Purpose Permit Application Amendment to CPS 7408-3

Assessment of Clearing Principles

Mt Morgans Gold Project

Prepared by Mt Morgans WA Mining Pty Ltd

MT MORGANS WA MINING PTY LTD
A WHOLLY OWNED SUBSIDIARY OF DACIAN GOLD LIMITED

March 2022

Version 1

Executive Summary

This report has been prepared to support an amendment to native vegetation clearing permit (Purpose Permit) CPS 7408-3 at the Mt Morgans Gold Project (**MMGP** or **the Project**).

The Project comprises three key areas that are covered under CPS 7408-3: Westralia project area, Jupiter project area, and an infrastructure corridor that connects the two project areas. This amendment to CPS 7408-3 relates to infrastructure development associated with the Jupiter project area.

Information is provided to enable assessment of the impacts of proposed clearing in relation to each of the ten 'Land Clearing Principles' described within Schedule 5 of the *Environmental Protection Act 1986*. The document presents the existing ecological information and environmental impact management measures for the proposed clearing.

The MMGP is located approximately 30 km south-west of Laverton, in the North Eastern Goldfields of Western Australia (Figure 1). Access to the MMGP is via the sealed public Laverton-Leonora Road and the unsealed public Korong-Mount Morgans Road.

The MMGP is owned by Mt Morgans WA Mining Pty Ltd (**MMWM**), a wholly owned subsidiary of Dacian Gold Limited (**Dacian**). This amendment to CPS 7408-3 requests permission to clear an additional 25 ha for the Mt Marven Waste Rock Dump (WRD) and extension to the Jupiter WRD, increasing the approved clearing area from 740 ha to 765 ha.

The Project is located in the Eastern Murchison subregion of the Murchison Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and *Tecticornia* shrublands.

Flora and fauna surveys were undertaken in 2016 by Native Vegetation Solutions (NVS) and Western Wildlife, respectively. Supplementary surveys were completed by NVS and Western Wildlife in 2019, covering the Mt Marven project areas. All vegetation units identified are well represented in the broader project area and region. No plant taxa listed as Threatened pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* were located in the survey area. One Priority flora species, *Olearia mucronata* (P3) was recorded in the survey area however will not be impacted by the proposed activities.

Overall, few conservation significant fauna species are likely to be present in most habitats. Conservation significant species that are likely to occur, such as the Rainbow Bee-eater and Long-tailed Dunnart are relatively widely distributed.

A desktop assessment was undertaken by Bennelongia Environmental Consultants Pty Ltd (Bennelongia 2016) to collate existing data on short range endemics (SRE) occurring in the vicinity of the Project, as well as invertebrate species listed as Specially Protected or Threatened fauna. Overall, the proposed impact areas in relation to the available habitats are very small and there are no known SRE invertebrate species from the Goldfields that have ranges smaller than the areas to be disturbed.

MMWM has developed a Land Clearing and Topsoil Disturbance Management Plan that aims to minimise impacts associated with clearing at the MMGP.

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1 Introduction

1.1 Background

The *Environmental Protection Act 1986* (WA) (EP Act) and *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (WA) require that all land clearing related to mining and mineral exploration activities are approved by the Department of Water and Environmental Regulation (DWER). In accordance with Section 20 of the EP Act, applications relating to mineral and petroleum activities are delegated to the Department of Mines, Industry, Regulation and Safety (DMIRS) for assessment.

This report supports the amendment of a native vegetation clearing permit (Purpose Permit) CPS 7408-3 for proposed mining activities as defined in Section 3. Information is provided to enable assessment of the impacts of the proposed clearing on each of the ten 'Land Clearing Principles' described within Schedule 5 of the EP Act. This document presents the existing ecological information and environmental impact management measures for proposed clearing.

1.2 Proponent

The Mt Morgans Gold Project (**MMGP** or **the Project**) is owned by Mt Morgans WA Mining Pty Ltd (**MMWM**), a wholly owned subsidiary of Dacian Gold Limited (**Dacian**). All compliance and regulatory requirements regarding this assessment document should be forwarded by email or post to the following address:

Mt Morgans WA Mining Pty Ltd
PO Box 7253
Cloisters Square PO
WA 6850

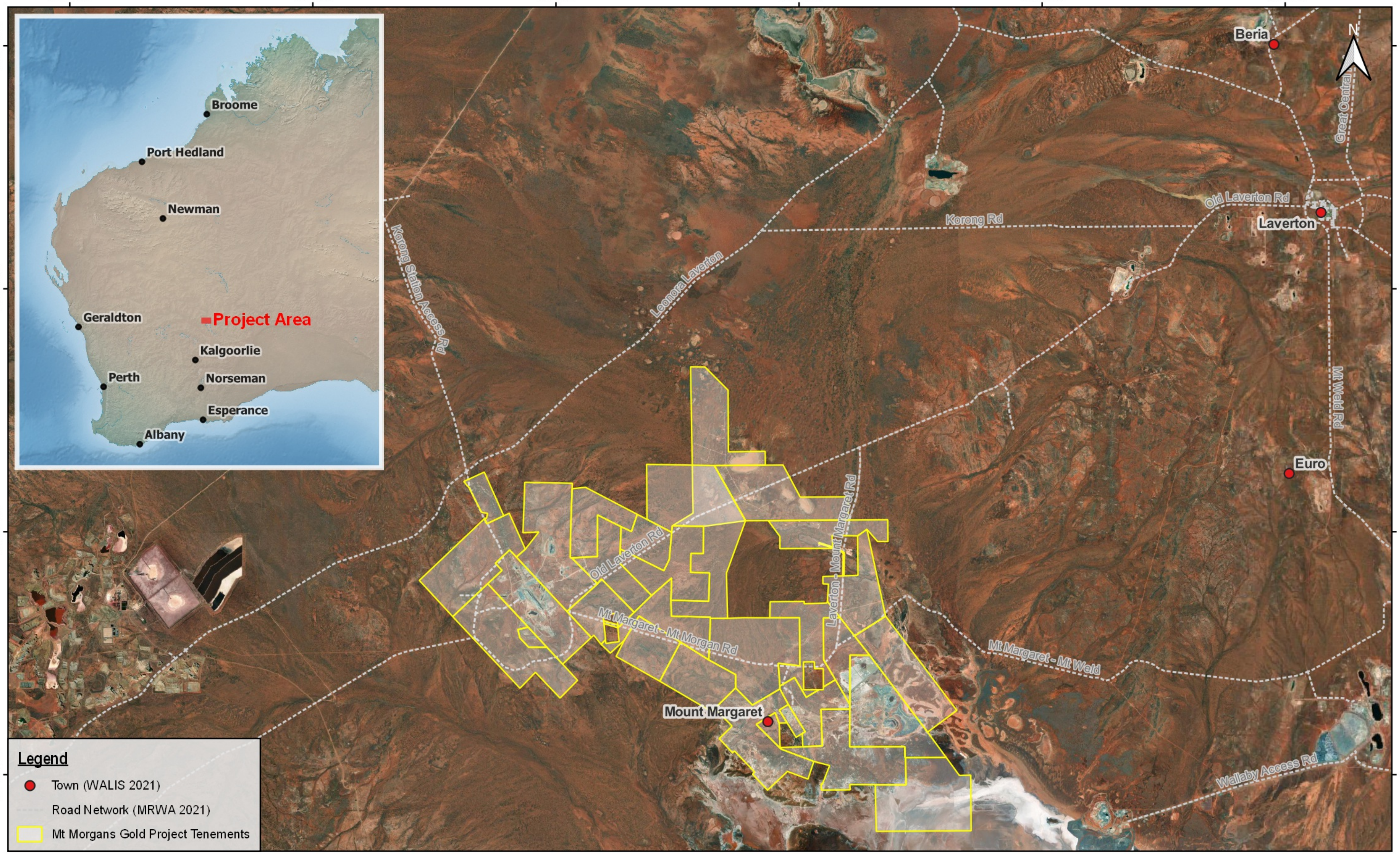
Contact:	Mr Ben McAllister
Title:	General Manager, Mt Morgans WA Mining Pty Ltd
Telephone:	(08) 6323 9101
E-mail:	Ben.McAllister@daciangold.com.au

1.3 Location and Tenure

The MMGP is located approximately 30 km south-west of Laverton, in the North Eastern Goldfields of Western Australia (Figure 1). Access to the MMGP is via the sealed public Laverton-Leonora Road and the unsealed public Korong-Mount Morgans Road. The applicable tenements associated with this Purpose Permit Application are listed in Table 1 and shown in Figure 2.

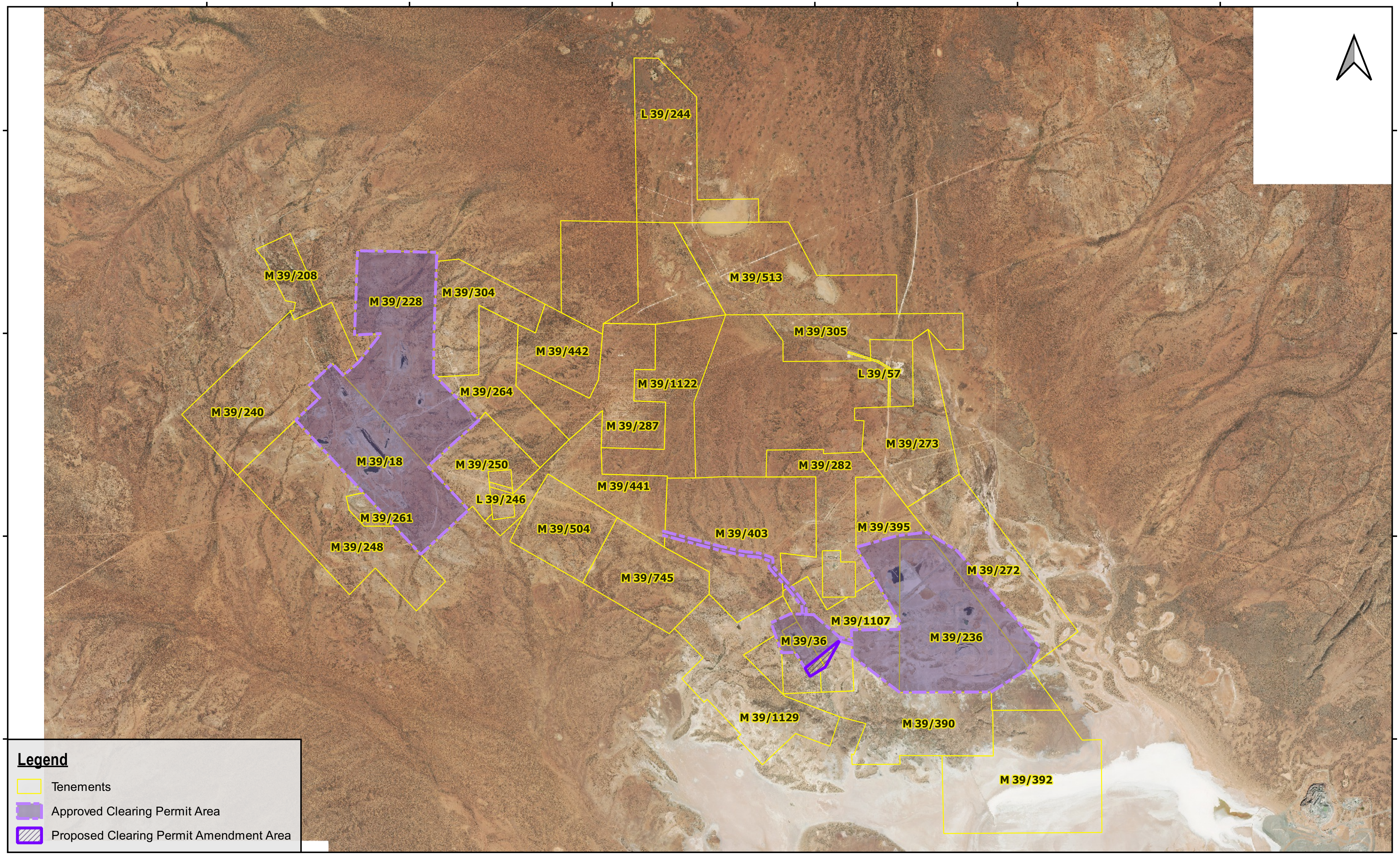
Table 1: Purpose Permit Amendments

Tenement ID	Existing and Previously Submitted Infrastructure in the Jupiter Area	Proposed Amendments
M39/36	• Mt Marven open pits. • Road. • Mt Marven North WRD. • Mt Marven ROM. • Abandonment bund. • Laydown.	• Mt Marven South WRD
M39/236	• Jupiter West WRD. • Tukey's Nest and Process Water Ponds. • Jupiter open pit. • Jupiter Processing Plant. • Jupiter ROM. • Jupiter TSF. • Jupiter East WRD. • Jupiter North WRD. • Access tracks. • Buildings and laydown area.	• Jupiter West WRD extension
M39/1107	• Borrow pit. • Turkeys nest. • Mt Marven and Mt Marven North WRD. • Mt Marven South WRD. • Mt Marven Heap Leach Pad. • Abandonment Bund. • Mt Marven Mine Services Area (workshop and laydown). • Exploration. • Access tracks.	• Mt Marven South WRD



Original Size: A4 Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Scale: 1:200000 Projection: GDA94 / MGA zone 51 0 1 2 3 4 5 km	**Mt Morgans WA Mining Pty Ltd** **Mt Morgans Gold Project** **NVCP Amendment**	**Figure 1** Location Plan	DACIAN GOLD LIMITED

C:\Users\HChin\RPMGLOBAL\ADV-AU-00293 Dacian - Mt Morgans - ESG - Mt Marven South and Jupiter ROM MP and MCP - Documents\01_ESG\06_GIS\ADV-AU-00293 - Dacian - Mt Marven South and Jupiter ROM CP.qgz 28/03/2022



Original Size: A4 Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Scale: 1:120000 Projection: GDA94 / MGA zone 51 0 1 2 3 4 5 km	**Mt Morgans WA Mining Pty Ltd** **Mt Morgans Gold Project** **NVCP Amendment**	**Figure 2** **Project Tenements Overview and Purpose Permit Amendment Area**	DACIAN GOLD LIMITED

C:\Users\HChin\RPMGLOBAL\ADV-AU-00293 Dacian - Mt Morgans - ESG - Mt Marven South and Jupiter ROM MP and MCP - Documents\01_ESG\06_GIS\ADV-AU-00293 - Dacian - Mt Marven South and Jupiter ROM CP.qgz 28/03/2022

2 Environmental Setting

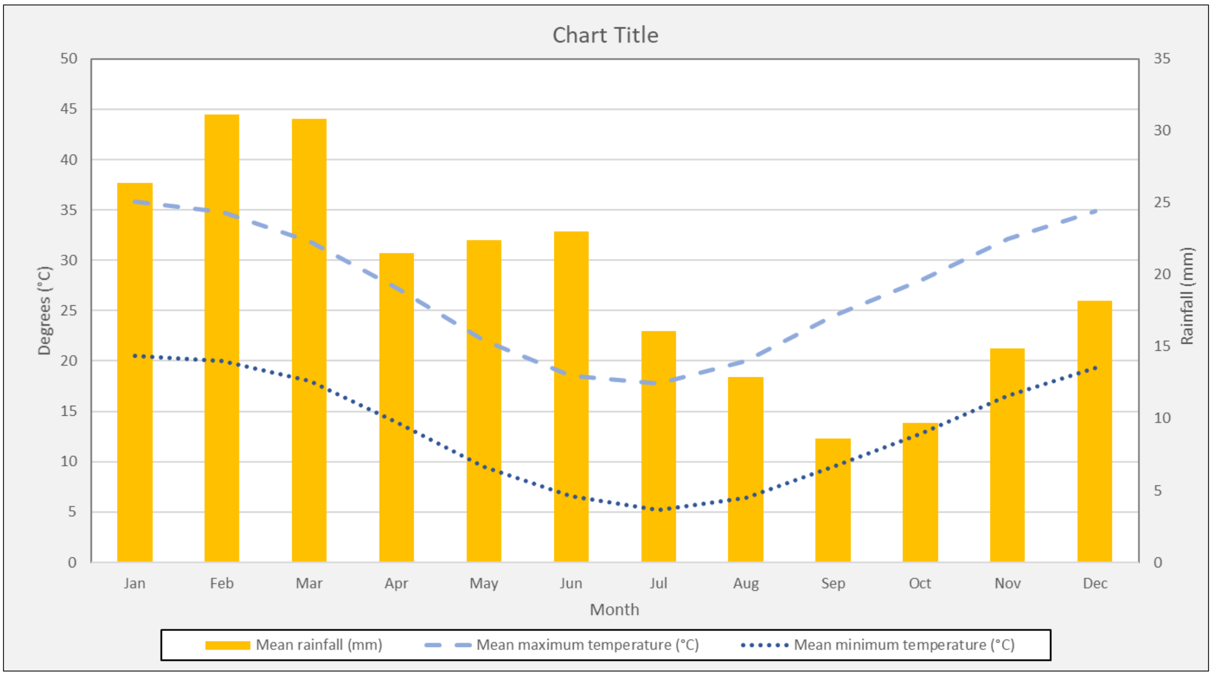
2.1 Regional Setting

The Project is located in the Eastern Murchison subregion of the Murchison Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion. The bioregion is characterised by internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development, broad plains of red-brown soils and breakaway complexes. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (Native Vegetation Solutions 2016). Salt lake systems are associated with occluded paleodrainage systems. Locally, the Project is located within the internally draining Lake Carey catchment which has a catchment area in the order of 113,900 km^2. The main land uses in the subregion are grazing and mining.

2.2 Climate

The climate of the North Eastern Goldfields region is arid to semi-arid and can be characterised by its relatively low annual rainfall and large temperature range. The nearest Bureau of Meteorology (BOM) rainfall station to the Project is located at Laverton. Recordings of the local climatic conditions commenced at Laverton in 1899 (BOM 2022). The mean annual rainfall recorded since 1899 is 235.2 mm (Chart 1), however rainfall may vary annually from less than one third to almost three times that amount. The rainfall that occurs during the autumn and early winter months of May to July tends to be more reliable though generally of a lesser total amount than the less dependable, but more intense summer cyclonic rainfall from December to March. Annual pan evaporation rates at the Project area estimated at approximately 2,900 mm/year (GRM 2016a).

Chart 1: Mean Rainfall at Laverton (Station 012045)



The North Eastern Goldfields region is subject to tropical cyclones, thunderstorms and related events. Of particular note was Tropical Cyclone Bobby which crossed the western Pilbara coast near Onslow on 25 February 1995 as a Category four event, before continuing southwards across the Gascoyne as a Category two event and then the Goldfields as a rain bearing depression. Intense rainfall accompanied Cyclone Bobby, with Onslow recording more than 400 mm over the duration of the cyclone. Many centres in the Goldfields recorded their maximum daily, monthly and annual rainfalls. Yundamindra, Leonora and Laverton recorded 287, 233 and 123 mm of rainfall respectively in the four days to 28 February 1995. It is considered that Tropical Cyclone Bobby is representative of 100-year average reoccurrence interval (ARI) flood conditions (GRM 2016a).

Inspection of the wind roses for Laverton Aero station show that easterlies of up to 30 km/hr predominate in the morning, but by the afternoon somewhat weaker westerlies are equally likely to occur (GRM 2016a).

2.3 Geology

2.3.1 Regional Geology

The MMGP lies within the Laverton Greenstone Belt, which forms the North Eastern part of the Eastern Goldfields Province of the Yilgarn Craton of Western Australia. It consists of belts of greenstone, intruded by granitic rocks of Archean age and areas of sedimentary banded iron formation (BIF) rocks associated with the greenstone (Pringle *et al.* 1994). The granites are generally expressed as low rounded tors surrounded by plains while the greenstones may be either low and rounded hills or steeper less-weathered hills with narrow drainages. The latter type is common in the Laverton area.

2.3.2 Project Geology

The MMGP lies in the overturned western limb of the Mt Margaret Anticline which plunges moderately to the south and has a north-northwest trending fold axis. The stratigraphy is dominated by mafic volcanics (predominantly massive tholeiitic basalt), mafic intrusives, minor ultramafics and metasediments, and a narrow band (<80 m wide) of a regionally continuous BIF. All of these units have been intruded by concordant and discordant felsic porphyry dykes and sills and by discordant lamprophyric dykes.

The Jupiter Prospect and surrounding mineralisation is centred on a series of syenite intrusive stocks aligned in a north-south orientation. The syenite intrudes into a sequence of host basaltic rocks. A major shear zone, termed the Cornwall Shear Zone, runs parallel to the western margin of the syenite intrusives and where it intersects these intrusive bodies mineralisation has occurred both within the syenite and the basaltic rocks. This mineralisation is primarily centred on the intrusive bodies but also extends several hundred metres into the basalt. The mineralisation is predominantly associated with alteration to albite and sericite, and quartz veining and pyrite development are commonly encountered within the mineralised lodes (Soilwater Consultants 2015).

2.4 Soils

MBS Environmental (2016) completed a landform and soil assessment at the MMGP. The primary objective of the study was to determine the volumes and suitability of topsoils for rehabilitation purposes as well as assessing baseline contaminant levels within the MMGP footprint.

The following landform systems identified in the proposed clearing areas include:

- Carnegie Land System: Salt lakes with fringing saline alluvial plains. Kopi dunes and sandy banks.
- Yilgangi Land System: Low breakaways with saline gravelly lower plains supporting predominantly halophytic low shrublands.

Assessment of the physical and chemical properties of soils by field assessment of profiles and laboratory analysis of selected samples indicated the following characteristics of soils:

- Generally unconsolidated red-brown sandy to clay loams with low concentrations of soil organic matter and low to moderate concentrations of nutrients.
- Surface soils rely mainly on stony surface lag materials rather than vegetation cover for stability against wind and water erosion.

- Variable pH values (ranging from 5.1 to 9.4). Despite this natural variation, the observed pH values are within typical ranges that support native vegetation in semi-arid regions of WA.
- Generally low salinity and low sodicity, with the exception of lakebed sediments at Jupiter.
- Generally low concentrations of heavy metals and metalloids.
- The average depth of recoverable surface soil and root-bearing gravels at Jupiter is variable. The average depth of recoverable surface soil and root-bearing gravels from gravelly colluvium and clay/loam alluvium is significantly lower (typically 100 mm), corresponding to a volume of 1,000 m^3/ha.
- Lakebed sediments and beaches at Jupiter are unsuitable for rehabilitation requirements as they are characterised by elevated salinity, high sodicity and very low wet strength. For these reasons, disturbance of these soils during the MMGP will be avoided.
- Gravelly/sandy colluvium soils associated with slopes and ridges will be preferentially placed on WRD batters.

2.5 Hydrogeology

The Project is located in the Goldfields Groundwater Area. Groundwater in the region typically occurs in the following units (from deepest to shallowest):

- Fresh and weathered Archaean basement fractured rock aquifers.
- Tertiary palaeochannel sands.
- Surficial deposits including lacustrine sediments, alluvium/colluvium and calcrete.

The Jupiter mine is located in Archean bedrock which is considered to have low aquifer potential. Hydraulic testing indicated that mean dewatering rate of 13 L/s will be required to maintain dry conditions at the Jupiter mine (GRM 2016b). Groundwater quality at Jupiter is typically pH neutral, hypersaline, and with generally low concentrations of metals and metalloids.

Low levels of groundwater have been extracted during mining operations of the Mt Marven open pit. It is expected these low levels will continue in the proposed southern extension. Any water extracted will be transported and used in the Jupiter processing plant.

2.6 Hydrology

The MMGP is located within the internally draining Lake Carey catchment which has a catchment area in the order of 113,900 km^2 and forms part of the Salt Lake Basin (total catchment area 441,000 km^2).

There are no major river systems in the vicinity of the MMGP, although there are several ephemeral creeks which generally drain in a north to south-east direction towards Lake Carey, which is the most dominant local hydrological feature. The bulk of runoff from around the MMGP reports to Lake Carey via a combination of surficial and shallow baseflow along the salt-lake drainage system.

Jupiter is situated on an upstream tributary to Lake Carey. A BIF ridge extending up to about 80 m above the lakebed lies between Jupiter and Lake Carey. Anecdotally water depths of up to about 600 mm have been witnessed on Lake Carey and other nearby playa lakes. Runoff entering the lake at this northern end continues down gradient towards the south, albeit at a slow rate due to the low gradient.

2.7 Flora and Vegetation

Two vegetation surveys have been completed over the extension area proposed to be cleared by MMWM. The outcomes of these surveys are detailed below.

Native Vegetation Solutions (2016)

Native Vegetation Solutions (NVS) were commissioned by Dacian in 2016 to undertake a Level 1 flora and vegetation survey of the Jupiter Project area, partially covering the location of the proposed Mt Marven WRD (Appendix 1).

A total of 18 major vegetation groups were recorded in the survey area that covered 4,641 ha. The vegetation units impacted by the proposed clearing for the Mt Marven WRD and Jupiter West WRD extension are displayed in Figure 3 described in Table 2.

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Very Good”, with few areas of “Good” vegetation condition, where exploration disturbance was more common.

No flora listed as Threatened or Priority were recorded in the survey area. No Threatened Ecological Communities (TECs) were recorded, however the survey area falls within the buffer region of the Priority 1 Priority Ecological Community (PEC) named "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station". This PEC is in place to protect the subterranean fauna community identified within the buffer zone. Given this, proposed clearing within the survey area is not likely to have an impact on this community.

Native Vegetation Solutions (2019)

NVS was commissioned by Dacian in 2019 to undertake a reconnaissance flora and vegetation survey of the Mt Marven area. A summary of the findings from the assessment are provided below with the full report provided in Appendix 2.

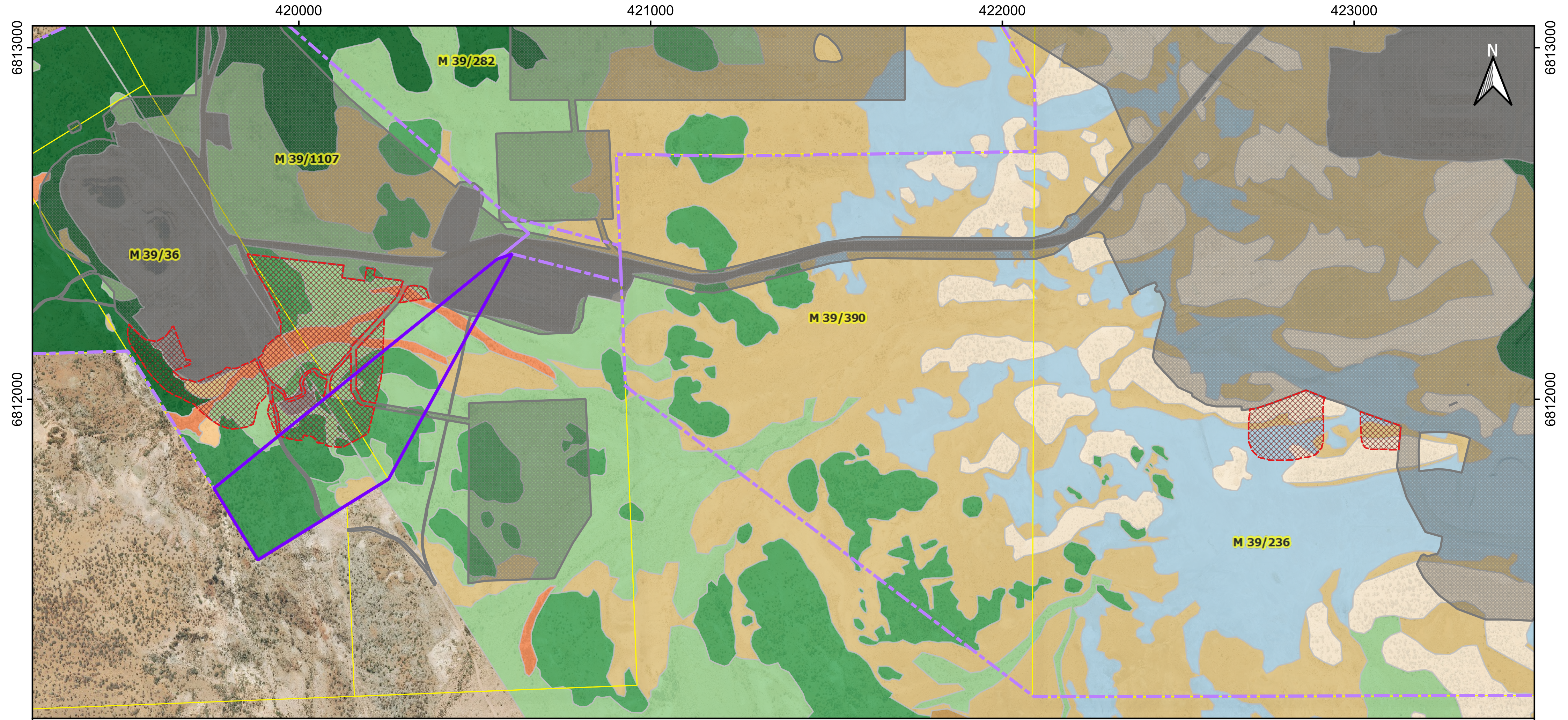
A total of 30 Families, 60 Genera and 156 Species were recorded within the entire survey area. Twelve major vegetation groups were recorded in the survey area of 498.69 ha. The vegetation units impacted by the proposed clearing are displayed in Figure 3 and described in Table 2.

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Very Good”, with other areas of “Good” vegetation condition, and “Degraded” where exploration disturbance was more common.

No Threatened Flora, TECs or PECs were recorded in the area. One Priority Flora species, *Olearia mucronata* (P3) was recorded at two locations within the Mount Marven survey area. The four plants recorded at these locations will not be impacted by the proposed clearing.

Table 2: Summary of Vegetation Communities

Vegetation Community	New Clearing (ha)	Total Mapped (ha)	% Impact
Jupiter WRD Extension			
Acacia mulganeura over *Eremophila forrestii* and grasslands	1.6656	388.204	0.4%
Bare Salt Lake	1.7934	462.6853	0.4%
Tecticornia shrubland	0.9738	612.8328	0.2%
Mt Marven Project Area			
Acacia aneura creekline vegetation	3.0018	40.5636	7.4%
Acacia over Chenopod shrubland	7.8243	899.8829	0.9%
Acacia over lower breakaways	0.0170	1.5610	1.1%
Acacia over *Maireana sedifolia* and other mixed shrublands	0.3505	0.8774	39.9%
Acacia shrubland on emergent hills	4.4777	93.7642	4.8%
Acacia shrubland on Greenstone rocky hills	1.2539	10.5932	11.8%
Acacia shrubland on undulating hills	1.3554	361.3830	0.4%
Tecticornia shrubland	0.5784	612.8328	0.1%
Existing Disturbance	1.3467	184.4990	0.7%



Legend

Clearing Permit
- Approved Clearing Permit Area
- Proposed Clearing Permit Amendment Area

Site Layout
- New Clearing
- Approved/Existing Clearing

- Tenements

Vegetation Mapping
(OES 2009, NVS 2016, NVS 2019)
- Tecticornia shrubland
- Tecticornia shrubland within laterite breakaways
- Bare Salt Lake
- Existing Disturbance
- Acacia over Chenopod shrubland
- Acacia over Maireana sedifolia and other mixed shrublands
- Acacia shrubland on emergent hills
- Acacia shrubland on Greenstone rocky hills
- Acacia shrubland on undulating hills
- Acacia aneura creekline vegetation
- Acacia over lower breakaways
- Acacia mulganeura over Eremophila forrestii and grasslands

Original Size: A4 Aerial: April 2019 Scale: 1:15000 Projection: GDA94 / MGA zone 51 0 100 200 300 400 500 m	**Mt Morgans WA Mining Pty Ltd** **Mt Morgans Gold Project** **NVCP Amendment**	**Figure 3** **Jupiter Project Area Vegetation Units**	DACIAN GOLD LIMITED

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2.8 Vertebrate Fauna and Habitat

Western Wildlife (2016)

A Level 1 fauna survey of the Mt Morgans Jupiter Project was undertaken by Western Wildlife in 2016 (Appendix 3). This survey was undertaken over five days in March 2016, with one frog, six reptiles, 54 birds and five mammals recorded opportunistically. Conservation significant species recorded were migratory shorebirds on Lake Carey.

Eleven fauna habitats were identified in the study area of which seven exist within or in close proximity to the proposed clearing:

- Acacia shrubland on low rocky hills.
- Chenepod shrubland.
- Samphire shrublands.
- Sandy hills and islets.
- Salt lake.
- Creeklines.
- Disturbed Areas.

The study area has the potential to support up to ten frog, 82 reptile, 141 bird and 32 mammal (24 native mammals) species. During the site visit one frog, six reptiles, 54 birds and five mammals were recorded opportunistically. A total of 20 fauna species of conservation significance have the potential to occur in the study area.

Of these, the Rainbow Bee-eater, Common Greenshank and Red-necked Stint were recorded in the project area. The Rainbow Bee-eater is likely to be a breeding visitor to the project area, but as its population is large and stable this species is unlikely to be significantly impacted by the development. Western Wildlife (2016) considered it unlikely that the Project will result in impacts to the status of conservation significant species.

Western Wildlife (2019)

A Level 1 fauna survey of the Mt Morgans Mt Marven project area was completed in 2019 by Western Wildlife (Appendix 4). Five fauna habitats (Figure 4) were identified in the Mt Marven project area including:

- Acacia shrubland on low rocky hills.
- Creeklines.
- Disturbed Area.
- Chenopod shrubland.
- Samphire shrubland.

The study areas have the potential to support up to ten frog, 85 reptile, 110 bird and 24 native mammal and nine introduced mammal species. Ten conservation significant fauna have been recorded or potentially occur in the Study Area.

The habitats in the Study Area are common and widespread in the subregion. The Low Rocky Hills may be refugia for fauna on a local level, providing cracks and crevices as shelter from extreme conditions. As the study area is set within a largely uncleared landscape and the habitats present are broadly distributed, it is unlikely to have particular importance as a regional ecological linkage. Creekline habitats potentially provide ecological linkage on a local level.

Of the habitats present in the study area, the Low Rocky Hills have some importance in supporting populations of the Long-tailed Dunnart (P4). The presence of this species in the region is likely to be determined by the availability of these habitats, and the loss of these habitats may lead to the local loss of this species. As only a small portion of the mapped habitat is to be disturbed, it is unlikely to cause a major impact to the local population.

A summary of the impact of the proposed clearing on the fauna habitats identified in the 2016 and 2019 surveys conducted by Western Wildlife is presented in Table 3 and shown in Figure 4.

Table 3: Summary of Fauna Habitats

Vegetation Community	New Clearing (ha)	Total Mapped (ha)	% Impact
Jupiter WRD Extension			
Salt Lake	1.7934	462.6856	0.4%
Samphire Shrubland	0.9738	615.0375	0.2%
Sandy hills and islets	1.6656	388.2038	0.4%
Mt Marven Project Area			
Acacia shrubland on low rocky hills	7.1390	483.0658	1.5%
Chenepod shrubland	8.1769	900.7795	0.9%
Creeklines	3.0027	40.5643	7.4%
Disturbed areas	1.3468	197.2132	0.7%
Samphire shrubland	0.5784	615.0375	0.1%

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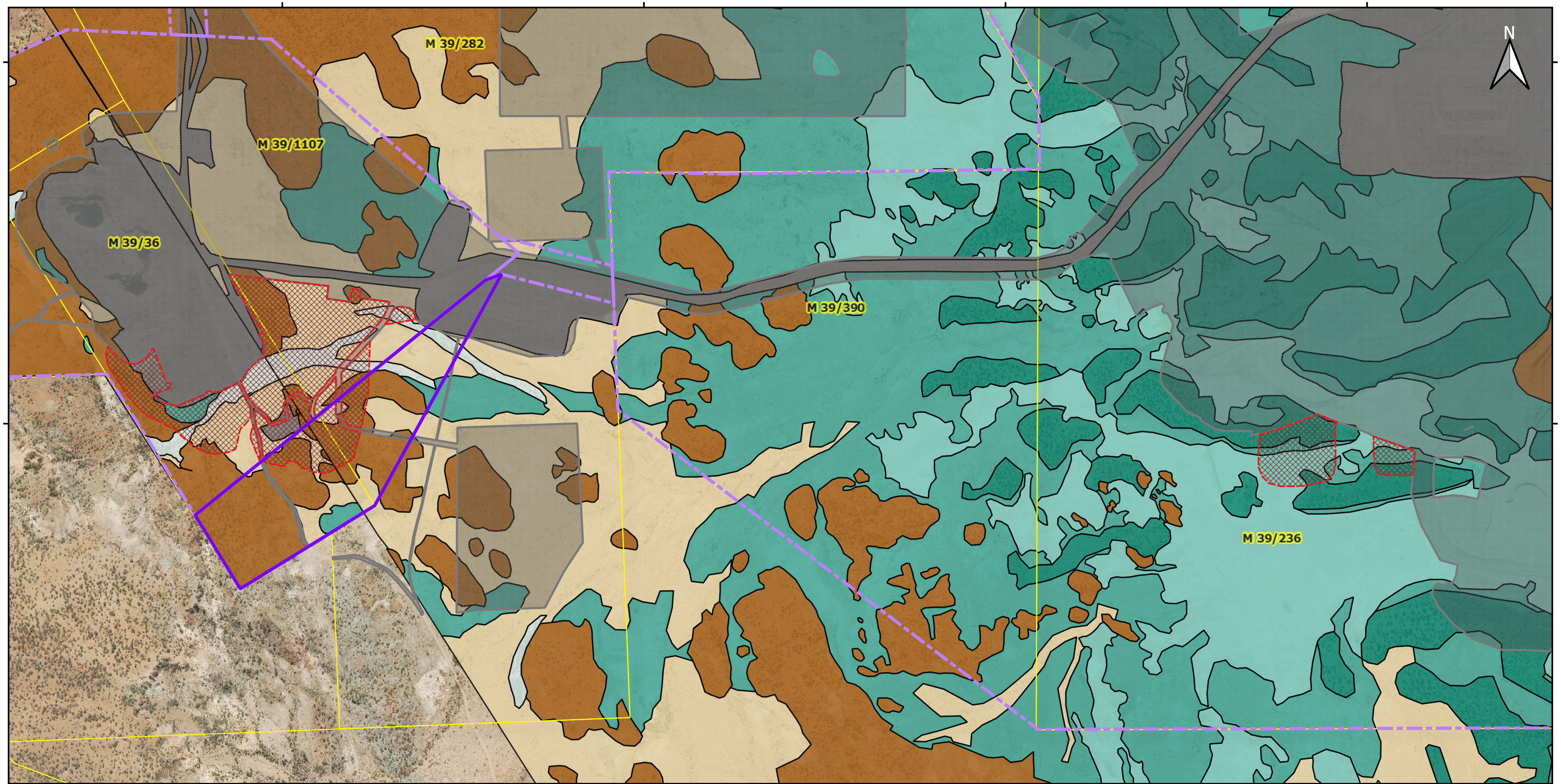

Legend

Clearing Permit
- Approved Clearing Permit Area
- Proposed Clearing Permit Amendment Area

Site Layout
- New Clearing
- Approved/Existing Clearing
- Tenements

Fauna Habitats (Western Wildlife 2016, 2019)
- Acacia shrubland on low rocky hills / Low rocky hills
- Chenopod shrubland
- Creeklines
- Salt lake
- Samphire shrubland
- Sandy hills and islets
- Disturbed areas

Original Size: A4
Aerial: April 2019
Scale: 1:15000
Projection: GDA94 / MGA zone 51

0 100 200 300 400 500 m

Mt Morgans WA Mining Pty Ltd
Mt Morgans Gold Project
NVCP Amendment

Figure 4

Jupiter Project Area Fauna Habitats

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2.9 Short Range Endemics

A Short Range Endemic (SRE) desktop assessment was completed for the MMGP by Bennelongia Environmental Consultants (BEC) in 2016 (Appendix 5).

Information contained in published literature, publicly available environmental reports and online databases were reviewed with regards to SRE species and their habitats. SRE status of species from the Project area and its vicinity was assessed according to the WA Museum SRE categories. All available landforms and macrohabitats in the study area were mapped and classified with regards to their suitability for SRE fauna.

The desktop assessments showed that that there are two habitat types in the proposed clearing areas that have a moderate or high prospect for SRE fauna: Minor Drainage Lines and Woodlands. The Minor Drainage Lines and Woodlands are common habitats and generally interconnected and not restricted at a local, subregional or regional scale extending far beyond the project boundaries (Bennelongia, 2016)

2.10 Subterranean Fauna

Bennelongia Environmental Consultants (Bennelongia) was commissioned to undertake a desktop assessment of subterranean fauna in the Jupiter Project area in 2017 (Appendix 6). Subterranean fauna distribution is closely linked to geology with both stygofauna and troglofaunal inhabiting subterranean spaces including interstices, voids, vugs, cavaties and fissures. Bennelongia examined the potential habitat and likelihood for subterranean fauna to occur within the Project area.

Bennelongia concluded that Jupiter was unlikely to provide suitable habitat due to the high salinity levels (>150,000 mg/L TDS). Low permeability aquifers also limit the potential for habitat. The relatively shallow water, lack of voids, high plant transpiration and arid environment make it unlikely that troglofaunal populations will establish in the Project area (Bennelongia, 2017).

2.11 Social Setting

2.11.1 Land Use and Community

The Mt Margaret Aboriginal Community is located 1.8 km north of the Mt Marven project area. The site of the Community was founded as a mission by the United Aborigines Mission in 1921, and drew in Aboriginal people from surrounding areas. Approximately 85 to 100 people currently reside in the settlement (Department of Planning 2012). The Community is managed through its incorporated body, the Aboriginal Movement for Outback Survival (AMOS). AMOS was incorporated under the *Aboriginal Councils and Associations Act 1976* (Cth) on 12 September 1997.

Mining has been a land use in the area since the 1890s and remains an active industry with a number of operational mines occurring within a 100 km radius, including Granny Smith, Sunrise Dam and Murrin-Murrin.

2.11.2 Aboriginal Heritage

A number of Aboriginal heritage surveys have been completed over the MMGP, dating back to the 1980s, culminating in the identification of numerous Aboriginal heritage sites. All heritage sites have been demarcated and are excluded from the proposed disturbance envelope in the MMGP Site Wide Mining Proposal Amendment (Reg ID 103705).

In 1994 Barrie Machin undertook and ethnographic survey that covered the Mt Marven tenements (Machin 1994). This survey involved consultation with an exhaustive list of twenty-five Aboriginal informants consulted over several fieldtrips for this survey. These informants represented six Aboriginal groups with heritage interests in the Goldfields region: The Goldfields Land and Sea Council, Burrna Yurrul Aboriginal Corporation, Wiltjinit Aboriginal

Corporation, Wongatha Wonganarra Aboriginal Corporation, Karrawang Christian Aboriginal Corporation, and AMOS. The results of this survey were as below:

‘There were no significant religious sites in leases. There were camping and hunting sites of historical interest in the vicinity of the leases but not in the lease areas…There are no Aboriginal objections to mining in the survey area (Machin 1994: 4).’

As a follow up to this survey to gauge contemporary views on the Mt Marven area, Dacian Gold undertook an archaeological and ethnographic survey of the Mt Marven area (LAS 2019). This survey involved consultation with senior men from the Wongatha Aboriginal community. No archaeological or ethnographic sites were identified during this survey by these senior Wongatha men. All Aboriginal informants were satisfied with the breadth of the ethnographic survey and endorsed the survey results.

2.11.3 European Heritage

There are no European heritage sites within the Jupiter area.

3 Proposed Additional Land Clearing

1.1 Overview of Operations

The MMGP comprises of three areas; Jupiter, Westralia and the Production Borefield. The Jupiter Project area comprises of two open pits (Mt Marven and Jupiter) and four WRDs (Jupiter North, Jupiter East, Jupiter West and Mt Marven North). The Mt Marven open pit comprises conventional drilling and blasting in 5 m lifts, with broken material excavated on 2.5 m flitches. Ore is transported to a surface Run-of-mine (ROM) pad before being hauled via road train to the Jupiter ROM for processing.

An amendment to the Site Wide Mining Proposal (Reg ID 103705) has been submitted to develop the Mt Marven South open pit extension and construct the Mt Marven South Waste Rock Dump (WRD). An extension to the Jupiter WRD is also required. These proposed activities will require an additional 25 ha of native vegetation clearing as outlined in Table 4.

Table 4: Proposed Clearing Areas

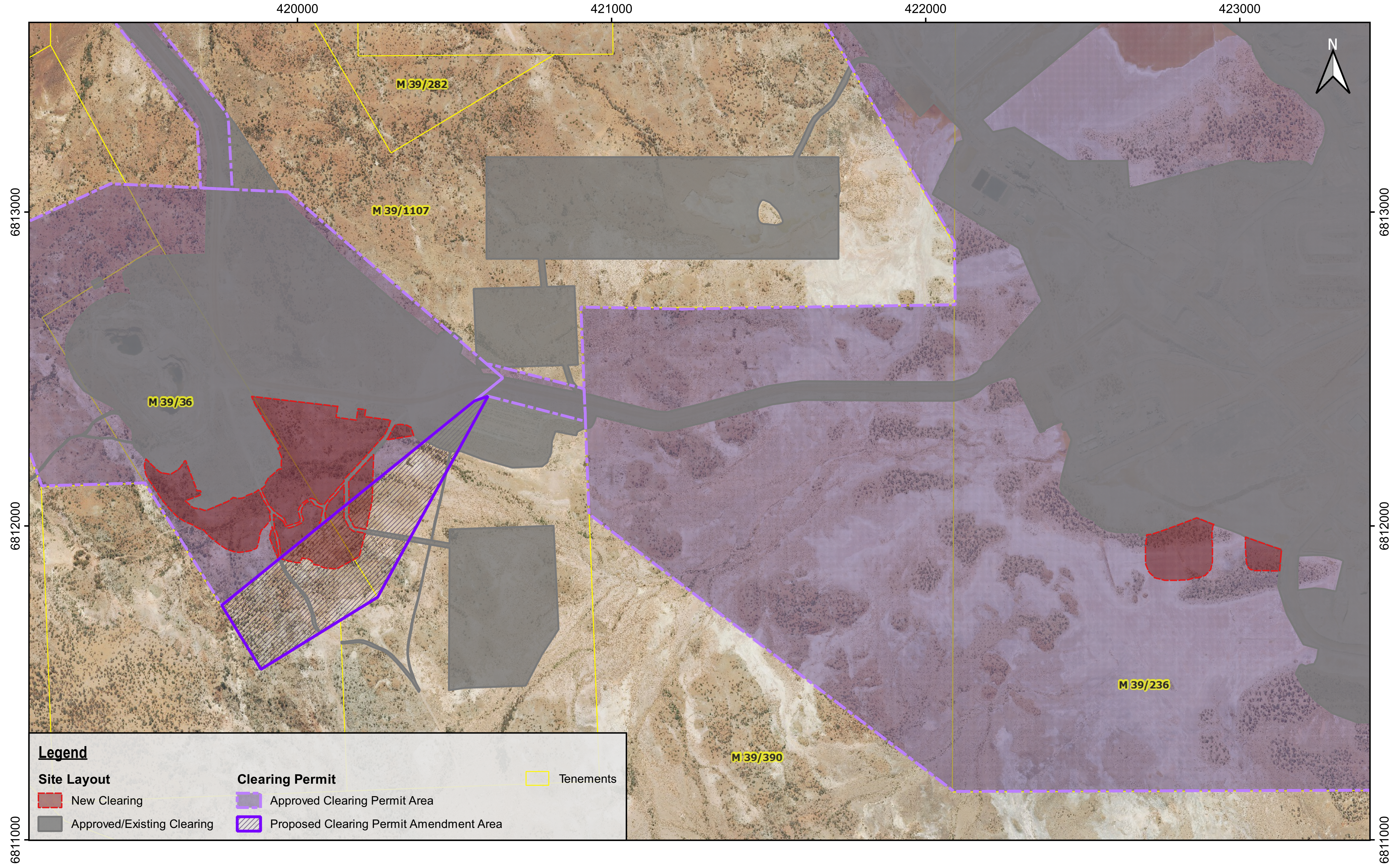
Infrastructure	New Clearing (ha)
Jupiter	
Jupiter West WRD Expansion	4.6
Mt Marven	
Mt Marven South open pit expansion	2.3
Mt Marven South WRD	13.6
Other Mine Activities	4.5
Total	**25**

1.2 Areas of Disturbance

This amendment to CPS 7408-3 seeks approval for the following changes:

- Increase the total amount of clearing from 740 ha to 765 ha.
- Increase total Purpose Permit area by 22 ha to include the proposed area for Mt Marven WRD to be cleared.

The proposed disturbance area is shown in Figure 5. A GIS shape file is provided for the clearing permit amendment area in MGA94 Zone 51. There may be minor variations made to the precise location and area of infrastructure.



Original Size: A4
Aerial: April 2019
Scale: 1:15000
Projection: GDA94 / MGA zone 51

0 100 200 300 400 500 m

Mt Morgans WA Mining Pty Ltd
Mt Morgans Gold Project
NVCP Amendment

Figure 5

Proposed Amendments to Clearing Areas and Purpose Permit Envelope

DACIAN GOLD LIMITED

C:\Users\HChin\RPMGLOBAL\ADV-AU-00293 Dacian - Mt Morgans - ESG - Mt Marven South and Jupiter ROM MP and MCP - Documents\01_ESG\06_GIS\ADV-AU-00293 - Dacian - Mt Marven South and Jupiter ROM CP.qgz 28/03/2022

4 Assessment of Clearing Principles

Clearing applications are assessed against 10 principles as outlined in Schedule 5 of the EP Act (Table 5). These principles aim to ensure that all potential impacts resulting from the removal of native vegetation can be assessed in an integrated way and applied to all lands throughout Western Australia. The principles address the four main environmental areas of biodiversity significance, land degradation, conservation estate and ground and surface water quality.

Information regarding the potential impact of clearing for mining activities on each of these principles for the project area is provided in Table 5.

Table 5: Native Vegetation Clearing Principles

Environmental Area	Clearing Principle	Assessment
Biodiversity Significance		
a.	Native vegetation should not be cleared if it comprises a high level of biological diversity.	• Vegetation communities and fauna habitats of the MMGP are considered widespread and well represented in the region. • No Threatened Ecological Communities or Environmentally Sensitive Areas were recorded in the Project area. • The vegetation units are not considered to support a high level of biological diversity.
b.	Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	• There are no restricted vegetation units that have been identified in the Project area that are considered significant for the maintenance of native fauna.
c.	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	• No flora species classified as Threatened under the *Biodiversity Conservation Act 1986* (WA) (BC Act) or *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) were recorded in the proposed areas to be cleared. • One Priority 2 species, *Olearia mucronata,* was recorded in the survey area, however is not located in the area proposed to be cleared.
d.	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	• No Threatened Ecological Communities or Environmentally Sensitive Areas were recorded in the Project area.
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.	• No remnant vegetation occurs within the Project area.
f.	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	• There are no major river systems in the vicinity of the MMGP, although there are several ephemeral creeks which drain generally in a north to south direction towards Lake Carey. Lake Carey and its tributaries are not listed on the Directory of Important Wetlands of Australia. • All the watercourses and drainages in the immediate vicinity of the project are ephemeral and for the majority of the year, the drainage systems are dry. • One vegetation group within the survey area, *Tecticornia* shrublands, is classified as riparian. The vegetation unit is dependent on surface water which is provided by rainfall onto the lake tributaries.

Environmental Area	Clearing Principle	Assessment
		• Less than 0.3% of the total mapped area of the *Tecticornia* shrublands unit will be disturbed by the proposed amendments. This unit occurs extensively outside the survey area. It is considered unlikely that this will have an appreciable impact on the health of the Lake Carey system.
Land Degradation		
g.	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	• The proposed vegetation clearing and mining operations will not cause any appreciable land degradation. • All disturbed areas will be rehabilitated at the completion of operations, or progressively throughout operation where it is practical to do so.
Conservation Estate		
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.	• There are no conservation estates in the vicinity of the Project.
Ground and Surface Water Quality		
i.	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	• Clearing of vegetation is unlikely to have an impact on the quality of groundwater. There are no groundwater dependant vegetation units within the Project area. The majority of clearing is occurring within the Jupiter Project area, where groundwater is hypersaline. • Clearing of vegetation around tributaries of Lake Carey has the potential to result in increased sediment loads. This will be minimised through installation of sediment control structures at locations where high sediment loads are anticipated or observed.
j.	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	• The Jupiter Project area, including Mt Marven, is located in a relatively flat to slightly undulating area which may on occasion be at risk of flooding following short intense rainfall events. All the watercourses and drainages in the immediate vicinity of the project are ephemeral and for the majority of the year, the drainage systems are dry. However, flows will occur periodically during high rainfall events. • Some localised increase in surface runoff may occur where vegetation is cleared. However, the impact is unlikely to be detectable in the context of the range of the natural variability of runoff. Any minor effects will be short term as the majority of the area cleared will be revegetated on completion of operations. • Flood protection infrastructure has been designed based on analysis of sub-catchment characteristics to ensure appropriately sized structures are built.

5 Site Land Clearing Approval Procedure

MMWM has developed a Land Clearing and Topsoil Disturbance Management Plan. A summary of key components of the clearing procedure is outlined in Table 6. The Land Clearing and Topsoil Disturbance Management Plan is provided in Appendix 7.

Table 6: Clearing Approval Procedure

No.	Description	Responsibility
1	Identify area of land requiring clearing. Produce a map that clearly shows the location and size of the area to be cleared.	Project Manager / Site Environmental Officer
2	Check that the area is within the boundaries approved by DMIRS for clearing.	Project Manager / Site Environmental Officer
3	Peg the area to be cleared with survey pegs and flagging tape such that the area to be cleared is clearly marked.	Project Manager / Site Environmental Officer
4	Inspect any earthworks equipment that has arrived at site or may have been used in an area where weed species are recorded. Ensure the underside of the machinery and implements are free of weed seeds, pieces of vegetation and caked mud or earth. Any machinery that is not free of weed seeds, vegetation or caked earth must not be allowed to operate until it is thoroughly cleaned. Equipment should only be cleaned at a designated vehicle wash bay.	Project Manager / Site Environmental Officer
5	Hold a pre-start meeting with the earthworks operators and supervisor to ensure they are advised of the following: • The exact requirements of the earthworks (e.g. where the clearing pegs are located). • Any clearing conditions specified in the permit (including depth of topsoil to be removed). • The location where vegetation and topsoil are to be stockpiled or re-spread. • The location of any environmental or heritage significant sites to avoid.	Project Manager / Site Environmental Officer
6	Once vegetation has been removed, commence the removal of topsoil to the depth specified by the Project Manager/Site Environmental Officer and in accordance with the Mining Proposal. Push the topsoil to the area where it is to be stored. If the topsoil is to be stockpiled elsewhere, push the topsoil into an area where it can be easily loaded and removed.	Earthworks Operator
7	Ensure the topsoil stockpile is less than two metres high, and is not located in an area where it can be inundated by water, driven over or disturbed.	Earthworks Operator / Site Environmental Officer
8	During earthworks, regularly inspect the activities and ensure the conditions of this procedure and associated approval documents are complied with.	Project Manager / Site Environmental Officer
9	Should any non-compliance with the permit conditions or this procedure, or the potential disturbance of an environmental or heritage significant site be noticed or suspected, immediately stop the earthworks until the issues are solved.	Project Manager / Site Environmental Officer
10	Undertake a post-clearing inspection, recording the final area of disturbance, location of the vegetation and topsoil stockpiles, volume and date.	Project Manager / Site Environmental Officer
11	Ensure all clearing is reported in the MMGP monthly operation reports and summarised in the annual environmental report submission.	Project Manager / Site Environmental Officer

6 Rehabilitation

Rehabilitation is the return of disturbed land to a safe, stable, productive, non-polluting and self-sustaining condition in consideration of beneficial uses of the land.

Rehabilitation of disturbed areas will generally involve:

- Design of landforms to produce safe and stable slopes.
- Design of landforms to manage water, including construction of water management structures.
- If required and subject to available material, armouring of final surfaces with cover material to increase surface stability.
- Replacement of available topsoil and vegetation.
- Ripping to break soil compaction and increase water infiltration ability.
- Seeding/planting and fertilising as required.

Rehabilitation, closure monitoring and maintenance programs will be initiated with the objective of ensuring the success of rehabilitation works, demonstrating achievement of completion criteria, and identifying the need for maintenance works as described in the Mine Closure Plan.

7 References

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8

APPENDICES

APPENDIX 1: LEVEL 1 FLORA AND VEGETATION SURVEY (NVS, 2016)

Level 1
Flora and Vegetation Survey
Dacian Gold Ltd
Mt Morgans Gold Project

Prepared for

FINAL
July 2016

Prepared by:
Native Vegetation Solutions
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FIGURES

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1 INTRODUCTION

Dacian Gold Limited (Dacian) is planning to develop the Mt Morgans Gold Project (the Project) located approximately 30 km south west of Laverton, in the northern goldfields of Western Australia. The Project is within the Eastern Murchison (MUR1) Subregion as delineated under the Biogeographic Regionalisation for Australia (IBRA) system.

The Project is a brownfields site that encompasses three historic operational areas, comprising:

- Westralia: Containing the Westralia and Transvaal pits, other satellite pits and historical processing areas;
- Jupiter: Containing the Jupiter pit and heap leach area, located approximately 15 km to the east of Westralia; and
- The Mt Morgans and Jupiter Borefields (hereafter referred to as the borefield), containing 14 bores constructed in a calcrete aquifer, of which 6 were pumped during the period 1985 - 1997 to supply raw water to the historic Westralia processing plant and Jupiter heap leach facility.

Dacian proposes to develop an open pit mining complex at Jupiter and three underground mines at Westralia. Associated infrastructure development will include a processing plant, tailings storage facility (TSF), Run of Mine (ROM) Pads, waste rock dumps, power plant, workshops, administration offices, borefield, camp, pipelines and roads.

Infrastructure at Westralia will be primarily located in existing disturbed areas with disturbance to native vegetation predominantly within the Jupiter area where the TSF and processing plant will be constructed.

Dacian commissioned NVS to complete a Level 1 Flora and Vegetation survey of the Project area from the 11th to 15th March 2016. A conceptual disturbance footprint and associated survey area was provided covering an area of approximately 4,641 hectares.

For the purpose of this report the survey is broken down into three areas:

- The proposed Jupiter mining and infrastructure area (2,902 ha);
- The proposed borefield area (1,699 ha); and
- The proposed camp (12.72 ha) and irrigation area (27.11 ha).

Maps of these areas are included in Figure 1, Figure 2 and Appendix 4.

Figure 1: Regional map of Project Area

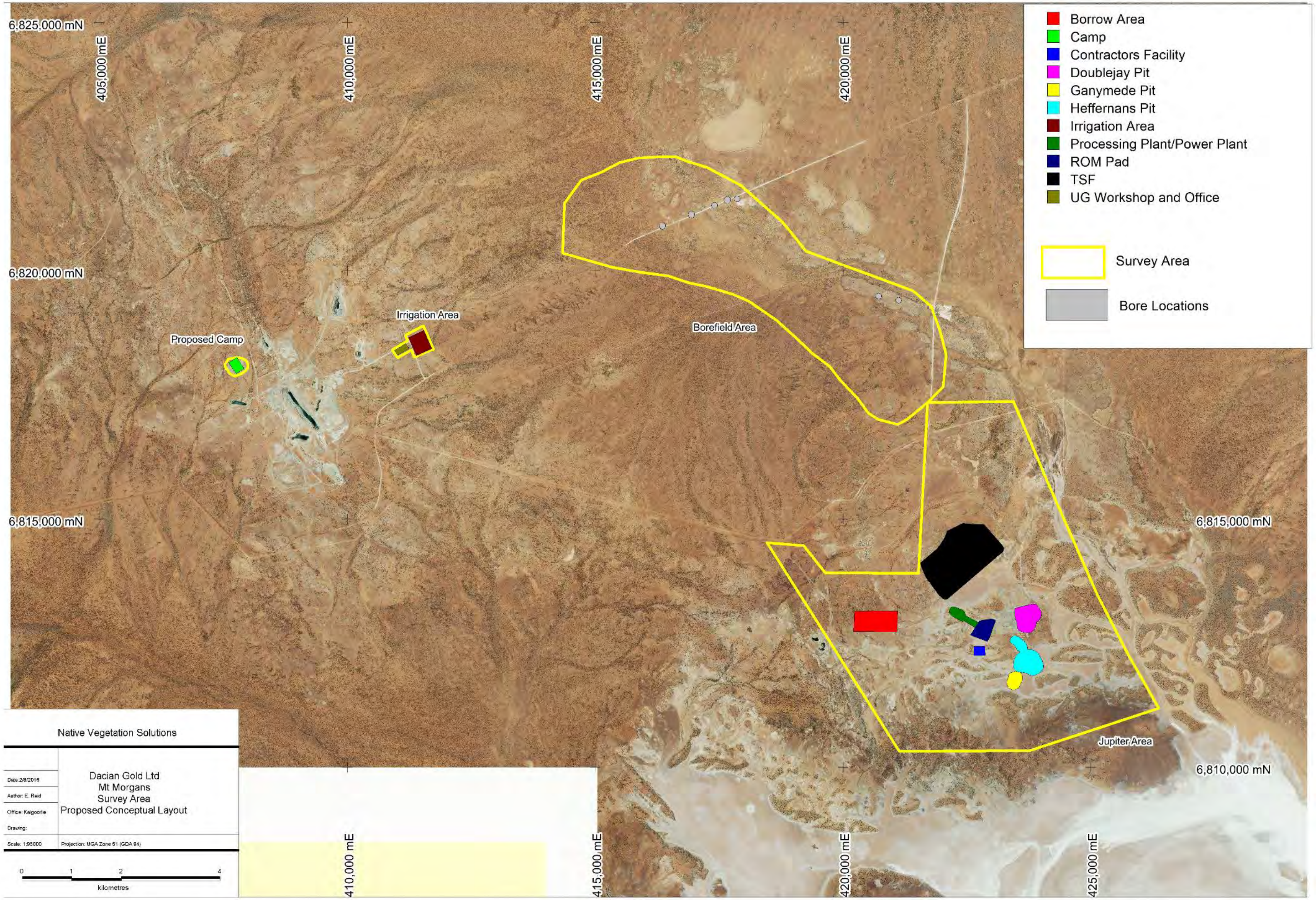

Figure 2: Survey Area and Conceptual Site Layout

1.1 Objectives

The objective of this report is to document the results of the flora and vegetation component of a Level 1 assessment conducted in accordance with the Environmental Protection Authority (EPA) "*Terrestrial Biological Surveys as an Element of Biodiversity Protection; Position Statement No 3*" (EPA, 2002) and *Guidance Statement No. 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004)", for the purpose of mining.

A Level 1 study has two components:
1). Desktop study which includes a literature review and a search of the relevant databases;

and

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.

EPA's *Position Statement No. 3* (EPA, 2002) provides indicative levels of biological survey in relation to the scale and nature of the impact and the sensitivity of the receiving environment. The EPA uses the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for Environmental Impact Assessment decision making in relation to the conservation of biodiversity. Given the scale and nature of the proposed disturbance, a Level 1 flora and vegetation assessment is considered suitable for the survey area.

Therefore, the scope of work for the Flora and Vegetation Survey was to:

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

1.2 Vegetation

The survey area lies in the Murchison (MUR) IBRA bioregion within the Eastern Murchison (MUR1) subregion which totals over 21 million hectares (CALM, 2002). The MUR1 subregion comprises vegetation dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (CALM, 2002).

1.3 Climate

The arid climate of the MUR1 subregion generally relies on winter rainfall (200 mm/pa) (CALM, 2002). The rainfall that occurs during the autumn and early winter months of May to July tends to be more reliable, though generally of a lesser total amount than the less dependable, but more intense summer cyclonic rainfall from December to March (Groundwater Resource Management, 2015).

The nearest official meteorological station to the survey area is located at Laverton, approximately 27 km northeast of the survey area. Recordings of the local climatic conditions commenced at Laverton in 1899 (BOM, 2016) and data collected at this station 012045 was used for this report.

1.3.1 Temperature

Mean annual minimum temperature is 13.2°C and mean annual maximum temperature is 27.3°C. The coldest month is July (mean minimum temperature 5.2°C), the hottest is January (mean maximum temperature 35.8°C) and diurnal temperature variations are relatively consistent throughout the year (Figure 3).

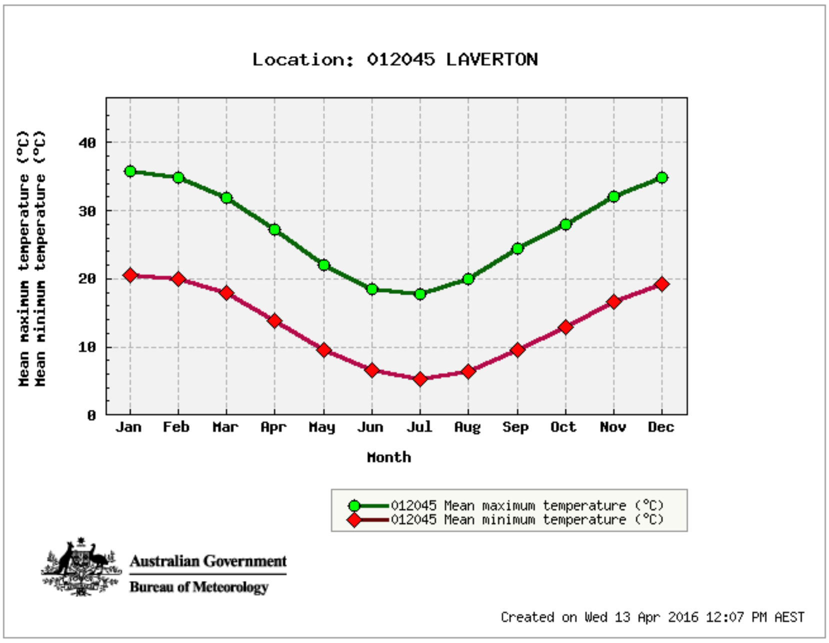

Figure 3: Mean Temperature ranges for the Laverton weather stations

1.3.2 Rainfall

The area is arid and the annual average rainfall at Laverton is 233.5 mm, which falls (>1 mm) on an average of 29.8 rain-days. Most of the rain usually falls between January and July and this amount varies greatly both seasonally and annually (Figure 4). Rainfall for January and February 2016 exceeded monthly averages, prior to the survey period. Rainfall data for March 2016 was not published by BoM at the time of writing this report, however Laverton Aero Weather Station (012305) recorded more than double the average rainfall for March 2016.

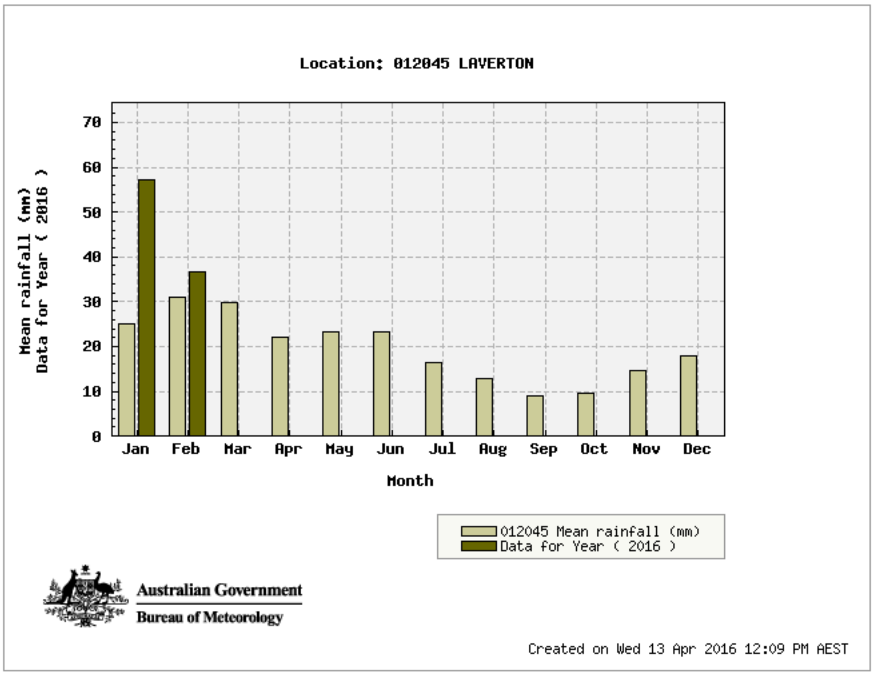

Figure 4: Monthly and mean rainfall for the Laverton weather station

2. ASSESSMENT METHODOLOGY

2.1 Preliminary Desktop Study

A preliminary assessment of the survey area and its potential constraints was undertaken by reviewing a number of government agency managed databases (see Appendix 1). The following sections provide a summary of the methodology used for each potential environmental aspect associated with the Project.

2.1.1 Environment Protection and Biodiversity Conservation Act Protected Matters

The *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Protected Matters Search tool was utilised to provide results for matters of National Environmental Significance within a 1 km buffer encompassing the survey area. (Search coordinates provided in Appendix 1) (http://www.environment.gov.au/arcgis-framework/apps/pmst/pmst-coordinate.jsf)

2.1.2 Threatened Flora and Communities

The Species and Communities Branch of the Department of Parks and Wildlife (DPaW) was contacted for a search of their databases containing known populations of threatened flora within a 40km buffer of GPS coordinates GDA94 51J 424230mE 6813029mN (Reference: 19-0316FL). Threatened flora include Declared Rare Flora (DRF- extant, now redefined as 'Threatened') and Priority Flora.

The presence of Threatened and Priority Ecological Communities (TECs & PECs) was determined by examining Geographic Information System (GIS) data supplied by the DPaW upon request within a 40km buffer of GPS coordinates GDA94 51J 424230mE 6813029mN (Reference: 18-0316EC).

2.1.3 Environmentally Sensitive Areas (ESAs) and Conservation Reserves

The Department of Environment Regulation (DER) Clearing Permit System Native Map Viewer was used to determine the location of any ESAs and Conservation Reserves (https://cps.der.wa.gov.au/main.html).

2.1.4 Vegetation Type, Extent and Status

Vegetation extent and status data was sourced from the Department of Agriculture and Food (DAFWA) report "Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit Report" and its associated GIS file. This data comprises Beard's Pre-European vegetation groups.

