 and 206344), but also a potential opportunity for water trading.

Mining lease areas generally do not affect the proposed target options, except for a small overlap of BIF/chert (S1) option.

3.4 Water supply infrastructure

The basic water supply infrastructure for delivery from groundwater sources includes:

- A borefield (or borefields). In case of both paleochannel and BIF/chert options the likely borefield would consist of 15 production bores drilled to an average depth of 70 m. The production bores will be equipped with submersible pumps able to abstract 300 to 700 kL/d; wellheads and connecting pipelines. The BIF/chert borefield may consist of fewer production bores if found feasible, probably 5 to 10, typically drilled to 150 m. Potential abstraction rates could vary between 700 to 4,000 kL/d (or more).
- Delivery and connecting pipelines. Due to distances involved, the pipeline considerations are important since some of the identified options are approximately 50 km ("as the crow flies") from the Mt Ida Project area. The terrain configuration is also important. This includes the need to overcome elevated areas or avoid licensed areas.
- Pumping station(s) to transport water from water supply borefield(s) to the processing plant.
- A water treatment facility to optimise water quality for processing. Paleochannel borefields will supply hypersaline water which may require treatment or desalination depending on the ore processing method. However, there are techniques developed for hypersaline water use in gold processing, such as carbon-in-pulp or carbon-in-leach. This includes also potentially other water infrastructure elements such as storage ponds.
- A recycling loop – if viable. Depending on the processing method there may be opportunities for water recycling which would be also supported by storage ponds.
- Power supply associated with the above water supply infrastructure.
- A monitoring bore network – a licence to take water (5C) will typically require on-going monitoring of abstracted volumes, groundwater levels and groundwater quality. This may include installation and construction of 10 to 20 monitoring bores depending on the option selected or more if more than one option would be selected.

3.5 Option summary / SWOT analysis

There are a number of options identified as potential water sources to be explored for Mt Ida Project water supply. To allow for better understanding of their suitability a SWOT (strengths, weaknesses, opportunities and threats) analysis is applied to the identified options.

The SWOT analysis is often applied in a workshop setting with key stakeholders or decision-makers and we consider the presented SWOT analysis as preliminary, subject to potential further refinement.

Our preliminary SWOT analysis is presented in Table 3-3:

Table 3-3 SWOT analysis of water supply target options

Option	Strengths	Weaknesses	Opportunities	Threats
C	Substantial water resource Fresher water quality One of the closest sources to Mt Ida	Unknown thickness and saturation thickness, therefore volume not guaranteed) May not cover the entire project demand Under third party miscellaneous licence Potential stygofauna constraints	Negotiation with or alliance with miscellaneous licence holder(s) Possible supplementation of or combination with other options, especially with regards to water quality	Environmental constraints Capacity issues (unsustainable) Third party issues
P1	Suitable capacity No tenure issues	Unexplored (i.e. capacity not confirmed) Water quality (hypersaline) Infrastructure issues - distance to Mt Ida, approximately 50 km or more	Opportunities to blend with fresher groundwater (i.e. C1)	Potentially contributing to cumulative effects on other parties affecting capacity Unknown environmental considerations
P2	Suitable capacity (possibly less than P1, but still within the demand) No tenure issues	Unexplored (i.e. capacity not confirmed) Water quality (hypersaline) Infrastructure issues - distance to Mt Ida,	Opportunities to blend with fresher groundwater	Potentially contributing to cumulative effects on other parties affecting capacity Unknown environmental considerations

Option	Strengths	Weaknesses	Opportunities	Threats
		approximately 50 km or more Terrain challenges to pipeline infrastructure		
P3/P4	Suitable capacity overall P4 option may cover part of required demand P4 may have fresher groundwater No tenure issues P4 closest to Mt Ida tenement (least infrastructure requirement)	Unexplored (ie capacity not confirmed, specifically for P4), however some exploration results are in the area to the west Water quality (hypersaline)	Opportunities to blend with fresher groundwater Possibility of fresher groundwater from P4 than from other P-options	Suffering from cumulative effects from other parties affecting capacity (although less if P4 found viable) Unknown environmental considerations
S1/S2	Potentially required capacity Fresher groundwater than P-options Suitable infrastructure considerations (distance, elevated area)	Unexplored, may not provide expected capacity) Under third party (water take) licence Tenement situation may provide challenges to infrastructure	Opportunities for blending to manage water quality Negotiation with or alliance with current licence holder(s)	Capacity misjudgement – not a proven aquifer in Goldfields area
F1	Provision of small quantities of water is guaranteed and already available Fresher water quality Close proximity to Project	Capacity is well below demand Unreliable resource for industrial use	Limited opportunities mostly linked to non-processing use	Drought may limit the already small capacity

3.6 Information gaps to be addressed by PFS

The information gaps to be addressed are similar to any geological or hydrogeological investigation undertaken at the current stage of the Project. They are to be focused on collection of relevant site-specific information which would confirm or improve high-level assumptions and target options presented in the above section.

The major gap is confirming capacity and sustainability, in line with principles of responsible water stewardship. In this sense the paleochannel resources are considered to be more reliable because they have already been used in similar settings for other mining projects in the broader Goldfields area. Confirmation of capacity and sustainability will require a combination of various steps and techniques:

- Geometry/delineation of the resource (evaluation of existing exploration drilling and geophysical data, application of geophysical surveys (TDEM/gravimetry, passive seismic); hydrogeological drilling investigation, conceptual hydrogeological model surfaces,
- Confirmation of transmissive and storage properties (analysis of granulometric data, in-bore geophysics, slug tests, pumping tests),
- Assessment of renewable volumes for sustainable uses,
- Confirmation of groundwater quality,
- Assessment of impact(s) on third party users and environmental receptors, and
- Outcomes for water supply engineering.

4 References

DEPARTMENT OF WATER, 2010: Leonora Water Reserve drinking water source protection plan, Leonora-Gwalia town water supply. Water resource protection series report No. 113

ELLIS, H. A., 1950: Report on domestic water supply "Timoni" Gold Mine, Mt Ida, North Coolgardie

JOHNSON, S.L., 2004: Hydrogeology of the Leonora 1:250,000 sheet: Western Australia, Department of Environment, Hydrogeological Map Explanatory Note Series, Report HM 10

JOHNSON, S. L., COMMANDER, D. P. & O'BOY, C. A., 1999: Groundwater resources of the Northern Goldfields, Western Australia. Water and Rivers Commission, Hydrogeological Record Series, Report HG 2, 57p

ROCKWATER, 2010: Mt Ida and Carnegie projects. Results of desk-top study of potential water sources. Unpublished report for Stirling Resources and Swan Gold Mining

Appendix A
Maps

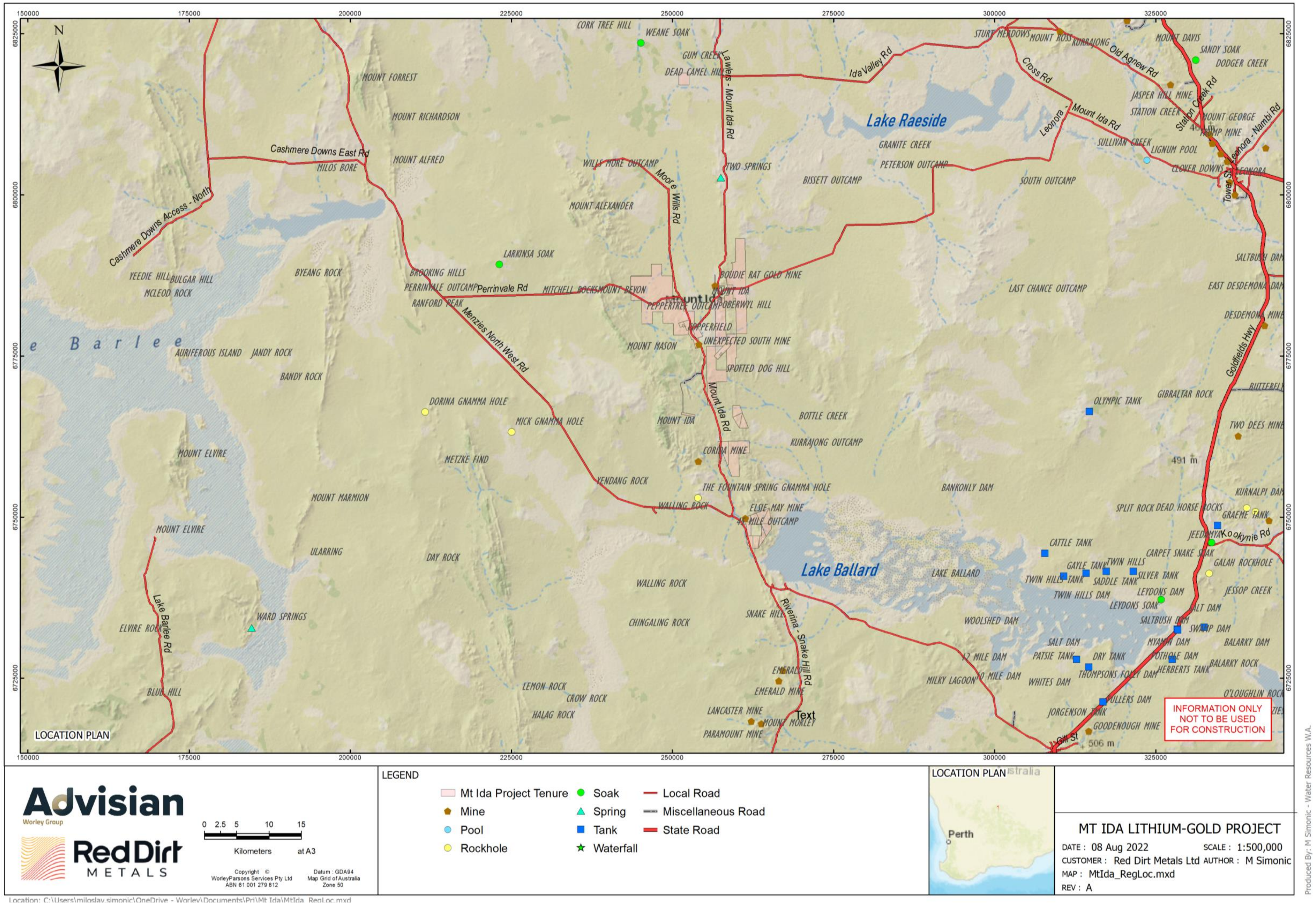


Figure A-1 Project location

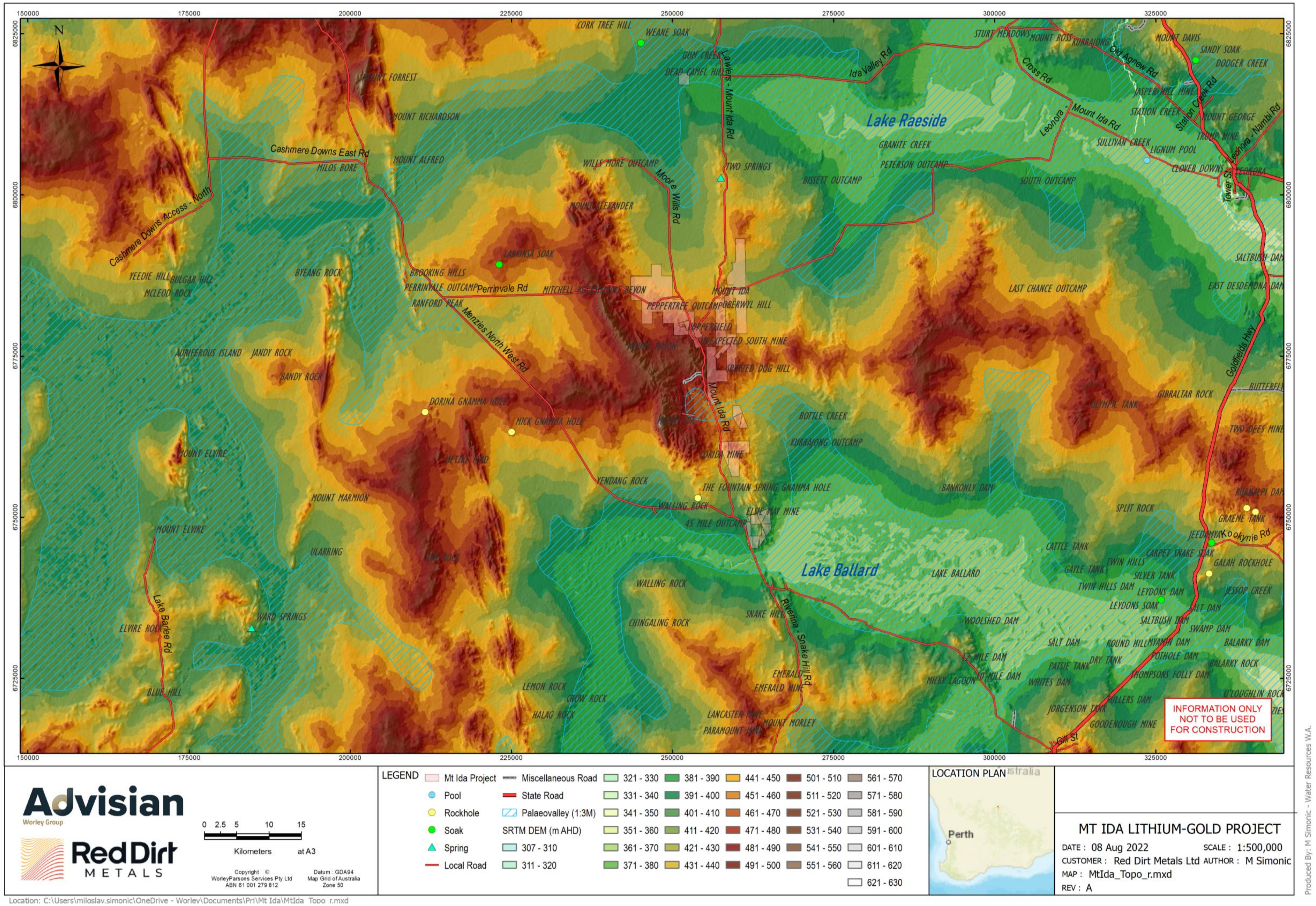


Figure A-2 Regional topography (SRTM) and 1:3,000,000 paleochannel mapping

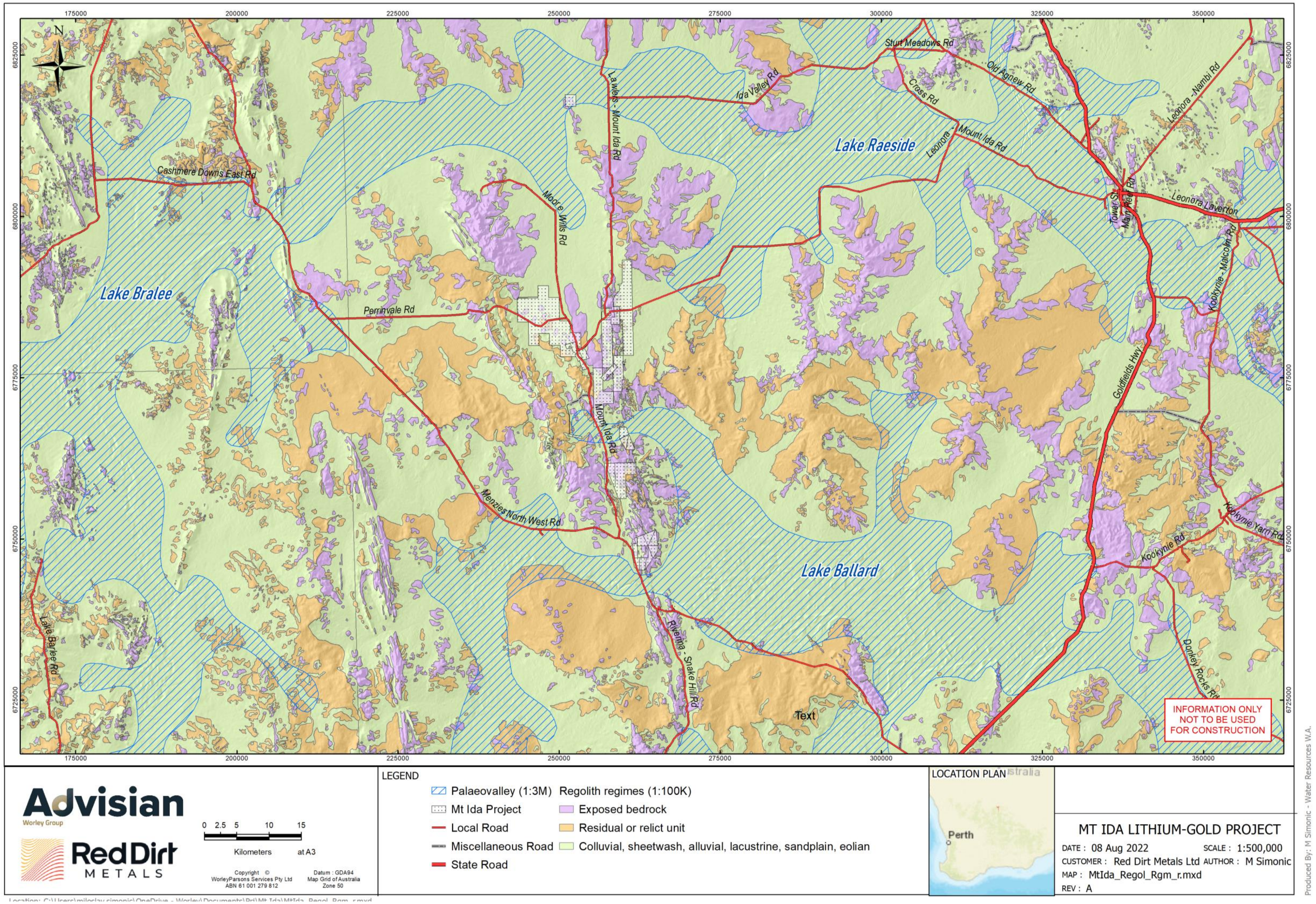


Figure A-3 Regolith regime 1:100,000 mapping (GeoView)

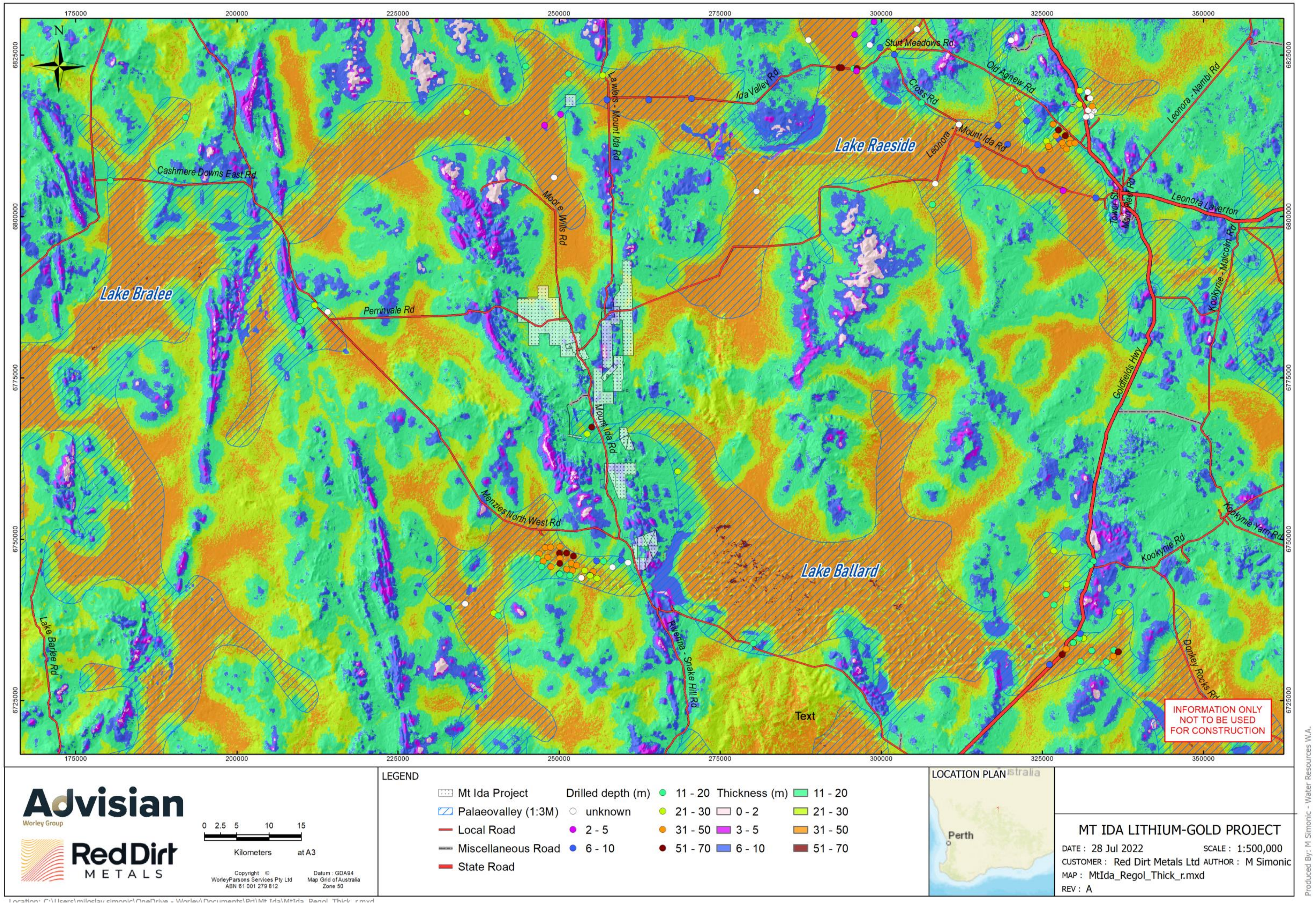


Figure A-4 Regolith thickness mapping (Australia dataset) and hydrogeological bore depth records

Advisian
Worley Group

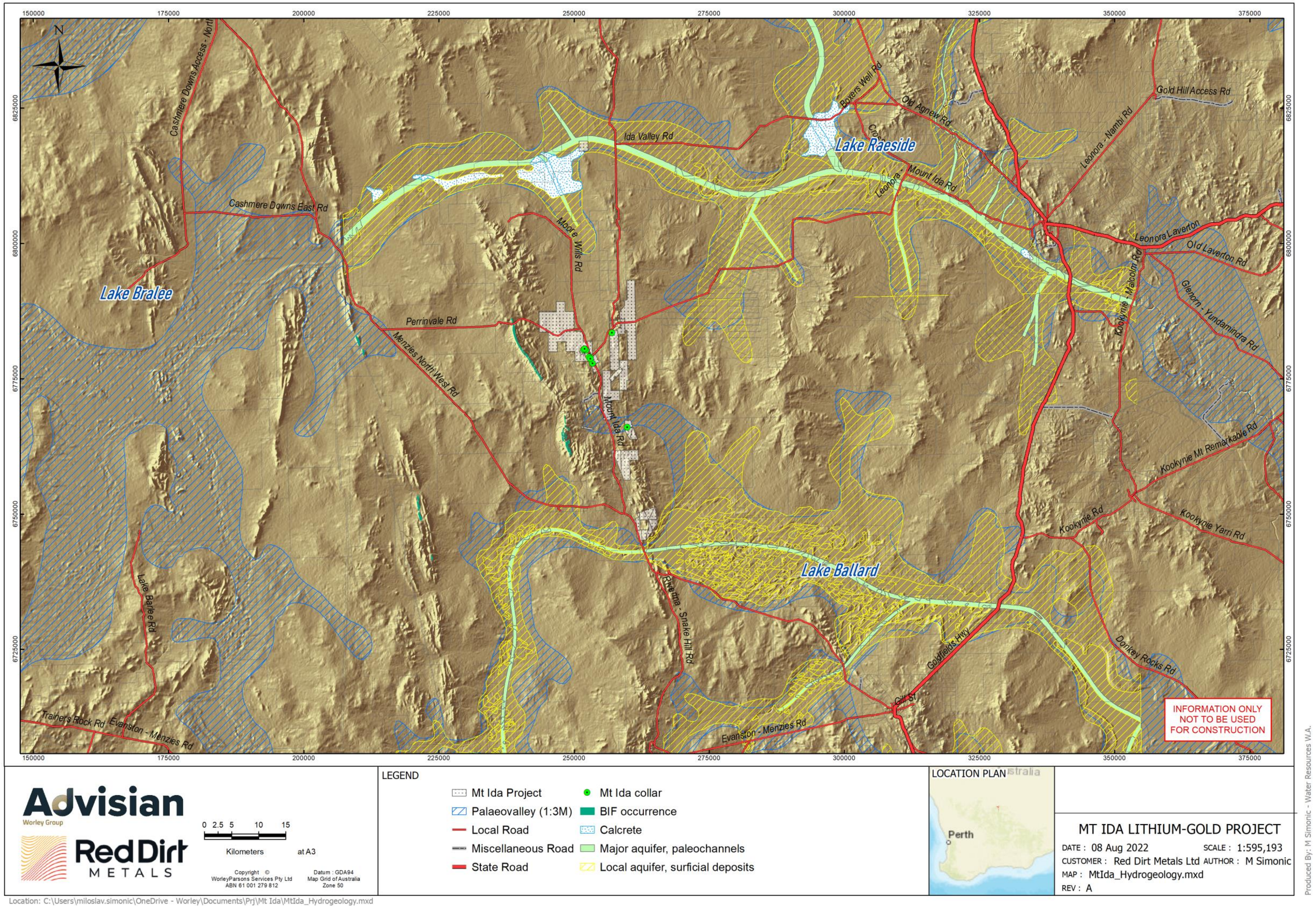


Figure A-5 Aquifers associated with paleodrainages (after Johnson et al, 1999)

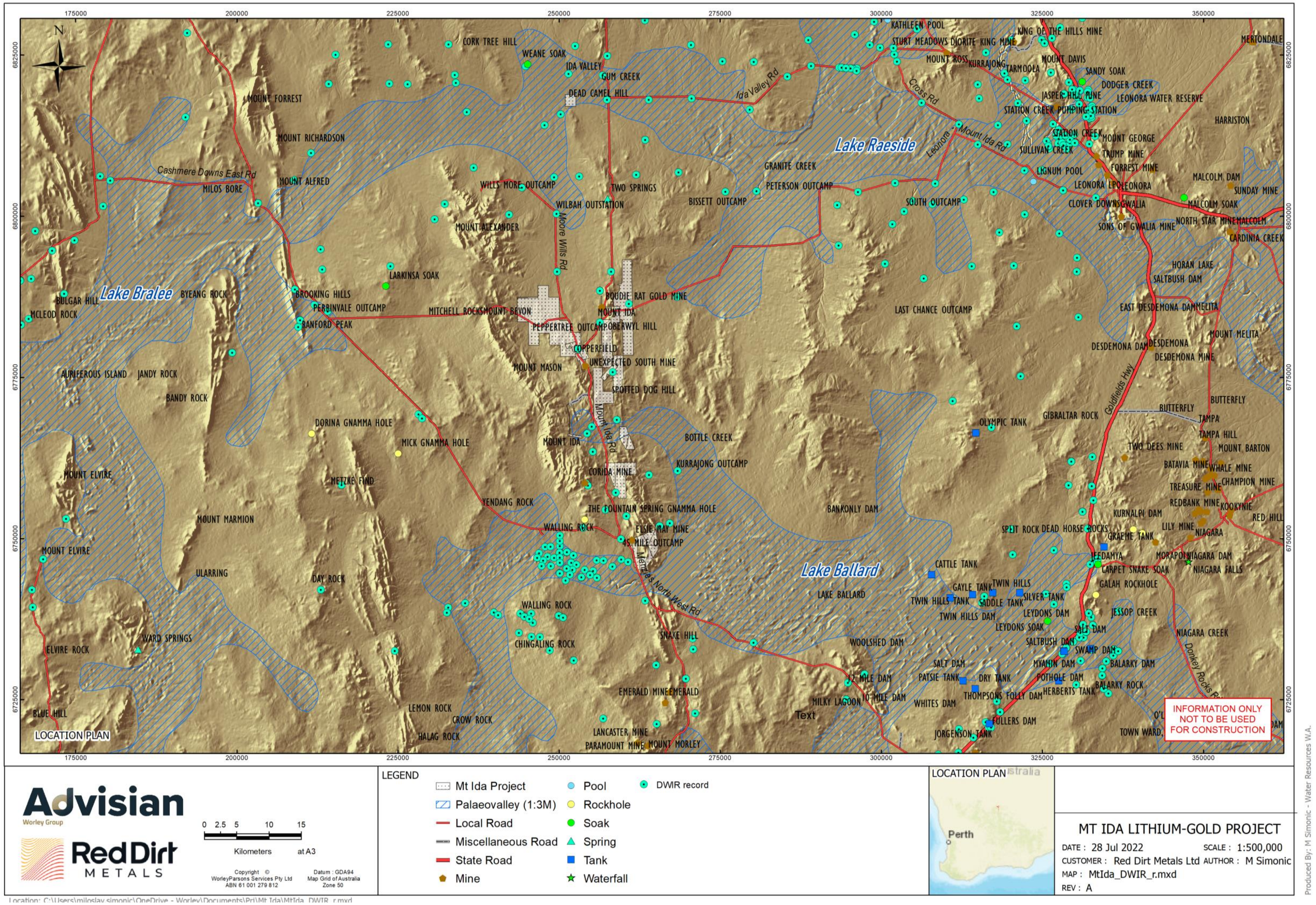


Figure A-6 Locations of DWIR recorded bores

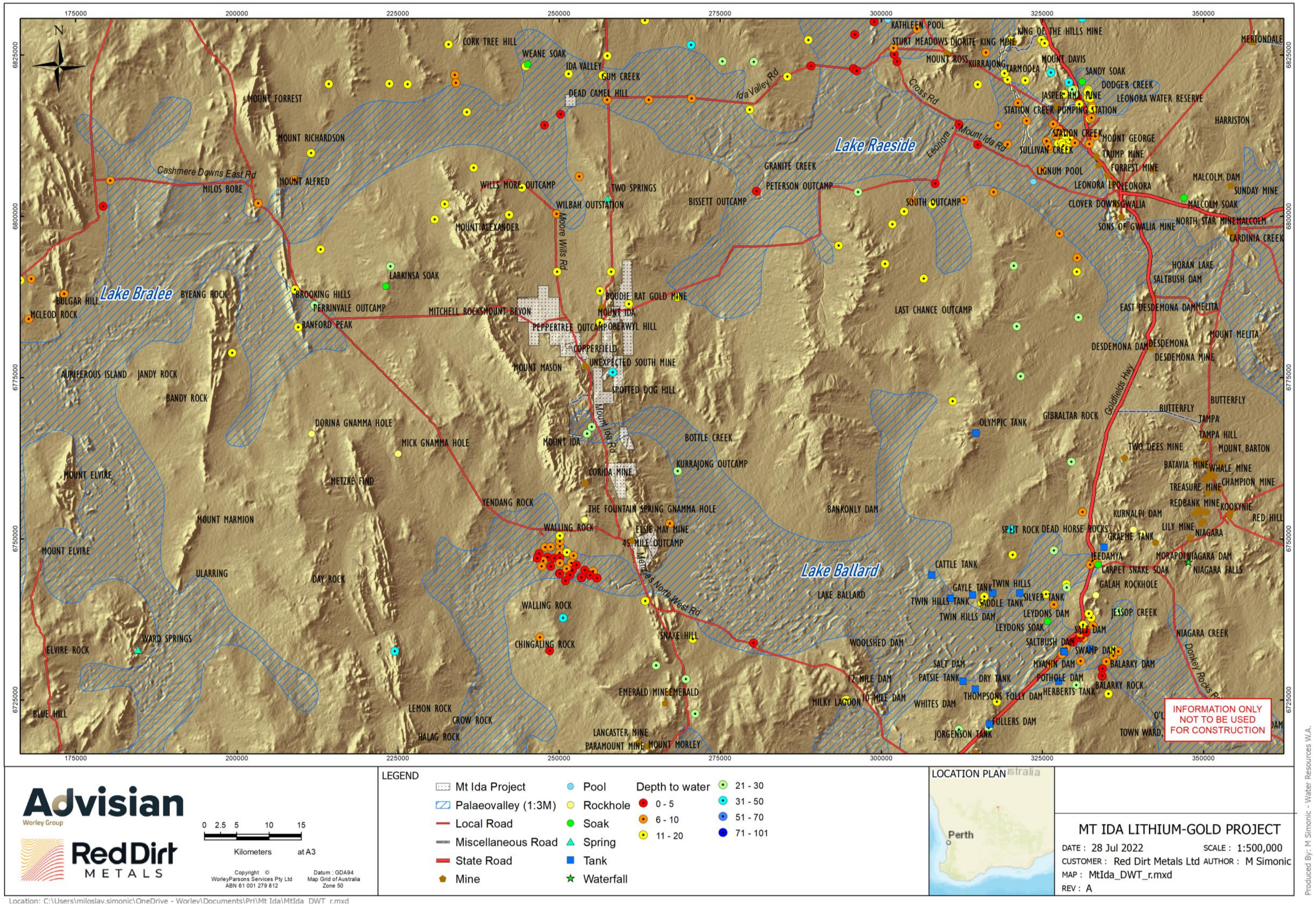


Figure A-7 Depth to groundwater (mean values from DWIR database)

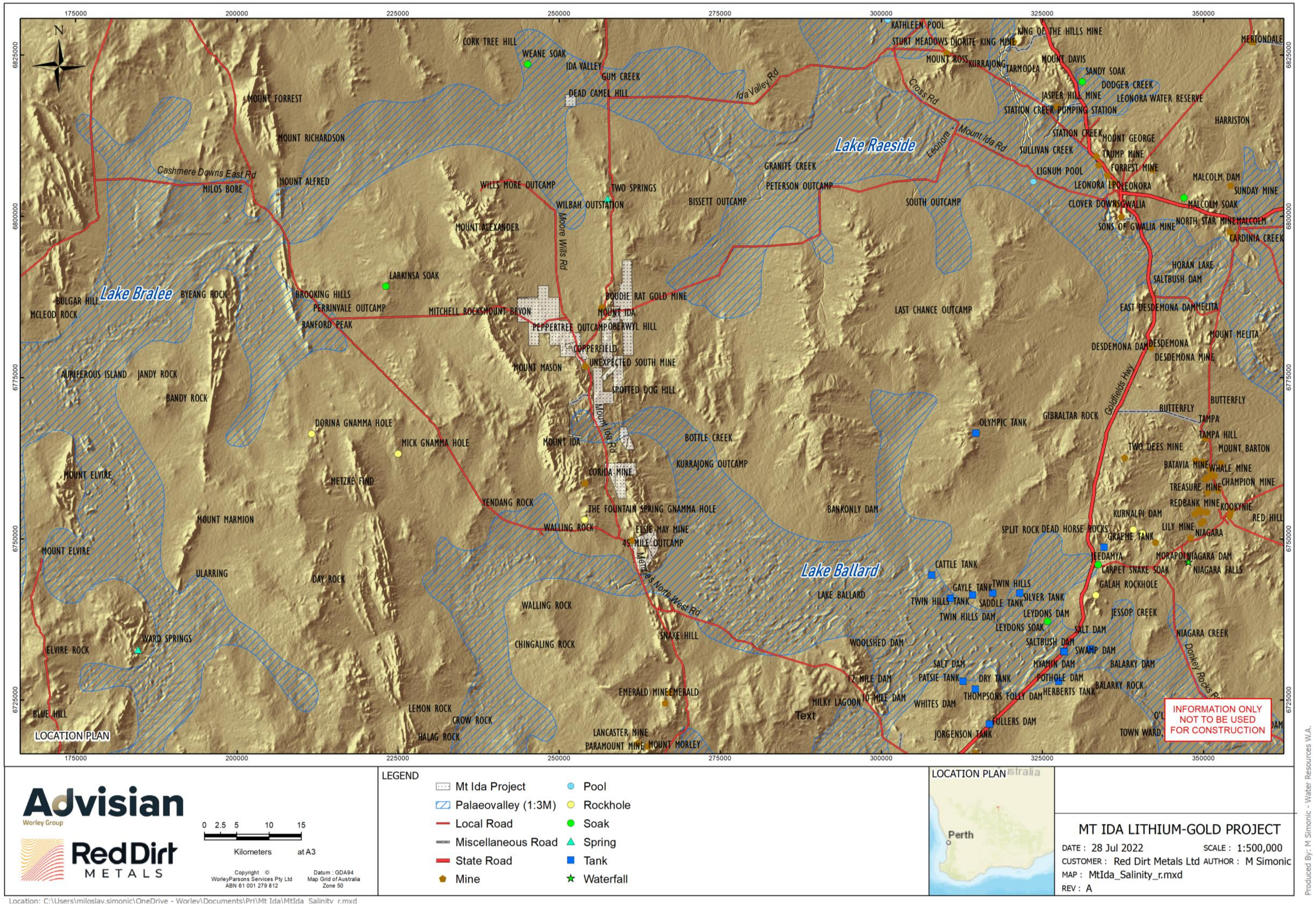


Figure A-8 Groundwater salinity records

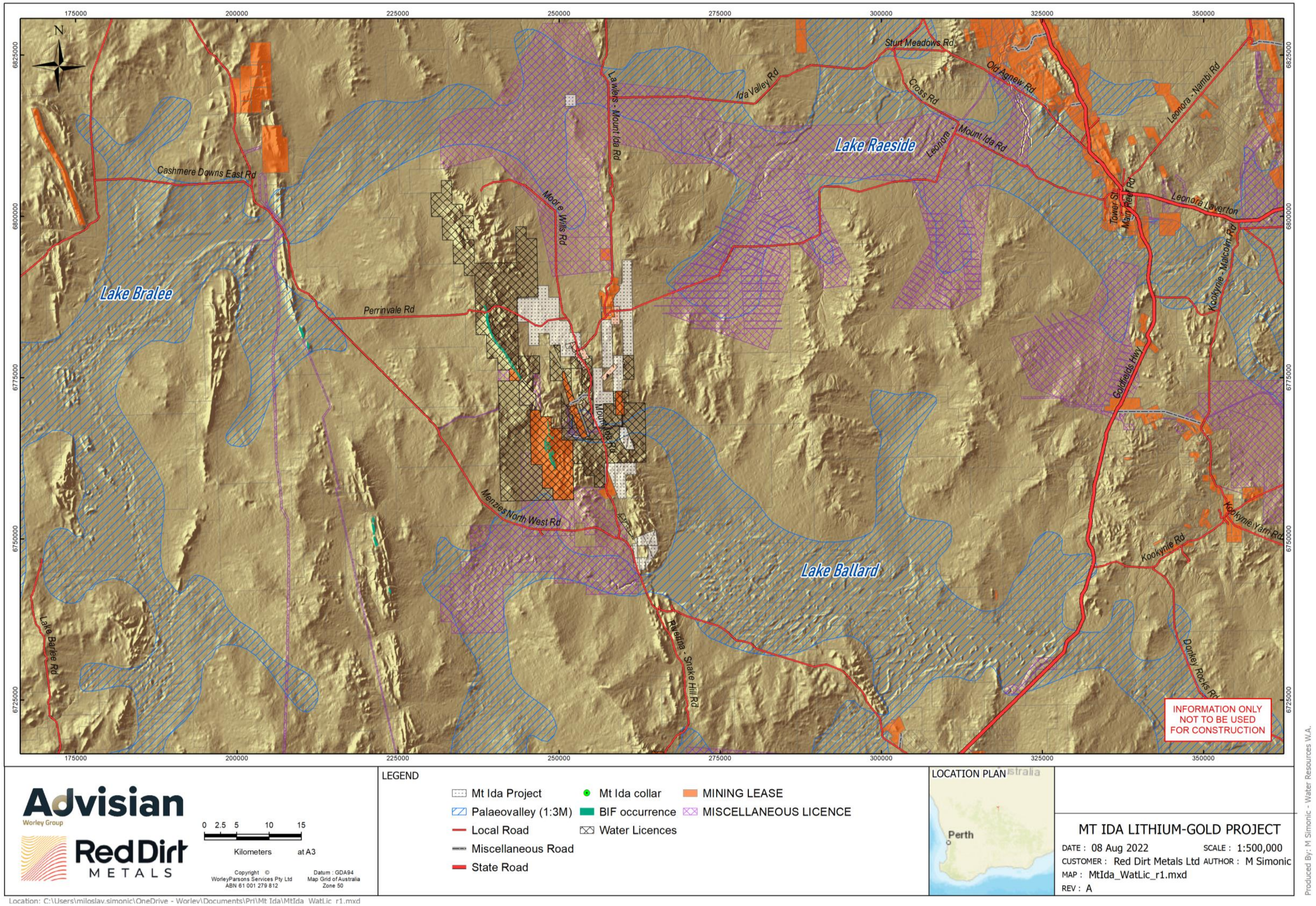
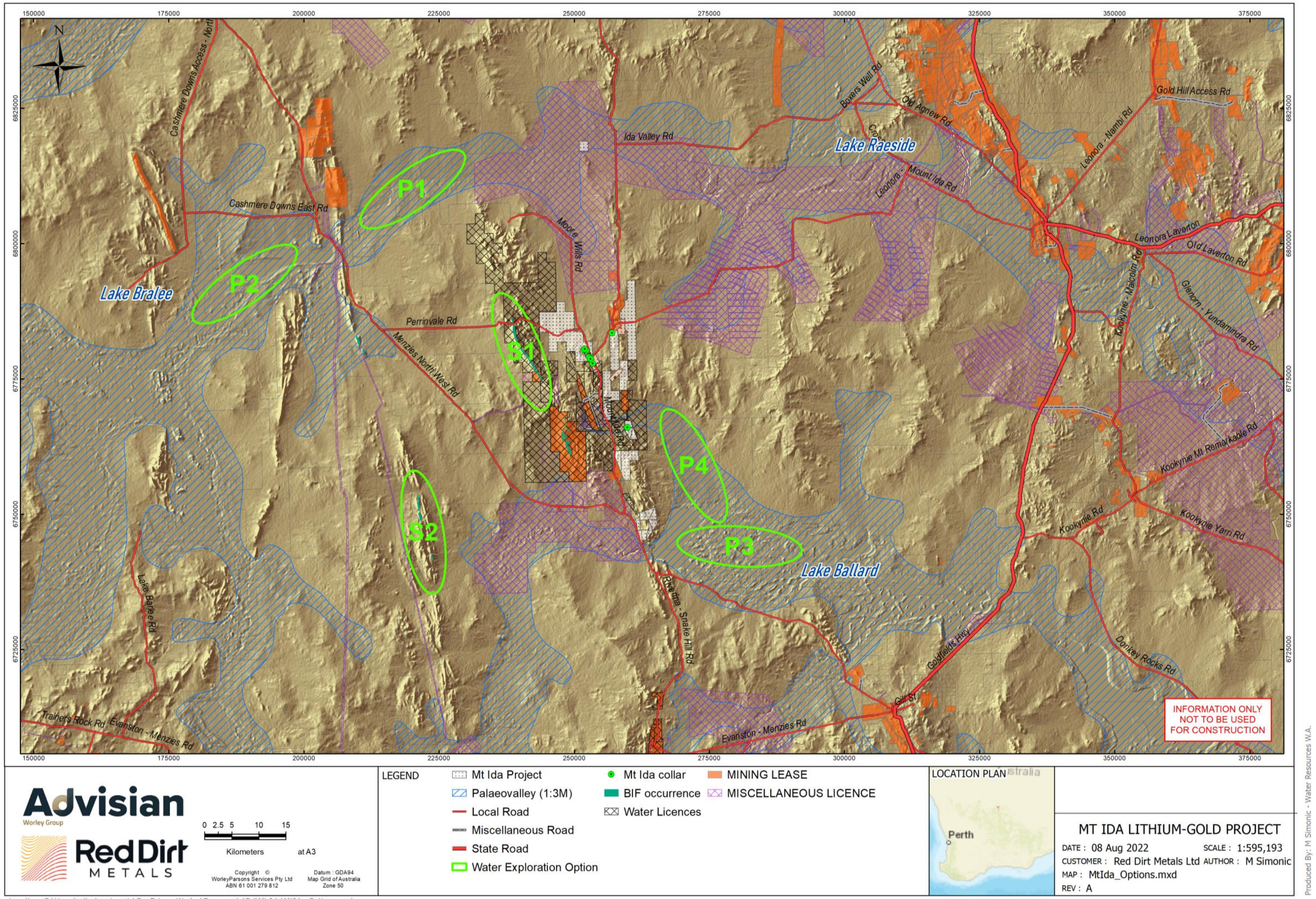


Figure A-9 Current miscellaneous, mining and water licences



Location: C:\Users\miloslav.simonic\OneDrive - Worley\Documents\Prj\Mt Ida\MtIda_Options.mxd

Figure A-10 Water supply target options

Appendix B
Water Licence Summary

Water licence summary: Licences active within 100 km from Mt Ida Project; download from DWER, on 25/07/2022

REGISTER EXTRACT INFORMATION

The Department of Water is committed to quality service to its customers and makes every attempt to ensure accuracy, currency and reliability of the data contained in this document. However changes in circumstances after time of publication may impact the quality of this information.