Note: This data was provided to Native Vegetation Solutions via a license agreement with the DAFWA.

DPaW's Statewide Vegetation Statistics (DPaW, 2014) was also referenced for the current extent of Beard's Vegetation Groups.

2.1.5 Wetlands

The location of wetlands within the project area was determined by examining DER's Clearing Permit System Native Map Viewer (https://cps.der.wa.gov.au/main.html).

2.1.6 Dieback

Dieback is only considered a potential issue for the project if both the mean annual rainfall of the area is >400mm, and if the project area resides south of the 26th parallel.

2.2 Site Investigation

A site visit was carried out by Botanist Eren Reid from NVS from the 11th to 15th March 2016 to examine the broad flora and vegetation groups contained within the survey area. A total of

60 hours was spent on site traversing the survey area. While a vehicle was used to reach the site, all traverses were made on foot or via Kawasaki Mule.

The survey was conducted in accordance with relevant EPA Statements and Guidelines (Section 1.1).

EPA's *Position Statement No. 3* (EPA, 2002) provides indicative levels of biological survey in relation to the scale and nature of the impact and the sensitivity of the receiving environment. The EPA uses the IBRA as the largest unit for Environmental Impact Assessment decision making in relation to the conservation of biodiversity. Given the scale and nature of the proposed disturbance and the project's location within the Murchison IBRA region, a Level 1 flora and vegetation survey was deemed appropriate.

2.2.1 Licenses

Flora was collected for identification under the Scientific Collection License SL011497 held by Mr E. R. Reid with expiry 09/07/2016.

2.3 Personnel and Reporting

The following personnel were involved in the preparation of this report:

- Eren Reid *BSc (Biological Science),* Principal Botanist, Native Vegetation Solutions, undertook the survey and prepared the report; and
- Frank Obbens *BSc* Consultant Botanist/Plant Taxonomist, undertook identification of unknown specimens collected during fieldwork.

2.4 Limitations

Table 1 lists potential limitations that may have affected the survey. These are based on the listing given by the EPA (2004).

Table 1: List of potential survey limitations

Potential Limitations	Constraint (Y/N)	Comment
Competency and experience of the consultants undertaking the survey	N	Mr Eren Reid is an experienced Botanist who has conducted many Flora and Vegetation surveys in the Goldfields, Pilbara and South-west regions of WA.
Proportion of flora identified during survey	N	The survey was planned to target species of conservation significance as well as document species present. Sufficient identifications were made to allow vegetation descriptions to be made.
Sources of information	N	Threatened and Priority Flora GIS information was available from DPaW.
Proportion of the task achieved	N	All tasks completed
Timing/Season	N	The targeted survey was conducted in Autumn 2016. Above Average rainfall in January, February and March 2016 allowed the emergence of many ephemeral species, with many other species in flower.
Disturbance in survey area	N	Disturbance was present with some minor access tracks present, as well as clearing associated with extensive exploration, in certain areas.
Intensity of survey effort	N	Transects were walked through the survey area with all parts visited
Resources	N	Adequate resources were available
Access problems	N	No problems with access
Availability of contextual information on the region	N	Information on the Murchison Bioregion area is readily available.

3. RESULTS

3.1 Preliminary Desktop Assessment

3.1.1 EPBC Act Protected Matters

The EPBC Protected Matters search tool revealed that the survey area could possibly be suitable habitat for weed species *Carrichtera annua* (Wards Weed) and *Cenchrus ciliaris* (Buffel Grass) (DOTE, 2016).

Carrichtera annua was introduced into Australia from the eastern Mediterranean, and is now widespread throughout South Australia, the Interior, and Western Australia (Lamp & Collet, 1999). This species is not listed as a declared plant by DAFWA (2015), 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 (DOTE, 2016).

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 *etc*. 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 a 1km buffer region of survey area.

The results of the EPBC Protected Matters search are included in Appendix 1.

3.1.2 Threatened Flora and Communities

The DPaW database searches revealed a potential for one Threatened and 41 Priority Flora species to occur within a 40km radius of the survey area (DPaW, 2016a). Two known locations of Priority Flora occur within the survey area. These species are *Tecticornia cymbiformis* (P3) and *Olearia mucronata* (P3).

The physical location of the DPAW location of *Tecticornia cymbiformis (P3)* was traversed within a 200m radius and no *Tecticornia* species were identified. This DPAW location was recorded in 1996, and the location may not be exact.

The physical location of the DPAW location of *Olearia mucronata (P3)* was traversed within a 200m radius and this species was not identified. *Olearia decurrens,* which is a non-threatened flora was located within the vicinity of this GPS location. This DPAW location was recorded in 1931, and perhaps the GPS location is inaccurate.

Results of the threatened flora database search are included in Appendix 2.

The PEC/TEC search (DPaW, 2016) revealed that the survey area does not contain any TECs or lie within any nearby TEC buffer regions.

However, the search did reveal the survey area falls within the buffer region of the Priority 1 PEC named "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station"

This PEC is designed to protect the subterranean fauna community identified within the buffer zone. Given this, proposed clearing within the survey area is not likely to have an impact on this community.

3.1.3 Environmentally Sensitive Areas and Conservation Reserves

No ESAs are located within the survey area (DER, 2016).

No Conservation Reserves were identified within the survey area (DOTE, 2016).

3.1.4 Vegetation Type, Extent and Status

Three vegetation units defined by Beard (1990) were identified as part of the desktop assessment. These vegetation units identify the Pre-European extent of vegetation, as mapped by Beard (1990).

Information relating to known Beard (1990) vegetation units within the survey area has been summarised in Tables 2, 3 and 4 below. This information has been compiled through both desktop assessments and the site visit.

Table 2: 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*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By Shire*** *(Shire of Laverton)*
	22,029,557*	19,892,304**	12,403,172**	10,269,896**	2,878,673**
% Pre-European Extent Remaining	*100.00%**	*99.76%***	*99.68%***	*99.66%***	*99.61%***
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DPaW, (2014)
*** Source: Field Assessment

Table 3: Summary of information regarding Pre-European and current vegetation extent of vegetation association 389 within the survey area

Factor	Value				
Beard Vegetation Association*	389				
Vegetation Association Description*	Succulent steppe with open low woodland; mulga over saltbush				
Pre-European Extent (ha)	**Scale**				
	By Association *(WA)*	***By Association*** *(WA)*	***By IBRA Region*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By Shire*** *(Shire of Laverton)*
	539,081*	642,356**	493,977**	493,977**	48,520**
% Pre-European Extent Remaining	*100.00%**	*99.71%***	*99.62%***	*99.62%***	*97.61%***
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DPaW, (2014)
*** Source: Field Assessment

Table 4: 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*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By Shire*** *(Shire of Laverton)*
	4,856,768*	6,613,569**	1,148,400**	711,328**	826,833**
% Pre-European Extent Remaining	*100.00%**	*99.83%***	*99.10%***	*98.68%***	*99.95%***
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

* Source: Shepherd *et al.* (2002) Appendix 2
**Source: DPaW, (2014)
*** Source: Field Assessment

3.1.5 Wetlands

Part of the Lake Carey water body occurs within the survey area (DER, 2016). This water body is not listed on the Directory of Important Wetlands of Australia.

One vegetation group within the survey area, *Tecticornia* shrublands, is classified as riparian vegetation and is considered water dependent. This is discussed further in Section 3.2.2.3.

3.1.6 Dieback

The survey area lies south of the 26th parallel however receives an average annual rainfall of 233.5mm, below the 400mm threshold mark. There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving <400mm rainfall per annum (CALM, 2003). Therefore, Dieback is not considered an issue for this survey area, however 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 plant taxa gazetted as DRF pursuant to subsection 2 of Section 23F of the *Wildlife Conservation Act 1950* were located in the survey area.

No plant taxa listed as Threatened pursuant to Schedule 1 of the *EPBC Act 1999* were located in the survey area.

No Priority flora species were recorded in the survey area.

3.2.2 Vegetation Type, Extent and Status

A total of 32 Families, 77 Genera and 195 Species were recorded within the entire survey area. Sixteen major vegetation groups were recorded in the survey area, excluding disturbed areas, and bare salt lakes. A summary of the vegetation groups (listed via their vegetation group code) can be seen in Table 5 below.

Table 5: Summary of taxa within vegetation groups and their spatial areas

Vegetation Group Code	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	Total
Family	15	14	7	6	17	11	16	13	13	16	14	15	4	12	11	9	0	0	**32**
Genus	25	29	10	6	29	16	26	15	22	21	18	28	4	23	17	12	0	0	**77**
Species	53	65	22	9	47	43	32	22	37	34	34	58	5	30	34	13	0	0	**195**
Area (ha)	12.73	1080.16	611.74	2.21	93.94	892.18	110.26	6.89	388.73	11.52	332.49	383.21	5.17	5.05	51.94	35.02	154.98	463.32	**4641.51**
Percentage of survey Area (%)	0.27	23.27	13.18	0.05	2.02	19.22	2.38	0.15	8.38	0.25	7.16	8.26	0.11	0.11	1.12	0.75	3.34	9.98	**100.00**

Most vegetation groups are considered to be in "Very Good" condition; with some areas "Good" (using the scale of Keighery 1994, see Appendix 3). Maps of the survey area can be seen in Appendix 4.

The vegetation groups are described in more detail in the sections below.

3.2.2.1 Rehabilitation Vegetation (a)

This vegetation group (Figure 5) consisted of 15 Families, 25 Genera and 53 Species. The vegetation group was approximately 12.73ha which makes up 0.27% of the survey area.

This area was previously a camp, which had been decommissioned and rehabilitated to a certain extent.

Some weed species are present here, including *Schinus molle var. areira* (Pepper Tree), *Nerium oleander* (Oleander), *Opuntia ?stricta* (Common Prickly Pear), *Salvia verbenaca* (Wild Sage) and *Cenchrus ciliaris* (Buffel Grass). These species (disregarding Buffel Grass) were most probably planted within the camp area, whilst it was previously operating.

Common Prickly Pear is listed as a Declared Pest (C3) according to the DAFWA's Western Australian Organism List (WAOL) (DAFWA, 2016).

Dominant species were *Acacia aneura, Acacia mulganeura, Eucalyptus clelandii, E. campaspe, E. torquata, Maireana pyramidata, Atriplex vesicaria* and *Senna artemisioides* subsp. *filifolia.*

Figure 5: Rehabilitation Vegetation within the survey area

3.2.2.2 *Acacia aneura* shrubland (b)

This vegetation group (Figure 6) consisted of 14 Families, 29 Genera and 65 Species. The vegetation group was approximately 1080.16 ha which makes up 23.27% of the survey area.

Dominant species were *Acacia aneura, A. mulganeura, A. pteraneura, A. craspedocarpa, Senna cardiosperma, Senna glutinosa* subsp. *chatelainiana, Eremophila platycalyx* subsp. *platycalyx* and *Eremophila compacta.*

Figure 6: *Acacia aneura* shrubland within the survey area

3.2.2.3 *Tecticornia* shrubland (c)

This vegetation group (Figure 7) consisted of 7 Families, 10 Genera and 22 Species. The vegetation group was approximately 611.74 ha which makes up 13.18% of the survey area.

Dominant species were numerous *Tecticornia* species, with occasional *Maireana glomerifolia, Sclerolaena cuneata, Atriplex vesicaria, Melaleuca interioris* and *Casuarina obesa.*

Figure 7: *Tecticornia* shrubland within the survey area

3.2.2.4 Kopai dunes with *Tecticornia* and *Casuarina* (d)

This vegetation (Figure 8) group consisted of 6 Families, 6 Genera and 9 Species. The vegetation group was approximately 2.21 ha which makes up 0.05% of the survey area.

Dominant species were *Casuarina obesa, Casuarina pauper, Acacia burkittii, Grevillea berryana, Exocarpos aphyllus, Tecticornia indica* subsp. *bidens, T. halocnemoides* subsp. *tenuis* and *T. disarticulata.*

Figure 8: Kopai dunes with *Tecticornia* and *Casuarina* within the survey area

3.2.2.5 *Acacia* shrubland on emergent hills (e)

This vegetation group (Figure 9) consisted of 17 Families, 29 Genera and 47 Species. The vegetation group was approximately 93.94 ha which makes up 2.02% of the survey area.

Dominant species were *Acacia aneura, A. pteraneura, A. grasbyi, A. tetragonophylla, Cratystylis subspinescens, Scaevola spinescens, Senna cardiosperma, Maireana sedifolia,* and *Eremophila oppositifolia* subsp. *angustifolia.*

Figure 9: *Acacia* shrubland on emergent hills within the survey area

3.2.2.6 *Acacia* over Chenopod shrubland (f)

This vegetation group (Figure 10) consisted of 11 Families, 16 Genera and 43 Species. The vegetation group was approximately 892.18 ha which makes up 19.22% of the survey area.

Dominant species were *Acacia aneura, A. mulganeura, A. pteraneura, Maireana pyramidata, Sclerolaena diacantha, Tecticornia indica* subsp*. bidens, T. peltata, T. undulata, Cratystylis subspinescens, Atriplex vesicaria* and *Atriplex bunburyana.*

Figure 10: ***Acacia*** **over Chenopod shrubland within the survey area**

3.2.2.7 *Acacia* over *Eremophila* and sclerophyll shrubland on BIF Ridges (g)

This vegetation group (Figure 11) consisted of 16 Families, 26 Genera and 32 Species. The vegetation group was approximately 110.26 ha which makes up 2.38% of the survey area.

Dominant species were *Acacia aneura, Eremophila georgei, Eremophila latrobei* subsp. *latrobei, Eremophila margarethae, Eremophila platycalyx* subsp. *platycalyx, Scaevola spinescens, Senna artemisioides* subsp. *helmsii, Solanum lasiophyllum* and *Dodonaea rigida.*

Figure 11: ***Acacia*** **over** ***Eremophila*** **and sclerophyll shrubland on BIF Ridges within the survey area**

3.2.2.8 *Tecticornia* shrubland within Laterite breakaways (h)

This vegetation group (Figure 12) consisted of 13 Families, 15 Genera and 22 Species. The vegetation group was approximately 6.89 ha which makes up 0.15% of the survey area.

Dominant species were *Tecticornia disarticulata, T. indica subsp. bidens, T. peltata, Frankenia setosa, Dodonaea lobulata, Pittosporum angustifolium and Eremophila pantonii.*

Figure 12: *Tecticornia* shrubland within Laterite breakaways within the survey area

3.2.2.9 *Acacia mulganeura* over *Eremophila forrestii* and grasslands (i)

This vegetation group (Figure 13) consisted of 13 Families, 22 Genera and 37 Species. The vegetation group was approximately 388.73 ha which makes up 8.38% of the survey area.

Dominant species were *Acacia mulganeura A. caesaneura, A. aneura, A. craspedocarpa, Eremophila forrestii* subsp. *forrestii, Scaevola spinescens, Eragrostis eriopoda, Eremophila platythamnos* subsp. *exotrachys, Crenidium spinescens* and *Triodia basedowii.*

Figure 13: *Acacia mulganeura* over *Eremophila forrestii* and grasslands within the survey area

3.2.2.10 *Acacia aneura* creekline vegetation (j)

This vegetation group (Figure 14) consisted of 16 Families, 21 Genera and 34 Species. The vegetation group was approximately 11.52 ha which makes up 0.25% of the survey area.

Dominant species were *Acacia aneura, Acacia caesaneura, Acacia mulganeura, Acacia tetragonophylla, Eremophila oppositifolia* subsp. *angustifolia, Scaevola spinescens, Ptilotus obovatus, Senna artemisioides* subsp. *sturtii, Lepidium platypetalum,* and *Spartothamnella teucriiflora.*

Figure 14: *Acacia aneura* creekline vegetation within the survey area

3.2.2.11 *Acacia* shrublands on undulating hills (k)

This vegetation group (Figure 15) consisted of 14 Families, 18 Genera and 34 Species. The vegetation group was approximately 332.49 ha which makes up 7.16% of the survey area.

Dominant species were *Acacia resinimarginea, Acacia aneura, Calytrix erosipetala, Eremophila georgei, Eremophila forrestii* subsp. *forrestii, Dodonaea rigida, Chrysocephalum puteale, Eremophila latrobei* subsp. *filiformis* and *Senna artemisioides* subsp. *helmsii.*

Figure 15: ***Acacia* shrublands on undulating hills within the survey area**

3.2.2.12 *Acacia aneura* woodland over *Maireana sedifolia* and *Acacia victoriae* mixed shrubland (l)

This vegetation group (Figure 16) consisted of 15 Families, 28 Genera and 58 Species. The vegetation group was approximately 383.21 ha which makes up 8.26% of the survey area.

This vegetation group is considered to occur on top of the Priority 1 PEC "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station". The soils here were raised and calcrete, and the PEC boundary buffer provided by DPAW is cantered on this vegetation group outline.

Dominant species were *Acacia aneura, A. pteraneura, Maireana sedifolia, Atriplex bunburyana, Maireana tomentosa, Acacia victoriae* subsp. *victoriae, Cratystylis subspinescens Eremophila miniata, Solanum plicatile, Solanum austropiceum, Acacia kempeana* and *Eremophila longifolia.*

Figure 16: *Acacia aneura* woodland over *Maireana sedifolia* and *Acacia victoriae* mixed shrubland within the survey area

3.2.2.13 *Acacia* shrubland on lower breakaways (m)

This vegetation group (Figure 17) consisted of 4 Families, 4 Genera and 5 Species. The vegetation group was approximately 5.17ha which makes up 0.11% of the survey area.

Dominant species were *Acacia kalgoorliensis, Tecticornia, peltata, T. pergranulata* subsp. *elongata, Frankenia georgei* and *Sida calyxhymenia.*

Figure 17: ***Acacia*** **shrubland on lower breakaways within the survey area**

3.2.2.14 *Acacia oswaldii* shrubland (n)

This vegetation group (Figure 18) consisted of 12 Families, 23 Genera and 30 Species. The vegetation group was approximately 5.05 ha which makes up 0.11% of the survey area.

Dominant species were *Acacia oswaldii, Brachychiton gregorii, Acacia ligulata, Acacia caesaneura, Jacksonia arida, Eragrostis eriopoda, Enneapogon caerulescens, Gunniopsis quadrifida* and *Pimelea microcephala,* subsp. *microcephala.*

Figure 18: ***Acacia oswaldii*** **shrubland within the survey area**

3.2.2.15 *Acacia burkittii* shrubland (o)

This vegetation group (Figure 19) consisted of 11 Families, 17 Genera and 34 Species. The vegetation group was approximately 51.94 ha which makes up 1.12% of the survey area.

Dominant species were *Acacia burkittii, Grevillea berryana, Acacia victoriae* subsp. *victoriae, Acacia tetragonophylla, Senna artemisioides* subsp. *filifolia, Acacia ayersiana, Acacia caesaneura, Melaleuca interioris* and *Enneapogon caerulescens.*

Figure 19: *Acacia burkittii* shrubland within the survey area

3.2.2.16 Open *Melaleuca* shrubland (p)

This vegetation group (Figure 20) consisted of 9 Families, 12 Genera and 13 Species. The vegetation group was approximately 35.02 ha which makes up 0.75% of the survey area.

Dominant species were *Melaleuca hamata, Duma florulenta, Spartothamnella teucriiflora* and *Rhagodia eremaea.*

Figure 20: Open *Melaleuca* shrubland within the survey area

3.2.2.17 Existing Disturbance (q)

These areas had been previously heavily disturbed, including pits waste dumps and haul roads. The total area of existing disturbance was approximately 154.98 ha which makes up 3.34% of the survey area.

3.2.2.18 Bare Salt Lakes (r)

This vegetation group (Figure 21) consisted of no species. The vegetation group was approximately 463.32 ha which makes up 9.98% of the survey area.

Figure 21: Bare Salt Lakes within the survey area

3.2.3 Weeds

Eight weed species were recorded within the survey area, *Schinus molle var. areira* (pepper tree), *Nerium oleander* (Oleander), *Opuntia ?stricta* (Common Prickly Pear), *Salvia verbenaca* (Wild Sage), *Cenchrus ciliaris* (Buffel Grass), *Acetosa vesicaria* (Ruby Dock), *Lysimachia arvensis* (Pimpernel) and Nicotiana glauca (Tobacco Tree) (Hussey *et al,* 2007).

Only one of these species, Common Prickly Pear, is considered a Declared Pest by DAFWA (DAFWA, 2016). This species was restricted to the rehabilitation vegetation group at the proposed new camp area.

This species should have some form of management applied that will alleviate the harmful impact of the species, reduce the numbers or distribution of the species or prevent or contain the spread of the species.

3.2.4 Vegetation Condition

Evidence of cattle and rabbits was observed during the field assessment.

Overall, the condition of the vegetation was determined to be "Very Good" with some areas in "Good" condition. Most disturbances were in the form of tracks and grazing, whilst more heavily disturbed areas were from exploration activities.

4. DISCUSSION

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Very Good”, with few areas of “Good” vegetation condition, where exploration disturbance was more common.

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

The survey area falls within the buffer region of the Priority 1 PEC named "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station". This PEC is in place to protect the subterranean fauna community identified within the buffer zone. Given this, proposed clearing within the survey area is not likely to have an impact on this community.

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.

Riparian (creekline) vegetation was identified near the shoreline of Lake Carey.

The following recommendations arise from the Level 1 flora and vegetation survey:

- Where possible, clearing be aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale intact native vegetation;
- Weed control measures to be implemented during and following clearing; and
- Disturbance to Riparian vegetation be kept to a minimum near the Lake Carey shoreline.

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6. GLOSSARY

Acronyms:

BoM	Bureau of Meteorology, Australian Government
BSc	Bachelor of Science
CALM	Department of Conservation and Land Management (now DPaW and DER)
DAFWA	Department of Agriculture and Food, Western Australia
DER	Department of Environment Regulation, Western Australia
DMP	Department of Mines and Petroleum, Western Australia
DRF	Declared Rare Flora
DotE	Department of the Environment, Australian Government
DPaW	Department of Parks and Wildlife, 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* (Federal Act)
ESA	Environmentally Sensitive Area
GIS	Geographical Information System
ha	Hectare (10,000 square metres)
IBRA	Interim Biogeographic Regionalisation for Australia
IUCN	International Union for the Conservation of Nature and Natural Resources – commonly known as the World Conservation Union
km	Kilometres
m	Metres
NVS	Native Vegetation Solutions
PEC	Priority Ecological Community, Western Australia
TEC	Threatened Ecological Community
WA	Western Australia

Definitions:

{DPaW (2015) Conservation Codes for Western Australian Flora and Fauna. Department of Parks and Wildlife, Western Australia}:-

T Threatened species:
Published as Specially Protected under the *Wildlife Conservation Act 1950,* listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act. 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. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species
Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species
Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species
Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement
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 the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna
Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna
Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species
Species which are poorly known; or Species that are adequately known, are rare but not threatened, and 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 One - 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 Two - 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 Three - 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 Four - 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

Australian Government

Department of 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.

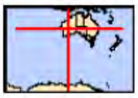
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 13/04/16 11:49:26

Coordinates

Buffer: 1.0Km



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:	2
Listed Migratory Species:	7

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
Commonwealth Reserves Marine:	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:	9
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		
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 likely to 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		
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
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
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 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		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may 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
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		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
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Capra hircus		
Goat [2]		Species or species habitat likely to occur within area
Equus asinus		
Donkey, Ass [4]		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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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

-28.759 122.04,-28.715 122.147,-28.761 122.228,-28.835 122.259,-28.837 122.191,-28.759 122.04

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
-Parks and Wildlife Commission NT, Northern Territory Government
-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, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-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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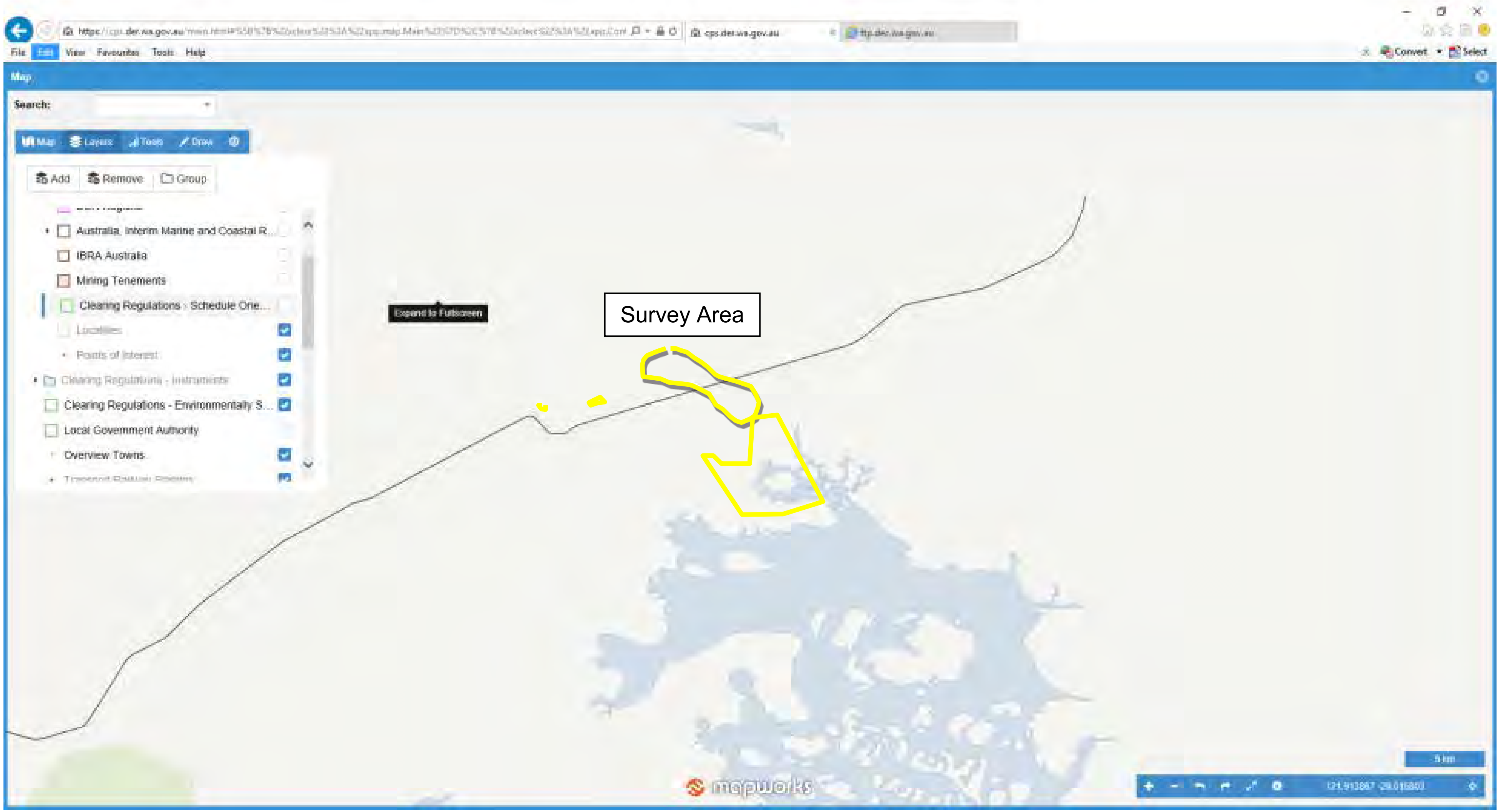
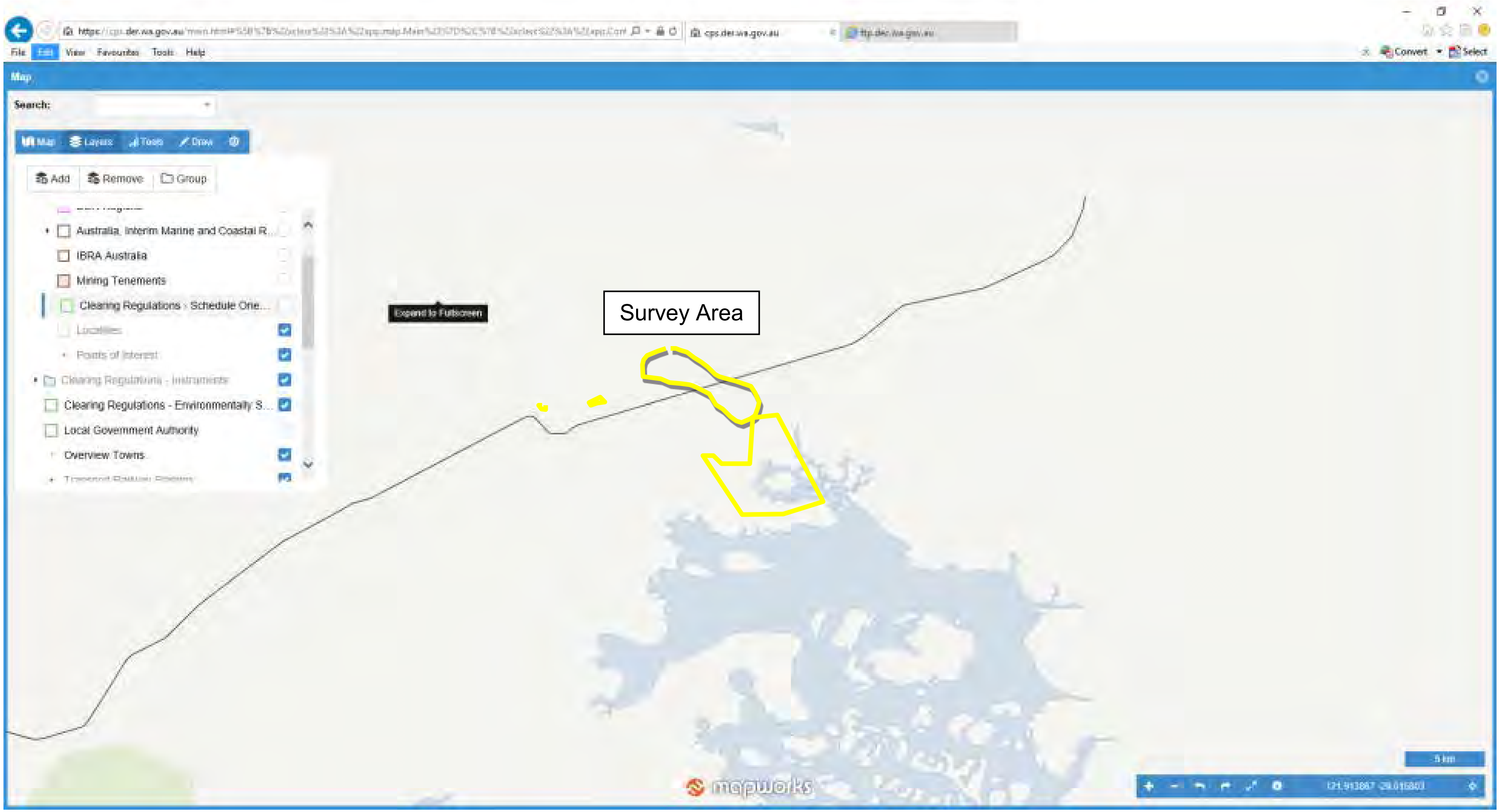
Canberra ACT 2601 Australia
+61 2 6274 1111



DER Clearing Permit System Map Viewer showing no ESA's (dark green shaded areas) within the survey area (DER, 2016)



DER Clearing Permit System Map Viewer showing part of the Lake Carey water body within the survey area (DER, 2016)

Appendix 2

Threatened Flora Databases Search Results

Taxon	Status	Distribution	Flowering Period
Acacia eremophila numerous-nerved variant (A.S. George 11924)	3	Norseman, Neale Junction, Great Victoria Desert, Balladonia, Plumridge Lakes	Sep,Jul
Acacia websteri	1		
Angianthus prostratus	3	Glenorn Stn, Baladjie Lake NR, Quairading, Lake Barlee, Bulga Downs Stn, Kalgoorlie	Jul-Sept
Beyeria lapidicola	1	Bulga Downs, Weld Range, Lake Way Stn.	Jul
Bossiaea eremaea	3	Merolia Stn, Sandstone, White Cliffs Stn	Jul-Sep
Caesia talingka	2	Plumridge Lakes N.R.	
Calytrix hislopii	3	Black Range Stn., Lake Mason Stn., White Cliffs Stn.	Sep
Calytrix praecipua	3	Melita Station, Laverton, Youno Downs, Wanjarri, Marymia, Erong Hmstd, Niagara Dam	Jun-Nov
Cratystylis centralis	3	Barwidgee Stn, Leonora	Aug-Nov
Dicrastylis cundeeleensis	4	Cundeelee, Plumridge Lakes, Rawlinna	Apr, Oct-Dec
Eremophila annosocaulis	3	Mt Morgans Mine (South of Leonora-Laverton Rd), Von Treuer Tableland	
Eremophila arachnoides subsp. tenera	1	Kambalda, Laverton	Sep,Dec
Eremophila dendritica	2	Rawlinna, Plumridge Lakes	Sep-Oct
Eremophila eversa	1	Yerilla	Oct
Eremophila mirabilis	2	Niagara, Morapoi, Kookynie, Woolgorong, Menzies	Aug-Sep
Eremophila simulans subsp. megacalyx	3	Mt Narryer, Boolardy Stn, Leonora	Aug-Sep
Goodenia lyrata	3	Laverton, Newman	
Gunniopsis propinqua	3	Laverton, Mt Margaret, Lake Carnegie, Windidda, Mt Eureka, Mt James, Menzies	Aug-Sep
Hemigenia exilis	4	Lake Darlot, Yakabindie, Leinster, Leonora, Mt Keith	Apr,May,Aug
Homalocalyx echinulatus	3	Carnegie Stn, Wiluna, Doolgunna Stn, Weld Range, Mount Hale, Windidda, Wongawal Stn	Dec
Hybanthus floribundus subsp. chloroxanthus	3	Leonora, Laverton	Aug-Oct
Lechenaultia aphylla	1	Cosmo Newbey - Laverton, SA	
Lechenaultia divaricata	1	Plumridge Lakes	Oct
Micromyrtus placoides	3	Cue, Weld Range, Mt Narryer, Tallering Peak	Aug,Sep
Micromyrtus serrulata	3	Karonie, Coonana, Melita, Jeedamya, Niagara Dam NR, Cardunia Rocks, Queen Victoria Spring NR	Mar,Jun,Nov
Mirbelia stipitata	3	Nth Sandstone, Nth Laverton	-
Olearia arida	4	Neale Junction, Plumridge Lakes, Great Victoria Desert	Jul
Olearia mucronata	3		
Persoonia leucopogon	1	Between Coolgardie & Laverton, Comet Vale (Menzies)	-
Philotheca linearis	1	White Cliffs Stn, Central Australia	Jul
Philotheca tubiflora	1	E of Laverton	Jun,Aug,Oct
Phyllanthus baeckeoides	3	Laverton, Merolia Stn, White Cliffs Stn, Windimurra Station, Cashmere Downs Stn, Leinster, Banjawarn Stn	Jul-Sep
Prostanthera petrophila	3	Cue, Mt Barloweerie, Woolgorong, Weld Range,	Jul-Aug
Ptilotus blackii	3	Plumridge Lakes N.R., Zanthus, Queen Victoria Springs N.R., S.A. N.T.	May-Sep
Ptilotus tetrandrus	1	Glenorn Station, Little Sandy Desert	Oct
Tecticornia cymbiformis	3		
Tecticornia mellaria	1		
Tecticornia sp. Lake Way (P. Armstrong 05/961)	1		
Thryptomene nealensis	3	Leinster, White Cliffs Stn, Neale Junction, Gt Victoria Desert	Oct
Thryptomene wittweri	T	Hamersley Range, Mt Augustus, Carnarvon Range, White Cliffs Stn, NT	Aug-Oct
Vittadinia cervicularis var. oldfieldii	1	Merredin, Laverton	
Vittadinia pustulata	3	Plumridge Lakes N.R., Morgan Range	

Appendix 3

Vegetation Condition Scale (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.

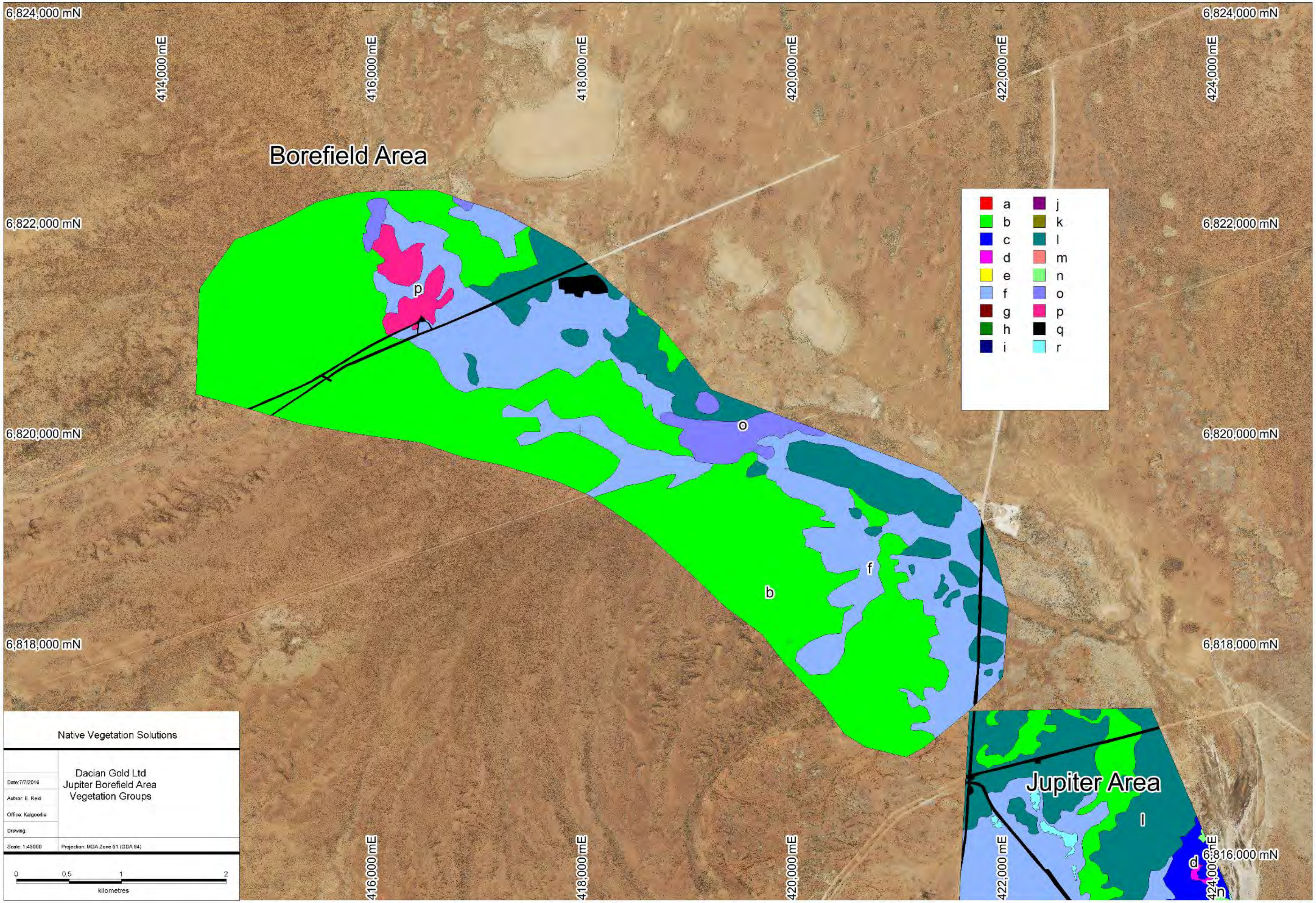
Good (4). Vegetation structure significantly altered by very obvious signs of multiple disturbance.
Retains basic vegetation structure or ability to regenerate it.
For example, disturbance to vegetation structure caused by frequent fires, the presence of some very aggressive weeds at high density, partial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

Appendix 4

Vegetation Mapping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Native Vegetation Solutions
Dacian Gold Ltd
Jupiter Borefield Area
Vegetation Groups
Date:7/7/2016
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:45000
Projection: MGA Zone 51 (GDA 94)
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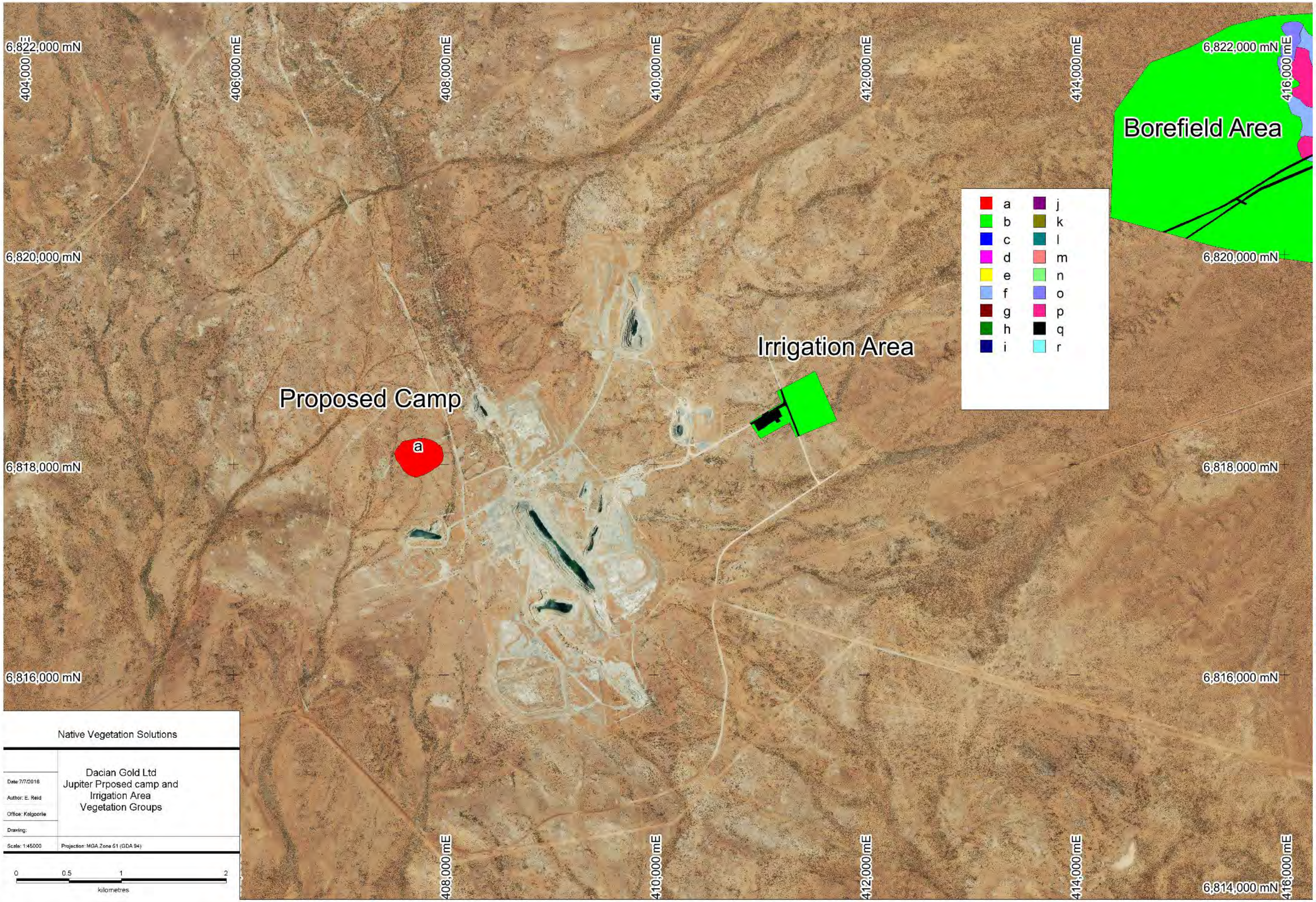
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Dacian Gold Ltd
Jupiter Prposed camp and
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Author: E. Reid
Office: Kalgoorlie
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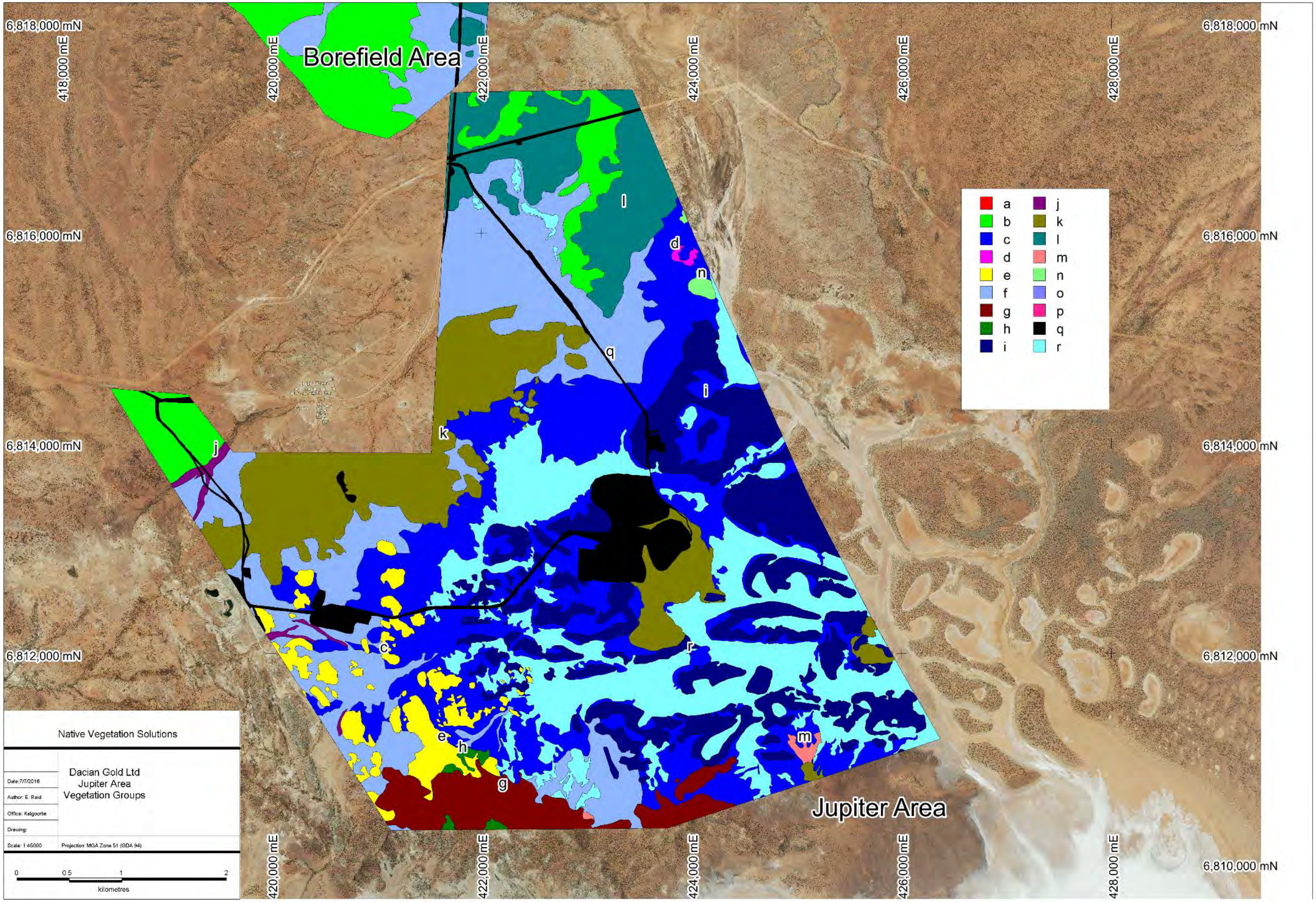
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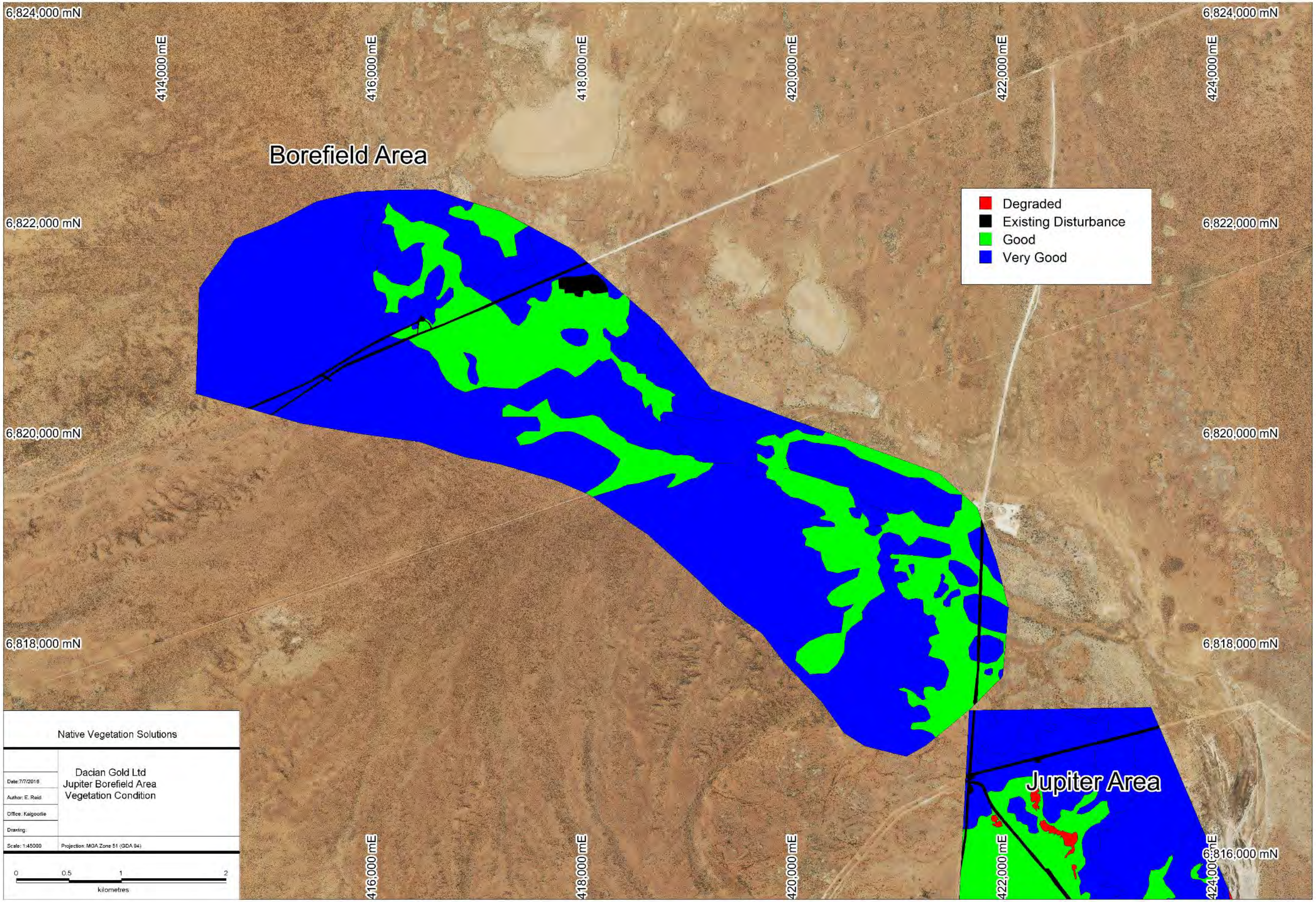
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Native Vegetation Solutions
Dacian Gold Ltd
Jupiter Borefield Area
Vegetation Condition
Date:7/7/2018
Author: E. Reid
Office: Kalgoorlie
Drawing:
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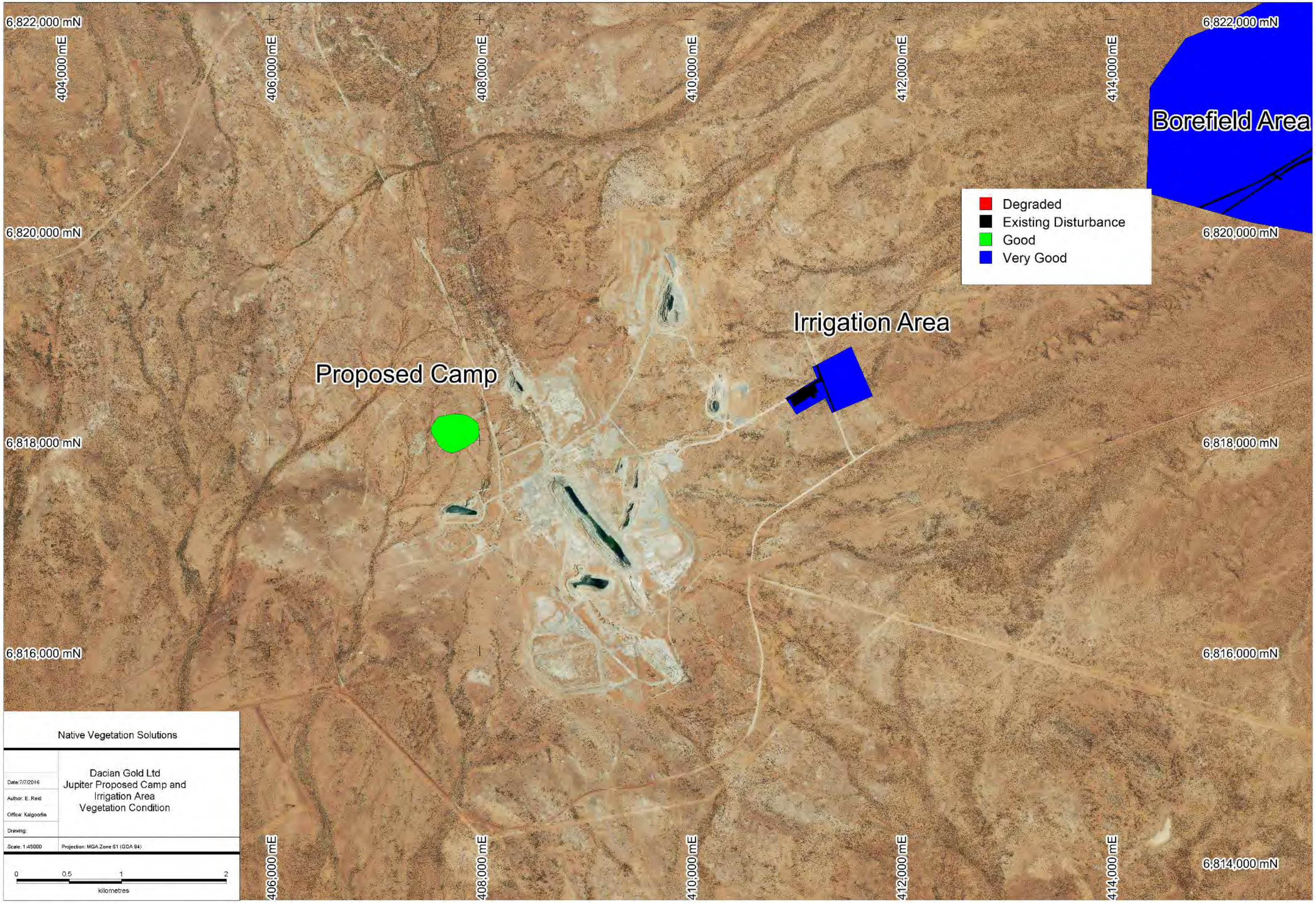
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Jupiter Proposed Camp and
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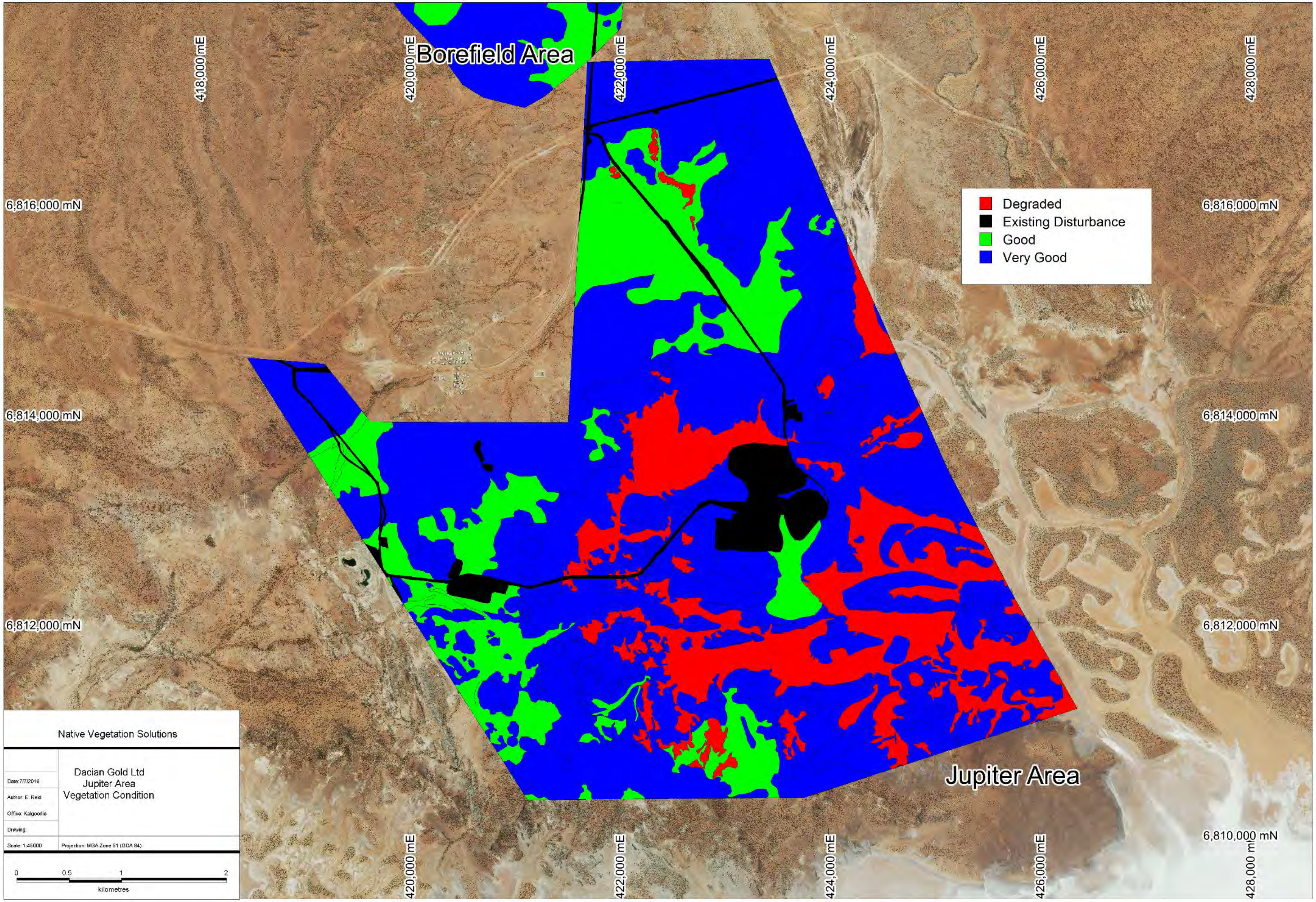
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Native Vegetation Solutions
Dacian Gold Ltd
Jupiter Area
Vegetation Condition
Date:7/7/2016
Author: E. Reid
Office: Kalgoorlie
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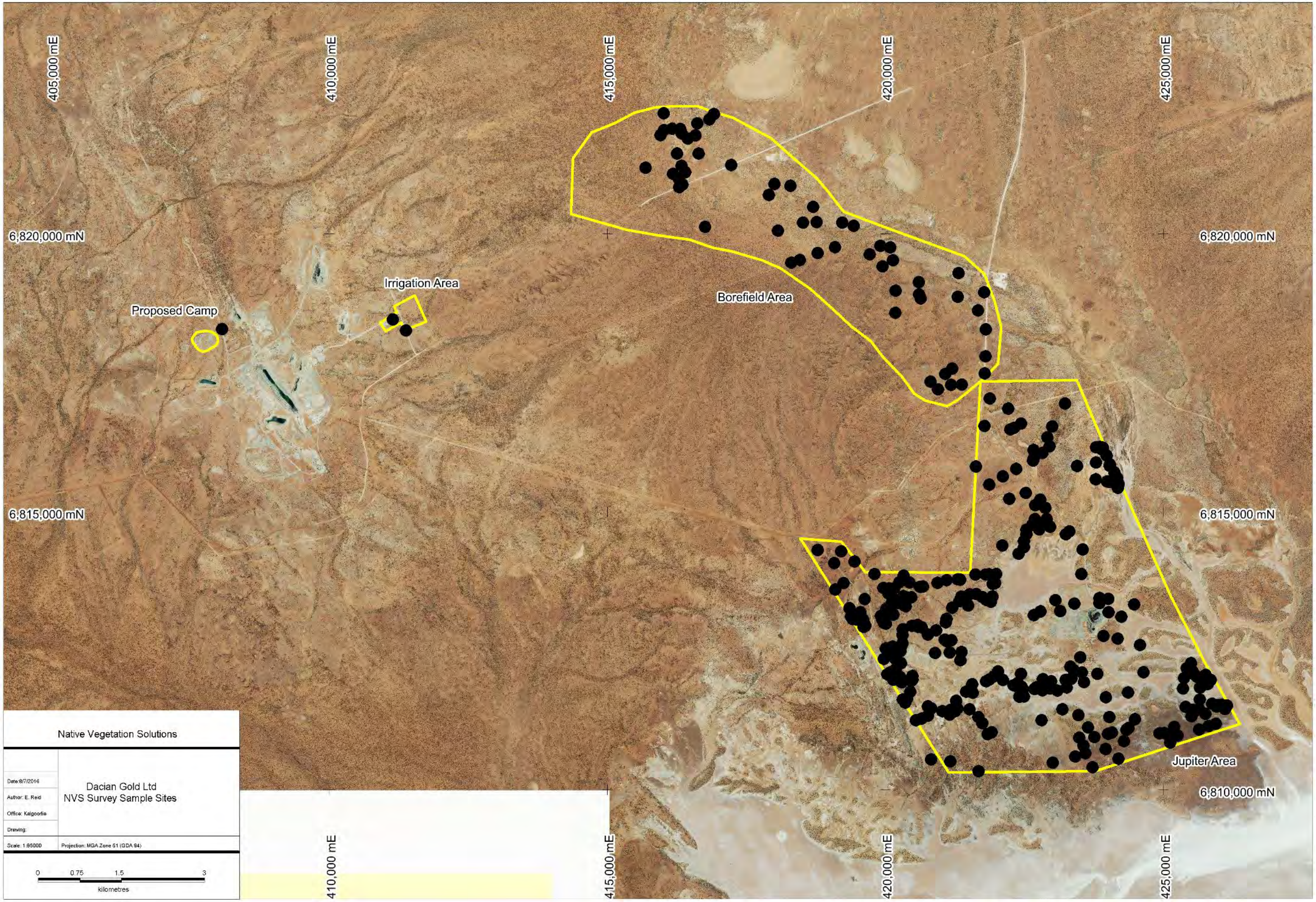
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Irrigation Area
Proposed Camp
Borefield Area
Jupiter Area
Native Vegetation Solutions
Date:8/7/2016
Author: E. Reid
Office: Kalgoorlie
Drawing:
Dacian Gold Ltd
NVS Survey Sample Sites
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Projection: MGA Zone 51 (GDA 94)
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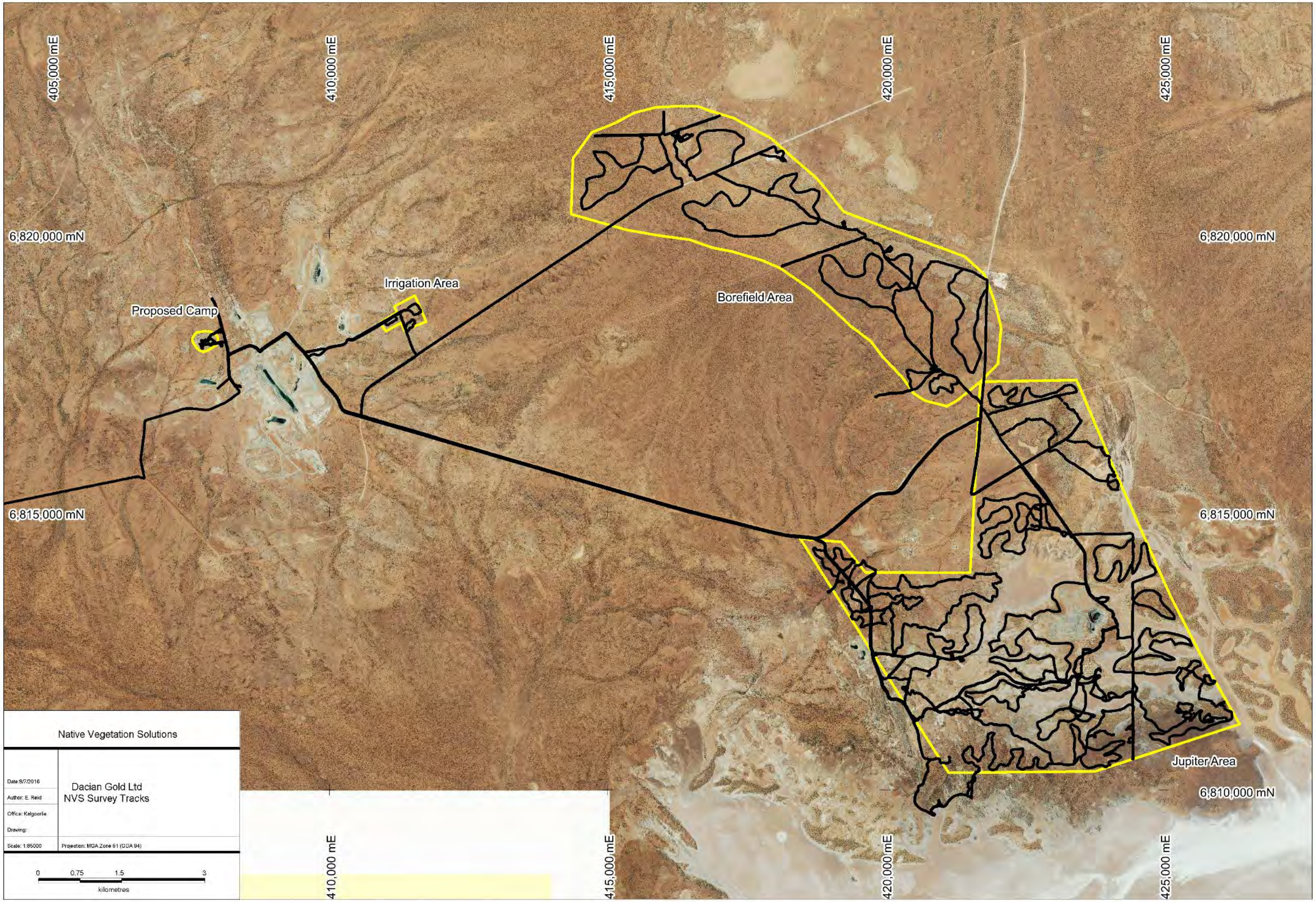
kilometres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Irrigation Area
Proposed Camp
Borefield Area
Jupiter Area
Native Vegetation Solutions
Date:8/7/2016
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:85000
Dacian Gold Ltd
NVS Survey Tracks
Projection: MGA Zone 51 (GDA 94)
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kilometres

Appendix 5

Species List

Family	Genus	Species	A, P or NN	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Amaranthaceae	*Ptilotus*	*aervoides*	A	*	*			*											
Amaranthaceae	*Ptilotus*	*divaricatus*	P												*		*	*	
Amaranthaceae	*Ptilotus*	*obovatus*	P	*	*			*		*	*		*	*	*		*	*	
Amaranthaceae	*Ptilotus*	*schwartzii*	P		*														
Anacardiaceae	*Schinus*	*molle* var. *areira*	NN, P	*															
Apocynaceae	*Marsdenia*	*australis*	P		*			*		*			*	*	*			*	
Apocynaceae	*Nerium*	*oleander*	NN, P	*															
Asteraceae	*Chrysocephalum*	*puteale*	P					*						*					
Asteraceae	*Cratystylis*	*subspinescens*	P					*				*			*				
Asteraceae	*Olearia*	*decurrens*	P									*							
Asteraceae	*Olearia*	*muelleri*	P								*								
Asteraceae	*Pterocaulon*	*sphacelatum*	P						*						*				
Asteraceae	*Rhodanthe*	*charsleyae*	A							*									
Asteraceae	*Rhodanthe*	*chlorocephala* subsp. *rosea*	A												*				
Asteraceae	*Rhodanthe*	*floribunda*	A												*				
Asteraceae	*Rhodanthe*	*laevis*	A		*														
Asteraceae	*Rhodanthe*	*maryonii*	A		*														
Asteraceae	*Streptoglossa*	*liatroides*	P		*					*			*						
Asteraceae	*Vittadinia*	*sulcata*	A	*	*					*			*						
Boraginaceae	*Halgania*	*cyanea* var. Allambi Stn	P												*				
Brassicaceae	*Lepidium*	*platypetalum*	P					*					*						
Cactaceae	*Opuntia*	*? stricta*	NN, P	*															
Casuarinaceae	*Casuarina*	*obesa*	P		*	*	*		*		*								
Casuarinaceae	*Casuarina*	*pauper*	P	*			*				*		*						
Chenopodiaceae	*Atriplex*	*amnicola*	P		*														
Chenopodiaceae	*Atriplex*	*bunburyana*	P	*	*				*				*		*		*	*	
Chenopodiaceae	*Atriplex*	*codonocarpa*	A		*	*			*										
Chenopodiaceae	*Atriplex*	*holocarpa*	A	*	*														
Chenopodiaceae	*Atriplex*	*stipitata*	P		*							*							
Chenopodiaceae	*Atriplex*	*vesicaria*	P	*	*	*		*	*									*	
Chenopodiaceae	*Dysphania*	*kalpari*	A																*
Chenopodiaceae	*Enchylaena*	*tomentosa* var. *tomentosa*	P	*	*			*		*	*				*		*	*	
Chenopodiaceae	*Eriochiton*	*sclerolaenoides*	P		*														
Chenopodiaceae	*Gunniopsis*	*quadrifidus*	P						*			*					*		
Chenopodiaceae	*Maireana*	*amoena*	P					*	*			*							
Chenopodiaceae	*Maireana*	*atkinsiana*	P						*										
Chenopodiaceae	*Maireana*	*brevifolia*	P						*										
Chenopodiaceae	*Maireana*	*carnosa*	P						*										
Chenopodiaceae	*Maireana*	*convexa*	P						*										
Chenopodiaceae	*Maireana*	*georgei*	P	*		*		*	*		*		*		*		*	*	
Chenopodiaceae	*Maireana*	*glomerifolia*	P			*		*	*		*								
Chenopodiaceae	*Maireana*	*pyramidata*	P	*	*				*				*		*		*	*	
Chenopodiaceae	*Maireana*	*sedifolia*	P		*			*	*					*	*				
Chenopodiaceae	*Maireana*	*thesioides*	P		*				*								*		
Chenopodiaceae	*Maireana*	*tomentosa*	P	*	*	*		*	*						*				
Chenopodiaceae	*Maireana*	*trichoptera*	P						*										