Licence Number	Issue date	Expiry date	Allocation (GL/yr))	Parties	Postal address	Groundwater subarea	Aquifer	Licence address
63550	27/01/2022	26/01/2032	6	Northern Star (Thunderbox) Pty Ltd	GPO BOX 2563 Perth WA 6001 Australia	Raeside	Palaeochannel - Palaeochannel	M37/356; L37/166; M36/504, M36/504 Thunderbox Gold Mine; M37/339; M36/542; L37/228; M36/599; M36/582; L37/215; M37/358; M37/493; L37/61; L37/73; M36/503; L37/222; L37/117; M37/359; M37/819; M37/437; M37/357; M37/340; M37/361; L37/229; M37/1063; M36/512; M37/350; L36/155 Roadside Borefield; M37/360
63771	27/01/2022	26/01/2032	2.84	Greenstone Resources (WA) Pty Ltd	L 2 35 Ventnor Ave West Perth WA 6005 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/547; M37/179; M37/21; M37/410; M37/76; M37/407; M37/449; L37/211; M37/90; M37/572; M37/451; M37/67; M37/248; M37/548; M37/429; M37/330; M37/222; M37/201; M37/573
65627	23/06/2016	19/10/2022	0.8395	St Barbara Limited	PO Box 1161 West Perth WA 6872 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/460, M37/459 and M37/458 (Sullivan's Creek, Leonora); M37/460, M37/459 and M37/458 (Sullivan's Creek, Leonora)
66199	23/07/2021	12/04/2031	1.825	Carnegie Gold Pty Ltd	PO Box 464 West Perth WA 6872 Australia	Rebecca	Palaeochannel - Fractured Rock	M24/39; M24/960; M30/255; L30/35; L24/115; L24/224; L24/240; L24/170; L24/174
100354	19/10/2018	30/06/2026	0.6	Water Corporation	PO BOX 100 Leederville WA 6902 Australia	Raeside	Palaeochannel - Alluvium	LOT 63 ON PLAN 238486 - Lot 63 LEONORA; CROWN RESERVE 9699; LOT 121 ON PLAN 217667 - Volume/Folio LR3120/504 - Lot 121 ; Station Creek Wellfield - Leonora; LOT 63 ON PLAN 238486 - Lot 63 LEONORA
102686	18/10/2018	31/05/2026	0.029	Water Corporation	PO BOX 100 Leederville WA 6902 Australia	Rebecca	Palaeochannel - Fractured Rock	Lot 1520 On Plan 72915 Volume/Folio Lr3163/40 Lot 1520 Menzies Wellfield
106474	5/06/2015	3/06/2025	0.11	Carnegie Gold Pty Ltd	PO Box 464 West Perth WA 6872 Australia	Rebecca	Palaeochannel - Fractured Rock	L30/37 Papertalk Brook; M30/108 North Coolgardie, Ularring
110913	3/05/2018	3/05/2028	4.7145	St Barbara Limited	PO Box 1161 West Perth WA 6872 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/137; M37/251; L37/213; M37/247; M37/333; M37/25; M37/849; L37/33 - Eastern Borefield; M37/55; M37/485; M37/626; M37/903
154581	20/05/2014	19/05/2024	0.003	International Petroleum Limited	PO BOX 1385 West Leederville WA 6901 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M29/2 Mt Ida Project
154584	19/05/2014	18/05/2024	0.52	International Petroleum Limited	PO BOX 1385 West Leederville WA 6901 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M29/2 Mt Ida Project
156854	21/02/2014	19/02/2023	1.5	Sand Queen Gold Mines Pty Ltd	Level 1, 12 Kings Park Rd West Perth WA 6005 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M29/52, M29/321, M29/233 & L29/67 Sand Queen Gold Mine
158766	12/03/2021	7/11/2026	2	Northern Star (Thunderbox) Pty Ltd	GPO BOX 2563 Perth WA 6001 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/998; M37/359; M37/340; L36/155 Roadside Borefield; M37/437; M37/339; M36/512; L37/227; M36/504; L36/158; M37/360; M36/582; M36/600; M36/542; L37/166; M37/493; M36/599; M36/503
163736	1/06/2017	31/05/2027	0.0005	William Ambrose Francis	PO BOX 10189 Kalgoorlie Po WA 6433 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/502

Licence Number	Issue date	Expiry date	Allocation (GL/yr))	Parties	Postal address	Groundwater subarea	Aquifer	Licence address
164770	24/08/2020	8/04/2030	0.1	Main Roads	PO BOX 6202 East Perth WA 6892 Australia	Raeside	Palaeochannel - Alluvium	Goldfields Highway road reserve adjacent to Lot 62 on Plan 220929 Leonora
168286	24/06/2015	19/05/2025	0.5	Northern Star (Talisman) Pty Ltd	PO BOX 7446 Cloisters Square WA 6850 Australia	Raeside	Palaeochannel - Palaeochannel	Marshall Creek Borefield M37/1148; M37/1136, M37/1063, M37/818, M37/1223
169326	29/04/2022	28/04/2032	0.12	Roxbury Trading Pty Ltd	PO BOX 58 North Dandalup WA 6207 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M30/71; Crown Reserve 24144; Crown Reserve 24145; Crown Reserve 8739
173305	7/05/2014	6/05/2024	0.035	Macarthur Minerals Limited	PO BOX 1148 Milton QLD 4064 Australia	Barlee	Combined - Fractured Rock West - Fractured Rock	E30/385, E30/384, E30/387, E30/392, E30/398, E30/443, E30/444, M30/213, M30/214, M30/215, M30/216, M30/217, M30/218, M30/219, M30/227, M30/228, M30/229, M30/248, M30/249, M30/251, M30/252, E77/1299, M30/250, P30/1083, P30/1095, P30/1096, M30/206, M30/207, M30/208, L30/53, P30/1070, P30/1071, P30/1085, P30/1089, E30/240, E30/321, E30/322, E30/323, E30/349, E30/386 Ularring Hematite Project
173326	7/05/2014	6/05/2024	0.035	Macarthur Minerals Limited	PO BOX 1148 Milton QLD 4064 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	E30/318, M30/249, E30/324, E30/407, E30/411, E30/410, E30/447, E30/448, L16/107, L30/51, L30/50, L30/56, L30/49, L30/54, L29/125, L29/126, L29/129, M30/206, M30/207, M30/208, M30/215, M30/229, M30/248 Ularring Hematite Project
173529	24/06/2021	4/10/2025	1.2	Ulysses Mining Pty Ltd	PO Box 937 West Perth WA 6872 Australia	Raeside	Combined - Fractured Rock West - Palaeochannel	M40/288; M40/293; L40/18; G40/5; M40/110; M40/120; M40/166; G40/6; M40/196; L40/10; M40/163; L40/30; M40/289; L40/21; L40/17; M40/291; M40/164; L40/11; M40/3; M40/340; G40/7; M40/339; M40/290; M40/345; M40/94; M40/107; M40/137; L40/31; M40/148; M40/343; M40/20; M40/292; M40/101; L40/12; G40/4; M40/136; M40/174
174010	4/11/2021	3/11/2031	0.05	Cashmere Iron Limited	unit 4/80 Colin St West Perth WA 6005 Australia	Meekatharra	Combined - Fractured Rock West - Fractured Rock	E57/553-I; M57/544-I; M57/546-I; M57/545-I; E57/549-I
177090	7/11/2013	6/11/2023	0.05	Beacon Minerals Limited	PO BOX 423 Kalgoolie WA 6433 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	L29/124
177905	29/10/2013	30/10/2023	0.0994	D. & C. Geraghty Pty Ltd	3 Kirkham Hill Tce Maylands WA 6051 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	Lot 25 On Plan 238312 Volume/Folio Lr3137/665 Lot 25 Kookynie Lot 40 On Plan 238644 Volume/Folio Cl1992/293 Lot 40 Kookynie Lot 25 On Plan 238312 Volume/Folio Cl1966/399 Lot 25 Kookynie Lot 45 On Plan 238655 Volume/Folio Cl1994/375 Lot 45 Kookynie Lot 45 On Plan 238655 Volume/Folio Lr3054/696 Lot 45 Kookynie Lot 23 On Plan 238318 Volume/Folio Cl1965/873 Lot 23 Kookynie Lot 23 On ; Lot 25 On Plan 238312 Volume/Folio Lr3137/665 Lot 25 Kookynie Lot 25 On Plan 238312 Volume/Folio Cl1966/399 Lot 25 Kookynie
180008	6/11/2014	5/11/2024	0.001	Kenalan Prospecting Pty Ltd	33 William Dr Broadwater WA 6280 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	P37/7817 Grattan Well
180490	13/08/2020	12/08/2030	0.895	Carnegie Gold Pty Ltd	PO Box 464 West Perth WA 6872 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M30/255; M30/103; M30/256
180868	27/03/2015	26/03/2025	1	Round Oak Jaguar Pty Ltd	PO BOX 370 Leonora WA 6438 Australia	Raeside	Palaeochannel - Alluvium	L37/119 Teutonic Bore Field, Leonora; L37/183 Teutonic Bore Field, Leonora; L37/119, L37/183 Teutonic Borefield, Leonora

Licence Number	Issue date	Expiry date	Allocation (GL/yr))	Parties	Postal address	Groundwater subarea	Aquifer	Licence address
181982	13/06/2018	12/06/2028	1.3	Northern Star (Thunderbox) Pty Ltd	GPO BOX 2563 Perth WA 6001 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/219; M37/46; M37/564; L37/221 - Harbour Kights
182172	19/01/2016	18/01/2026	0.0007	Donald Maxwell Daniels	15 Oakover Rd Herne Hill WA 6056 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	P37/7518
182709	18/06/2021	30/01/2029	0.8	Genesis Minerals Limited	PO BOX 937 West Perth WA 6872 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	L40/18; M40/288; M40/343; M40/164; L40/21; M40/292; M40/94; M40/120; L40/10; M40/101; G40/5; L40/17; M40/20; M40/148; M40/174; M40/290; M40/3; M40/137; L40/12; M40/293; L40/30; M40/339; M40/291; M40/110; M40/166; M40/196; M40/107; G40/6; M40/136; M40/289; G40/4; M40/345; L40/11; M40/340; L40/31; G40/7; M40/163
203335	5/09/2019	4/09/2029	0.0025	Arrow Minerals Ltd	Shop 18/40 St Quentin Ave CLAREMONT WA 6010 Australia	Barlee	Combined - Fractured Rock West - Fractured Rock	E30/488; E77/2403; E77/2432; E30/494; E16/495; E30/493; E16/498; E77/2416
203336	5/09/2019	4/09/2029	0.0025	Arrow Minerals Ltd	Shop 18/40 St Quentin Ave CLAREMONT WA 6010 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	E16/498; E77/2416; E16/495; E30/488; E30/494; E77/2403; E77/2432
203577	11/11/2019	10/11/2029	0.00005	Barry James Donkin	91 Laithwood Circuit Albany WA 6330 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	P29/2432; M29/425; P29/2431
204011	27/01/2022	26/01/2032	2.4	Greenstone Resources (WA) Pty Ltd	L 2 35 Ventnor Ave West Perth WA 6005 Australia	Raeside	Palaeochannel - Palaeochannel	M37/407; M37/1081; M37/573; M37/551; M37/76; M37/248; M37/548; M37/201; M37/222; M37/572; M37/429; M37/547; M37/67; L37/211; M37/330; M37/90; M37/410; M37/449
204012	20/02/2020	19/02/2030	0.76	Greenstone Resources (WA) Pty Ltd	L 2 35 Ventnor Ave West Perth WA 6005 Australia	Raeside	Palaeochannel - Alluvium	M37/429; M37/547; M37/407; M37/573; M37/410; M37/201; M37/330; M37/572; M37/248; M37/449; M37/76; M37/67; M37/222; L37/211; M37/548; M37/90
204119	19/03/2020	18/03/2030	0.25	MGK Resources Pty Ltd	PO Box 1054 Jindabyne NSW 2627 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M29/150; M29/421; M29/151; P29/2521; L29/139; E29/921-I; E29/1016; E29/790; E29/1007; E29/1014
204350	20/05/2020	19/05/2030	0.0015	Michael Francis Crowley	1 Arthur St PICCADILLY WA 6430 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M29/143
204482	30/06/2020	29/06/2030	0.000412	Blockchain Resources Pty Ltd	3 Bencubbin street Dawesville WA 6211 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	P40/1417
204971	23/10/2020	22/10/2030	0.0015	SGR Systems Pty Ltd	PO Box 120 Leonora WA 6438 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	P37/8633
205011	29/10/2020	28/10/2030	0.035	Nex Metals Explorations Ltd	null	Raeside	Combined - Fractured Rock West - Fractured Rock	M40/61; M40/27
205666	19/03/2021	18/03/2031	0.1	Cliffs Asia Pacific Iron Ore Pty Ltd	Locked Bag 13 Osborne Park DC WA 6916 Australia	Barlee	Combined - Fractured Rock West - Fractured Rock	E29/989; E29/571-I

Licence Number	Issue date	Expiry date	Allocation (GL/yr))	Parties	Postal address	Groundwater subarea	Aquifer	Licence address
205691	15/04/2021	28/03/2031	0.5	Red Dirt Mining Pty Ltd	PO Box 594 West Perth WA 6872 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	P30/1144; P30/1125; M30/99; M30/256; M30/157; M30/91
206035	22/06/2021	21/06/2031	0.02	Menzies Goldfield Pty Ltd	7 Odeon Place Heathcote NSW 2233 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M29/189
206344	10/09/2021	9/09/2031	0.82	Juno Minerals Limited	GPO Box Z5117 Perth WA 6000 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M29/408-I; M29/414-I; G29/22; G29/23; L29/100
206360	16/09/2021	15/09/2031	0.0001	Gregory John Bowden	18 Wildflower Crt Kambalda West WA 6442 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	M37/1346
207032	8/03/2022	7/03/2032	1.5	Ardea Resources Limited	PO Box 1433 West Perth WA 6872 Australia	Rebecca	Palaeochannel - Palaeochannel	M24/744-I; M29/278-I; M29/426; M29/202-I; M24/778-I; M24/731-I; M29/272-I; E24/196; M24/541-I; L24/239; M29/423; M29/424; E29/934; P24/5260; P24/5329; M24/732-I
207033	8/03/2022	7/03/2032	2	Ardea Resources Limited	PO Box 1433 West Perth WA 6872 Australia	Rebecca	Combined - Fractured Rock West - Fractured Rock	M29/278-I; E29/934; M29/424; M29/426; M29/202-I; M24/541-I; M24/731-I; E24/196; M29/272-I; L24/239; P24/5260; M29/167-I; M24/732-I; M24/778-I; M29/423
207385	18/05/2022	17/05/2032	0.1	Atlas Iron Pty Ltd	PO BOX 7071 Cloister Square WA 6850 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	E29/510-I
207456	1/06/2022	31/05/2032	0.001	Kateva Lillian Susan Dubberley	PO Box 81 Leonora WA 6438 Australia	Raeside	Combined - Fractured Rock West - Fractured Rock	P37/9249

Appendix 4: Tenement Summary Reports

MINING TENEMENT SUMMARY REPORT

MINING LEASE 29/2

Status: Live

TENEMENT SUMMARY

Area: 382.85000 HA
Mark Out : 06/04/1982 10:30:00
Received : 16/04/1982 09:30:00
Term Granted : 21 Years (Renewed)
Death Reason :
Death Date :
Commence : 22/12/1982

CURRENT HOLDER DETAILS

Name and Address
MT IDA GOLD PTY LTD
MCMAHON MINING TITLE SERVICES PTY LTD, C/- MCMAHON MINING TITLE SERVICES PTY LTD, PO BOX 6301, EAST PERTH, WA, 6892, xxxx@mmts.net.au, xxxxxxx997

DESCRIPTION

Locality: MT IDA
Datum: NW CNR PEG OF SURVEYED GML 29/6020
Boundary: THENCE: boundaries identical to GML 29/5997, 5999, 6001, 6002,6003, 6008, 6009, 6013, 6014, 6015, 6016, 6017, 6018, 6019, 6020, 6021, 6022, 6023, 6024, 6034, MC 29/3240, 3241, 3242

Area :

Type	Dealing No	Start Date	Area
Surveyed		28/03/1984	382.85000 HA
Granted		22/12/1982	382.86000 HA
Applied For		06/04/1982	382.86000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MENZIES SHIRE	5390	16/04/1982		382.85000 HA

MINING TENEMENT SUMMARY REPORT

MINING LEASE 29/165

Status: Live

TENEMENT SUMMARY

Area: 160.25000 HA
Mark Out : 18/06/1994 14:20:00
Received : 20/06/1994 13:30:00
Term Granted : 21 Years (Renewed)
Death Reason :
Death Date :
Commence : 21/12/1994

CURRENT HOLDER DETAILS

Name and Address

MT IDA GOLD PTY LTD
MCMAHON MINING TITLE SERVICES PTY LTD, C/- MCMAHON MINING TITLE SERVICES PTY LTD, PO BOX 6301, EAST PERTH, WA, 6892, xxxx@mmts.net.au, xxxxxxx997

HOOPER, Stuart Leslie
MCMAHON MINING TITLE SERVICES PTY LTD, C/- MCMAHON MINING TITLE SERVICES PTY LTD, PO BOX 6301, EAST PERTH, WA, 6892, xxxx@mmts.net.au, xxxxxxx997

DESCRIPTION

Locality: Copperfield
Datum: Datum situated 40 metres bearing 253 degrees from south east corner of late surveyed MC 29/3240
Boundary: THENCE: 920 metres bearing 73 degrees 1660 metres bearing 153 degrees 1120 metres bearing 255 degrees Approx. 1620 metres along eastern boundary of late surveyed GML 29/6013; GML 29/6024; 6023; 6022; 6034; 6003 Back to datum Conversion of Prospecting Licence 29/1206 under Section 49

Area :

Type	Dealing No	Start Date	Area
Surveyed		21/04/2016	160.25000 HA
Granted		21/12/1994	160.00000 HA
Applied For		18/06/1994	160.00000 HA

SHIRE DETAILS

Shire	Shire No	Start	End	Area
MENZIES SHIRE	5390	18/06/1994		160.25000 HA

Appendix 5: Consent to Mine in various reserves (DMIRS)

Red Dirt METALS

Ref: CPS

General Manager Environmental Compliance
Resource and Environmental Compliance Division
Department of Mines Industry Regulation and Safety
Mineral House, 100 Plain Street
EAST PERTH WA 6004

Dear Sir/Madam

Letter of Authority - Clearing Permit Applications

I refer to the request from your department that **Green Values Australia** provide a letter of authority for applications to clear native vegetation made on behalf of the company.

Please be advised that the following people are authorised to sign each 'Application for Clearing Permit' on behalf of **Mt Ida Gold Pty Ltd a subsidiary of Red Dirt Metals Limited** for **Mt Ida Lithium Project**.

NAMES	SIGNATURES
Rhys Houlihan - Director	

Yours faithfully

Daniel Kendall
Company Secretary

1 March 2023

Appendix 6: Mt Ida Lithium Project Baseline Soil and Landform Assessment (Mine Earth, 2023)

MINE EARTH

The mine closure specialists

Red Dirt METALS

MT IDA LITHIUM PROJECT

BASELINE SOIL AND LANDFORM ASSESSMENT

JANUARY 2023

MINE EARTH
Unit 1, 94 Forsyth St
O'Connor WA 6163

+61 8 9431 7318
info@mineearth.com.au
www.mineearth.com.au

100% of Mine Earth's carbon footprint has been voluntarily offset by the planting of native trees

Mine Earth Pty Ltd (ACN 141 633 696)

Author	Checked	Distribution	Date	Version
S. Perry H. Crisp	M. Braimbridge	C. McGuire	1 December 2022	Revision A
S. Perry	M. Braimbridge	C. McGuire	23 January 2023	Revision 0

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Mine Earth was commissioned by Red Dirt Metals Limited to complete a baseline soil and landform assessment for the Mt Ida Lithium Project (the Project). The Project is located approximately 100 km north-west of Menzies in the Goldfields Region of Western Australia (WA). The study area for the assessment comprised tenements M29/165, M29/2 and part of E29/0640, which has an area of 702 ha.

The objectives of the assessment were to:

- Assess the characteristics of soil profiles within the study area.
- Characterise the physical and chemical characteristics of collected soil samples.
- Develop recommendations for soil salvaging, management, stockpiling and application of soil resources in rehabilitation and mine closure activities.

Surface Soil Characteristics

The physical and chemical characteristics of surface soil materials were assessed from 13 representative locations within the study area, which were sampled to a maximum depth of 30 cm. The characteristics of surface soils, as identified by the field investigation, sampling and analysis program, have been grouped into the following soil-landform associations: ‘Stony plains, ‘Low rises’ and ‘Drainage lines’.

Many of the chemical and physical characteristics of the surface soils across the study area were relatively similar, with little consistent correlation with soil-landform association, or sample depth. The soils within the study area typically have a loamy texture with varying amounts of clay, range from non-saline to extremely saline, are non-sodic, free draining (‘moderately rapid’ to ‘rapid’ hydraulic conductivity), have a low potential for hard-setting, and are typically low in organic carbon and plant-available nutrients.

Soil Management Recommendations

Overall, the surface soils within the Project disturbance areas are considered a valuable source of rehabilitation material. The soils are generally non-sodic, with only minor dispersion of the clay fraction observed within some samples following severe disturbance. The surface soils typically have a high hydraulic conductivity and a low potential for hard-setting. The salinity of some soils is relatively high, so care will need to be taken when selecting seed lists to target species that can tolerate the relevant soil salinity levels. The topsoil above the weathered amphibolite hardpan (5 to 30cm) from all areas of the proposed project disturbance areas should be salvaged and stockpiled for use as a surface rehabilitation medium if required. Areas with historical tailings present on the surface should be managed in accordance with the tailings characterisation report and should not be stockpiled with the topsoil.

Where utilised as a surface rehabilitation medium, the stockpiled soil resources should be placed at a depth of 20 cm. Where topsoil resources are placed on the sloped batters of constructed landforms, the soils will need to be incorporated with competent waste rock, via contour ripping, to armour the rehabilitation surface and minimise erosion as far as practicable.

The weathered amphibolite / hardpan material, which is present across the study area at depths ranging from 5 to 30 cm, should be considered as a potential source of rehabilitation material / growth medium to assist in stabilising rehabilitated surfaces prior to topsoil application.

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Figures

Tables

Appendices

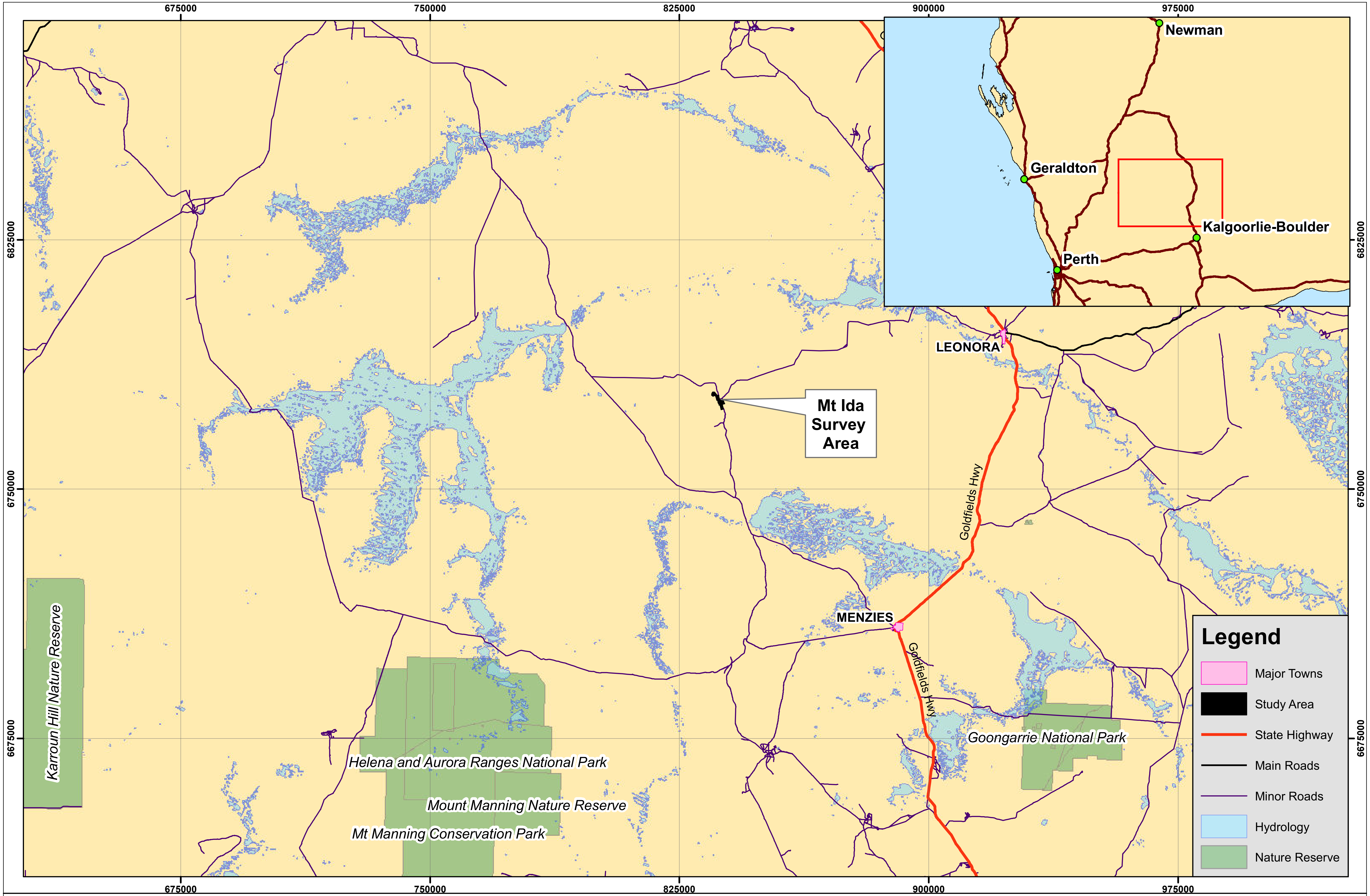
1 INTRODUCTION

Red Dirt Metals Limited are the proponents of the proposed Mt Ida Lithium Project (the Project), located approximately 100 km north-west of Menzies in the Northern Goldfields region of Western Australia (WA) (Figure 1). Mine Earth was commissioned to complete a baseline soil and landform assessment for the Project.