Family	Genus	Species	A, P or NN	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Chenopodiaceae	*Maireana*	*triptera*	P	*	*	*			*				*	*	*				
Chenopodiaceae	*Rhagodia*	*drummondii*	P							*			*						
Chenopodiaceae	*Rhagodia*	*eremaeum*	P		*							*					*	*	*
Chenopodiaceae	*Salsola*	*australis*	A	*											*				
Chenopodiaceae	*Sclerolaena*	*cuneata*	P	*	*	*			*										*
Chenopodiaceae	*Sclerolaena*	*densiflora*	P	*	*								*		*				
Chenopodiaceae	*Sclerolaena*	*diacantha*	P	*	*	*		*	*	*				*	*				
Chenopodiaceae	*Sclerolaena*	*eurotioides*	P												*				
Chenopodiaceae	*Tecticornia*	*disarticulata*	P			*	*		*		*								
Chenopodiaceae	*Tecticornia*	*halocnemoides* subsp. *tenuis*	P			*	*		*										
Chenopodiaceae	*Tecticornia*	*indica* subsp. *bidens*	P			*	*		*		*								*
Chenopodiaceae	*Tecticornia*	*peltata*	P			*			*		*					*			
Chenopodiaceae	*Tecticornia*	*pergranulata* subsp. *elongata*	P									*				*			
Chenopodiaceae	*Tecticornia*	*pruinosa*	P			*			*										
Chenopodiaceae	*Tecticornia*	*pterygosperma* subsp. *pterygosperma*	P			*			*										
Chenopodiaceae	*Tecticornia*	*undulata*	P			*			*										
Euphorbiaceae	*Beyeria*	*sulcata* subsp. *sulcata*	P							*									
Euphorbiaceae	*Euphorbia*	*drummondii*	A																*
Fabaceae	*Acacia*	*aneura*	P	*	*				*	*		*	*	*	*			*	
Fabaceae	*Acacia*	*ayersiana*	P															*	
Fabaceae	*Acacia*	*burkittii*	P	*	*		*						*		*			*	
Fabaceae	*Acacia*	*caesaneura*	P									*	*				*	*	
Fabaceae	*Acacia*	*craspedocarpa*	P		*							*							
Fabaceae	*Acacia*	*grasbyi*	P					*											
Fabaceae	*Acacia*	*jennerae*	P	*															
Fabaceae	*Acacia*	*kalgoorliensis*	P													*			
Fabaceae	*Acacia*	*kempeana*	P												*				
Fabaceae	*Acacia*	*ligulata*	P	*								*					*		
Fabaceae	*Acacia*	*mulganeura*	P	*	*				*			*	*						
Fabaceae	*Acacia*	*oswaldii*	P														*		
Fabaceae	*Acacia*	*pteraneura*	P	*	*			*	*						*			*	
Fabaceae	*Acacia*	*quadrimarginea*	P	*				*											
Fabaceae	*Acacia*	*ramulosa* var. *linophylla*	P	*	*														
Fabaceae	*Acacia*	*ramulosa* var. *ramulosa*	P	*	*														
Fabaceae	*Acacia*	*resinimarginea*	P					*						*					
Fabaceae	*Acacia*	*sibirica*	P									*	*	*					
Fabaceae	*Acacia*	*tetragonophylla*	P	*	*			*					*	*	*			*	
Fabaceae	*Acacia*	*victoriae* subsp. *victoriae*	P	*										*	*		*	*	
Fabaceae	*Jacksonia*	*arida*	P									*					*		
Fabaceae	*Senna*	*artemisioides* subsp. *artemisioides*	P	*										*	*			*	
Fabaceae	*Senna*	*artemisioides* subsp. *filifolia*	P	*	*			*						*	*		*	*	
Fabaceae	*Senna*	*artemisioides* subsp. *helmsii*	P	*				*		*				*					
Fabaceae	*Senna*	*artemisioides* subsp. *sturtii*	P					*					*	*					
Fabaceae	*Senna*	*cardiosperma*	P	*	*			*					*		*				
Fabaceae	*Senna*	*glutinosa* subsp. *chatelainiana*	P	*	*			*			*		*	*					
Fabaceae	*Senna*	*pleurocarpa* subsp. *angustifolia*	P	*															

Family	Genus	Species	A, P or NN	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Fabaceae	*Swainsona*	*oroboides*	P		*														
Fabaceae	*Swainsona*	*tenuis*	P		*														
Frankeniaceae	*Frankenia*	*georgei*	P													*			
Frankeniaceae	*Frankenia*	*interioris*	P						*										
Frankeniaceae	*Frankenia*	*pauciflora*	P						*		*								
Frankeniaceae	*Frankenia*	*setosa*	P					*	*		*	*					*		
Goodeniaceae	*Goodenia*	*havilandii*	A							*									
Goodeniaceae	*Scaevola*	*spinescens*	P	*				*		*	*	*	*	*	*				
Haloragaceae	*Haloragis*	*trigonocarpa*	A										*						*
Lamiaceae	*Prostanthera*	*albiflora*	P					*						*					
Lamiaceae	*Salvia*	*verbenaca*	NN, P	*															
Lamiaceae	*Spartothamnella*	*teucriiflora*	P		*					*			*					*	*
Loranthaceae	*Amyema*	*nestor*	P		*														
Malvaceae	*Abutilon*	*cryptopetalum*	P		*					*					*				
Malvaceae	*Abutilon*	*leucopetalum*	P					*											
Malvaceae	*Brachychiton*	*gregorii*	P					*									*		
Malvaceae	*Hannafordia*	*bissillii* subsp. *bissillii*	P	*	*														
Malvaceae	*Lawrencia*	*helmsii*	P														*		
Malvaceae	*Lawrencia*	*squamata*	P	*					*										
Malvaceae	*Sida*	*calyxhymenia*	P	*	*						*	*		*	*	*			
Malvaceae	*Sida*	*ectogama*	P		*			*						*					
Malvaceae	*Sida*	*intricata*	P	*	*							*			*				
Malvaceae	*Sida*	sp *Excedentifolia*	P							*									
Malvaceae	*Sida*	sp golden calyces	P		*					*	*		*						
Myrtaceae	*Calytrix*	*desolata*	P					*											
Myrtaceae	*Calytrix*	*erosipetala*	P					*						*					
Myrtaceae	*Eucalyptus*	*? trivalva*	P									*							
Myrtaceae	*Eucalyptus*	*camaldulensis* subsp. *obtusa*	P	*															
Myrtaceae	*Eucalyptus*	*campaspe*	P	*															
Myrtaceae	*Eucalyptus*	*clelandii*	P	*													*		
Myrtaceae	*Eucalyptus*	*salubris*	P	*															
Myrtaceae	*Eucalyptus*	*torquata*	P	*															
Myrtaceae	*Melaleuca*	*hamata*	P															*	*
Myrtaceae	*Melaleuca*	*interioris*	P			*												*	
Myrtaceae	*Melaleuca*	*xerophila*	P												*				
Pittosporaceae	*Pittosporum*	*angustifolium*	P	*	*	*			*		*				*				
Poaceae	*Aristida*	*contorta*	A				*			*				*	*		*		
Poaceae	*Austrostipa*	*elegantissima*	P														*	*	
Poaceae	*Austrostipa*	*nitida*	P		*			*						*					
Poaceae	*Cenchrus*	*ciliaris*	NN, P	*															
Poaceae	*Cymbopogon*	*ambiguus*	P	*															
Poaceae	*Enneapogon*	*caerulescens*	P		*			*							*		*	*	
Poaceae	*Enteropogon*	*ramosus*	P										*						
Poaceae	*Eragrostis*	*dielsii*	A		*							*							*
Poaceae	*Eragrostis*	*eriopoda*	P	*	*							*			*		*		
Poaceae	*Eriachne*	*helmsii*	P									*							

Family	Genus	Species	A, P or NN	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Poaceae	*Eriachne*	*pulchella* subsp. *pulchella*	A	*	*					*					*				
Poaceae	*Monachather*	*paradoxus*	P					*		*		*							
Poaceae	*Rostraria*	*pumila*	A					*											
Poaceae	*Triodia*	*basedowii*	P									*							
Poaceae	*Triodia*	*melvillei*	P									*							
Polygonaceae	*Acetosa*	*vesicaria*	NN, A												*				
Polygonaceae	*Duma*	*florulenta*	P																*
Portulacaceae	*Calandrinia*	*eremaea*	A																*
Portulacaceae	*Calandrinia*	*polyandra*	A																*
Primulaceae	*Lysimachia*	*arvensis*	NN, A										*						
Proteaceae	*Grevillea*	*berryana*	P				*					*		*				*	
Proteaceae	*Hakea*	*lorea* subsp. *lorea*	P					*											
Proteaceae	*Hakea*	*preissii*	P						*	*							*		
Proteaceae	*Hakea*	*recurva* subsp. *recurva*	P							*				*					
Pteridaceae	*Cheilanthes*	*sieberi* subsp. *sieberi*	P							*									
Rubiaceae	*Psydrax*	*latifolia*	P		*							*							
Rubiaceae	*Psydrax*	*suaveolens*	P									*							
Santalaceae	*Exocarpos*	*aphyllus*	P				*	*			*	*			*			*	
Santalaceae	*Santalum*	*lanceolatum*	P					*		*					*			*	
Santalaceae	*Santalum*	*spicatum*	P							*									
Sapindaceae	*Dodonaea*	*lobulata*	P								*								
Sapindaceae	*Dodonaea*	*rigida*	P					*		*				*					
Scrophulariaceae	*Eremophila*	*alternifolia*	P												*				
Scrophulariaceae	*Eremophila*	*clarkei*	P												*				
Scrophulariaceae	*Eremophila*	*compacta*	P		*														
Scrophulariaceae	*Eremophila*	*falcata*	P											*					
Scrophulariaceae	*Eremophila*	*forrestii* subsp. *forrestii*	P					*				*		*	*			*	
Scrophulariaceae	*Eremophila*	*georgei*	P					*		*				*					
Scrophulariaceae	*Eremophila*	*glabra* subsp. *glabra*	P									*						*	
Scrophulariaceae	*Eremophila*	*glabra* subsp. *tomentosa*	P									*							
Scrophulariaceae	*Eremophila*	*glandulifera*	P		*														
Scrophulariaceae	*Eremophila*	*granitica*	P		*								*						
Scrophulariaceae	*Eremophila*	*latrobei* subsp. filiformis	P											*	*				
Scrophulariaceae	*Eremophila*	*latrobei* subsp. *latrobei*	P		*					*				*					
Scrophulariaceae	*Eremophila*	*longifolia*	P												*			*	
Scrophulariaceae	*Eremophila*	*maculata* subsp. *brevifolia*	P												*			*	
Scrophulariaceae	*Eremophila*	*margarethae*	P		*	*			*	*		*	*		*			*	
Scrophulariaceae	*Eremophila*	*metallicorum*	P		*														
Scrophulariaceae	*Eremophila*	*miniata*	P									*			*		*		
Scrophulariaceae	*Eremophila*	*oldfieldii* subsp. *angustifolia*	P					*	*						*				
Scrophulariaceae	*Eremophila*	*oppositifolia* subsp. *angustifolia*	P					*			*		*						
Scrophulariaceae	*Eremophila*	*pantonii*	P		*						*				*				
Scrophulariaceae	*Eremophila*	*platycalyx* subsp. *platycalyx*	P		*	*			*	*		*	*		*			*	
Scrophulariaceae	*Eremophila*	*platythamnos* subsp. *exotrachys*	P									*							
Scrophulariaceae	*Eremophila*	*youngii* subsp. *youngii*	P		*														
Solanaceae	*Crenidium*	*spinescens*	P									*							

Family	Genus	Species	A, P or NN	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Solanaceae	*Lycium*	*australe*	P					*	*		*				*		*		
Solanaceae	*Nicotiana*	*glauca*	NN, P		*														
Solanaceae	*Solanum*	*ashbyae*	P							*									
Solanaceae	*Solanum*	*austropiceum*	P										*	*	*				
Solanaceae	*Solanum*	*lasiophyllum*	P	*	*	*		*	*	*				*	*			*	*
Solanaceae	*Solanum*	*nummularium*	P												*		*	*	
Solanaceae	*Solanum*	*orbiculatum* subsp. *orbiculatum*	P												*		*		
Solanaceae	*Solanum*	*plicatile*	P					*					*	*	*				
Thymelaeaceae	*Pimelea*	*microcephala* subsp. *microcephala*	P			*			*								*		
Zygophyllaceae	*Zygophyllum*	*eichleri*	A										*						
Zygophyllaceae	*Zygophyllum*	*eremaeum*	A														*		

APPENDIX 2: RECONNAISSANCE FLORA AND VEGETATION SURVEY (NVS, 2019)

Reconnaissance Flora and Vegetation Survey of BIF Ridge and Mount Marven- September 2019

Prepared for

Dacian Gold Limited

FINAL V2.0
November 2019

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1 INTRODUCTION

Dacian Gold Limited (Dacian) is planning to develop the BIF Ridge and Mt Marven Project areas as a component of the Mt Morgans Gold Project (MMGP). The MMGP is located approximately 30 km south west of Laverton, in the northern goldfields of Western Australia (Figure 1). It comprises two key mining areas; Westralia and Jupiter, which are currently operating.

Dacian commissioned NVS to complete a Reconnaissance Flora and Vegetation survey of the BIF Ridge and Mount Marven Project areas from the 16th to 18th September 2019. The two survey areas were provided covering a total area of approximately 498.69 hectares.

For the purpose of this report the survey is broken down into two areas:

- The proposed Mount Marven project area (81 ha); and
- The proposed BIF Ridge project area (417.69 ha).

Maps of these areas are included in Figure 1, Figure 2 and Appendix 4.

Figure 1: Regional map of Project Area

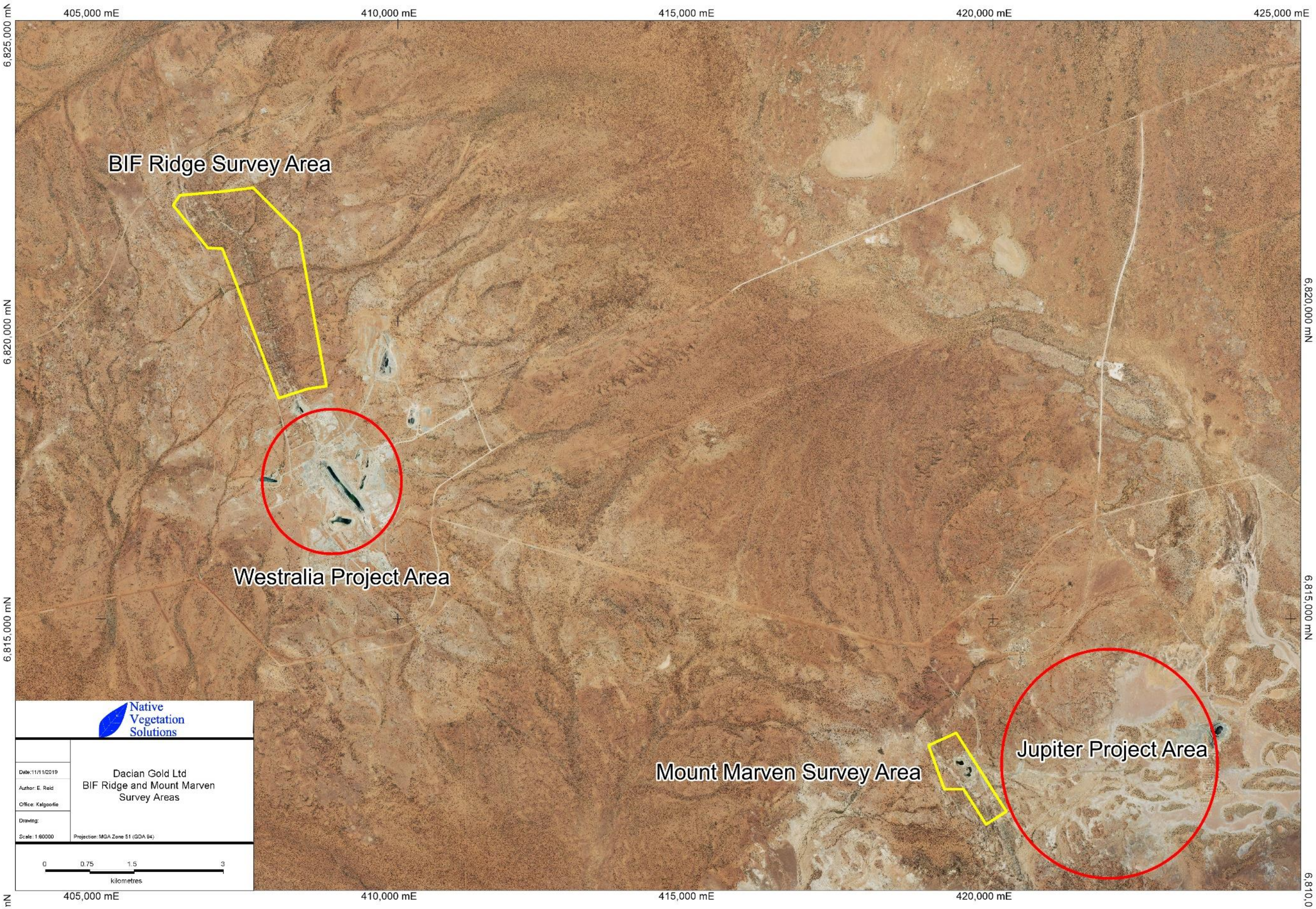

Figure 2: Survey Areas

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 groups 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:

- 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

According to the Interim Biogeographic Regionalisation for Australia (IBRA, 2019), the survey area lies in the Murchison (MUR) IBRA bioregion within the Eastern Murchison (MUR1) subregion which totals over 21 million hectares (CALM, 2002). The MUR1 subregion comprises vegetation dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (CALM, 2002).

1.3 Climate

The arid climate of the MUR1 subregion generally relies on winter rainfall (200 mm/pa) (CALM, 2002).

The rainfall that occurs during the autumn and early winter months of May to July tends to be more reliable, though generally of a lesser total amount than the less dependable, but more intense summer cyclonic rainfall from December to March (Groundwater Resource Management, 2015).

The nearest official meteorological station to the survey area is located at Laverton Aero, approximately 27 km northeast of the survey area. Recordings of the local climatic conditions commenced at Laverton in 1991 (BOM, 2019) and data collected at this station 012305 was used for this report.

1.3.1 Temperature

Mean annual minimum temperature is 14°C and mean annual maximum temperature is 27.2°C. The coldest month is July (mean minimum temperature 5.8°C), the hottest is January (mean maximum temperature 35.6°C) and diurnal temperature variations are relatively consistent throughout the year (Figure 3).

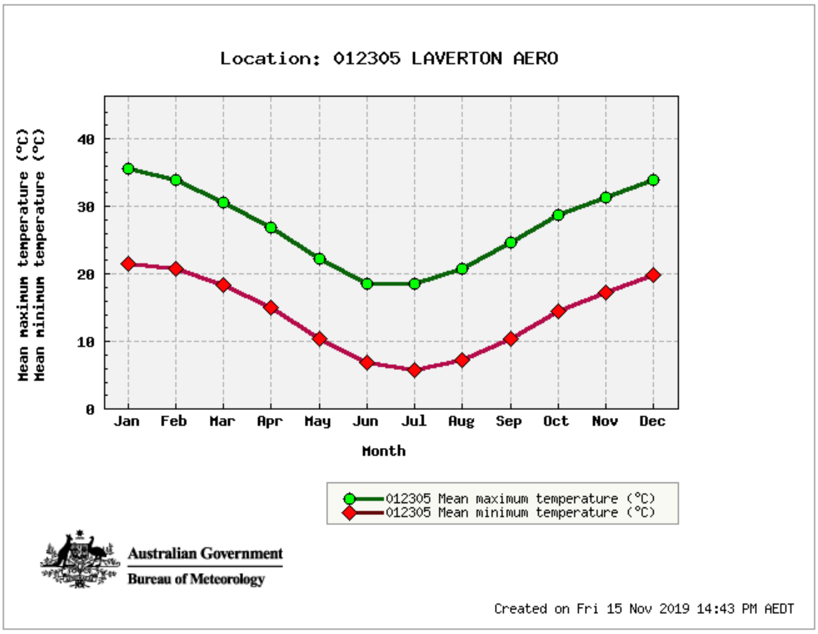

Figure 3: Mean Temperature ranges for the Laverton Aero weather stations

1.3.2 Rainfall

The area is arid and the annual average rainfall at Laverton Aero is 302.8 mm, which falls (>1 mm) on an average of 35.5 rain-days. Most of the rain usually falls between December and March and this amount varies greatly both seasonally and annually (Figure 4). Only rainfall for April 2019 exceeded the monthly average prior to the survey period. All other months fell short of their monthly averages.

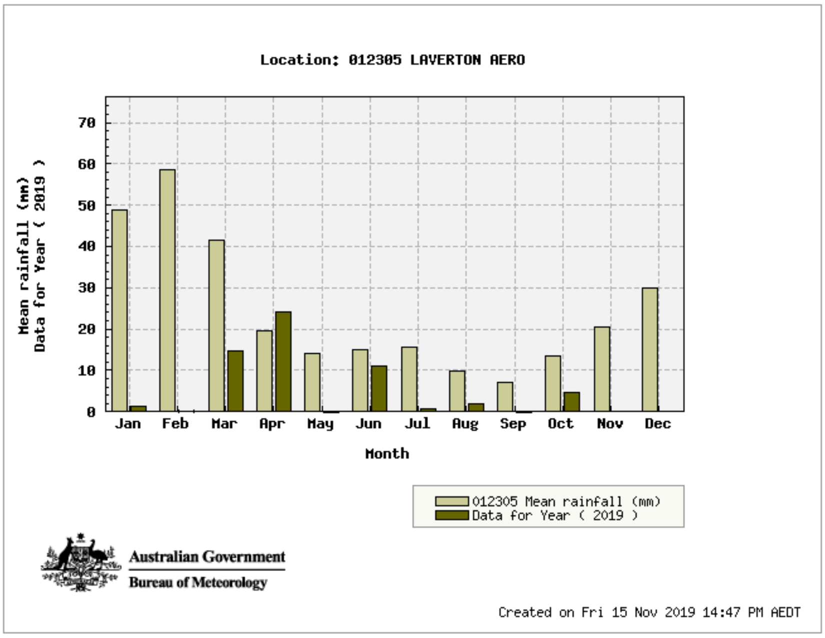

Figure 4: Monthly and mean rainfall for the Laverton weather station

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, identification of flora, preparation and review of the report;
- Mr Frank Obbens (*BSc*), Consultant Botanist, Bushtech Consultancy, undertook identification of unknown flora samples collected from the field.

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 *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 a 10km buffer of coordinates -28.7818 and 122.1168 (DOTEE, 2019). (http://www.environment.gov.au/arcgis-framework/apps/pmst/pmst-coordinate.jsf)

2.2.2 Threatened Flora and Communities

The Species and Communities Branch of the Department of Biodiversity, Conservation and Attractions (DBCA) was contacted for a search of their databases containing known populations of threatened flora within a 40km buffer of GPS coordinates GDA94 51J 424230mE 6813029mN (Reference: 19-0316FL). Threatened flora include Declared Rare Flora (DRF- extant, now redefined as 'Threatened') and Priority Flora.

The presence of Threatened and Priority Ecological Communities (TECs & PECs) was determined by examining Geographic Information System (GIS) data supplied by the DBCA upon request within a 40km buffer of GPS coordinates GDA94 51J 424230mE 6813029mN (Reference: 18-0316EC).

2.2.3 Environmentally Sensitive Areas (ESAs) and Conservation Reserves

The Department of Water and Environmental Regulation (DWER, 2019) Clearing Permit System Map Viewer was used to determine the location of any ESAs and Conservation Reserves (https://cps.der.wa.gov.au/main.html).

2.2.4 Vegetation Type, Extent and Status

Vegetation extent and status data was sourced from the Department of Agriculture and Food (DAFWA) report "Land-Use and Vegetation in Western Australia- National Land and Water Resources Audit 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.

2.2.5 Wetlands

The potential of wetlands within the project area was determined by examining DWER's Clearing Permit System Map Viewer (DWER, 2019).

2.2.6 Dieback

Dieback is only considered a potential issue for the project if both the mean annual rainfall of the area is >400mm, and if the project area resides south of the 26th parallel.

2.3 Site Investigation

A site visit was carried out by Botanist Eren Reid from NVS from the 16th to 18th September 2019 to examine the broad flora and vegetation groups contained within the survey area. A total of 36 hours was spent on site traversing the survey area. While a vehicle was used to reach the site, all traverses were made on foot or via Yamaha Viking.

The survey was conducted in accordance with relevant EPA's Statements and Guidelines (Section 1.1).

The EPA uses the Interim Biogeographic Regionalisation of Australia (IBRA) as the largest unit for Environmental Impact Assessment 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 IBRA region, a reconnaissance flora and vegetation survey was deemed adequate.

2.3.1 Licenses

Flora was collected for identification under the Scientific Collection License SL012445, held by Mr E. R. Reid with expiry 18/09/2019.

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, these sites were visited and non-permanent 20 x 20m relevé sites were established in appropriate locations, considering representativeness of the site to 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 Botanists were collected and pressed along with specimens of taxa recognised as, or thought to be, conservation-significant species.

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 (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, relevés 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 with reference to published keys and the reference herbarium at the Western Australian Herbarium (WAHERB) and information published on Florabase (WAHERB, 2019).

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 utilized (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.

2.4 Limitations

Table 1 lists potential limitations that may have affected the survey. As shown, this survey may have been limited by drier than average conditions, which affected most of the State of Western Australia in 2019.

Table 1: List of potential survey limitations

Potential Limitations	Constraint (Y/N)	Comment
Competency and experience of the consultants undertaking the survey	N	Mr Eren Reid is an experienced botanist who has conducted many flora and vegetation surveys in the Goldfields, Pilbara and South-west regions of WA.
Proportion of flora identified during survey	N	As the survey was planned to target species of conservation significance and flora within a known 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	Y- Possible	Although many months prior to the field work received below average rainfall, the survey was conducted in September 2019, following above average rainfall in April.
Disturbance in survey area	N	Disturbance was present with some minor access tracks present, as well as clearing associated with extensive exploration, in certain areas.
Intensity of survey effort	N	Transects were walked through the survey area with all parts visited
Resources	N	Adequate resources were available
Access problems	N	No problems with access
Availability of contextual information on the region	N	Information on the Murchison Bioregion is readily available.

3. RESULTS

3.1 Preliminary Desktop Assessment

3.1.1 Previous Flora Survey Reports

3.1.1.1 Jupiter Project and Borefield Flora and Vegetation Survey (NVS, 2016)

The Jupiter Project and Borefield survey area is located adjacently east of the Mount Marven survey rea and covers an area of 4,641 hectares.

A total of 32 Families, 77 Genera and 195 Species were recorded within Jupiter Project and Borefield survey area. Sixteen major vegetation groups were recorded in the survey area, excluding disturbed areas, and bare salt lakes. A summary of the vegetation groups and relevant vegetation code can be seen below:

- Rehabilitation Vegetation (A);
- *Acacia* aneura shrubland (B);
- *Tecticornia* shrubland (C);
- Kopai dunes with *Tecticornia* and *Casuarina* (D);
- *Acacia* shrubland on emergent hills (E);
- *Acacia* over Chenopod shrubland (F);
- *Acacia* over *Eremophila* and sclerophyll shrubland on BIF Ridges (G);
- *Tecticornia* shrubland within Laterite breakaways (H);
- *Acacia mulganeura* over *Eremophila forrestii* and grasslands (I);
- *Acacia aneura* creekline vegetation (J);
- *Acacia* shrublands on undulating hills (K);
- *Acacia aneura* woodland over *Maireana sedifolia* and *Acacia victoriae* mixed shrubland (L);
- *Acacia* shrubland on lower breakaways (M);
- *Acacia oswaldii* shrubland (N);
- *Acacia burkittii* shrubland (O); and
- Open *Melaleuca* shrubland (P).

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Very Good”, with few areas of “Good” vegetation condition, where exploration disturbance was more common.

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

The survey area falls within the buffer region of the Priority 1 PEC named "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station". This PEC is in place to protect the subterranean fauna community identified within the buffer zone. Given this, proposed clearing within the survey area is not likely to have an impact on this community.

3.1.1.2 Cameron Well Project (NVS, 2018)

The Cameron Well survey area is located 6km northwest of the Mount Marven survey area, and covered an area of 2,231.83 hectares.

A total of 23 Families, 53 Genera and 134 Species were recorded within the Cameron Well survey area. Four major vegetation groups were recorded in the survey area, a summary of the vegetation groups is listed below:

- Mulga Broad Floodplains*;*

- *Acacia aneura* shrubland over *Eremophila* and Tussock grasslands*;*
- *Acacia* over Chenopod shrubland; and
- *Acacia aneura* woodland over *Maireana sedifolia* and *Acacia victoriae* mixed shrubland.

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Good”, with few areas of “Very Good” vegetation condition, where exploration disturbance was less common.

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

The survey area falls within the buffer region of the Priority 1 PEC named "Mount Morgan calcrete groundwater assemblage type on Carey palaeodrainage on Mt Weld Station". This PEC is in place to protect the subterranean fauna community identified within the buffer zone. Given this, proposed clearing within the survey area is not likely to have an impact on this community.

3.1.2 EPBC Act Protected Matters

The EPBC Protected Matters search tool revealed that the survey area could possibly be suitable habitat for weed species *Carrichtera annua* (Wards Weed) and *Cenchrus ciliaris* (Buffel Grass) (DOTEE, 2019).

Carrichtera annua was introduced into Australia from the eastern Mediterranean, and is now widespread throughout South Australia, the Interior, and Western Australia (Lamp & Collet, 1999). This species is not listed as a declared plant by DPIRD (2019), 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 (DOTEE, 2019).

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 *etc*. 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 search area.

The results of the EPBC Protected Matters search are included in Appendix 1.

3.1.3 Threatened Flora and Communities

The DBCA database searches revealed a potential for one Threatened and 41 Priority Flora species to occur within a 40km radius of the survey area (DBCA, 2016a). No known locations of Priority Flora occur within the survey area. The closes known location of Priority Flora occurs 153m to the east of the Mount Marven survey area. This location was searched by NVS in 2016 (NVS, 2016) however this species could not be located.

Results of the threatened flora database search are included in Appendix 2.

The PEC/TEC search (DBCA, 2016) revealed that the survey area does not contain any TECs or PECs or lie within any nearby TEC or PEC buffer regions.

3.1.4 Environmentally Sensitive Areas and Conservation Reserves

No ESAs are located within the survey area (DWER, 2019).

No Conservation Reserves were identified within the survey area (DOTEE, 2019).

3.1.5 Vegetation Type, Extent and Status

Two vegetation units defined by Beard (1990) were identified as part of the desktop assessment. These vegetation units identify the Pre-European extent of vegetation, as mapped by Beard (1990).

Information relating to known Beard (1990) vegetation units within the survey area has been summarised in Tables 2 and 3 below. This information has been compiled through both desktop assessments and the site visit.

Table 2: 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*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By Shire*** *(Shire of Laverton)*
	22,029,557*	19,892,306**	12,403,172**	10,269,896**	2,878,673**
% Pre-European Extent Remaining	*100.00%**	*99.75%***	*99.68%***	*99.66%***	*99.61%***
Surrounding Land Use***	Mining, Exploration, Pastoral Lease				
Weed prevalence***	Low				

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

Table 3: 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*** *(Murchison)*	***By IBRA Sub-region*** *(Eastern Murchison)*	***By Shire*** *(Shire of Laverton)*
	4,856,768*	6,613,567**	1,148,400**	711,328**	826,833**
% Pre-European Extent Remaining	*100.00%**	*99.83%***	*99.10%***	*98.68%***	*99.95%***
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

No wetlands which are recorded on the DWER Clearing Permit System Map Viewer occur within the survey area (DWER, 2019).

3.1.7 Dieback

The survey area lies south of the 26th parallel however receives an average annual rainfall of 302.8mm, below the 400mm threshold mark. There is no record of *Phytophthora cinnamomi* establishing in natural ecosystems in regions receiving <400mm rainfall per annum (CALM, 2003). Therefore, Dieback is not considered an issue for this survey area, however 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 flora located in the survey area, are gazetted as Threatened pursuant to Section 5(1) of the *Biodiversity Conservation Act 2016*.

No plant taxa listed as Threatened pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* were located within the survey area.

One Priority species, *Olearia mucronata* (P3), was recorded in the Mount Marven survey area at two locations relatively close to each other.

The locations are listed in Table 4 below:

Table 4: Priority Flora recorded in the survey area

Taxon	Conservation status	GDA94 51J Easting (m)	GDA94 51J Northing (m)	Number of Plants
Olearia mucronata	P3	420007	6811642	2
Olearia mucronata	P3	419978	6811637	2

3.2.2 Vegetation Type, Extent and Status

A total of 30 Families, 60 Genera and 156 Species were recorded within the entire survey area. Twelve major vegetation groups were recorded in the survey area, excluding disturbed areas. A summary of the vegetation groups can be seen in Table 5 below.

Table 5: Summary of taxa within vegetation groups and their spatial areas

Vegetation Group	**Family**	**Genus**	**Species**	**Area (ha)**	**Percentage of Survey Area (%)**
Acacia shrublands on Greenstone rocky hills	18	26	46	10.61	2.13%
Acacia over Chenopod shrublands	12	17	44	9.51	1.91%
Tecticornia shrubland	7	10	22	1.93	0.39%
Acacia over *Maireana sedifoli*a and other mixed shrublands	14	27	57	0.88	0.18%
Acacia aneura creekline vegetation	18	23	36	29.10	5.84%
Tecticornia shrublands on lower breakaways	2	4	14	3.68	0.74%
Acacia over lower breakaways	10	13	16	1.56	0.31%
Acacia shrublands on undulating hills	14	18	34	29.39	5.89%
Acacia aneura shrubland over Banded Ironstone hills	16	27	48	27.73	5.56%
Acacia aneura shrubland	13	17	31	257.30	51.60%
Acacia burkittii shrubland	11	18	37	1.08	0.22%
Acacia aneura and *Acacia ramulosa* shrubland	12	14	26	96.13	19.28%
Existing Disturbance	N/A	N/A	N/A	29.78	5.97%
Total	**30***	**60***	**156***	**498.69#**	**100.00%#**

Note: * Represent total in survey area
Represents sum of column

The vegetation groups are described in more detail in the sections below.

3.2.2.1 *Acacia* shrublands on Greenstone rocky hills

This vegetation (Figure 5) group consisted of 18 Families, 26 Genera and 46 Species. The vegetation group was approximately 10.61 ha which makes up 2.13% of the survey area.

Dominant species were *Acacia pteraneura, Acacia ligulata, Acacia prainii, Senna artemisioides* subsp. *filifolia, Eremophila pantonii, Hakea recurva* subsp*. recurva, Maireana sedifolia, Senna artemisioides* subsp*. sturtii, Scaevola spinescens* and *Hakea preissii.*

Figure 5: *Acacia* shrublands on Greenstone rocky hills within the survey area

3.2.2.2 *Acacia* over Chenopod shrubland

This vegetation group (Figure 6) consisted of 12 Families, 17 Genera and 44 Species. The vegetation group was approximately 9.51 ha which makes up 1.91% of the survey area.

Dominant species were *Acacia aneura, Acacia mulganeura, Acacia pteraneura, Maireana pyramidata, Sclerolaena diacantha, Senna artemisioides* subsp. *sturtii, Tecticornia indica* subsp. *bidens, Tecticornia peltata, Tecticornia undulata, Cratystylis subspinescens, Atriplex vesicaria* and *Atriplex bunburyana.*

Figure 6: *Acacia* over Chenopod shrubland within the survey area

3.2.2.3 *Tecticornia* shrubland

This vegetation group (Figure 7) consisted of 7 Families, 10 Genera and 22 Species. The vegetation group was approximately 1.93 ha which makes up 0.39% of the survey area.

Dominant species were numerous *Tecticornia* species, with occasional *Maireana glomerifolia, Sclerolaena cuneata, Atriplex vesicaria, Melaleuca interioris* and *Casuarina obesa.*

Figure 7:*Tecticornia* shrubland within the survey area

3.2.2.4 *Acacia* over *Maireana sedifolia* and other mixed shrublands

This vegetation group (Figure 8) consisted of 14 Families, 27 Genera and 57 Species. The vegetation group was approximately 0.88 ha which makes up 0.18% of the survey area.

Dominant species were *Acacia aneura, A. pteraneura, Maireana sedifolia, Atriplex bunburyana, Maireana tomentosa, Cratystylis subspinescens Eremophila miniata, Solanum plicatile, Solanum austropiceum, Acacia kempeana* and *Eremophila longifolia.*

Figure 8: *Acacia* woodland over *Maireana sedifolia* and other mixed shrublands within the survey area

3.2.2.5 *Acacia aneura* creekline vegetation

This vegetation group (Figure 9) consisted of 18 Families, 23 Genera and 36 Species. The vegetation group was approximately 29.10 ha which makes up 5.84% of the survey area.

Dominant species were *Acacia aneura, Acacia caesaneura, Acacia mulganeura, Acacia tetragonophylla, Eremophila oppositifolia* subsp. *angustifolia, Scaevola spinescens, Ptilotus obovatus, Senna artemisioides* subsp. *sturtii, Lepidium platypetalum,* and *Teucrium teucriiflorum.*

Figure 9: *Acacia aneura* creekline vegetation within the survey area

3.2.2.6 *Tecticornia* shrubland on lower breakaways

This vegetation group (Figure 10) consisted of 2 Families, 4 Genera and 14 Species. The vegetation group was approximately 1.56 ha which makes up 0.31% of the survey area.

Dominant species were *Tecticornia disarticulata, Tecticornia indica subsp. bidens, Tecticornia peltata* and *Maireana triptera.*

Figure 10: *Tecticornia* shrublands on lower breakaways within the survey area

3.2.2.7 *Acacia* over lower breakaways

This vegetation group (Figure 11) consisted of 10 Families, 13 Genera and 16 Species. The vegetation group was approximately 1.56ha which makes up 0.31% of the survey area.

Dominant species were *Acacia kalgoorliensis, Acacia sibirica, Senna artemisioides* subsp. *filifolia, Hakea lorea* subsp. *lorea, Ptilotus obovatus* and *Eremophila pantonii.*

Figure 11: *Acacia* over lower breakaways within the survey area

3.2.2.8 *Acacia* shrublands on undulating hills

This vegetation group (Figure 12) consisted of 14 Families, 18 Genera and 34 Species. The vegetation group was approximately 29.39 ha which makes up 5.89% of the survey area.

Dominant species were *Acacia resinimarginea, Acacia aneura, Calytrix erosipetala, Eremophila georgei, Eremophila forrestii* subsp. *forrestii, Dodonaea rigida, Chrysocephalum puteale, Eremophila latrobei* subsp. *filiformis* and *Senna artemisioides* subsp. *helmsii.*

Figure 12**: *Acacia* shrublands on undulating hills within the survey area**

3.2.2.9 *Acacia aneura* shrubland over Banded Ironstone hills

This vegetation group (Figure 13) consisted of 16 Families, 27 Genera and 48 Species. The vegetation group was approximately 27.73 ha which makes up 5.56% of the survey area.

Dominant species were *Acacia aneura, Acacia craspedocarpa, Acacia mulganeura, Acacia tetragonophylla, Psydrax suaveolens, Senna artemisioides* subsp. *filifolia, Dodonaea petiolaris, Dodonaea rigida* and *Eremophila platycalyx* subsp. *platycalyx.*

Figure 13: *Acacia aneura* shrubland over Banded Ironstone hills within the survey area

3.2.2.10 *Acacia aneura* shrubland

This vegetation group (Figure 14) consisted of 13 Families, 17 Genera and 31 Species. The vegetation group was approximately 257.30 ha which makes up 51.6% of the survey area.

Dominant species were *Acacia aneura, A. mulganeura, A. pteraneura, A. craspedocarpa, Senna cardiosperma, Senna glutinosa* subsp. *chatelainiana, Eremophila platycalyx* subsp. *platycalyx*, *Eremophila compacta, Maireana triptera* and *Ptilotus obovatus.*

Figure 14: *Acacia aneura* shrubland within the survey area

3.2.2.11 *Acacia burkittii* shrubland

This vegetation group (Figure 15) consisted of 11 Families, 18 Genera and 37 Species. The vegetation group was approximately 1.08 ha which makes up 0.22% of the survey area.

Dominant species were *Acacia burkittii, Acacia caesaneura, Acacia tetragonophylla, Senna artemisioides* subsp. *filifolia, Melaleuca hamata* and *Eremophila glabra* subsp. *glabra.*

Figure 15: *Acacia burkittii* shrubland within the survey area

3.2.2.12 *Acacia aneura* and *Acacia ramulosa* shrubland

This vegetation group (Figure 16) consisted of 12 Families, 23 Genera and 30 Species. The vegetation group was approximately 5.05 ha which makes up 0.11% of the survey area.

Dominant species were *Acacia aneura, Acacia mulganeura, Acacia ramulosa subsp. ramulosa, Acacia grasbyi, Senna artemisioides* subsp. *artemisioides, Senna artemisioides* subsp. *helmsii, Eremophila platycalyx* subsp*. platycalyx, Dodonaea rigida* and *Scaevola spinescens.*

Figure 16: *Acacia oswaldii* shrubland within the survey area

3.2.2.13 Existing Disturbance

These areas had been previously heavily disturbed, including open pits, waste dumps and haul roads. The total area of existing disturbance was approximately 29.78 ha which makes up 5.97% of the survey area.

Figure 17: Existing Disturbance within the survey area

3.2.3 Weeds

Three weed species were recorded within the survey area, *Schinus molle var. areira* (pepper tree), *Lysimachia arvensis* (Pimpernel) and *Cylindropuntia fulgida* var. *mamillata* (Coral Cactus) (Hussey *et al,* 2007).

Only one of these species, Coral Cactus, is considered a Declared Pest by DPIRD (DPIRD, 2019). This species was restricted to a single location within the *Acacia aneura* creekline vegetation group in the BIF Ridge survey area.

This species should have some form of management applied that will alleviate the harmful impact of the species, reduce the numbers or distribution of the species or prevent or contain the spread of the species.

3.2.4 Vegetation Condition

Evidence of cattle and rabbits was observed during the field assessment.

Overall, the condition of the vegetation was determined to be “Very Good” with other areas in “Good” condition and “Degraded” condition. Most disturbances were in the form of tracks and grazing, whilst more heavily disturbed areas were from of historic exploration activities.

4. DISCUSSION

The field assessment established that the condition of the vegetation in the proposed disturbance area is overall “Very Good”, with other areas of “Good” vegetation condition, and “Degraded” where exploration disturbance was more common.

No Threatened Flora, TECs or PECs were recorded in the area.

One Priority Flora species, *Olearia mucronata* (P3) was recorded at two locations within the Mount Marven survey area. A total of four plants were recorded at these locations.

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 and vegetation survey:

- Where possible, clearing be aligned to existing roads, tracks and other barriers or follow the boundaries of broad-scale intact native vegetation;
- Where possible avoid clearing where Priority Flora are located; and
- Weed control measures to be implemented prior to and following clearing.

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6. GLOSSARY

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
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 <u>Priority Species</u>

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

Australian Government

Department of the Environment and Energy

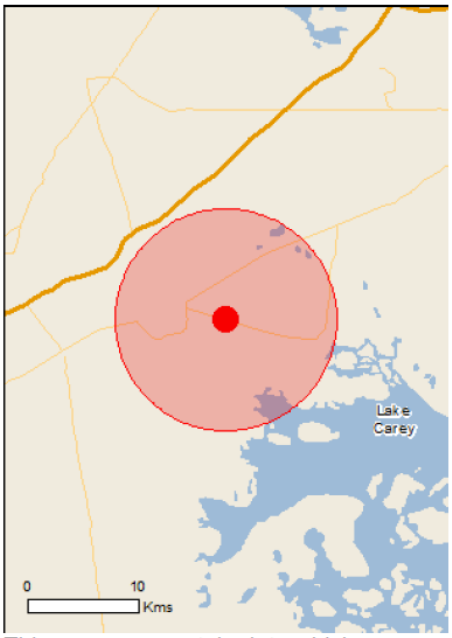
EPBC Act Protected Matters Report

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: 15/11/19 15:23:41



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates

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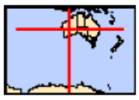

Summary

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:	3
Listed Migratory Species:	8

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:	11
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		
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 likely to 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
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 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
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		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
Ardea alba Great Egret, White Egret [59541]		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
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		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
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		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
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
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 habitat likely to occur within area
Equus asinus Donkey, Ass [4]		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

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

-28.7818 122.1168

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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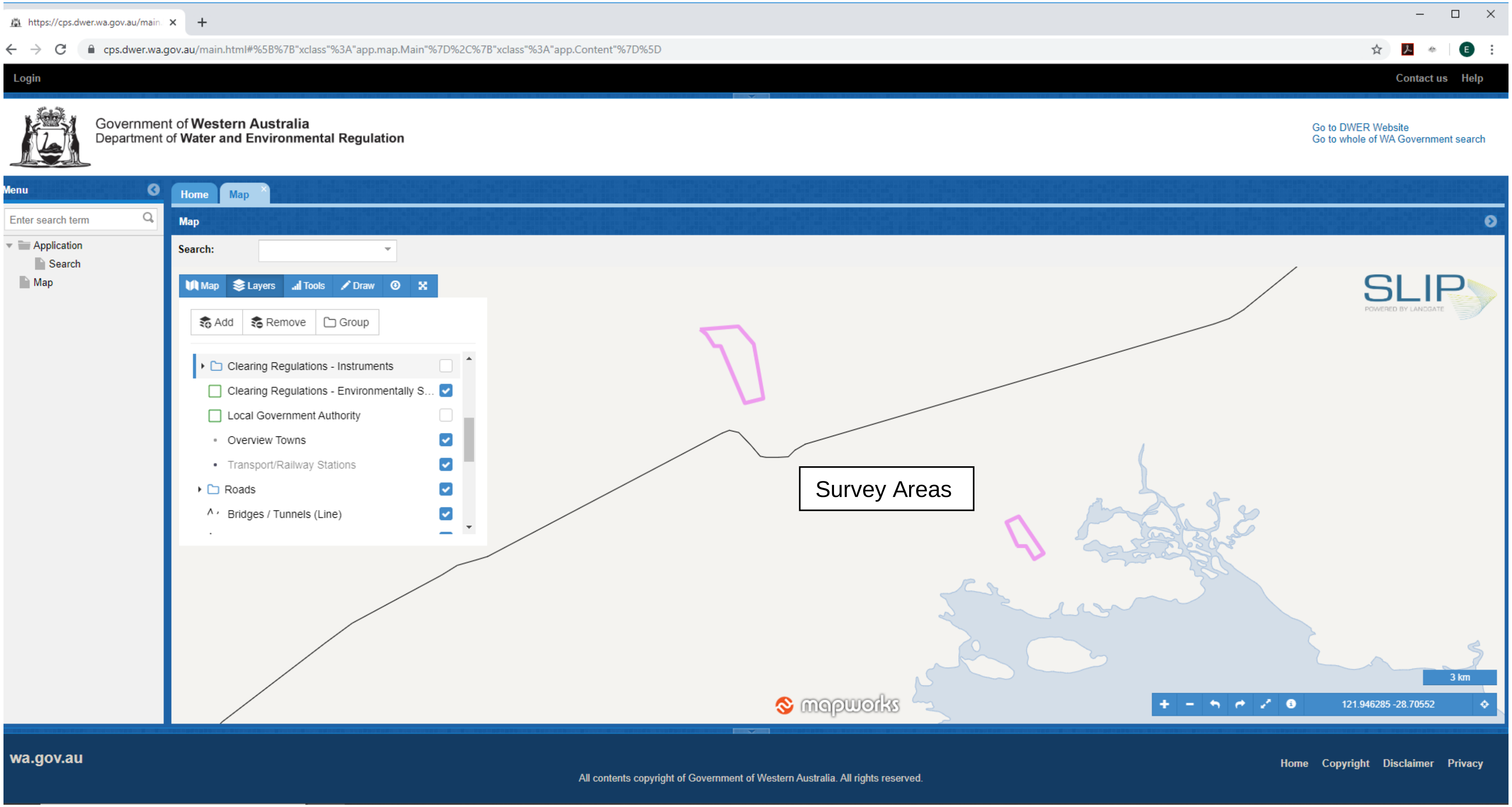
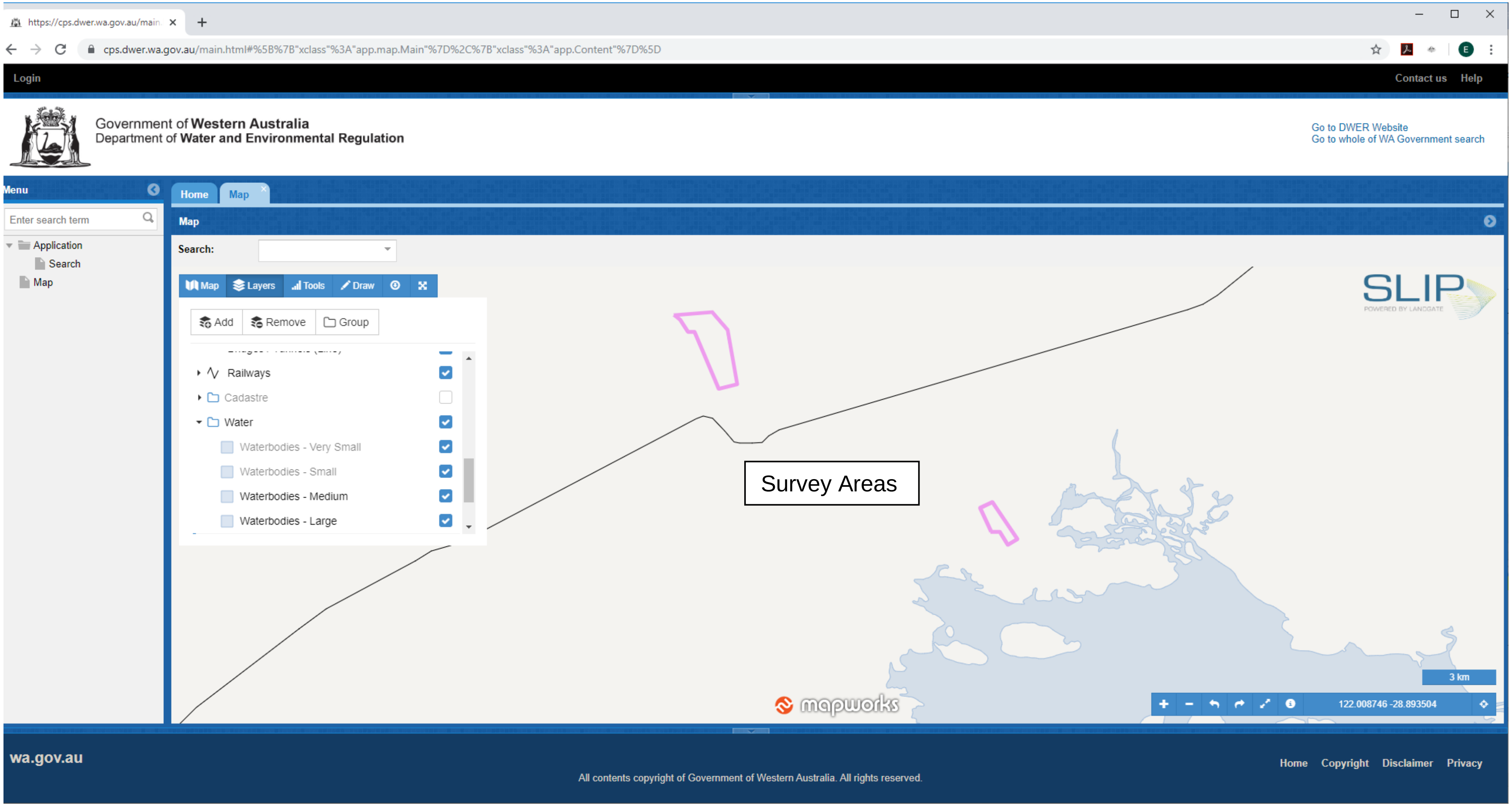
+61 2 6274 1111



DWER Clearing Permit System Map Viewer showing no ESA's (dark green shaded areas) within the survey area (DWER, 2019)



DWER Clearing Permit System Map Viewer showing part of the Lake Carey water body to the southeast of the survey area (DWER, 2019)

Appendix 2

Threatened Flora Databases Search Results

Taxon	Status	Distribution	Flowering Period
Acacia eremophila numerous-nerved variant (A.S. George 11924)	3	Norseman, Neale Junction, Great Victoria Desert, Balladonia, Plumridge Lakes	Sep,Jul
Acacia websteri	1		
Angianthus prostratus	3	Glenorn Stn, Baladjie Lake NR, Quairading, Lake Barlee, Bulga Downs Stn, Kalgoorlie	Jul-Sept
Beyeria lapidicola	1	Bulga Downs, Weld Range, Lake Way Stn.	Jul
Bossiaea eremaea	3	Merolia Stn, Sandstone, White Cliffs Stn	Jul-Sep
Caesia talingka	2	Plumridge Lakes N.R.	
Calytrix hislopii	3	Black Range Stn., Lake Mason Stn., White Cliffs Stn.	Sep
Calytrix praecipua	3	Melita Station, Laverton, Youno Downs, Wanjarri, Marymia, Erong Hmstd, Niagara Dam	Jun-Nov
Cratystylis centralis	3	Barwidgee Stn, Leonora	Aug-Nov
Dicrastylis cundeeleensis	4	Cundeelee, Plumridge Lakes, Rawlinna	Apr, Oct-Dec
Eremophila annosocaulis	3	Mt Morgans Mine (South of Leonora-Laverton Rd), Von Treuer Tableland	
Eremophila arachnoides subsp. tenera	1	Kambalda, Laverton	Sep,Dec
Eremophila dendritica	2	Rawlinna, Plumridge Lakes	Sep-Oct
Eremophila eversa	1	Yerilla	Oct
Eremophila mirabilis	2	Niagara, Morapoi, Kookynie, Woolgorong, Menzies	Aug-Sep
Eremophila simulans subsp. megacalyx	3	Mt Narryer, Boolardy Stn, Leonora	Aug-Sep
Goodenia lyrata	3	Laverton, Newman	
Gunniopsis propinqua	3	Laverton, Mt Margaret, Lake Carnegie, Windidda, Mt Eureka, Mt James, Menzies	Aug-Sep
Hemigenia exilis	4	Lake Darlot, Yakabindie, Leinster, Leonora, Mt Keith	Apr,May,Aug
Homalocalyx echinulatus	3	Carnegie Stn, Wiluna, Doolgunna Stn, Weld Range, Mount Hale, Windidda, Wongawal Stn	Dec
Hybanthus floribundus subsp. chloroxanthus	3	Leonora, Laverton	Aug-Oct
Lechenaultia aphylla	1	Cosmo Newbey - Laverton, SA	
Lechenaultia divaricata	1	Plumridge Lakes	Oct
Micromyrtus placoides	3	Cue, Weld Range, Mt Narryer, Tallering Peak	Aug,Sep
Micromyrtus serrulata	3	Karonie, Coonana, Melita, Jeedamya, Niagara Dam NR, Cardunia Rocks, Queen Victoria Spring NR	Mar,Jun,Nov
Mirbelia stipitata	3	Nth Sandstone, Nth Laverton	-
Olearia arida	4	Neale Junction, Plumridge Lakes, Great Victoria Desert	Jul
Olearia mucronata	3		
Persoonia leucopogon	1	Between Coolgardie & Laverton, Comet Vale (Menzies)	-
Philotheca linearis	1	White Cliffs Stn, Central Australia	Jul
Philotheca tubiflora	1	E of Laverton	Jun,Aug,Oct
Phyllanthus baeckeoides	3	Laverton, Merolia Stn, White Cliffs Stn, Windimurra Station, Cashmere Downs Stn, Leinster, Banjawarn Stn	Jul-Sep
Prostanthera petrophila	3	Cue, Mt Barloweerie, Woolgorong, Weld Range,	Jul-Aug
Ptilotus blackii	3	Plumridge Lakes N.R., Zanthus, Queen Victoria Springs N.R., S.A. N.T.	May-Sep
Ptilotus tetrandrus	1	Glenorn Station, Little Sandy Desert	Oct
Tecticornia cymbiformis	3		
Tecticornia mellaria	1		
Tecticornia sp. Lake Way (P. Armstrong 05/961)	1		
Thryptomene nealensis	3	Leinster, White Cliffs Stn, Neale Junction, Gt Victoria Desert	Oct
Thryptomene wittweri	T	Hamersley Range, Mt Augustus, Carnarvon Range, White Cliffs Stn, NT	Aug-Oct
Vittadinia cervicularis var. oldfieldii	1	Merredin, Laverton	
Vittadinia pustulata	3	Plumridge Lakes N.R., Morgan Range	

Appendix 3

Vegetation Condition Scale (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.

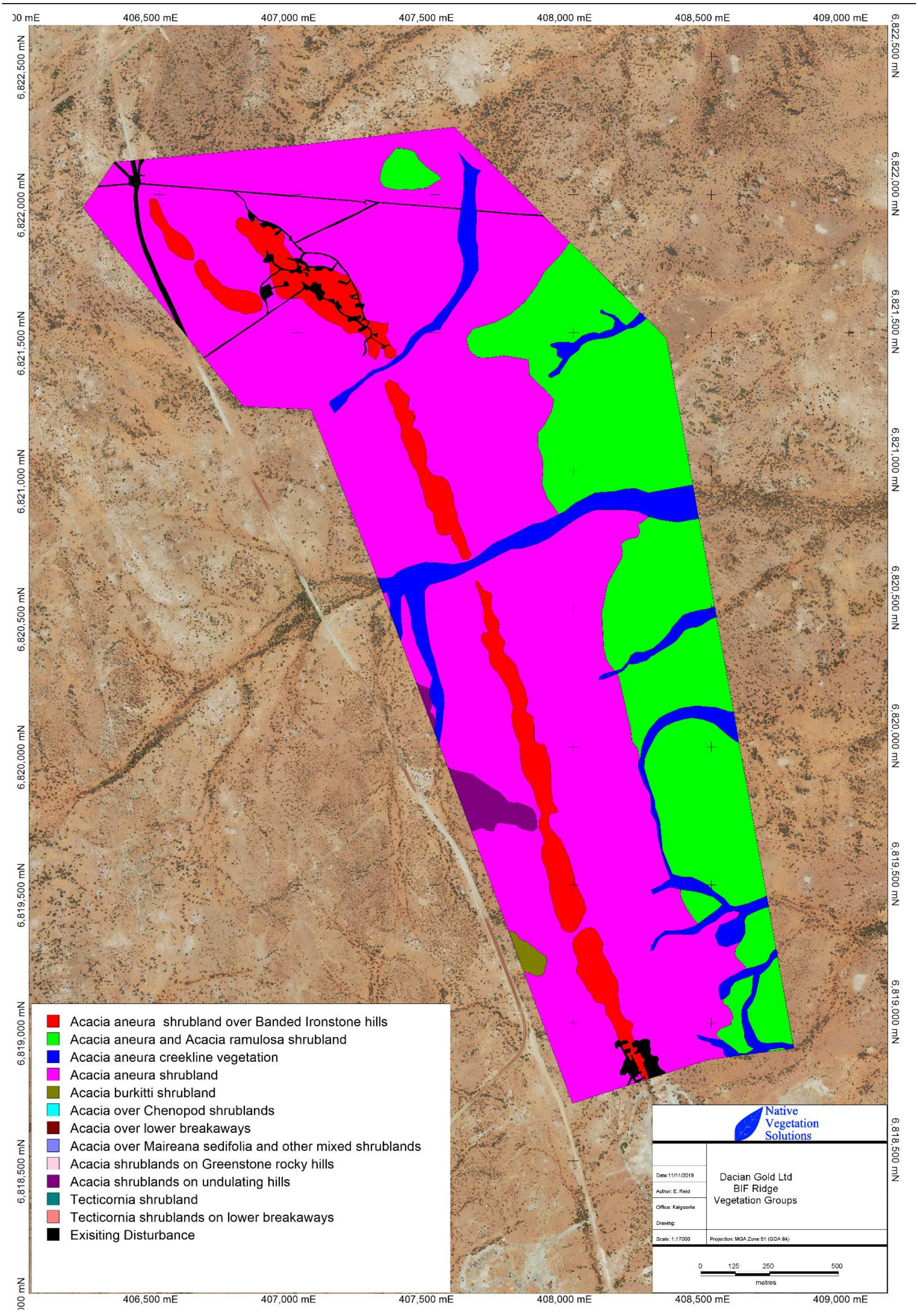
Degraded (5). Basic vegetation structure severely impacted by disturbance.
Scope for regeneration but not to a state approaching good condition without intensive management.
For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial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

Appendix 4

Vegetation Mapping


406,500 mE
407,000 mE
407,500 mE
408,000 mE
408,500 mE
409,000 mE
6,822,500 mN
6,822,000 mN
6,821,500 mN
6,821,000 mN
6,820,500 mN
6,820,000 mN
6,819,500 mN
6,819,000 mN
6,818,500 mN
Native Vegetation Solutions
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:17000
Dacian Gold Ltd
BIF Ridge
Survey Area
Projection: MGA Zone 51 (GDA 94)
0 125 250 500
metres



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6,822,500 mN
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6,821,500 mN
6,821,000 mN
6,820,500 mN
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6,819,500 mN
6,819,000 mN
6,818,500 mN
Acacia aneura shrubland over Banded Ironstone hills
Acacia aneura and Acacia ramulosa shrubland
Acacia aneura creekline vegetation
Acacia aneura shrubland
Acacia burkitti shrubland
Acacia over Chenopod shrublands
Acacia over lower breakaways
Acacia over Maireana sedifolia and other mixed shrublands
Acacia shrublands on Greenstone rocky hills
Acacia shrublands on undulating hills
Tecticornia shrubland
Tecticornia shrublands on lower breakaways
Exisiting Disturbance
Native Vegetation Solutions
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:17000
Dacian Gold Ltd
BIF Ridge
Vegetation Groups
Projection: MGA Zone 51 (GDA 94)
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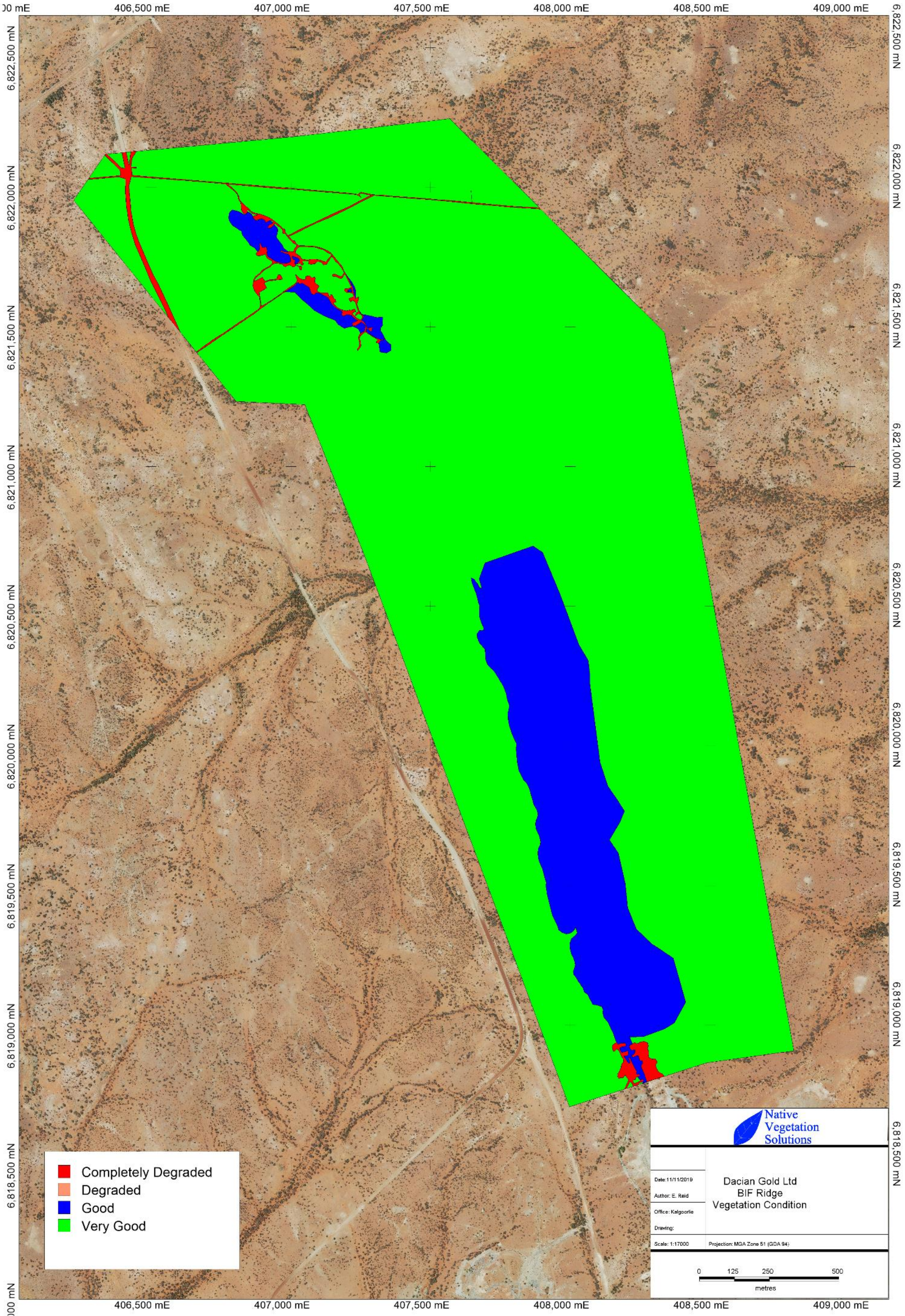
metres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6,820,000 mN
6,819,500 mN
6,819,000 mN
6,818,500 mN
Completely Degraded
Degraded
Good
Very Good
Native Vegetation Solutions
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Dacian Gold Ltd
BIF Ridge
Vegetation Condition
Scale: 1:17000
Projection: MGA Zone 51 (GDA 94)
0 125 250 500
metres

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408,000 mE
408,500 mE
409,000 mE
6,822,500 mN
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6,821,500 mN
6,821,000 mN
6,820,500 mN
6,820,000 mN
6,819,500 mN
6,819,000 mN
6,818,500 mN
Releve Sample Point
NVS GPS Tracklog
BIF Ridge Survey Area
Native Vegetation Solutions
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:17000
Dacian Gold Ltd
BIF Ridge
NVS GPS Data
Projection: MGA Zone 51 (GDA 94)
0 125 250 500
metres