An assessment of soil and landform associations within the study area was undertaken to support regulatory approvals, to identify soil management requirements and potential utilisation of soil resources in rehabilitation activities, and to facilitate mine closure planning.

This report includes:

- A description of the study area.
- A description of the materials and methods used for sample collection and analysis.
- Surface soil profile descriptions.
- A description of soil physical characteristics including surface soil profile morphology, soil texture, soil structure, structural stability and hydraulic conductivity.
- A description of soil chemical characteristics including pH, electrical conductivity, organic matter, exchangeable cations, exchangeable sodium percentage, plant-available nutrients and total metal concentrations.
- Mapping of the soil-landform associations within the study area.
- Soil management recommendations for topsoil stripping, handling and placement as a rehabilitation resource.



MINE EARTH

Date: 20/01/2023

Author: H. Crisp

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
Datum: GDA 1994

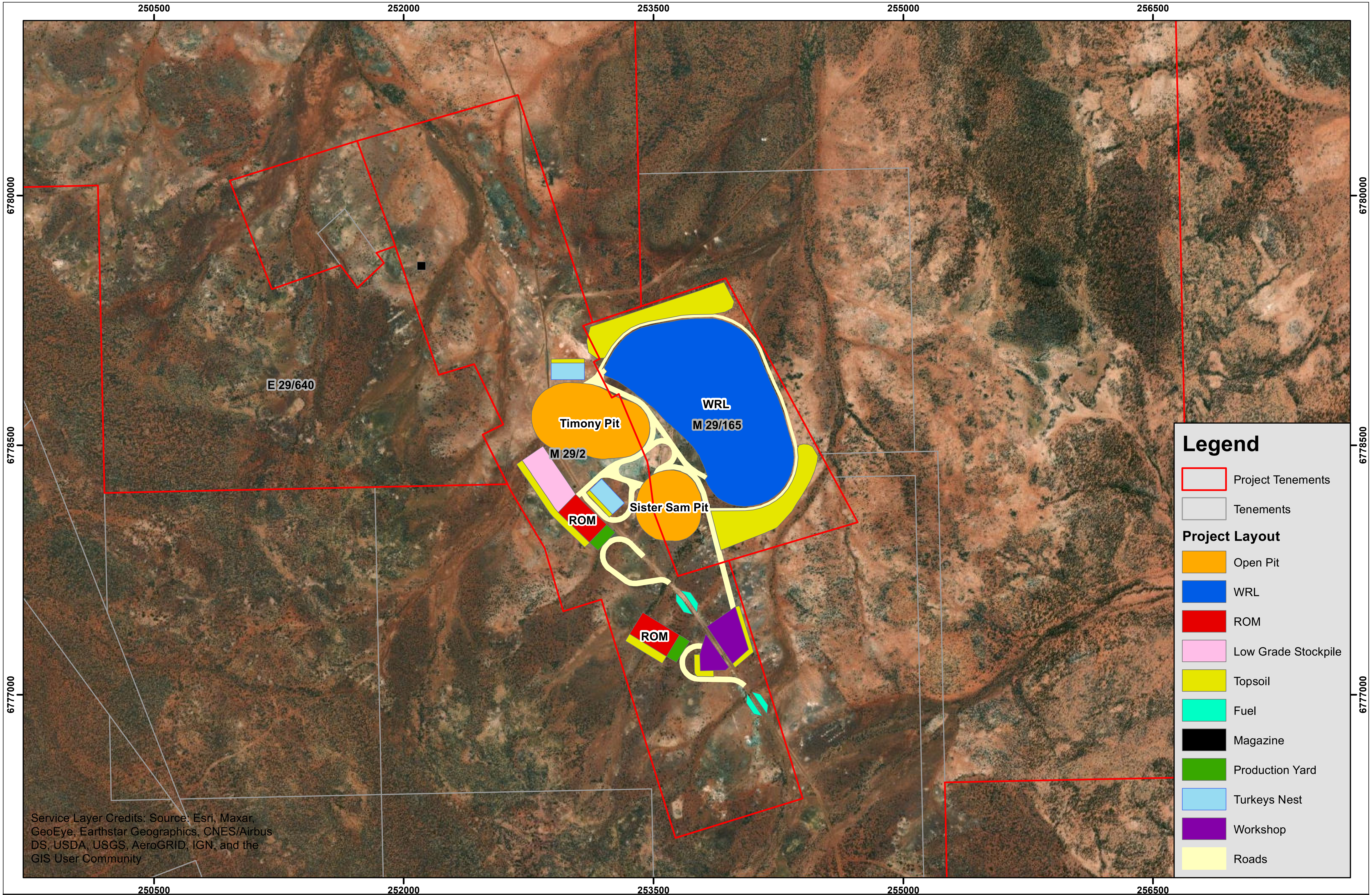
N

0 75 150 Kilometers

1:1,000,000 at A3

Regional Location

Figure 1



MINE EARTH

Date: 20/01/2023

Author: H. Crisp

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

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1:20,000 at A3

Project Layout and Tenements

Figure 2

2 DESCRIPTION OF STUDY AREA

2.1 Project description

The Project area has been historically mined since the 1890s. Red Dirt Metals propose to mine Lithium in 2023 and are currently in the pre-feasibility stage of Project development. The Project will consist of two open pits, a waste rock landform, ROM pads, low grade stockpiles and other mine infrastructure (Figure 2)

The study area for the assessment comprised tenements M29/165, M29/2 and part of E29/640, which has an area of 702 ha (Figure 4).

2.2 Climate

The closest Bureau of Meteorology (BOM) weather station to the study area is located at Leonora, situated approximately 90km to the north-east. The climate at Leonora is classified as arid desert, with hot summers, cool winters and both summer and winter rainfall (BOM, 2022).

The Leonora meteorological station records a mean monthly maximum temperature ranging from 37°C in January to 18.4° C in July (BOM, 2022). The mean minimum temperature is 21.8° C in January and 6.1° C during July (Figure 3). Mean total annual rainfall for this region is 236.4mm, ranging between a maximum average annual rainfall of 30.9mm in February and a minimum of 8.9mm in September; the average annual number of days with rainfall over 1mm is 28.9 (BOM, 2022).

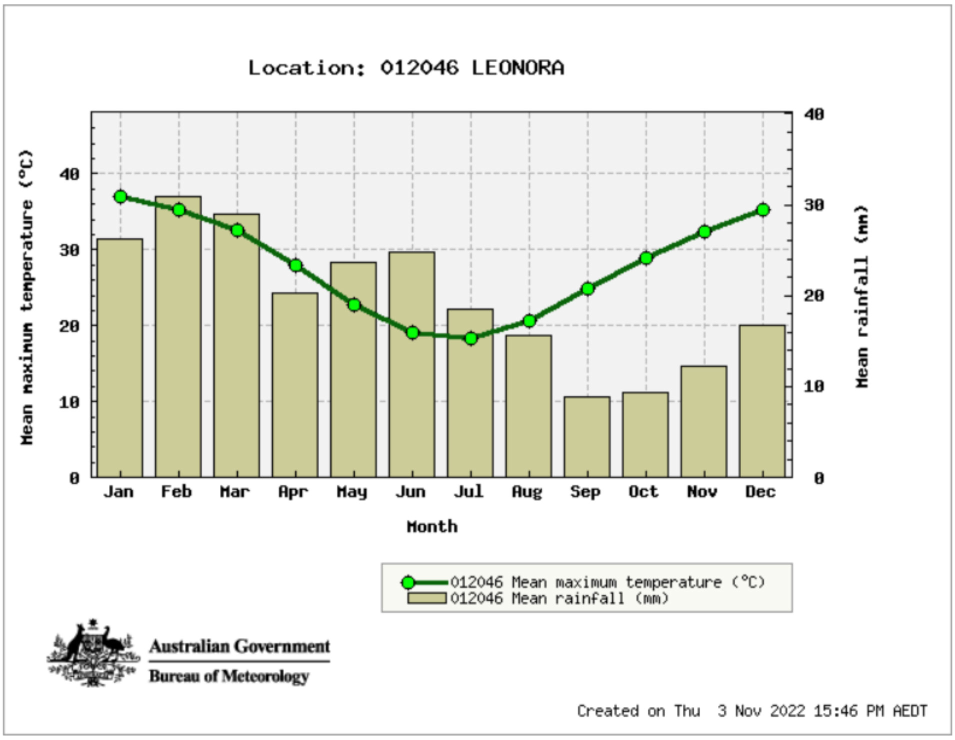
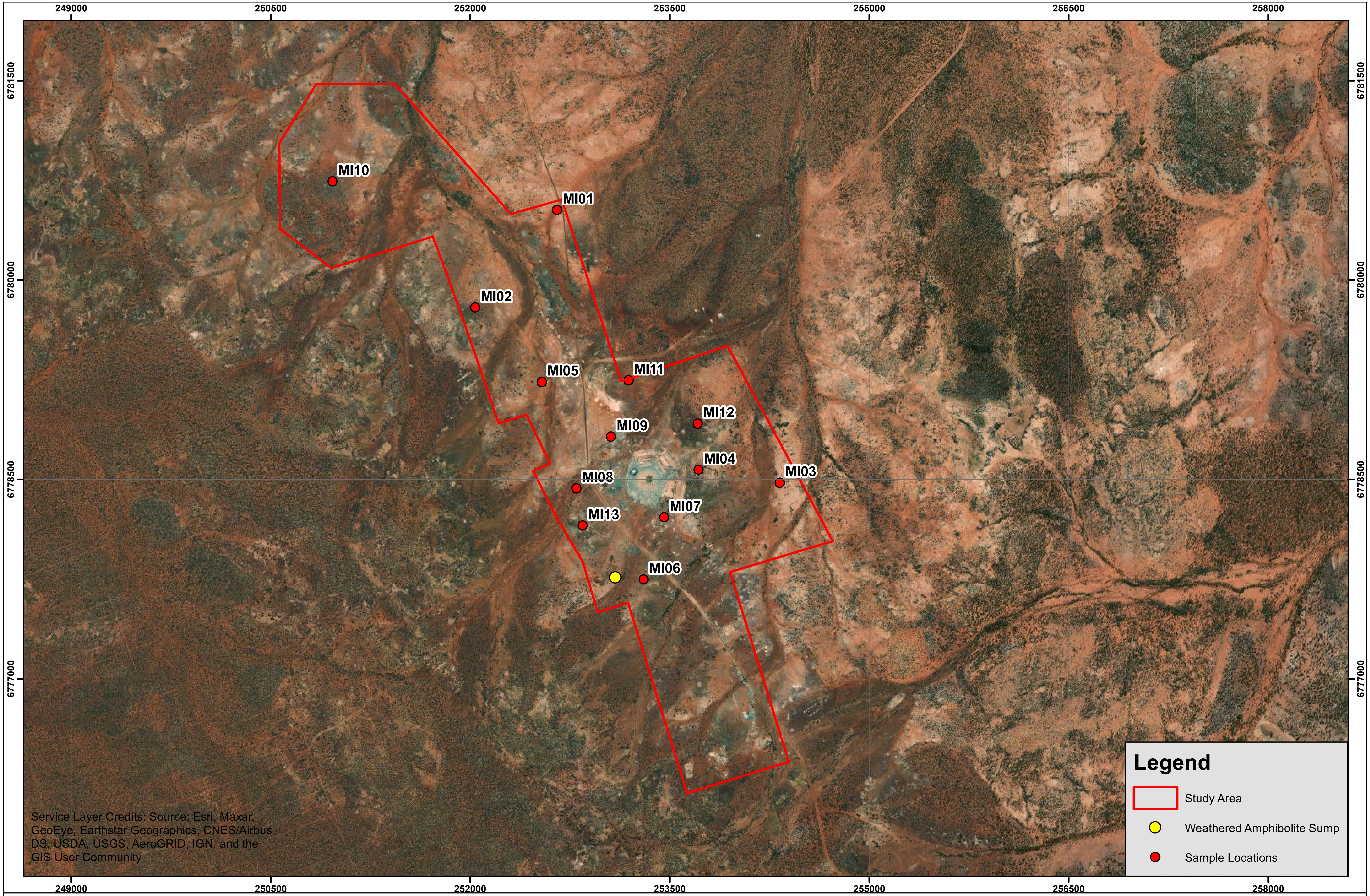


Figure 3 Average rainfall and mean monthly maximum temperature for Leonora (BOM, 2022)



MINE EARTH

Date: 20/01/2023

Author: H. Crisp

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

N

0 1.5 3 Kilometers

1:25,000 at A3

Study Area and Sampling Locations

Figure 4

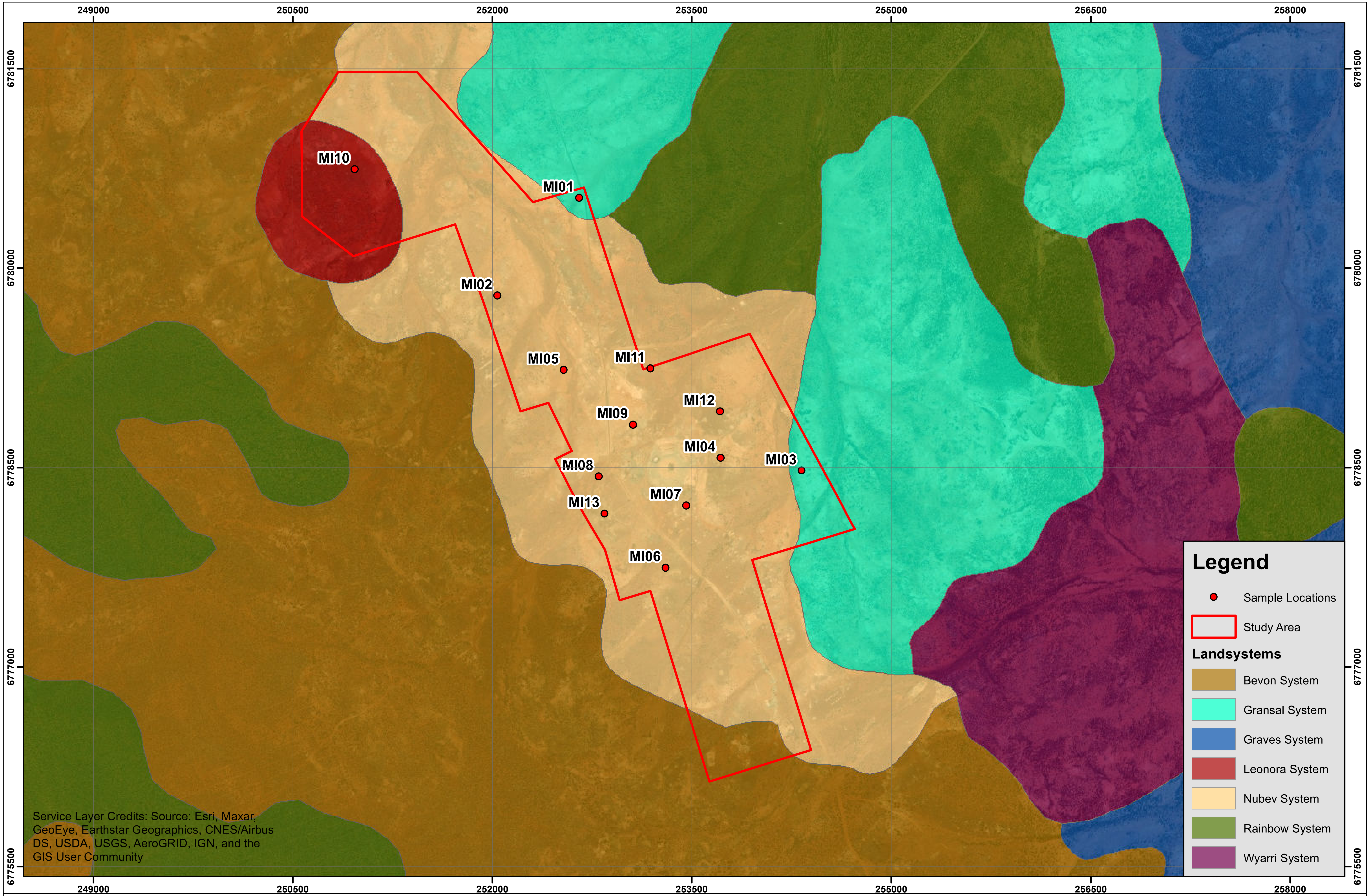
2.3 Land systems

The Project is situated within the East Murchison subregion of the Murchison bioregion according to the Interim Biogeographic Regionalisation for Australia (IBRA) (McKenzie, N.I., May, J.E. and McKenna, S., 2003). This region is characterised by its internal drainage and areas of elevated red desert sandplains with minimal dune development. Salt lake systems are common and associated with the paleodrainage system. The subregion is dominated by plains of red-brown soils, along with breakaway complexes and red sandplains. Vegetation consists of Mulga Woodlands, hummock grasslands and salt bush shrublands (McKenzie, N.I., May, J.E. and McKenna, S., 2003).

Land systems of the north-eastern Goldfields were mapped in 1994 (Pringle, Van Vreeswyck, & Gilligan, 1994). Only two land systems occur within the Project area as shown on Figure 5 and described in Table 1.

Table 1 Land system characteristics of the study area

Land system	Description	Geomorphology	Geology	Major landforms	Major soils
Gransal	Stony plains and low rises on granite, supporting mainly halophytic shrublands	Very occasional low breakaways, tors and rises, extensive plains on deeply weathered granite which have been variably stripped and minor alluvial tracts in lower sectors. Poorly developed drainage patterns	Archaean granite and Quaternary colluvium and alluvium	Stony plains – level to gently undulating plains with mixed mantles of quartz, silcrete and granite pebbles. Hardpan plains – level plains subject to sheet flow, occasionally with quartz pebble mantles.	Shallow red sand with a stony mantle or shallow red earth on granite. Red sand on hardpan.
Nubev	Gently undulating stony plains, minor limonitic low rises and drainage floors, supporting mulga and halophytic shrublands	Gently undulating plains and low rises, frequently with ferruginous duricrust and colluvium, and level alluvial plains receiving concentrated flow off adjacent uplands. Relief to 15m.	Minor Archaen greenstone, Tertiary ferruginous duricrust, Quaternary colluvium and alluvium.	Stony plains – gently undulating plains with abundant ironstone and quartz pebble mantles. Lateritic plains – very gently inclined to level plains receiving diffuse run-on, with abundant mantles of fine ironstone gravel.	Shallow read earth or duplex on greenstone or red sand on hardpan



MINE EARTH

Date: 20/01/2023

Author: H. Crisp

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

N

0 1.5 3 Kilometers

1:25,000 at A3

Landsystems of the Study Area

Figure 5

3 MATERIALS AND METHODS

3.1 Sampling Regime

Soil samples were collected by Mine Earth personnel from 13 sites within the study area in August 2022 (Figure 2). Due to the presence of a hardpan / weathered amphibolite below the surface soils within the proposed mining areas, sampling was conducted by hand to a maximum depth of approximately 30cm, where possible.

Samples were taken from one to two depth intervals at each soil sampling site, depending upon the near-surface soil profile morphology and depth of excavation possible.

Three samples of the weathered amphibolite hardpan were taken from a freshly excavated drilling sump.

Field based observations made during the sampling program included a description of soil surface characteristics, surface soil profile morphology, vegetation assemblage present and the surface drainage characteristics of each soil sampling site, as per the Australian Soil and Land Survey guidelines (CSIRO, 2009).

3.2 Test Work and Procedures

Laboratory test work on the sampled soils was conducted at the Mine Earth in-house laboratory for physical parameters and sent to the CSBP Soil and Plant Laboratory for analysis of chemical parameters.

Laboratory based soil analyses included:

- Physical characteristics:
    - Soil texture / particle size distribution
    - Soil structural stability (Emerson Dispersion Test)
    - Saturated hydraulic conductivity
    - Modulus of rupture (soil strength)
- Chemical characteristics:
    - Soil pH
    - Electrical conductivity
    - Organic carbon
    - Exchangeable cations
    - Plant available nutrients (N, P, K and S)
    - Total metal concentrations

All soil test work procedures were conducted in accordance with standard analytical procedures to assess potential soil erodibility and soil properties related to the support of plant growth (Rayment, 2011). Descriptions of relevant soil classification categories are detailed in Appendix A. All external laboratory results for the soils sampled are provided in Appendix B.

4 RESULTS AND DISCUSSION

The findings of the soil survey and laboratory test work program are presented and discussed in the following sections.

4.1 Sample Site and Soil Profile Descriptions

Sampling site and surface soil descriptions for the 13 sites within the Study Area are presented below. The descriptions also include the soil groups of Western Australia soil classification as per the Department of Agriculture and Food Resource Management Technical Report 380 (Schoknecht & Pathan, 2013).

Site Reference:	MI01	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Floodplain of a minor drainage line	**Easting:**	252741
Soil Landform Association:	Drainage lines	**Northing:**	6780580
Soil group:	Red shallow loam (Group 522)		

Plate 1 Surface soil at Site MI01

Soil profile description:

0-10cm: Strong indurated soil aggregates in a single-grained pinky-red matrix. Approximately 10% angular to sub-rounded coarse fragments, 2 to 10mm in size.

10-30cm: Strong indurated soil aggregates in a single-grained pinky-red matrix. No coarse fragments.

>30cm: Partially weathered hardpan

Soil surface: Strong surface crust with approximately 75% cover of coarse fragments, predominantly 2 to 5mm in size, with larger fragments 60 to 100mm in areas. Approximately 10% cryptogams and 5% leaf litter cover.

Vegetation: Open chenopod shrubland with occasional Mulga overstorey (Native Vegetation Solutions, 2022).

Plate 2 Soil surface / vegetation at Site MI01

Site Reference:	MI02	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Lower slope of a low rocky rise	**Easting:**	252039
Soil Landform Association:	Low rises	**Northing:**	6779793
Soil group:	Red shallow loam (Group 522)		

Plate 3 Surface profile at Site MI02

Soil profile description:

0-10 cm Well-structured pinky-red soil with polyhedral aggregates 2 to 30 mm in size and approximately 30% sub-angular to sub-rounded coarse fragments 2 to 20 mm in size.

10-30 cm: Friable weathered amphibolite in a matrix of single-grained pinky-red clayey fine sand.

>30cm: Hardpan / weathered amphibolite

Soil surface: Strong surface crust with approximately 90% cover of quartz and ironstone coarse fragments, 2 to 150 mm in size. Approximately 5% cryptogams and 30 to 40% leaf litter cover.

Vegetation: Mulga woodland (Native Vegetation Solutions, 2022).