418,750 mE
419,000 mE
419,250 mE
419,500 mE
419,750 mE
420,000 mE
420,250 mE
6,813,500 mN
6,813,250 mN
6,813,000 mN
6,812,750 mN
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6,812,000 mN
6,811,750 mN
6,811,500 mN
6,811,250 mN
6,811,000 mN
Native Vegetation Solutions
Dacian Gold Ltd
Mount Marven
Survey Area
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:10000
Projection: MGA Zone 51 (GDA 94)
0
100
200
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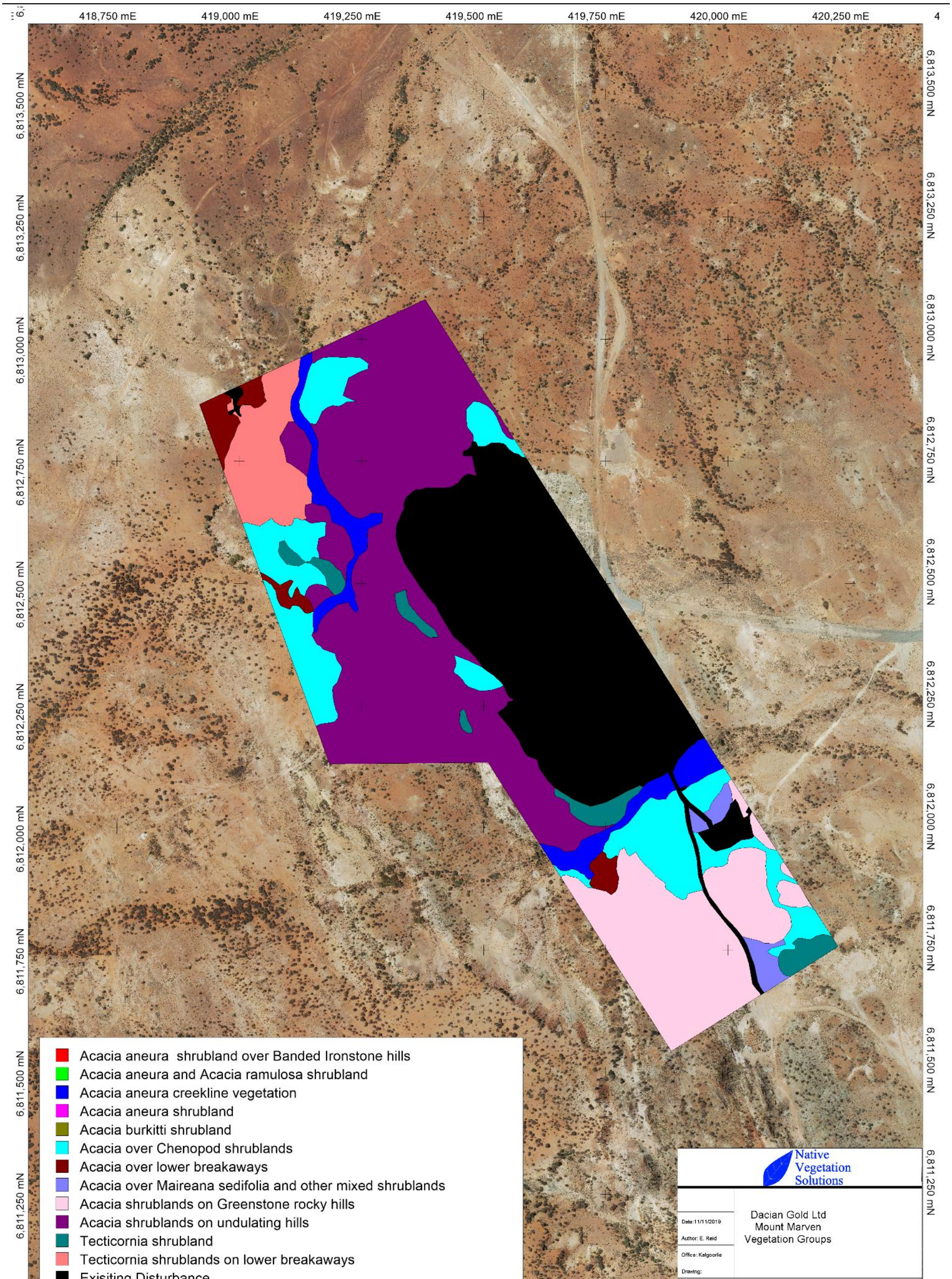
metres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6,811,500 mN
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Acacia aneura shrubland over Banded Ironstone hills
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Acacia aneura creekline vegetation
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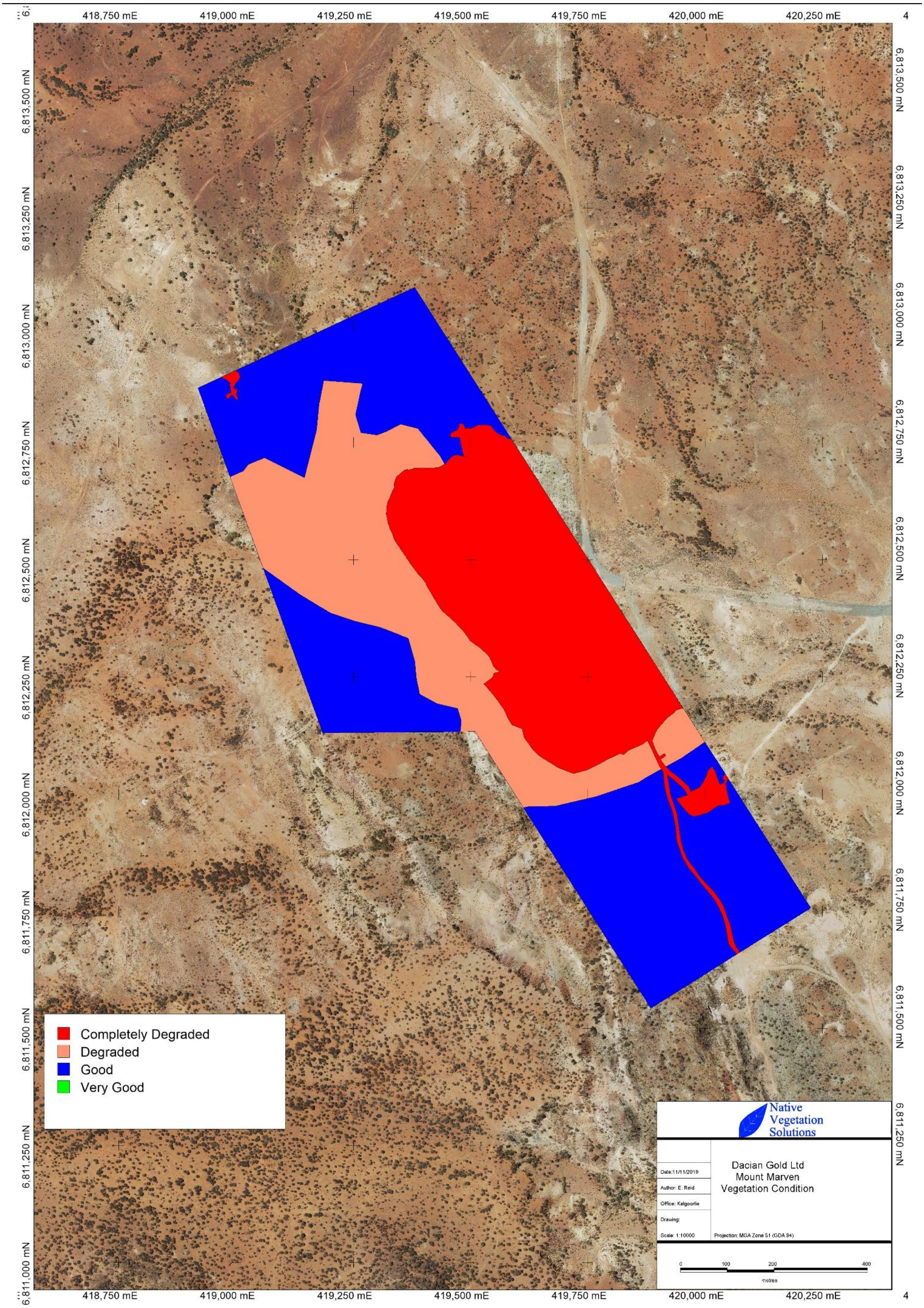
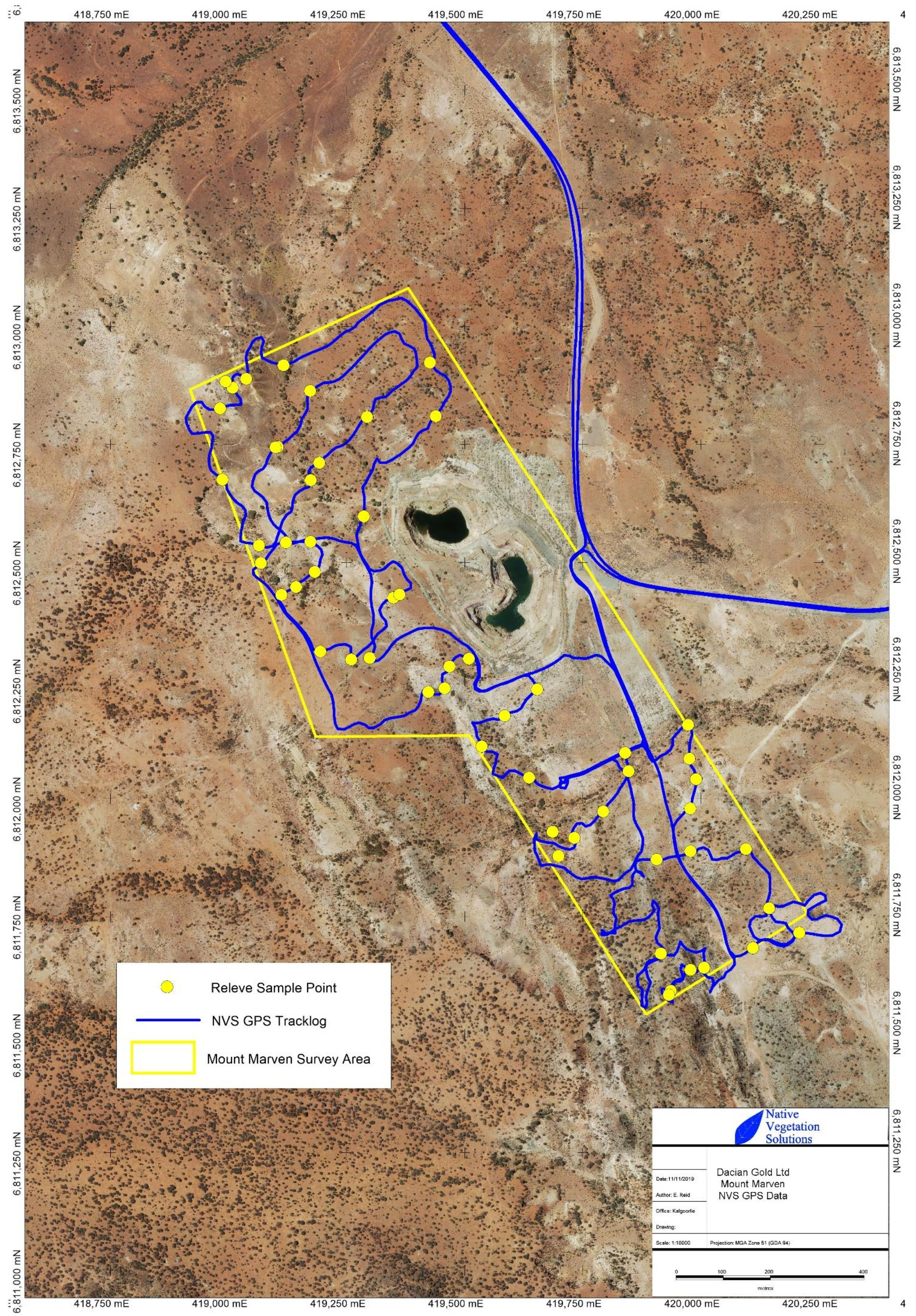
Exisiting Disturbance
Native Vegetation Solutions
Date: 11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Dacian Gold Ltd
Mount Marven
Vegetation Groups
Scale: 1:10000
Projection: MGA Zone 51 (GDA 94)
0
100
200
400
metres



418,750 mE
419,000 mE
419,250 mE
419,500 mE
419,750 mE
420,000 mE
420,250 mE
6,813,500 mN
6,813,250 mN
6,813,000 mN
6,812,750 mN
6,812,500 mN
6,812,250 mN
6,812,000 mN
6,811,750 mN
6,811,500 mN
6,811,250 mN
6,811,000 mN
Completely Degraded
Degraded
Good
Very Good
Native Vegetation Solutions
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:10000
Dacian Gold Ltd
Mount Marven
Vegetation Condition
Projection: MGA Zone 51 (GDA 94)
0
100
200
400
metres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6,813,500 mN
6,813,250 mN
6,813,000 mN
6,812,750 mN
6,812,500 mN
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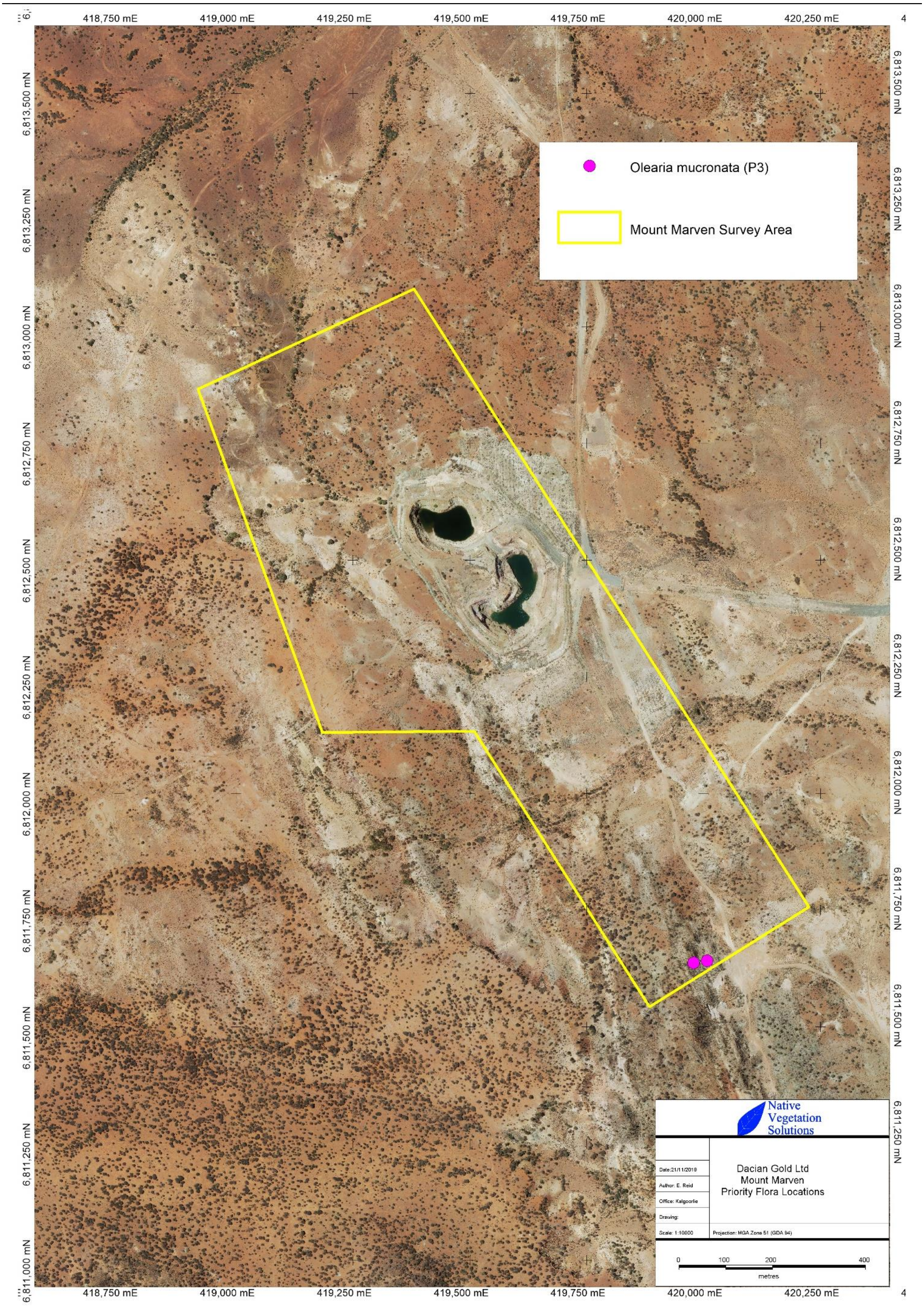
6,812,000 mN
6,811,750 mN
6,811,500 mN
6,811,250 mN
6,811,000 mN
Releve Sample Point
NVS GPS Tracklog
Mount Marven Survey Area
Native Vegetation Solutions
Dacian Gold Ltd
Mount Marven
NVS GPS Data
Date:11/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:10000
Projection: MGA Zone 51 (GDA 94)
0
100
200
400
metres



418,750 mE
419,000 mE
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6,813,500 mN
6,813,250 mN
6,813,000 mN
6,812,750 mN
6,812,500 mN
6,812,250 mN
6,812,000 mN
6,811,750 mN
6,811,500 mN
6,811,250 mN
6,811,000 mN
Olearia mucronata (P3)
Mount Marven Survey Area
Native Vegetation Solutions
Date:21/11/2019
Author: E. Reid
Office: Kalgoorlie
Drawing:
Scale: 1:10000
Dacian Gold Ltd
Mount Marven
Priority Flora Locations
Projection: MGA Zone 51 (GDA 94)
0
100
200
400
metres

Appendix 5

Species List

Family	Genus	Species	Conservation Status	A, P, NN	*Acacia* shrublands on Greenstone rocky hills	*Acacia* over Chenopod shrublands	*Tecticornia* shrubland	*Acacia* over *Maireana sedifolia* and other mixed shrublands	*Acacia aneura* creekline vegetation	*Tecticornia* shrublands on lower breakaways	*Acacia* over lower breakaways	*Acacia* shrublands on undulating hills	*Acacia aneura* shrubland over Banded Ironstone hills	*Acacia aneura* shrubland	*Acacia burkittii* shrubland	*Acacia aneura* and *Acacia ramulosa* shrubland
Aizoaceae	Gunniopsis	quadrifida		P		*										
Amaranthaceae	Ptilotus	divaricatus		P				*							*	
Amaranthaceae	Ptilotus	obovatus		P	*			*	*		*	*	*	*	*	*
Amaranthaceae	Ptilotus	schwartzii		P									*	*		
Anacardiaceae	Schinus	molle var. areira*		P, NN									*			
Apocynaceae	Marsdenia	australis		P	*			*	*			*	*		*	
Asteraceae	Chrysocephalum	puteale		P								*				
Asteraceae	Cratystylis	subspinescens		P	*	*		*								
Asteraceae	Olearia	mucronata	P3	P	*											
Asteraceae	Pterocaulon	sphacelatum		P	*	*		*								
Asteraceae	Rhodanthe	chlorocephala subsp. rosea		A				*								
Asteraceae	Rhodanthe	floribunda		A				*								
Asteraceae	Streptoglossa	liatroides		P					*							
Asteraceae	Vittadinia	sulcata		A					*							
Boraginaceae	Halgania	cyanea var. Allambi Stn		P				*								
Brassicaceae	Lepidium	platypetalum		P					*							
Cactaceae	Cylindropuntia	fulgida var. mamillata*		P, NN					*							
Casuarinaceae	Casuarina	obesa		P		*	*									
Casuarinaceae	Casuarina	pauper		P	*				*				*			
Chenopodiaceae	Atriplex	bunburyana		P	*	*		*	*						*	
Chenopodiaceae	Atriplex	codonocarpa		A		*	*			*			*			
Chenopodiaceae	Atriplex	lindleyi subsp. inflata		A									*			
Chenopodiaceae	Atriplex	vesicaria		P	*	*	*			*	*				*	
Chenopodiaceae	Enchylaena	tomentosa var. tomentosa		P				*					*		*	
Chenopodiaceae	Maireana	amoena		P		*										
Chenopodiaceae	Maireana	atkinsiana		P		*										
Chenopodiaceae	Maireana	brevifolia		P		*										
Chenopodiaceae	Maireana	carnosa		P		*										
Chenopodiaceae	Maireana	convexa		P		*										
Chenopodiaceae	Maireana	georgei		P	*	*	*	*	*	*			*		*	
Chenopodiaceae	Maireana	glomerifolia		P		*	*			*						
Chenopodiaceae	Maireana	pentatropis		P	*											
Chenopodiaceae	Maireana	pyramidata		P		*		*	*				*	*	*	
Chenopodiaceae	Maireana	sedifolia		P	*	*		*			*	*	*			
Chenopodiaceae	Maireana	thesioides		P		*										
Chenopodiaceae	Maireana	tomentosa		P		*	*	*		*			*			
Chenopodiaceae	Maireana	trichoptera		P	*	*							*			
Chenopodiaceae	Maireana	triptera		P		*	*	*	*	*		*	*	*		*
Chenopodiaceae	Rhagodia	drummondii		P					*				*			
Chenopodiaceae	Rhagodia	eremaeum		P											*	
Chenopodiaceae	Salsola	australis		A				*					*			
Chenopodiaceae	Sclerolaena	cuneata		P		*	*						*			
Chenopodiaceae	Sclerolaena	densiflora		P				*	*							
Chenopodiaceae	Sclerolaena	diacantha		P	*	*	*	*				*	*			
Chenopodiaceae	Sclerolaena	eurotioides		P				*					*			
Chenopodiaceae	Tecticornia	disarticulata		P		*	*			*						
Chenopodiaceae	Tecticornia	halocnemoides subsp. tenuis		P		*	*			*						
Chenopodiaceae	Tecticornia	indica subsp. bidens		P		*	*			*						
Chenopodiaceae	Tecticornia	peltata		P		*	*			*	*					

Family	Genus	Species	Conservation Status	A, P, NN	*Acacia* shrublands on Greenstone rocky hills	*Acacia* over Chenopod shrublands	*Tecticornia* shrubland	*Acacia* over *Maireana sedifolia* and other mixed shrublands	*Acacia aneura* creekline vegetation	*Tecticornia* shrublands on lower breakaways	*Acacia* over lower breakaways	*Acacia* shrublands on undulating hills	*Acacia aneura* shrubland over Banded Ironstone hills	*Acacia aneura* shrubland	*Acacia burkittii* shrubland	*Acacia aneura* and *Acacia ramulosa* shrubland
Chenopodiaceae	Tecticornia	pergranulata subsp. elongata		P							*					
Chenopodiaceae	Tecticornia	pruinosa		P		*	*			*						
Chenopodiaceae	Tecticornia	pterygosperma subsp. pterygosperma		P		*	*			*						
Chenopodiaceae	Tecticornia	undulata		P		*	*			*						
Fabaceae	Acacia	aneura		P	*	*		*	*			*	*	*	*	*
Fabaceae	Acacia	ayersiana		P	*										*	
Fabaceae	Acacia	burkittii		P				*	*						*	
Fabaceae	Acacia	caesaneura		P					*						*	
Fabaceae	Acacia	craspedocarpa		P									*	*		
Fabaceae	Acacia	grasbyi		P												*
Fabaceae	Acacia	kalgoorliensis		P							*					
Fabaceae	Acacia	kempeana		P				*								
Fabaceae	Acacia	ligulata		P	*											
Fabaceae	Acacia	mulganeura		P	*	*			*				*	*		*
Fabaceae	Acacia	prainii		P	*											
Fabaceae	Acacia	pteraneura		P	*	*		*						*	*	*
Fabaceae	Acacia	ramulosa var. ramulosa		P										*	*	
Fabaceae	Acacia	resinimarginea		P								*				
Fabaceae	Acacia	rigens		P	*											
Fabaceae	Acacia	sibirica		P					*		*	*		*	*	
Fabaceae	Acacia	tetragonophylla		P	*			*	*		*	*	*	*	*	*
Fabaceae	Acacia	victoriae subsp. victoriae		P				*				*			*	
Fabaceae	Senna	artemisioides subsp. artemisioides		P	*			*				*	*		*	*
Fabaceae	Senna	artemisioides subsp. filifolia		P	*			*			*	*	*	*	*	*
Fabaceae	Senna	artemisioides subsp. helmsii		P	*							*		*		*
Fabaceae	Senna	artemisioides subsp. sturtii		P	*				*			*	*	*		
Fabaceae	Senna	cardiosperma		P				*	*							*
Fabaceae	Senna	glutinosa subsp. chatelainiana		P					*			*				
Frankeniaceae	Frankenia	georgei		P							*					
Frankeniaceae	Frankenia	interioris		P		*										
Frankeniaceae	Frankenia	pauciflora		P		*										
Frankeniaceae	Frankenia	setosa		P	*	*										
Goodeniaceae	Scaevola	spinescens		P	*			*	*			*	*	*		*
Haloragaceae	Haloragis	trigonocarpa		A					*							
Hemerocallidaceae	Dianella	revoluta var. divaricata		P												*
Lamiaceae	Prostanthera	albiflora		P	*							*				
Lamiaceae	Teucrium	teucriiflorum		P					*						*	*
Malvaceae	Abutilon	cryptopetalum		P				*								
Malvaceae	Brachychiton	gregorii		P	*								*	*		*
Malvaceae	Lawrencia	squamata		P		*										
Malvaceae	Sida	calyxhymenia		P	*			*			*	*				
Malvaceae	Sida	ectogama		P								*	*			
Malvaceae	Sida	intricata		P				*								
Malvaceae	Sida	sp. Excedentifolia		P									*			
Malvaceae	Sida	sp. golden calyces		P					*							
Myrtaceae	Calytrix	erosipetala		P	*							*				
Myrtaceae	Eucalyptus	loxophleba subsp. lissophloia		P										*		
Myrtaceae	Eucalyptus	oleosa subsp. oleosa		P							*					
Myrtaceae	Melaleuca	hamata		P											*	

Family	Genus	Species	Conservation Status	A, P, NN	*Acacia* shrublands on Greenstone rocky hills	*Acacia* over Chenopod shrublands	*Tecticornia* shrubland	*Acacia* over *Maireana sedifolia* and other mixed shrublands	*Acacia aneura* creekline vegetation	*Tecticornia* shrublands on lower breakaways	*Acacia* over lower breakaways	*Acacia* shrublands on undulating hills	*Acacia aneura* shrubland over Banded Ironstone hills	*Acacia aneura* shrubland	*Acacia burkittii* shrubland	*Acacia aneura* and *Acacia ramulosa* shrubland
Myrtaceae	Melaleuca	interioris		P			*									
Myrtaceae	Melaleuca	xerophila		P				*								
Pittosporaceae	Pittosporum	angustifolium		P		*	*	*								
Poaceae	Aristida	contorta		A				*				*	*			
Poaceae	Austrostipa	elegantissima		P											*	
Poaceae	Austrostipa	nitida		P								*		*		
Poaceae	Cymbopogon	ambiguus		P	*								*			
Poaceae	Enneapogon	caerulescens		P				*							*	
Poaceae	Enteropogon	ramosus		P	*				*							
Poaceae	Eragrostis	eriopoda		P				*						*		*
Poaceae	Eragrostis	setifolia		P									*			
Poaceae	Eriachne	pulchella subsp. pulchella		A				*					*	*		
Poaceae	Monachather	paradoxus		P									*			
Poaceae	Tripogonella	loliiformis		P	*											
Primulaceae	Lysimachia	arvensis*		A, NN					*							
Proteaceae	Grevillea	berryana		P								*	*	*	*	*
Proteaceae	Hakea	lorea subsp. lorea		P					*		*			*		*
Proteaceae	Hakea	preissii		P	*	*								*	*	*
Proteaceae	Hakea	recurva subsp. arida		P	*											
Proteaceae	Hakea	recurva subsp. recurva		P								*		*	*	
Pteridaceae	Cheilanthes	sieberi subsp. sieberi		P	*								*	*		
Rubiaceae	Psydrax	latifolia		P									*			
Rubiaceae	Psydrax	rigidula		P									*			
Rubiaceae	Psydrax	suaveolens		P										*		
Santalaceae	Exocarpos	aphyllus		P				*			*				*	
Santalaceae	Santalum	lanceolatum		P				*							*	
Santalaceae	Santalum	spicatum		P	*								*			
Sapindaceae	Dodonaea	lobulata		P	*											
Sapindaceae	Dodonaea	petiolaris		P									*			
Sapindaceae	Dodonaea	rigida		P								*	*	*		*
Sapindaceae	Dodonaea	viscosa subsp. angustissima		P							*					
Scrophulariaceae	Eremophila	alternifolia		P				*								
Scrophulariaceae	Eremophila	clarkei		P	*			*						*		
Scrophulariaceae	Eremophila	falcata		P								*				
Scrophulariaceae	Eremophila	forrestii subsp. forrestii		P				*				*			*	*
Scrophulariaceae	Eremophila	georgei		P								*				
Scrophulariaceae	Eremophila	glabra subsp. glabra		P									*		*	
Scrophulariaceae	Eremophila	granitica		P					*							
Scrophulariaceae	Eremophila	latrobei subsp. filiformis		P				*				*				
Scrophulariaceae	Eremophila	latrobei subsp. latrobei		P	*							*	*			
Scrophulariaceae	Eremophila	longifolia		P	*			*							*	
Scrophulariaceae	Eremophila	maculata subsp. brevifolia		P				*							*	
Scrophulariaceae	Eremophila	margarethae		P		*	*	*	*					*	*	*
Scrophulariaceae	Eremophila	miniata		P				*								
Scrophulariaceae	Eremophila	oldfieldii subsp. angustifolia		P		*		*					*			*
Scrophulariaceae	Eremophila	oppositifolia subsp. angustifolia		P					*							
Scrophulariaceae	Eremophila	pantonii		P	*			*			*		*			
Scrophulariaceae	Eremophila	platycalyx subsp. platycalyx		P		*	*	*	*				*		*	*
Scrophulariaceae	Eremophila	scoparia		P	*											

Family	Genus	Species	Conservation Status	A, P, NN	*Acacia* shrublands on Greenstone rocky hills	*Acacia* over Chenopod shrublands	*Tecticornia* shrubland	*Acacia* over *Maireana sedifolia* and other mixed shrublands	*Acacia aneura* creekline vegetation	*Tecticornia* shrublands on lower breakaways	*Acacia* over lower breakaways	*Acacia* shrublands on undulating hills	*Acacia aneura* shrubland over Banded Ironstone hills	*Acacia aneura* shrubland	*Acacia burkittii* shrubland	*Acacia aneura* and *Acacia ramulosa* shrubland
Solanaceae	Lycium	australe		P		*		*								
Solanaceae	Solanum	austropiceum		P				*	*			*				
Solanaceae	Solanum	ferocissimum		P	*								*	*		*
Solanaceae	Solanum	lasiophyllum		P	*	*	*	*				*		*	*	*
Solanaceae	Solanum	nummularium		P				*							*	
Solanaceae	Solanum	orbiculatum subsp. orbiculatum		P				*								
Solanaceae	Solanum	plicatile		P				*	*			*				
Thymelaeaceae	Pimelea	microcephala subsp. microcephala		P		*	*			*						
Zygophyllaceae	Roepera	eichleri		A					*							

APPENDIX 3: LEVEL 1 VERTEBRATE FAUNA SURVEY (WESTERN WILDLIFE, 2016)

Dacian Gold Limited: Mt Morgans Gold Project

Level 1 Vertebrate Fauna Survey March 2016

Jupiter study area at Mt Morgans Project (above) and Borefield study area (left).

Prepared for: Dacian Gold Limited

Prepared by: Western Wildlife
8 Ridgeway Pl
Mahogany Creek WA 6072
Ph: 0427 510 934

July 2016

Executive Summary

Introduction

Dacian Gold Limited (Dacian) is planning to develop the Mt Morgans Gold Project (the Project), located approximately 35 km south west of Laverton, in the northern goldfields of Western Australia. Dacian commissioned Western Wildlife to carry out a Level 1 vertebrate fauna survey of four study areas at the Project, comprising:

- Jupiter study area - 2,937.9ha
- Borefield study area - 1,695.6ha
- Camp study area - 12.7ha
- Workshop and irrigation area study area - 31.1ha

The Level 1 assessment involved a desktop assessment and field study to inventory the fauna habitats present in the project area and make opportunistic observations of fauna.

The objectives of the Level 1 vertebrate fauna survey and literature review was to:

- Identify the fauna habitats present in the study areas.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study areas.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study areas.
- Comment on the potential impacts the proposed development may have on fauna, particularly on fauna of conservation significance.

This report details the findings of the fauna survey conducted in March 2016.

Methods

The Level 1 fauna survey was undertaken in accordance with Environmental Protection Authority (EPA) Position Statement No.3 (EPA 2002), EPA Guidance Statement 56 (EPA 2004) and the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC 2010). The field survey was carried out by two zoologists between the 14th and 18th March 2016. The field study included:

- Identification of fauna habitats.
- Opportunistic records of fauna.
- Targeted search for evidence of any conservation significant species.

Species of conservation significance were classified as: Conservation Significance 1 (CS1) if listed under *The Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or *The Western Australian Wildlife Conservation Act 1950* (WC Act); Conservation Significance 2 (CS2) if listed as a Priority species by the Department of Parks and Wildlife; or Conservation Significance 3 (CS3) if a locally significant species.

Results and Discussion

Eleven fauna habitats were identified across the four study areas:

- Acacia shrubland on low rocky hills
- Acacia shrubland on plains
- Banded Ironstone Formation (BIF) ridge
- Chenopod shrubland
- Claypans
- Creeklines
- Mulga woodlands on plains
- Salt lake
- Samphire shrublands
- Sandy hills and islets
- Disturbed areas

The study area has the potential to support up to ten frog, 82 reptile, 141 bird and 32 mammal (24 native mammals) species. During the site visit one frog, six reptiles, 54 birds and five mammals were recorded opportunistically. A total of 20 fauna species of conservation significance have the potential to occur in the study area, 17 of CS1, two of CS2 and one of CS3. Eleven of the conservation significant species are migratory (Mig.)

The 17 species of CS1 that may occur are the:

- Great Desert Skink (*Liopholis kintorei*) – EPBC Act (Vulnerable), WC Act (Schedule 3)
- Malleefowl (*Leipoa ocellata*) - EPBC Act (Vulnerable), WC Act (Schedule 3)
- Eastern Great Egret (*Ardea modesta*) – EPBC Act (Mig.), WC Act (Schedule 5)
- Red-necked Stint (*Calidris ruficollis*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Curlew Sandpiper (*Calidris ferruginea*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Sharp-tailed Sandpiper (*Calidris acuminata*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Wood Sandpiper (*Tringa glareola*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Common Sandpiper (*Tringa hypoleucos*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Common Greenshank (*Tringa nebularia*)– EPBC Act (Mig.), WC Act (Schedule 5)
- Oriental Plover (*Charadrius veredus*) – EPBC Act (Mig.), WC Act (Schedule 5)
- Gull-billed Tern (*Sterna nilotica*) – EPBC Act (Mig.), WC Act (Schedule 5)
- Fork-tailed Swift (*Apus pacificus*) – EPBC Act (Mig.), WC Act (Schedule 5)
- Rainbow Bee-eater (*Merops ornatus*) – EPBC Act (Mig.), WC Act (Schedule 5)
- Grey Falcon (*Falco hypoleucos*) - WC Act (Schedule 3)
- Peregrine Falcon (*Falco peregrinus*) – WC Act (Schedule 7)
- Princess Parrot (*Polytelis alexandrae*) – EPBC Act (Vulnerable), Priority 4
- Night Parrot (*Pezoporus occidentalis*) - EPBC Act (Endangered), WC Act (Schedule 1)

Of these, the Rainbow Bee-eater, Common Greenshank and Red-necked Stint were recorded in the project area. The Rainbow Bee-eater is likely to be a breeding visitor to the project area, but as its population is large and stable this species is unlikely to be significantly impacted by the development.

The Great Desert Skink, Malleefowl, Princess Parrot and Night Parrot are considered unlikely to occur, as the project area is located outside the core species distribution, suitable habitat is absent and there is an absence of records in the region.

The majority of CS1 species are migratory shorebirds such as stints, sandpipers, greenshanks and plovers. Along with the Eastern Great Egret and Gull-billed Tern, these species may occur on the salt lake (Jupiter study area) or claypans (Borefield study area) when inundated. It is unlikely that the study areas support globally significant populations of migratory shorebirds though other parts of Lake Carey (outside the project area) may do so.

The Peregrine Falcon may forage over the project area, but only potentially breeds in old open pits or the BIF ridge. The Grey Falcon may also forage in the area, but the study area is outside its core range and there is no significant breeding habitat present. The Fork-tailed Swift is likely to overfly the study area on occasion, but unlikely to be affected by changes to study area habitats.

The two species of CS2 that may occur are the:

- Striated Grasswren (*Amytornis striatus striatus*) – Priority 4
- Long-tailed Dunnart (*Sminthopsis longicaudata*) – Priority 4

Of these, the Long-tailed Dunnart may occur in rocky habitats, favouring the BIF ridge. The Striated Grasswren may occur in the Spinifex grasslands on the sandy hills and islets associated with the salt lake margins.

There is one species of Conservation Significance 3 likely to be present, Woolley's False Antechinus (*Pseudantechinus woolleyae*). This species is restricted to rocky areas, and may occur in the BIF ridge habitat.

Development of the Project will result in the loss of some native vegetation (and therefore fauna habitats) within the study areas. Potential impacts include direct mortality of fauna when clearing, habitat loss, a small increase in habitat fragmentation, disturbance to fauna, increase in feral fauna and hydrological changes. It is considered unlikely that the Project will result in impacts to the status of conservation significant species.

Recommendations have been provided with the aim of minimising or mitigating impacts during the planning phase of the mining development:

- Avoid clearing during late winter and spring, to avoid mortalities of young birds in nests.
- Carry out clearing in a progressive manner towards remaining fauna habitat, to avoid pushing fauna into already-cleared areas.
- Ensure all drill holes are securely capped to prevent fauna becoming fatally trapped.
- Minimise habitat loss in the planning phase by minimising the mine footprint area.
- Carry out re-vegetation once mining activities are complete, to restore fauna habitats.
- Avoid the creation of small islands of native vegetation surrounded by cleared land.
- Where practicable, cluster noisy activities together in order to reduce the amount of disturbance to fauna.
- Minimise light spill by using the minimum of lighting necessary for safety, and where possible, situate necessary lighting low to the ground and shielded from fauna habitat in creeklines or salt lake pools.
- If shorebirds are noted to be present at a pool, restrict access to the area where practicable.
- Appropriately dispose of food waste so as not to provide a food source to feral predators.

- Prohibit feeding fauna on site.
- Where practicable, avoid changes to surface and sub-surface hydrology.
- Where practicable, avoid impacts on Lake Carey outside of the mine footprint.

Table of Contents

Tables, Figures and Plates

1. Introduction

Dacian Gold Limited (Dacian) is planning to develop the Mt Morgans Gold Project (the Project), located approximately 35 km south west of Laverton, in the northern goldfields of Western Australia (Figure 1). Dacian commissioned Western Wildlife to carry out a Level 1 vertebrate fauna survey of four study areas at the Project. The Level 1 assessment involved a desktop assessment and field study to inventory the fauna habitats present in the project area and make opportunistic observations of fauna.

The objectives of the Level 1 vertebrate fauna survey and literature review was to:

- Identify the fauna habitats present in the study areas.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study areas.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study areas.
- Comment on the potential impacts the proposed development may have on fauna, particularly on fauna of conservation significance.

This report details the findings of the fauna survey conducted in March 2016.

2. The Study Area – Context and Description

The Project is a brownfields site that encompasses three historic operational areas, comprising:

- Westralia: Containing the Westralia and Transvaal pits, other satellite pits and historical processing areas;
- Jupiter: Containing the Jupiter pit and heap leach area, located approximately 15 km to the east of Westralia; and
- The Mt Morgans and Jupiter Borefields (hereafter referred to as the borefield), containing 14 bores constructed in a calcrete aquifer, of which 6 were pumped during the period 1985 - 1997 to supply raw water to the historic Westralia processing plant and Jupiter heap leach facility.

Dacian proposes to develop an open mining complex at Jupiter and three underground mines at Westralia. Associated infrastructure development will include a processing plant, tailings storage facility (TSF), Run of Mine Pads (ROMs), waste rock dumps, power plant, workshops, administration offices, borefield, camp, pipelines and roads. Infrastructure at Westralia will be primarily located in existing disturbed areas with disturbance to native vegetation predominantly within the Jupiter project area where the TSF and processing plant will be constructed.

Four study areas were defined as part of the Level 1 survey (Figure 2), comprising:

- Jupiter study area - 2,937.9ha
- Borefield study area - 1,695.6ha
- Camp study area - 12.7ha
- Workshop and irrigation area study area - 31.1ha

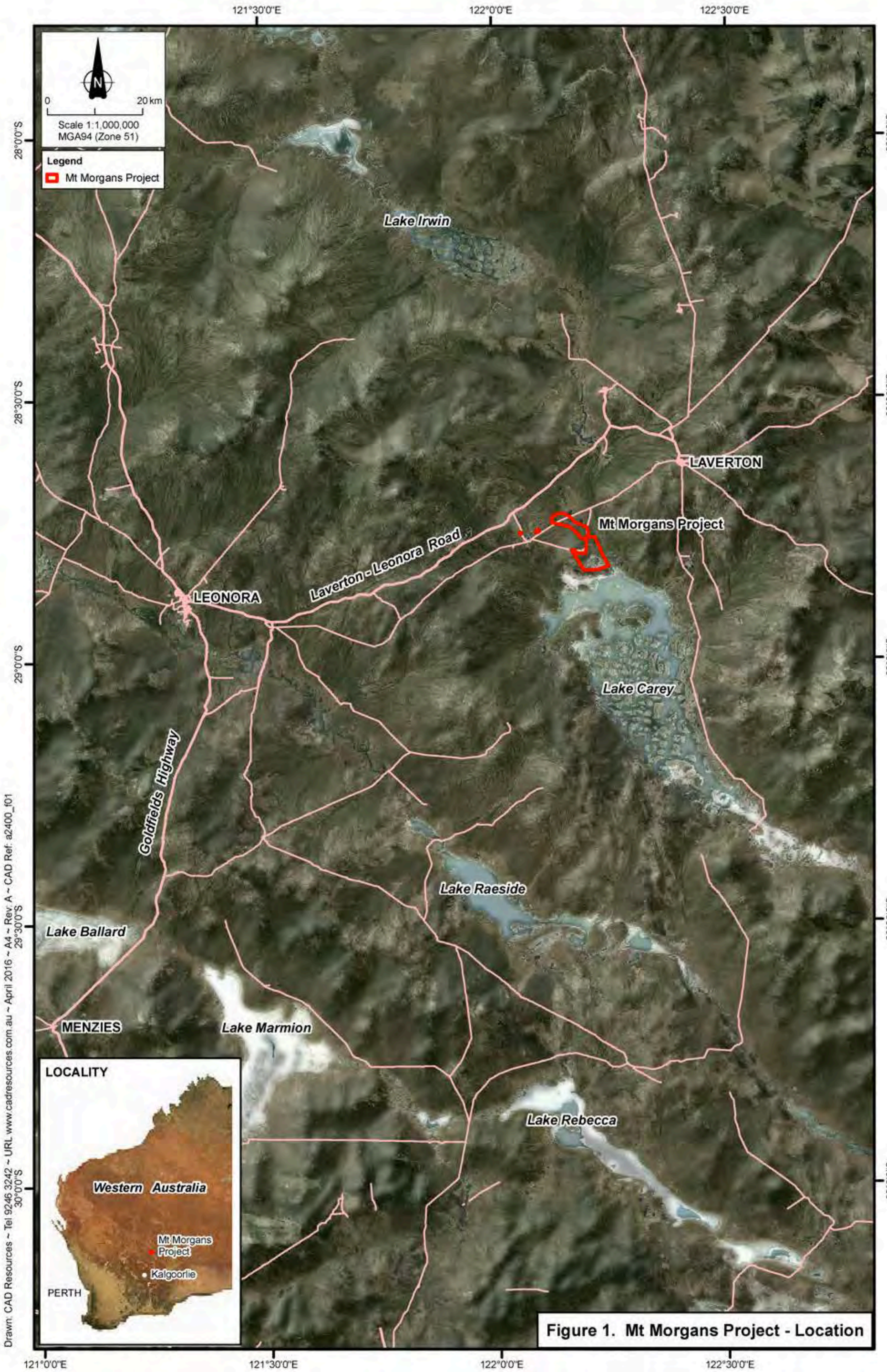

Figure 1. Mt Morgans Project - Location

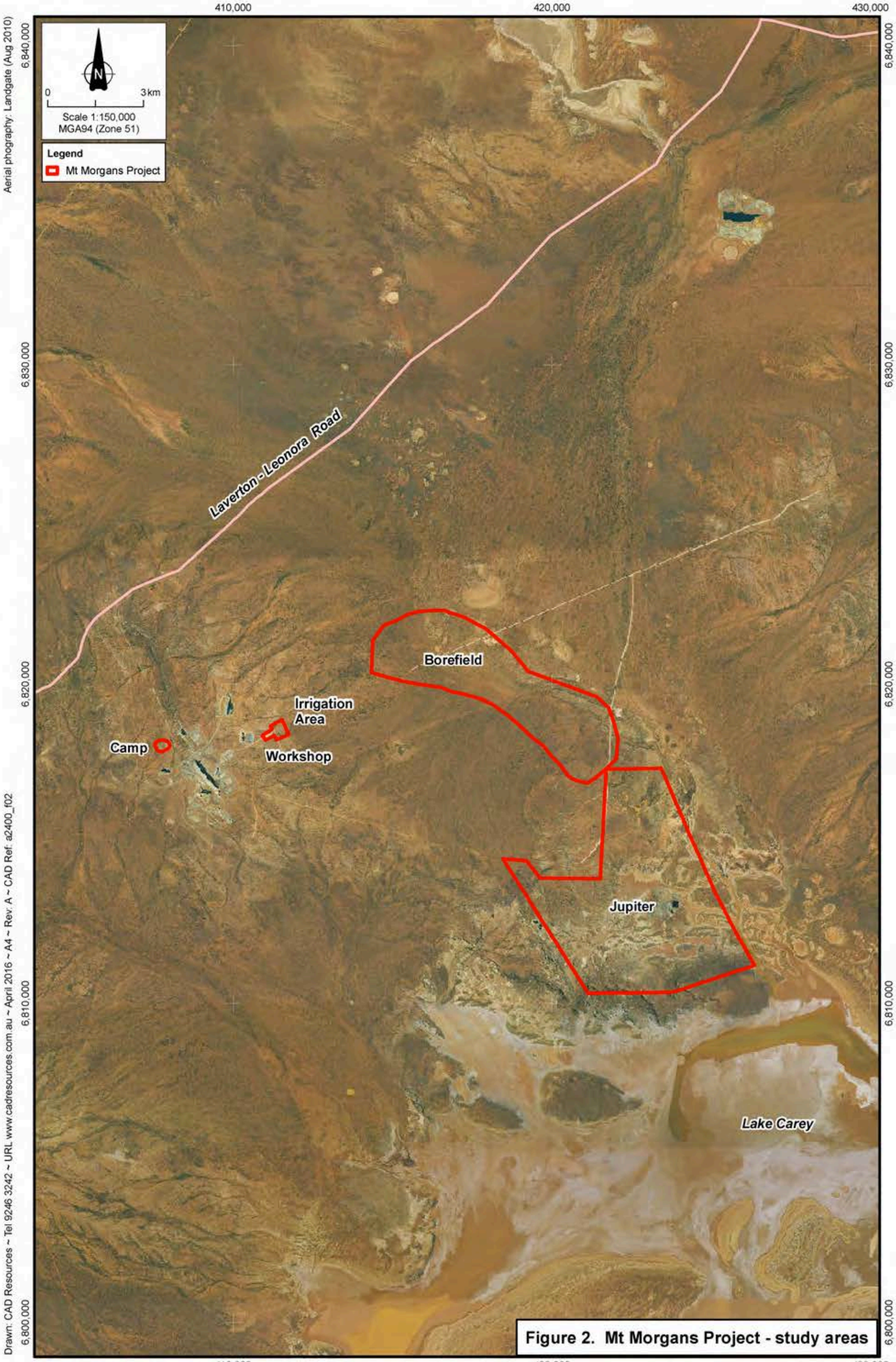

Figure 2. Mt Morgans Project - study areas

Of these, the Jupiter and Borefield study areas included a very large buffer zone, and the proposed disturbance footprint will be significantly smaller. The Jupiter study area is on the northern shore of Lake Carey, a large salt lake of about 75,000ha. Throughout the area there is evidence of historical exploration and mining activities, such as drill pads, access tracks, pits, waste rock dumps and heap leach facility

The study areas fall within the Interim Biogeographic Regionalisation of Australia ('IBRA') Bioregion Murchison 1 – East Murchison Subregion (DEWHA 2004, Cowan 2001). The Murchison Bioregion is characterised by an arid climate, primarily with a winter rainfall of about 200mm. The primary land-use is grazing on native pastures (over 85%), with smaller areas of unallocated Crown land, Crown reserves, mining and conservation (Cowan 2001). The East Murchison Subregion is large at 7,847,996ha and is characterised by red sandplains, broad plains of red-brown soils, breakaways and saltlake systems (Cowan 2001). The vegetation in the region is dominated by Mulga woodlands, hummock grasslands, saltbush shrublands and Halosarcia shrublands (Cowan 2001).

3. Methods

The survey was conducted as a Level 1 fauna survey in accordance with the Environmental Protection Authority (EPA) Position Statement No.3 (EPA, 2002), Guidance Statement 56 (EPA, 2004), Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC 2010) and relevant Commonwealth Government guidelines. The Level 1 fauna survey included a search of available literature and databases (a 'desktop' study), and a field survey of the study area for five days between 14th and 18th March 2016. The field survey served to put the desktop study into context, as well as allowing for the identification of fauna habitats and likely fauna assemblages of the study area.

It was considered that a Level 1 fauna survey was sufficient to characterise the fauna habitats, vertebrate faunal assemblage and the likely conservation significant fauna using the study area. Although a Level 2 fauna survey involving trapping would be likely to add to the list of vertebrate fauna species known to occur in the project area, particularly of reptiles and small mammals, it is unlikely to provide extra information useful in managing potential impacts on fauna.

3.1 Personnel

The personnel involved in the fauna survey were Ms Jenny Wilcox (*BSc.Biol./Env.Sci., Hons.Biol.*) as the supervising zoologist and Mr Cameron Everard (*BSc.Env.Sci., M.Science.*) as the field zoologist. Each zoologist has 16 and 11 years experience in fauna consulting respectively. The report was prepared by Ms Jenny Wilcox.

3.2 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists. These were last updated in 2015. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

3.3 Habitat Mapping

Habitat mapping was undertaken using vegetation mapping by Native Vegetation Solutions (2016), observations made by fauna personnel in the field and interpretation of aerial photography. CAD Resources produced the maps from information provided by Western Wildlife.

3.4 Literature Review

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998 and 2004) and mammals (Churchill 1998, Menkhorst and Knight 2011; Van Dyck and Strahan 2008).

The databases listed in Table 1 were searched for fauna records in and around the study area. In all cases the extent of the database search was larger than the extent of the study area, in order to pick up records of species in the wider area that may also occur in the study area. Some species may occur on database results that are not likely to be present in the study area, usually due to a lack of suitable habitat or the study area being outside the known range of the species as presented in the literature. These species are generally not included in lists of expected fauna unless some discussion is thought to be necessary.

Table 1. Databases used in the preparation of Appendices 1 - 4.

Database	Type of records held on database	Area searched
WA Museum Specimen Database (DPAW 2007-)	Records of specimens held in the Western Australian Museum. Includes historical records.	40km radius around 28º48'28" S, 122º12'37" E
Fauna Survey Returns Database (DPAW 2007-)	Records collected from fauna surveys carried out in Western Australia. Includes observational and trapping data.	40km radius around 28º48'28" S, 122º12'37" E
DPAW's Threatened and Priority Fauna Database (DPAW 2007-)	Information and records on Threatened and Priority species in Western Australia	40km radius around 28º48'28" S, 122º12'37" E
Birds Australia Atlas Database (DPAW 2007-)	Records of bird observations in Australia, 1998-current.	40km radius around 28º48'28" S, 122º12'37" E
EPBC Act Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species and ecological communities, migratory species and marine species.	40km radius around 28º48'28" S, 122º12'37" E

Two recent fauna surveys were carried out for other historic developments in the Project area, comprising:

- A Level 1 fauna survey of the Mt Morgans North Project,undertaken in November 2010 (RPS 2011). This survey was carried out over two days, with only ten fauna species observed opportunistically (six birds and four mammals). None of the observed species were of conservation significance.
- A desktop study of The Craic Project, with no additional records of fauna from the site (Outback Ecology Services 2009).

These sources of information were used to create lists of species that potentially occur in the study area. As far as possible, expected species are those that are likely to utilise the study area. The lists exclude species that have been recorded in the general region as vagrants, or for which suitable habitat is absent within the study area.

3.5 Field Studies

The field study was carried out by two zoologists between 14th - 18th March 2016. The field study component of a Level 1 fauna survey is primarily to identify the fauna habitats present in the study area. In addition, all fauna encountered during the field survey are recorded. The fauna species recorded are usually conspicuous species such as birds, large mammals and large reptiles. The presence of other species may be inferred from evidence such as tracks, burrows, scats or evidence of foraging. Particular attention was paid to searching for evidence of conservation significant species, or habitats likely to support conservation significant species.

In addition, three motion-sensitive cameras were deployed for two nights, targeting areas where fauna may drink or forage (Figure 3).

3.6 Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Guidance Statement 56 (EPA 2004), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 2 below. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 2. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Experience of fauna personnel	Not limiting:	The supervising zoologist has over 16 years experience in fauna consulting. Team member has 11 years experience.
Types of traps or other survey methods used	Not limiting:	No trapping was undertaken as this was a Level 1 survey. This restricts fauna records to opportunistic observations.
Number of trapping sites	Not limiting:	As above.
Ability to survey all habitats present	Not limiting:	All habitats present were surveyed during the fauna survey.
Availability of fauna information for the area in literature and on databases	Not limiting:	Moderate amount of fauna information available on databases and in the literature.
Effects of weather during the survey	Not limiting:	Weather during the field survey ranged from hot and humid to cool and wet. Weather conditions are unlikely to affect the outcomes of a Level 1 fauna survey.
Seasonal effects	Not limiting:	Seasonal effects are not taken into account with a Level 1 survey, as the primary function is habitat assessment.
Disturbance to site such as recent fires, cattle grazing	Minor limitation:	Parts of the site are disturbed due to historical mining activities, current drilling programs and the presence of infrastructure such as roads.
Ease of access to site	Not limiting:	Site access is generally good with numerous tracks to all habitat types. Entirety of site is accessible on foot.

3.7 Assessment of Conservation Significance

Three levels of conservation significance are used within this report to indicate the level of significance of fauna species. These are described in the following sub-sections.

3.7.1 Conservation Significance 1

Conservation Significance 1 (CS1) is the highest level of conservation significance, describing species that are protected under State or Commonwealth legislation. These species are considered to be of state and/or national conservation significance, and some species (e.g. some migratory species) may be considered of international significance.

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance'. These include threatened species, threatened ecological communities and migratory species.

Fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria. These criteria are as follows:

Extinct:	Taxa not definitely located in the wild during the past 50 years.
Extinct in the wild:	Taxa known to survive only in captivity.
Critically Endangered:	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered:	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable:	Taxa facing a very high risk of extinction in the wild in the medium-term future.
Conservation Dependent:	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Of the above, only fauna classified as 'extinct in the wild' 'critically endangered', 'endangered' or 'vulnerable' are listed as Matters of National Environmental Significance.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Bonn Convention for which Australia is a range state.

Reports on the conservation status of most vertebrate fauna species have been produced by the Department of Environment (DoE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett *et al*. 2011) and mammals (Woinarski *et al*. 2012). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Western Australian Wildlife Conservation Act 1950* (WC Act) is State legislation for fauna protection administered by the Department of Parks and Wildlife (DPAW). The WC Act lists species under a set of Schedules, as listed below.

Schedule 1:	Fauna that is rare or likely to become extinct (critically endangered fauna)
Schedule 2:	Fauna that is rare or likely to become extinct (endangered fauna)
Schedule 3:	Fauna that is rare or likely to become extinct (vulnerable fauna)
Schedule 4:	Fauna presumed to be extinct
Schedule 5:	Migratory birds protected under an international agreement
Schedule 6:	Fauna that is of special conservation need (conservation dependent fauna)
Schedule 7:	Other specially protected fauna

3.7.2 Conservation Significance 2

Species of Conservation Significance 2 (CS2) are not listed under State or Commonwealth Acts, but are listed as Priority species by DPAW. These species may be considered to be regionally significant. In Western Australia, DPAW maintains a list of Priority Fauna made up of species that are not considered Threatened under the WC Act, but for which DPAW feels there is cause for concern. There are four levels of Priority as defined by DPAW, as listed below.

Priority 1:	Poorly known species (on threatened lands)
Priority 2:	Poorly known species in few locations (some on conservation lands)
Priority 3:	Poorly known species in several locations (some on conservation lands)
Priority 4:	Rare, near threatened and other species in need of monitoring

3.7.3 Conservation Significance 3

Conservation Significance 3 (CS3) species are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DPAW, but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or they occur in breeding colonies (e.g. some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

4. Habitats of the Study Area

The fauna habitats in the study area were identified on the basis of observations made in the field by the fauna team and interpretation of aerial photography (Figures 3 - 5). The eleven fauna habitats are listed in Table 3 and described in the sections below.

Table 3. Fauna habitats of the Mt Morgans Project study areas.

Fauna habitat	Total Area (ha)	Area (ha) in each study area			
		Jupiter	Borefield	Camp	Workshop & irrigation
Acacia shrubland on low rocky hills	437.6	437.6	-	-	-
Acacia shrubland on plains	1138.9	115.7	996.1	-	27.1
Banded Ironstone Formation (BIF) ridge	110.0	110.0	-	-	-
Chenopod shrubland	889.9	441.1	448.8	-	-
Claypan	34.9	-	34.9	-	-
Creeklines	11.5	11.5	-	-	-
Mulga woodlands on plains	382.5	189.3	193.2	-	-
Salt lake	462.4	462.4	-	-	-
Samphire shrubland	654.4	654.4	-	-	-
Sandy hills and islets	387.9	387.9	-	-	-
Disturbed areas	167.4	128.0	22.7	12.7	4.0
Total:	**4,677.4**	**2,937.9**	**1,695.7**	**12.7**	**31.1**

There is some disturbance to all habitats, from drilling access tracks, roads and some historical clearing. In addition, the area is inhabited by livestock (cattle) and evidence of their presence, such as tracks and scats, was ubiquitous throughout the study area. All the habitats present in the study areas are widely represented in the region, though some are patchily distributed, such as BIF ridges, claypans and habitats associated with salt lakes.

The Jupiter study area is the largest and most diverse, as it contains the habitats associated with the salt lake (salt lake, samphire shrubland and sandy hills and islets) and rocky habitats (low rocky hills, BIF ridge), as well as the more ubiquitous *Acacia* shrublands, chenopod shrublands and Mulga woodlands. Apart from roads and tracks, disturbance to the Jupiter study area is centred around the existing historic Jupiter pit, associated waste dump and heap leach facility, as well as the current resource drilling program.

The Borefield study area is dominated by *Acacia* shrublands and chenopod shrublands. Small claypans occur in the northern part of the study area, and also north of the study area. There is little disturbance to this study area, except for roads, tracks and existing bores.

The Camp study area is entirely disturbed, consisting of a partially rehabilitated hill. However, there are some established plants, including eucalypts, that provide some fauna habitat.

The Workshop and Irrigation study area includes mostly *Acacia* shrubland on plains with some disturbed areas.

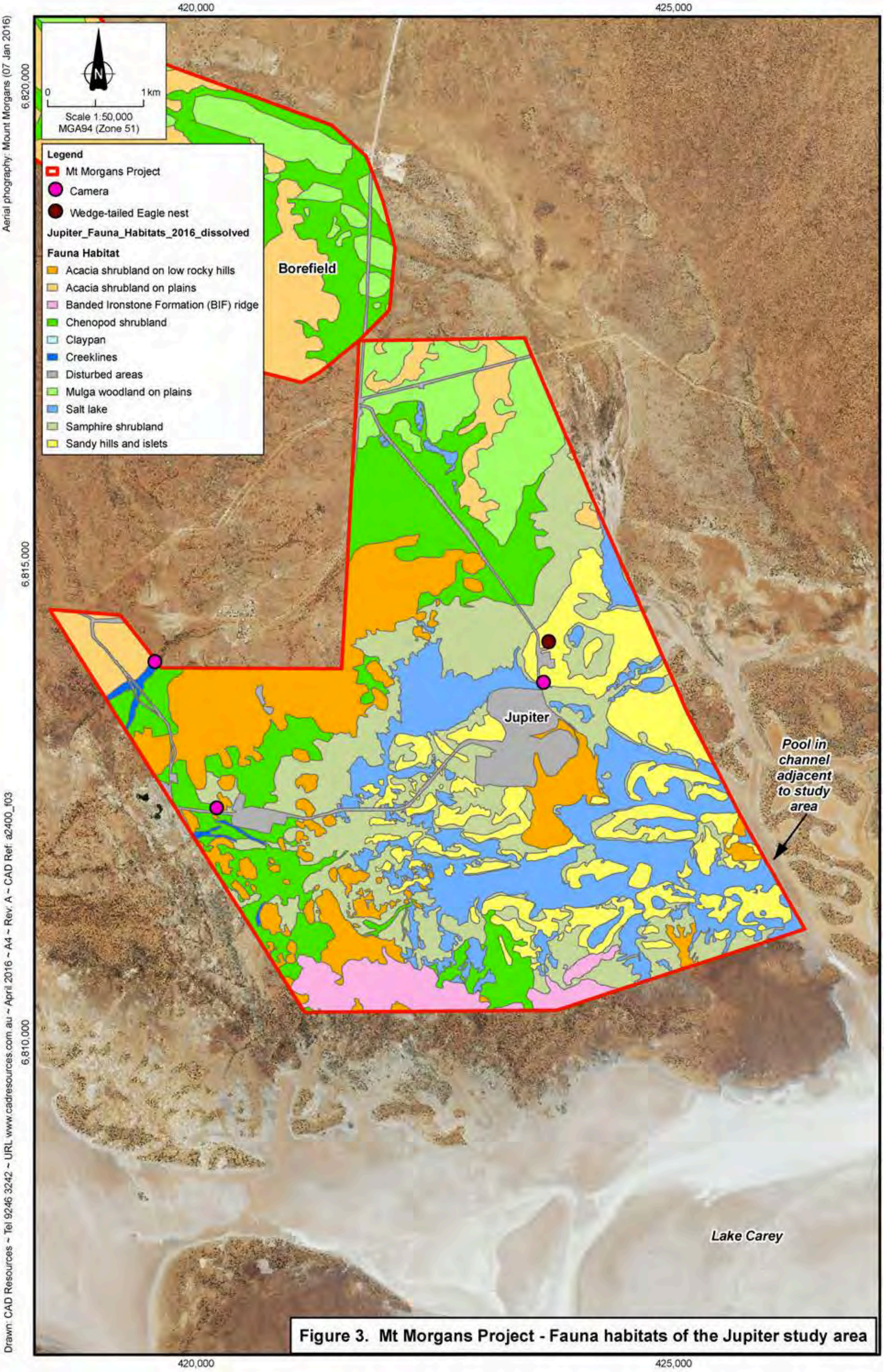

Figure 3. Mt Morgans Project - Fauna habitats of the Jupiter study area

Aerial phography: Mount Morgans (07 Jan 2016)

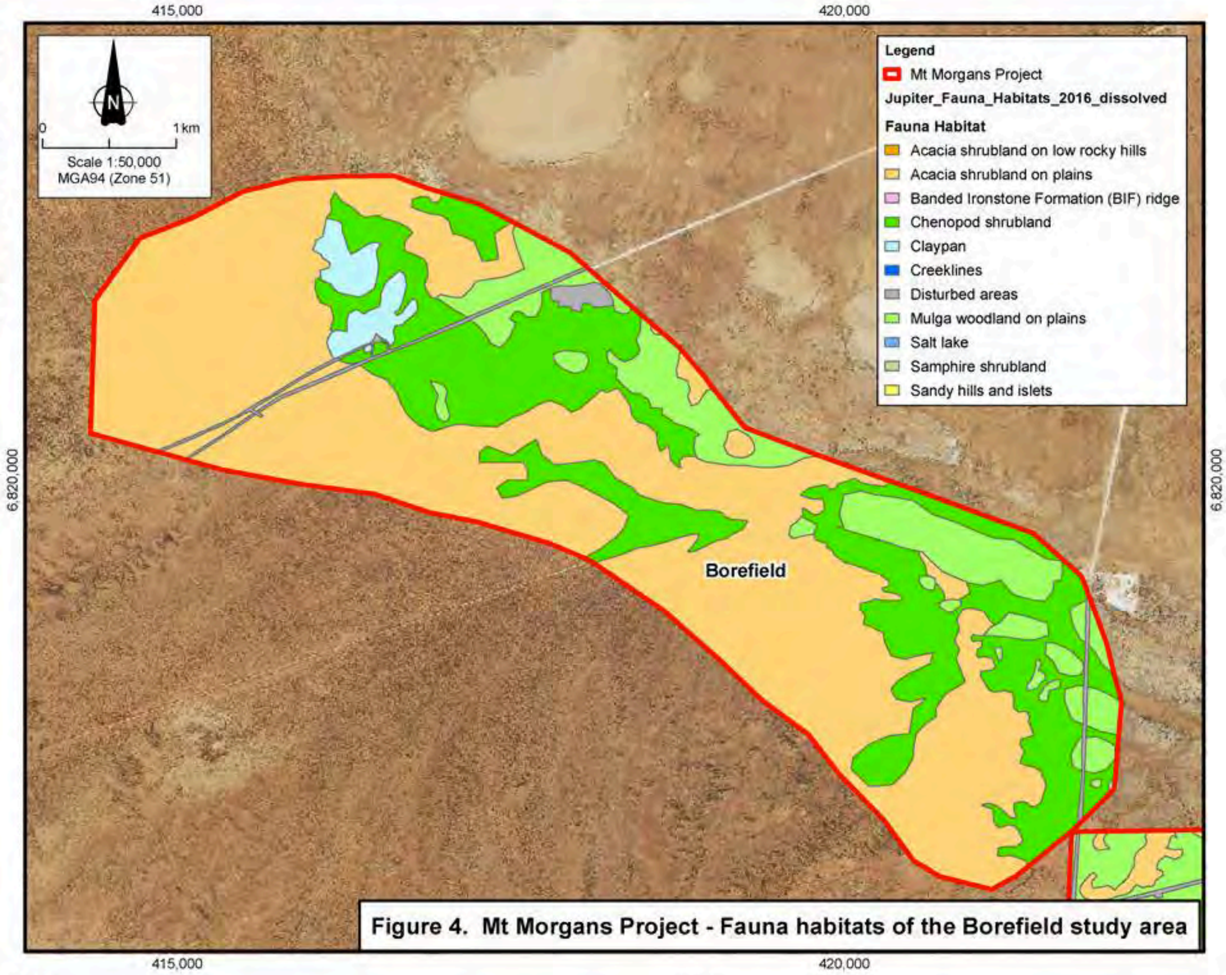

Figure 4. Mt Morgans Project - Fauna habitats of the Borefield study area

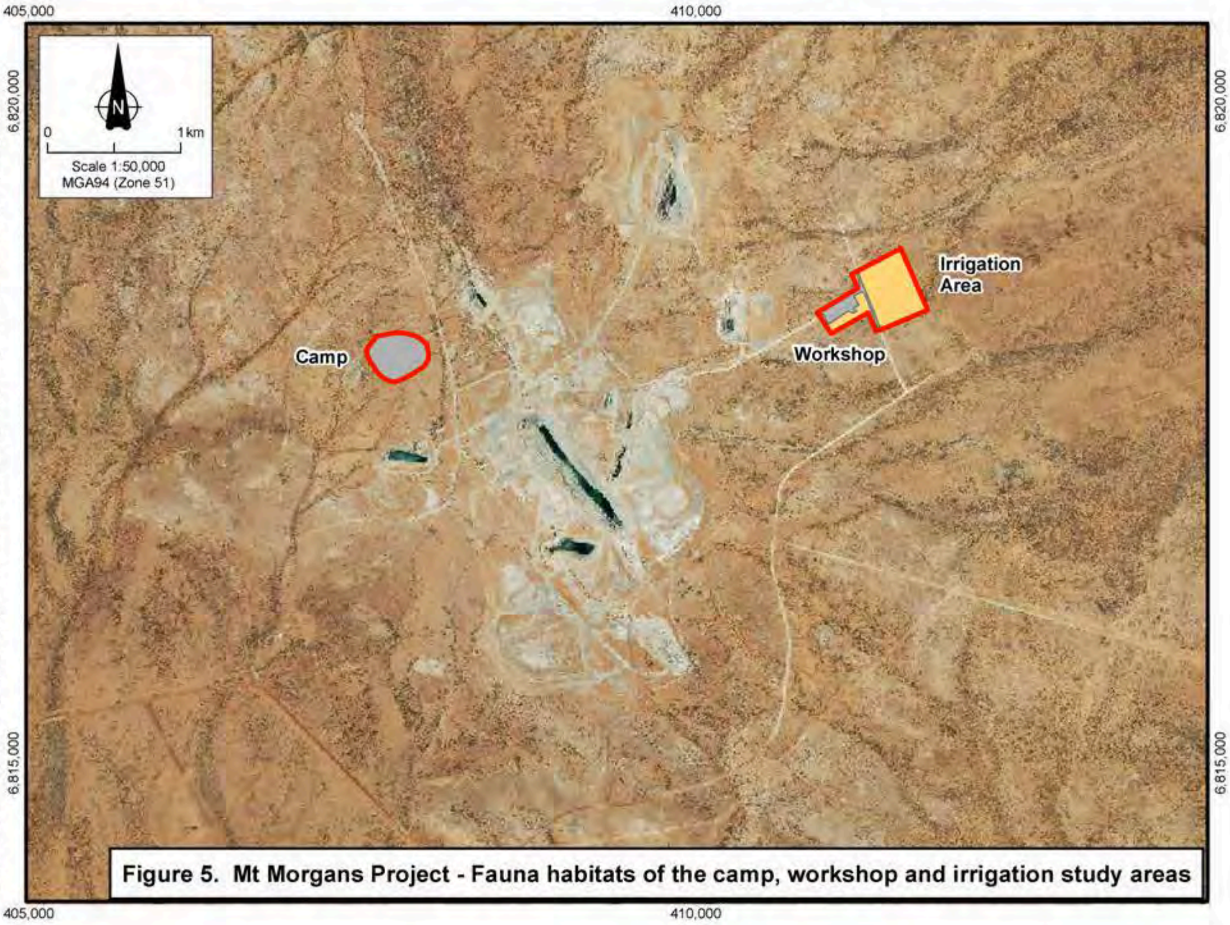

Figure 5. Mt Morgans Project - Fauna habitats of the camp, workshop and irrigation study areas

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4.1 Acacia Shrubland on Low Rocky Hills

Low rocky hills occur mainly in the southern and western parts of the Jupiter study area (Figure 3). These hills are generally low and have a stony or rocky surface with some cracks and crevices (Plate 1). Conservation significant species that may be present in this habitat include the Long-tailed Dunnart (*Sminthopsis longicaudata*) and Peregrine Falcon (*Falco peregrinus*).

Plate 1. Low rocky hills (Jupiter).

4.2 Acacia Shrubland on Plains

Acacia shrubland on plains is a very common habitat, both in the study area and in the region. The shrublands are generally dominated by Mulga (*Acacia aneura*) and other species of *Acacia*, and are often relatively sparse (Plate 2). Although conservation significant fauna such as the Malleefowl (*Leipoa ocellata*) occur in this habitat, the *Acacia* shrublands in the project area are likely to be too sparse to support this species.

4.3 Banded Ironstone Formation (BIF) Ridge

A low BIF ridge runs east-west in the southern part of the Jupiter study area. There are small overhangs and breakaways present in areas with greater relief (Plate 3). Rocky areas provide shelter for a range of reptile and small mammal species. Overhangs and ledges may provide nesting habitat for some birds and shelter for kangaroo species. Conservation significant species that may be present in this habitat include the Long-tailed Dunnart (*Sminthopsis longicaudata*) and Peregrine Falcon (*Falco peregrinus*). Currently, the proposed conceptual layout of the mine does not impact the BIF ridge.