Plate 4 Soil surface / vegetation at Site MI02

Site Reference:	MI03	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Flat stony quartz plain	**Easting:**	254327
Soil Landform Association:	Stony plains	**Northing:**	6778476
Soil group:	Red shallow loam (Group 522)		

Plate 5 Surface profile at Site MI03

Soil profile description:

0-10cm: Light pinky-brown well-structured indurated soil with friable polyhedral aggregates 2 to 60 mm and approximately 10 to 15% quartz coarse fragments 2 to 20 mm in size.

10-25cm: Light pinky-brown well-structured indurated soil with friable polyhedral aggregates 2 to 60 mm and approximately 15 to 20% calcrete coarse fragments 2 to 20 mm in size.

>25cm: Hardpan / weathered amphibolite

Soil surface: Strong crust with 5 to 10% cryptogams and approximately 90% cover of 2 to 60 mm sub-angular to angular quartz, ironstone and calcrete fragments. Approximately 5 to 10% leaf litter. Evidence of minor sheet flow.

Vegetation: Mulga over *Maireana sedifolia* and sclerophyll shrubland (Native Vegetation Solutions, 2022).

Plate 6 Soil surface / vegetation at Site MI03

Site Reference:	MI04	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Gently undulating stony plain	**Easting:**	253718
Soil Landform Association:	Stony plain	**Northing:**	6778572
Soil group:	Red shallow loam (Group 522)		

Plate 7 Surface soil at Site MI04

Soil profile description:

0-5cm: Light pinky-brown well-structured indurated soil with friable polyhedral aggregates.

5-20cm: Predominantly weathered calcrete hardpan with minor soil sized fraction.

>20 cm: Hardpan / weathered amphibolite

Soil surface: Strong surface crust with 10 to 15% cryptogams and approximately 90% cover of 2 to 70 mm sub-angular to angular quartz and calcrete fragments.

Vegetation: Mulga over *Maireana sedifolia* and sclerophyll shrubland (Native Vegetation Solutions, 2022).

Plate 8 Soil surface / vegetation at Site MI04

Site Reference:	MI05	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Flat stony plain	**Easting:**	252538
Soil Landform Association:	Stony plain	**Northing:**	6779234
Soil group:	Red shallow loam (Group 522)		

Plate 9 Surface soil at Site MI05

Soil profile description:

0-10cm: Pinky-brown well-structured indurated soil with polyhedral aggregates 2 to 40 mm and approximately 10 to 15% quartz coarse fragments, 2 mm to 5 mm in size.

10-30cm: Light pinky-brown well-structured indurated soil with friable polyhedral aggregates 2 to 60 mm and approximately 15 to 20% calcrete coarse fragments 2 to 20 mm in size.

>30cm: Hardpan / weathered amphibolite

Soil surface: Strong crust with 10% cryptogams and approximately 70 to 80% cover of sub-rounded to angular quartz (2 to 100 mm) and ironstone (2 to 30 mm) coarse fragments. Approximately 10% leaf litter.

Vegetation: Open chenopod shrubland with occasional Mulga overstorey (Native Vegetation Solutions, 2022).

Plate 10 Soil surface / vegetation at Site MI05

Site Reference:	MI06	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Very gently undulating stony plain	**Easting:**	253305
Soil Landform Association:	Stony plain	**Northing:**	6777747
Soil group:	Red shallow loam (Group 522)		

Plate 11 Surface soil at Site MI06

Soil profile description:

0-10cm: Orange-pink well-structured soil with indurated polyhedral aggregates 5 to 40 mm and approximately 60 to 70% coarse fragments 2 to 30 mm in size. Moderate root abundance.

>15cm: Hardpan / weathered amphibolite

Soil surface: Moderately strong surface crust with 5 to 10% cryptogams and approximately 90 to 95% cover of 2 to 200 mm sub-angular to angular quartz, ironstone and calcrete fragments. Approximately 30% leaf litter.

Vegetation: Mulga over *Maireana sedifolia* and sclerophyll shrubland (Native Vegetation Solutions, 2022).

Plate 12 Soil surface / vegetation at Site MI06

Site Reference:	MI07	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Flat stony plain	**Easting:**	253460
Soil Landform Association:	Stony plain	**Northing:**	6778214
Soil group:	Red shallow loam (Group 522)		

Plate 13 Surface soil at Site MI07

Soil profile description:

0-15cm: Pinky-red well-structured soil with indurated polyhedral aggregates 5 to 20 mm and approximately 30 to 40% coarse fragments 2 to 60 mm in size. Moderate root abundance.

>15cm: Hardpan / weathered amphibolite

Soil surface: Weak crust with 15% cryptogams and approximately 70% cover of 2 to 100 mm sub-angular to angular quartz and ironstone fragments. Approximately 50% leaf litter.

Vegetation: Mulga over *Maireana sedifolia* and sclerophyll shrubland (Native Vegetation Solutions, 2022).

Plate 14 Soil surface / vegetation at Site MI07

Site Reference:	MI08	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Drainage line	**Easting:**	252800
Soil Landform Association:	Drainage lines	**Northing:**	6778433
Soil group:	Red shallow loam (Group 522)		

Soil profile description:

0-10cm: Orangey-brown well-structured indurated soil with polyhedral aggregates 2 to 20 mm and approximately 60% quartz coarse fragments 5 to 30 mm in size.

10-20cm: Orangey-brown single-grained to moderately-structured soil with indurated polyhedral aggregates 2 to 30 mm and approximately 60 to 70% calcareous coarse fragments 2 to 40 mm in size.

>20cm: Hardpan / weathered amphibolite

Plate 15 Surface soil at Site MI08

Soil surface: Strong crust with 10% cryptogams and approximately 60 to 70% cover of 2 to 100 mm sub-angular to angular quartz fragments. Approximately 30 to 40% leaf litter. Areas of erosion and deposition from surface water flow.

Vegetation: Creekline vegetation (Native Vegetation Solutions, 2022)**.**

Plate 16 Soil surface / vegetation at Site MI08

Site Reference:	MI09	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Flat stony plain	**Easting:**	253059
Soil Landform Association:	Stony plain	**Northing:**	6778822
Soil group:	Red shallow loam (Group 522)		

Plate 17 Surface soil at Site MI09

Soil profile description:

0-10 cm: Orangey-brown moderately-structured soil with polyhedral aggregates 2 to 20 mm and approximately 30% coarse fragments 2 to 15 mm in size.

10-30cm: Orangey-brown single-grained to moderately-structured soil with approximately 10 to 15% coarse fragments 2 to 5 mm in size.

>30cm: Hardpan / weathered amphibolite

Soil surface: Weak crust and approximately 90% cover of sub-rounded to angular quartz (2 mm to 70 mm) and ironstone (2 mm to 30 mm) fragments. Approximately 15% leaf litter. A very minor drainage channel adjacent.

Vegetation: Open chenopod shrubland with occasional Mulga overstorey (Native Vegetation Solutions, 2022).

Plate 18 Soil surface / vegetation at Site MI09

Site Reference:	MI10	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Mid-slope of a low rocky rise	**Easting:**	251965
Soil Landform Association:	Low rise	**Northing:**	6780742
Soil group:	Red shallow loam (Group 522)		

Plate 19 Surface soil at Site MI10

Soil profile description:

0-10 cm: Orangey-red well-structured soil with polyhedral aggregates 2 to 60 mm and approx. 30% coarse fragments 2 to 15 mm in size. Moderate roots.

10-30cm: Orangey-brown moderately-structured soil with approximately 50 to 60% coarse fragments 2 to 30 mm in size. Minor roots.

>30cm: Hardpan / weathered amphibolite

Soil surface: Strong crust and approximately 90% cover of sub-angular to angular quartz coarse fragments (2 to 300 mm inn size, plus outcropping rock). Approximately 50% leaf litter.

Vegetation: Acacia trees to 6m and shrubs 0.3-1m.

Plate 20 Soil surface / vegetation at Site MI10

Site Reference:	MI11	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Very gentle rocky slope	**Easting:**	253191
Soil Landform Association:	Stony plains	**Northing:**	6779246
Soil group:	Red shallow loam (Group 522)		

Plate 21 Surface soil at Site MI11

Soil profile description:

0-5 cm: Single-grained to weakly-structured red/orange soil with approximately 15 to 20% angular coarse fragments (2 to 10 mm). Minor roots.

>5cm: Hardpan / weathered amphibolite

Soil surface: Weak thin crust and approximately 70 to 80% cover of sub-angular to angular quartz coarse fragments (2 to 60 mm). Approximately 10 to 15% leaf litter. Evidence of minor surface water flow.

Vegetation: Open chenopod shrubland with occasional Mulga overstorey (Native Vegetation Solutions, 2022).

Plate 22 Soil surface / vegetation at Site MI11

Site Reference:	MI12	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Gently undulating stony plain	**Easting:**	253712
Soil Landform Association:	Stony plains	**Northing:**	6778920
Soil group:	Red shallow loam (Group 522)		

Soil profile description:

0-5cm: Light pinky-brown single-grained to moderately structured soil with polyhedral aggregates and approximately 20 to 30% sub-rounded to angular coarse fragments, 2 to 30 mm in size.

5-20cm: Predominantly weathered hardpan with minor soil sized fraction.

>20 cm: Hardpan / weathered amphibolite

Plate 23 Surface soil at Site MI12

Soil surface: Medium surface crust with 5% cryptogams and approximately 90% cover of 2 to 60 mm sub-angular to angular ironstone fragments, with minor amounts of quartz. Approximately 15% leaf litter.

Vegetation: Mulga woodland (Native Vegetation Solutions, 2022).

Plate 24 Soil surface / vegetation at Site MI12

Site Reference:	MI13	**Datum:**	GDA 1994 MGA Zone 51
Site Description:	Top of low rocky rise	**Easting:**	252845
Soil Landform Association:	Low rises	**Northing:**	6778153
Soil group:	Red shallow loam (Group 522)		

Plate 25 Surface soil at Site MI13

Soil profile description:

0-15cm: Pinky-brown moderately structured soil with polyhedral aggregates (5 to 30 mm) and approximately 10 to 15% sub-rounded to angular coarse fragments, 2 to 5mm in size.

>15cm: Hardpan / weathered amphibolite

Soil surface: Strong crust with 10% cryptogams and approximately 90% cover of 2 to 150 mm sub-rounded to angular quartz and ironstone fragments. Approximately 50% leaf litter.

Vegetation: Open chenopod shrubland with occasional Mulga overstorey (Native Vegetation Solutions, 2022).

Plate 26 Soil surface / vegetation at Site MI13

4.2 Soil Physical Characteristics

The physical characteristics of the surface soils within the study area, as determined by the field investigation and laboratory analysis of collected samples, are discussed in the following sections.

4.2.1 Soil Profile Morphology

The surface soil profiles within the study area exhibited only minor variation in terms of morphological characteristics. The surface soils were grouped into three soil-landform associations based on the mapping from this assessment, namely 'Stony plains', 'Low rises' and 'Drainage lines'. Approximate boundaries of the soil-landform associations within the study area are detailed in Figure 6.

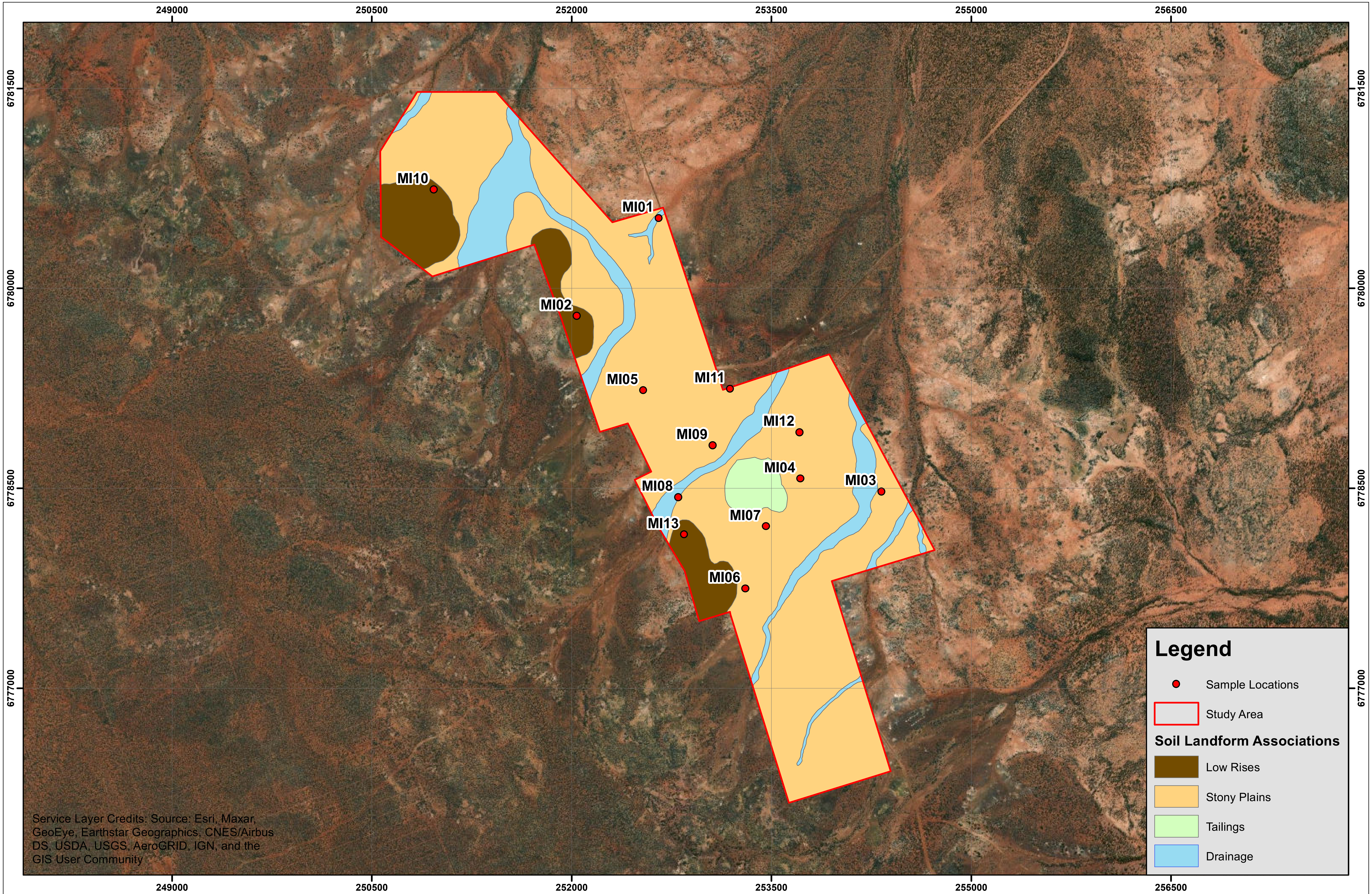
The landforms and surface soils within these associations were typically characterised as follows:

- Stony plains;
  - Flat to very gently undulating stony plains
  - Surface lag of quartz, ironstone and granite coarse fragments
  - Shallow surface soil profiles with moderately structured 'topsoil' layer to variable depths (5 to 30cm) over weathered amphibolite
  - Low to moderate coarse fraction (>2mm)
- Low rises;
  - Low rises with minor outcropping rock in some areas
  - Shallow surface soils (variable depth) over weathered amphibolite
  - Moderate percentage of competent rock fragments through the surface soil profile
- Drainage lines;
  - Ephemeral minor drainage lines
  - Shallow surface soils over weathered amphibolite
  - Moderate coarse fraction (>2mm) with variable sized fragments.

4.2.2 Soil Texture

Soil texture describes the proportions of sand, silt and clay (the particle size distribution) within the <2 mm fraction of a soil. The particle size distribution and resulting textural class of a soil is an important factor influencing most physical, and many chemical and biological, properties. Soil structure, water holding capacity, hydraulic conductivity, soil strength, fertility, erodibility and susceptibility to compaction are some of the factors closely linked to the texture of a soil material.

There were a relatively narrow range of soil particle size distributions exhibited throughout the study area, with surface and near-surface soil textures ranging from 'sandy loam' (approximately 10% clay) to 'clay loam' (approximately 30-35% clay) (Table 2). There was no apparent correlation with soil-landform association, with all soil textures represented in each soil-landform association.



MINE EARTH

Date: 20/01/2023

Author: H. Crisp

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator
Datum: GDA 1994

N

0 1.5 3 Kilometers

1:25,000 at A3

Soil Landform Assocations

Figure 6

4.2.3 Soil Structure

Soil structure describes the arrangement of solid particles and void space in a soil. It is an important factor influencing the ability of soil to support plant growth, store and transmit water and resist erosional processes. A well-structured soil is one with a range of different sized aggregates; with component particles bound together to give a range of pore sizes facilitating root growth and the transfer of air and water.

Soil structure can be influenced by the particle size distribution, chemical composition and organic matter content of a soil. Soil structure is often affected by root growth, vehicle compaction and, with respect to reconstructed soil profiles, the methods of soil handling and deposition. When a soil material is disturbed, the breakdown of aggregates into primary particles can lead to structural decline (Moore, 1998). This can result in hard-setting and crusting at the soil surface and a 'massive' soil structure at depth, potentially reducing the ability of seeds to germinate, roots to penetrate the soil matrix and water to infiltrate to the root zone.

The structure of the surface soils within the study area was relatively consistent, with the topsoil materials at most of the sampling locations recording structured soils with moderate to strong aggregation. Soil structure typically decreased with depth. A strong soil crust was observed at the surface of most sampling sites.

4.2.4 Structural Stability

The structural stability of a soil and its susceptibility to structural decline is complex and depends on the net effect of a number of properties, including the amount and type of clay present, organic matter content, soil chemistry and the nature of disturbance. Soil aggregates that slake and, particularly those that disperse, indicate a weak soil structure that is easily degraded. These soils should be seen as potentially problematic when used as a rehabilitation medium, particularly if left exposed at the surface.

The Emerson Aggregate Test identifies the potential slaking and dispersive properties of soil aggregates. The dispersion test identifies the properties of the soil materials under a worst-case scenario, where severe stress is applied to the soil material. Generally, samples allocated into Emerson Classes 1 and 2 are those most likely to exhibit dispersion of the clay sized fraction and therefore be the most problematic.

The majority of surface soils from the study area were identified as Emerson Class 5 or 6, indicating that the soils slake but are not prone to dispersion of the clay fraction in their natural state, and are relatively structurally stable.

A number of soils were identified as Emerson Class 3b (slaking, remoulded soil partially dispersed) (Table 2). These results indicate that the soils are not prone to dispersion of the clay fraction in their natural state, but may exhibit dispersion following severe disturbance (e.g. earthworks). Care should be taken to minimise the handling of these soil materials where possible, particularly when wet.

Table 2 Soil texture and Emerson Test Class for selected soil samples

Site #	Depth (cm)	Soil-landform association	Soil texture (< 2 mm soil fraction)	Approximate clay content (%)[1]	Emerson Test Class[2]
MI01	0-10	Drainage lines	Loam	13	Class 3b
	10-30		Loam	19.6	Class 5
MI02	0-10	Low rises	Clay loam	24.9	Class 3b
	10-30		Loam	21.7	Class 5
MI03	0-10	Stony plains	Clay loam	31.8	Class 5
	10-25		Clay loam	24.2	Class 5
MI04	0-5	Stony plains	Light sandy clay loam	15	Class 5
MI05	0-10	Stony plains	Loam	20	Class 2
	20-30		Silty loam	24	Class 5
MI06	0-15	Stony plains	Sandy loam	10	Class 5
MI07	0-15	Stony plains	Sandy loam	10	Class 3b
MI08	0-10	Drainage lines	Sandy loam	10.7	Class 3a
MI08	10-20	Drainage lines	Sandy loam	14	Class 5
MI09	0-10	Stony plains	Sandy clay loam	24.8	Class 3b
	20-30		Clay loam	33.8	Class 6
MI10	0-10	Low rises	Sandy loam	13.1	Class 3b
	10-30		Sandy loam	13.9	Class 3b
MI11	0-5	Stony plains	Silty clay loam	25	Class 5
MI12	0-5	Stony plains	Loam	13.2	Class 6
MI13	0-15	Low rises	Sandy clay loam	25	Class 5

[1]As measured through a combination of hand texturing and laboratory analysis of particle size distribution
[2]Class 2 - aggregate slakes and partially disperses
Class 3a - aggregate slakes but does not disperse, complete dispersion of remoulded soil
Class 3b - aggregate slakes but does not disperse, partial dispersion of remoulded soil
Class 5 - aggregate slakes but does not disperse, no dispersion of remoulded soil, soil:water suspension remains dispersed
Class 6 - aggregate slakes but does not disperse, no dispersion of remoulded soil, soil:water suspension remains flocculated

4.2.5 Hydraulic conductivity

Hydraulic conductivity (K_{sat}) refers to the saturated permeability of soil, or the ability of water to infiltrate and drain through the soil matrix, and is dependent on soil properties such as texture and structure (Moore, 1998). Freely draining soils with high K_{sat} values will generally be less susceptible to surface runoff and erosion. Slow draining soils with low K_{sat} values, are more likely to experience waterlogging, increased surface runoff and erosion.

Saturated hydraulic conductivity was determined for selected soil samples from the study area. Drainage classes were determined for each sample according to their K_{sat} (Hunt, N and Gilkes, R, 1992) (Table 3). Average K_{sat} values for the surface soils from each soil-landform association are presented in Figure 7.

The drainage class of the samples tested ranged between 'moderately slow' and 'rapid' (Table 3 and Figure 7), with the majority of soils classified as having a 'moderately rapid' to 'rapid' drainage class. The surface soils from the study area are considered to be relatively free-draining, however the K_{sat} values may decrease if the soils are compacted during salvage and rehabilitation operations.

Table 3 Saturated hydraulic conductivity (K_{sat}) for selected soils

Site #	Depth (cm)	Soil-landform association	K_{sat} (mm/hr)	Drainage Class [1.]
MI01	0-10	Drainage lines	8.7	Moderately slow
	10-30	Drainage lines	65.3	Moderately rapid
MI02	0-10	Low rises	118.2	Moderately rapid
	10-30	Low rises	85.4	Moderately rapid
MI03	0-10	Stony plains	114.8	Moderately rapid
	10-25	Stony plains	168.0	Rapid
MI05	0-10	Stony plains	19.23	Moderately slow
	20-30	Stony plains	154.36	Rapid
MI08	0-10	Drainage lines	201.68	Rapid
MI08	10-20	Drainage lines	122.89	Moderately rapid
MI09	0-10	Stony plains	74.84	Moderately rapid
	20-30	Stony plains	147.51	Rapid
MI10	0-10	Low rises	91.61	Moderately rapid
	10-30	Low rises	86.60	Moderately rapid
MI12	0-5	Stony plains	31.65	Moderate

1. (Hunt, N and Gilkes, R, 1992)

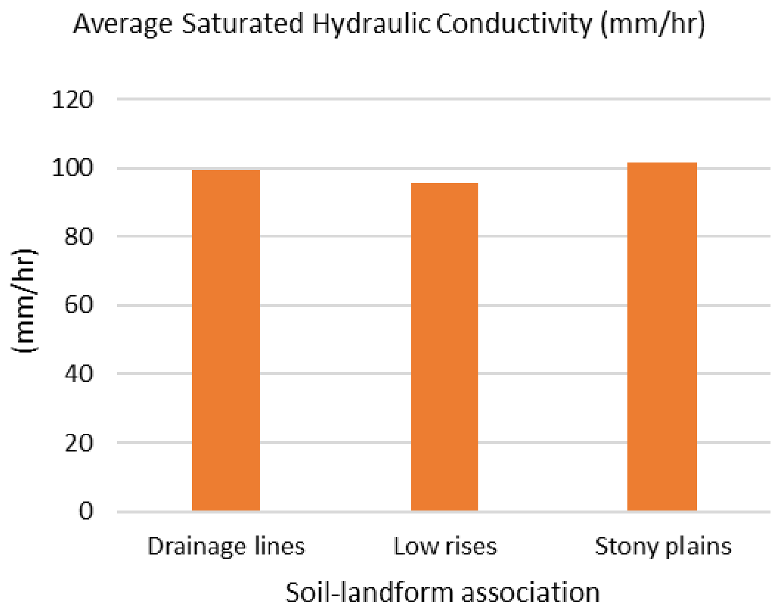


Figure 7 Average K_{sat} values for each soil-landform association.