Plate 2. Acacia shrubland dominated by Mulga (Borefield).

Plate 3. Breakaway at the base of the BIF ridge (Jupiter).

4.4 Chenopod Shrublands

The Chenopod shrubland occurs in the Jupiter and Borefield study areas (Figure 2), and typically consisted of sparse low shrubs (Plate 4). This habitat occurred as isolated patches and not associated with a saltlake system. As this habitat is sparsely vegetated it is likely to support a lower diversity of fauna than some of the surrounding habitats. However, conservation significant species that may be present include the Oriental Plover (*Charadrius veredus*).

Plate 4. Chenopod shrubland (Jupiter).

4.5 Claypans

Claypans are present in the northern part of the Borefield study area (Figure 4), and are sparsely vegetated with thickets of *Melaleuca hamata* (Plate 5). There are other, larger claypans to the north of the Borefield study area, as can be seen in Figure 4. The claypans were dry at the time of sampling, except for an area modified to hold water for livestock. Claypans are likely to hold water for varying lengths of time after rain events. When water is present the claypans are likely to support waterbirds including conservation significant species such as the Eastern Great Egret (*Ardea modesta*) and migratory shorebirds. Currently, the proposed conceptual layout of the mine does not impact the claypans.

4.6 Creeklines

Minor creeklines occur in the Jupiter study area (Figure 3) and typically have denser vegetation than the surrounding Acacia shrublands. The creeks in the study area are unlikely to hold water for long periods of time, though they may retain small waterholes after rain. The dense vegetation around creeks provide shelter and breeding sites for birds and other fauna. Conservation significant species that may be present include the Rainbow Bee-eater (*Merops ornatus*) and Eastern Great Egret (*Ardea modesta*).

Plate 5. Claypan (Borefield).

4.7 Mulga Woodlands on Plains

Mulga woodlands are dominated by *Acacia aneura* and occur on plains with a hardpan surface (Plate 6). The Mulga woodland is generally open with a sparse understorey of shrubs and herbs. As a common habitat in the region, Mulga woodland is likely to support a large range of vertebrate species. Small insectivorous birds forage and nest among Mulga trees. Where *Eremophila* shrubs are present and flowering, nectar-feeding birds are likely to be present. Some reptile species, such as geckos, shelter under logs or in crevices on Mulga trees. Although conservation significant fauna such as the Malleefowl (*Leipoa ocellata*) occur in this habitat, the Mulga woodlands in the project area are likely to be too sparse to support this species.

4.8 Salt Lake

The Jupiter study area overlaps with the northern reaches of Lake Carey. In the study area the salt lake consists of interconnecting channels surrounding sandy islets. The bed of the salt lake is unvegetated and unlikely to support many species of vertebrate fauna, except when water is present. Water was present on the south-eastern edge of the Jupiter study area during the March 2016 site visit (Figure 3, Plate 7). When water is present the salt lake potentially supports waterbirds as well as conservation significant species such as migratory shorebirds.

Plate 6. Mulga woodland (Jupiter).

Plate 7. Pool on Lake Carey (southeast boundary of Jupiter, see Figure 3).

4.9 Samphire Shrublands

On the salt lake margins are low samphire shrublands. The shrublands are dominated by samphires (*Tecticornia spp*.) and Bluebushes (*Maireana spp*.) on saline soils, varying in density from very sparse to dense shrubland (Plate 8). Samphire shrublands are likely to support only a few vertebrate fauna species. As this habitat is adjacent to the salt lake and may be periodically inundated, conservation significant migratory shorebirds may occur.

Plate 8. Samphire shrubland (Jupiter).

4.10 Sandy Hills and Islets

On the salt lake margins are numerous low sandy hills and islets supporting *Acacia mulganeura* woodland over Wilcox Bush (*Eremophila forrestii*) and Spinifex (*Triodia spp*.) (Plate 9). Conservation significant fauna that may be present include the Striated Grasswren (*Amytornis striatis*) and Rainbow Bee-eater (*Merops ornatus*).

4.11 Disturbed Areas

Disturbed areas occur where mining has occurred historically, where infrastructure is present or where areas have been subject to partial rehabilitation (Plate 10). Disturbed areas are likely to support few vertebrate fauna species. Though conservation significant species may occur, as many species are wide-ranging, disturbed areas are unlikely to provide significant habitat.

Plate 9. Sandy islet with Spinifex (Jupiter).

Plate 10. Disturbed area (workshop).

5. Vertebrate Fauna of the Study Area

The numbers of vertebrate species potentially occurring in the study area are summarised below in Table 4. The amphibians, reptiles, birds and mammals that have the potential to occur in the study area are listed in Appenices 1 - 4. Indicated in each table are the species recorded:

- In each study area by Western Wildlife during the 2016 site visit.
- In the wider area on the WA Museum Specimen Database (see Table 1).
- In the wider area on the Birds Australia Atlas Database (see Table 1).
- In the wider area on DPAW's Threatened and Priority Fauna Database (see Table 1).
- In the wider area on the EPBC Protected mattered Search Tool (see Table 1).

Table 4. Summary of vertebrate fauna potentially occurring in the study area.

Taxon	Total species	Introduced species	Conservation significant species		
			CS1	CS2	CS3
Amphibians	10	0	-	-	-
Reptiles	82	0	1	-	-
Birds	141	0	16	1	-
Mammals	32	8	-	1	1
Totals:	**265**	**8**	**17**	**2**	**1**

Fauna of conservation significance are discussed in the sections below and are summarised in Table 5. The results of the EPBC Act Protected Matters search are given in Appendix 5.

5.1 Amphibians

There are ten species of frog that have the potential to occur in the study area (Appendix 1). The only frog species observed opportunistically during the site visit was the Desert Tree Frog (*Litoria rubella*), which was common around the existing camp. Frogs are likely to occur throughout the project area, potentially breeding anywhere that holds relatively fresh water after rainfall, including man-made depressions. Many species develop from tadpoles into frogs very quickly, and can make use of ephemeral pools in minor creeks or on claypans. The salt lake is not likely to be frog breeding habitat as it is too saline. During the dry season most species aestivate underground.

In general, the frog species that occur in the study area are common and widely distributed in the semi-arid zone.

5.1.1 Amphibians of Conservation Significance

No frogs of conservation significance are likely to be present in the study area.

5.2 Reptiles

There are 82 species of reptile that have the potential to occur in the study area, of which six species were recorded opportunistically during the 2016 site visit (Appendix 2). The species recorded are all common in the region. The Jupiter study area is likely to support the most diverse reptile assemblage, as it is a large area with diverse habitats including those associated with salt lakes and rocky hills. The Camp and Workshop and Irrigation study areas are likely to support relatively few species, as these areas are small and much less diverse. The Borefield study area is likely to support a reptile assemblage typical of the semi-arid shrublands in the region.

Most of the reptile species listed in Appendix 2 are common and widespread in the semi-arid region of Western Australia.   Many species have broad habitat preferences, or are associated with *Acacia* shrublands and woodlands, a very common habitat type in the region.

Several reptile species are likely to have preferences for sandy habitats dominated by Spinifex, including Broad-banded Sand-swimmer (*Eremiascincus richardsonii*), *Liopholis inornata, Strophurus elderi* and *Ctenotus grandis*. Although sandplain habitats are absent, these species may occur on the sandy hills and islets associated with Lake Carey. Similarly, the Claypan Dragon (*Ctenophorus salinarum*) is likely to be restricted to salt lake edges, chenopod shrublands and claypans in the Jupiter and Borefield study areas. Species such as the Stimpson's Python (*Antaresia stimpsoni*) are likely to favour rocky habitats, where there is shelter available in rock crevices.

5.2.1 Reptiles of Conservation Significance

There is one reptile of conservation significance that may occur in vicinity of the study area, as listed and discussed below.

Conservation Significance 1

Great Desert Skink *Liopholis kintorei*
This species is listed under Schedule 3 (Vulnerable) of the WA Wildlife Conservation Act and as Vulnerable under the EPBC Act.

There is a record of the **Great Desert Skink** 39km east-northeast of Laverton on DPAW's Threatened and Priority Fauna Database. However, the habitat of this species is Spinifex grassland on red sandplains and sand ridges. Although this habitat occurs near the study area, there is no suitable habitat within the study area to support the Great Desert Skink. Therefore, this species is considered highly unlikely to occur in the study area.

5.3 Birds

There are 141 species of bird that have the potential to occur in the study area, of which 54 were recorded during the 2016 site visit (Appendix 3).   Wedge-tailed Eagles (*Aquila audax*) were recorded over Jupiter, and a nest was found in the Jupiter study area (Figure 3, Plate 11).   The Jupiter study area is likely to support the most diverse bird assemblage as it is large and includes habitats that may support waterbirds as well as terrestrial species.

The Borefield study area may support a few waterbirds on the claypans, but is likely to support a bird assemblage typical of the *Acacia* and chenopod shrublands in the region. The Workshop and Irrigation study area will support a similar but smaller assemblage, as the area is much smaller. As the camp study area is disturbed, relatively few species are likely to occur.

The waterbirds that have been listed are those known to utilise inland waterbodies. These species are likely to be highly mobile, varying in abundance according to prevailing weather conditions and the amount of flooding of the claypans and salt lake. While conservation significant migratory shorebirds do not breed in Australia, local species such as the Red-capped Plover (*Charadrius ruficapillus*), Black-winged Stilt (*Himantopus himantopus*) and Banded Stilt (*Cladorhynchus leucocephalus*), potentially breed on islets in salt lakes.

Many of the terrestrial bird species listed are widespread and abundant in semi-arid shrublands and woodlands of the region. When understorey shrubs (*Eremophila spp.*) are flowering, they are likely to provide a seasonal food resource for nectar-feeding species such as honeyeaters. Seeding *Acacia* shrubs and trees provide a food resource for seed-eating birds such as parrots and pigeons. The minor creeklines are more densely vegetated than the surrounding shrublands and are likely to provide shelter and breeding sites for birds. The project area lacks the large eucalypt-lined watercourses that are significant breeding habitat for some species.

Plate 11. Wedge-tailed Eagle nest (Jupiter).

5.3.1 Birds of Conservation Significance

There are 17 birds of conservation significance that may potentially occur in the study area. Each species is listed in the box below, and discussed.

Conservation Significance 1

Malleefowl *Leipoa ocellata*
This species is listed as Vulnerable under the EPBC Act and under Schedule 3 (Vulnerable) of the WC Act.

Eastern Great Egret *Ardea modesta (Ardea alba)*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Red-necked Stint *Calidris ruficollis*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Curlew Sandpiper *Calidris ferruginea*
This species is listed as migratory under the EPBC Act, under Schedule 3 (Vulnerable) of the WA WC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Sharp-tailed Sandpiper *Calidris acuminata*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Wood Sandpiper *Tringa glareola*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Common Sandpiper *Tringa hypoleucos*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Common Greenshank *Tringa nebularia*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Oriental Plover *Charadrius veredus*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Gull-billed Tern *Sterna nilotica*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Fork-tailed Swift *Apus pacificus*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Rainbow Bee-eater *Merops ornatus*
This species is listed as migratory under the EPBC Act and under Schedule 5 (migratory birds under international agreement) of the WC Act.

Grey Falcon *Falco hypoleucos*
This species is listed under Schedule 3 (Vulnerable) of the WC Act.

Peregrine Falcon *Falco peregrinus*
This falcon is listed under Schedule 7 (other specially protected fauna) of the WC Act.

Princess Parrot *Polytelis alexandrae*
This species is listed as Vulnerable under the EPBC Act and Priority 4 by DPAW.

Night Parrot *Pezoporus occidentalis*
This species is listed as Endangered under the EPBC Act and under Schedule 1 (critically endangered fauna) of the WC Act.

The **Malleefowl** is at the north-eastern limit of its range in the study area. This large ground-dwelling bird inhabits mallee and *Acacia* thickets that have a dense layer of leaf litter (Johnstone and Storr 1998). The habitats present in the study area appear unsuitable for this species as they lack leaf litter and are generally sparsely vegetated. Searching during the site visit failed to record any evidence of Malleefowl mounds in the study area. Although the Malleefowl can be locally common, it is rare in much of its range, and is likely to be locally extinct in the vicinity of the study area.

The **Eastern Great Egret** was not recorded during the site visit, but may occasionally visit claypans, pools on salt lakes and possibly minor creeks in the study area. This species generally occurs in the better-watered parts of Western Australia, such as the southwest, Kimberley and Pilbara, where it inhabits a variety of shallow freshwater and saltwater habitats (Johnstone and Storr 1998). Although a listed migratory species, the status of the Eastern Great Egret is secure as it has a large distribution and large population size (BirdLife International 2016).

There are several species of migratory shorebird that may occur in the study area, the **Red-necked Stint**, **Curlew Sandpiper**, **Sharp-tailed Sandpiper**, **Wood Sandpiper**, **Common Sandpiper**, **Common Greenshank** and **Oriental Plover**. These are species that are known to utilise inland waterbodies, including claypans and salt lakes, although the Oriental Plover may also occur on sparsely vegetated plains (Geering *et al*. 2007, Johnstone and Storr 1998). Species that use salt lakes may also use the adjacent samphire shrubland for roosting or foraging when inundated. Though a few birds may overwinter, migratory shorebirds are summer visitors to Australia. They are likely to occur in the study area when water is present between late spring and early autumn. During the site visit a single Common Greenshank was observed in the claypan habitat and a group of about 40 Red-necked Stints were observed on the salt lake, on the pool on the border of the Jupiter study area (Figure 3). In order to qualify as an internationally significant site for shorebirds, a site needs to regularly support either 1% or more of the global population of a species or more than a total of 20,000 shorebirds. According to Bamford *et al*. (2008), the 1% population criteria for the species listed here are:

- Red-necked Stint - 3,250 birds
- Curlew Sandpiper - 1,800 birds
- Sharp-tailed Sandpiper - 1,600 birds
- Wood Sandpiper - 1,000 birds
- Common Sandpiper - 250 birds
- Common Greenshank - 600 birds
- Oriental Plover - 700 birds

It is highly unlikely that the claypans in the Borefield study area or the portion of Lake Carey within the Jupiter study area meets these criteria. The remainder of Lake Carey is a very large salt lake covering 75,000ha, and it is unknown whether the remainder of the lake supports internationally significant shorebird populations.

The **Gull-billed Tern** has been recorded within 30km of the project area on the Birds Australia Atlas Database (Appendix 3). This species occurs along the coast of Western Australia, but also utilises inland waterbodies including flooded claypans and salt lakes (Johnstone and Storr 1998). This species is known to breed colonially at inland salt lakes, nesting on islets when lakes are partially flooded (Johnstone and Storr 1998). Although it is unknown whether this species breeds at Lake Carey, it potentially occurs as a breeding visitor to the region. Small numbers of Gull-billed Terns may occur in the study area on occasion.

The **Grey Falcon** generally occurs further north and east than the project area, though there is a nearby record on DPAW's Threatened and Priority Fauna Database (Appendix 3). The Grey Falcon forages over timbered plains, including *Acacia* shrublands, with its distribution centred on inland drainages. The Grey Falcon nests in tall trees on watercourses (Garnett *et al*. 2011) and occasionally on man-made structures such as transmission line towers (pers. obs.). Other than man-made structures, the study areas appear to lack suitable breeding habitat for this species. Although the Grey Falcon may occur in the study areas on occasion, it is unlikely to provide significant habitat for this species.

The **Peregrine Falcon** is a widespread bird of prey that globally has a very large range and a very large population that appears to be secure (BirdLife International 2016). In Western Australia the population is secure, though this species may experience reductions at a local level due to human disturbance at nesting sites (Debus 1998). The Peregrine Falcon nests mainly on ledges on cliffs or rocky outcrops, and it may also use tall trees (Johnstone and Storr 1998). This species often takes advantage of man-made structures such as abandoned open pits or quarries. The Peregrine Falcon may occur and forage in the project area, with potential breeding habitat present on the low BIF range on the southern boundary of the Jupiter study area.

The **Fork-tailed Swift** is a non-breeding visitor to Australia between September and April (Boehm 1962). While it can be scarce in southwest Australia this species is generally more common in the north (Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (BirdLife International 2016). The Fork-tailed Swift is largely an aerial species and is unlikely to be affected by changes to the study area.

The **Rainbow Bee-eater** is a common species that migrates southwards in summer to breed. It is widespread in Western Australia and was recorded in the Jupiter study area during the site visit (Appendix 3). The Rainbow Bee-eater may forage anywhere over the project area, but is only likely to breed where there are sandy soils in which to burrow, such as along the minor creeks or sandy islets and salt lake margins. As the Rainbow Bee-eater has an extremely large range and an extremely large population size that does not appear to be declining (BirdLife International 2016), it is unlikely that the study area is of particular significance for this species.

The range of the **Princess Parrot** is generally further north and east of the study areas (Garnett *et al*. 2011, Johnstone and Storr 1998) and database records in the local area are likely to be of vagrant birds. This species inhabits lightly wooded desert areas, foraging in the swales between sand dunes and nesting in eucalypt or desert oak (*Allocasuarina decaisneana*) hollows (Garnett *et al*. 2011, Johnstone and Storr 1998). The study area is likely to be outside the core range of the Princess Parrot, and the habitats present are unlikely to support this species.

Historically, the **Night Parrot** was recorded across a large range in the arid and semi-arid interior of Australia (Garnett *et al*. 2011). In recent times however, there are very few verified records of the species, though it may still occur across its range at low densities (Garnett *et al*. 2011). The key habitats for the Night Parrot are thought to be chenopod shrublands and Spinifex grasslands, with the chenopod shrublands a refuge during dry conditions (Garnett *et al*. 2011). Although the Jupiter and Borefield study areas contain chenopod shrubland habitat, the likelihood of the Night Parrot occurring in the study area is extremely low as this species is very rarely recorded anywhere in Australia.

Conservation Significance 2

Striated Grasswren *Amytornis striatus striatus*
This species is listed as Priority 4 by DPAW.

The subspecies of **Striated Grasswren** *Amytornis striatus striatus* occurs mainly in the eastern desert region in Western Australia, with an apparently isolated population between Meekatharra and Wiluna (Johnstone and Storr 2004). It inhabits Spinifex, Spinifex with low shrubs or *Acacia* shrubland over Spinifex on sandy or loamy plains (Johnstone and Storr 2004). There is a record of Striated Grasswren from Sunrise Dam, on the eastern side of Lake Carey (Kingfisher Environmental Consulting 2014), so it is possible that this species occurs in Spinifex habitats that surround the lake. The Striated Grasswren may occur on the sandy islands associated with the margins of Lake Carey and is unlikely to be present in other habitats.

5.4 Mammals

There are 32 species of mammal that have the potential to occur in the study area, of which 24 are native and eight introduced (Appendix 4). Five species of mammal were recorded opportunistically during the site visit, two native species and three introduced (Appendix 4). The native species observed were the Euro (*Macropus robustus*), which is likely to be common in the study area sheltering in the rocky hills, and the Red Kangaroo (*Macropus rufus*), a large species that favours plains and open habitats.

Almost a third of the mammals listed in Appendix 4 are insectivorous bats. These species are likely to forage over the study area at night. Some species, such as Hill's Sheathtail Bat (*Taphozous hilli*), roost in caves or mine shafts, while others, such as the White-striped Freetail Bat (*Tadarida australis*), roost in tree hollows (Churchill 1998). There does not appear to be any caves in the study area, but some cave-roosting species may roost in crevices in the low rocky hills in the Jupiter study area and adjacent to the project area.

5.4.1 Mammals of Conservation Significance

Many native mammals in the region are locally extinct, including the Chuditch (*Dasyurus geoffroii),* Bilby (*Macrotis lagotis*) and Numbat (*Myrmecobius fasciatus*). These species may occur on databases as historical records, but are no longer considered to be present in the area. There are two mammals of conservation significance that may occur in the study areas, as listed and discussed below.

Conservation Significance 2

Long-tailed Dunnart *Sminthopsis longicaudata*
This species is listed as Priority 4 by DPAW.

The **Long-tailed Dunnart** is associated with breakaways and scree slopes, but also occurs on gravel or stony plains (Van Dyck and Strahan 2008). There are records of this species within 30km of the study areas on the Fauna Survey Returns Database (Appendix 4). This species potentially occurs on the BIF ridge and low rocky hills in the Jupiter study area.

Conservation Significance 3

Woolley's False Antechinus *Pseudantechinus woolleyae*
This species is restricted to rocky hills

Woolley's False Antechinus occurs in rocky habitats in the Pilbara, Murchison, Ashburton and Little Sandy Desert (Van Dyck and Strahan 2008). This species may be present in the BIF ridge and surrounding rocky areas. This species has been listed as locally significant as it relies on the patchy rocky habitats in this region.

6. Discussion and Conclusions

6.1 Fauna Habitats and Faunal Assemblage

Eleven fauna habitats were identified in the project area. These habitats are common and widespread in the region. All of the habitats were somewhat disturbed due to the presence of livestock cattle, infrastructure and drilling activities. However, the project area has the potential to support a range of vertebrate species including up to ten frog, 82 reptile, 141 bird and 32 mammal species (Appendices 1 - 4). During the site visit, one frog, six reptiles, 54 birds and five mammals (two native mammals) were recorded opportunistically.

6.2 Conservation Significant Fauna

A total of 20 fauna species of conservation significance have the potential to occur in the study area, consisting of one reptile, 17 bird and two mammal species. These are summarised in Table 5.

The 17 species of Conservation Significance 1 that may occur are the:

- Great Desert Skink (*Liopholis kintorei*)
- Malleefowl (*Leipoa ocellata*)
- Eastern Great Egret (*Ardea modesta*)
- Red-necked Stint (*Calidris ruficollis*)
- Curlew Sandpiper (*Calidris ferruginea*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Wood Sandpiper (*Tringa glareola*)
- Common Sandpiper (*Tringa hypoleucos*)
- Common Greenshank *(Tringa nebularia*)
- Oriental Plover (*Charadrius veredus*)
- Gull-billed Tern (*Sterna nilotica*)
- Fork-tailed Swift (*Apus pacificus*)
- Rainbow Bee-eater (*Merops ornatus*)
- Grey Falcon (*Falco hypoleucos*)
- Peregrine Falcon (*Falco peregrinus*)
- Princess Parrot (*Polytelis alexandrae*)
- Night Parrot (*Pezoporus occidentalis*)

Of these, the Rainbow Bee-eater, Common Greenshank and Red-necked Stint were recorded in the project area (Table 10). The Rainbow Bee-eater is likely to be a breeding visitor to the project area, but as its population is large and stable this species is unlikely to be significantly impacted by the development.

The Great Desert Skink, Malleefowl, Princess Parrot and Night Parrot are considered unlikely to occur, as either the project area is located outside the core species distribution, or suitable habitat is absent.

The majority of CS1 species are migratory shorebirds such as stints, sandpipers, greenshanks and plovers. Along with the Eastern Great Egret and Gull-billed Tern, these species may occur on the salt lake or claypans when inundated. It is unlikely that the study areas support globally significant populations of migratory shorebirds.
The Peregrine Falcon may forage over the project area, only potentially breeds in old open pits or on the BIF ridge. The Grey Falcon may also forage in the area, but the study area is outside its core range and there is no breeding habitat present. The Fork-tailed Swift is likely to overfly the study area on occasion, but unlikely to be affected by changes to study area habitats.

The two species of Conservation Significance 2 that may occur are the:

- Striated Grasswren (*Amytornis striatus striatus*)
- Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Long-tailed Dunnart may occur in rocky habitats, favouring the BIF ridge over the low rocky hills. The Striated Grasswren may occur in the Spinifex grasslands on the sandy hills and islets associated with the salt lake margins (Table 5).

There is one species of Conservation Significance 3 likely to be present:

- Woolley's False Antechinus (*Pseudantechinus woolleyae*).

Woolley's False Antechinus is restricted to rocky areas, most likely to the BIF ridge (Table 5).

Overall, few conservation significant fauna species are likely to be present in most habitats. Many of the species that are likely to occur, such as the Rainbow Bee-eater, Eastern Great Egret, and Peregrine Falcon, are relatively widely distributed. Species likely to be associated with the BIF ridge (e.g. Long-tailed Dunnart) are unlikely to be significantly impacted, as this habitat is outside the proposed mine infrastructure layout. The Striated Grasswren, if present, is only likely to occur in the Spinifex on the sandy hills and islets around the salt lake, and may be impacted by some habitat loss. Migratory shorebirds are likely to occur in small numbers on claypans, and potentially large numbers on the salt lake. It is unlikely that the areas of salt lake in the Jupiter study area supports globally significant populations of shorebirds, though other parts of Lake Carey potentially do.

Table 5. Summary of conservation significant (CS) fauna in the study area.

Species	Status				Records	Likelihood of occurrence	Habitat preferences	Likely habitat use in the study area										
	Level of Conservation Significance	EPBC Act	WC Act	DPAW Priority				Acacia shrublan, low rocky hills	Acacia shrubland on plains	BIF ridge	Chenopod shrublands	Claypans	Creeklines	Mulga woodlands on plains	Salt lake	Samphire shrubland	Sandy hills and islets	Disturbed areas
Liopholis kintorei **Great Desert Skink**	CS1	Vu	S3		-	Very low	Spinifex grassland on red sandplains.											
Leipoa ocellata **Malleefowl**	CS1	Vu	S3		-	Very low	Acacia thickets or mallee woodlands with leaf litter.											
Ardea modesta **Eastern Great Egret**	CS1	Mig	S5		-	Low	Wetlands, shallow waters.					✓	✓		✓	✓		
Calidris ruficollis **Red-necked Stint**	CS1	Mig	S5		Within 30km (DPAW 2007-)	Present	Intertidal mudflats, wetlands, inland waters.					✓			✓	✓		
Calidris ferruginea **Curlew Sandpiper**	CS1	Mig	S5		-	High	Intertidal mudflats, inland freshwater wetlands.					✓						
Calidris acuminata **Sharp-tailed Sandpiper**	CS1	Mig	S5		-	High	Coastal and inland wetlands, mainly fresh or brackish non-tidal wetlands.					✓			✓	✓		
Tringa glareola **Wood Sandpiper**	CS1	Mig	S5		Within 30km (DPAW 2007-)	High	Mainly freshwater wetlands.					✓						
Tringa hypoleucos **Common Sandpiper**	CS1	Mig	S5		-	High	Rocky creeks, channels, dams and wetlands.					✓			✓	✓		
Tringa nebularia **Common Greenshank**	CS1	Mig	S5		Borefield study area	Present	Intertidal mudflats, wetlands, inland waters.					✓			✓	✓		
Charadrius veredus **Oriental Plover**	CS1	Mig	S5		-	Moderate	Open plains, salt lakes, claypans.				✓	✓			✓	✓		

Table 5. (cont.)

Species	Status				Records	Likelihood of occurrence	Habitat preferences	Likely habitat use in the study area										
	Level of Conservation Significance	EPBC Act	WC Act	DPAW Priority				Acacia shrubland, low rocky hills	Acacia shrubland on plains	BIF ridge	Chenopod shrublands	Claypans	Creeklines	Mulga woodlands on plains	Salt lake	Samphire shrubland	Sandy hills and islets	Disturbed areas
Sterna nilotica **Gull-billed Tern**	CS1	Mig	S5		Within 30km (DPAW 2007-)	Low	Salt lakes, claypans.					✓			✓	✓	✓	
Apus pacificus **Fork-tailed Swift**	CS1	Mig	S5		-	Low	Overfly any habitat.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Merops ornatus **Rainbow Bee-eater**	CS1	Mig	S5		Jupiter study area	Present	Forages in a variety of habitats, breeds in sandy areas.	✓	✓	✓	✓	✓	✓	✓			✓	✓
Falco hypoleucos **Grey Falcon**	CS1		S3		Within 30km (DPAW 2007-)	Low	Timbered plains and tree-lined watercourses	✓	✓	✓	✓	✓	✓	✓			✓	✓
Falco peregrinus **Peregrine Falcon**	CS1		S7		Within 30km (DPAW 2007-)	Moderate	Variety of habitats, nests in tall trees, cliffs, open pits.	✓	✓	✓	✓	✓	✓	✓			✓	✓
Polytelis alexandrae **Princess Parrot**	CS1	Vu			Within 30km (DPAW 2007-)	Very low	Lightily timbered deserts and tree-lined watercourses										✓	
Pezoporus occidentalis **Night Parrot**	CS1	En	S1		-	Very low	Chenopod shrublands, Spinifex plains.				✓						✓	
Amytornis striatus striatus **Striated Grasswren**	CS2			P4	-	Low	Spinifex plains, Acacia shrublands over Spinifex on sands or loams.										✓	
Sminthopsis longicaudata **Long-tailed Dunnart**	CS2			P4	Within 30km (DPAW 2007-)	High	Rocky areas, scree slopes and breakaways.	✓		✓								
Pseudantechinus woolleyae **Woolley's False Antechinus**	CS3				-	High	Rocky areas.	✓		✓								

6.3 Potential Impacts on Fauna

The most likely potential impacts of the proposed mining development are:

- direct mortality of fauna (i.e. by heavy machinery when clearing is carried out)
- habitat loss
- increased habitat fragmentation
- increased disturbance to fauna (e.g. noise and light)
- increased feral fauna
- hydrological changes

These are discussed in the sections below, along with potential impacts on conservation significant fauna and potential mitigation strategies.

6.3.1 Direct mortality

Some direct mortality of fauna is unavoidable when clearing, but it may be minimised by clearing in a progressive manner, towards fauna habitat areas that are to be retained. In addition, avoiding clearing during late winter and spring (where possible), will aid in minimising mortality of young birds in nests. Species most at risk of direct mortality are those with limited mobility, such as reptiles, frogs and small mammals. Most conservation significant fauna likely to occur in the project area are birds and unlikely to be subject to direct mortality when clearing, except when in the nest. However, species such as the Long-tailed Dunnart (CS2) and Woolley's False Antechinus (CS3) may be vulnerable if present in rocky areas, as they are more likely to hide, rather than move away from earth-moving machinery. The Rainbow Bee-eater (CS1) may nest along the minor creeks or sandy hills and islets, and young birds in burrows would be vulnerable to direct mortality.

Road mortalities are undesirable both from a fauna welfare point of view as well as driver safety. Species at higher risk of road mortalities include large mammals (such as kangaroos) as well as reptiles that bask on the road (such as goannas and snakes). In general, road mortalities are unlikely to negatively impact the conservation status of a fauna species, unless the fauna population was small or otherwise fragile. If present, the Great Desert Skink (CS1) or Malleefowl (CS1) would be vulnerable to road mortalities, but these species are considered very unlikely to occur at the Project.

Uncapped drill holes are a source of direct mortality for reptiles and small mammals. These species may be attracted to the drill hole as shelter, but perish when they are unable to climb out. Conservation significant species that may be potentially affected are the Long-tailed Dunnart (CS2) and Woolley's False Antechinus (CS3).

Recommendations:

- *Where possible, avoid clearing during late winter and spring, to avoid mortalities of young birds in nests.*
- *Carry out clearing in a progressive manner towards remaining fauna habitat, to avoid pushing fauna into already-cleared areas.*
- *Ensure all drill holes are securely capped to prevent fauna becoming fatally trapped.*

6.3.2 Habitat loss

Should the proposed mining at the Mt Morgans Project proceed, some habitat loss is inevitable. With the current layout of infrastructure and pits, there is likely to be little or no habitat loss to the BIF ridge, claypans, creeklines or Mulga woodlands on plains in any study area (Table 6). Overall, the impact of habitat loss may be reduced by minimising the footprint of the areas cleared and avoiding disturbance to surrounding areas of native vegetation.

Jupiter study area

The Jupiter study area is the largest of the four at 2,937.9ha. The development proposed for this area includes a cutbacks on an existing pit and establishment of two new pits, plus the associated infrastructure such as the processing plant site, ROM pad and TSF as shown in Figure 6. The proposed location of the Waste Rock Landform (WRL) has not been specified at this time and there is likely to be additional infrastructure such as roads and access tracks that also remain unspecified.

The pits and infrastructure proposed for the Jupiter study area total 273.6ha thus far (Table 6), which is less than 10% of the entire study area. The main impacts are on the samphire shrubland (84.3ha), low rocky hills (70.3ha), salt lake (39.1ha). There will also be some habitat loss for the Rainbow Bee-eater (potential breeding habitat) and potentially the Striated Grasswren, through the loss of 23.2ha of sandy hills and islets (Table 6).

Camp study area

The proposed development in this study area is the accommodation village. The proposed layout of 5.1ha is entirely within disturbed areas and is unlikely to result in the loss of significant fauna habitat (Table 6).

Workshop and Irrigation study area

The Workshop and Irrigation study area is relatively small at 31.1ha. This study area only included a small buffer around the proposed infrastructure, so up to 60% of the habitat in this study area will be lost. This includes a total of 14.5ha of *Acacia* shrubland on plains and the remainder is disturbed (Table 6). *Acacia* shrubland on plains is a very common habitat type in the region and no conservation significant fauna are likely to be reliant upon it. Any conservation significant fauna that may occur, such as the Peregrine Falcon, are likely to be wide-ranging.

Borefield study area

The Borefield study area is large at 1,695.6ha. This includes a very large buffer area, as the proposed development (establishment of bores) is likely to result in very little habitat loss overall, particularly if existing tracks can be utilised. The exact location of the bores remains unspecified at this time.

All study areas

In general, habitat loss at the Project is unlikely to be significant on a regional scale, as the habitats present are common and widespread. The main potential impacts of habitat loss are on the Striated Grasswren (CS2), which if present is reliant on the Spinifex on the sandy hills and islets, and on migratory shorebirds (CS1) which rely on salt lake pools.

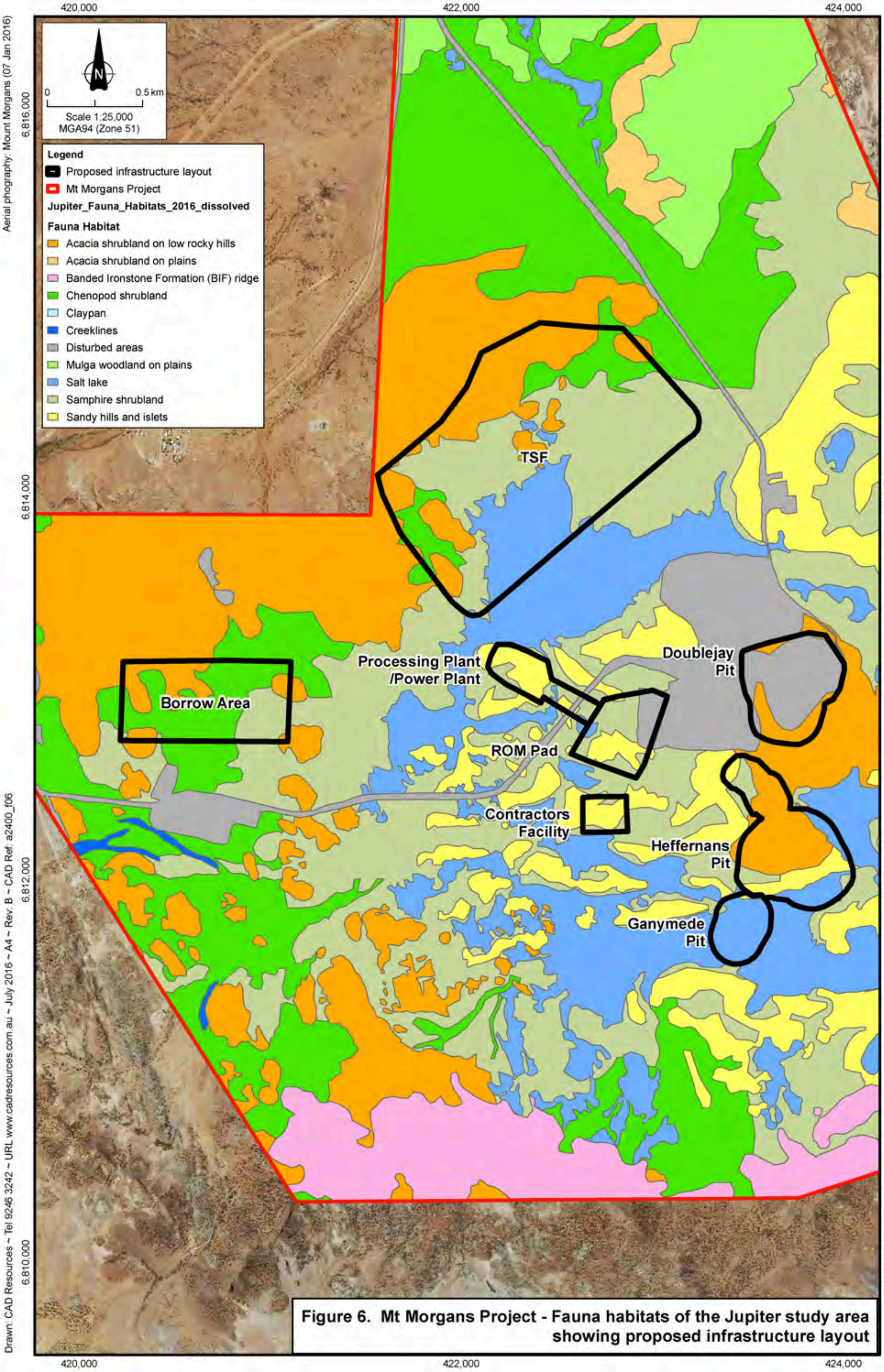

Figure 6. Mt Morgans Project - Fauna habitats of the Jupiter study area showing proposed infrastructure layout

Recommendations:

- *Minimise habitat loss in the planning phase by minimising the mine footprint area.*
- *Carry out re-vegetation once mining activities are complete, to restore fauna habitats.*

Table 6. Fauna habitats in each proposed pit or infrastructure area.

Proposed Infrastructure	**Total Area (ha)**	**Area of Fauna Habitat (ha)**										
		Acacia shrubland on low rocky hills	Acacia shrubland on plains	BIF ridge	Chenopod shrublands	Claypans	Creeklines	Mulga woodlands on plains	Salt lake	Samphire shrubland	Sandy hills and islets	Disturbed areas
Jupiter												
Doublejay Pit	23.5	6.0										17.5
Ganymede Pit	9.1								8.6		0.5	
Heffernans Pit	31.3	16.5							5.6		9.2	
TSF	145.5	37.8			15.6				24.1	68.0		
Borrow area	36.6	10.0			20.1					6.5		
Processing plant/power plant	9.5								0.4	3.2	5.6	0.3
ROM pad	13.9								0.4	6.6	3.7	3.2
Contractors facility	4.2										4.2	
Total at Jupiter:	***273.6***	***70.3***	***-***	***-***	***35.7***	***-***	***-***	***-***	***39.1***	***84.3***	***23.2***	***21.0***
Camp												
Proposed camp	5.1											5.1
Total at Camp:	***5.1***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***5.1***
Workshop & Irrigation (W & I)												
UG workshop & office	5.5		3.2									2.3
Irrigation area	13.6		13.6									
Total at W & I:	***19.1***	***-***	***16.8***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***-***	***2.3***

6.3.3 Habitat fragmentation

In an un-fragmented landscape fauna are free to move, allowing gene-flow between populations and the capacity to move to take advantage of dispersed or temporary resources such as food or nesting sites. Clearing native vegetation can result in habitat fragmentation. It can be difficult for fauna to move through a landscape that includes areas of cleared land, and this difficultly will be greater for some species than others. Highly mobile species (such as many birds and large mammals such as kangaroos) may be able to negotiate cleared areas to travel between isolated patches of native vegetation. Small ground-dwelling species (such as many frogs and reptiles) may not be able to negotiate cleared land, impacting on their ability to maintain gene-flow between populations, or repopulate areas after local extinction events.

The Project area is within a landscape of continuous native vegetation, generally only dissected by roads, with discrete areas of open pits and other disturbances (Figure 1). Natural barriers to dispersal in the region include the bare surface of salt lakes and large ranges.

The developments proposed for the camp, borefield, workshop and irrigation study areas are unlikely to significantly increase habitat fragmentation in these areas, as they are relatively small impact areas within a large, relatively homogeneous habitat area. The development proposed in the Jupiter study area is likely to result in a small increase in habitat fragmentation in the area, particularly in the samphire shrubland and sandy hills and islet habitats associated with the salt lake margins. Although these habitats are naturally patchy, the developments in the Jupiter study area may increase the distance between habitat patches across this small area of the salt lake edge. However, the proposed development is unlikely to be a complete barrier to dispersal around the lake edge, as these habitats occur to the north and south of the development area (Figure 6).

Recommendation:

- *Avoid the creation of small islands of native vegetation surrounded by cleared land.*

6.3.4 Increased disturbance to fauna

Disturbance to fauna can be due to noise, movement or light, and includes examples such as the use of heavy machinery, workshop noises, road lighting, and the presence of people or vehicles. Disturbance to fauna may result in fauna avoiding an area, e.g. due to excessive noise, and therefore being unable to utilise an area of available habitat. Fauna may also experience increased stress and/or expend extra energy in avoidance behaviours.

As the study areas include public roads, there is likely to be some of these types of disturbance already present. Further development is likely to result in an increase in disturbance of fauna in areas habitat adjacent to the study area. Most habitats in the study areas are extensive and widespread (e.g *Acacia* shrublands) and any impacts of disturbance is likely to be mimimal. Disturbance to potential shelter habitats, where fauna may congregate or roost at night, should be minimised if possible. Fauna may shelter in creeklines, on the BIF ridge or around pools on claypans or the salt lake. Of these, only pools on the salt lake may potetntially be impacted (Table 6). Conservation significant fauna that may be affected by disturbance include migratory shorebirds such as the Red-necked Stint (CS1), Common Sandpiper (CS1) and Common Greenshank (CS1). These species are non-breeding visitors that may forage and roost around pools on the salt lake.

Recommendations:

- *Where practicable, cluster noisy activities together in order to reduce the amount of disturbance to fauna.*

- *Minimise light spill by using the minimum of lighting necessary for safety, and where possible, situate necessary lighting low to the ground and shielded from fauna habitat in creeklines or salt lake pools.*

- *If shorebirds are noted to be present at a pool, restrict access to the area where practicable.*

6.3.5 Increased feral fauna

Feral fauna, particularly feral predators such as the fox, cat and wild dogs, can negatively impact native species. An increase in mining activity potentially leads to an increase in feral predators, as these species thrive in modified landscapes with additional water sources, food from rubbish tips and increased access in the form of tracks and roads. Conservation significant species that may be negatively impacted by increased feral predators include migratory shorebirds (CS1) that roost on the ground at night, and small mammals such as the Long-tailed Dunnart (CS2).

Recommendations:

- *Appropriately dispose of food waste so as not to provide a food source to feral predators.*

- *Prohibit feeding fauna on site.*

6.3.6 Hydrological changes

Mining developments may cause hydrological changes to surface water or cause sub-surface changes. Changes to surface water can include barriers to waterflow (e.g. along creeklines or salt lake channels), creation of addition depressions that hold water or loss of water-holding depressions. Sub-surface changes can occur when the watertable is affected by water extraction or major excavations. Where changes occur to the watertable lead to vegetation changes, vertebrate fauna populations are affected. Changes to surface water can have negative impacts by providing additional watering points for feral fauna, or by loss or changes to habitats upon which waterbirds, frogs and other fauna depend.

Recommendations:

- *Where practicable, avoid changes to surface and sub-surface hydrology.*

- *Where practicable, avoid impacts on Lake Carey outside of the mine footprint.*

6.4 Conclusions

Overall, the Project area is likely to support an assemblage of vertebrate fauna typical of the region, with the greatest diversity in the Jupiter study area where the habitat diversity is greatest. The habitats present are widespread in the region, with the BIF ridges and salt lake vegetation the most restricted. A few conservation significant fauna are likely to be present, with the majority of these being EPBC Act listed migratory shorebird species that may use the salt lake or claypans when inundated. On the basis of the habitats available, database records and published information, it appears unlikely that EPBC Act listed threatened species (Great Desert Skink, Malleefowl, Princess Parrot or Night Parrot) are present in the project area. Mining in the project area is likely to result in the loss of some native vegetation (and therefore fauna habitats) from the project area. Potential impacts are some direct mortality of fauna when clearing, habitat loss, a small increase in habitat fragmentation, disturbance to fauna, increases in feral fauna populations and potential hydrological changes. Recommendations have been provided with the aim of minimising or mitigating these impacts during the planning phase of the mining development.

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Appendix 1. Amphibians potentially occurring in the study area.

c,j,b,w = species recorded in the study area during the 2016 level 1 fauna survey at either the proposed camp, Jupiter pit, borefield or workshop & irrigation area.
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DPAW Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Hylidae (tree frogs and water-holding frogs)							
Main's Frog	*Cyclorana maini*				+		
Water-holding Frog	*Cyclorana platycephala*				+		
Desert Tree Frog	*Litoria rubella*		c		+		
Limnodynastidae (ground frogs)							
Northern Burrowing Frog	*Neobatrachus aquilonius*						
Kunapalari Frog	*Neobatrachus kunapalari*			+	+		
Desert Trilling Frog	*Neobatrachus sudellae*						
Shoemaker Frog	*Neobatrachus sutor*			+	+		
Plonking Frog	*Neobatrachus wilsmorei*				+		
Centralian Burrowing Frog	*Platyplectrum spenceri*			+			
Myobatrachidae (ground frogs)							
Western Toadlet	*Pseudophryne occidentalis*						
# frog species expected in the study area:		**10**					
# frog species recorded in the study area in 2016:		**1**					

Appendix 2. Reptiles potentially occurring in the study area.

c,j,b,w = species recorded in the study area during the 2016 level 1 fauna survey at either the proposed camp, Jupiter pit, borefield or workshop & irrigation area.
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DPAW Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Carphodactylidae (knob-tailed geckoes)							
Barking Gecko	*Underwoodisaurus milii*			+			
	Nephrurus vertebralis			+			
Diplodactylidae (geckoes)							
Variable Fat-tailed Gecko	*Diplodactylus conspicillatus*						
Wheatbelt Stone Gecko	*Diplodactylus granariensis*				+		
	Diplodactylus pulcher			+	+		
	Lucasium squarrosum			+			
Sand-plain Gecko	*Lucasium stenodactylum*						
Western Beaked Gecko	*Rhynchoedura ornata*			+	+		
Goldfields Spiny-tailed Gecko	*Strophurus assimilis*			+	+		
Jewelled Gecko	*Strophurus elderi*			+			
Western Spiny-tailed Gecko	*Strophurus strophurus*				+		
	Strophurus wellingtonae			+	+		
Gekkonidae (geckoes)							
	Gehyra purpurascens			+	+		
	Gehyra variegata			+	+		
Bynoe's Gecko	*Heteronotia binoei*		j	+	+		
Pygopodidae (legless lizards)							
	Delma butleri						
	Delma nasuta			+			
Burton's Legless Lizard	*Lialis burtonis*			+			
	Pygopus nigriceps			+			
Agamidae (dragon lizards)							
Ring-tailed Dragon	*Ctenophorus caudicinctus*			+			
Mallee Sand Dragon	*Ctenophorus fordi*						
Military Dragon	*Ctenophorus isolepis*			+	+		
Central Netted Dragon	*Ctenophorus nuchalis*			+			
Western Netted Dragon	*Ctenophorus reticulatus*		b	+			
Claypan Dragon	*Ctenophorus salinarum*			+			
Lozenge-marked Dragon	*Ctenophorus scutulatus*		b	+	+		
Mulga Dragon	*Diporiphora amphiboluroides*						
Thorny Devil	*Moloch horridus*			+			
Bearded Dragon	*Pogona minor*			+	+		
Pebble Dragon	*Tympanocryptis cephalus*			+	+		

Appendix 2. (cont.)

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Egerniidae (blue-tongues, spiny-tailed skinks & allies)							
Slender Blue-tongue	*Cyclodomorphus melanops*						
Pygmy Spiny-tailed Skink	*Egernia depressa*			+	+		
	Egernia formosa						
Desert Skink	*Liopholis inornata*			+			
Great Desert Skink	*Liopholis kintorei*	CS1					+
Night Skink	*Liopholis striata*						
Central Blue-tongue	*Tiliqua multifasciata*				+		
Western Bluetongue	*Tiliqua occipitalis*			+			
Eugongylidae (skink lizards)							
	Cryptoblepharus australis						
	Cryptoblepharus buchananii						
	Cryptoblepharus plagiocephalus						
Dwarf Skink	*Menetia greyii*			+	+		
	Morethia butleri			+	+		
Sphenomorphidae (skink lizards)							
	Ctenotus atlas						
	Ctenotus grandis						
	Ctenotus greeri						
	Ctenotus hanloni			+			
	Ctenotus helenae			+			
	Ctenotus leonhardii			+	+		
	Ctenotus pantherinus			+			
	Ctenotus schomburgkii						
	Ctenotus severus			+	+		
	Ctenotus uber				+		
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*			+	+		
	Lerista bipes						
	Lerista desertorum			+	+		
	Lerista kingi						
	Lerista timida			+			
Varanidae (monitors & goannas)							
Short-tailed Pygmy Monitor	*Varanus brevicauda*						
Stripe-tailed Monitor	*Varanus caudolineatus*			+	+		
Pygmy Desert Monitor	*Varanus eremius*			+			
Perentie	*Varanus giganteus*						
Gould's Goanna	*Varanus gouldii*		b		+		
	Varanus panoptes		b		+		
Black-tailed Monitor	*Varanus tristis*			+			
Typhlopidae (blind snakes)							
Southern Blind Snake	*Anilios australis*						
	Anilios bicolor						
	Anilios hamatus						
	Anilios waitii						

Appendix 2. (cont.)

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Boidae (pythons)							
Stimpson's Python	*Antaresia stimsoni*						
Elapidae (front-fanged snakes)							
Desert Death Adder	*Acanthophis pyrrhus*						
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*			+			
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*						
Yellow-faced Whipsnake	*Demansia psammophis*						
Moon Snake	*Furina ornata*			+			
Monk Snake	*Parasuta monachus*			+	+		
Mulga Snake	*Pseudechis australis*			+			
Spotted Mulga Snake	*Pseudechis butleri*			+			
Ringed Brown Snake	*Pseudonaja modesta*		b	+			
Western Brown Snake	*Pseudonaja mengdeni*			+			
Jan's Banded Snake	*Simoselaps bertholdi*			+			
Rosen's Snake	*Suta fasciata*			+			
# reptile species expected in the study area:		**82**					
# reptile species recorded in the project area in 2016:		**6**					

Appendix 3. Birds potentially occurring in the study areas.

c,j,b,w = species recorded in the study area during the 2016 level 1 fauna survey at either the proposed camp, Jupiter pit, borefield or workshop & irrigation area.
BA = species recorded in the area on the Birds Australia Atlas Database (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DPAW Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records					
			Mt Morgan	BA	WAM	FSDB	TF	EPBC
Dromaiidae (emu)								
Emu	*Dromaius novaehollandiae*		b	+				
Anatidae (ducks, geese & swan)								
Black Swan	*Cygnus atratus*		j	+				
Musk Duck	*Biziura lobata*			+				
Australian Shelduck	*Tadorna tadornoides*		j	+				
Pink-eared Duck	*Malacorhynchus membranaceus*		j b	+				
Australian Wood Duck	*Chenonetta jubata*			+				
Pacific Black Duck	*Anas superciliosa*			+				
Grey Teal	*Anas gracilis*		j b	+		+		
Australasian Shoveler	*Anas rhynchotis*			+				
Hardhead	*Aythya australis*			+				
Freckled Duck	*Stictonetta naevosa*			+				
Megapodiidae (mound-builders)								
Malleefowl	*Leipoa ocellata*	CS1						+
Phasianidae (quails)								
Stubble Quail	*Coturnix pectoralis*			+				
Podicipedidae (grebes)								
Australasian Grebe	*Tachybaptus novaehollanidae*			+				
Hoary-headed Grebe	*Poliocephalus poliocephalus*		b	+				
Ardeidae (herons, egrets and bitterns)								
Eastern Great Egret	*Ardea modesta (formerly A. alba)*	CS1						+
White-faced Heron	*Ardea novaehollandiae*			+				
White-necked Heron	*Ardea pacifica*							
Accipitridae (osprey, hawks, eagles and harriers)								
Black-shouldered Kite	*Elanus caeruleus*			+				
Square-tailed Kite	*Hamirostra isura*							
Black-breasted Buzzard	*Hamirostra melanosternon*							
Black Kite	*Milvus migrans*							
Whistling Kite	*Haliastur sphenurus*			+				
Brown Goshawk	*Accipiter fasciatus*							
Collared Sparrowhawk	*Accipiter cirrocephalus*			+		+		
Little Eagle	*Aquila morphnoides*		j					
Wedge-tailed Eagle	*Aquila audax*		j	+		+		
Spotted Harrier	*Circus assimilis*							

Appendix 3. (cont.)

Species		Conservation Status	Records: Mt Morgan	BA	WAM	FSDB	TF	EPBC
Otididae (bustard)								
Australian Bustard	*Ardeotis australis*							
Rallidae (crakes, rails, coots & allies)								
Eurasian Coot	*Fulica atra*			+				
Black-tailed Native Hen	*Gallinula ventralis*			+				
Turnicidae (button-quails)								
Little Button-Quail	*Turnix velox*			+				
Burhinidae (stone-curlews)								
Bush Stone-Curlew	*Burhinus grallarius*							
Recurvirostridae (stilts & avocet)								
Black-winged Stilt	*Himantopus himantopus*							
Banded Stilt	*Cladorhynchus leucocephalus*							
Red-necked Avocet	*Recurvirostra novaehollandiae*			+				
Charadriidae (plovers, dotterels and lapwings)								
Black-fronted Dotterel	*Charadrius melanops*		j	+				
Inland Dotterel	*Charadrius australis*							
Red-capped Plover	*Charadrius ruficapillus*		j	+				
Oriental Plover	*Charadrius veredus*	CS1						+
Red-kneed Dotterel	*Erythrogonys cinctus*			+				
Banded Lapwing	*Vanellus tricolor*					+		
Scolopacidae (sandpipers, stints, godwits, tattlers & allies)								
Sharp-tailed Sandpiper	*Calidris acuminata*	CS1						
Curlew Sandpiper	*Calidris ferruginea*	CS1						
Red-necked Stint	*Calidris ruficollis*	CS1	j	+				
Wood Sandpiper	*Tringa glareola*	CS1		+				
Common Sandpiper	*Tringa hypoleucos*	CS1						
Common Greenshank	*Tringa nebularia*	CS1	b	+				+
Laridae (gulls, terns & noddys)								
Silver Gull	*Larus novaehollandiae*							
Whiskered Tern	*Sterna hybrida*							
Gull-billed Tern	*Sterna nilotica*	CS1		+				
Columbidae (pigeons and doves)								
Diamond Dove	*Geopelia cuneata*			+				
Common Bronzewing	*Phaps chalcoptera*		j b	+		+		
Crested Pigeon	*Ocyphaps lophotes*		j b	+		+		
Cuculidae (cuckoos)								
Pallid Cuckoo	*Cacomantis pallidus*			+				
Black-eared Cuckoo	*Chrysococcyx osculans*							
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*							

Appendix 3. (cont.)

Species		Conservation Status	Records: Mt Morgan	BA	WAM	FSDB	TF	EPBC
Strigidae (hawk owls)								
Boobook Owl	*Ninox boobook*							
Tytonidae (barn owls)								
Barn Owl	*Tyto alba*							
Podargidae (frogmouths)								
Tawny Frogmouth	*Podargus strigoides*							
Caprimulgidae (nightjars)								
Spotted Nightjar	*Eurostopodus argus*					+		
Aegothelidae (owlet-nightjars)								
Australian Owlet-Nightjar	*Aegotheles cristatus*					+		
Apodidae (swifts)								
Fork-tailed Swift	*Apus pacificus*	CS1						+
Alcedinidae (kingfishers)								
Red-backed Kingfisher	*Todiramphus pyrrhopygius*							
Sacred Kingfisher	*Todiramphus sanctus*							
Meropidae (bee-eaters)								
Rainbow Bee-eater	*Merops ornatus*	CS1	j	+				+
Falconidae (falcons)								
Brown Falcon	*Falco berigora*		j b w	+				
Australian Kestrel	*Falco cenchroides*		j	+		+		
Grey Falcon	*Falco hypoleucos*	CS1					+	
Australian Hobby	*Falco longipennis*							
Peregrine Falcon	*Falco peregrinus*	CS1					+	
Cacatuidae (cockatoos)								
Galah	*Cacatua roseicapilla*		j b	+	+			
Cockatiel	*Nymphicus hollandicus*			+				
Psittacidae (parrots, lorikeets & rosellas)								
Budgerigar	*Melopsittacus undulatus*		b w	+		+		
Bourkes Parrot	*Neophema bourkii*			+		+		
Mulga Parrot	*Platycercus varius*		j					
Australian Ringneck	*Platycercus zonarius*			+				
Princess Parrot	*Polytelis alexandrae*	CS1			+			+
Night Parrot	*Pezoporus occidentalis*	CS1						+
Ptilonorhynchidae (bowerbirds)								
Western Bowerbird	*Ptilonorhynchus maculatus*		w					
Climacteridae (treecreepers)								
White-browed Treecreeper	*Climacteris affinis*							
Maluridae (fairy-wrens, grasswrens and emu-wrens)								
Striated Grasswren	*Amytornis striatus*	CS2						
White-winged Fairy-wren	*Malurus leucopterus*		j b w	+		+		
Splendid Fairy-wren	*Malurus splendens*		j w	+		+		

Appendix 3. (cont.)

Species		Conservation Status	Records					
			Mt Morgan	BA	WAM	FSDB	TF	EPBC
Meliphagidae (honeyeaters and chats)								
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*		j b w	+	+	+		
Black Honeyeater	*Sugomel nigrum*							
Pied Honeyeater	*Certhionyx vareigatus*			+		+		
Brown Honeyeater	*Lichmera indistincta*			+		+		
Singing Honeyeater	*Gavicalis virescens*		c j b w		+			
Grey-fronted Honeyeater	*Ptilotula plumula*							
Yellow-throated Miner	*Manorina flavigula*		j b w	+		+		
White-fronted Honeyeater	*Purnella albifrons*		b	+		+		
White-fronted Chat	*Epthianura albifrons*			+				
Orange Chat	*Epthianura aurifrons*			+				
Crimson Chat	*Epthianura tricolor*			+				
Pardalotidae (pardalotes)								
Red-browed Pardalote	*Pardalotus rubricatus*					+		
Striated Pardalote	*Pardalotus striatus*			+	+			
Acanthizidae (thornbills, gerygones & allies)								
Inland Thornbill	*Acanthiza apicalis*		b	+		+		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		j b	+	+	+		
Slender-billed Thornbill	*Acanthiza iredalei*							
Slaty-backed Thornbill	*Acanthiza robustirostris*		b	+	+	+		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		c j b w	+		+		
Southern Whiteface	*Aphelocephala leucopsis*			+	+	+		
Western Gerygone	*Gerygone fusca*				+			
Redthroat	*Pyrrholaemus brunneus*					+		
Weebill	*Smicrornis brevirostris*				+	+		
Pomatostomidae (babblers)								
White-browed Babbler	*Pomatostomus superciliosus*		j b			+		
Psophodidae (whipbird, wedgebills & quail-thrush)								
Western Quail-Thrush	*Cinclosoma marginatum*		b	+	+	+		
Chestnut Quail-Thrush	*Cinclosoma castanotus*							
Western Wedgebill	*Psophodes occidentalis*							
Artamidae (woodswallows)								
Masked Woodswallow	*Artamus personatus*			+				
Black-faced Woodswallow	*Artamus cinereus*		j b w	+		+		
Little Woodswallow	*Artamus minor*					+		
Cracticidae (magpies, butcherbirds & currawongs)								
Grey Butcherbird	*Cracticus torquatus*		j	+		+		
Pied Butcherbird	*Cracticus nigrogularis*		j b w	+		+		
Australian Magpie	*Cracticus tibicen*			+	+			
Grey Currawong	*Strepera versicolor*			+				

Appendix 3. (cont.)

Species		Conservation Status	Records: Mt Morgan	BA	WAM	FSDB	TF	EPBC
Campephagidae (cuckoo-shrikes and trillers)								
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*		b w	+		+		
Ground Cuckoo-Shrike	*Coracina maxima*		c	+				
White-winged Triller	*Lalage tricolor*		j					
Neosittidae (sittellas)								
Varied Sittella	*Daphoenositta chrysoptera*		b					
Oreoicidae (crested bellbird)								
Crested Bellbird	*Oreoica gutteralis*		j b w	+	+	+		
Pachycephalidae (shrike-tits, whistlers and allies)								
Rufous Whistler	*Pachycephala rufiventris*		j b w	+		+		
Grey Shrike-thrush	*Colluricincla harmonica*		j b	+		+		
Rhipiduridae (fantails)								
Willie Wagtail	*Rhipidura leucophrys*		j b w	+		+		
Grey Fantail	*Rhipidura albiscapa*							
Monarchidae (flycatchers, monarchs & magpie-lark)								
Magpie-lark	*Grallina cyanoleuca*		c b w	+		+		
Corvidae (ravens and crows)								
Torresian Crow	*Corvus orru*		j b w	+		+		
Little Crow	*Corvus bennetti*			+	+	+		
Petroicidae (robins)								
Jacky Winter	*Microeca fascinans*							
Hooded Robin	*Melanodryas cucullata*		b					
Red-capped Robin	*Petroica goodenovii*		j b w	+		+		
Hirundinidae (swallows and martins)								
White-backed Swallow	*Cheramoeca leucosterna*		j	+		+		
Welcome Swallow	*Hirundo neoxena*		j b	+		+		
Tree Martin	*Petrochelidon nigricans*		j w					
Fairy Martin	*Petrochelidon ariel*							
Locustellidae (grassbirds, songlarks & old world warblers)								
Rufous Songlark	*Megalurus mathewsi*			+		+		
Brown Songlark	*Megalurus cruralis*			+				
Dicaeidae (flowerpeckers)								
Mistletoebird	*Dicaeum hirundinaceum*		j	+		+		
Estrildidae (grassfinches and allies)								
Zebra Finch	*Taeniopygia guttata*		j b w	+		+		
Motacillidae (pipits and wagtails)								
Australian Pipit	*Anthus australis*		b					
# bird species expected in the study area:		**141**						
# bird species recorded in the study areas in 2016:		**54**						

Appendix 4. Mammals Potentially occurring in the study areas.

c,j,b,w = species recorded in the study area during the 2016 level 1 fauna survey at either the proposed camp, Jupiter pit, borefield or workshop & irrigation area.
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DPAW Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Tachyglossidae (echidnas)							
Echidna	*Tachyglossus aculeatus*						
Dasyuridae (dasyurid marsupials)							
Kultarr	*Antechinomys laniger*				+		
Wongai Ningaui	*Ningaui ridei*			+			
Woolley's False Antechinus	*Pseudantechinus woolleyae*	CS3					
Fat-tailed Dunnart	*Sminthopsis crassicaudata*			+			
Little Long-tailed Dunnart	*Sminthopsis dolichura*				+		
Hairy-footed Dunnart	*Sminthopsis hirtipes*				+		
Long-tailed Dunnart	*Sminthopsis longicaudata*	CS2			+		
Striped-faced Dunnart	*Sminthopsis macroura*				+		
Ooldea Dunnart	*Sminthopsis ooldea*						
Macropodidae (kangaroos and wallabies)							
Euro	*Macropus robustus*		c j b w				
Red Kangaroo	*Macropus rufus*		j		+		
Emballonuridae (sheathtail bats)							
Hill's Sheathtail Bat	*Taphozous hilli*						
Molossidae (freetail bats)							
Inland Freetail Bat	*Mormopterus planiceps*						
White-striped Freetail Bat	*Tadarida australis*						
Vespertilionidae (ordinary bats)							
Gould's Wattled Bat	*Chalinolobus gouldii*						
Finlayson's Cave Bat	*Vespadelus finlaysoni*				+		
Inland Forest Bat	*Vespadelus baverstocki*						
Inland Broad-nosed Bat	*Scotorepens balstoni*						
Lesser Long-eared Bat	*Nyctophilus geoffroyi*			+	+		
Muridae (rats and mice)							
House Mouse	*Mus musculus*	Int.			+		
Spinifex Hopping-Mouse	*Notomys alexis*			+	+		
Desert Mouse	*Pseudomys desertor*						
Sandy Inland Mouse	*Pseudomys hermannsbergensis*			+	+		

Appenidx 4. (cont.)

Species		Conservation Status	Records				
			Mt Morgan	WAM	FSDB	TF	EPBC
Canidae (dogs and foxes)							
Fox	*Vulpes vulpes*	Int.					
Dingo	*Canis lupus dingo*						
Felidae (cats)							
Feral/House Cat	*Felis catus*	Int.	j				
Equidae (horses and donkeys)							
Donkey	*Equus asinus*	Int.					
Camelidae (camels)							
Camel	*Camelus dromedarius*	Int.					
Leporidae (rabbits & hares)							
Rabbit	*Oryctolagus cuniculus*	Int.	j b w		+		
Bovidae (horned ruminants)							
Cow	*Bos taurus*	Int.	j b w				
Goat	*Capra hircus*	Int.					
# mammal species expected in the study area:		**32 (24 native)**					
# mammal species recorded in the study area in 2016:		**5 (2 native)**					

Appendix 5. EPBC Protected Matters Search Tool results.

Species listed for the area 40km in radius from 28º 48’ 28”S, 122º 12’ 37”E on the EPBC Protected Matters Search Tool.

Species	Status	Author’s Comment
Malleefowl *Leipoa ocellata*	Vulnerable	Unlikely to be present due to lack of suitable habitat – likely to be locally extinct in the area.
Night Parrot *Pezoporus occidentalis*	Endangered	Unlikely to be present due to lack of suitable habitat – likely to be locally extinct in the area.
Princess Parrot *Polytelis alexandrae*	Vulnerable	Unlikely to be present due to lack of suitable habitat (i.e. lightly timbered desert and tree-lined watercourses).
Great Desert Skink *Liopholis kintorei*	Vulnerable	Unlikely to be present due to lack of suitable habitat (i.e. sandy desert).
Rainbow Bee-eater *Merops ornatus*	Migratory (terrestrial)	May be present in the study area.
Grey Wagtail *Motacilla cinerea*	Migratory (terrestrial)	Unlikely to be present - vagrant to the area
Yellow Wagtail Motacilla flava	Migratory (terrestrial)	Unlikely to be present - vagrant to the area
Great Egret *Ardea modesta (formerly A. alba)*	Migratory (wetland & marine)	May be present in the study area.
Oriental Plover *Charadrius veredus*	Migratory (wetland)	May be present in the study area.
Comon Greenshank *Tringa nebularia*	Migratory (wetland)	Recorded in the study area (Borefields, claypan habitat).
Fork-tailed Swift *Apus pacificus*	Migratory (marine)	May be present in the study area.

APPENDIX 4: PHOENIX RIDGE AND MT MARVEN LEVEL 1 VERTEBRATE FAUNA SURVEY (WESTERN WILDLIFE, 2019)

Mt Morgans Gold Project: Phoenix Ridge and Mt Marven

Level 1 Vertebrate Fauna Survey July 2019

Prepared for: Dacian Gold Limited

Prepared by: Western Wildlife
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Mahogany Creek WA 6072
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February 2020

Executive Summary

Introduction

Dacian Gold Limited (Dacian) is conducting exploration at Phoenix Ridge and Mt Maven (the 'study areas'), as components of the Mt Morgans Gold Project. Dacian commissioned Western Wildlife to carry out a Level 1 vertebrate fauna survey of the two areas. The objectives of the fauna survey were to:

- Identify the fauna habitats present in the study area.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study area.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study area.

This report details the findings of the fauna survey conducted in July 2019.

Methods

A Level 1 fauna survey was undertaken in accordance with Environmental Protection Authority (EPA) Statement of Environmental Principles, Factors and Objectives (EPA 2016a), Environmental Factor Guidelines – Terrestrial Fauna (EPA 2016b), Technical Guide – Terrestrial Fauna Surveys (EPA 2016c) and the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC 2010). The field surveys were carried out by two zoologists between the 30th – 31st July 2019.

The field study included:

- Identification of fauna habitats
- Opportunistic records of vertebrate fauna
- Targeted searches for evidence of conservation significant fauna

Species of conservation significance were classified as: **Threatened** if listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and/or *Biodiversity Conservation Act 2016* (BC Act); **Migratory** if listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened; **Specially Protected** if listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act; **Priority** if listed as Priority by DBCA and **Locally Significant** if considered by the author to potentially be of local significance.

Fauna Habitats

Seven fauna habitats were identified across the two study areas:

- Low rocky hills
- Banded Ironstone Formation (BIF) ridge
- Mulga woodlands
- Acacia shrubland on plains
- Creeklines
- Chenopod shrubland
- Samphire shrubland

Faunal Assemblage

The study areas have the potential to support up to ten frog, 85 reptile, 110 bird and 24 native mammal and nine introduced mammal species. The assemblage is likely to be relatively intact and typical of the region.

Conservation Significant Fauna

Ten conservation significant fauna have been recorded or potentially occur in the Study Area, as summarised in Table 5. The species have been grouped into their conservation significance categories and discussed below.

1. Threatened species

Four threatened species potentially occur in the study areas:

- Malleefowl (*Leipoa ocellata*) – EPBC Act (Vulnerable), BC Act (Vulnerable)
- Night Parrot (*Pezoporus occidentalis*) – EPBC Act (Endangered), BC Act (Critically Endangered)
- Princess Parrot (*Polytelis alexandrae*) – EPBC Act (Vulnerable), Priority 4
- Grey Falcon (*Falco hypoleucos*) – BC Act (Vulnerable)

The Malleefowl is unlikely to occur. Although known from many records in the region, the study areas lack the dense litter-forming shrublands that would provide breeding habitat for this species. The Night Parrot and Princess Parrot are unlikely to occur. While possible chenopod foraging habitat is present for the Night Parrot, there is no breeding habitat in the study areas. The Princess Parrot is a vagrant to the region and the study area is not likely to be important habitat. The Grey Falcon may occur as a foraging visitor, but no breeding habitat is present.

2. Migratory species

Two Migratory species potentially occur in the study areas, none of which have been recorded:

- Oriental Plover (*Charadrius veredus*) – EPBC Act (Migratory), BC Act (Migratory)
- Fork-tailed Swift (*Apus pacificus*) – EPBC Act (Migratory), BC Act (Migratory)

The Oriental Plover is likely to occur, but not in significant numbers. The Fork-tailed Swift is thought to be almost entirely aerial when visiting Australia, so the study area is not likely to provide important habitat for this species.