4.2.6 Soil strength

A modified Modulus of Rupture (MOR) test was conducted on selected samples, representative of the various soil materials from across the study area. This test is a measure of soil strength and identifies the tendency of a soil to hard-set as a direct result of soil slaking and dispersion. An MOR of over 60 kPa has been described as the critical value for distinguishing potentially problematic soils in agricultural scenarios (Cochrane & Alymore, 1997). Restricted root penetration into the soil matrix is a likely consequence of a high modulus of rupture. In reconstructed soil profiles, materials normally deep within the profile that may have a high MOR can often be re-deposited closer to the surface, leading to germination / emergence and root penetration problems.

As this test is conducted on reconstructed soil blocks composed of the < 2 mm soil fraction, it does not take into account the effect of soil structure on soil strength, nor any degree of compaction that may be present in the field. It does, however, provide insight into the potential for soils to hard-set and compact with repeated wetting and drying cycles, and the ability of roots to fracture the soil and penetrate crack faces.

The majority of the soils sampled from across the study area (i.e. across all soil-landform associations) recorded low MOR values, indicating a low propensity to hard-set with repeated wetting/drying cycles (Table 4). None of the samples tested recorded MOR values above the 60 kPa threshold.

Table 4 Modulus of Rupture (soil strength) of selected soils.

Site #	Depth (cm)	Soil-landform association	Modulus of Rupture (kPa)[1.]
MI01	0-10	Drainage lines	21.4
	10-30	Drainage lines	25.7
MI02	0-10	Low rises	23.7
	10-30	Low rises	23.9
MI03	0-10	Stony plains	3.0
	10-25	Stony plains	1.4
MI05	0-10	Stony plains	14.4
	20-30	Stony plains	6.4
MI08	0-10	Drainage lines	46.5
	10-20	Drainage lines	17.8
MI09	0-10	Stony plains	13.6
	20-30	Stony plains	17.6
MI10	0-10	Low rises	59.3
	10-30	Low rises	46.5
MI12	0-5	Stony plains	35.8

1. Values above the threshold of 60kPa are identified as potentially hard-setting (Cochrane and Aylmore 1997).

4.3 Soil Chemical Characteristics

4.3.1 Soil pH and Electrical Conductivity

Soil pH (H_2O) measures the acidity or alkalinity of the soil in relation to suitability for plant growth. Ratings for soil pH are based on the Land Evaluation Standards for Land Resource Mapping categories (van Gool, 2005).

Soil pH (H_2O) varied only slightly between and within the various soil-landform associations / sampling locations within the study area, ranging from pH 6.4 (classified as 'slightly acidic') to pH 8.9 ('moderately alkaline'). There was no consistent change in soil pH with depth. Soil pH (H_2O) was, on average, highest for the surface soils from within the 'stony plains' soil landform association.

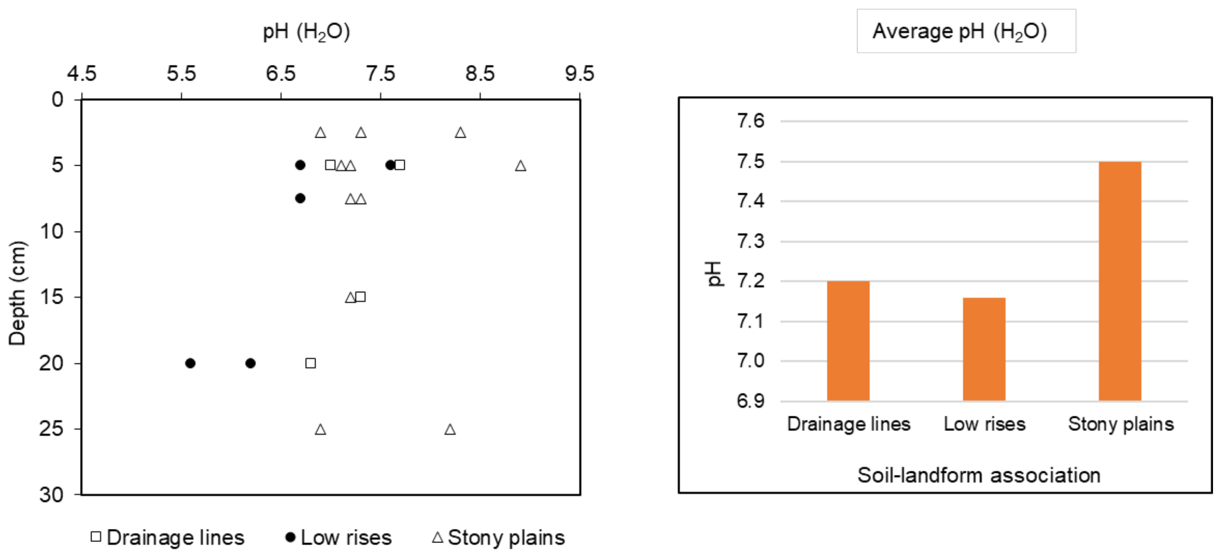


Figure 8 Individual pH (H_2O) of soils with depth and average pH of all depths for each soil-landform association

Electrical conductivity (EC) is a measurement of the soluble salts in soils or water. Soil salinity results from natural processes of landscape evolution, hydrological processes and rainfall (Hunt, N and Gilkes, R, 1992). Individual EC values of the soils sampled ranged between 0.02 dS/m (non-saline) and 5.91 dS/m (extremely saline) (Figure 9), based on the standard USDA and CSIRO electrical conductivity categories (Appendix A). On average, EC was highest in the soils from the 'stony plains' soil-landform association.

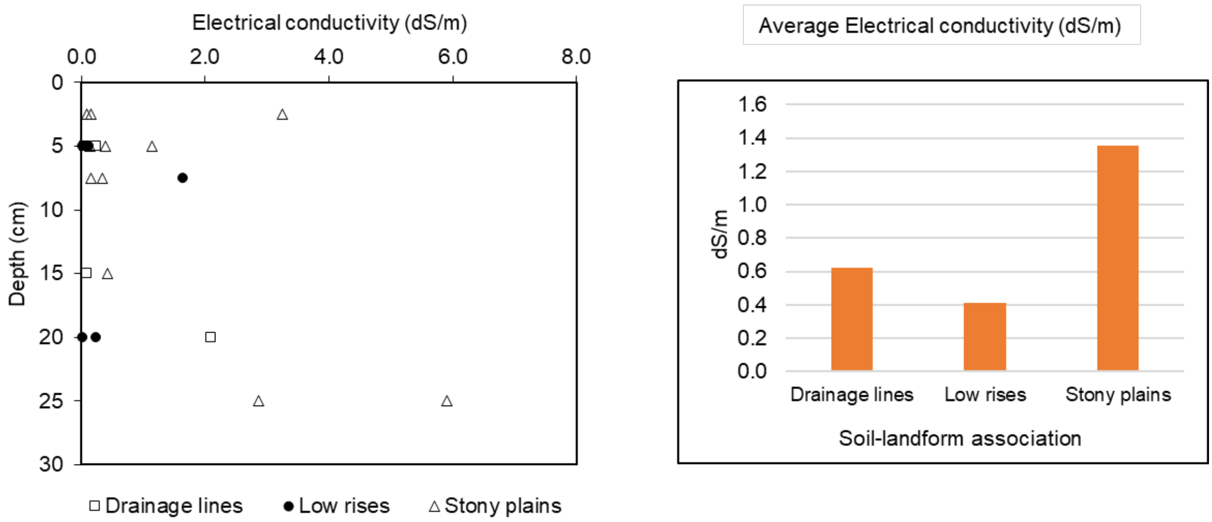


Figure 9 Individual EC (dS/m) of soils with depth and average EC of all depths for each soil-landform association

4.3.2 Soil Organic Matter

The organic matter content of soil is an important factor influencing many physical, chemical and biological soil characteristics. Directly derived from plants and animals, its functions in soil include supporting the micro and macro fauna and flora populations, increasing the water retention capacity, buffering pH and improving soil structure.

The organic matter content of the soils within the study area was determined as a measure of the soil organic carbon percentage (SOC%). The SOC% of the soil samples was low, as is typical of most highly weathered soils in the Goldfields, ranging between 0.21% and 1.66% (Figure 10).

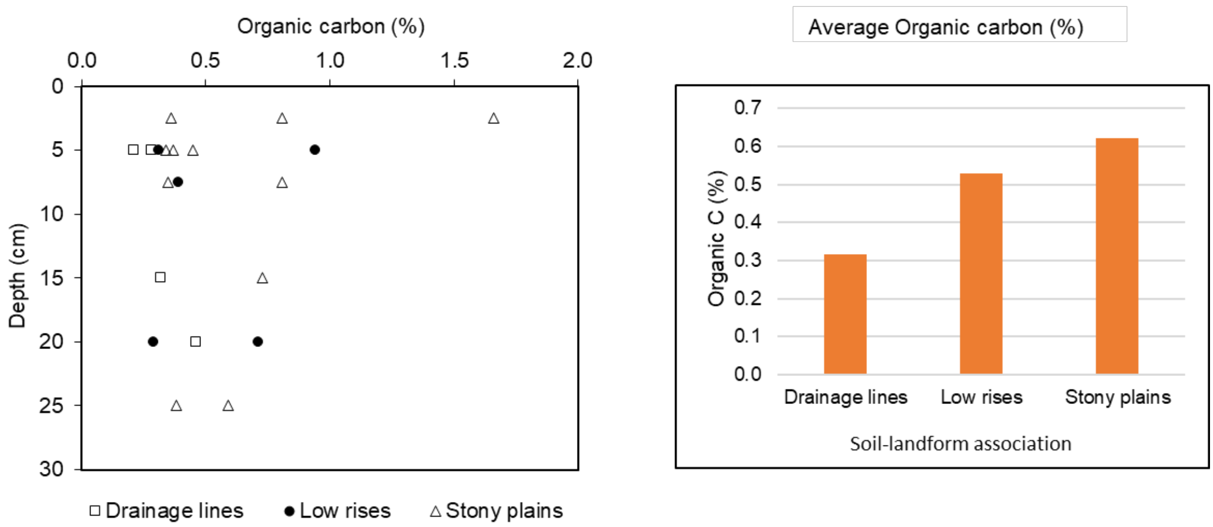


Figure 10 Individual Organic C concentration (%) of soils with depth and average Organic C of all depths for each soil-landform association

4.3.3 Exchangeable Cations and Exchangeable Sodium Percentage

Exchangeable cations, held on clay surfaces and within organic matter, are an important source of soil fertility and can influence the physical properties of soil. Generally, if cations such as Ca^{2+}, Mg^{2+} and K^{+} are dominant on the clay exchange surfaces, the soil will typically display increased physical structure and stability, leading to increased aeration, drainage and root growth (Moore, 1998). If Na cations (Na^{+}) are dominant on exchange surfaces and the exchangeable sodium percentage (ESP) exceeds more than 6% of the total exchangeable cations, then the soil is considered to be 'sodic', which can lead to poor physical properties (i.e. dispersion, hardsetting and erosion in clay-rich soils). ESP values over 15% are classified as 'highly sodic'.

Exchangeable cation concentration, effective cation exchange capacity (eCEC) and ESP results were relatively consistent across the various soil-landform associations (Table 5), with most soils identified as 'non-sodic'. When considering the ESP results in combination with the Emerson test classes in Section 4.2.4, it can be seen that those soil samples identified as 'sodic' or 'highly sodic' in Table 5, are considered to have a relatively low risk of clay dispersion.

It is important to note that the salinity of the surface soils, may, in some instances, have a flocculating effect on the clay fraction in solution. The propensity for clay dispersion, particularly for sodic and highly sodic soils, may therefore increase if salts are leached from the soil matrix.

Table 5 Exchangeable cations and ESP of selected samples. Shading of ESP values denotes non-sodic, sodic and highly sodic classifications

Site #	Depth (cm)	Soil-landform association	Exchangeable cations (meq/100g)				eCEC (meq/100g)	ESP (%)
			Ca	Mg	K	Na		
MI01	0-10	Drainage lines	3.75	0.34	0.89	0.33	5.31	6.21
	10-30	Drainage lines	10.76	0.23	2.84	0.79	14.62	5.40
MI02	0-10	Low rises	6.33	0.37	2.48	0.05	9.23	0.54
	10-30	Low rises	8.20	0.19	3.16	0.27	11.82	2.28
MI03	0-10	Stony plains	8.22	0.58	2.89	0.17	11.86	1.43
	10-25	Stony plains	12.61	0.45	3.75	0.33	17.14	1.93
MI04	0-5	Stony plains	14.59	0.82	1.67	0.13	17.21	0.76
MI05	0-10	Stony plains	6.16	0.55	1.65	0.20	8.56	2.34
	20-30	Stony plains	10.55	0.26	4.00	0.55	15.36	3.58
MI06	0-15	Stony plains	0.83	0.17	1.75	0.33	3.08	10.71
MI07	0-15	Stony plains	5.04	0.46	1.59	0.05	7.14	0.70
MI08	0-10	Drainage lines	1.90	0.27	0.61	0.05	2.83	1.77
	10-20	Drainage lines	3.29	0.20	0.84	0.12	4.45	2.70
MI09	0-10	Stony plains	6.42	0.32	2.11	4.00	12.85	31.13
	20-30	Stony plains	12.82	0.24	5.85	4.39	23.30	18.84
MI10	0-10	Low rises	6.32	0.11	2.15	0.05	8.63	0.58
	10-30	Low rises	12.23	0.05	2.86	0.11	15.25	0.72
MI11	0-5	Stony plains	6.07	0.42	3.69	0.05	10.23	0.49
MI12	0-5	Stony plains	8.68	0.31	1.10	0.69	10.78	6.40
MI13	0-15	Low rises	3.38	0.14	3.17	0.37	7.06	5.24

4.3.4 Soil Nutrients

The most important macro-nutrients for plant growth are nitrogen (N), phosphorus (P), potassium (K), and sulphur (S). These nutrients are largely derived from the soil mineral component and organic matter. Native plant species have a number of physiological adaptations that enable them to be productive in areas where the supply of macronutrients is limited. There is limited information available which details the specific nutritional requirements for native plant species in the semiarid zone of WA. Therefore, the use of analogue sites is an effective way to baseline the soil nutritional requirements of native plant species within the study area.

Most (>98%) N in soils organic (Moore, 1998). Plant-available forms of inorganic N (nitrate and ammonium) are produced via mineralisation of soil organic matter. The plant-available N concentrations of the soils from the study area were variable, but generally low, ranging from 1 mg/kg to 121 mg/kg nitrate (Figure 11) and from 0.5 mg/kg to 18 mg/kg ammonium (Figure 12). These concentrations of plant-available N are typical of native soils in the region. There was no apparent relationship between plant-available nitrogen concentrations and soil-landform association.

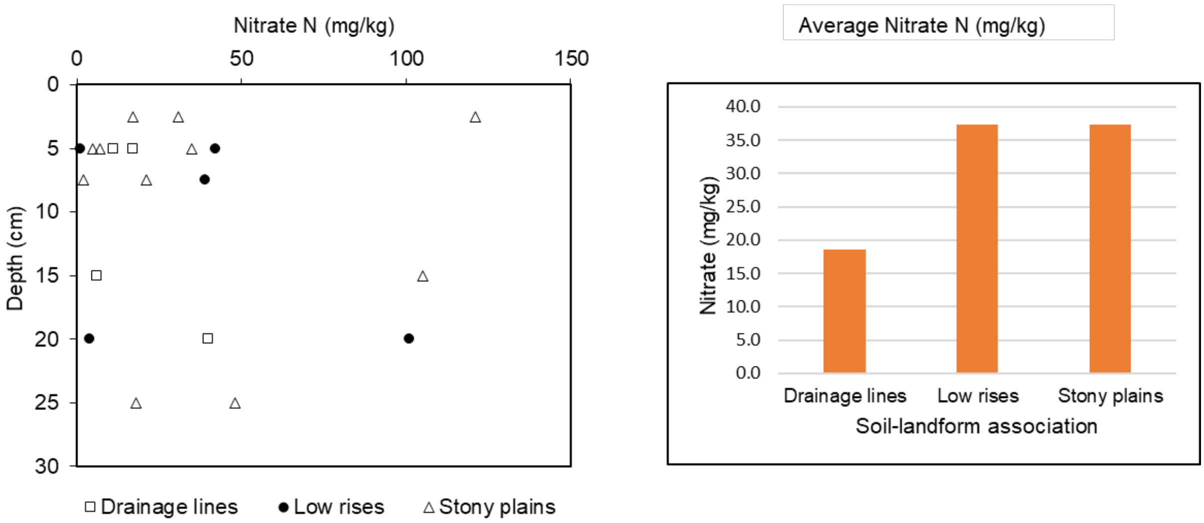


Figure 11 Individual Nitrate-N concentration (mg/kg) of soils with depth and average Nitrate-N for all depths for each soil-landform association

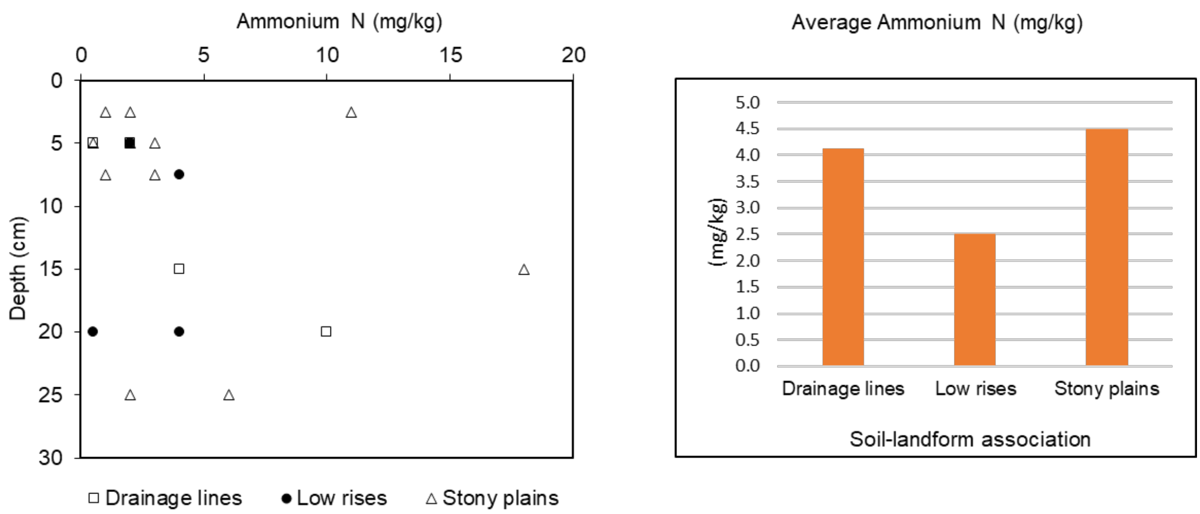


Figure 12 Individual Ammonium-N concentration (mg/kg) of soils with depth and average Ammonium-N of all depths for each soil-landform association

Phosphorus is essential for the growth of vegetation as it plays a key role in the formulation of energy producing organic compounds. Adequate phosphorus nutrition enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed production), and maturation (Brady, N. and Weil, R., 2002).

The plant-available phosphorus concentrations of the soils from the study area were classed as low to medium (Moore, 1998) (Figure 13), which is typical for native soils in the region. Average plant-available P concentration was lowest in the 'low rises' soil-landform association.

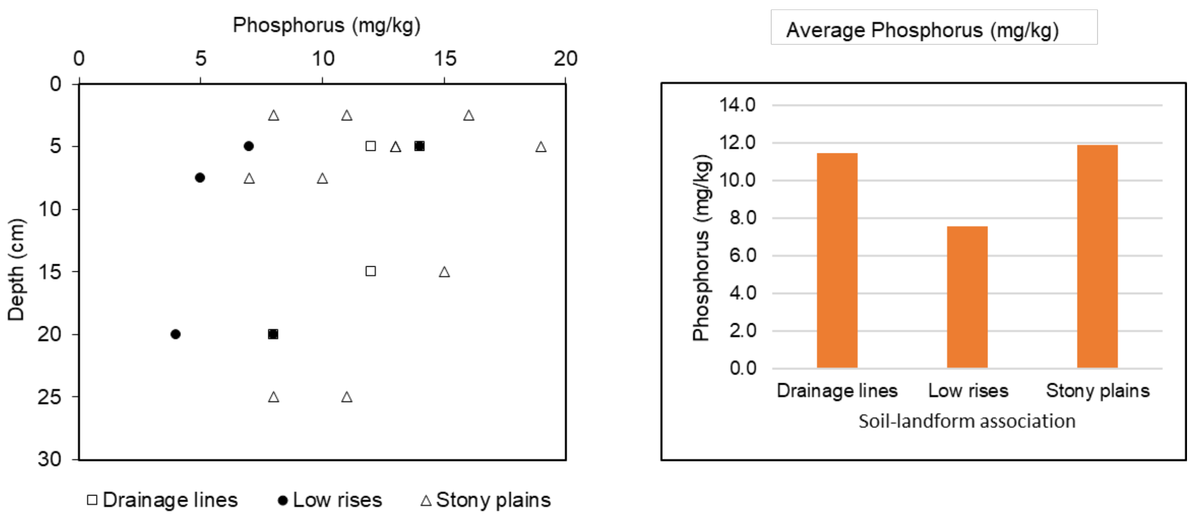


Figure 13 Individual plant-available phosphorus concentration (mg/kg) of soils with depth and average plant-available phosphorus of all depths for each soil-landform association

Potassium (K) plays a critical role in a number of plant physiological processes. Adequate amounts of K have been linked to improved drought tolerance, better resistance to certain fungal diseases and greater tolerance to insect pests (Brady, N. and Weil, R., 2002).

The plant-available K concentrations of the soils from the study area ranged from low to high (low rating: <90 mg/kg, high rating: >200 mg/kg (Moore, 1998)), with the 'low rises' soil-landform association having the lowest plant-available K concentrations on average (Figure 14).

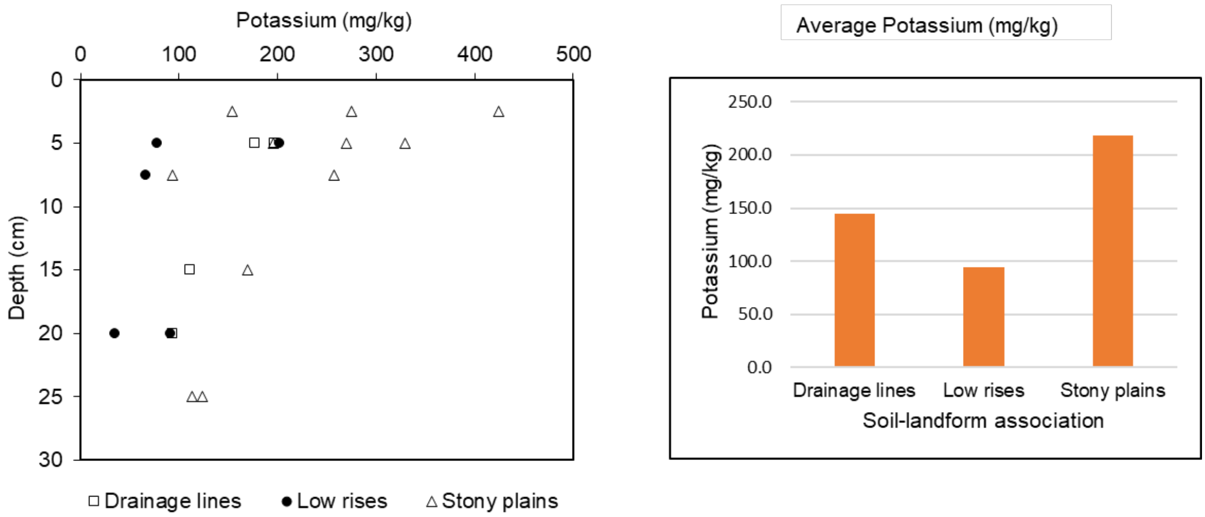


Figure 14 Individual plant-available potassium concentration (mg/kg) of soils with depth and average plant-available potassium of all depths for each soil-landform association

Plant-available sulfur (S) (i.e. sulfate) concentrations measured for soils from the study area were highly variable, ranging from 1.4 mg/kg to 3857 mg/kg. This range in plant-available S values is considered low (<8 mg/kg) to high, based on target values for agricultural soils (Agriculture Western Australia, 2020), however, are considered typical for native soils in the region. The stony plains soil-landform association had the highest average plant-available sulfur (S) concentrations (Figure 15), strongly influenced by the relatively high S concentration of one sample.

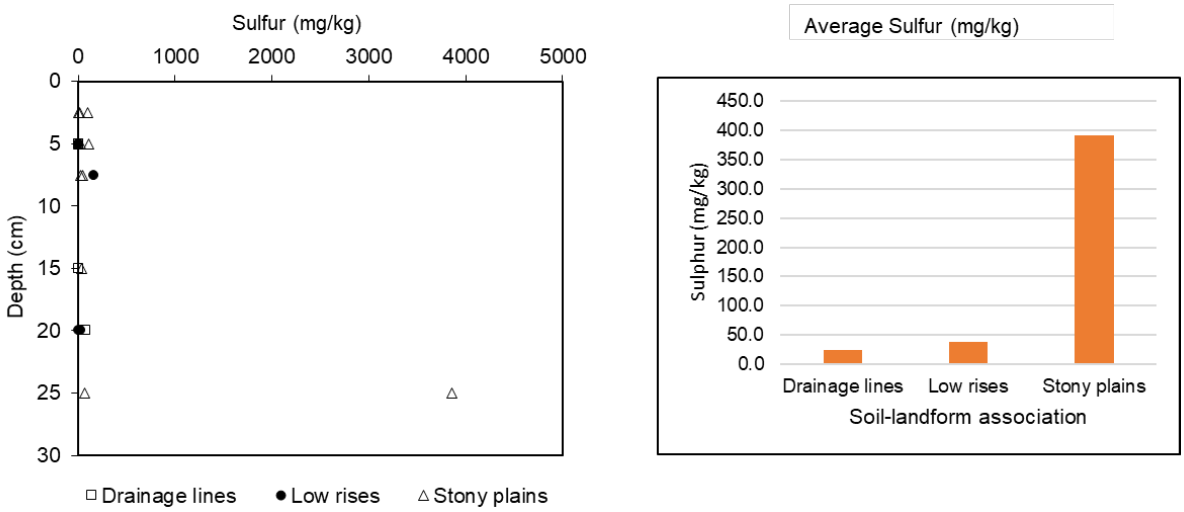


Figure 15 Individual plant-available sulfur concentration (mg/kg) of soils with depth and average plant-available sulfur of all depths for each soil-landform association

4.3.5 Total metal concentrations

The total concentration of selected metals was measured for selected surface soil samples, with the results presented in Table 6. As a point of comparison, the average crustal abundance (ACA) (Reimann, C. and de Caritat, P, 1998) for each metal is also provided in Table 6. Of particular note are the high baseline concentrations of As, Cr and Se in many of the analogue soils tested, relative to the average crustal abundance.

Table 6 Total metal concentrations for selected samples. Concentrations above the ACA are denote in bold font.

Site #	Depth (cm)	Soil-landform association	Total metal concentrations (ug/kg)						
			As	Cd	Cr	Co	Pb	Mo	Se
MI01	0-10	Drainage lines	**2,477**	25	100,103	5,764	8,865	1,019	**556**
	10-30	Drainage lines	**2,901**	47	83,277	8,227	13,420	**1,427**	**633**
MI02	0-10	Low rises	**2,740**	**121**	**164,720**	**29,796**	8,195	850	**1,080**
	10-30	Low rises	**2,218**	**120**	**155,482**	**32,620**	8,060	768	**1,160**
MI03	0-10	Stony plains	**2,028**	77	98,278	8,033	**16,172**	695	**643**
	10-25	Stony plains	**1,937**	56	88,467	6,714	12,952	695	**875**
MI04	0-5	Stony plains	**3,449**	54	**123,642**	10,409	11,196	**2,558**	**1,223**
MI05	0-10	Stony plains	**4,365**	**207**	**184,236**	**29,943**	11,389	885	**746**
	20-30	Stony plains	**6,244**	**171**	**170,254**	**29,098**	12,255	879	**771**
MI06	0-15	Stony plains	**4,986**	79	**261,222**	22,842	9,591	**1,128**	**1,504**
MI07	0-15	Stony plains	**6,086**	**156**	**172,228**	16,192	13,051	811	**434**
MI08	0-10	Drainage lines	**8,989**	88	**400,416**	9,041	**16,720**	1,029	**1,344**
	10-20	Drainage lines	**8,705**	72	**305,958**	10,937	11,318	975	**989**
MI09	0-10	Stony plains	**29,350**	**175**	**263,991**	17,178	**22,009**	**1,164**	**1,559**
	20-30	Stony plains	**20,120**	96	**160,311**	10,721	**16,809**	824	**1,284**
MI10	0-10	Low rises	**3,584**	98	**134,291**	18,246	4,520	460	71
	10-30	Low rises	**2,647**	65	108,292	20,992	3,332	395	**246**
MI11	0-5	Stony plains	**36,011**	87	**126,013**	**32,214**	7,805	590	**267**
MI12	0-5	Stony plains	**7,942**	28	**131,610**	7,622	10,022	**2,398**	**719**
MI13	0-15	Low rises	**3,620**	**148**	**153,186**	**27,938**	7,902	**1,378**	**1,021**
Average crustal abundance[1.]			**1,700**	**100**	**126,000**	**24,000**	**14,800**	**1,100**	**120**

1. (Reimann, C. and de Caritat, P, 1998)

4.4 Hardpan characteristics

The hardpan / weathered amphibolite material is present across the study area, at depths ranging from 5 to 30 cm. Samples of the hardpan material were taken from a freshly excavated drill sump at the location shown in Figure 2. Plates 27 and 28 show the soil profile over the weathered amphibolite. Plate 29 shows the weathered amphibolite material that has been removed from the sump. The characteristics of the hardpan material in comparison to the surface soils within the Study Area are provided in Table 7. The hardpan material is considered a valuable source of rehabilitation material to assist in stabilising flat surfaces prior to topsoil application. The hardpan material has moderate hydraulic conductivity and has a low potential for hardsetting. The hardpan is classified as sodic, however was not dispersive and has a high percentage of relatively competent material which would assist in stabilising rehabilitated surfaces.

Table 7 Hardpan characteristics

Parameter	Unit	Average for hardpan (including qualifier where relevant)	Average for all soils across the Study area	Comparison to average for Study Area soils
Ammonium Nitrogen	mg/kg	0.7	4	Low
Nitrate Nitrogen	mg/kg	7	31	Low
Plant-available Phosphorus	mg/kg	5	10	Low
Plant-available Potassium	mg/kg	73	153	Low
Plant-available Sulfur	mg/kg	8,518	151	Very high
Organic Carbon	%	0.4	0.5	Similar
Conductivity	dS/m	3.8 (extremely saline)[1]	0.79	Very high
pH (H_2O)	pH units	8.1 (moderately alkaline)[1]	7.29	Similar
% Clay	%	11	20	Low
eCEC		23.3	10.8	High
ESP		6.3 (sodic)[2]	5.2	Similar
Structural stability	Emerson's	Class 5[3]	Class 4	Similar
Hydraulic conductivity	mm/hr	43.2 (Moderate)[4]	99.38	Low
Modulus of rupture (potential for hardsetting)	kPa	6.25	23.8	Low

[1] See section 4.3.1
[2] See section 4.3.3
[3] See section 4.2.4
[4] See section 4.2.5

Plate 27 Exposed soil profile (approx. 20 cm) over weathered amphibolite / hardpan

Plate 28 Weathered amphibolite profile to 2.1m

Plate 29 Hardpan / weathered amphibolite material excavated from a drill sump

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Suitability of soil for rehabilitation

Three soil-landform associations were identified within the study area namely; ‘Stony plains’, ‘Low rises’ and ‘Drainage lines’. The major differences in the soil-landform associations related to their position in the landscape.

Many of the chemical and physical characteristics of the surface soils across the study area were relatively similar, with little consistent correlation with soil-landform association, or sample depth. The soils sampled typically had a loamy texture with varying amounts of clay, ranged from non-saline to extremely saline, were non-sodic, free draining (‘moderately rapid’ to ‘rapid’ hydraulic conductivity), had a low potential for hardsetting, and were typically low in organic carbon and plant-available nutrients.

Salinity of some surface soils is relatively high, so care will need to be taken in selecting seed lists for species that can tolerate the relevant salt levels. Some of the soils are prone to dispersion upon severe disturbance, and care should be taken to minimise the handling of these soil materials where possible, particularly when wet. The erodibility of these soils is likely to be relatively low, however, where utilised as a surface rehabilitation medium on the sloped batters of waste rock landforms, will require ripping into underlying competent waste rock to armour the surface and minimise erosion as far as practicable.

The hardpan / weathered amphibolite was present at all sites sampled, starting at depths varying from 5 to 30 cm below the surface soil horizons. This material may also be a useful source of near-surface rehabilitation material if required.

5.2 Soil management and handling

It is recommended that topsoil materials, to the depth above the weathered amphibolite hardpan (5 to 30 cm) are salvaged from all disturbance areas, for potential use as a rehabilitation resource.

Specific topsoil management and handling recommendations which can optimise the success of future rehabilitation are as follows:

- It is recommended that the topsoil portion of the soil profiles above the hardpan / weathered amphibolite (5 to 30cm) within all of the proposed disturbance areas is stripped (where possible) and placed in stockpiles for use as a surface rehabilitation medium.
- Any areas with historical tailings material at the surface should be managed in accordance with the tailings characterisation report (Mine Earth, 2023). The historic tailings materials should not be stockpiled with salvaged topsoil.
- Any rock fragments and surface litter present within the soil profiles should be collected and stockpiled with the topsoil.
- Machinery operators should minimise the frequency and intensity of disturbance, so they do not compromise the structural integrity of the material.
- Soil stripping should occur as close as possible to the time when the proposed disturbance is scheduled to commence.

- Where possible, all stripped soil should be paddock-dumped into piles no greater than two metres in height. The piles should have adequate distance between them to create a series of mounds and troughs.
- Excessive traffic and disturbance of the stockpiles should be minimised to minimise erosion and degradation of soil structure. Care should be taken to minimise the handling of the soils where possible, particularly when wet.
- As a general rule, topsoil rehabilitation materials should not be placed at depths greater than 20 cm on rehabilitated areas. This is particularly the case for sloped areas of rehabilitation.

5.3 Preliminary soil resource inventory

A preliminary topsoil inventory has been developed to provide an indicative volume of topsoil likely to be available for salvage from the major proposed disturbance areas (Table 8). The volumes have been calculated, based on the information derived from the soil survey conducted, aerial and landscape photography. A nominal stripping depth of 0.2 m and a nominal value of 10% soil loss during stripping and stockpiling has been applied. It was also assumed that there is not any topsoil available in the area of the historical tailings and this area has been subtracted from the total salvageable area.

It is recommended that the inventory is updated as the Project footprints are finalised and the actual volume of topsoil salvaged from each disturbance footprint is identified. This should then be updated within the inventory and balanced against the volume of soil required for rehabilitation works, to facilitate optimal application of soil resources to rehabilitation areas.

Table 8 Preliminary topsoil resource inventory

Disturbance footprint	Disturbance footprint area (ha)	Topsoil volume (m^3) [1.]
WRL	75.8	136,383
Open Pit	30.4[1]	69,640
Low Grade Stockpile	5.5	9,866
Turkeys Nest	4.0	7,200
ROM	7.8	14,040
Production Yard	2.1	3,770
Fuel	1.7	3,031
Workshop	6.6	11,868
Topsoil	30.0	54,026
Magazine	0.3	450
Roads	18.2[1]	38,395
	TOTAL	**327,987**

1. Equals the disturbance footprint area minus the area of tailings where topsoil is not salvageable
2. Assumes average soil salvage depth of 0.2m and 10% soil loss factor during salvage and stockpiling operations.

6 REFERENCES

Agriculture Western Australia website: (accessed July 2020) https://www.agric.wa.gov.au/climate-land-water/soils/measuring-and-assessing-soils

BOM. (2022, November 3). *Climate Statistics for Australian locations*. Retrieved from BOM.

Brady, N. and Weil, R. (2002). *The Nature and Properties of Soils - Thirteenth Edition.* New Jersey: Prentice Hall.

Cochrane, H. R., & Alymore, L. A. (1997). Assessing management induced changes in the structural stability of hardsetting soils. *Soil and Tillage Research*.

CSIRO. (2009). *Australian Soil and Land Survey Field Handbook.* CSIRO Publishing.

Hunt, N and Gilkes, R. (1992). *Farm monitoring handbook, a practical down-to-earth manual for farmers and other land users.* Perth: The University of Western Australia.

McKenzie, N.I., May, J.E. and McKenna, S. (2003). *Bioregional Summary of the 2002 Biodiversity Audit for Western Australia.* Department of Conservation and Land Management.

Mine Earth. (2023). *Mt Ida Historical Tailings Characterisation* . Perth, Western Australia: Unpublished report for Red Dirt Metals.

Moore, G. (1998). *Soilguide. A handbook for understanding and managing agricultural soils. Bulletin No. 4343.* Perth: Agriculture Western Australia.

Native Vegetation Solutions. (2022). *Reconnaissance Flora and Vegetation Survey of the Mt Ida Lithium -Gold Project.* Perth, Western Australia: Unpublished report fo Red Dirt Metals.

Pringle, H., Van Vreeswyck, A., & Gilligan, S. (1994). *An inventory and condition survey of rangelands in the north-eastern Goldfields, Western Australia: Technical Bulletin No. 87.* Perth, Western Australia: Department of Agriculture.

Rayment, G. a. (2011). *Soil Chemical Methods.* CSIRO Publishing.

Reimann, C. and de Caritat, P. (1998). *Chemical Elements in the Environment.* Berlin: Springer.

Schoknecht, N., & Pathan, S. (2013). *Soil groups of Western Australia; a simple guide to the main soils of Western Australia (4th ed). Report 380.* Perth, Western Australia: Department of Agriculture and Food.

van Gool, D. T. (2005). *Land evaluation standards for land resource mapping.* Agriculture Western Australia.

Appendix A

Soil analysis classifications

Emerson Dispersion Test Classes (Moore 1998)

Class	Description
Class 1	Dry aggregate slakes and completely disperses
Class 2	Dry aggregate slakes and partly disperses
Class 3a	Dry aggregate slakes but does not disperse; remoulded soil disperses completely
Class 3b	Dry aggregate slakes but does not disperse; remoulded soil partly disperses
Class 4	Dry aggregate slakes but does not disperse; remoulded soil does not disperse; carbonates and gypsum are present
Class 5	Dry aggregate slakes but does not disperse; remoulded soil does not disperse; carbonates and gypsum are absent; 1:5 suspension remains dispersed
Class 6	Dry aggregate slakes but does not disperse; remoulded soil does not disperse; carbonates and gypsum are absent; 1:5 suspension remains flocculated
Class 7	Dry aggregate does not slake; aggregate swells
Class 8	Dry aggregate does not slake; aggregate does not swell

Soil Electrical conductivity classes (based on standard USDA and CSIRO categories)

EC (1:5) (dS/m)						
Salinity class	**Sand**	**Sandy loam**	**Loam**	**Clay loam**	**Light / medium clay**	**Heavy clay**
Non-saline	<0.13	<0.17	<0.20	<0.22	<0.25	<0.33
Slightly saline	0.13-0.26	0.17-0.33	0.20-0.40	0.22-0.44	0.25-0.50	0.33-0.67
Moderately saline	0.26-0.52	0.33-0.67	0.40-0.80	0.44-0.89	0.50-1.00	0.67-1.33
Very saline	0.52-1.06	0.67-1.33	0.80-1.60	0.89-1.78	1.00-2.00	1.33-2.67
Extremely saline	>1.06	>1.33	>1.60	>1.78	>2.00	>2.67

Soil pH classes

	Soil pH rating						
	Very strongly acid (Vsac)	**Strongly acid (Sac)**	**Moderately acid (Mac)**	**Slightly acid (Slac)**	**Neutral (N)**	**Moderately alkaline (Malk)**	**Strongly alkaline (Salk)**
pH_w	< 5.3	5.3 - 5.6	5.6 - 6.0	6.0 - 6.5	6.5 - 8.0	8.0 - 9.0	> 9.0
pH_{Ca}	< 4.2	4.2 - 4.5	4.5 - 5.0	5.0 - 5.5	5.5 - 7.0	7.0 - 8.0	> 8.0

Appendix B

CSBP Laboratory Analysis Certificates

Analysis Results

CSBP Soil and Plant Laboratory

CSBP

90423
Mine Earth Pty Ltd

	Lab No	9SS22014	9SS22015	9SS22016	9SS22017	9SS22018	9SS22019	9SS22020	9SS22021
	Name	MI 01	MI 01	MI 02	MI 02	MI 03	MI 03	MI 04	MI 05
	Code	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
	Customer	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
	Depth	0-10	10-30	0-10	10-30	0-10	10-25	0-5	0-10
Colour		BROR	BROR	BR	BR	GRBR	GRBR	BR	BR
Gravel	%	0	0	0	0	0	5	0	0
Texture		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Ammonium Nitrogen	mg/kg	< 1	10	2	4	3	18	1	< 1
Nitrate Nitrogen	mg/kg	11	40	42	101	35	105	17	5
Phosphorus Colwell	mg/kg	12	8	14	8	13	15	8	19
Potassium Colwell	mg/kg	197	93	202	91	270	170	424	329
Sulfur	mg/kg	7.8	77.4	9.0	21.2	105.9	32.3	9.7	2.3
Organic Carbon	%	0.28	0.46	0.94	0.71	0.37	0.73	1.66	0.34
Conductivity	dS/m	0.234	2.093	0.118	0.239	0.400	0.427	0.166	0.148
pH Level (CaCl2)		6.8	5.9	6.7	6.2	6.3	6.6	7.2	6.5
pH Level (H2O)		7.7	6.8	7.0	7.2	7.1	7.2	8.3	7.2
% Clay	%	12.99	19.62	24.91	21.72	31.78	24.18		19.95
% Course Sand	%	27.01	21.42	19.37	19.03	20.94	21.95		16.40
% Fine Sand	%	40.93	33.40	44.75	43.42	30.36	41.28		38.63
% Sand	%	67.94	54.82	64.12	62.45	51.30	63.23		55.03
% Silt	%	19.06	25.57	10.98	15.83	16.91	12.60		25.01
Prewash exch. Ca	meq/100g	3.75	10.76	6.33	8.20	8.22	12.61	14.59	6.16
Prewash exch. K	meq/100g	0.34	0.23	0.37	0.19	0.58	0.45	0.82	0.55
Prewash exch. Mg	meq/100g	0.89	2.84	2.48	3.16	2.89	3.75	1.67	1.65

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22022	9SS22023	9SS22024	9SS22025	9SS22026	9SS22027	9SS22028	9SS22029
Name		MI 05	MI 06	MI 07	MI 08	MI 08	MI 09	MI 09	MI 10
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		20-30	0-15	0-15	0-10	10-20	0-10	20-30	0-10
Colour		DKBR	BR	BR	DKBR	BRGR	BR	DKBR	BRRD
Gravel	%	0	0	0	0	0	0	0	0
Texture		2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.5
Ammonium Nitrogen	mg/kg	6	1	3	2	4	2	2	2
Nitrate Nitrogen	mg/kg	48	2	21	17	6	7	18	1
Phosphorus Colwell	mg/kg	11	10	7	14	12	13	8	7
Potassium Colwell	mg/kg	113	93	257	177	111	196	124	78
Sulfur	mg/kg	71.2	47.6	25.1	4.8	6.6	30.7	3857.7	1.4
Organic Carbon	%	0.38	0.35	0.81	0.21	0.32	0.45	0.59	0.31
Conductivity	dS/m	2.870	0.335	0.152	0.060	0.094	1.152	5.913	0.021
pH Level (CaCl2)		6.0	6.8	6.5	6.3	6.4	8.0	7.5	7.6
pH Level (H2O)		6.9	7.2	7.3	7.0	7.3	8.9	8.2	8.1
% Clay	%	23.98			10.74	13.95	24.82	33.82	13.09
% Course Sand	%	11.76			50.39	46.11	39.87	20.50	33.59
% Fine Sand	%	33.21			35.93	36.93	29.34	23.77	43.20
% Sand	%	44.97			86.32	83.04	69.21	44.27	76.79
% Silt	%	31.04			2.94	3.00	5.97	21.92	10.11
Prewash exch. Ca	meq/100g	10.55	0.83	5.04	1.90	3.29	6.42	12.82	6.32
Prewash exch. K	meq/100g	0.26	0.17	0.46	0.27	0.20	0.32	0.24	0.11
Prewash exch. Mg	meq/100g	4.00	1.75	1.59	0.61	0.84	2.11	5.85	2.15

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22030	9SS22031	9SS22032	9SS22033	9SS22034	9SS22035	9SS22037	9SS22038
Name		MI 10	MI 11	MI 12	MI 13	MI T1	MI T1	MI T1	MI T2
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		10-30	0-5	0-5	0-15	0-50	50-100	100-150	0-50
Colour		BR	BROR	BR	DKBR	LTBR	BRGR	BRGR	GR
Gravel	%	0	0	0	0	0	0	5	0
Texture		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.0
Ammonium Nitrogen	mg/kg	< 1	11	2	4	4	2	2	< 1
Nitrate Nitrogen	mg/kg	4	31	121	39	146	92	52	53
Phosphorus Colwell	mg/kg	4	16	11	5	5	3	4	2
Potassium Colwell	mg/kg	35	275	154	66	247	246	127	1518
Sulfur	mg/kg	2.5	12.1	101.0	156.4	4984.7	4918.9	2658.9	2806.5
Organic Carbon	%	0.29	0.81	0.36	0.39	0.27	0.22	0.22	0.27
Conductivity	dS/m	0.020	0.089	3.242	1.651	5.391	4.249	2.685	6.073
pH Level (CaCl2)		5.6	6.1	6.2	6.7	8.2	6.3	7.8	7.9
pH Level (H2O)		6.4	7.3	6.9	7.1	8.5	7.3	8.0	8.3
% Clay	%	13.86		13.20			2.80		
% Course Sand	%	43.50		27.07			8.07		
% Fine Sand	%	33.69		43.41			79.63		
% Sand	%	77.19		70.48			87.70		
% Silt	%	8.94		16.31			9.50		
Prewash exch. Ca	meq/100g	12.23	6.07	8.68	3.38		7.81		
Prewash exch. K	meq/100g	0.05	0.42	0.31	0.14		0.14		
Prewash exch. Mg	meq/100g	2.86	3.69	1.10	3.17		1.13		