3. Specially Protected species

A single Specially Protected species potentially occurs in the study areas:

- Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is likely to occur as a foraging visitor but the rocky hills are too low to provide breeding habitat.

4. Priority species

Two Priority species potentially occur in the study areas:

- Striated Grasswren (*Amytornis striatus striatus*)
- Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Striated Grasswren is unlikely to occur as the study areas lack its favoured spinifex grasslands. The Long-tailed Dunnart is likely to occur in the low rocky hills and BIF ridge.

5. Locally significant species

A single Locally Significant species potentially occurs in the study areas:

- Black-headed Worm Lizard (*Aprasia picturata*)

This species is known from very few records overall, but may occur in the low rocky hills and BIF Ridge.

Important Habitats

The habitats in the Study Area are common and widespread in the subregion. The Low Rocky Hills and BIF Ridge may be refugia for fauna on a local level, providing cracks and crevices as shelter from extreme conditions. As the study area is set within a largely uncleared landscape and the habitats present are broadly distributed, it is unlikely to have particular importance as a regional ecological linkage. Creekline habitats potentially provide ecological linkage on a local level. Of the habitats present in the study area, the Low Rocky Hills and BIF Ridge have some importance in supporting populations of the Long-tailed Dunnart. The presence of this species in the region is likely to be determined by the availability of these habitats, and the loss of these habitats may lead to the local loss of this species.

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Tables, Figures and Plates

1. Introduction

Dacian Gold Limited (Dacian) is conducting exploration at Phoenix Ridge and Mt Maven (the 'study areas'), as components of the Mt Morgans Gold Project. Dacian commissioned Western Wildlife to carry out a Level 1 vertebrate fauna survey of the two areas. The objectives of the fauna survey were to:

- Identify the fauna habitats present in the study area.
- List the vertebrate fauna that were recorded in the study area and/or have the potential to occur in the study area.
- Identify species of conservation significance, or habitats of particular importance for fauna, that may occur in the study area.

This report details the findings of the fauna survey conducted in August 2019.

1.1 Regional Location

The Mt Morgans Gold Project is located approximately 30 km south west of Laverton, in the northern goldfields of Western Australia.

The study area falls within the Interim Biogeographic Regionalisation of Australia ('IBRA') Bioregion Murchison 1 – East Murchison Subregion (DoEE 2017, Cowan 2001). The Murchison Bioregion is characterised by an arid climate, primarily with a winter rainfall of about 200mm. The primary land-use is grazing on native pastures (over 85%), with smaller areas of unallocated Crown land, Crown reserves, mining and conservation (Cowan 2001). The East Murchison Subregion is large at 7,847,996ha and is characterised by red sandplains, broad plains of red-brown soils, breakaways and saltlake systems (Cowan 2001). The vegetation in the region is dominated by Mulga woodlands, hummock grasslands, saltbush shrublands and Teticornia shrublands (Cowan 2001).

1.2 Study Areas

The two study areas are Phoenix Ridge (416.8 ha) and Mt Marven (80.8 ha). They are adjacent areas that were surveyed in March 2016 and December 2017 (Figure 2). Though it does not include salt lake vegetation, the study areas are between 3 and 14 km north of the northern shore of Lake Carey, a large salt lake of about 75,000ha.

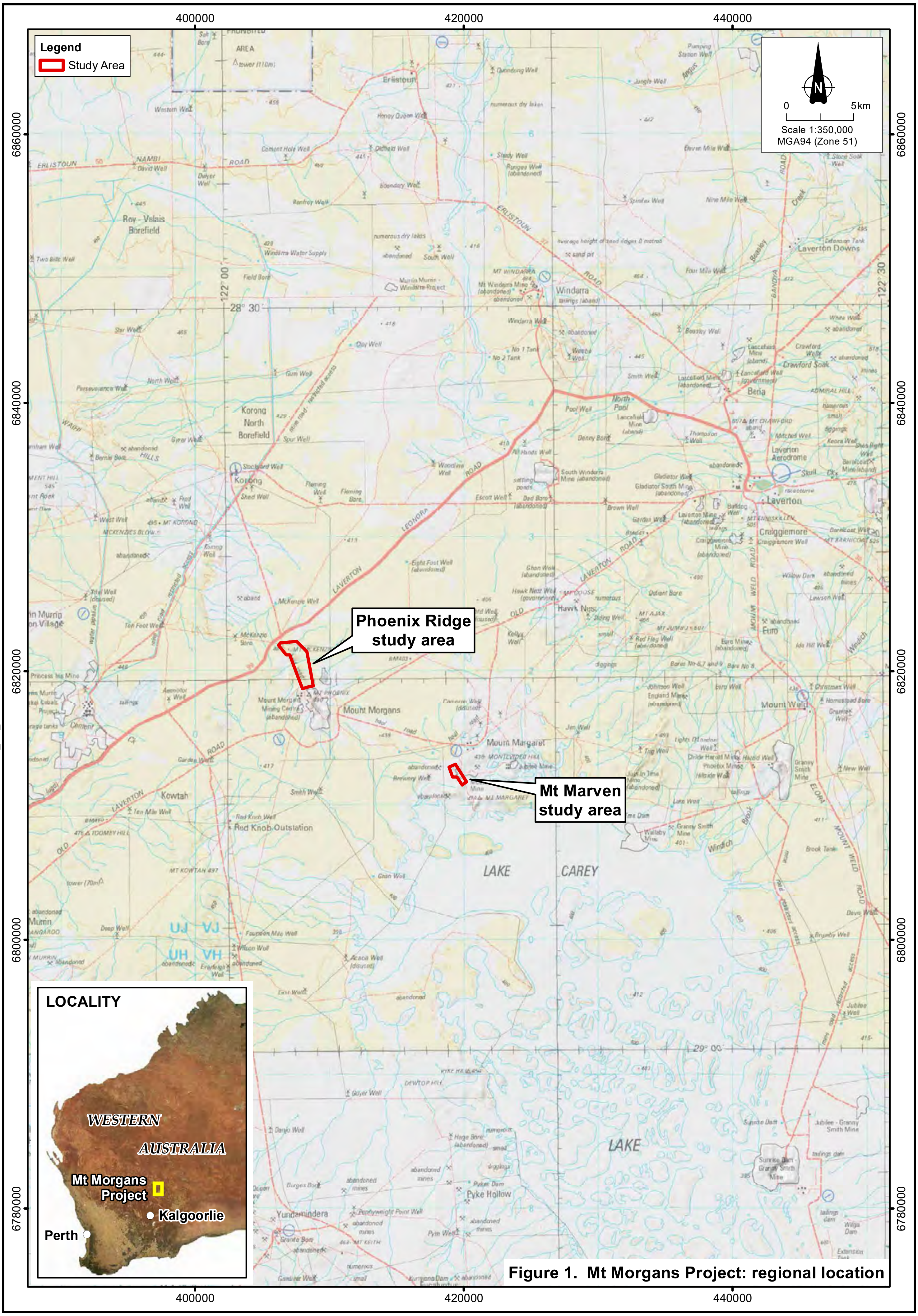

Figure 1. Mt Morgans Project: regional location

Drawn: CAD Resources ~ Tel 9246 3242 ~ URL www.cadresources.com.au ~ December 2019 ~ A4 ~ Rev: A ~ CAD Ref: a2400_f10_01

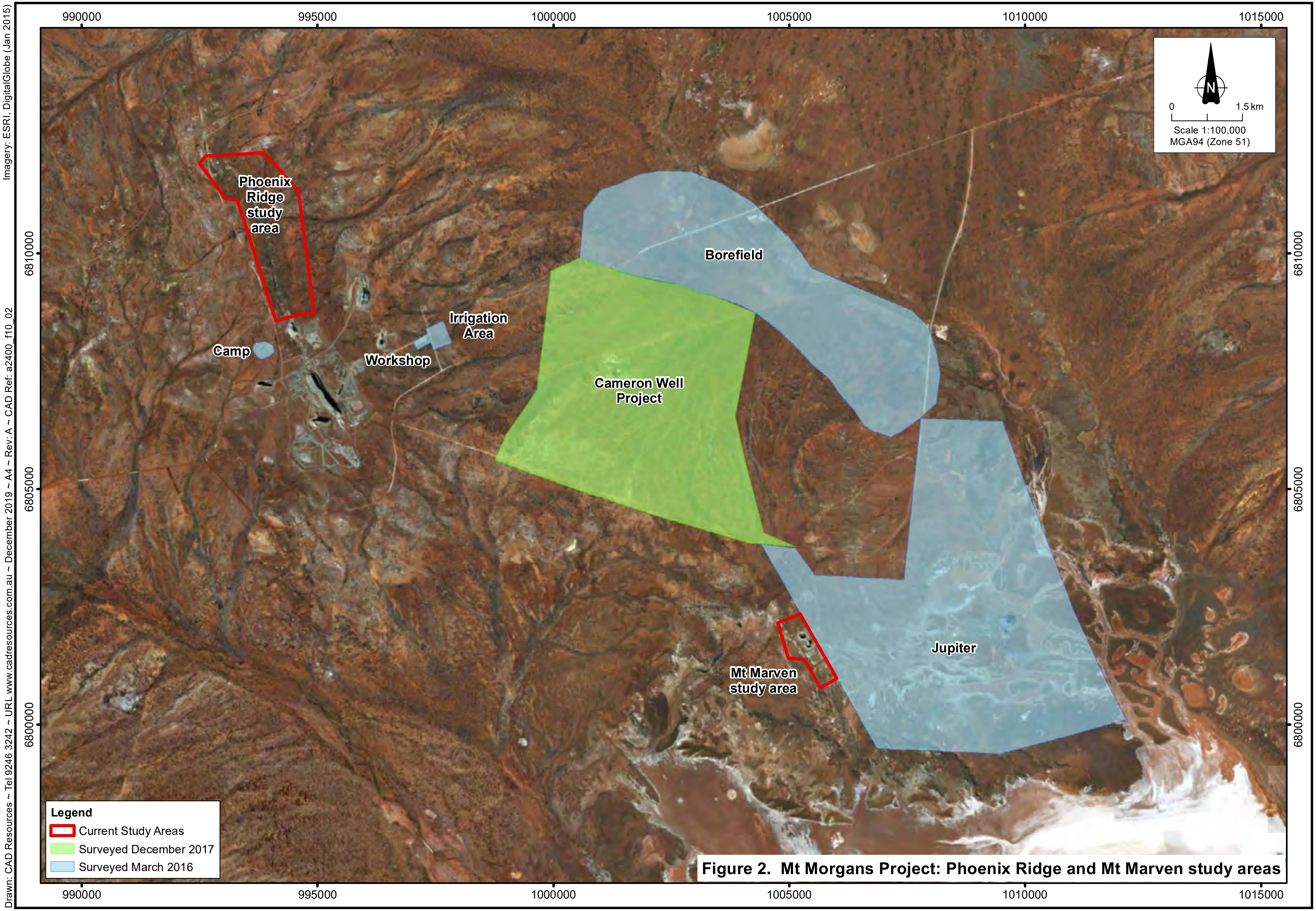

Figure 2. Mt Morgans Project: Phoenix Ridge and Mt Marven study areas

1.3 Climate and Weather

The study area is situated 30km southwest of the Laverton weather station (site 012045). The mean monthly temperatures show a summer maximum (Figure 3). The annual rainfall recorded at Laverton in 2018 was above average at 336.1mm, compared with the long-term average of 237.1mm collected between 1899 and 2019 (Bureau of Meteorology 2019). The beginning of 2019 also showed a lower than average rainfall in the months prior to the field survey in August 2019 (Figure 3).

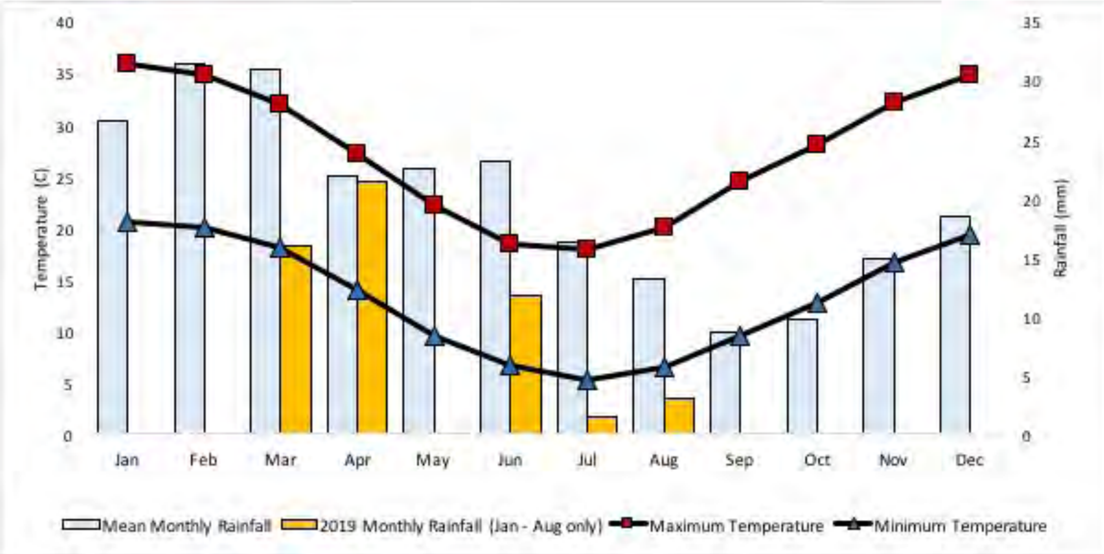

Figure 3. Climate statistics for Laverton (data after Bureau of Meteorology 2019).

The weather during the field survey was cool and dry, with the maximum temperature ranging from 19.3 – 35.3°C and the minimum temperature ranging from 7.3 – 4.1°C (Bureau of Meteorology 2019). No rain fell during or in the fortnight prior to the field survey.

2. Methods

2.1 Level of Survey

The survey was conducted as a Level 1 fauna survey in accordance with:

- Statement of environmental principles, factors and objectives (Environmental Protection Authority (EPA) 2016a)
- Environmental factor guideline – terrestrial fauna (EPA 2016b)
- Technical guidance – terrestrial fauna surveys (EPA 2016c)
- Technical Guide: terrestrial vertebrate fauna surveys for environmental impact assessment (EPA and DEC 2010)

The Level 1 fauna survey included a search of available literature and databases (a 'desktop' study), and a brief field survey of the study area. The field survey served to put the desktop study into context, as well as allowing for the identification of fauna habitats and likely fauna assemblages of the study area.

It was considered that a Level 1 fauna survey was sufficient to characterise the fauna habitats, vertebrate faunal assemblage and the likely conservation significant fauna using the study area. Although a Level 2 fauna survey involving trapping would be likely to add to the list of vertebrate fauna species known to occur in the study area, particularly of reptiles and small mammals, it is unlikely to provide extra information useful in managing potential impacts on fauna.

2.2 Personnel

The personnel involved in the fauna survey were Ms Jenny Wilcox (*BSc.Biol./Env.Sci., Hons.Biol.*) as the supervising zoologist and Mr Wes Bancroft (*BSc.Zool.,PhD.Zool.*) as the field zoologist. The zoologists have 19 and 21 years' experience in fauna consulting respectively. The report was prepared by Ms Jenny Wilcox.

2.3 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report follow the Western Australian Museum checklists. These were last updated in 2019. In the text, common names are used where appropriate, and all scientific names are given in species lists. Where a species lacks a common name, they are referred to by their scientific name.

2.4 Literature Review

Lists of fauna expected to occur in the study area were produced using information from a number of sources. These included publications that provide information on general patterns of distribution of frogs (Tyler *et al*. 2000), reptiles (Wilson and Swan 2010, Storr *et al*. 1983, 1990, 1999 and 2002), birds (Barrett *et al*. 2003; Johnstone and Storr 1998 and 2004) and mammals (Churchill 1998, Menkhorst and Knight 2011; Van Dyck and Strahan 2008).

The databases listed in **Error! Reference source not found.** were searched for fauna records in and around the study area. In all cases the extent of the database search was larger than the extent of the study area, in order to pick up records of species in the wider area that may also occur in the study area. Some species may occur on database results that are not likely to be present in the study area, usually due to a lack of suitable habitat or the study area being outside the known range of the species as presented in the literature. These species are generally not included in lists of expected fauna unless some discussion is thought to be necessary.

Table 1. Databases used in the preparation of this report.

Database	Type of records held on database	Area searched
Western Australian Museum Specimen Database (DBCA 2007-)	Records of specimens held in the WA Museum. Includes historical data.	40km surrounding 28.76778 ºS, 122.13722 ºE.
Fauna Survey Returns Database (DBCA 2007-)	Records of fauna captured, observed or inferred from secondary evidence during fauna surveys.	40km surrounding 28.76778 ºS, 122.13722 ºE.
Birds Australia Atlas Database (DBCA 2007-)	Records of bird observations in Australia, 1998-2009.	40km surrounding 28.76778 ºS, 122.13722 ºE.
Birdata (DBCA 2007-)	Records of bird observations in Australia, 2010-current.	40km surrounding 28.76778 ºS, 122.13722 ºE.
DBCA's Threatened and Priority Fauna Database	Records of Threatened and Priority species in Western Australia, also drawing from the databases above.	200km surrounding 51J 413346 E, 6815777 N.
EPBC Act Protected Matters Search Tool	Records on matters protected under the EPBC Act, including threatened species.	20km surrounding 28.76778 ºS, 122.13722 ºE.

Recent fauna surveys were carried out for other developments in the Project area include:

- A Level 1 fauna survey of the Mt Morgans North Project, undertaken in November 2010 (RPS 2011). This survey was carried out over two days, with only ten fauna species observed opportunistically (six birds and four mammals). None of the observed species were of conservation significance.
- A desktop study of The Craic Project, with no additional records of fauna from the site (Outback Ecology Services 2009).
- A Level 1 fauna survey of the Mt Morgans Jupiter Project, with associated borefields, camp and workshop sites (Western Wildlife 2016). This survey was undertaken over five days in March 2016, with one frog, six reptiles 54 birds and five mammals recorded opportunistically. Conservation significant species recorded were migratory shorebirds on Lake Carey.
- A Level 1 fauna survey of the Mt Morgans Cameron Well Project (Western Wildlife 2018). This survey was undertaken over two days in December 2017, with two reptiles, 33 birds and two mammals recorded opportunistically. No conservation significant fauna were recorded.

These sources of information were used to create lists of species that potentially occur in the study area. As far as possible, expected species are those that are likely to utilise the study area. The lists exclude species that have been recorded in the general region as vagrants, or for which suitable habitat is absent within the study area.

2.5 Field Studies

The field study was carried out by two zoologists on the 30th and 31st July 2019. The field study component of a Level 1 fauna survey is primarily to identify the fauna habitats present in the study area. In addition, all fauna encountered during the field survey are recorded. The fauna species recorded are usually conspicuous species such as birds, large mammals and large reptiles. The presence of other species may be inferred from evidence such as tracks, burrows, scats or evidence of foraging. Particular attention was paid to searching for evidence of conservation significant species, such as Malleefowl mounds, or habitats likely to support conservation significant species.

2.6 Habitat Mapping

Habitat mapping was undertaken using vegetation mapping provided by Native Vegetation Solutions (2019), observations made by fauna personnel in the field and interpretation of aerial photography. CAD Resources produced the maps from information provided by Western Wildlife.

2.7 Likelihood of Occurrence

Fauna of conservation significance were assessed and ranked for their likelihood of occurrence in the study area, according to the following criteria:

- **Very Low:** The study area is outside the current known distribution of the species as presented in the literature; no suitable habitat was identified as being present during the field survey; for some species, individuals may occur occasionally as vagrants, especially if suitable habitat is located nearby, but the study area itself would not support the species; includes species generally accepted as being locally extinct.
- **Low:** The study area is within or just outside the current known distribution of the species, as presented in the literature; any habitat present is either limited in extent or of marginal quality at best; no recent or nearby records of the species on databases; the species is generally known to be less common in the vicinity of the study area (e.g. for inland sites, where the species usually occurs on the coast).
- **Moderate:** The study area is within the current known distribution of the species, as presented in the literature; habitat of reasonable quality was identified as being present during the field survey; some recent and/or nearby records of the species of databases;
- **High:** The study area is well within the current known distribution of the species, as presented in the literature; habitat of good quality was identified as being present during the field survey; many recent and nearby records of the species on databases.
- **Known to Occur:** The species was positively identified in the study area during this field survey, or recorded as occurring in the study area on previous recent field surveys. Note that for a species ‘known to occur’, the habitat may still be marginal and therefore the population may be small or the species may visit the site irregularly.

2.8 Assessing Conservation Significance of Fauna

2.8.1 Legislative Protection for Fauna

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the Commonwealth Government's primary piece of environmental legislation. Listed under Part 3 of the EPBC Act are 'Matters of National Environmental Significance' (MNES); these include threatened species, threatened ecological communities and migratory species. Threatened fauna species are assessed against categories based on International Union for Conservation of Nature (IUCN) criteria.

The migratory species listed under the EPBC Act are those recognised under international agreements. These agreements are the China-Australia Migratory Bird Agreement (CAMBA), the Japan-Australia Migratory Bird Agreement (JAMBA), the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), or species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) for which Australia is a range state.

Matters of National Environmental Significance (MNES) include the following categories:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.
- **Migratory (Mi):** Taxa listed under international agreements to which Australia is a party.

Reports on the conservation status of most vertebrate fauna species have been produced by the federal Department of Environment and Energy (DoEE) in the form of Action Plans. An Action Plan is a review of the conservation status of a taxonomic group against IUCN categories. Action Plans have been prepared for amphibians (Tyler 1998), reptiles (Cogger *et al*. 1993), birds (Garnett *et al*. 2011) and mammals (Woinarski *et al*. 2014). These publications also use categories similar to those used by the EPBC Act. The information presented in some of the earlier Action Plans may be out of date due to changes since publication.

The *Biodiversity Conservation Act 2016* (BC Act) is State legislation that aims to conserve and protect biodiversity and biodiversity components in Western Australia, including threatened fauna. It is administered by the Department of Biodiversity, Conservation and Attractions (DBCA). In addition to threatened fauna, the BC Act has scope to protect threatened ecological communities and important habitats.

Fauna species are listed under the BC Act as threatened species using IUCN categories, or as specially protected species, as described below.

Threatened Species:

- **Extinct in the wild (EW)**: Taxa known to survive only in captivity.
- **Critically Endangered (Cr)**: Taxa facing an extremely high risk of extinction in the wild in the immediate future.
- **Endangered (En)**: Taxa facing a very high risk of extinction in the wild in the near future.
- **Vulnerable (Vu)**: Taxa facing a very high risk of extinction in the wild in the medium-term future.

Specially Protected Species:

- **Migratory (Mi)**: A subset of the migratory fauna that are known to visit Western Australia that are protected under the international agreements or treaties, excluding species that are listed as Threatened species.
- **Conservation dependent fauna (CD):** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened
- **Other specially protected species (OS):** fauna in need of special protection to ensure their conservation.

The BC Act supersedes the *Western Australian Wildlife Conservation Act 1950* (WC Act).
Priority species are not listed under State or Commonwealth Acts. In Western Australia, DBCA maintains a list of Priority Fauna made up of species that are possibly Threatened but do not meet adequacy of survey requirements or are otherwise data deficient. There are four levels of Priority as defined by DBCA, as listed below.

- **Priority 1:** Poorly known species (on threatened lands)
- **Priority 2:** Poorly known species in few locations (some on conservation lands)
- **Priority 3:** Poorly known species in several locations (some on conservation lands)
- **Priority 4:** Rare, near threatened and other species in need of monitoring

2.8.2 Levels of Conservation Significance in this report

Five levels of conservation significance are used within this report to indicate the level of significance of fauna species, according to the following criteria:

- **Threatened (T):** Taxa listed as Extinct in the Wild, Critically Endangered, Endangered or Vulnerable under the EPBC Act and/or BC Act. These species are grouped as they are all species considered to be at risk of extinction, are often rare and are likely to be subject to on-going threatening processes.
- **Migratory (Mi):** Taxa listed as Migratory under the EPBC Act and/or BC Act, excluding those species also listed as threatened. These species are grouped as they are not necessarily rare, but may be dependent on specific habitats for a portion of their life-cycle. For these species, loss of important foraging, breeding or stop-over sites may have a disproportionately large impact on populations.
- **Specially Protected (SP):** Taxa listed as Other Specially Protected Species or Conservation Dependent Fauna under the BC Act. These species are not necessarily rare, but may be dependent on on-going conservation to ensure their protection.
- **Priority (P):** Taxa listed as Priority by DBCA. These species are grouped as they are either conservation dependent or data deficient and in need of further survey.
- **Locally Significant (LS):** Locally significant taxa are not listed under State or Commonwealth Acts or in publications on threatened fauna or as Priority species by DBCA, but are considered by the author to potentially be of local significance because they are at the limit of their distribution in the area, they have a very restricted range or they occur in breeding colonies (e.g. some waterbirds). This level of significance has no legislative recognition and is based on interpretation of information on the species patterns of distribution. For example, the Government of Western Australia (2000) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Bush Forever. Recognition of such species is consistent with the aim of preserving regional biodiversity.

2.9 Survey Limitations

Various factors can limit the effectiveness of a fauna survey. Pursuant to EPA Technical Guidance (EPA 2016c), these factors have been identified and their potential to impact on the effectiveness of the surveys has been assessed in Table 2 below. All fauna surveys have limitations, and not all fauna species present on the site are likely to be sampled during a survey. Fauna may not be recorded because they are rare, they are difficult to trap or observe, or because they are only present on the site for part of the year.

Table 2. Fauna survey limitations.

Potential Limitation	Extent of limitation for the fauna survey	
Competency /experience of the team carrying out the survey	Not limiting	Supervising zoologist has 19 years' experience with fauna surveys in Western Australia. Field zoologist has more than 20 years' experience.
Proportion of fauna identified, recorded and/or collected.	Not limiting	Although only a small proportion of the fauna were recorded, a complete inventory is not the purpose of a Level 1 survey.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	Minor limitation	There is a moderate amount of data available on databases for this region, but other than for birds, few records of fauna species from the Mt Morgans Gold Project.
Timing/weather/season/cycle	Not limiting	The weather was warm and dry, and conducive to recording fauna including signs of the Malleefowl
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Not limiting	Although disturbances such as tracks were noted, these are unlikely to have affected the outcome of the survey. Malleefowl mounds persist in the landscape for many years, and the key purpose of the Level 1 survey was habitat assessment.
Intensity (in retrospect, was the intensity adequate)	Not limiting	Sufficient time was allowed to survey all habitats.
Completeness (e.g. was relevant area fully surveyed)	Not limiting	A representative proportion of all habitats were able to be accessed and surveyed.
Resources (e.g. degree of expertise available in animal identification to taxon level)	Not limiting	No taxonomic issues were encountered.
Remoteness and/or access problems	Not limiting	Entire Study Area accessible by vehicle or on foot.
Availability of contextual (e.g. biogeographic) information on the region	Minor limitation	There is some contextual information available for this region and many of the fauna that occur have widespread distributions across the semi-arid zone, however, the current status of some conservation significant species is not well understood.

3. Habitats of the Study Area

Seven fauna habitats were identified in the study areas (Table 3, Figures 4 and 5). All the habitats present in the study areas are widely represented in the region. Other habitats in the region, such as Spinifex sandplains, claypans or salt lakes, are absent from the study area, though some of these occur nearby. There is some disturbance to habitats, from drilling access tracks, roads, rubbish dumps and an open pit at Mt Marven (Plate 1).

Table 3. Fauna habitats in the study area.

Fauna Habitat	Key Habitat Elements	Phoenix Ridge - Area (ha)	Mt Marven - Area (ha)
Low Rocky Hills	• Cracks and crevices in the rocks provide shelter for reptiles and small mammals.	4.1	41.1
Low Banded Ironstone Formation (BIF) Ridge	• Cracks and crevices in the rocks provide shelter for reptiles and small mammals.	27.7	-
Mulga Woodland	• Seeding mulga and flowering *Eremophila spp*. provides a foraging resource for birds.	352.7	-
Acacia Shrubland on Plains	• Seeding mulga and flowering *Eremophila spp*. provides a foraging resource for birds.	1.1	-
Creeklines	• Dense vegetation provides shelter and breeding habitat for birds. • May provide ecological linkage on a local level.	25.8	3.2
Chenopod Shrubland	• Chenopods provide a seed resource for foraging birds.	-	10.4
Samphire Shrubland	• Nil	-	1.9
Disturbed Areas	• Nil	5.5	24.2
		416.8	**80.8**

Plate 1. Rubbish (left) and drill track (right) in the study areas.

Figure 4. Mt Morgans Project – Phoenix Ridge fauna habitats

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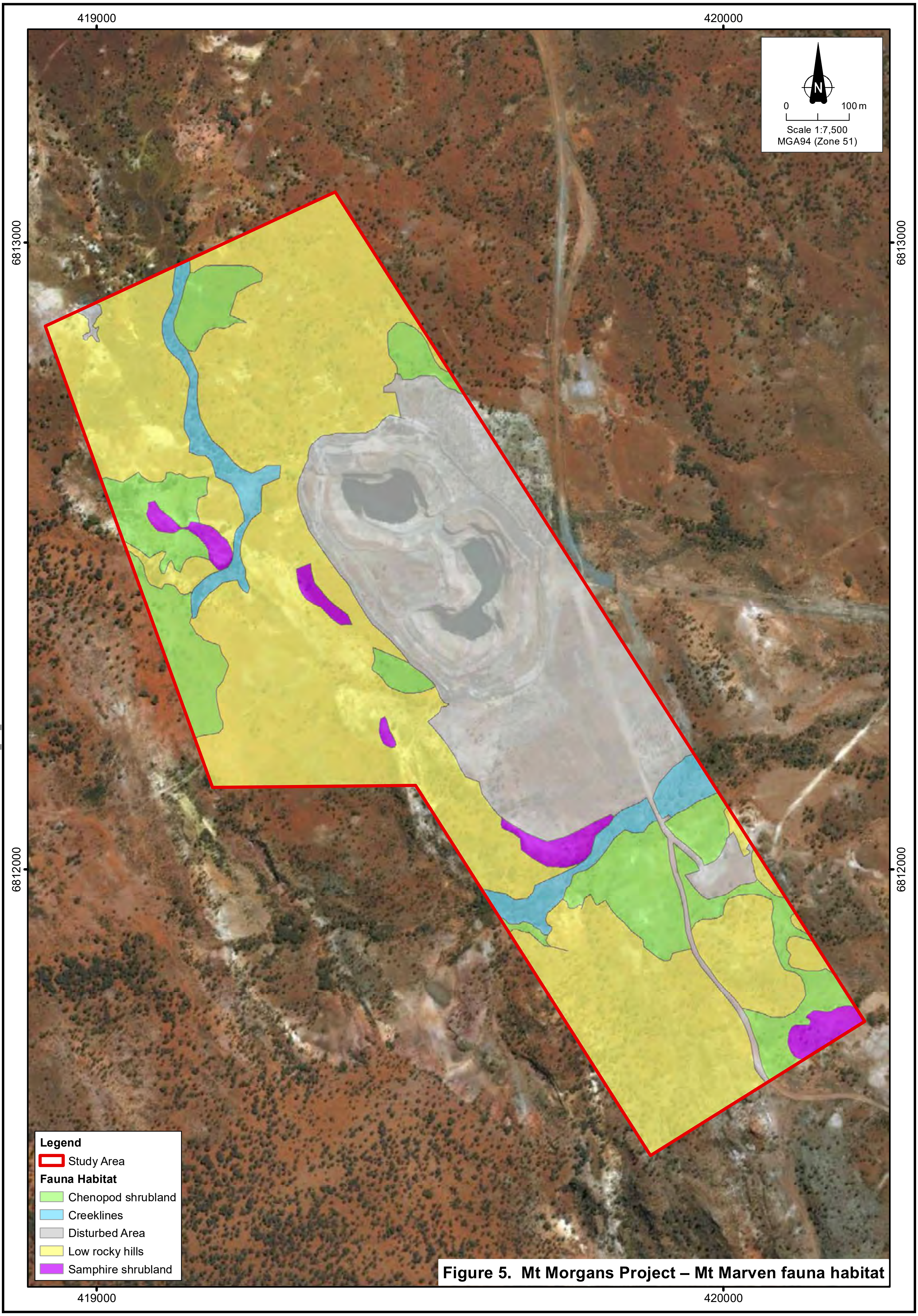

Figure 5. Mt Morgans Project – Mt Marven fauna habitat

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3.1 Low Rocky Hills

Low rocky hills occur mainly in the Mt Marven study area (Figure 5). These hills are generally low and have a stony or rocky surface with some cracks and crevices (Plate 2). Conservation significant species that may be present in this habitat include the Long-tailed Dunnart (*Sminthopsis longicaudata*) and Peregrine Falcon (*Falco peregrinus*).

Plate 2. Low Rocky Hills in the Mt Marven study area.

3.2 Low Banded Ironstone formation (BIF)

A low BIF ridge runs north-south in the Phoenix Ridge study area. There are small overhangs and breakaways present in areas with greater relief (Plate 3). Rocky areas provide shelter for a range of reptile and small mammal species. Overhangs and ledges may provide nesting habitat for some birds and shelter for kangaroo species. Conservation significant species that may be present in this habitat include the Long-tailed Dunnart (*Sminthopsis longicaudata*) and Peregrine Falcon (*Falco peregrinus*).

Plate 3. Banded Ironstone Formation in the Phoenix Ridge study area.

3.3 Mulga Woodland

Broad floodplains are dominated by Mulga (*Acacia aneura*) woodland (Plate 4), typically with denser vegetation than the surrounding Acacia shrublands. The floodplains are unlikely to hold water, but the dense vegetation provides shelter and breeding sites for fauna. As a common habitat in the region, Mulga woodland is likely to support a large range of vertebrate species. Small insectivorous birds forage and nest among Mulga trees. Where *Eremophila* shrubs are present and flowering, nectar-feeding birds are likely to be present. Some reptile species, such as geckos, shelter under logs or in crevices on Mulga trees. Although conservation significant fauna such as the Malleefowl (*Leipoa ocellata*) occur in this habitat, the Mulga woodlands in the study area are likely to be too sparse to support this species.

Plate 4. Mulga Woodlands.

3.4 Acacia Shrubland on Plains

Acacia shrubland on plains is a very common habitat in the region, but only comprise a small part of the Phoenix Ridge study area (Figure 4). The shrublands are generally dominated by Mulga (*Acacia aneura*) and other species of *Acacia*, with scattered *Eremophila* over tussock grass on clay-loam or stony soils. The shrubland is often relatively sparse, and although conservation significant fauna such as the Malleefowl (*Leipoa ocellata*) occur in this habitat, the *Acacia* shrublands in the study area are likely to be too sparse to support this species.

3.5 Creeklines

Minor creeklines occur in both study areas, and typically have denser vegetation than the surrounding Acacia shrublands or Mulga woodlands (Plate 5). The creeks in the study area are unlikely to hold water for long periods of time, though they may retain small waterholes after rain. The dense vegetation around creeks provide shelter and breeding sites for birds and other fauna.


Plate 5. Creeklines.

3.6 Chenopod Shrubland

Chenopod shrubland occurred in a small portion of the Mt Marven study area (Figure 5), and typically consisted of *Acacia* over sparse low shrubs of *Maireana*, *Sclerolaena*, *Teticornia* and *Atriplex* species (Plate 6). As this habitat is sparsely vegetated it is likely to support a lower diversity of fauna than some of the surrounding habitats. However, conservation significant species that may be present include the Oriental Plover (*Charadrius veredus*).


Plate 6. Chenopod shrubland.

3.7 Samphire Shrubland

The shrublands are dominated by samphires (*Tecticornia spp*.) and Bluebushes (*Maireana spp*.) on saline soils, and is generally sparse. Samphire shrublands comprise a small part of the Mt Marven study area and are likely to support only a few vertebrate fauna species.

4. Vertebrate Fauna of the Study Area

The results of the literature review and field survey were combined to create lists of the vertebrate fauna likely to occur in the study area. The number of vertebrate species potentially occurring in the study area are summarised in Table 4. The amphibians, reptiles, birds and mammals that have the potential to occur in the study area are listed in Appendices 1 to 4.

Table 4. Summary of vertebrate fauna potentially occurring in the study area.

Taxon	Total species	Introduced species	Recorded on this survey	Conservation significant species				
				T	Mi	OS	P	LS
Amphibians	10	-	-	-	-	-	-	-
Reptiles	85	-	1	-	-	-	-	1
Birds	110	-	20	5	2	1	1	-
Mammals	33	9	5	-	-	-	1	-
Totals:	**238**	**9**	**26**	**5**	**2**	**1**	**2**	**1**

The study areas are likely to support a relatively intact faunal assemblage, with only regionally extinct species likely to be missing. The predicted faunal assemblages and fauna of conservation significance are discussed in the sections below and summarised in Table 5. The results of the EPBC Act Protected Matters search are given in Appendix 5. Records of conservation significant fauna within 200km of the study area on DBCA's Threatened and Priority Fauna Database search are shown on Figure 6.

4.1 Amphibians

There are ten species of frog that have the potential to occur in the study area (Appendix 1). No frogs were observed opportunistically during the site visit, though the Desert Tree Frog (*Litoria rubella*), was common around the exploration camp at the Mt Morgans townsite in 2016 (Western Wildlife 2016). Frogs are likely to occur throughout the study area, potentially breeding anywhere that holds relatively fresh water after rainfall, including man-made depressions. Many species develop from tadpoles into frogs very quickly, and can make use of ephemeral pools in minor creeks or on claypans. During the dry season most species aestivate underground.

The frog species that occur in the study area are common and widely distributed in the semi-arid zone.

4.1.1 Amphibians of Conservation Significance

No frogs of conservation significance are likely to be present in the study area.

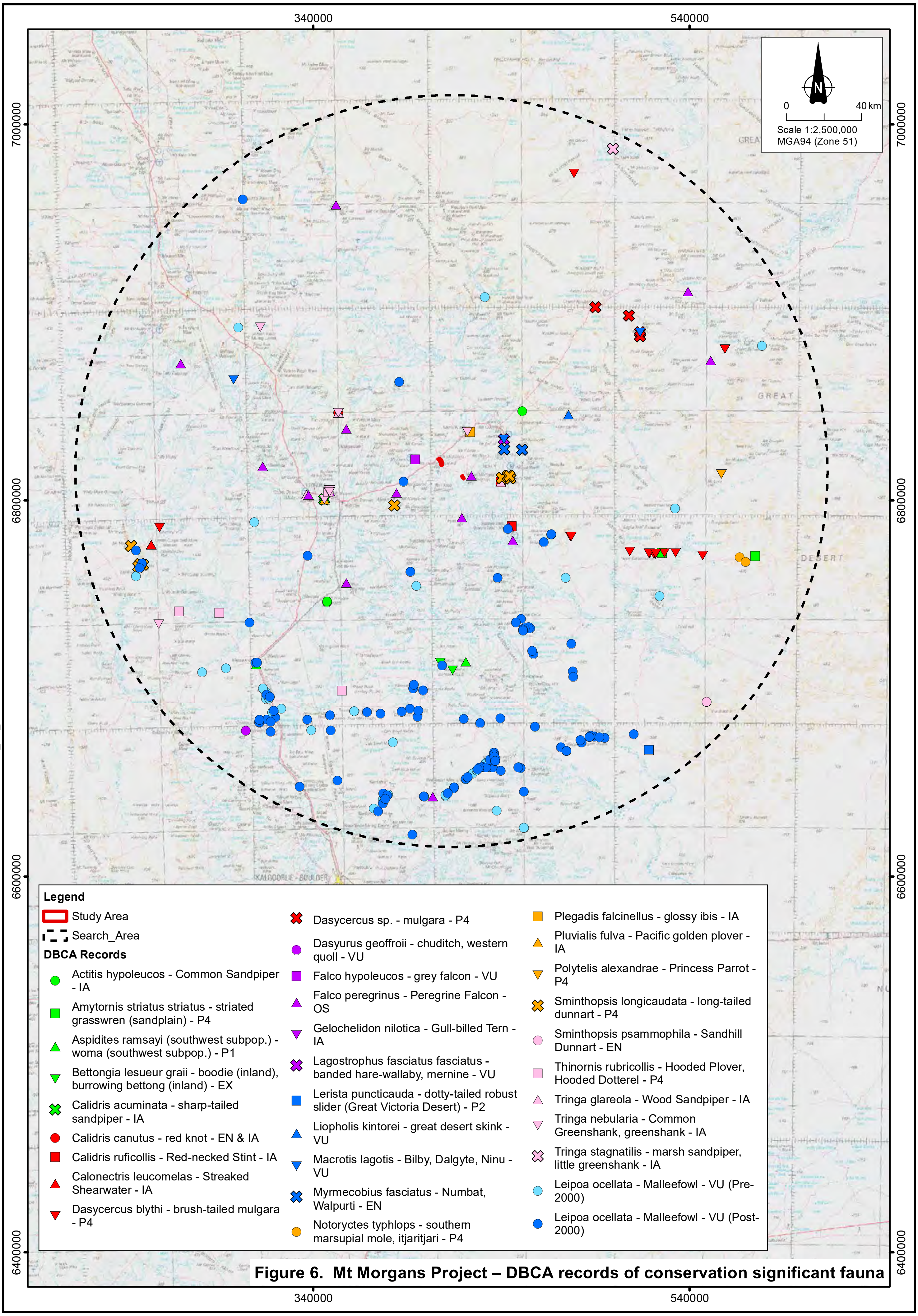

Figure 6. Mt Morgans Project – DBCA records of conservation significant fauna

4.2 Reptiles

There are 85 species of reptile that have the potential to occur in the study areas, of which one species was recorded opportunistically during the survey. A further four species were recorded in nearby surveys at Mt Morgans Gold Project (Appendix 2). The species recorded are all common in the region. The study area is likely to support an intact reptile assemblage. However, as each study area is relatively small, it is unlikely that all the potentially occurring species occur.

Most of the reptile species listed in Appendix 2 are common and widespread in the semi-arid region of Western Australia. Many species have broad habitat preferences, or are associated with *Acacia* shrublands and woodlands, a very common habitat type in the region. Several of the species listed favour Spinifex sandplains, such as the Beaded Gecko (*Lucasium damaeum*), Jewelled Gecko (*Strophurus elderi*) and the Pygmy Desert Monitor (*Varanus eremius*). These species are likely to be absent from the study area, though they would occur nearby.

4.2.1 Reptiles of Conservation Significance

There are three reptiles listed on DBCA's Threatened and Priority Fauna Database (Figure 6) that would not occur in the study areas. The Great Desert Skink (*Liopholis kintorei*) and Woma (*Aspidites ramsayi*) occur only on spinifex sandplains, a habitat that is absent from the study areas. The Dotty-tailed Robust Slider (*Lerista puncticauda*) is known only from Queen Victoria Spring, about 200km south of the study areas. These species are not included in the list of potentially occurring species and are excluded from the discussion below.

There is one reptile of conservation significance that may occur in vicinity of the study area, as listed and discussed below.

Locally Significant Fauna	
Black-headed Worm-lizard	*Aprasia picturata*

There is a record of the **Black-headed Worm-lizard** within 40 km of the study area on the WA Museum database (Appendix 2). This species is known from a record in rocky ridges vegetated with low *Acacia* and *Eremophila* near Leonora (Wilson and Swan 2010). As this species is known only from a few individuals, it is uncertain as to whether it may occur in other habitats, as other species of *Aprasia* inhabit loose soils rather than ridges. However, based on the habitat of the specimens collected near Leonora, this species potentially occurs on the low rocky hills or BIF ridge in the study areas.

4.3 Birds

There are 110 species of bird that have the potential to occur in the study area, of which 20 were recorded during the survey (Appendix 3). The study area is likely to support a bird assemblage typical of the Mulga shrublands and woodlands in the region. A total of 54 bird species were recorded nearby during the 2016 site visit (Western Wildlife 2016), though some of these were waterbirds and are thus unlikely to occur in the study area, and 33 species were recorded nearby at Camerons Well (Western Wildlife 2018). Waterbirds have been excluded from the list in Appendix 3, as the study area lacks wetland habitats.

Many of the terrestrial bird species listed are widespread and abundant in semi-arid shrublands and woodlands of the region. When understorey shrubs (*Eremophila spp.*) are flowering, they are likely to provide a seasonal food resource for nectar-feeding species such as honeyeaters. Seeding *Acacia* shrubs and trees provide a food resource for seed-eating birds such as parrots and pigeons. The Mulga woodlands in the broad floodplains are more densely vegetated than the surrounding shrublands and are likely to provide shelter and breeding sites for birds. The study area lacks the large eucalypt-lined watercourses that are significant breeding habitat for some species.

4.3.1 Birds of Conservation Significance

Several migratory shorebirds, seabirds and wetland birds are listed on databases for the region (Figure 6, Appendix 5), but have been excluded from the discussion below as the study area lacks suitable wetland habitats to support them. This includes the Common Sandpiper (*Actitis hypoleucos*), Sharp-tailed Sandpiper (*Calidris acuminata*), Red-necked Stint (*Calidris ruficollis*), Red Knot (*Calidris canutus*), Hooded Plover (*Thinornis rubricollis*), Wood Sandpiper (*Tringa glareola*), Common Greenshank (*Tringa nebularia*), Marsh Sandpiper (*Tringa stagnatilis*), Pectoral Sandpiper (*Calidris melanotos*), Pacific Golden Plover (*Pluvialis fulva*), Glossy Ibis (*Plegadis falcinellus*), Streaked Shearwater (*Calonectris leucomelas*), Gull-billed Tern (*Geochelidon nilotica*), Grey Wagtail (*Motacilla cinerea*) and Yellow Wagtail (*Motacilla fulva*). These species may occur on nearby Lake Carey, but are not likely to use the study areas.

There are eight birds of conservation significance that may potentially occur in the study areas, as listed and discussed below.

Threatened Fauna

Malleefowl *Leipoa ocellata*
This species is listed as Vulnerable under the EPBC Act and BC Act.

Grey Falcon *Falco hypoleucos*
This species is listed as Vulnerable under the BC Act.

Peregrine Falcon *Falco peregrinus*
This falcon is listed as Other specially protected fauna under the **B**C Act.

Princess Parrot *Polytelis alexandrae*
This species is listed as Vulnerable under the EPBC Act and as Priority 4 by DBCA.

Night Parrot *Pezoporus occidentalis*
This species is listed as Endangered under the EPBC Act and as Critically Endangered under the BC Act.

The **Malleefowl** is at the north-eastern limit of its range in the study area. This large ground-dwelling bird inhabits mallee and *Acacia* thickets that have a dense layer of leaf litter (Johnstone and Storr 1998). There are many records of this species from the surrounding area on DBCA's Threatened and Priority Fauna Database (Figure 6). The habitats present in the study area appear unsuitable for this species as they lack leaf litter and are generally sparsely vegetated. Searching during the site visit failed to record any evidence of historic Malleefowl mounds in the study area. Although the Malleefowl can be locally common in other parts of its range, it is unlikely to occur in the study areas, except as an occasional dispersing visitor.

The **Grey Falcon** generally occurs further north and east than the study area. There is a single record within 200km of the study area on DBCA's Threatened and Priority Fauna Database (Figure 6). The Grey Falcon forages over timbered plains, including *Acacia* shrublands, with its distribution centred on inland drainages. The Grey Falcon nests in tall trees on watercourses (Garnett *et al*. 2011) and occasionally on man-made structures such as transmission line towers (pers. obs.). The study area lacks suitable breeding habitat for this species. Although the Grey Falcon may occur in the study area on occasion, it is unlikely to provide significant habitat for this species.

The **Peregrine Falcon** is a widespread bird of prey that globally has a very large range and a very large population that appears to be secure (BirdLife International 2019). In Western Australia the population is secure, though this species may experience reductions at a local level due to human disturbance at nesting sites (Debus 1998). The Peregrine Falcon nests mainly on ledges on cliffs or rocky outcrops, and it may also use tall trees (Johnstone and Storr 1998). This species often takes advantage of man-made structures such as abandoned open pits or quarries. The Peregrine Falcon may occur and forage in the study area. Potential breeding habitat is present nearby, but the rocky hills in the study area a likely to be too low to provide breeding sites for this species.

The range of the **Princess Parrot** is generally further north and east of the study area (Garnett *et al*. 2011, Johnstone and Storr 1998) and database records in the local area are likely to be of vagrant birds. This species inhabits lightly wooded desert areas, foraging in the swales between sand dunes and nesting in eucalypt or desert oak (*Allocasuarina decaisneana*) hollows (Garnett *et al*. 2011, Johnstone and Storr 1998). There two records of this species on the DBCA Threatened and Priority Fauna Database (Figure 6), from Laverton (an undated historical record) and Mt Luck, 150km to the east, in 1984. The study area is outside the core range of the Princess Parrot and the habitats present are unlikely to support this species.

Historically, the **Night Parrot** was recorded across a large range in the arid and semi-arid interior of Australia (Garnett *et al*. 2011). In recent times however, there are very few verified records of the species, though it may still occur across its range at low densities (Garnett *et al*. 2011). Reliable records in recent times are from two main areas, one in western Queensland and one in the Pilbara region of Western Australia (TSSC 2016). The key habitats for the Night Parrot are thought to be chenopod shrublands and Spinifex grasslands, with the chenopod shrublands a refuge during dry conditions (Garnett *et al*. 2011). With the reasons for its decline unknown, potential threats to the species remain unconfirmed (TSSC 2016). Possible threats include predation by feral cats or foxes, human-induced fire and degradation of soil around watering points (TSSC 2016). The Mt Marven study area contains a small area of chenopod shrubland habitat, but the likelihood of the Night Parrot occurring in the study area is very low. This species is very rarely recorded anywhere, has not been recorded within 200km of the study area on DBCA's Threatened and Priority Fauna Database and the study areas lack Spinifex grasslands. If present in the region, the Night Parrot may potentially forage in the study area, but the study area does not include the Spinifex grasslands currently understood to be breeding habitat.

Migratory Fauna

Oriental Plover *Charadrius veredus*
This species is listed as migratory under the EPBC Act and BC Act.

Fork-tailed Swift *Apus pacificus*
This species is listed as migratory under the EPBC Act and BC Act.

The **Oriental Plover** is a migratory shorebird that occurs on sparsely vegetated plains, as well as beaches and tidal flats (Johnstone and Storr 1998). This species is a non-breeding visitor to Australia between August and April and is more common in the north (Geering 2011, Johnstone and Storr 1998). The study area would need to support 1% of the population (700 birds) in order to be a significant site for the species (Bamford *et al*. 2008). Although the Oriental Plover may occur in the study areas on occasion, it is only likely to be represented by a small number of individuals.

The **Fork-tailed Swift** is a non-breeding visitor to Australia between September and April (Boehm 1962). While it can be scarce in southwest Australia this species is generally more common in the north (Johnstone and Storr 1998). The bird is primarily observed foraging for insects in proximity to cyclonic weather (Boehm 1962). Although a migratory species, the Fork-tailed Swift has a large range and a large population that appears to be stable (BirdLife International 2019). Although there are no nearby records of this species (Figure 6), it is likely to occur in the region from time to time. The Fork-tailed Swift is largely an aerial species and is unlikely to be affected by changes to the study areas.

Priority Fauna

Striated Grasswren *Amytornis striatus striatus*
This species is listed as Priority 4 by DBCA.

The subspecies of **Striated Grasswren** *Amytornis striatus striatus* occurs mainly in the eastern desert region in Western Australia, with an apparently isolated population between Meekatharra and Wiluna (Johnstone and Storr 2004). It inhabits Spinifex, Spinifex with low shrubs or *Acacia* shrubland over Spinifex on sandy or loamy plains (Johnstone and Storr 2004). There is a record of Striated Grasswren from Sunrise Dam, on the eastern side of Lake Carey (Kingfisher Environmental Consulting 2014), and this record has been captured in the DBCA Threatened and Priority Fauna Database, so is also shown on Figure 6. Although it is possible that this species occurs in Spinifex habitats that surround nearby Lake Carey, the Striated Grasswren is not likely to occur in the study areas due to lack of suitable habitat.

4.4 Mammals

There are 33 species of mammal that have the potential to occur in the study area, of which 24 are native and nine introduced (Appendix 4). Five species of mammal were recorded opportunistically during the site visit, two native species and three introduced (Appendix 4). The native species observed were the Red Kangaroo (*Osphranter robustus*), which is likely to be common in the study area, favouring plains and open habitats, and the Euro (*Osphranter robustus*), a common species of hilly areas. Most of the mammals listed in Appendix 4 have wide distributions in the semi-arid region, occurring in a variety of habitats. A few species, such as the Wongai Ningaui (*Ningaui ridei*), Hairy-footed Dunnart (*Sminthopsis hirtipes*) and Spinifex Hopping Mouse (*Notomys alexis*) favour sandplains, and may be absent from the study area, though they are likely to occur nearby.

Several species of dunnart and other dasyurid marsupials may occur. Dunnarts are nocturnal foragers, and by day they shelter in a nest constructed under fallen timber or in a hollow log (Van Dyck and Strahan 2008). Almost a third of the mammals listed in Appendix 4 are insectivorous bats. These species are likely to forage over the study area at night. Some species, such as Hill's Sheathtail Bat (*Taphozous hilli*), roost in caves or mine shafts, while others, such as the White-striped Freetail Bat (*Ozimops australis*), roost in tree hollows (Churchill 1998). The study areas do not appear to contain caves, but cave-roosting species are likely to roost in crevices in the low rocky hills.

4.4.1 Mammals of Conservation Significance

Many native mammals in the region are locally extinct, including the Chuditch (*Dasyurus geoffroii),* Bilby (*Macrotis lagotis*), Numbat (*Myrmecobius fasciatus*), Banded Hare-wallaby (*Lagostrophus fasciatus*) and Boodie (*Bettongia lesueur*). These species may occur on databases as historical records, but are no longer considered to be present in the area. Other species, such as the Brush-tailed Mulgara (*Dasyurus blythi*), Southern Marsupial Mole (*Notoryctes typhlops*) and Sandhill Dunnart (*Sminthopsis psammophila*) are known from the region, but only occur in sandy habitats such as spinifex sandplains and sand dunes.

There is one mammal of conservation significance that may occur in the study areas, as listed and discussed below.

Priority Fauna

Long-tailed Dunnart *Sminthopsis longicaudata*
This species is listed as Priority 4 by DBCA.

The **Long-tailed Dunnart** is associated with breakaways and scree slopes, but also occurs on gravel or stony plains (Van Dyck and Strahan 2008). There are several records of this species on DBCA's Threatened and Priority Fauna Database (Figure 6). This species is likely to occur on the low rocky hills and BIF ridge in the study areas, and may range onto the adjacent stony plains. Low rocky hills and the BIF ridge, such as the ones in the study areas, are likely to be important habitat for maintaining this species in the local area.

Table 5. Summary of conservation significant (CS) fauna in the study area.

Key to Status: Cr = Critically Endangered, En = Endangered, Vu = Vulnerable, OS = Other Specially Protected Fauna, Mi = Migratory, P1 – P4 = Priority 1 – Priority 4.

Species	Status				DBCA records within 200km (see Figure 6)	Likelihood of occurrence in the study area	Habitat preferences	Potential habitat use in the study area						
	EPBC Act	BC Act	DBCA Priority	Locally Significant				Low rocky hills	BIF Ridge	Acacia shrubland on plains	Mulga woodlands	Creeklines	Chenopod shrublands	Samphire shrublands
Pezoporus occidentalis **Night Parrot**	En	Cr			-	Very low	Chenopod shrublands, Spinifex plains.						✓	
Leipoa ocellata **Malleefowl**	Vu	Vu			Many records, including the Black Swan Mine Site, Kurnalpi (2009, 2010), Murrin Murrin, Leonora (2011), Tropicana Gold Mine (2014), Laverton (2009 & 2014), Leonora (2016), Goongarrie National Park (2017).	Very low	*Acacia* thickets, mallee woodlands with leaf litter.			✓	✓	✓		
Polytelis alexandrae **Princess Parrot**	Vu		P4		Within 40km (DBCA 2007-)	Very low	Lightly timbered deserts, tree-lined watercourses							
Falco hypoleucos **Grey Falcon**		Vu			One record from Murrin Murrin (1996)	Low	Timbered plains, tree-lined watercourses.	✓	✓	✓	✓	✓	✓	✓
Falco peregrinus **Peregrine Falcon**		OS			Several records, including Laverton (2012 & 2004) and Murrin Murrin, Leonora (2012)	Moderate	Variety of habitats, nests in tall trees, cliffs, open pits.	✓	✓	✓	✓	✓	✓	✓

Table 5. (cont.).

Species	Status				DBCA records within 200km (see Figure 6)	Likelihood of occurrence in the study area	Habitat preferences	Potential habitat use in the study area						
	EPBC Act	BC Act	DBCA Priority	Locally Significant				Low rocky hills	BIF Ridge	Acacia shrubland on plains	Mulga woodlands	Creeklines	Chenopod shrublands	Samphire shrublands
Charadrius veredus **Oriental Plover**	Mi	Mi			-	Low	Sparsely vegetation plains, beaches, tidal flats.			✓	✓		✓	✓
Apus pacificus **Fork-tailed Swift**	Mi	Mi			-	Low	Overfly any habitat.	✓	✓	✓	✓	✓	✓	✓
Amytornis striatus striatus **Striated Grasswren**			P4		Two records, both from Tropicana Gold Mine (2014).	Very low	Spinifex plains, Acacia shrublands over Spinifex on sands or loams.							
Sminthopsis longicaudata **Long-tailed Dunnart**			P4		Several records, including from Laverton (2011), Granny Deeps Mine (2011), Mt Ida (2011 & 2012), Mt Mason (2012) and Murrin Murrin, Leonora (2011).	High	Rocky areas, scree slopes, breakaways, stony plains.	✓	✓					
Aprasia picturata **Black-headed Worm-lizard**				LS	Near Leonora (Wilson and Swan 2017)	Low	Rocky ridges with *Acacia* and *Eremophila*.	✓	✓					

5. Conclusions

5.1 Faunal Assemblage

The faunal assemblage of the study areas is likely to be typical of the region, with many of the species widely distributed through semi-arid Western Australia. Species that use wetlands or inhabit spinifex sandplains are likely to be absent as these habitats do not occur in the study areas.

The predicted faunal assemblage includes up to 10 frogs, 85 reptiles, 110 birds and 24 native mammals and nine introduced mammals. The observed assemblage for the study areas includes no frogs, 1 reptiles, 20 birds, two native mammals and three introduced mammals. The observed assemblage for the Mt Morgan Gold Project as a whole now stands at one frog, eight reptile, 52 bird, two native mammals and four introduced mammals.

5.2 Conservation Significant Fauna

Ten conservation significant fauna have been recorded or potentially occur in the Study Area, as summarised in Table 5. The species have been grouped into their conservation significance categories and discussed below.

1. <u>Threatened species</u>

Four threatened species potentially occur in the study areas:

- Malleefowl (*Leipoa ocellata*)
- Night Parrot (*Pezoporus occidentalis*)
- Princess Parrot (*Polytelis alexandrae*)
- Grey Falcon (*Falco hypoleucos*)

Threatened species are those that are considered in danger of extinction as their populations have declined and/or are still declining, and their total population size is small and/or fragmented or geographically restricted. Sites that support these species may be important for their long-term conservation, particularly if the site supports a resident breeding population.

The Malleefowl is unlikely to occur. Although known from many records in the region, the study areas lack the dense litter-forming shrublands that would provide breeding habitat for this species. Although it may occur on occasion, the study areas are unlikely to provide important habitat for the Malleefowl.

The Night Parrot and Princess Parrot are unlikely to occur. The Night Parrot is a very rare bird that nests in large Spinifex hummocks. While possible chenopod foraging habitat is present, there is no breeding habitat in the study areas. The Princess Parrot is a vagrant to the region and the study area is not likely to be important habitat. The Grey Falcon may occur as a foraging visitor, but no breeding habitat is present.

2. Migratory species

Two Migratory species potentially occur in the study areas, none of which have been recorded:

- Oriental Plover (*Charadrius veredus*)
- Fork-tailed Swift (*Apus pacificus*)

Migratory species are not always present at a site, but a particular site may have significance as a seasonal or ephemeral foraging, breeding or shelter area. Impacts to these sites may then impact the population both within the site and further afield.

The Oriental Plover is likely to occur, but not in significant numbers. The Fork-tailed Swift is thought to be almost entirely aerial when visiting Australia, so the study area is not likely to provide important habitat for this species.

3. Specially Protected species

A single Specially Protected species potentially occurs in the study areas:

- Peregrine Falcon (*Falco peregrinus*)

The Peregrine Falcon is likely to occur as a foraging visitor. The study areas are unlikely to be important for this species as its population is large and secure, and the rocky hills are too low to provide breeding habitat.

4. Priority species

Two Priority species potentially occur in the study areas:

- Striated Grasswren (*Amytornis striatus striatus*)
- Long-tailed Dunnart (*Sminthopsis longicaudata*)

The Striated Grasswren is unlikely to occur as the study areas lack its favoured spinifex grasslands. The Long-tailed Dunnart is likely to occur in the low rocky hills and BIF ridge.

5. Locally significant species

A single Locally Significant species potentially occurs in the study areas:

- Black-headed Worm Lizard (*Aprasia picturata*)

This species is known from very few records overall, but may occur in the low rocky hills and BIF Ridge.

5.3 Important Habitats

All habitats have some importance in that they support native fauna, however, habitats may be of particular importance if they:

- support very diverse or unique faunal assemblages
- are restricted or rare in the region (and thus the faunal assemblages are restricted or rare)
- are refugia (e.g. from drought or fire)
- provide ecological linkage
- support conservation significant fauna

The habitats in the Study Area are common and widespread in the subregion and are likely to support a faunal assemblage typical of the region. The Low Rocky Hills and BIF Ridge may be refugia for fauna on a local level, providing cracks and crevices as shelter from extreme conditions. As the study area is set within a largely uncleared landscape and the habitats present are broadly distributed, it is unlikely to have particular importance as a regional ecological linkage. Creekline habitats potentially provide ecological linkage on a local level.

Of the habitats present in the study area, the Low Rocky Hills and BIF Ridge have some importance in supporting populations of the Long-tailed Dunnart. The presence of this species in the region is likely to be determined by the availability of these habitats, and the loss of these habitats may lead to the local loss of this species.

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Appendices.

Appendix 1. Amphibians potentially occurring in the study area.

This survey = species recorded at Mt Marven or Phoenix Ridge, August 2019.
Cameron Well = species recorded at Cameron Well during the 2017 level 1 fauna survey.
Mt Morgan = species recorded during the 2016 level 1 fauna survey at either the proposed camp (c), Jupiter pit (j), borefield (b) or workshop & irrigation area (w).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Pelodryadidae (tree frogs and water-holding frogs)									
Main's Frog	*Cyclorana maini*					+	+		
Water-holding Frog	*Cyclorana platycephala*					+	+		
Desert Tree Frog	*Litoria rubella*				c		+		
Limnodynastidae (ground frogs)									
Northern Burrowing Frog	*Neobatrachus aquilonius*								
Kunapalari Frog	*Neobatrachus kunapalari*					+	+		
Desert Trilling Frog	*Neobatrachus sudellae*								
Shoemaker Frog	*Neobatrachus sutor*					+	+		
Plonking Frog	*Neobatrachus wilsmorei*						+		
Centralian Burrowing Frog	*Platyplectrum spenceri*					+			
Myobatrachidae (ground frogs)									
Western Toadlet	*Pseudophryne occidentalis*						+		
# frog species expected in the study area:		**10**							
# frog species recorded in the study area in 2019:		**0**							

Appendix 2. Reptiles potentially occurring in the study area.

This survey = species recorded at Mt Marven or Phoenix Ridge, August 2019.
Cameron Well = species recorded at Cameron Well during the 2017 level 1 fauna survey.
Mt Morgan = species recorded during the 2016 level 1 fauna survey at either the proposed camp (c), Jupiter pit (j), borefield (b) or workshop & irrigation area (w).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Carphodactylidae (knob-tailed geckoes)									
Southern Barking Gecko	*Underwoodisaurus milii*					+	+		
	Nephrurus vertebralis					+			
Diplodactylidae (geckoes)									
Variable Fat-tailed Gecko	*Diplodactylus conspicillatus*					+			
Wheatbelt Stone Gecko	*Diplodactylus granariensis*						+		
	Diplodactylus pulcher					+	+		
Beaded Gecko	*Lucasium dameum*						+		
	Lucasium squarrosum					+			
Sand-plain Gecko	*Lucasium stenodactylum*								
Western Beaked Gecko	*Rhynchoedura ornata*					+	+		
Goldfields Spiny-tailed Gecko	*Strophurus assimilis*					+	+		
Jewelled Gecko	*Strophurus elderi*					+			
Western Spiny-tailed Gecko	*Strophurus strophurus*						+		
	Strophurus wellingtonae					+	+		
Gekkonidae (geckoes)									
	Gehyra purpurascens					+	+		
	Gehyra variegata		+			+	+		
Bynoe's Gecko	*Heteronotia binoei*				j	+	+		
Pygopodidae (legless lizards)									
Black-headed Worm-lizard	*Aprasia picturata*	LS				+			
	Delma butleri					+			
	Delma nasuta					+			
Burton's Legless Lizard	*Lialis burtonis*					+			
	Pygopus nigriceps					+	+		
Agamidae (dragon lizards)									
Crested Dragon	*Ctenophorus cristatus*			+					
Mallee Sand Dragon	*Ctenophorus fordi*								
Laverton Rong-tailed Dragon	*Ctenophorus infans*					+	+		
Military Dragon	*Ctenophorus isolepis*					+	+		
Central Netted Dragon	*Ctenophorus nuchalis*					+	+		
Western Netted Dragon	*Ctenophorus reticulatus*				b	+	+		

Appendix 2. (cont.)

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Agamidae (cont.)									
Claypan Dragon	*Ctenophorus salinarum*					+			
Lozenge-marked Dragon	*Ctenophorus scutulatus*			+	b	+	+		
Mulga Dragon	*Diporiphora amphiboluroides*								
Thorny Devil	*Moloch horridus*					+			
Bearded Dragon	*Pogona minor*					+	+		
Pebble Dragon	*Tympanocryptis cephalus*					+	+		
Scincidae (skink lizards)									
	Cryptoblepharus australis								
	Cryptoblepharus buchananii						+		
	Cryptoblepharus plagiocephalus						+		
	Ctenotus atlas						+		
	Ctenotus grandis								
	Ctenotus greeri								
	Ctenotus hanloni					+			
	Ctenotus helenae					+			
	Ctenotus leonhardii					+	+		
	Ctenotus pantherinus					+			
	Ctenotus schomburgkii								
	Ctenotus severus					+	+		
	Ctenotus uber					+	+		
Slender Blue-tongue	*Cyclodomorphus melanops*								
Pygmy Spiny-tailed Skink	*Egernia depressa*					+	+		
	Egernia formosa								
Broad-banded Sand Swimmer	*Eremiascincus richardsonii*					+	+		
	Lerista bipes								
	Lerista desertorum					+	+		
	Lerista distinguenda						+		
	Lerista kingi								
	Lerista timida					+	+		
Desert Skink	*Liopholis inornata*					+			
Night Skink	*Liopholis striata*								
Dwarf Skink	*Menetia greyii*					+	+		
	Morethia butleri					+	+		
Central Blue-tongue	*Tiliqua multifasciata*						+		
Western Bluetongue	*Tiliqua occipitalis*					+			
Bobtail	*Tiliqua rugosa*						+		
Varanidae (monitors & goannas)									
Short-tailed Pygmy Monitor	*Varanus brevicauda*								
Stripe-tailed Monitor	*Varanus caudolineatus*					+	+		
Pygmy Desert Monitor	*Varanus eremius*					+			
Perentie	*Varanus giganteus*								

Appendix 2. (cont.)

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Varanidae (cont.)									
Gould's Goanna	*Varanus gouldii*				b		+		
	Varanus panoptes				b		+		
Black-tailed Monitor	*Varanus tristis*					+			
Typhlopidae (blind snakes)									
Southern Blind Snake	*Anilios australis*								
	Anilios bicolor								
	Anilios hamatus								
	Anilios waitii								
Boidae (pythons)									
Stimpson's Python	*Antaresia stimsoni*						+		
Elapidae (front-fanged snakes)									
Desert Death Adder	*Acanthophis pyrrhus*								
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolatus*					+			
Southern Shovel-nosed Snake	*Brachyurophis semifasciatus*								
Yellow-faced Whipsnake	*Demansia psammophis*								
Moon Snake	*Furina ornata*					+			
Monk Snake	*Parasuta monachus*					+	+		
Mulga Snake	*Pseudechis australis*					+			
Spotted Mulga Snake	*Pseudechis butleri*					+			
Ringed Brown Snake	*Pseudonaja modesta*				b	+			
Western Brown Snake	*Pseudonaja mengdeni*					+			
Jan's Banded Snake	*Simoselaps bertholdi*					+			
Rosen's Snake	*Suta fasciata*					+	+		
# reptile species expected in the study area:		85							
# reptile species recorded in the study area in 2019:		1							

Appendix 3. Birds potentially occurring in the study areas.

This survey = species recorded at Mt Marven or Phoenix Ridge, August 2019.
Cameron Well = species recorded at Cameron Well during the 2017 level 1 fauna survey.
Mt Morgan = species recorded during the 2016 level 1 fauna survey at either the proposed camp (c), Jupiter pit (j), borefield (b) or workshop & irrigation area (w).
Birds Aust. = species recorded in the area on the Birds Australia Atlas Database (see Table 1).
Birdata = species recorded in the area on the Birdata Database (see Table 1).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records								
			This survey	Cameron Well	Mt Morgan	Birds Aust.	Birdata	WAM	FSDB	TF	EPBC
Dromaiidae (emu)											
Emu	*Dromaius novaehollandiae*		+		b	+			+		
Megapodiidae (mound-builders)											
Malleefowl	*Leipoa ocellata*	T							+		+
Phasianidae (quails)											
Stubble Quail	*Coturnix pectoralis*					+					
Accipitridae (osprey, hawks, eagles and harriers)											
Black-shouldered Kite	*Elanus caeruleus*					+			+		
Square-tailed Kite	*Hamirostra isura*										
Black-breasted Buzzard	*Hamirostra melanosternon*										
Black Kite	*Milvus migrans*										
Whistling Kite	*Haliastur sphenurus*					+	+				
Brown Goshawk	*Accipiter fasciatus*										
Collared Sparrowhawk	*Accipiter cirrocephalus*					+			+		
Little Eagle	*Hieraaetus morphnoides*				j						
Wedge-tailed Eagle	*Aquila audax*		+	+	j	+	+		+		
Spotted Harrier	*Circus assimilis*								+		
Otididae (bustard)											
Australian Bustard	*Ardeotis australis*								+		
Turnicidae (button-quails)											
Little Button-Quail	*Turnix velox*					+	+		+		
Burhinidae (stone-curlews)											
Bush Stone-Curlew	*Burhinus grallarius*										
Charadriidae (plovers, dotterels and lapwings)											
Inland Dotterel	*Peltohyas australis*										
Oriental Plover	*Charadrius veredus*	Mi									+
Banded Lapwing	*Vanellus tricolor*							+	+		
Columbidae (pigeons and doves)											
Diamond Dove	*Geopelia cuneata*						+		+		
Common Bronzewing	*Phaps chalcoptera*			+	j b	+	+		+		
Crested Pigeon	*Ocyphaps lophotes*			+	j b	+	+		+		

Appendix 3 (cont.)

Species		Conservation Status	Records								
			This survey	Cameron Well	Mt Morgan	Birds Aust.	Birdata	WAM	FSDB	TF	EPBC
Cuculidae (cuckoos)											
Pallid Cuckoo	*Cacomantis pallidus*					+	+		+		
Black-eared Cuckoo	*Chrysococcyx osculans*								+		
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*										
Strigidae (hawk owls)											
Boobook Owl	*Ninox boobook*										
Tytonidae (barn owls)											
Eastern Barn Owl	*Tyto alba*										
Podargidae (frogmouths)											
Tawny Frogmouth	*Podargus strigoides*										
Caprimulgidae (nightjars)											
Spotted Nightjar	*Eurostopodus argus*								+		
Aegothelidae (owlet-nightjars)											
Australian Owlet-Nightjar	*Aegotheles cristatus*								+		
Apodidae (swifts)											
Fork-tailed Swift	*Apus pacificus*	Mi									+
Alcedinidae (kingfishers)											
Red-backed Kingfisher	*Todiramphus pyrrhopygius*										
Sacred Kingfisher	*Todiramphus sanctus*										
Meropidae (bee-eaters)											
Rainbow Bee-eater	*Merops ornatus*				j	+			+		+
Falconidae (falcons)											
Brown Falcon	*Falco berigora*				j b w	+	+		+		
Australian Kestrel	*Falco cenchroides*			+	j	+	+		+		
Grey Falcon	*Falco hypoleucos*	T								+	
Australian Hobby	*Falco longipennis*								+		
Peregrine Falcon	*Falco peregrinus*	OS							+	+	
Cacatuidae (cockatoos)											
Galah	*Cacatua roseicapilla*				j b	+		+	+		
Cockatiel	*Nymphicus hollandicus*					+	+		+		
Psittacidae (parrots, lorikeets & rosellas)											
Budgerigar	*Melopsittacus undulatus*			+	b w	+	+		+		
Bourkes Parrot	*Neophema bourkii*			+		+			+		
Mulga Parrot	*Platycercus varius*				j				+		
Australian Ringneck	*Platycercus zonarius*		+			+			+		
Princess Parrot	*Polytelis alexandrae*	T						+		+	+
Night Parrot	*Pezoporus occidentalis*	T									+
Ptilonorhynchidae (bowerbirds)											
Western Bowerbird	*Ptilonorhynchus maculatus*		+	+	w	+			+		

Appendix 3 (cont.)

Species		Conservation Status	Records								
			This survey	Cameron Well	Mt Morgan	Birds Aust.	Birdata	WAM	FSDB	TF	EPBC
Climacteridae (treecreepers)											
White-browed Treecreeper	*Climacteris affinis*								+		
Maluridae (fairy-wrens, grasswrens and emu-wrens)											
Striated Grasswren	*Amytornis striatus*	P								+	
Variegated Fairy-wren	*Malurus lamberti*						+		+		
White-winged Fairy-wren	*Malurus leucopterus*			+	j b w		+		+		
Splendid Fairy-wren	*Malurus splendens*		+	+	j w		+		+		
Meliphagidae (honeyeaters and chats)											
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*			+	j b w	+	+	+	+		
Black Honeyeater	*Sugomel niger*										
Pied Honeyeater	*Certhionyx vareigatus*						+		+		
Brown Honeyeater	*Lichmera indistincta*					+			+		
Singing Honeyeater	*Gavicalis virescens*		+	+	c j b w	+	+	+	+		
Grey-fronted Honeyeater	*Ptilotula plumula*					+	+				
Yellow-throated Miner	*Manorina flavigula*			+	j b w	+	+		+		
White-fronted Honeyeater	*Purnella albifrons*				b	+			+		
White-fronted Chat	*Epthianura albifrons*					+	+				
Orange Chat	*Epthianura aurifrons*						+				
Crimson Chat	*Epthianura tricolor*			+		+	+		+		
Pardalotidae (pardalotes)											
Red-browed Pardalote	*Pardalotus rubricatus*								+		
Striated Pardalote	*Pardalotus striatus*					+	+	+			
Acanthizidae (thornbills, gerygones & allies)											
Inland Thornbill	*Acanthiza apicalis*		+	+	b	+	+		+		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		+	+	j b	+	+	+	+		
Slender-billed Thornbill	*Acanthiza iredalei*								+		
Slaty-backed Thornbill	*Acanthiza robustirostris*		+	+	b	+		+	+		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*		+	+	c j b w	+	+		+		
Southern Whiteface	*Aphelocephala leucopsis*		+	+		+		+	+		
Western Gerygone	*Gerygone fusca*					+			+		
Redthroat	*Pyrrholaemus brunneus*		+						+		
Weebill	*Smicrornis brevirostris*		+			+			+		
Pomatostomidae (babblers)											
White-browed Babbler	*Pomatostomus superciliosus*		+	+	j b	+			+		
Psophodidae (whipbird, wedgebills & quail-thrush)											
Western Quail-thrush	*Cinclosoma marginatum*			+	b	+	+	+	+		
Western Chestnut Quail-thrush	*Cinclosoma clarum*			+							
Western Wedgebill	*Psophodes occidentalis*										

Appendix 3 (cont.)

Species		Conservation Status	Records								
			This survey	Cameron Well	Mt Morgan	Birds Aust.	Birdata	WAM	FSDB	TF	EPBC
Artamidae (woodswallows)											
Masked Woodswallow	*Artamus personatus*					+	+		+		
Black-faced Woodswallow	*Artamus cinereus*			+	j b w	+	+		+		
Little Woodswallow	*Artamus minor*								+		
Cracticidae (magpies, butcherbirds & currawongs)											
Grey Butcherbird	*Cracticus torquatus*				j	+	+		+		
Pied Butcherbird	*Cracticus nigrogularis*		+	+	j b w	+	+		+		
Australian Magpie	*Cracticus tibicen*					+		+	+		
Grey Currawong	*Strepera versicolor*					+			+		
Campephagidae (cuckoo-shrikes and trillers)											
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*			+	b w	+	+		+		
Ground Cuckoo-Shrike	*Coracina maxima*				c	+	+		+		
White-winged Triller	*Lalage tricolor*				j				+		
Neosittidae (sittellas)											
Varied Sittella	*Daphoenositta chrysoptera*				b						
Oreoicidae (crested bellbird)											
Crested Bellbird	*Oreoica gutteralis*			+	j b w	+	+	+	+		
Pachycephalidae (shrike-tits, whistlers and allies)											
Rufous Whistler	*Pachycephala rufiventris*		+	+	j b w	+	+		+		
Grey Shrike-thrush	*Colluricincla harmonica*		+	+	j b	+	+		+		
Rhipiduridae (fantails)											
Willie Wagtail	*Rhipidura leucophrys*			+	j b w	+	+		+		
Grey Fantail	*Rhipidura albiscapa*					+					
Monarchidae (flycatchers, monarchs & magpie-lark)											
Magpie-lark	*Grallina cyanoleuca*				c b w	+	+		+		
Corvidae (ravens and crows)											
Torresian Crow	*Corvus orru*		+		j b w	+	+		+		
Little Crow	*Corvus bennetti*					+	+	+	+		
Petroicidae (robins)											
Jacky Winter	*Microeca fascinans*										
Hooded Robin	*Melanodryas cucullata*			+	b	+	+		+		
Red-capped Robin	*Petroica goodenovii*		+	+	j b w	+			+		
Hirundinidae (swallows and martins)											
White-backed Swallow	*Cheramoeca leucosterna*				j	+	+				
Welcome Swallow	*Hirundo neoxena*				j b	+	+		+		
Tree Martin	*Petrochelidon nigricans*		+		j w	+	+				
Fairy Martin	*Petrochelidon ariel*					+	+		+		

Appendix 3 (cont.)

Species	Conservation Status	Records								
		This survey	Cameron Well	Mt Morgan	Birds Aust.	Birdata	WAM	FSDB	TF	EPBC
Locustellidae (grassbirds, songlarks & old world warblers)										
Rufous Songlark *Megalurus mathewsi*					+	+		+		
Brown Songlark *Megalurus cruralis*					+					
Dicaeidae (flowerpeckers)										
Mistletoebird *Dicaeum hirundinaceum*			+	j	+	+		+		
Estrildidae (grassfinches and allies)										
Zebra Finch *Taeniopygia guttata*			+	j b w	+	+		+		
Motacillidae (pipits and wagtails)										
Australian Pipit *Anthus australis*			+	b				+		
# bird species expected in the study area:		**110**								
# bird species recorded in the study area in 2019:		**20**								

Appendix 4. Mammals potentially occurring in the study area.

This survey = species recorded at Mt Marven or Phoenix Ridge, August 2019.
Cameron Well = species recorded at Cameron Well during the 2017 level 1 fauna survey.
Mt Morgan = species recorded during the 2016 level 1 fauna survey at either the proposed camp (c), Jupiter pit (j), borefield (b) or workshop & irrigation area (w).
WAM = species recorded in the area on the Western Australian Museum Specimen Database (see Table 1).
FSDB = species recorded in the area on the Fauna Survey Returns Database (see Table 1).
TF = species recorded in the area on the DBCA Threatened and Priority Fauna Database (see Table 1).
EPBC = species or species habitat recorded in the area on the EPBC Protected Matters Search Tool (see Table 1).

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Tachyglossidae (echidnas)									
Echidna	*Tachyglossus aculeatus*						+		
Dasyuridae (dasyurid marsupials)									
Kultarr	*Antechinomys laniger*						+		
Wongai Ningaui	*Ningaui ridei*					+			
Fat-tailed Dunnart	*Sminthopsis crassicaudata*					+	+		
Little Long-tailed Dunnart	*Sminthopsis dolichura*						+		
Hairy-footed Dunnart	*Sminthopsis hirtipes*					+	+		
Long-tailed Dunnart	*Sminthopsis longicaudata*	P					+	+	
Striped-faced Dunnart	*Sminthopsis macroura*						+		
Ooldea Dunnart	*Sminthopsis ooldea*								
Macropodidae (kangaroos and wallabies)									
Euro	*Osphranter robustus*		+		c j b w		+		
Red Kangaroo	*Osphranter rufus*		+	+	j		+		
Muridae (rats and mice)									
House Mouse	*Mus musculus*	Int.					+		
Spinifex Hopping-Mouse	*Notomys alexis*					+	+		
Desert Mouse	*Pseudomys desertor*								
Sandy Inland Mouse	*Pseudomys hermannsbergensis*					+	+		
Leporidae (rabbits & hares)									
Rabbit	*Oryctolagus cuniculus*	Int.	+	+	j b w		+		
Emballonuridae (sheathtail bats)									
Hill's Sheathtail Bat	*Taphozous hilli*								
Molossidae (freetail bats)									
Inland Freetail Bat	*Ozimops petersi*								
White-striped Freetail Bat	*Austronomus australis*								
Vespertilionidae (ordinary bats)									
Gould's Wattled Bat	*Chalinolobus gouldii*								
Chocolate Wattled Bat	*Chalinolobus morio*						+		
Finlayson's Cave Bat	*Vespadelus finlaysoni*						+		
Inland Forest Bat	*Vespadelus baverstocki*								
Inland Broad-nosed Bat	*Scotorepens balstoni*								
Lesser Long-eared Bat	*Nyctophilus geoffroyi*					+	+		

Appendix 4. (cont.)

Species		Conservation Status	Records						
			This survey	Cameron Well	Mt Morgan	WAM	FSDB	TF	EPBC
Canidae (dogs and foxes)									
Fox	*Vulpes vulpes*	Int.	+						
Dingo	*Canis dingo*						+		
Dog	*Canis familiaris*	Int.							
Felidae (cats)									
Feral/House Cat	*Felis catus*	Int.			j		+		
Equidae (horses and donkeys)									
Donkey	*Equus asinus*	Int.							
Camelidae (camels)									
Camel	*Camelus dromedarius*	Int.							
Bovidae (horned ruminants)									
Cow	*Bos taurus*	Int.	+		j b w		+		
Goat	*Capra hircus*	Int.					+		
# mammal species expected in the study area:		**33 (24 native, 9 introduced)**							
# mammal species recorded in the study area in 2019:		**5 (2 native)**							

Appendix 5. EPBC Protected Matters Search Tool results.

Species listed for the area 20km in radius from 28.76778 ºS, 122.13722 ºE on the EPBC Protected Matters Search Tool.

Species	Status	Type of Presence
Malleefowl *Leipoa ocellata*	Vu	Species or species habitat **likely** to occur within area
Night Parrot *Pezoporus occidentalis*	En	Species or species habitat **may** occur within area
Princess Parrot *Polytelis alexandrae*	Vu	Species or species habitat **likely** to occur within area
Chuditch *Dasyurus geofroii*	Vu	Species or species habitat **may** occur within area
Fork-tailed Swift *Apus pacificus*	Mi	Species or species habitat **likely** to occur within area
Grey Wagtail *Motacilla cinerea*	Mi	Species or species habitat **may** occur within area
Yellow Wagtail Motacilla flava	Mi	Species or species habitat **may** occur within area
Common Sandpiper *Actitis hypoleucos*	Mi	Species or species habitat **may** occur within area
Sharp-tailed Sandpiper *Calidris acuminata*	Mi	Species or species habitat **may** occur within area
Pectoral Sandiper *Calidris melanotos*	Mi	Species or species habitat **may** occur within area
Oriental Plover *Charadrius veredus*	Mi	Species or species habitat **may** occur within area
Common Greenshank *Tringa nebularia*	Mi	Species or species habitat **likely** to occur within area

APPENDIX 5: SHORT RANGE ENDEMIC FAUNA DESKTOP ASSESSMENT (BENNELONGIA, 2016)

Bennelongia Environmental Consultants

Mt Morgans Gold Project: Short-Range Endemic Fauna Desktop Assessment

Prepared for:

Dacian Gold Limited

August 2016

Final Report

Short-Range Endemics I Subterranean Fauna

Waterbirds I Wetlands

Mt Morgans Project: Short-Range Endemic Fauna Desktop Assessment

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Draft	Danilo Harms	Renee Young	email	24 March 2016
Draft	Renee Young	Stuart Halse	email	22 April 2016
Final	Renee Young	Stuart Halse	email	09 August 2016

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EXECUTIVE SUMMARY

Introduction. Dacian Gold Limited (Dacian) is planning to develop the Mt Morgans Gold Project (the Project) in the northern goldfields of Western Australia, located approximately 35 km south west of Laverton. The Project is a brownfields site that encompasses three historic operational areas, comprising:

- Westralia: Containing the Westralia and Transvaal pits, other satellite pits and historical processing areas;
- Jupiter: Containing the Jupiter pit and heap leach area, located approximately 15 km to the east of Westralia; and
- The Mt Morgans and Jupiter Borefields (hereafter referred to as the production borefield).

Dacian proposes to develop three open pits at Jupiter and three underground mines at the Westralia. Associated infrastructure development will include a processing plant, tailings storage facility, Run of Mine Pads (ROMs), waste rock dumps, power plant, workshops, administration offices, camp, pipelines and roads.

A desktop assessment was completed to provide information about the occurrence of short-range endemic (SRE) and listed invertebrate species across the Project area, and to assess the potential impact on this fauna from the proposed mining operation.

Methods. A desktop review was undertaken to collate existing data on SREs occurring in the vicinity of the Project, as well as invertebrate species listed as Specially Protected or Threatened fauna. Information contained in published literature, publically available environmental reports and online databases were reviewed with regards to SRE species and their habitats. The databases of the Western Australian Museum (WAM) were searched to identify potential and confirmed SRE species in the vicinity of the Project, and the taxonomic groups that may occur locally. SRE status of species from the Project area and its vicinity was assessed according to the WAM SRE categories. All available landforms and macrohabitats in the study area were mapped and classified with regards to their suitability for SRE fauna.

Results. The desktop review showed that that there are three habitat types in the survey area that have a moderate or high prospect for SRE fauna: BIF Ridges, Minor Drainage Lines and Woodlands. BIF ridges are by far the least common habitat type in the survey area and are too small to support diverse SRE communities. The Minor Drainage Lines and Woodlands are more common but not restricted at a local, sub-regional or regional scale and extend far beyond the project boundaries. The SRE community in the vicinity of the Project is poorly known but appears depauperate when compared to other areas in the Goldfields. Three SRE Groups that potentially occur in the Project vicinity seem to be moderately diverse (mygalomorph spiders, scorpions and centipedes) but no harvestmen, pseudoscorpions, millipedes, slaters or terrestrial snails have been collected in the Project area or its vicinity. All named species in the SRE Groups that are likely to occur in the Project area are widespread and have known ranges that extend regionally. Some potential SRE species have been recorded but they have deficient data and their ranges cannot be assessed. One listed species, the fairy shrimp *Branchinella simplex* may occur although there are currently no records at the Project. This species is known from fresh and saline waters on clay pans and these habitats occur in the Project area. Further suitable habitat extends beyond the mapped areas and the species tolerates a wide range of salinities with a linear range of approximately 550 km. If present in the Project area, the impacts to *B. simplex* are expected to be minimal. Overall, the proposed impact areas in relation to the available habitats are very small and there are no known SRE invertebrate species from the Goldfields that have ranges smaller than the areas to be disturbed.

Conclusions. The available data suggest that Project development will not have a significant impact on SRE communities or listed species. This conclusion is reached because:

1. The most suitable habitats for SRE species at the Project area are wide-ranging, interconnected and extend far beyond the tenement boundaries;
2. The SRE Group fauna of the Project appears to be depauperate at all taxonomic levels and comprises predominantly widespread species;
3. The proposed impact areas are small and the primary impact will be on the Plains (with the western TSF option) or the Salt Pans and Tributaries (with the eastern TSF option); and
4. The habitat in which the listed species *Branchinella simplex* may occur (Salt Pans and Tributaries) will have minimal impact and this habitat occurs widely beyond the project area.

A field survey that could validate the findings of this desktop review and characterise the SRE community present is unnecessary for the reasons given above and the level of threat to such species from Project development is considered negligible. It is suggested that SRE invertebrates are not a relevant environmental assessment factor at the Mt Morgans Project.

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1. INTRODUCTION

Dacian Gold Limited (Dacian) is planning to develop the Mt Morgans Project in the Northern Goldfields of Western Australia, located approximately 35 km south west of Laverton (Figure 1). A desktop assessment was completed to provide information about the occurrence of short-range endemic (SRE) and listed invertebrate species across the Project area, and to assess the potential impact on this fauna from the proposed mining operation.

SRE invertebrates are species with distributions of less than 10,000 km^2 and their occurrence within their distributions is usually patchy because they are confined to discontinuous habitats. The small ranges of SRE invertebrates, combined with poor dispersal capacities, slow growth and low fecundity, make them particularly vulnerable to habitat loss or disturbance (Harvey 2002; Ponder and Colgan 2002). The Environmental Protection Authority's (EPA) Guidance Statement 20 (Environmental Protection Authority 2009) requires that impacts on SRE invertebrates are considered during environmental impact assessments. In practice, assessment of risk to SRE invertebrates in arid Western Australia is focused on eight taxonomic groups with a known high proportion of SRE species (the *SRE Groups*): harvestmen (Opiliones), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), spiders (Araneae), centipedes (Chilopoda), millipedes (Diplopoda), slaters (Isopoda), and terrestrial snails (Gastropoda).

Listed invertebrate species are those listed under the Western Australian *Wildlife Conservation Act 1950* or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). They may belong to any invertebrate group and are listed because they potentially face severe population reduction, have lost much of their habitat, or are collected intensively.

This report assesses whether any short-range endemic (SRE) invertebrate fauna, or habitats promoting such fauna, are likely to occur at the Project. It also assesses if any listed invertebrate species or those protected otherwise under commonwealth or state legislation are likely to occur at the Project. The overall aims of the desktop assessment are to:

- Collate existing information on SREs and listed invertebrates that may occur in the vicinity or are known from within the Project area;
- Characterise habitats and classify landforms according to their suitability for listed or SRE invertebrate species;
- Compile existing data on SRE species distributions and abundance with the overarching aim of characterising the community that is potentially present; and
- Determine if the Project is likely to have significant conservation impacts on any SRE or listed aquatic invertebrate species.

For this purpose, records of species belonging to the SRE Groups or listed species were compiled for a 100 by 100 km search area surrounding the Project and their ranges estimated. Habitat mapping was also undertaken and the Project was split into distinct habitat types that were evaluated with regards to their suitability for SRE fauna. All listed invertebrate species from the Yilgarn are discussed, to evaluate their likelihood of occurrence in the Project area and potential threats to them arising from Project development.

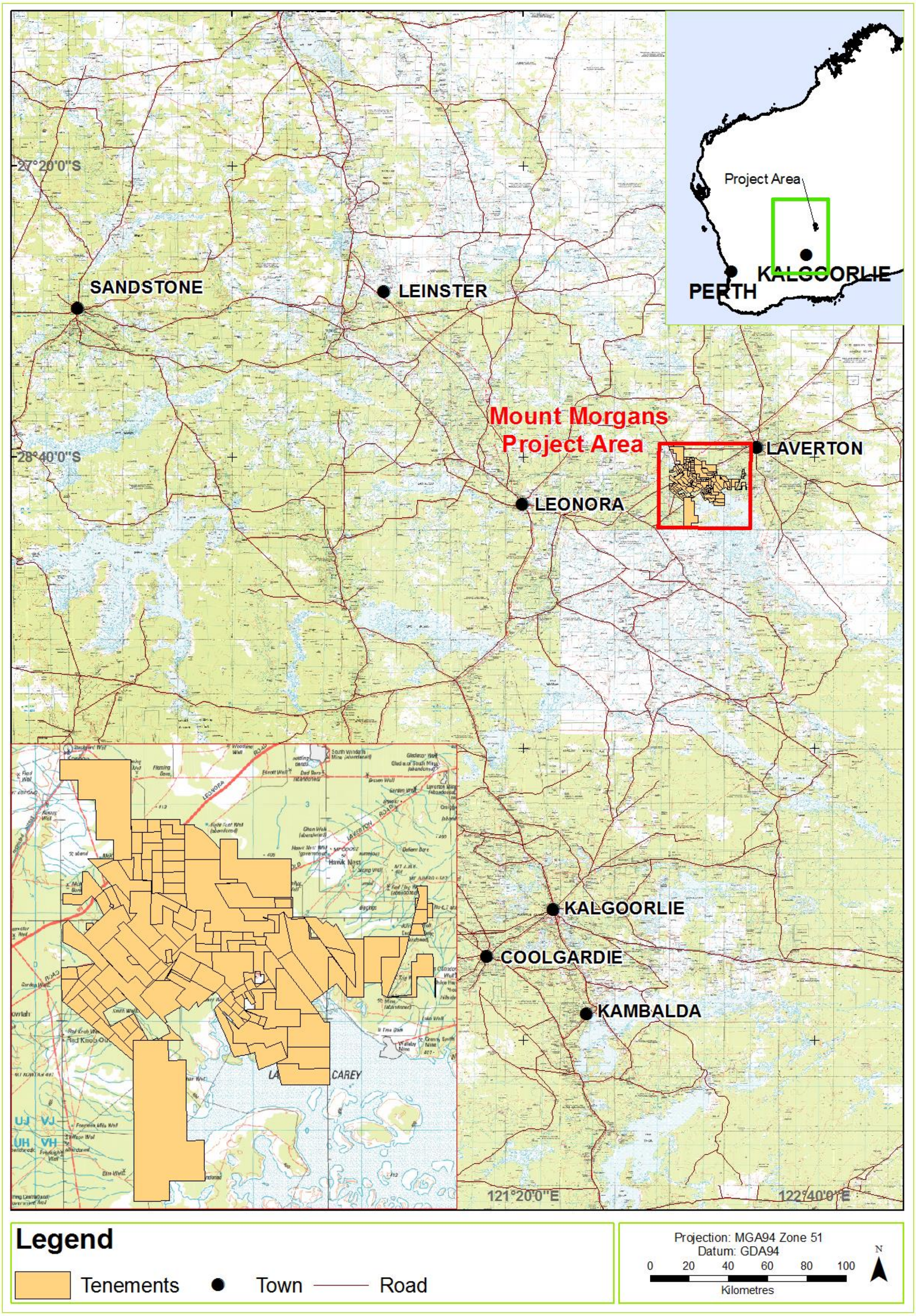

Figure 1. Location of the Mt Morgans Project area.

2. BACKGROUND

2.1. Project Details

The Project is a brownfields site that encompasses three historic operational areas, comprising:

- Westralia: Containing the Westralia and Transvaal pits, other satellite pits and historical processing areas;
- Jupiter: Containing the Jupiter pit and heap leach area, located approximately 15 km to the east of Westralia; and
- The Mt Morgans and Jupiter Borefields (hereafter referred to as the production borefield).

Dacian is proposing to commence construction and mining activities at the Project in 2017 (Blueprint 2015). Three mineral resources have been identified for development:

1. Jupiter– comprising three pit developments (Heffernans, Doublejay and Ganymede) along a 1.8 km north-south trending strike.
2. Westralia– comprising development of Westralia underground (UG), Morgans UG and Morgans North pit cutback. It is proposed to access Westralia UG via the existing Westralia pit and Morgan UG via the deepened Morgans North pit.
3. Transvaal Project - expansion of the historic Transvaal UG, with access via the historic Transvaal pit.

Approximately 16 million tonnes of ore and 73.8 million tonnes of waste will be mined over a six year period. Ore will be transported to a newly constructed carbon-in-leach processing plant, located west of the proposed Jupiter pits. The anticipated throughput of the plant is 2.5 million tonnes per annum. Tailings produced from processing will be discharged to a tailings storage facility (TSF), located within the Jupiter project area.

An overview of the Project areas and the existing and proposed conceptual layouts for Westralia and Jupiter are presented in Figure 2.

2.2. Regional Context

The Project is located in the East Murchison subregion (Cowan 2001; DSEWPC 2012) of Western Australia, approximately 35 km south west of Laverton. The East Murchison is characterised by low hills and mesas separated by flat colluvium and alluvial plains. The regional geology within the Project area is characterised by belts of greenstone separated by granites, with areas of sedimentary and volcanic rocks associated with the greenstone. The granites are generally expressed as low rounded tors surrounded by plains while the greenstones may be either low and rounded hills or steeper less weathered hills with narrow drainages (Blueprint 2015).

The Salinaland Plateau of the Yilgarn Plateau Province is characterised by "sandplains and laterite breakaways; granitic and alluvial plains; ridges of metamorphic rocks and granite hills and rises; calcretes, large salt lakes and dunes along valleys" (Pringle *et al.* 1994). The Project comprises elevated BIF ridges (20-30 m) with associated stony footslopes; sandy plains and intermittent drainage lines (Outback Ecology 2009a; Outback Ecology 2009b; RPS 2011). Generally within the region the vegetation is dominated by Mulga Woodlands that tend to form ephemerals, hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (Cowan 2001). Vegetation at the site has been described to encompass: mixed *Acacia* tall shrublands in minor drainage lines; low woodland of mixed *Acacia* in minor drainage lines; Mulga groves and woodlands, Mulga/*Eucalyptus* woodlands;

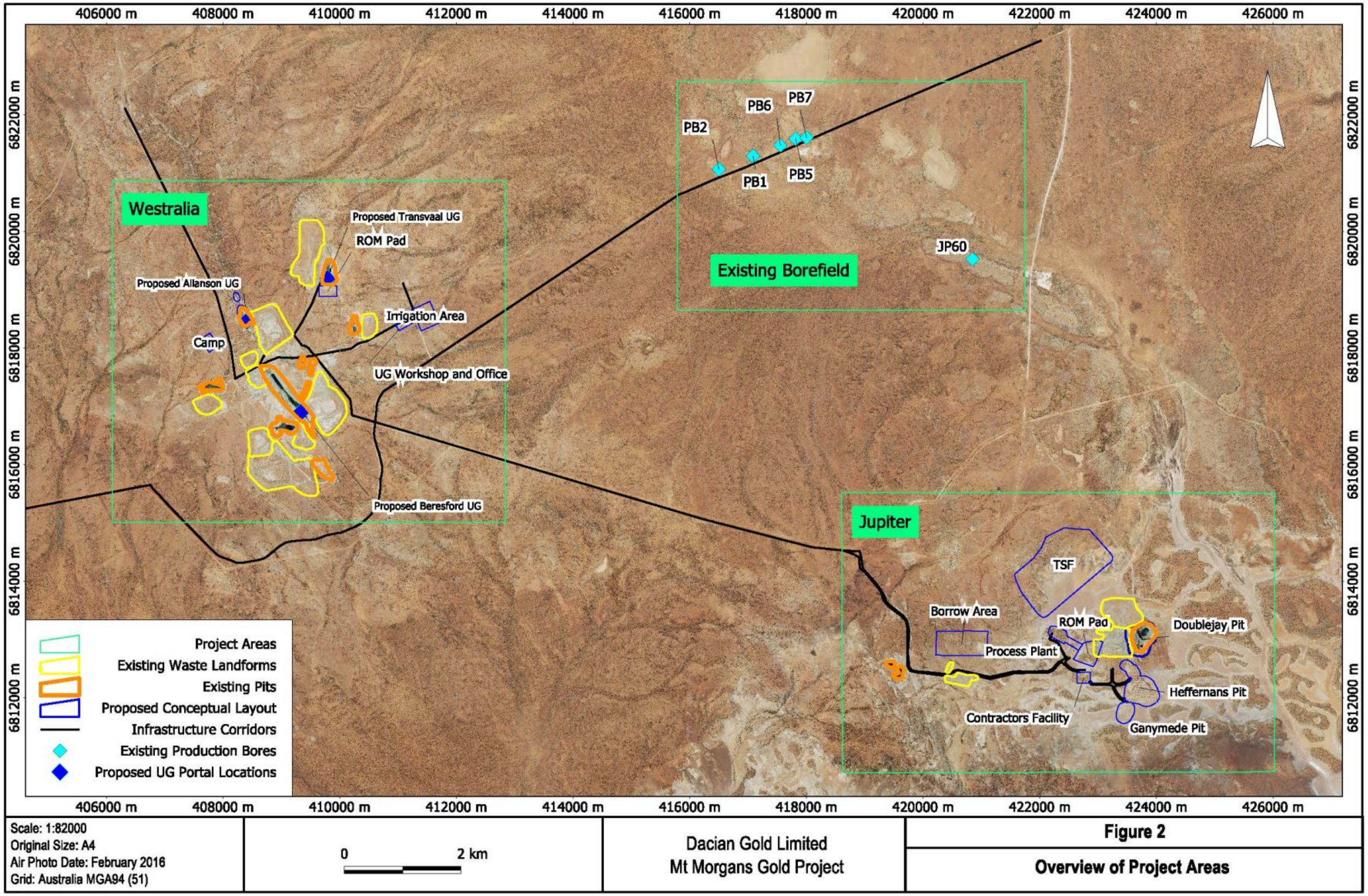

Figure 2. Overview of Project Areas

Chenopod shrublands; BIF ridge; Tall mulga on stony ironstone slopes; and *Acacia* shrubland on stony footslopes and plains beside drainage lines (Outback Ecology 2009b; RPS 2011). There are no known refugia for fauna in the Project vicinity and little is known about the SRE fauna in the vicinity of Mt Morgans.

The climate in the East Murchison subregion of the Yilgarn is arid, experiencing high temperatures in summer and low irregular rainfall over the year (Table 1, Figure 3). The region receives ca. 233 mm of rainfall annually, with the majority falling from January to June. Evaporation far exceeds annual rainfall with approximately 3000 mm per year (Bureau of Meteorology 2016). Average maximum temperatures at the weather station that is closest to the Project (Laverton, Station ID 012045) range from 17.8 °C in winter to 35.8 °C in summer, although temperatures can reach 39.4°C. Average minimum temperatures range from 5.2 °C in winter to 20.5 °C in summer. Fire risk is highest during the summer months.

Table 1. Climatic data for Laverton (Weather Station 012045) since 1900.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	35.8	34.8	31.9	27.2	22.1	18.5	17.8	20.0	24.5	28.0	32.1	34.9	27.3
Mean minimum temperature (°C)	20.5	20.0	18.0	13.9	9.5	6.6	5.2	6.4	9.5	12.8	16.6	19.3	13.2
Mean rainfall (mm)	25.1	31.0	29.8	22.1	23.2	23.3	16.3	12.9	9.0	9.6	14.6	18.0	233.5
Solar exposure	27.4	24.4	21.0	16.8	13.5	11.6	12.8	16.5	21.0	24.6	27.2	28.3	20.4

Data courtesy of the Australian Bureau of Meteorology website (2016). Red text indicates mean maximums and blue text indicates mean minimums.

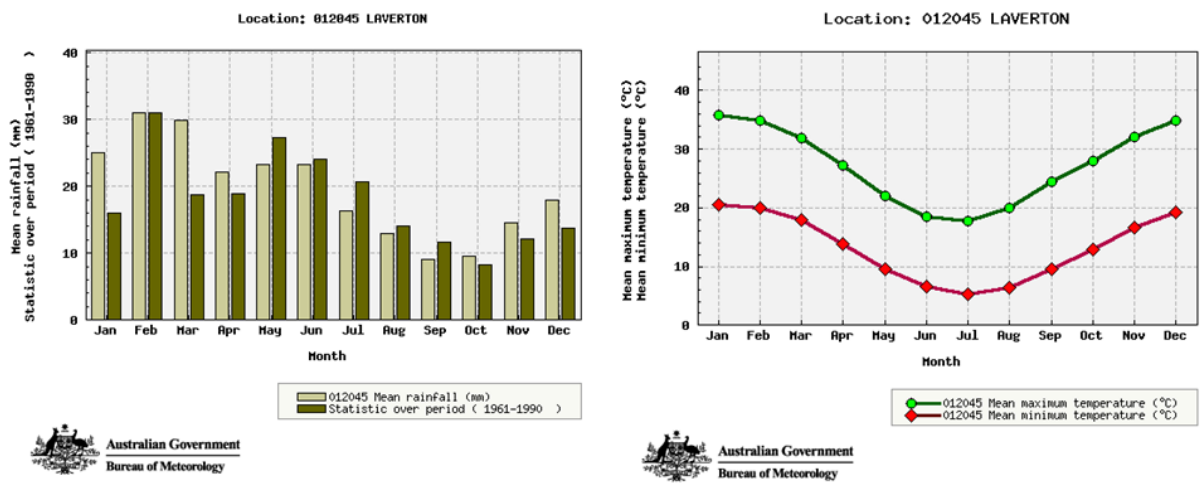

Figure 3. Mean rainfall and mean temperatures for Laverton (Weather Station 012045).

Lands protected under state and federal legislation near Laverton include Goongarrie National Park, Niagara Dam Nature Reserve and Malcom Dam Nature Reserve. However, none of these Reserves are located in the vicinity of the Project. The buffer zone for the Priority 1 PEC '*Mount Morgan calcrete assemblage type on Carey palaeodrainage on Mount Weld Station*' coincides with the Project but this PEC is designated for subterranean fauna and not SREs.

3. FRAMEWORK

3.1. Conservation Framework

Protection of native flora and fauna in Western Australia is provided at both state and federal levels. At the federal level, a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places is provided via the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

At the state level, native flora and fauna are protected under the *Wildlife Conservation Act 1950* (in particular Section 14, pp. 8-9). The highest level of protection is given to Schedule 1 species that are considered rare, likely to become extinct, or otherwise in need of special protection. The current list of threatened species is the Wildlife Conservation (Specifically Protected Fauna) Notice 2015.

The Department of Parks and Wildlife (DPaW) also maintains a list of priority fauna species that are of conservation importance but, for various reasons, do not meet the criteria for listing as threatened. The current list from November 2015 includes 113 terrestrial invertebrate species: seven insects, 26 arachnids, 22 crustaceans, 22 millipedes, one bristle worm and 35 molluscs (DPaW 2015).

Sampling methods for SRE invertebrates are outlined in the Guidance Statement 20 (Environmental Protection Authority 2009), which also provides a theoretical framework for SRE assessments and sampling protocols.

3.2. SRE Framework

It can be difficult to determine whether or not a species belonging to a SRE Group is actually a species with a range <10,000 km^2. The Western Australian Museum (WAM) uses a three-tier classification scheme for SRE species which we have applied to all species listed in this report:

Confirmed SREs are species with a known distribution range <10,000 km^2. The taxonomy is well known and the group is well represented in collections and/or via comprehensive sampling.

Potential SREs are species that belong to a group where there are gaps in our knowledge of the taxon, either because the group is not well represented in collections, taxonomic knowledge is incomplete, or the distribution is imperfectly understood because sampling has been patchy.

Widespread (not SRE) species have a known distribution range >10,000 km^2. The taxonomy is well known and the species is well represented in collections and/or via comprehensive sampling.

The WAM further uses five sub-categories if a species is determined to be a "Potential SRE". These sub-categories are:

1. Data deficient: There are insufficient data available to determine SRE status, either because there is a lack of geographic and taxonomic information, or because the individuals sampled cannot be identified to species level (e.g. wrong sex, juvenile, damaged);
2. Habitat Indicators: The status of a species can be elucidated through its association with a particular habitat and vice versa;
3. Morphological Indicators: The status of a species can be determined through its morphological characteristics;
4. Molecular Evidence: DNA sequence data reveal patterns congruent or incongruent with SRE status for a species; and
5. Research & Expertise: Available research data and/or WAM expertise provide the basis for a decision about the species' status.

It should be recognised, however, that identifying SRE species is part of a filtering process used to determine whether species may be threatened by development. While SRE species have the potential to be threatened because their ranges may fall entirely within an area of disturbance, the actual level of threat to SRE species depends on the relationship between the species range and development footprint. The inference of SRE status is the first step in evaluating potential threats to a species but other factors, such as preferred habitat and amount of habitat disturbance, are also considered and the conservation assessment for particular species is principally on a case-by-case basis.

4. DESKTOP REVIEW

A desktop review process was used to assess whether any listed invertebrate species or a significant SRE community was likely to occur at the Project. The assessment of the SRE community focussed on the eight SRE Groups that are usually targeted during environmental surveys in arid areas: centipedes (Chilopoda), harvestmen (Opiliones), land snails (Pulmonata), millipedes (Diplopoda), pseudoscorpions (Pseudoscorpiones), scorpions (Scorpiones), terrestrial slaters (Isopoda) and spiders (Araneae).

Records of species belonging to the SRE Groups or listed species were compiled for a 100 by 100 km search area surrounding the Project (defined by the coordinates -20.59S; 118.409E and -21.483S; 119.382) from the databases of the Western Australian Museum (WAM). Published research papers, available environmental reports, and online sources such as the Atlas of Living Australia (ALA 2016) and DPaW's NatureMap (DPaW 2007 - 2016) were also reviewed. The search area included many environments that are geologically and climatically similar to the Project area and include the same broader habitat types. The species belonging to SRE Groups that were identified in this search were filtered further by the in-house expertise of the Bennelongia staff as not all species in these groups have ranges < 10,000 km^2 and are of potential conservation concern.

Habitat mapping was also undertaken and the Project was split into distinct habitat types that were evaluated with regards to their suitability for SRE fauna. Using high-resolution orthophotos provided by Dacian, the Project area was split into distinct habitat types which were evaluated further according to five criteria: the likely availability of moisture, soil structure, geological diversity, vegetation type and extent of shading or shelter. The emphasis was on identifying 'relict' habitats (sheltered, moist for millipedes) and those that may contain specialist species (e.g. rocky outcrops for selenopid spiders). The extent of these habitat types beyond the survey area was also evaluated, as well as the extent of habitat connectivity and the presence of habitat isolates that could restrict dispersal in the SRE fauna potentially present. Habitat mapping considered the current knowledge regarding SRE Group ecologies, e.g. trapdoor spiders and millipedes are expected to occur in *Eucalyptus* woodlands but are unlikely to occur on claypans.

4.1. Habitat Characterisation

Preliminary habitat characterisation was undertaken using orthophotos provided by Dacian. Emphasis was given to the identification of macro-habitats likely to support a suitable microclimate for SREs. Based on macro-habitat mapping, Bennelongia distinguishes six major habitat types that differ in their prospectivity for SRE species (Figure 4). These habitats range from low suitability to moderate and high suitability for SRE fauna. Each of these six broad habitat types is described below. The landscape in the south-east of the mapped habitat area hosts a mosaic of habitat types. In this area, fine-scale vegetation mapping provided by Native Vegetation Solutions was applied to the SRE habitat assessment (Figure 5). No additional SRE habitat types were identified in the fine-scale assessment.

Banded Iron Formations and Ridges habitat
This is the least common habitat type locally and some isolated ridgelines occur in the north-west and south-east of the survey area. BIF ridges generally have a high prospect for SRE fauna because they have topographic diversity and offer shelter for relict SRE Groups such as slaters and millipedes. They also tend to support a diverse microhabitat for specialist species such as those that live under rocks such as selenopid spiders and *Synsphyronus* pseudoscorpions (Crews and Harvey 2011; Harvey 1987; Harvey 2010). Diverse communities of millipedes, trapdoor spiders, pseudoscorpions, snails and scorpions have been documented from such habitats in the Yilgarn (Bennelongia 2011; Bennelongia 2014; ecologia Environment 2014) and endemism is generally very high. However, the BIF ridges in the survey area are small, narrow, not very high (20-30 m) and appear to be more exposed with less vegetation cover than those elsewhere in the Yilgarn. It is unlikely that any species would have ranges that fall entirely within this habitat type in the survey area. Nevertheless, it is almost certain that some species in SRE Groups will occur here and there could be limits to dispersal in SRE fauna between the isolated ridges. The BIF ridges in the survey area have a moderate prospect for SRE fauna and may promote some species in both relict and specialist SRE groups.

Calcrete habitat
This was the second least common habitat type in the survey area and occurs in patches in the eastern and north-eastern survey area. Calcretes are not usually considered prospective SRE habitat because they are exposed and have little vegetation cover. The moisture holding capacity may be higher than in Plains habitat as the calcrete basins may flood periodically however they dry quickly afterwards, so are not suitable for refugial SRE fauna that require stable climatic conditions, such as millipedes. Within the SRE Groups, terrestrial slaters may occur in debris or organic matter that has accumulated over time within this habitat and the families Philosciidae and Armadillidae may occur. Some specialist trapdoor spiders may also be found here and wishbone spiders of the family Nemesiidae and spiny trapdoor spiders of the family Idiopidae have been recorded in similar habitat during a previous survey at Mulga Rocks (Bennelongia 2015). Small land snails of the genera *Gastrocopta* and *Pupoides* are expected to occur at low abundance but species in these genera are typically widespread and not of conservation significance. Scorpions will also utilise this habitat type but are unlikely to be restricted to it. The calcretes in the Project area appear to have comparably little prospect for SRE species although the presence of habitat specialists cannot be excluded with the available data.

Minor Creekline habitat
This habitat type occurs throughout the entire survey area but is particularly common in the western sections. Minor creeklines have a higher prospect for SRE fauna because they have elevated moisture-holding capacity, vegetation cover, and are often shaded. Organic matter that provides food and shelter for many SRE invertebrates is also present although this depends on the amount of periodic flooding if it occurs, depth of the creeklines, and integration with the surrounding landscape features (Car and Harvey 2014; Car *et al.* 2013; Edward and Harvey 2010). So-called relict groups that have the potential to occur include slaters of the families Armadillidae and Philosciidae, millipedes, centipedes, harvestmen and terrestrial snails of the families Bothriembryontidae, Camaenidae and Pupillidae. Several families of trapdoor spiders (Actinopodidae, Ctenizidae, Idiopidae and Nemesiidae) have also been recorded from such habitats and they construct their burrows usually on higher ground and banks of the creeklines where no periodic flooding occurs. Habitat-specialists are less likely to occur here although some trapdoor spiders may prefer such habitats and withstand short periods of flooding. More generally, this habitat type is not restricted to the survey area and minor creek lines and tributaries are strongly tied with other habitat types such as the surrounding woodlands, larger creeklines and ranges.

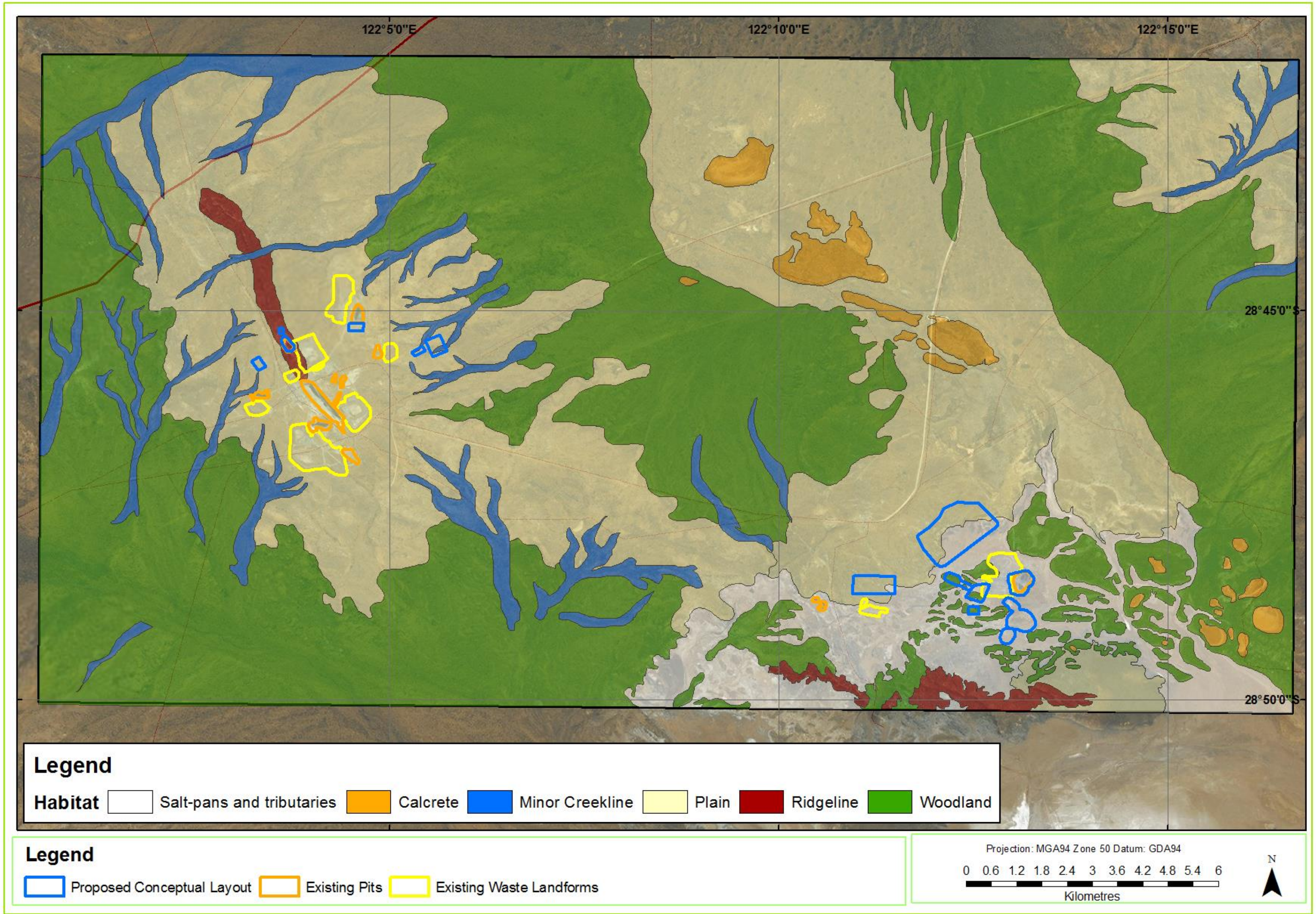

Figure 4. Major SRE habitats at the Mt Morgans Project.

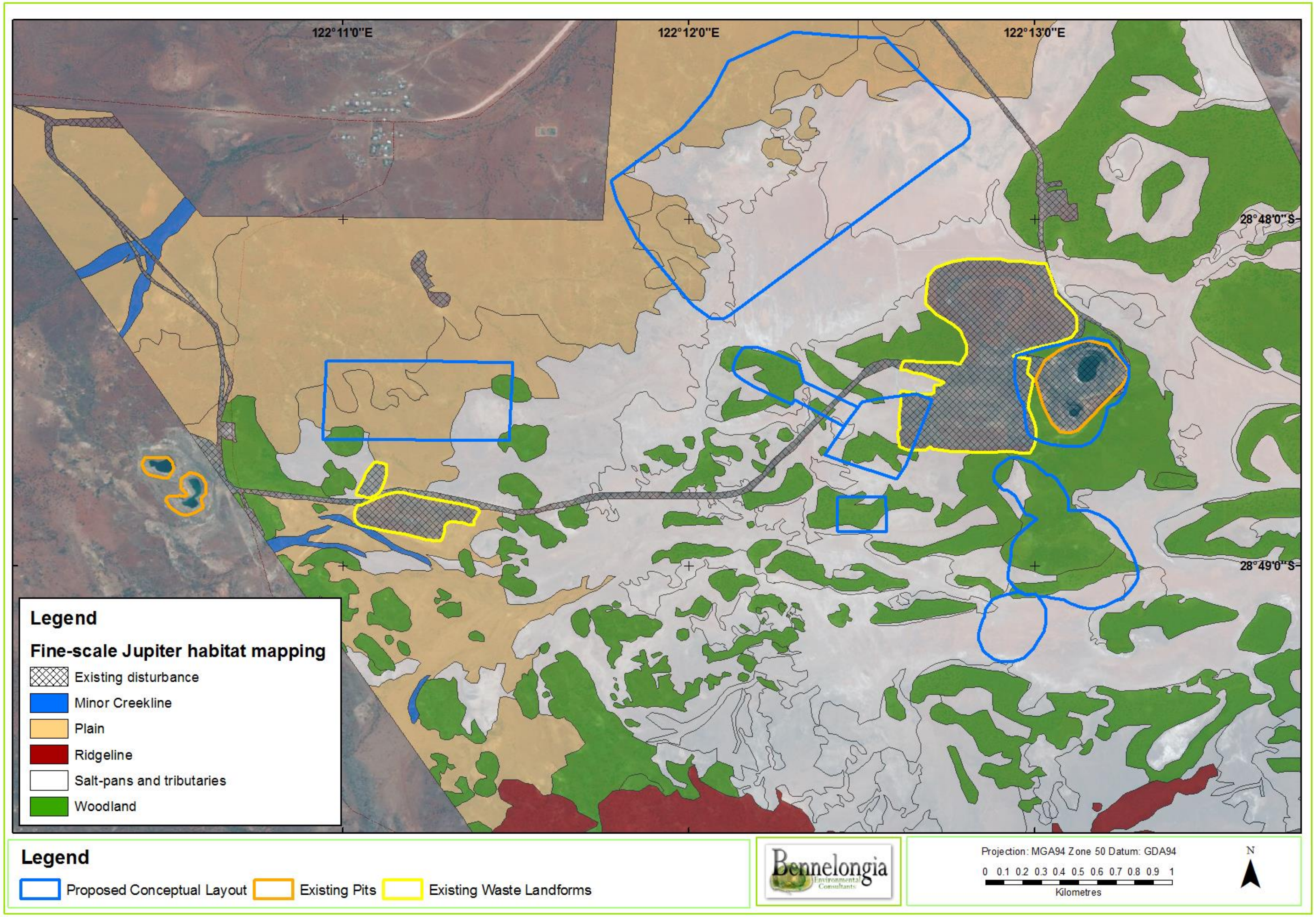

Figure 5. Fine-scale SRE habitats at Jupiter.
Mapping modified from Native Vegetation Solutions 2016.

Plains habitat
This is the second most common habitat type in the survey area and extends well beyond the survey boundaries. It is a relatively exposed habitat type with predominantly shrubby vegetation or open *Eucalyptus* woodlands over yellow or red sands. There are extensive stretches of grasslands that lack complex vegetation associations and contain a lot of exposed substrate. Organic matter is not as frequent as in the Woodlands and microhabitat diversity is lower. However, the Sandy Plains habitat does have some prospectivity for species in SRE groups, with the groups most likely to occur being mygalomorph spiders (in particular the family Nemesiidae), pseudoscorpions of the family Olpiidae and scorpions of the genus *Lychas*. Moisture-dependent SRE groups such as snails and millipedes are less likely to occur. Species in SRE Groups occurring in Sandy Plains are expected to be relatively widespread because of good habitat connectivity.

Salt-pan and tributaries habitat
This is the third-most common habitat type in the survey area and is generally unsuitable for SRE fauna. The salt-pans and tributaries are largely exposed, flat, without vegetation cover and poor in microhabitats that are essential to SRE fauna. Periodic flooding may occur in winter and temperature shifts in summer will be significant. Moisture-dependent SRE fauna such as millipedes and many trapdoor spiders will not tolerate such climatic conditions and habitat specialists, such as some pseudoscorpions and selenopid spiders, are not typically associated with such habitats either. There is some potential for specialist invertebrates to occur, such as wolf spiders of the family Lycosidae, but these do not belong to the SRE Groups and are typically not assessed in EIAs. The salt-pans and tributaries habitat has very little prospect for SRE fauna and extends widely beyond the survey area, without any barriers or isolates that could restrict the dispersal of invertebrates.

Woodland habitat
This is the most common habitat type in the survey area and extends widely beyond the tenement boundaries. It is also the most prospective habitat type for SRE fauna in this area. This habitat type is generally interconnected and occurs broadly, except in the south-eastern portion of the survey area where outliers of woodlands occur in association with salt-pans and tributaries and plains, forming a diverse mosaic of habitat islands (Figure 4, 5). However, these isolates appear too small and are generally too well-interconnected to effectively limit dispersal of any SRE fauna present; hence are not considered to be habitat isolates that could support unique elements of SRE fauna (i.e. endemic species). Woodlands in the Yilgarn generally support highly diverse SRE faunas that comprise several families of trapdoor spiders, millipedes of the genera *Atelomastix* and *Antichiropus* (Car and Harvey 2014; Car, Wojcieszek *et al.* 2013; Edward and Harvey 2010), centipedes of the families Cryptopidae and Geophilidae, diverse snail communities and scorpions of the genera *Lychas* and *Urodacus*. Endemism can be high if the woodlands surround high-elevation features (e.g. BIF ranges) and restrict dispersal in species with specific requirements (i.e. moisture-dependence in millipedes; see Nistelberger *et al.* 2014). Conversely, species in this habitat type can be widespread if the woodlands extend widely, are well-interconnected with uniform vegetation features. Since the woodlands in the survey area fall into this category, species in SRE Groups that prefer this habitat type are expected to be widespread.

In summary, there are six broad habitat types in the survey area. The most prospective habitat types for SRE fauna are woodlands followed by Banded Iron Ridges and Minor Creeklines whereas the remaining three habitat types have little suitability for SRE fauna. None of the more prospective habitat types are restricted at local, sub-regional or regional scales and all habitat types extend beyond the survey area. There are also no habitat outliers, isolates or geological barriers that could restrict dispersal in SRE fauna and lead to small ranges. It appears that all habitat types are generally interconnected and form a diverse mosaic of landscape features across a wide area. The BIF ridges that support diverse SRE communities in other areas of the Yilgarn are a minor element of this mosaic and appear too small and shallow for diverse SRE communities to occur. Woodland habitat is probably the most prospective habitat type but is also the most common one and is spread widely beyond the survey. SRE fauna in this habitat type is therefore expected to be more widespread; with ranges that extend beyond the survey area.

4.2. SRE Fauna of the Yilgarn

The Yilgarn generally supports very diverse communities of SRE fauna but knowledge is principally derived from surveys undertaken as part of environmental impact assessments as there has not been any systematic-broad scale survey for terrestrial invertebrates in this area, including in the wider Murchison bioregion. The general richness of the Yilgarn may be linked to the specific climatic features such as the rainfall gradient in this Transitional Rainfall Zone (Hopper and Gioia 2004) but also landscape features. High-elevation features such as BIF ranges are embedded into a dense matrix of woodlands and serve as terrestrial islands that promote speciation in this otherwise flat and eroded landscape (Nistelberger *et al.* 2014). Many so-called relict groups persist in local refugia that occur in this landscape matrix but several other groups have undergone extensive radiations and are highly diverse at the species level (Car and Harvey 2014; Car, Wojcieszek *et al.* 2013).

Six diverse families of trapdoor spiders potentially occur in the Project area and include: Actinopodidae, Barychelidae, Ctenizidae, Idiopidae, Nemesiidae, and Theraphosidae. Many of the recorded species are known only from very few specimens and localities, indicating that endemism is high and distribution ranges are often small (Castalanelli *et al.* 2014; Harms and Framenau 2013; Main 1983; Main 1986; Main 2008; Raven 1994). Some of the idiopid and barychelid genera (e.g. *Aganippe* and *Synothele*) are highly diverse at a species level and will include dozens of species; most of which are currently undescribed. Wall-crab spiders of the family Selenopidae are also diverse and endemic species have been collected from under rocks in isolated BIF formations and rocky ridges.

The multipede (millipede and centipede) fauna is also very diverse at the species level. Two genera of millipedes are of conservation significance: all described species of the megadiverse genus *Antichiropus* in the Yilgarn are SRE species and have ranges < 10,000 km^2 (Car and Harvey 2014; Car, Wojcieszek *et al.* 2013). The same pattern is being observed in *Atelomastix* that also includes a high proportion of listed species (Edward and Harvey 2010). The centipede faunas are virtually unknown taxonomically but the families Geophilidae and Cryptopidae are collected frequently during fauna surveys in the Yilgarn and contain at least some potential SREs.

Terrestrial slaters are common in woodlands, BIF formations and creekline habitats. Genera such as *Buddelundia* are megadiverse at a species level, although there is no taxonomic framework for terrestrial slaters in Western Australia and the assessment of putative ranges is extremely difficult with current knowledge fragmentary (Judd and Horwitz 2003). Slaters are collected in almost every invertebrate fauna survey in the Yilgarn and are one of the prime target groups in SRE assessments.

Terrestrial snails are also collected frequently during fauna surveys in this region. Of these, the genera *Pupoides* and *Gastocopta* comprise widespread species but the families Camaenidae and Bothriembryontidae are extremely diverse at the species level and comprise mostly undescribed SREs (Breure and Whisson 2012; Whisson and Kirkendale 2014). The snail genus *Bothriembryon* in particular is currently the focus of systematic study and it appears that there is major diversity and endemism in this fauna. The Succineidae also occur in the Yilgarn but not much is known about species ranges and the taxonomy is generally unresolved. Freshwater snails are also diverse but often have wider-ranges and are not always included in SRE fauna assessments.

Harvestmen, pseudoscorpions and scorpions occur more widely throughout this region. Within the scorpion fauna, the genus *Urodacus* includes a moderately high proportion of potential SRE species because there are a number of lithophiles (species that live under rocks) that may be restricted to specific BIF ranges and have patchy distributions within these habitats. In contrast, the genus *Lychas* predominantly comprises widespread species of sandy plains and open woodlands although there is no taxonomic revision and species identification is virtually impossible. The pseudoscorpion genus

Synsphyronus also includes many range restricted species that live under rocks on BIF, with additional species collected from tree bark currently considered more widespread (Harvey 1987; Harvey 2010). Genera such as *Austrochthonius*, *Austrohorus* and *Amblyolpium* are taxonomically unrevised but thought to include at least some SRE species. Not much is known about harvestmen in the Yilgarn but based on biological characteristics (moisture-dependence, restriction to leaf litter habitats) this fauna will include SREs.

In summary, the Yilgarn has a highly diverse SRE fauna at all taxonomic levels that most likely exceeds those of the Pilbara and south-coast. Most SRE species have been collected from BIF ranges (e.g. Bennelongia 2011; ecologia 2014) and the surrounding woodlands whereas very few SRE species have been collected from other habitat types (e.g. calcretes in palaeochannels, open plains).

4.3. Previous Fauna Surveys

There has been no systematic survey for SRE invertebrates in the Murchison bioregion and only a few fauna surveys have been carried out in the vicinity of the Project as part of environmental impact assessments. Previous assessments collated data on SRE fauna and habitats in the Project area but did not conduct any SRE surveys. They are:

1. Outback Ecology 2009: *Mount Morgans The Craic Project: Level 1 Flora and Fauna Assessment*; and
2. RPS 2011: *Mount Morgans Mine – Morgans North. Level 1 Flora and Fauna Assessment*.
3. Blueprint 2015 – *Mt Morgans Gold Project. Summary of Information Relating to Subterranean Fauna and Short Range Endemics.*

All assessments concluded that no significant SRE fauna community was likely to occur at the Project. The Outback Ecology 2009 report did not identify any suitable habitats (or SRE species) but the 2011 RPS report identified BIF ranges and as potentially important habitat for SRE fauna. The Blueprint 2015 report summarised the data from the two previous reports.

Additional fauna surveys have been carried out by Rapallo Consulting in 2007 east of Leonora and Mt Milkenny, Biota Environmental Sciences in 2010 at Lake Carey and Terrestrial Ecosystems in 2011 at Granny Deeps. The invertebrate data contained in these reports were available through the WAM databases as these specimens have been lodged. Some additional reports that may be of relevance are not in the public domain and could not be checked. These include Jupiter Mines Central Yilgarn Iron Project Level 1 Flora and Fauna Assessment (Outback Ecology 2013). In general, the SRE assessments have indicated that the SRE communities in similar habitats as those present at Mt Morgans are depauperate.

4.4. SRE Fauna near the Project

No SRE field surveys have been carried out at the Mt Morgans Project. Similarly, comparably little is known about the SRE fauna in the search area around the Project because relatively few fauna surveys have been conducted here to date (the available environmental reports are desktop assessments without SRE field survey); taxonomic papers predominantly describe species from the southern Yilgarn (e.g. Car, Wojcieszek *et al.* 2013), and resource developments have been focused largely on larger BIF formations that do not occur in the search area. The primary data source is therefore the database of the Western Australian Museum (WAM).

Based on the data available, the SRE fauna at the Project is probably depauperate by Yilgarn standards (Table 2). The most dominant SRE group is the mygalomorph spiders that are represented by four families and eleven genera. Most of the species are widespread although several juvenile and female specimens have been collected over the years that may belong to SRE species, although not confirmed. The described species, such as *Aname mellosa*, *Aname tepperi* and *Aurecocrypta lugubris* are all widespread and have ranges >10,000 km^2 (e.g. Harvey *et al.* 2012). A goblin spider of the genus *Opopaea* has also been recorded from a juvenile specimen. Goblin spiders can be SRE species (Baehr and Harvey 2013) but the species identity of the single specimen from the search area is uncertain. Scorpions are represented by three genera in two families. All but one species occur widely in the xeric regions of Western Australia and are frequently collected during fauna surveys. One scorpion, *Urodacus* 'yeelirrie; may be more restricted but too little is known about this species to infer ranges. Centipedes appear moderately diverse with five species and genera in the single family Scolopendridae. Cryptopid centipedes are also known from subterranean habitats in the survey area (WAM database) and are expected to occur in near-surface habitats at the Project. Five of these species are widespread across Western Australia and the single cryptopid specimen is too poorly known for an assessment. No terrestrial snails and slaters have been collected in the search area to date. No millipedes have been collected from this area either, which is evident from maps contained in the published literature (Car, Wojcieszek *et al.* 2013).

Even under consideration that this area is poorly surveyed for SRE fauna and that relatively few environmental reports are available for review, this area is considered to have little prospect for species with ranges <10,000 km^2. All species for which detailed distribution data are available (i.e. the described species) have wide ranges that extent far beyond the survey area. This pattern can be observed in three faunas independently: mygalomorph spiders, scorpions and centipedes. All potential SRE species in Table 2 have an uncertain taxonomy (they are juveniles, the wrong sex for identification or generally undescribed) and their ranges are unknown. These species are potential SREs with deficient data according to the framework of the Western Australian Museum.

Table 2. SRE Groups recorded previously from the search area.

Records collated from the WAM database, published information, online databases and publically available environmental reports. Species 'sp. indet' are records based on juvenile or female specimens that cannot be identified based on morphology. 1= WAM database and WAM staff interpretation of SRE status.

Taxonomic Groups	Species	SRE Status	No. of Records	Source/Reference
Arachnida				
Araneae (Mygalomorphae)				
Actinopodidae	*Missulena occatoria*	No	2	1, Harms and Framenau 2013
	Missulena sp. indet. (juvenile)	Potential	2	1, Harms and Framenau 2013
Barychelidae	*Aurecocrypta lugubris*	No	1	1, Raven 1994
	Idiommata sp. indet. (juvenile)	Potential	2	1, Raven 1994
	Mandjelia 'wanjarri'	Potential	3	1, Raven 1994
Idiopidae	*Aganippe* 'MYG017'	Potential	1	1, Castalanelli *et al.* 2014
	Aganippe sp. indet.	Potential	5	1,
	Anidiops sp. *indet.*	Potential	1	1
	Euoplos sp. indet.	Potential	9	1
Nemesiidae	*Aname* 'brown wish-bone'	Potential	1	1, Castalanelli *et al.* 2014
	Aname mellosa	No	13	1, Harvey *et al.* 2012
	Aname sp. indet. (juvenile)	Potential	6	1, Castalanelli *et al.* 2014
	Aname tepperi	No	2	1, Harvey *et al.* 2012
	Kwonkan 'MYG175'	No	2	1, Castalanelli *et al.* 2014
	?*Teyl* sp. indet. (juvenile)	Potential	5	1
Theraphosidae	*Selenocosmia* sp. indet.	Potential	1	1
	Selenocosmia 'wacarina'	Potential	1	1
Araneae (Araneomorphae)				
Oonopiidae	*Opopaea* sp.	Potential	1	Baehr and Harvey, 2013
Scorpiones				
Buthidae	*Isometroides* sp.	No	1	1
	Lychas jonesae	No	4	1, ALA 2015
	Lychas splendens	No	1	1, ALA 2015
,	*Lychas* sp. indet.	No	2	1, ALA 2015
Urodacidae	*Urodacus hoplurus*	No	33	1, ALA 2015
	Urodacus yaschenkoi	No	5	1, ALA 2015

Taxonomic Groups	Species	SRE Status	No. of Records	Source/Reference
	Urodacus cf. *armatus*	No	3	1, ALA 2015
	Urodacus 'yeelirrie'	Potential	2	1
Chilopoda				
Scolopendromorpha				
Scolopendridae	*Arthrorhabdus paucispinus*	No	1	1, ALA 2015
	Cormocephalus michaelseni	No	1	1, ALA 2015
	Cormocephalus turneri	No	1	1, ALA 2015
	Scolopendra laeta	No	2	1, ALA 2015
	Scolopendra morsitans	No	9	1, ALA 2015

4.5. Listed Species at the Project

There are no PECs or TECs in the vicinity of the survey area that have been listed on a basis of terrestrial SRE taxa. Priority species listed in DPAW's Wildlife Conservation Notice includes the Arid Bronze Azure Butterfly *Ogyris subterrestris petrina*, the Inland Hairstreak *Jalmenus aridus*, the trapdoor spider *Kwonkan moriartii*, and the shrimps *Branchinella apophysata*, *B. basispina*, and *B. denticulata*.

The critically endangered butterfly *Ogyris subterrestris petrina* is known from two sites near Kalgoorlie (ALA 2016) and occurs in mallee-dominated woodland. This species depends on the sugar ant (*Camponotus terebrans*) with the butterfly depositing eggs at the entrances of sugar ant nests that abut the base of living trees and shrubs of various species. There are no records of this species (either historical or recent) in the search area and this species is unlikely to occur here. In the event that it does occur, its primary habitat will be woodlands habitats (where the host ant constructs the nests) and this habitat type is the most common in the survey area, extending widely beyond the tenement boundaries, and will receive minimal impact from the proposed Project. There is no threat to *Ogyris subterrestris petrina* from Project development.

The near-threatened butterfly *Jalmenus aridus* is known from a handful of records near Kalgoorlie and Ngaanyatjarraku in the Northern Yilgarn, indicating that it may be rare but more widespread in the Yilgarn. The species is not commonly collected and poorly represented in Australian research collections. The larvae of this butterfly feed on the leaves and flowers of *Senna* sp. and *Acacia tetragonophylla* (Graham and Moulds 1988). Both host plants occur more widely in the Yilgarn and are generalist species that do not occur on specific geologies or soils, so potentially this butterfly is also more widespread but poorly sampled. Both *Senna* sp. and *Acacia tetragonophylla* plants occur in the survey area but almost all records of this butterfly are near Kalgoorlie and there is no indication that this species should occur in the survey area. Hence it is not of relevance to the current assessment.

The near-threatened wishbone spider *Kwonkan moriartii* is known only from Kathleen Valley Station north of Leonora (Main 1983). Only the male holotype is known (ALA 2016) and the distribution range of this species is unclear at present, with no data available on the biology and ecology of the species. There are no records of this species in the search area surrounding the Project. Many *Kwonkan* species have very short ranges and are confined to specific soil types or geological features, with field data suggesting that some species prefer open plain habitats whilst others are confined to BIF habitats (Bennelongia, unpublished data). Given the short-ranges of most *Kwonkan* species and the absence of records from elsewhere in the Yilgarn (despite many SRE surveys in the southern Yilgarn over the last decade) it is reasonable to assume that this species is restricted to the area surrounding Kathleen Valley Gold Mine.