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

		9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Lab No		9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Name		MI T2	MI T2	MI T3	MI T3	MI T3	MI T4	MI T4	MI T4
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		50-100	100-150	0-50	50-100	100-150	0-50	50-100	100-150
Colour		GR	GR	GR	GR	GR	GR	GR	GR
Gravel	%	5	0	0	0	0	0	0	0
Texture		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5
Ammonium Nitrogen	mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nitrate Nitrogen	mg/kg	20	16	21	14	14	50	29	27
Phosphorus Colwell	mg/kg	< 2	2	5	3	2	< 2	< 2	2
Potassium Colwell	mg/kg	1434	1941	1980	2194	2358	1747	1830	2018
Sulfur	mg/kg	2774.6	3506.7	3566.5	3398.9	2922.2	2954.1	3943.5	2808.5
Organic Carbon	%	0.22	0.26	0.23	0.20	0.22	0.31	0.27	0.22
Conductivity	dS/m	4.045	3.106	4.234	3.235	3.021	5.652	4.096	3.630
pH Level (CaCl2)		7.7	7.9	7.5	7.5	7.5	7.8	7.5	7.7
pH Level (H2O)		8.1	8.3	8.2	8.2	8.1	8.4	8.2	8.3
% Clay	%				8.16				
% Course Sand	%				2.27				
% Fine Sand	%				68.92				
% Sand	%				71.19				
% Silt	%				20.65				
Prewash exch. Ca	meq/100g				5.67				
Prewash exch. K	meq/100g				0.15				
Prewash exch. Mg	meq/100g				0.33				

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

		9SS22047	9SS22048	9SS22049	9SS22050	9SS22051	9SS22052	9SS22053	9SS22054
Lab No		9SS22047	9SS22048	9SS22049	9SS22050	9SS22051	9SS22052	9SS22053	9SS22054
Name		MI T5	MI T5	MI T5	MI T6	MI T6	MI T6	MI Calcrete 1	MI Calcrete 2
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		0-50	50-100	100-150	0-50	50-100	100-150	0-10	0-10
Colour		BR	BRGR	GRBR	GR	GR	GR	GRPK	BR
Gravel	%	0	0	0	0	0	0	0	0
Texture		2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.5
Ammonium Nitrogen	mg/kg	17	5	2	< 1	< 1	< 1	< 1	1
Nitrate Nitrogen	mg/kg	267	100	63	49	28	24	6	5
Phosphorus Colwell	mg/kg	3	3	5	< 2	< 2	2	4	5
Potassium Colwell	mg/kg	362	398	177	1710	1876	1456	73	56
Sulfur	mg/kg	7372.3	9173.5	4184.8	2597.1	2982.1	2894.3	11008.6	8252.0
Organic Carbon	%	0.31	0.23	0.21	0.29	0.22	0.25	0.31	0.26
Conductivity	dS/m	7.427	4.353	3.039	5.173	4.410	4.009	3.281	4.019
pH Level (CaCl2)		7.7	7.7	7.8	7.9	7.6	7.8	7.7	7.6
pH Level (H2O)		8.0	8.2	8.3	8.4	8.1	8.1	8.1	8.0
% Clay	%		10.59					9.82	
% Course Sand	%		13.40					44.55	
% Fine Sand	%		61.50					30.83	
% Sand	%		74.90					75.38	
% Silt	%		14.51					14.81	
Prewash exch. Ca	meq/100g		10.09					23.09	
Prewash exch. K	meq/100g		0.19					0.13	
Prewash exch. Mg	meq/100g		1.92					1.54	

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22055
Name		MI Calcrete 3
Code		MID-2206
Customer		Mine Earth Pty Ltd
Depth		0-10
Colour		GRPK
Gravel	%	0
Texture		2.5
Ammonium Nitrogen	mg/kg	< 1
Nitrate Nitrogen	mg/kg	10
Phosphorus Colwell	mg/kg	6
Potassium Colwell	mg/kg	90
Sulfur	mg/kg	6293.2
Organic Carbon	%	0.53
Conductivity	dS/m	4.059
pH Level (CaCl2)		7.6
pH Level (H2O)		8.2
% Clay	%	11.74
% Course Sand	%	32.35
% Fine Sand	%	39.20
% Sand	%	71.55
% Silt	%	16.70
Prewash exch. Ca	meq/100g	16.35
Prewash exch. K	meq/100g	0.20
Prewash exch. Mg	meq/100g	2.41

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22014	9SS22015	9SS22016	9SS22017	9SS22018	9SS22019	9SS22020	9SS22021
Prewash exch. Na	meq/100g	0.33	0.79	< 0.10	0.27	0.17	0.33	0.13	0.20
Arsenic	ug/kg	2477.00	2901.00	2739.83	2217.90	2028.08	1936.80	3448.82	4364.60
Cadmium	ug/kg	25.10	46.60	121.35	119.69	77.19	55.59	53.78	206.81
Chromium	ug/kg	100102.54	83276.57	164720.38	155482.32	98277.98	88467.25	123641.66	184236.13
Cobalt	ug/kg	5764.26	8227.15	29795.54	32620.28	8033.44	6714.32	10408.70	29942.88
Lead	ug/kg	8865.14	13420.11	8195.21	8059.78	16171.78	12952.31	11195.73	11389.20
Molybdenum	ug/kg	1018.6	1427.0	850.4	768.2	694.9	695.3	2557.6	884.9
Selenium	ug/kg	556.18	632.68	1079.61	1159.96	643.46	875.06	1222.68	746.06

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22022	9SS22023	9SS22024	9SS22025	9SS22026	9SS22027	9SS22028	9SS22029
Prewash exch. Na	meq/100g	0.55	0.33	< 0.10	< 0.10	0.12	4.00	4.39	< 0.10
Arsenic	ug/kg	6243.77	4985.72	6086.24	8988.86	8705.21	29350.00	20119.61	3583.56
Cadmium	ug/kg	171.08	78.59	155.88	88.17	71.66	174.80	95.56	97.79
Chromium	ug/kg	170254.38	261221.71	172228.18	400416.41	305957.51	263990.77	160310.78	134290.93
Cobalt	ug/kg	29097.85	22842.20	16192.32	9041.20	10937.37	17178.26	10720.51	18246.47
Lead	ug/kg	12254.84	9590.96	13050.59	16719.70	11317.97	22009.17	16809.37	4519.90
Molybdenum	ug/kg	879.1	1128.0	810.7	1029.1	975.3	1164.4	824.2	459.7
Selenium	ug/kg	771.17	1504.41	433.75	1344.36	989.40	1559.01	1283.98	71.12

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22030	9SS22031	9SS22032	9SS22033	9SS22034	9SS22035	9SS22037	9SS22038
Prewash exch. Na	meq/100g	0.11	< 0.10	0.69	0.37		0.79		
Arsenic	ug/kg	2646.52	36010.72	7941.58	3620.11				
Cadmium	ug/kg	65.21	86.93	27.96	147.51				
Chromium	ug/kg	108291.75	126013.06	131609.61	153185.82				
Cobalt	ug/kg	20991.80	32214.24	7622.19	27937.76				
Lead	ug/kg	3331.72	7804.95	10021.95	7901.54				
Molybdenum	ug/kg	394.9	590.0	2397.6	1377.8				
Selenium	ug/kg	246.16	266.90	719.48	1020.92				

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Prewash exch. Na	meq/100g				0.27				
Arsenic	ug/kg								
Cadmium	ug/kg								
Chromium	ug/kg								
Cobalt	ug/kg								
Lead	ug/kg								
Molybdenum	ug/kg								
Selenium	ug/kg								

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22047	9SS22048	9SS22049	9SS22050	9SS22051	9SS22052	9SS22053	9SS22054
Prewash exch. Na	meq/100g		1.16					1.15	
Arsenic	ug/kg							3109.67	3498.32
Cadmium	ug/kg							21.99	15.45
Chromium	ug/kg							72416.11	89583.38
Cobalt	ug/kg							14057.03	11115.77
Lead	ug/kg							2852.90	2241.62
Molybdenum	ug/kg							410.3	1468.2
Selenium	ug/kg							953.71	2630.53

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22055
Prewash exch. Na	meq/100g	1.68
Arsenic	ug/kg	3522.20
Cadmium	ug/kg	15.31
Chromium	ug/kg	90441.24
Cobalt	ug/kg	11089.72
Lead	ug/kg	2272.87
Molybdenum	ug/kg	1532.7
Selenium	ug/kg	2142.31

Analysis Results

CSBP Soil and Plant Laboratory

90423
Mine Earth Pty Ltd

		9SS22014	9SS22015	9SS22016	9SS22017	9SS22018	9SS22019	9SS22020	9SS22021
Lab No		9SS22014	9SS22015	9SS22016	9SS22017	9SS22018	9SS22019	9SS22020	9SS22021
Name		MI 01	MI 01	MI 02	MI 02	MI 03	MI 03	MI 04	MI 05
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		0-10	10-30	0-10	10-30	0-10	10-25	0-5	0-10
Colour		BROR	BROR	BR	BR	GRBR	GRBR	BR	BR
Gravel	%	0	0	0	0	0	5	0	0
Texture		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Ammonium Nitrogen	mg/kg	< 1	10	2	4	3	18	1	< 1
Nitrate Nitrogen	mg/kg	11	40	42	101	35	105	17	5
Phosphorus Colwell	mg/kg	12	8	14	8	13	15	8	19
Potassium Colwell	mg/kg	197	93	202	91	270	170	424	329
Sulfur	mg/kg	7.8	77.4	9.0	21.2	105.9	32.3	9.7	2.3
Organic Carbon	%	0.28	0.46	0.94	0.71	0.37	0.73	1.66	0.34
Conductivity	dS/m	0.234	2.093	0.118	0.239	0.400	0.427	0.166	0.148
pH Level (CaCl2)		6.8	5.9	6.7	6.2	6.3	6.6	7.2	6.5
pH Level (H2O)		7.7	6.8	7.0	7.2	7.1	7.2	8.3	7.2
% Clay	%	12.99	19.62	24.91	21.72	31.78	24.18		19.95
% Course Sand	%	27.01	21.42	19.37	19.03	20.94	21.95		16.40
% Fine Sand	%	40.93	33.40	44.75	43.42	30.36	41.28		38.63
% Sand	%	67.94	54.82	64.12	62.45	51.30	63.23		55.03
% Silt	%	19.06	25.57	10.98	15.83	16.91	12.60		25.01
Prewash exch. Ca	meq/100g	3.75	10.76	6.33	8.20	8.22	12.61	14.59	6.16
Prewash exch. K	meq/100g	0.34	0.23	0.37	0.19	0.58	0.45	0.82	0.55
Prewash exch. Mg	meq/100g	0.89	2.84	2.48	3.16	2.89	3.75	1.67	1.65

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22022	9SS22023	9SS22024	9SS22025	9SS22026	9SS22027	9SS22028	9SS22029
Name		MI 05	MI 06	MI 07	MI 08	MI 08	MI 09	MI 09	MI 10
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		20-30	0-15	0-15	0-10	10-20	0-10	20-30	0-10
Colour		DKBR	BR	BR	DKBR	BRGR	BR	DKBR	BRRD
Gravel	%	0	0	0	0	0	0	0	0
Texture		2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.5
Ammonium Nitrogen	mg/kg	6	1	3	2	4	2	2	2
Nitrate Nitrogen	mg/kg	48	2	21	17	6	7	18	1
Phosphorus Colwell	mg/kg	11	10	7	14	12	13	8	7
Potassium Colwell	mg/kg	113	93	257	177	111	196	124	78
Sulfur	mg/kg	71.2	47.6	25.1	4.8	6.6	30.7	3857.7	1.4
Organic Carbon	%	0.38	0.35	0.81	0.21	0.32	0.45	0.59	0.31
Conductivity	dS/m	2.870	0.335	0.152	0.060	0.094	1.152	5.913	0.021
pH Level (CaCl2)		6.0	6.8	6.5	6.3	6.4	8.0	7.5	7.6
pH Level (H2O)		6.9	7.2	7.3	7.0	7.3	8.9	8.2	8.1
% Clay	%	23.98			10.74	13.95	24.82	33.82	13.09
% Course Sand	%	11.76			50.39	46.11	39.87	20.50	33.59
% Fine Sand	%	33.21			35.93	36.93	29.34	23.77	43.20
% Sand	%	44.97			86.32	83.04	69.21	44.27	76.79
% Silt	%	31.04			2.94	3.00	5.97	21.92	10.11
Prewash exch. Ca	meq/100g	10.55	0.83	5.04	1.90	3.29	6.42	12.82	6.32
Prewash exch. K	meq/100g	0.26	0.17	0.46	0.27	0.20	0.32	0.24	0.11
Prewash exch. Mg	meq/100g	4.00	1.75	1.59	0.61	0.84	2.11	5.85	2.15

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22030	9SS22031	9SS22032	9SS22033	9SS22034	9SS22035	9SS22037	9SS22038
Name		MI 10	MI 11	MI 12	MI 13	MI T1	MI T1	MI T1	MI T2
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		10-30	0-5	0-5	0-15	0-50	50-100	100-150	0-50
Colour		BR	BROR	BR	DKBR	LTBR	BRGR	BRGR	GR
Gravel	%	0	0	0	0	0	0	5	0
Texture		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.0
Ammonium Nitrogen	mg/kg	< 1	11	2	4	4	2	2	< 1
Nitrate Nitrogen	mg/kg	4	31	121	39	146	92	52	53
Phosphorus Colwell	mg/kg	4	16	11	5	5	3	4	2
Potassium Colwell	mg/kg	35	275	154	66	247	246	127	1518
Sulfur	mg/kg	2.5	12.1	101.0	156.4	4984.7	4918.9	2658.9	2806.5
Organic Carbon	%	0.29	0.81	0.36	0.39	0.27	0.22	0.22	0.27
Conductivity	dS/m	0.020	0.089	3.242	1.651	5.391	4.249	2.685	6.073
pH Level (CaCl2)		5.6	6.1	6.2	6.7	8.2	6.3	7.8	7.9
pH Level (H2O)		6.4	7.3	6.9	7.1	8.5	7.3	8.0	8.3
% Clay	%	13.86		13.20			2.80		
% Course Sand	%	43.50		27.07			8.07		
% Fine Sand	%	33.69		43.41			79.63		
% Sand	%	77.19		70.48			87.70		
% Silt	%	8.94		16.31			9.50		
Prewash exch. Ca	meq/100g	12.23	6.07	8.68	3.38		7.81		
Prewash exch. K	meq/100g	0.05	0.42	0.31	0.14		0.14		
Prewash exch. Mg	meq/100g	2.86	3.69	1.10	3.17		1.13		

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

		9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Lab No		9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Name		MI T2	MI T2	MI T3	MI T3	MI T3	MI T4	MI T4	MI T4
Code		MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
Customer		Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
Depth		50-100	100-150	0-50	50-100	100-150	0-50	50-100	100-150
Colour		GR	GR	GR	GR	GR	GR	GR	GR
Gravel	%	5	0	0	0	0	0	0	0
Texture		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.5
Ammonium Nitrogen	mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Nitrate Nitrogen	mg/kg	20	16	21	14	14	50	29	27
Phosphorus Colwell	mg/kg	< 2	2	5	3	2	< 2	< 2	2
Potassium Colwell	mg/kg	1434	1941	1980	2194	2358	1747	1830	2018
Sulfur	mg/kg	2774.6	3506.7	3566.5	3398.9	2922.2	2954.1	3943.5	2808.5
Organic Carbon	%	0.22	0.26	0.23	0.20	0.22	0.31	0.27	0.22
Conductivity	dS/m	4.045	3.106	4.234	3.235	3.021	5.652	4.096	3.630
pH Level (CaCl2)		7.7	7.9	7.5	7.5	7.5	7.8	7.5	7.7
pH Level (H2O)		8.1	8.3	8.2	8.2	8.1	8.4	8.2	8.3
% Clay	%				8.16				
% Course Sand	%				2.27				
% Fine Sand	%				68.92				
% Sand	%				71.19				
% Silt	%				20.65				
Prewash exch. Ca	meq/100g				5.67				
Prewash exch. K	meq/100g				0.15				
Prewash exch. Mg	meq/100g				0.33				

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22047	9SS22048	9SS22049	9SS22050	9SS22051	9SS22052	9SS22053	9SS22054
	Name	MI T5	MI T5	MI T5	MI T6	MI T6	MI T6	MI Calcrete 1	MI Calcrete 2
	Code	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206	MID-2206
	Customer	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd	Mine Earth Pty Ltd
	Depth	0-50	50-100	100-150	0-50	50-100	100-150	0-10	0-10
Colour		BR	BRGR	GRBR	GR	GR	GR	GRPK	BR
Gravel	%	0	0	0	0	0	0	0	0
Texture		2.5	2.5	2.5	2.0	2.0	2.0	2.5	2.5
Ammonium Nitrogen	mg/kg	17	5	2	< 1	< 1	< 1	< 1	1
Nitrate Nitrogen	mg/kg	267	100	63	49	28	24	6	5
Phosphorus Colwell	mg/kg	3	3	5	< 2	< 2	2	4	5
Potassium Colwell	mg/kg	362	398	177	1710	1876	1456	73	56
Sulfur	mg/kg	7372.3	9173.5	4184.8	2597.1	2982.1	2894.3	11008.6	8252.0
Organic Carbon	%	0.31	0.23	0.21	0.29	0.22	0.25	0.31	0.26
Conductivity	dS/m	7.427	4.353	3.039	5.173	4.410	4.009	3.281	4.019
pH Level (CaCl2)		7.7	7.7	7.8	7.9	7.6	7.8	7.7	7.6
pH Level (H2O)		8.0	8.2	8.3	8.4	8.1	8.1	8.1	8.0
% Clay	%		10.59					9.82	
% Course Sand	%		13.40					44.55	
% Fine Sand	%		61.50					30.83	
% Sand	%		74.90					75.38	
% Silt	%		14.51					14.81	
Prewash exch. Ca	meq/100g		10.09					23.09	
Prewash exch. K	meq/100g		0.19					0.13	
Prewash exch. Mg	meq/100g		1.92					1.54	

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22055
	Name	MI Calcrete 3
	Code	MID-2206
	Customer	Mine Earth Pty Ltd
	Depth	0-10
Colour		GRPK
Gravel	%	0
Texture		2.5
Ammonium Nitrogen	mg/kg	< 1
Nitrate Nitrogen	mg/kg	10
Phosphorus Colwell	mg/kg	6
Potassium Colwell	mg/kg	90
Sulfur	mg/kg	6293.2
Organic Carbon	%	0.53
Conductivity	dS/m	4.059
pH Level (CaCl2)		7.6
pH Level (H2O)		8.2
% Clay	%	11.74
% Course Sand	%	32.35
% Fine Sand	%	39.20
% Sand	%	71.55
% Silt	%	16.70
Prewash exch. Ca	meq/100g	16.35
Prewash exch. K	meq/100g	0.20
Prewash exch. Mg	meq/100g	2.41

CSBP Lab. Extract Value.

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22014	9SS22015	9SS22016	9SS22017	9SS22018	9SS22019	9SS22020	9SS22021
Prewash exch. Na	meq/100g	0.33	0.79	< 0.10	0.27	0.17	0.33	0.13	0.20
Arsenic	ug/kg	2477.00	2901.00	2739.83	2217.90	2028.08	1936.80	3448.82	4364.60
Cadmium	ug/kg	25.10	46.60	121.35	119.69	77.19	55.59	53.78	206.81
Chromium	ug/kg	100102.54	83276.57	164720.38	155482.32	98277.98	88467.25	123641.66	184236.13
Cobalt	ug/kg	5764.26	8227.15	29795.54	32620.28	8033.44	6714.32	10408.70	29942.88
Lead	ug/kg	8865.14	13420.11	8195.21	8059.78	16171.78	12952.31	11195.73	11389.20
Molybdenum	ug/kg	1018.6	1427.0	850.4	768.2	694.9	695.3	2557.6	884.9
Selenium	ug/kg	556.18	632.68	1079.61	1159.96	643.46	875.06	1222.68	746.06

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22022	9SS22023	9SS22024	9SS22025	9SS22026	9SS22027	9SS22028	9SS22029
Prewash exch. Na	meq/100g	0.55	0.33	< 0.10	< 0.10	0.12	4.00	4.39	< 0.10
Arsenic	ug/kg	6243.77	4985.72	6086.24	8988.86	8705.21	29350.00	20119.61	3583.56
Cadmium	ug/kg	171.08	78.59	155.88	88.17	71.66	174.80	95.56	97.79
Chromium	ug/kg	170254.38	261221.71	172228.18	400416.41	305957.51	263990.77	160310.78	134290.93
Cobalt	ug/kg	29097.85	22842.20	16192.32	9041.20	10937.37	17178.26	10720.51	18246.47
Lead	ug/kg	12254.84	9590.96	13050.59	16719.70	11317.97	22009.17	16809.37	4519.90
Molybdenum	ug/kg	879.1	1128.0	810.7	1029.1	975.3	1164.4	824.2	459.7
Selenium	ug/kg	771.17	1504.41	433.75	1344.36	989.40	1559.01	1283.98	71.12

Analysis Results

CSBP Soil and Plant Laboratory

Lab No		9SS22030	9SS22031	9SS22032	9SS22033	9SS22034	9SS22035	9SS22037	9SS22038
Prewash exch. Na	meq/100g	0.11	< 0.10	0.69	0.37		0.79		
Arsenic	ug/kg	2646.52	36010.72	7941.58	3620.11				
Cadmium	ug/kg	65.21	86.93	27.96	147.51				
Chromium	ug/kg	108291.75	126013.06	131609.61	153185.82				
Cobalt	ug/kg	20991.80	32214.24	7622.19	27937.76				
Lead	ug/kg	3331.72	7804.95	10021.95	7901.54				
Molybdenum	ug/kg	394.9	590.0	2397.6	1377.8				
Selenium	ug/kg	246.16	266.90	719.48	1020.92				

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22039	9SS22040	9SS22041	9SS22042	9SS22043	9SS22044	9SS22045	9SS22046
Prewash exch. Na	meq/100g				0.27				
Arsenic	ug/kg								
Cadmium	ug/kg								
Chromium	ug/kg								
Cobalt	ug/kg								
Lead	ug/kg								
Molybdenum	ug/kg								
Selenium	ug/kg								

Analysis Results

CSBP Soil and Plant Laboratory

CSBP

	Lab No	9SS22047	9SS22048	9SS22049	9SS22050	9SS22051	9SS22052	9SS22053	9SS22054
Prewash exch. Na	meq/100g		1.16					1.15	
Arsenic	ug/kg							3109.67	3498.32
Cadmium	ug/kg							21.99	15.45
Chromium	ug/kg							72416.11	89583.38
Cobalt	ug/kg							14057.03	11115.77
Lead	ug/kg							2852.90	2241.62
Molybdenum	ug/kg							410.3	1468.2
Selenium	ug/kg							953.71	2630.53

Analysis Results

CSBP Soil and Plant Laboratory

	Lab No	9SS22055
Prewash exch. Na	meq/100g	1.68
Arsenic	ug/kg	3522.20
Cadmium	ug/kg	15.31
Chromium	ug/kg	90441.24
Cobalt	ug/kg	11089.72
Lead	ug/kg	2272.87
Molybdenum	ug/kg	1532.7
Selenium	ug/kg	2142.31