Three fairy shrimp species of the genus *Branchiella* are listed from the Yilgarn. Only one of these has the potential to occur in the Project area: *Branchinella simplex*. This is a species of fresh and hyposaline waters on clay pans and it "has been found in a wide band (linear range of 550 km) across the middle of the state" with records from Larkes Dam, Mongers Samphire Pan, and Lakes Arrow, Cronin and Kopai (Timms 2002). More recent records include saline waters of Lake Carey (in the vicinity of the Project area) and it is now believed that this species has a wide tolerance for salinity levels (Timms 2008) and a fairly wide distribution in ephemeral water bodies around Kalgoorlie. It is a passive disperser and the eggs may be passed through the digestive tract of wetland birds, with dispersal occurring between the ephemeral clay pans when they are flooded. It is possible that this species occurs in the salt-pan and tributaries habitat in the south-eastern and eastern study area but no records have been documented. If it does occur, its local distribution would reflect the extent of these clay pans that extend more widely beyond the search area. Whilst having the potential to occur within the Project area, minimal impact is expected and the project is not considered likely to impact the viability of the population of *B. simplex* if present (Figure 5).

4.6. Summary of Desktop data

The review of broader habitat types revealed that there are six habitat types (Figure 4, 5) of which only one (woodlands habitat) has a high suitability for SRE fauna. BIF ridges and rocky hills that usually support diverse SRE communities in the Yilgarn are too poorly developed at the Project to host such communities. The woodlands are likely to support SRE fauna but this is the most common habitat type in the survey area, is generally interconnected, and extends widely beyond the tenement boundaries. Hence, species found in this habitat type will be more widespread with ranges that mirror the wide distribution of these woodlands.

The SRE community in the vicinity of the Project is poorly known because very few SRE fauna surveys have been undertaken but, nevertheless, appears quite depauperate by Yilgarn standards. Three SRE Groups seem to be moderately diverse: mygalomorph spiders, scorpions and centipedes. All named species in these groups are widespread and have ranges that extend far beyond the survey area. The potential SRE species identified in these groups have an unresolved taxonomy and are SREs with deficient data according to the WAM framework, meaning that their ranges cannot be assessed and that they may be more widespread also. Groups that typically have a high proportion of SRE species, e.g. slaters and millipedes, have not been documented in the search area. In general, it is expected that the Project will host poorly developed SRE fauna that comprises predominantly widespread species.

Five listed species are known from the Yilgarn but four of these are unlikely to occur at Mt Morgans. The fairy shrimp *Branchinella simplex* may occur in the salt-pan and tributaries habitat at the Project but has not been collected and is fairly widespread in the Murchison. This species is found in ephemeral habitats and has well-developed dispersal capacities. The impact to this habitat type will be minimal.

5. CONCLUSIONS

This desktop review collated existing information on SREs and listed invertebrate species that may occur within the Mt Morgans Project and its vicinity, and characterised habitats according to their suitability for SRE fauna.

The review identified three habitat types that have a moderate or high prospect for SRE fauna. Of these, the BIF Formations and Ridgeline habitat has potential for both relict and specialist SRE species but is also the least common habitat type in the survey area and is too small to support diverse SRE communities. Minor Creekline habitats and Woodlands habitats are much more common in the study area but not restricted at a local, sub-regional and regional scale. Species that occur in these habitat types will be more widespread. The SRE fauna at the Project, as currently documented, is poorly developed and almost exclusively comprises widespread species in three taxonomic groups (mygalomorph spiders, scorpions and centipedes) although there are some potential SRE species with deficient data. Only one listed species (*Branchinella simplex*) has the potential to be present locally but occurs in a habitat type that will have minimal impact from the development.

While the final locations of all disturbance areas are still pending, the assessment of threat to SRE fauna is considered to be minimal given the indicated small size of the proposed impact areas. Bennelongia is not aware of any SRE species with ranges so small that they could fall entirely within the impact areas, especially considering that the disturbance areas will be located in habitat types that are either unsuitable for SRE fauna (plains and salt-pans and tributaries habitat in the south-east; Figure 4, 5), or occur in a BIF ridge that extends further to the north and has already been impacted by past mining.

Overall, there is minimal impact on SRE or listed species from the proposed mining operation. A field survey that could help to characterise the local SRE community and validate the findings of this desktop review appears unnecessary given that the known SRE fauna in this area is depauperate and comprises widespread species, but also the small scale of the Project impact. There is no foreseeable threat to either SRE fauna or listed species from the Project and it is suggested that SRE invertebrates are not a relevant environmental assessment factor at the Mt Morgans Project.

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APPENDIX 6: SUBTERRANEAN FAUNA ASSESSMENT (BENNELONGIA, 2017)

Bennelongia Environmental Consultants

Mt Morgans Gold Project: Subterranean Fauna Assessment

Prepared for:

Dacian Gold Ltd

January 2017

Final Version

Short-Range Endemics | Subterranean Fauna

Waterbirds | Wetlands

Mt Morgans Gold Project: Subterranean Fauna Assessment

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Executive Summary

Dacian Gold Limited (Dacian) plans to develop the Mt Morgans Gold Project (the Project) in the northern Goldfields of Western Australia, approximately 35 km southwest of Laverton. The Project encompasses three historic operational areas, namely Westralia, Jupiter and the Mt Morgan/Jupiter borefields (the production borefield). The production borefield is associated with a calcrete aquifer that comprises a Priority 1 Priority Ecological Community (PEC) for subterranean fauna. This study assesses the likelihood of operations at the Project impacting the conservation values of subterranean fauna.

Specific objectives of the assessment were to: collate information on subterranean fauna that may occur within the Project and its vicinity; characterise habitats according to suitability for subterranean fauna; and conduct a field survey to determine diversity and distribution of stygofauna at the Project.

Eleven troglofauna species were identified in the desktop assessment within the search area, which is considered to reflect a depauperate community. Pit excavation at Jupiter is the only proposed Project activity that will potentially degrade troglofauna habitat. Proposed pits cover 80 ha, compared to the ranges of Yilgarn troglofauna, which typically exceed 100 ha. Given consolidated geology at Jupiter, occurrence of significant troglofauna communities is considered unlikely. It is concluded that development of the Project is unlikely to significantly impact troglofauna.

In contrast, a rich community of stygofauna occurs in the region surrounding the Project. Desktop assessment showed that at least 48 stygofauna species occur within the search area. Conclusions drawn from the desktop study regarding potential for subterranean habitat within the three operational areas are summarised in Table ES1.

Table ES1. Conclusions of desktop assessment.

Area	Likelihood of supporting significant fauna		Study Outcome
Westralia	stygofauna	Low – moderate	Further assessment of subterranean fauna not required.
	troglofauna	Low – moderate	
Jupiter	stygofauna	Low	Further assessment of subterranean fauna is not required.
	troglofauna	Low	
Production Borefield	stygofauna	High	Field assessment of borefield required to document composition of the stygal community within the calcrete aquifer. Further assessment of troglofauna not required.
	troglofauna	Low – moderate	

A three-phase stygofauna field survey of the borefield was completed in accordance with EPA Guidance Statement 54a and Environmental Assessment Guideline 12. A total of 66 stygofauna samples were collected across 23 reference sites and 16 impact sites. Sites were delineated based on their occurrence outside (reference) or inside (impact) a predicted 2 m drawdown contour (modelling by Red Creek Water Solutions Pty Ltd). Modelling shows that ≥70 % of aquifer habitat will persist outside the 2 m contour. All specimens were identified to species level where possible.

In total, 2,179 stygofauna specimens belonging to at least 45 species of stygofauna were recorded. Crustaceans were by far the most diverse group with 31 species in six orders: harpacticoid copepods (10 species), cyclopoid copepods (7), isopods (6), ostracods (2), syncarids (4) and calanoid copepods

(1). Forty of these species are known to occur outside the predicted area of groundwater drawdown. Two flatworm species were only recorded within the 2 m drawdown are but are not currently assessed in EIA. Three species are known only from the 2 m drawdown area: the worms Tubificidae sp. and Echytraeidae sp. and the isopod *Andricophiloscia* sp. B02. While it is difficult to determine the ranges of species identified only to family level, both worm species are considered likely to be widespread at the Project scale and not threatened by drawdown. The isopod *Andricophiloscia* sp. B02 is likely to be restricted to the Mt Morgan calcrete. However, it is likely to extend beyond the area of groundwater drawdown because of high habitat connectedness across the calcrete, as shown by the wider distribution of the biological surrogate Haloniscus sp. B09. Accordingly, *Andricophiloscia* sp. B02 is unlikely to be threatened by Project-related groundwater drawdown.

Further confidence that drawdown will not significantly affect the stygofauna community in the Project area is provided by analysis of stygofauna communities inside and outside the area affected by previous pumping of up to 1 GL annually. Both mean abundance and species richness per bore are similar between sites inside and outside the previous drawdown, suggesting that stygofauna were not impacted by historic pumping of the borefield.

Based on drawdown modelling, the predicted loss of calcrete aquifer habitat as a result of groundwater abstraction associated with the Project is not likely to exceed 30 %. A layer of saturated calcrete of 1.5–2 m thick will persist throughout the area, including the most heavily impacted zones surrounding the production borefield. The saturated layer of underlying sand will not be affected by pumping and may provide refuge/additional habitat for stygofauna.

In order to protect the habitat and species richness within the Mt Morgans PEC, Bennelongia recommends the following management framework should be adopted by Dacian:

- Ecological monitoring bores to be established within 500 m of production bores.
- Standing Water Level (SWL) measurements to be taken on a quarterly basis when bores are being pumped.
- Where SWLs measured in ecological monitoring bores indicate a trending decline in aquifer saturated thickness, monitoring of SWL to increase to a monthly frequency.
- Where monthly SWL monitoring suggests an ongoing reduction in saturated thickness, pumping rates of the production bore(s) to be reduced to maintain the groundwater levels predicted in the hydrogeological studies associated with this assessment.

Additionally, the potential impacts of groundwater abstraction at the Project on spatial and temporal patterns in salinity are unknown. Four of five bores historically pumped showed increases in electrical conductance (EC) of between 1.51 mS cm^{-1} and 8.44 mS cm^{-1}. Therefore, changes to EC in the dewatering impact zone and ecological monitoring bores should be monitored during and after groundwater abstraction, with follow up stygofauna monitoring if excessive changes in EC are observed.

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1. INTRODUCTION

Dacian Gold Limited (Dacian) plans to develop the Mt Morgans Gold Project (the Project) in the northern goldfields of Western Australia, located approximately 35 km south west of Laverton (Figure 1).

The Environmental Protection Authority (EPA) usually requires that the risks to subterranean fauna are considered when assessing proposed mine developments because subterranean fauna have very limited ranges. There are two kinds of subterranean fauna: stygofauna and troglofauna. Stygofauna occur in groundwater, whereas troglofauna are air-breathing and occur in the various unsaturated layers of the vadose zone (Gibert and Deharveng 2002). Species with restricted ranges, such as stygofauna and troglofaunal, are vulnerable to extinction through habitat loss and other environmental changes (Fontaine *et al.* 2007; Ponder and Colgan 2002), and are therefore a focus for conservation and environmental impact assessments (EIAs).

Dacian proposes to commence mining and processing at the Project in 2017. As the proposed activities have the potential to impact subterranean fauna, Bennelongia Environmental Consultants was engaged to complete a subterranean fauna assessment of the Project.

This report provides the results of:

- A desktop assessment of the likelihood of stygofauna and troglofauna in the Project area.
- A comprehensive field assessment for stygofauna undertaken within the production borefield area in accordance with the Environmental Assessment Guideline 12 (EPA 2013).

The aims of the desktop assessment were to:

- Undertake a review of existing project and regional data to determine the likelihood of occurrence of subterranean fauna in the vicinity of the Project;
- Complete an assessment of the suitability of habitat within the area for subterranean fauna and its geological extension to the wider local area;
- Document the known occurrences of any listed subterranean species or communities in the vicinity of the Project (*Wildlife Conservation Act 1950* or *Environment Protection and Biodiversity Conservation Act 1999*); and
- Determine the likelihood of the Project having significant conservation impacts in the areas for which approval is being sought.

From the desktop assessment it was determined that a field survey of the production borefield (and associated calcrete aquifer) was required. Bores in reference areas and areas of predicted groundwater drawdown were sampled to:

- Provide information about the subterranean fauna community within the Project impact area; and
- Improve confidence in the conclusions reached in the desktop assessment about the likely level of threat to subterranean fauna from the proposed Project.

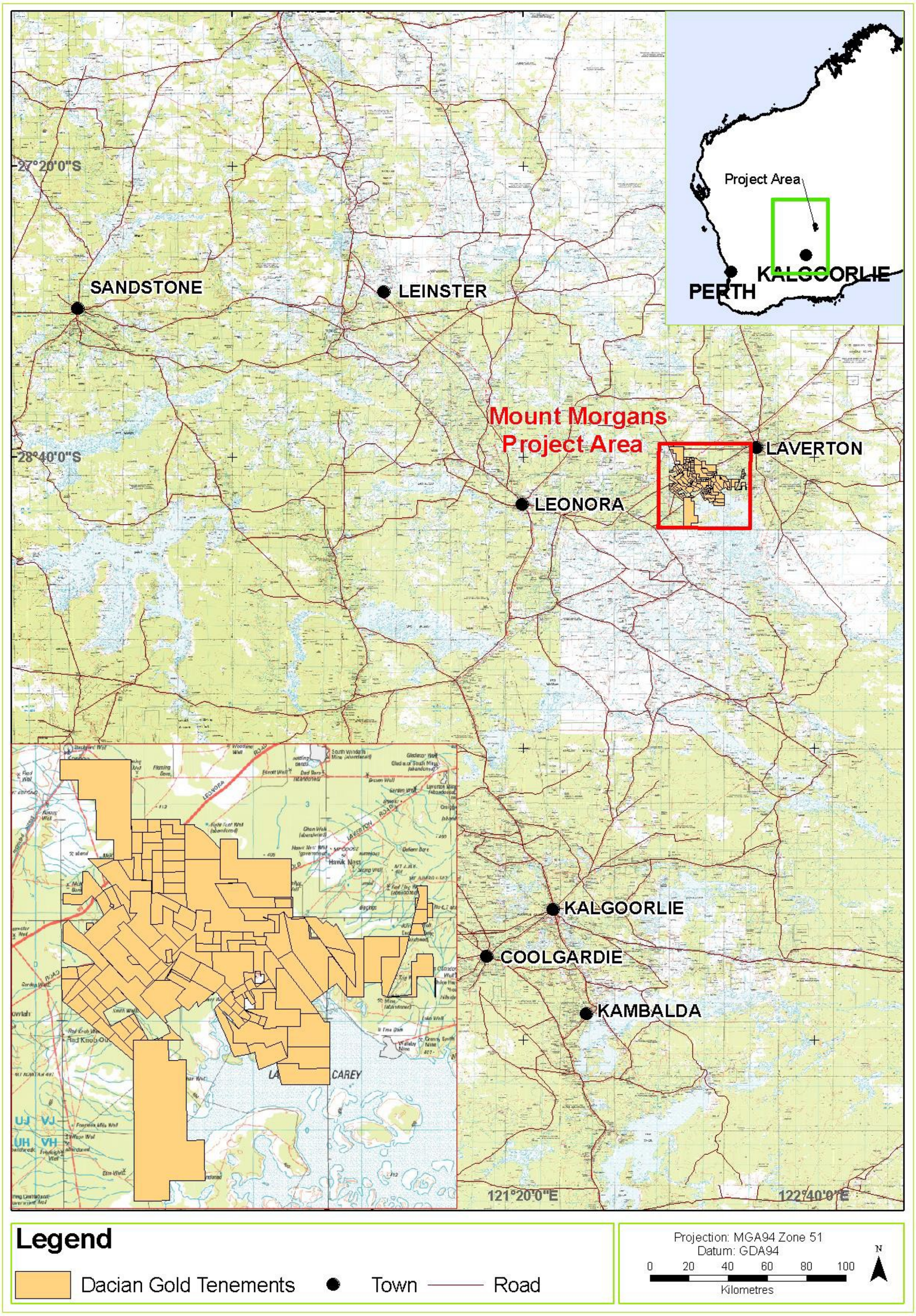

Figure 1. Location of the Mt Morgans Gold Project area.

2. FRAMEWORK

2.1 Project Description

The Project is a brownfields site that encompasses three historic operational areas, comprising:

- Westralia: containing the Westralia and Transvaal pits, other satellite pits and historical processing areas;
- Jupiter: containing the historical Jupiter pit and heap leach area, located approximately 15 km to the east of Westralia; and
- Mt Morgans and Jupiter Borefields (hereafter referred to as the production borefield): containing six production bores situated in a calcrete aquifer.

Dacian is proposing to recommence construction and mining activities at the Project in 2017 (Blueprint 2016). Two mineral resource areas have been identified for development:

1. Jupiter – comprising three pit developments (Heffernans, Doublejay and Ganymede) along a 1.8 km north-south trending strike; and
2. Westralia – comprising development of Beresford underground (UG), Allanson UG, Morgans North pit cutback and Transvaal UG.

Approximately 16 million tonnes of ore and 73.8 million tonnes of waste will be mined over a seven year period. Ore will be transported to a newly constructed carbon-in-leach processing plant, located west of the proposed Jupiter pits. The anticipated throughput of the plant is 2.5 million tonnes per annum. Tailings produced from processing will be discharged to a tailings storage facility (TSF), located at Jupiter.

Mine dewatering will be required to enable mining to occur in a dry working environment. Hydrogeological assessments completed to date have indicated that the aquifers associated with all deposits have relatively low permeability. Groundwater entering open mining voids is therefore likely to be extracted via sump pumps and disposed of into existing pit voids. Excess water will be utilised in dust suppression and processing.

It is proposed that water supply for processing and domestic / potable uses will be sourced from the existing production borefield and a proposed expansion to this borefield, located within a large calcrete unit. Six bores (PB1, 2, 5, 6, 7 and JP60) were pumped between 1985 and 1997 to supply water to the historic processing plant and Jupiter heap leach facility.

An overview of the Project areas is presented in Figure 2.

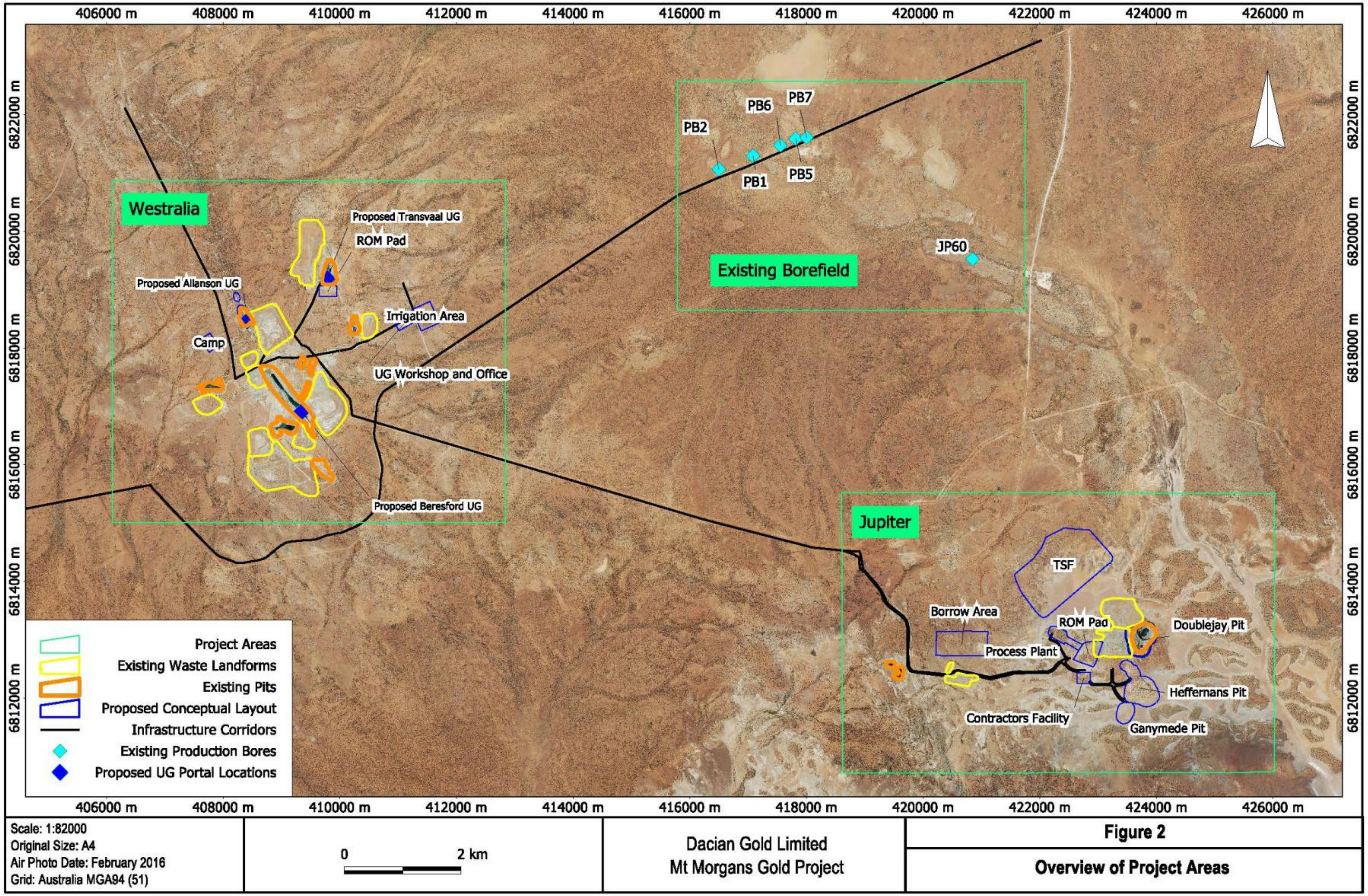

Figure 2. Overview of Project tenement layout.

2.2 Environmental Setting

The Project is located in the East Murchison subregion (Cowan 2001; DSEWPC 2012) within the Yilgarn Plateau of Western Australia, approximately 35 km south west of Laverton. The East Murchison is characterised by low hills and mesas separated by flat colluvium and alluvial plains. The regional geology within the Project area is characterised by belts of greenstone separated by granites, with areas of sedimentary and volcanic rocks associated with the greenstone (Blueprint 2015).

Landforms of the broader Project area comprise Banded Ironstone Formations (BIF) elevated ridges (20-30 m) with associated stony footslopes; sandy plains and intermittent drainage lines (Outback Ecology 2009a; 2009b; RPS 2011). Generally, within the region the vegetation is dominated by Mulga Woodlands often rich in ephemerals, hummock grasslands, saltbush shrublands and *Halosarcia* shrublands (Cowan 2001).

The Project is located in the Goldfields groundwater area. Groundwater in the region typically occurs in the following units: fresh and weathered Archaean basement fractured rock aquifers; tertiary palaeochannel sands and surficial deposits including lacustrine sediments, alluvium/colluvium and calcrete.

2.3 Conservation framework

Protection of native flora and fauna in Western Australia is provided at both state and federal levels. At the federal level, a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places is provided via the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

At the state level, native flora and fauna are protected under the *Wildlife Conservation Act 1950* (in particular Section 14, pp. 8-9). The highest level of protection is given to Schedule 1 species that are considered rare, likely to become extinct, or otherwise in need of special protection. The Department of Parks and Wildlife (DPaW) also maintains a list of priority fauna species that are of conservation importance but, for various reasons, do not meet the criteria for listing as threatened. The current list of threatened and priority species is given in the Wildlife Conservation (Specifically Protected Fauna) Notice 2015. The current list includes 113 terrestrial invertebrate species: seven insects, 26 arachnids, 22 crustaceans, 22 millipedes, one bristle worm and 35 molluscs (DPaW, 2015). Five priority invertebrate species are from the goldfields bioregion (DPaW 2015) but none of these are subterranean species.

In addition to protection mechanisms for species, the EPBC Act lists Threatened Ecological Communities (TECs) for protection. The WC Act has no provision for listing TECs but the Minister for the Environment has endorsed a list of TECs. Other communities of potential conservation concern, but for which there is little information, are listed informally as Priority Ecological Communities (PECs).

Sampling methods for subterranean fauna are outlined in the Guidance Statement 54A (EPA 2007), while Environmental Assessment Guidance 12 (EPA 2013) provides a theoretical framework for subterranean fauna assessments.

2.4 Subterranean Fauna of the Yilgarn

The vast majority of subterranean fauna in Western Australia are invertebrates, although stygofaunal fish and troglofaunal reptiles have been recorded (Aplin 1998; Whitely 1945). Subterranean fauna usually show morphological modifications to life underground that include loss (or reduction) of eyes and skin pigmentation, elongation of appendages and sensory setae, and development of a vermiform body shape.

The occurrence and distribution of subterranean fauna is closely related to geology. Both stygofauna and troglofauna inhabit subterranean spaces, which may include interstices, voids, vugs, cavities and fissures. Geologies that contain many such spaces represent potential habitat. Both vertical and lateral connectivity of spaces are factors that contribute to determining the distribution of subterranean fauna. Calcretes and shallow alluvial aquifers are prospective habitat for aquatic subterranean invertebrates (stygofauna) in the Goldfields while air-breathing subterranean species (troglofauna) also occur in fractured BIF habitats, although at low abundance.

2.4.1 Troglofauna

Whether troglofauna occur in an area is dependent on the availability of habitat, which can be inferred with moderate accuracy from the geology of the area. Potential troglofauna habitat extends from the lower layers of loose soil and sand (usually 1-3 m below the ground surface in arid areas) to the interface with groundwater (Halse and Pearson 2014). The richness of the community in these spaces is affected by the degree to which the subterranean spaces are connected to the ground surface to supply energy and nutrients to the troglofauna community (plant roots are an important surface connection), while lateral connectivity of spaces is crucial to underground dispersal of species (Korbel and Hose 2011). Geological features such as major faults, dykes, rock formations with no voids, and valleys may block continuity of habitat and act as barriers to dispersal, which may lead to troglofauna species having restricted ranges.

Troglofauna are typically classified as troglobite (obligate subterranean species), troglophile (subterranean species with either a life stage or populations occurring above ground) and trogloxene (species primarily found on the surface but with facultative occurrence below ground) (Sket 2008) although the lack of life history information for Yilgarn troglofauna often makes it difficult to assign species to their correct classification. Both troglobites and troglophiles are effectively dependent on subterranean habitats for species persistence and this may also be the case for trogloxenes if the species uses subterranean habitat as a refuge.

Data in the public domain indicate that troglofauna communities in ranges of the Yilgarn are less rich than in the Pilbara. Nevertheless, Yilgarn ironstone formations have been shown to support a range of troglofaunal groups including pseudoscorpions, isopods, millipedes, centipedes, spiders, silverfish, beetles, symphylans, cockroaches, pauropods, bristletails and bugs (Bennelongia 2008b; 2008c; Biota 2007). Surveys in ironstone at the Koolyanobbing Range, Mount Jackson Range, Hunt Range, Mt Dimmer and Yendilberin Hills and Mummaloo have documented either depauperate or moderately developed troglofauna communities, depending on the characteristics of the site (Bennelongia 2008b; 2008c; 2012c).

2.4.2 Stygofauna

Stygofauna are aquatic invertebrates that inhabit fissures and voids in an array of groundwater habitats including porous, karstic and fractured-rock aquifers, springs and the hyporheos of streams (Eberhard *et al.* 2005). Mining activities may potentially threaten stygofauna species with small ranges if mining occurs below the groundwater table. This could be through both physical excavation and more widely through the groundwater dewatering required for dry-pit mining. In addition, when significant groundwater abstraction is required for mineral processing (e.g. beneficiation of magnetite ore), there may be impacts on stygofauna because of habitat loss in the water production borefields.

Rich stygofauna communities have been documented from calcrete bodies in the palaeovalleys of the Yilgarn (Guzik *et al.* 2008; Karanovic and Cooper 2011b; Karanovic *et al.* 2014) and endemism is generally high, with many species restricted to single calcrete bodies or aquifers. Groups commonly occurring in calcrete with high species richness include copepod, syncarid and amphipod crustaceans (Guzik *et al.* 2008; Karanovic and Cooper 2011b; Karanovic *et al.* 2014). These restricted stygofauna communities have often been listed as either TECs or PECs (DEC 2009; DEC 2010). In both cases, the communities are seen as having high conservation value during the assessment process. A Priority 1 PEC, the '*Mt Morgan calcrete groundwater assemblage*', coincides with the production borefield.

In contrast, surveys in geologies other than alluvium and calcrete have recorded very low levels of stygofauna richness (Bennelongia 2009). For example, past surveys have recorded one potential stygobitic nematode species at the Hinge Iron Ore deposit (Rockwater 2014), one amphipod at Jack Hills (GHD 2009) and two cycloid copepods at Kirkalocka (Bennelongia 2011b). While these results demonstrate that stygofauna do occur in BIF habitats if sufficient groundwater is present, the overwhelming picture is that the BIF aquifers in the Yilgarn support very few stygofauna species. Furthermore, irrespective of the suitability of the geology, few species and only low abundances are expected to occur where depth to groundwater is much more than 30 m (Halse *et al.* 2014).

3. DESKTOP REVIEW

A desktop assessment was undertaken to examine whether suitable habitat for subterranean fauna might be present at the Project, and to assess whether any listed invertebrate species or a significant subterranean fauna community was likely to occur locally.

3.1 Habitat Characterisation

3.1.1 Geology and Hydrogeology

The geological, hydrogeological setting and associated subterranean habitat potential of each operational area is described below and presented in Figure 3.

Westralia

The stratigraphy of the Westralia area is dominated by mafic volcanics (predominantly massive tholeiitic basalt), mafic intrusives, minor ultramafics and metasediments, and a narrow band (<80 m wide) of a regionally continuous BIF. All of these units have been intruded by concordant and discordant felsic porphyry dykes and sills and by discordant lamprophyric dykes.

Groundwater entering mines in the Westralia area is associated with low yielding fractured rock aquifers. Airlift and water level recovery testing on four holes in the Westralia area suggested the geology of the area has a very low permeability (between 1.99×10^{-4} m/day and 1.49×10^{-1} m/day). Water storage is likely to correspond only with localised fracture zones. A high variation in measured permeabilities is likely due to some of the drill-holes intersecting fracture zones. The estimated inflows to mine pits are low and are not anticipated to have any significant impact on the wider groundwater system or any groundwater dependent ecosystems. Based on the low yields, the requirements for dewatering are predicted to be minor and it is anticipated in-mine dewatering methods will be sufficient to cope with the volumes of groundwater involved.

Water quality analysis completed as part of the 2014/15 Groundwater Monitoring Summary showed water quality in Westralia area to be:

- pH neutral to slightly alkaline
- Low to moderate salinity with TDS values ranging between 6000 mg/L and 14,500 mg/L (Westralia)
- Elevated sulphate levels of 2000mg/L.
- Low concentrations of metals and metalloids.

The water levels in the Westralia area are approximately 20 m below ground surface.

Jupiter

Mineralisation at Jupiter is centred on a series of syenite intrusive stocks aligned in a north-south orientation. The syenite intrudes into a sequence of host basaltic rocks. A major shear zone, termed the Cornwall Shear Zone, runs parallel to the western margin of the syenite intrusives and where it intersects these intrusive bodies mineralisation has occurred within both the syenite and the host basaltic rocks. This mineralisation is primarily centred on the intrusive bodies but also extends several hundred metres into the basaltic rocks.

The mineralisation is predominantly associated with alteration to albite and sericite, and quartz veining and pyrite development are commonly encountered within the mineralised basalt hosted lodes.

The Archean basement is considered to have a low aquifer potential, apart from a possible fractured rock aquifer which trends east-west across the southern end of the Heffernans deposit. The low permeability of the basement rocks is consistent with historic dewatering rates at the earlier mined Jupiter pit. Weathered basement rocks are thought to have low to modest permeabilities.

A programme of hydraulic testing was carried out on eight angled resource drill-holes and falling head tests completed on nine vertical resource and metallurgical drill-holes (Appendix 1) located within the Heffernans deposit area. The following conclusions were made on the results of hydraulic testing:

- Permeability values are mostly low in the intact fresh rock;
- Permeability values in the weathered rock are moderately low; and
- There is a linear feature of higher permeability trending east-west across the southern edge of the deposit, possibly associated with the northern contact of the steeply dipping intermediate intrusive across the southern limit of the deposit.

The groundwater modelling of the Heffernans deposit has shown a base case dewatering rate of 5 to 9 L/s.

The groundwater level data showed that away from outcropping portion of the Heffernans deposit (syenite hill) the groundwater levels range from 396.48 mAHD on the edge of the lake at the south-eastern side of the deposit to 399.37 mAHD at the northern end of the deposit. The groundwater level contours indicate a low hydraulic gradient from north to south consistent with groundwater discharge towards Lake Carey.

Groundwater samples collected from seven resource drill-holes within the Heffernans deposit (Appendix 3) show groundwater to be:

- pH neutral;
- Hypersaline, ranging from 150,000 to 260,000 mg/L;
- Sodium chloride type;
- High in nitrate, with slightly elevated concentrations of manganese.

Although the buffer of the PEC also overlaps part of the Jupiter area, extensive drilling has confirmed that no calcrete habitat occurs within the Jupiter area.

Production Borefield

The production borefield is located in a calcrete aquifer of the Lake Carey drainage system.

The aquifer covers an area of about 60 km^2 and forms an elongate unit that broadly trends northwest from the northern margin of Lake Carey (MMA 1990). The unit is thin, sub-cropping close to surface with a maximum depth of about 10 m. It comprises vuggy carbonate rock interbedded with alluvium and silcrete. Dissolution of the carbonate is common, which results in the development of secondary porosity and on occasion good aquifer yields. The results of groundwater field programmes indicate that higher permeabilities generally occur on the western side of the calcrete unit. Groundwater flows in the calcrete are likely to be towards the east and south, ultimately discharging to the Carey trunk palaeochannel and Lake

Carey, respectively. The aquifer is subject to direct rainfall recharge resulting in rapid groundwater level rises after major storm events.

The aquifer and borefield coincides with a Priority 1 PEC - 'Mt *Morgan calcrete groundwater assemblage on Carey palaeodrainage on Mt Weld Station*' which is identified as having a unique assemblage of invertebrates in the groundwater calcretes.

3.1.2 Potential Subterranean Fauna Habitat

Stygofauna typically inhabit fresh to brackish groundwater, but they may occur in salinities up to 50,000 mg/L total dissolved solids). Both troglofauna and stygofauna depend on the presence of suitable underground spaces such as interstices, voids, vugs, cavities and fissures. Based on review of the Project geology and hydrogeology, the following assessment is made regarding potential subterranean fauna habitat:

Stygofauna Habitat Potential

- **Westralia –** Stygofauna could persist in the groundwater which is of relatively good quality (i.e. <20,000mg/L TDS), however low permeability aquifers and fine grained geological units limit habitat potential.
- **Jupiter –** Unlikely to provide suitable habitat due to high salinity (>150,000 mg/L TDS). Additionally, low permeability aquifers limit habitat potential.
- **Production Borefield** – Likely to provide good habitat for stygofauna due to the fresh – brackish water quality, high permeability formation and vuggy nature of the calcrete.

Troglofauna Habitat Potential

- **Westralia –** BIF units above the water table may provide suitable habitat for troglofauna.
- **Jupiter –** The relatively shallow water table (less than 10 mbgl away from outcropping portion of the Heffernans deposit) is likely to constrain the quantity of habitat available to troglofauna. This is because the arid environment and high plant transpiration would dry out the most of the habitat above water table and make establishment of troglofauna populations unlikely. Additionally, rock units above the water table (syenite and weathered basalt) do not provide extensive voids for troglofauna to inhabit (see Appendix 1).
- **Production borefield** - The relatively shallow water table (level ranging between 2.97 to 6.25 mbgl) is likely to constrain the quantity of habitat available to troglofauna, however a depauperate community could occur.

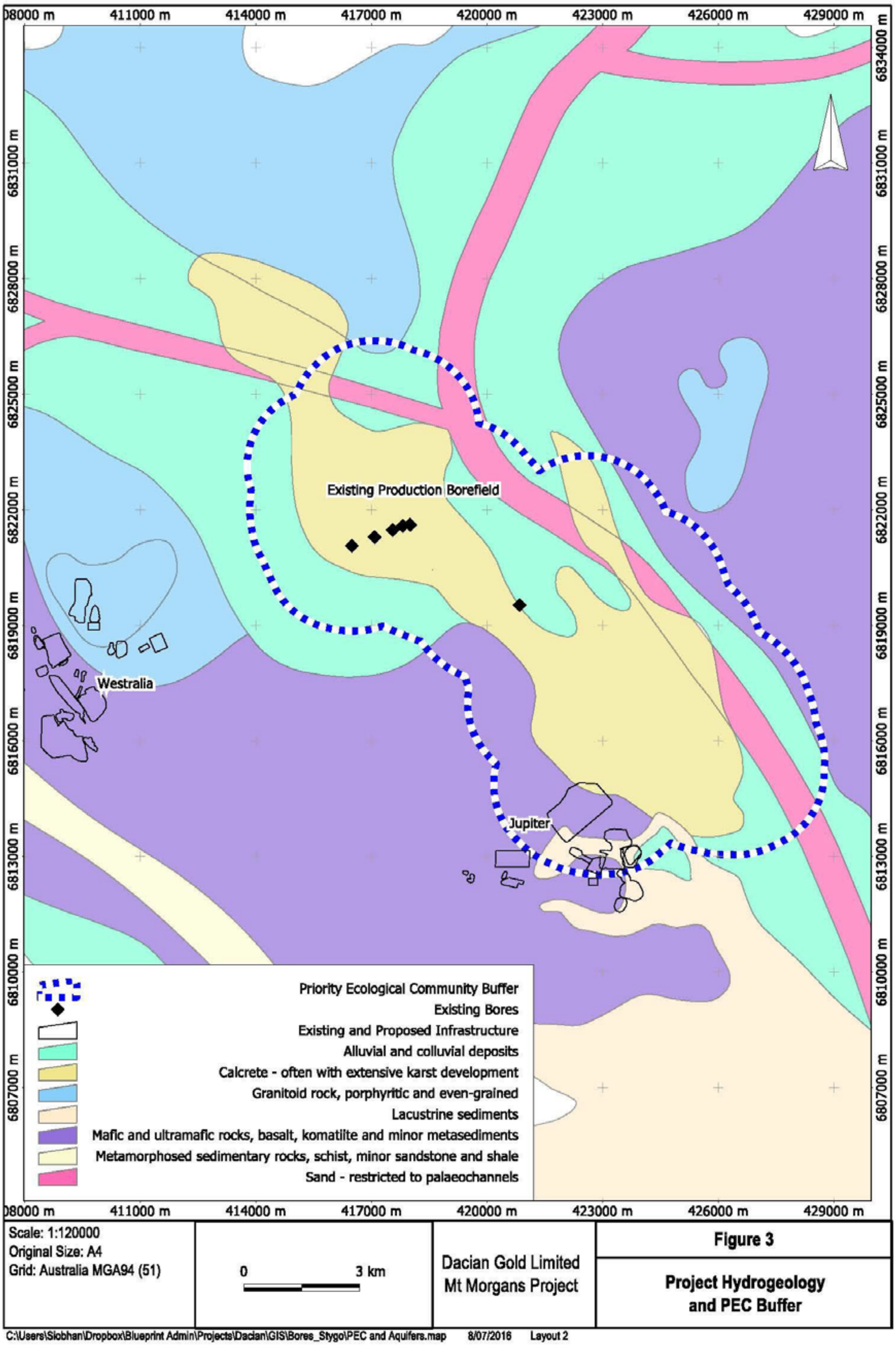

Figure 3. Project Hydrogeology and PEC Buffer.

3.2 Subterranean Fauna in the Vicinity of the Project

3.2.1 Database and Literature Searches

To assess the likelihood of subterranean fauna occurring in the Project area, a review was conducted of troglofauna and stygofauna records in the Western Australian Museum (WAM) databases (arachnids, myriapods and crustaceans). Data were reviewed for a search area of 100 km by 100 km around the Project (defined by - 27.900S; 121.200E and -29.70S; 123.200E). Published research papers, online databases and available environmental reports (Table 1) were also reviewed. Higher level identifications were not included in counts of species within the search area unless it was certain they represented a species that was not already recorded (e.g. *Enchytraeus sp.* was not included as an additional species because the genus *Enchytraeus* was already represented by *Enchytraeus* Pilbara sp. 1).

Table 1. Reports included in the desktop assessment.

Author	Year	Report Name	Produced for	Distance from the Project
BEC	2007	Report on Subterranean Fauna of the Duketon Gold Project Area, North of Laverton	Regis Resources NL	93 km N
BEC	2011	Duketon Gold Project: Subterranean Fauna Assessment at Garden Well and Erlitoun	Regis Resources NL	93 km N
BEC	2013	Yamarna Project Subterranean Fauna Assessment	Gold Road Resources	133 km NE
BEC	2015	Duketon Gold Project: Subterranean Fauna Desktop Assessment for Gloster Deposit	Regis Resources NL	93 km N
BEC	2016	Duketon Gold Project: Subterranean Fauna Desktop Assessment for Baneygo Deposit	Regis Resources NL	93 km N

BEC = Bennelongia Environmental Consultants Pty Ltd

3.2.2 Troglofauna

The limited troglofauna surveys in the public domain that have been undertaken in the Yilgarn have recorded modest to rich troglofauna communities in calcretes above the watertable, with the groups present including palpigrads (Barranco and Harvey 2008), pseudoscorpions (Edward and Harvey 2008), spiders (Baehr *et al.* 2012; Platnick 2008) and isopods (S. Taiti in litt.). Outback Ecology (2012) collected 20 troglofauna species at Lake Way near Wiluna and cited unpublished WAM reports referring to “numerous [other] troglomorphic species” in Lake Way calcretes (250 km NNE), while Bennelongia (2015) reported the collection of 45 species of troglofauna from calcrete at Yeelirrie (250 km NW).

Other lithologies in the Yilgarn support fewer troglofauna species, especially where gold occurs. Only four species in four taxonomic groups (isopods, centipedes, diplurans and cockroaches) were collected at the gold deposits of Tropicana (ecologia Environment 2009a, 2009b, 2010). Depending on the site, studies in BIF at Koolyanobbing, Mount Jackson Hunt Range, Mt Dimmer and Yendilberin Hills have documented depauperate through to moderately rich troglofaunal communities that included species of isopods, millipedes, centipedes, spiders, silverfish, beetles, symphylans, cockroaches, pauropods, bristletails and bugs (Bennelongia 2008b; 2008c; 2009).

Eleven troglofauna species were identified in the desktop assessment within the search area (Table 2) representing a depauperate community within the area. The nearest known records of troglofauna to the Project are from Duketon, 93 km north of the Project where three troglofauna species were recorded at Erlistoun and Garden Well (Bennelongia 2011a). They were the isopod *Trichorhina* sp. B8, dipluran Japygidae sp. and silverfish Atelurinae sp. B14. *Trichorhina* ` sp. B8 has a known linear range of 6.8 km. Japygidae sp. belongs to a family that appears to contain widespread species compared with typical troglofauna ranges (Halse 2010). The silverfish Atelurinae sp. B14 also belongs to a sub-family characterised by moderately widespread species (Halse 2010). No troglofauna was recorded from bores in the mine pit area at Moolart Well (Bennelongia 2007).

3.2.3 Stygofauna

A literature search undertaken as part of the subterranean desktop assessment identified that stygofaunal communities of the calcretes within the Yilgarn are generally very rich. Stygofauna survey at the Yamarna Project (133 km NE) yielded 2,852 specimens from at least 33 species and eight higher order groups including Nematoda (1 species), Aphanoneura (1 species), Oligochaeta (4 species), Turbellaria (1 species), Copepoda (18 species), Syncarida (2 species), Amphipoda (2 species) and Coleoptera (4 species). (Bennelongia 2013). Copepods were both the most diverse and the most abundant group, representing 68% of all specimens collected. Amphipods also represented a significant proportion of total abundance (23%) (Bennelongia 2013).

Stygofaunal communities in other lithologies in the Yilgarn are less rich compared to those in calcrete habitats (Bennelongia 2007; 2011a). Stygofauna sampling yielded only 14 specimens from Erlistoun (93 km N) consisting of at least three species. No species were collected at Garden Well (Bennelongia 2011a).

In summary, a rich community of stygofauna was identified in parts of the region surrounding the Project. A total of 62 stygofauna species were identified through the desktop assessment and are known to occur within the search area. These species are presented below in Table 3

3.2.4 Listed Species and Threatened/Priority Communities

No subterranean invertebrate species from the vicinity of the Project are listed under the WC Act.

The production borefield occurs within the Priority 1 PEC: '*Mt Morgan calcrete groundwater assemblage type on Carey paleodrainage on Mount Weld Station*'. This community is described as a unique assemblages of invertebrates that has been identified in the groundwater calcretes and is currently threatened by mining (DEC 2009). The presence of a PEC within the production borefield prompted further work to determine the composition of the stygofaunal community in the production borefield and Bennelogia undertook a comprehensive two-phase field survey. The findings of this survey are presented below.

Table 2. Troglofauna species recorded in the search area defined by -27.900S; 121.200E and -29.70S; 123.200E.

Taxonomy	Species	No. of specimens	Reference/Source	Comment/ Known Range
Arthropoda				
Chelicerata				
Arachnida				
Palpigradida	Palpigradida sp. B14	1	BEC 2013	
Araneae	*Prethopalpus framenaui*	3	WAM	
Crustacea				
Malacostraca				
Isopoda	*Trichorhina sp. B8*	6	BEC 2011a	Known range of 6.8 km
	Trichorhina sp. B15	117	BEC 2013	
Hexapoda				
Insecta				
Thysanura	*Atelurinae* sp. B14	1	BEC 2011a, Halse 2010	Family mostly contains widespread species
	Atelurinae sp. B15	2	BEC 2013	
Diplura	Japygidae sp.	1	BEC 2011a, Halse 2010	Family mostly contains widespread species
Myriapoda				
Chilopoda				
Scolopendromorpha	*Cryptopidae* `genus?` `sp.` Laverton Downs Station	1	WAM	
Pauropoda				
Tetramerocerata	*Pauropus* sp. B02	4	WAM	
Symphyla				
Cephalostigmata	*Scutigerella* sp. B07	1	BEC 2013	
	Scutigerella sp. B08	1	BEC 2013	

Table 3. Stygofauna species recorded in the search area defined by -27.900S; 121.200E and -29.70S; 123.200E.

Taxonomy	Species	No. of specimens	Reference/Source	Comment/ Known Range
Platyhelminthes				
Turbellaria	Turbellaria sp.	20	BEC 2013	Not identified to species level and not part of the assessment
Rotifera				
Eurotatoria				
Bdelloidea	Bdelloidea sp	3	BEC 2007	Not identified to species level and not part of the assessment
Nematoda				
	Nematoda sp.	31	BEC 2013	Not identified to species level and not part of the assessment
	Nematoda sp.	8	BEC 2007	Not identified to species level and not part of the assessment
	Nematoda sp.	11	BEC 2011a	Not identified to species level and not part of the assessment
Annelida				
Aphanoneura				
	Aeolosomatidae sp.	3	BEC 2013	Uncertain
Clitellata				
Enchytraeida	*Enchytraeus* sp.	1	BEC 2013	Uncertain
	Enchytraeus Pilbara sp 1	9	BEC 2007, Bennelongia Unpublished	Widespread in arid WA
Haplotaxida	*Insulodrilus* sp.	1	BEC 2013	Uncertain
	Tubificidae sp. B01	44	BEC 2013	Not identified to species level and not part of the assessment
	Tubificidae sp. B02	53	BEC 2013	Not identified to species level and not part of the assessment
	Tubificidae stygo type 5	3	BEC 2007, Bennelongia Unpublished	Widespread in WA
	Phreodrilid slim vent chaetae	1	BEC 2007, Bennelongia Unpublished	Widespread in WA
Crustacea				
Malacostraca				
Isopoda	*Paraplatyarthrus subterraneus*	6	WAM;	Probably restricted to the local calcrete
	Paraplatyarthrus nahidae sp. nov.	7	WAM; Javidkar 2014	Probably restricted to the Mt Morgan calcrete
Maxillopoda (sub-class Copepoda)				
Harpacticoida	Ameiridae sp.	1	BEC 2011a	
	Nitokra lacustris sp. B02	9	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitokra lacustris regis ms	1	BEC 2007	
	Nitokra l pacificus X regis	2	BEC 2007	Known from single bore in Moolart Well area
	Nitocrella sp B02A	1	BEC 2007	Moolart Well calcrete
	Nitocrella sp. B06	7	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete

Taxonomy	Species	No. of specimens	Reference/Source	Comment/ Known Range
	Nitocrella sp. B07	840	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitocrellopsis halsei	11	BEC 2007, WAM	Moolart Well calcrete and alluvium, known linear range >40km
	Nitocrellopsis sp B03	5	BEC 2007	Moolart Well calcrete
	Nitocrellopsis sp. B04	1	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitocrellopsis sp. B05	147	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitocrellopsis sp. B06	53	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitocrellopsis sp. B07	106	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nitocrellopsis sp. B08	53	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Parapseudoleptomesochra? sp. B03	214	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Australocamptus hamondi	2	BEC 2007, Karanovic 2004	Known linear distribution of >150 km in Murchison Region
	Schizopera sp B01	3	BEC 2007	Moolart Well calcrete
	Schizopera sp. B08	5	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Schizopera sp. B09	15	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Schizopera sp. B11	6	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Schizopera sp. B14	32	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Schizopera jundeei	1	BEC 2007	
	Kinnecaris solitaria		Karanovic 2004, BEC 2007	
	Parastenocaris sp B2	1	BEC 2007	
	Parastenocaris sp. B24	4	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Parastenocaris solitaria	1	BEC 2007	
Cyclopoida	*Fierscyclops (Fierscyclops) fiersi*	198	BEC 2013	Widespread in Murchison; linear range 450 km
	Cyclopoida sp	1	BEC 2007	
	Goniocyclops uniarticulatus	23	BEC 2013, BEC 2007	Widespread in Murchison; linear range 400 km
	Goniocyclops sp B01	2	BEC 2007	Known from single bore in Moolart Well area
	Halicyclops eberhardi	188	BEC 2013	Murchison and Gascoyne; linear range 750 km
	Microcyclops varicans	3	BEC 2007, Karanovic 2004	Cosmopolitan
	Mesocyclops brooksi	2	BEC 2007, Karanovic 2004	Widespread in Pilbara and arid WA
Ostracoda				
	Plesiocypridopsis sp A	8	BEC 2007,	Not applicable, not species level
Podocopa	?Candoninae sp 1	4	BEC 2007	Known linear range of 50 km
	Candonidae sp.	2	BEC 2011a	
Malacostraca				
Bathynellacea	*Bathynella* sp B1	*2*	BEC 2007	

Taxonomy	Species	No. of specimens	Reference/Source	Comment/ Known Range
	Atopobathynella sp. B13	1	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Atopobathynella sp B1	3	BEC 2007	Moolart Well calcrete and alluvium, known linear range 50 km
	Hexabathynella sp. B07	6	BEC 2013	Probably restricted to the local calcrete
	Parabathynellidae n gen PS	3	BEC 2007, WAM	Moolart Well calcrete and alluvium, known linear range 30 km
Amphipoda	*Stygochiltonia* sp. B02	500	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Yilgarniella sp. B02	148	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
Hexapoda				
Insecta				
Coleoptera	*Limbodessus* sp. B05	31	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Limbodessus sp. B06	43	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Limbodessus sp. B07	19	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete
	Nirripirti sp. B01	2	BEC 2013	Probably restricted to the Yeo Palaeovalley calcrete

4. STYGOFAUNA FIELD SURVEY

4.1 Methods

4.1.1 Site Selection and Sampling Effort

Sampling sites were categorised according to their occurrence inside or outside the predicted 2 m drawdown contour based on drawdown modelling completed by Red Creek Water Solutions Pty Ltd (2016) (Figure 4). The 2 m drawdown contour utilised for this assessment represents a conservative assessment of drawdown. Bores inside the 2 m contour were considered as impact sites that will potentially be affected by groundwater abstraction. Bores outside the 2 m drawdown contour were considered to be reference sites. Historical groundwater monitoring data suggests that negligible drawdown was observed at distances greater than 400 m from abstraction points.

A total of 66 stygofauna samples from 39 sites were collected from within the survey area over the three surveys: 20 in phase one; 20 in phase two; and 26 in phase three (Figure 4) comprising:

- Reference sites – 23 sites located outside the predicted 2 m drawdown contour of the production borefield.
- Impact sites – 16 sites located within the predicted 2 m drawdown contour associated with the production borefield; and

Sampling was conducted on 10-12 February 2016, 16-18 May 2016 and 2-4 November 2016. A complete list of bores sampled is provided in Appendix 3.

4.1.2 Sampling Methods

Stygofauna sampling followed the methods recommended by the EPA (2007). At each bore, six net hauls were collected using a weighted plankton net. After the net was lowered to the bottom of the bore it was bounced up and down briefly to agitate benthic and epibenthic stygofauna into the water column prior to a slow retrieve of the net. Contents of the net were transferred to a 125 ml polycarbonate vial after each haul and the contents were preserved in 100% ethanol and stored below 4^{o}C for up to four days for possible sequencing. Nets were washed between bores to minimise contamination between sites. Three hauls were taken using a 50 µm mesh net and three with a 150 µm mesh net.

4.1.3 Sampling Sorting and Identification

In the laboratory, samples were elutriated to separate out heavy sediment particles and sieved into size fractions using 250, 90 and 53 µm screens. All samples were sorted under a dissecting microscope. Sorted animals were identified to species or morphospecies using available keys and species descriptions. When necessary, animals were dissected and examined under a compound microscope. Morphospecies determinations were based on characters used in species keys. Higher order identifications were only regarded as distinct ‘species’ if that taxonomic unit had not otherwise been recorded (e.g. *Schizopera* sp. was not included in the final list of species as it probably corresponded to a recorded species of that genus).

4.1.4 Personnel

Fieldwork was undertaken by Michael Curran and Jim Cocking in phase one, Mike Scanlon and Renee Young in phase two, and Michael Curran and Jim Cocking in phase three. Samples were sorted by Mike Scanlon and Jane McRae and identifications were made by Jane McRae and Stuart Halse.

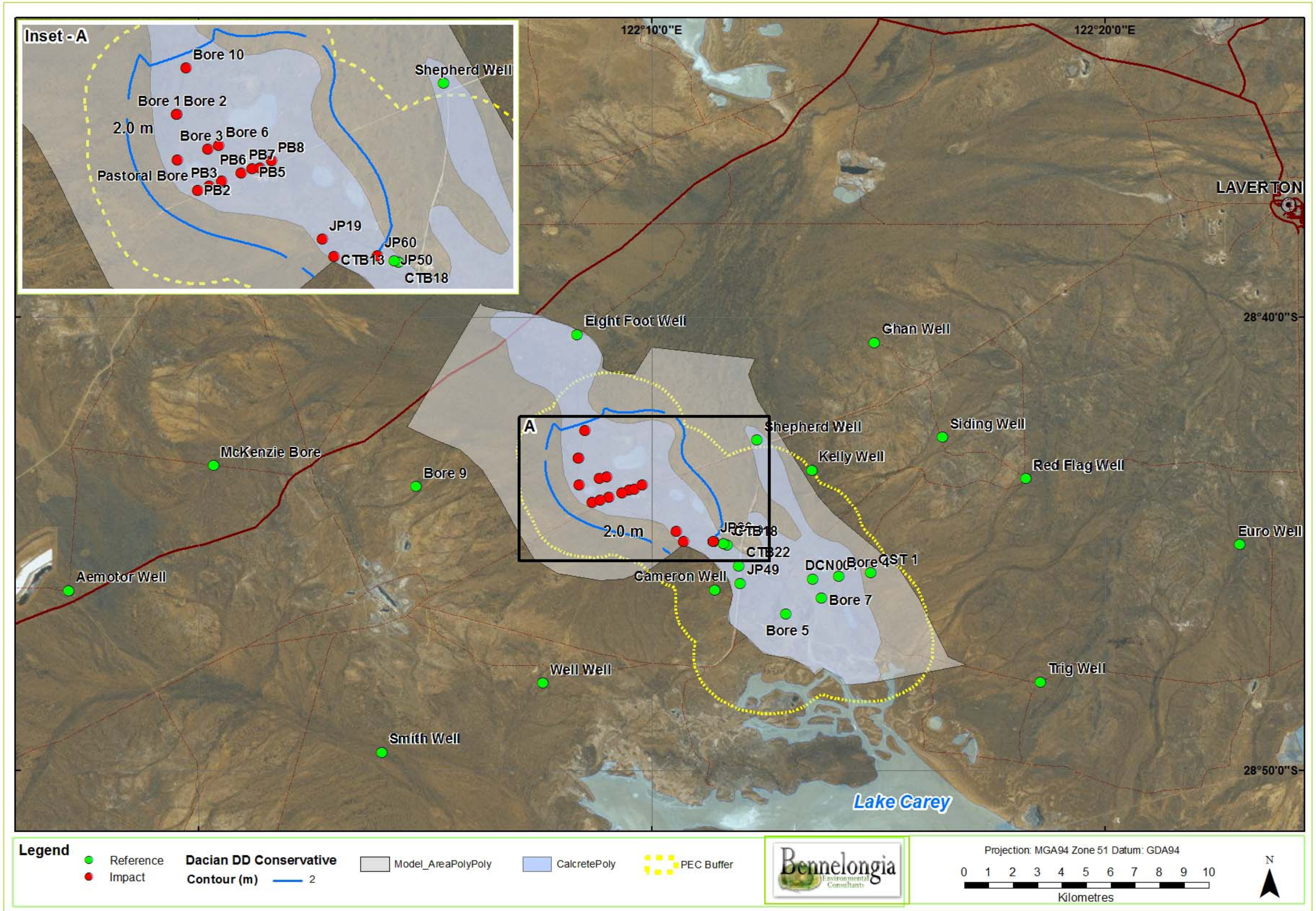

Figure 4. Locations of bores sampled for stygofauna.

4.2 General Results

A total of 2,179 specimens belonging to at least 45 species of stygofauna were collected during this survey (Table 4). Most bores yielded, containing from 1–13 species and 1–314 individuals per bore. Reference sites Bore 9, Eight Foot Well, Smith Well, Trig Well and Well Well and the impact site Bore 10 did not yield stygofauna. Crustaceans were by far the most diverse group with 31 species of six orders collected: harpacticoid copepods (10 species), cyclopoid copepods (7), isopods (6), ostracods (3), syncarids (4) and calanoid copepods (1). Five oligochaete taxa were collected, although four of these represent higher level identifications and only one naidid worm could be identified to species level. Insects were represented by three species of diving beetle (Dytiscidae), as well as indeterminate larvae of that family. Rotifers (3 species), turbellarian flatworms (2 species) and nematodes (1 species) were also recorded.

Cyclopoid and harpacticoid copepods were the most abundant groups, with 481 and 743 specimens collected, respectively. The most abundant species were the undescribed harpacticoid Ameiridae gen. nov. sp. B05 (470 specimens) and the cyclopoid *Fierscyclops* (*Fierscyclops*) *fiersi* (262 specimens). Eight species were collected as singletons.

A list of higher order identifications that were removed from the final species list to avoid artificial inflation of richness is given in Appendix 4.

4.3 Summary of Recorded Fauna

Details on the taxa collected are provided in the sections below. Figures 5-8 show collection locations of taxa that are known only from (and are possibly restricted to) the study area or else are of potential conservation concern. Exemplar stygofauna taxa of the Project area are shown in Figure 9.

4.3.1 Flatworms, nematodes, oligochaetes and rotifers

The taxonomy of worms and rotifers in Australia is poorly resolved and the taxonomic papers available focus on other bioregions than the Yilgarn (e.g. Pinder 2003; Pinder *et al.* 2006). It is usually not possible to identify stygal rotifers to species level (most are bdelloids) and this group is excluded from environmental impact assessments because the ranges of species cannot be readily determined. A rotifer species belonging to the genus *Brachionus* was collected from two reference bores, but could not be identified further. Two bdelloid rotifer species, Bdelloidea sp. 2:2 and Bdelloidea sp. 7:7 were recorded from five and one reference bores, respectively (Figure 5). Nematodes (roundworms) and flatworms (Platyhelminthes) collected in stygofauna samples cannot be identified to species level and these groups are excluded from impact assessments.

Juvenile stages of oligochaetes can also be difficult to identify to species level. Nevertheless, the survey area seems to have a moderately diverse oligochaete fauna that comprises four families (Aeolosomatidae, Enchytraeidae, Naididae and Tubificidae). Two oligochaete taxa recorded were collected only from impact sites (Figure 5A) but are probably more widely distributed (see Section 5.3.1). *Pristina aequiseta* was only collected from the impact area but has a cosmopolitan distribution.

4.3.2 Isopoda

Six aquatic isopod species were collected across 12 bores and all are possibly restricted to the study area (Figure 6). The most abundant were *Haloniscus* sp. B08, of which 65 specimens were collected across seven bores and *Haloniscus* sp. B09, of which 21 individuals were collected across five sites. These species differ in the length of the uropod furca and antennae ratios. *Haloniscus* is a very diverse genus in the Yilgarn and some species have been described (e.g. Taiti and Humphreys 2001) but many more undescribed species have been collected from calcretes and surface waters in the last decade. Like other onisicdean genera, species of *Haloniscus* are often endemic to single calcrete aquifers, having diverged within calcretes following independent colonisation events. Six putative species are currently recognised from the Carey palaeodrainage based on genetic data, demonstrating high species richness and endemism in this fauna (Cooper *et al.* 2008).

The species *Andricophiloscia* sp. B01, *Andricophiloscia* sp. B02 and ?*Adoniscus* sp. B02 are presently known from one, three and one specimens, respectively. *Andricophiloscia* sp. B01 was recorded from JP49, *Andricophiloscia* sp. B02 from PB6 and Bore 6 and ?*Adoniscus* sp. B02 from DCN001. All three species are probably endemic to the Mt Morgan calcrete. Four specimens of *Angeliera* sp. B01 were recorded from reference bore DCN001. The species is of biogeographic significance, being the first record of the family Microparasellidae in Western Australia. The family has marine origins.

The collection locations of all six recorded isopod species are shown in Figure 5B. All isopod species were recorded from reference bores except *Andricophiloscia* sp. B02, which is discussed further in Section 5.3.1.

4.3.3 Syncarida

Syncarids are a common element of stygal communities worldwide and are frequently collected during stygofauna surveys in Australia. The Western Australian fauna has been studied both genetically (Abrams *et al.* 2012; Guzik, Abrams *et al.* 2008) and taxonomically (e.g. Cho and Humphreys 2010; Cho *et al.* 2005). The data available indicate high species diversity and pronounced regional endemism, with species typically endemic to single calcretes or subterranean waters within them. Species ranges are typically small but differ according to physico-chemical characteristics of the groundwater habitats. Four new species of syncarid were collected at the Project Area – *Bathynella* sp. B27, *Atopobathynella* sp. B22, *Atopobathynella* sp. B23 and *Atopobathynella* sp. B24 (Figure 6). *Bathynella* sp. B27 was recorded only from DCN001 (two individuals); *Atopobathynella* sp. B23 from five bores (17 individuals); *Atopobathynella* sp. B22 was recorded from seven bores (54 individuals); and *Atopobathynella* sp. B24 was recorded from the regional reference site Ghan Well (9 individuals). These species are likely restricted ranges but were all recorded in reference bores (Figure 6A).

4.3.4 Calanoid copepods

Only one species of calanoid was collected in this survey and it belongs to the genus *Boeckella*, which has Australasian distribution (Bayly 1992). Species of *Boeckella* in Australia are known from surface waters so it is likely that *Boeckella* sp. B01 is a trogloxene or the accidental occurrence of a surface species. While *Boeckella* sp. B01, represented by 17 animals from bore JP49 (Figure 6B), is an undescribed species, it is likely to occur outside the study area with a localised range in the context of surface species. It belongs to the *Boeckella triarticulata* complex. Other new species in this complex occur in Western Australia (Jane McRae, unpublished data)

4.3.5 Cyclopoid copepods

Cyclopoids are diverse in groundwater habitats throughout Western Australia and are probably the richest stygal group worldwide. The taxonomy of stygal cyclopoids in Western Australia is comparatively well resolved (e.g. Karanovic 2004). The fauna recorded from the survey area comprises seven species from six genera: *Dussartcyclops*, *Fierscyclops*, *Halicyclops*, *Mesocyclops*, *Metacyclops* and *Pescecyclops* (Table 4). All of the recorded species are widespread across the Yilgarn and have been collected from multiple calcretes and palaeochannels. All were described from material collected in the Murchison and Gascoyne regions (Karanovic 2004). *Pescecyclops laurentiisae* is less-common than other cyclopoids in the study area and was only recorded from the impact area, but is known to occur in the Murchison and Gascoyne regions. None of these species are of conservation concern as all were recorded in reference bores and occur outside the study area.

4.3.6 Harpacticoid copepods

Harpacticoids are another diverse stygofauna group. There are at least 11 harpacticoid species in the survey area belonging to five genera: *Australocamptus*, *Nitokra*, *Pseudectinosoma*, *Schizopera* and a genus of the family Ameiridae that is currently undescribed. Some species are widespread and have been collected elsewhere in the Yilgarn, such as *Australocamptus similis*. Other species may be more tightly restricted. All the harpacticoid species were recorded occurred in both impact and reference sites, with the exception of *Pseudectinosoma* sp. B03, of which one and two individuals were recorded from reference bores Bore 7 and DCN001, respectively (Figure 7).

The genus *Schizopera* is very diverse in the Yilgarn and Pilbara regions of Western Australia and a number of species have been described (e.g. Karanovic and McRae 2013). Species diversity and abundance in the calcretes of the Yilgarn can be very high. For example, multiple species of *Schizopera* were collected from individual bores at Yeelirrie (Karanovic and Cooper 2011a). The *Schizopera* fauna of the Project Area comprises three undescribed species that differ in the relative length, shape and supination of the operculum and furca. *Schizopera* sp. B18 and *Schizopera* sp. B19 collected from seven and nine bores and were represented by 15 and 52 individuals, respectively. *Schizopera* sp. B20 was less common with 11 individuals collected from four bores.

The genus *Nitokra* is not as diverse as *Schizopera* and includes both wide-ranging and restricted species (Karanovic, Eberhard *et al.* 2014; Karanovic and Pesce 2002). Of the three species collected in the study area, *Nitokra lacustris pacifica* is a described and wide-ranging species, whereas *Nitokra* sp. B05 and *Nitokra* sp. B06 may be restricted to the Mt Morgan calcrete aquifer. Eight individuals of *Nitokra* sp. B05 were recorded across four bores, while 16 individuals of *Nitokra* sp. B06 were recorded across five bores. These species differ from one another in the number of spines on the operculum and the presence or absence of the internal chitonus rib of the anal segment (present in *N. lacustris pacifica* and *N.* sp. B06; absent in *N.* sp. B05). *Nitokra* sp. B06 differs from in *N. lacustris pacifica* by the more angular shape of the chitonus rib, the shape of the furca, the very long hyaline fringe on the somites and only five setae on exopodite of P5 of females (six in *N. lacustris pacifica*).

Two species of a presently undescribed genus of Ameiridae were also collected. The specimens of the new genus most closely align with the genus *Stygonitocrella*, but differ in the setation patterns of the fourth endopodite. One of the species, Ameiridae gen. nov. sp. B05, was very abundant, with 470 individuals collected across 13 bores. The second species, Ameiridae gen. nov. sp. B06, was less common, with 27 individuals collected across five bores. The two species clearly differ in the number of setae of the operculum (B05 with 25-30 spines; B06 with 13 spines). All Harpacticoids occurred in reference bores.

4.3.7 Ostracoda

Three species of ostracods were collected in the survey area. *Sarscypridopsis ochracea* is the name that has been widely applied in Western Australia (e.g. Halse et al. 2014) to the cypridopsid ostracod collected from the Project. It is a cosmopolitan species (e.g. Martens et al. 1996) and further taxonomic work may show that Australian animals belong to a different species. *Sarscypridopsis ochracea* was recorded from one reference bore in the study area, Cameron Well, where 36 individuals were collected. A congeneric species, *Sarscypridopsis aculeata*, was recorded at four bores from which 29 individuals were collected. This species, which inhabits surface waters as well as subterranean habitats, is a stygophile with a near cosmopolitan distribution and has been recorded by Bennelongia across WA (De Deckker 1981). Five indeterminate specimens belonging to a species of the family Cyprididae were also collected as immature specimens or valves and, although it was not possible to identify them to species level, they could be differentiated from *Sarscypridopsis* and are therefore included in the final species list as Cyrididae sp. BOS668. Several surface genera of Cyprididae are frequently found in bores, including *Cyprinotus, Riocypris* and *Bennelongia* (Karanovic 2008) and it is considered that Cyrididae sp. BOS668 is likely to have similar biology. It is likely to be a species that inhabits both surface and subterranean habitats and consequently is widespread at the scale of the Project.

4.3.8 Coleoptera

At least three species of diving beetles belonging to the genus *Limbodessus* were collected from the study area (Figure 8B). The genus is extremely diverse in subterranean calcrete habitats across the Yilgarn and includes more than 30 described species (Leys *et al*. 2003; Watts and Humphreys 2006; Watts and Humphreys 2009). Stygal species of this genus are short-range endemics that are restricted to single calcretes, or specific habitats within these calcretes. The three species in the Project area are undescribed and differ from each other in body size (*Limbodessus* sp. B08 is much larger than *Limbodessus* sp. B09) and morphology of the pronotum, elytra and gentalia. *Limbodessus* sp. B13 is similar to *Limbodessus* sp. B08 but there are differences in the shape of the aedeagus. *Limbodessus* sp. B08 and *Limbodessus* sp. B09 were abundant and have been collected from six and 17 bores, respectively, whereas *Limbodessus* sp. B13 was recorded only at Bore 7 where just two individuals were collected. Larval *Limbodessus* were collected from 15 bores across the study area and probably correspond to the three recorded species. All three species of *Limbodessus* were recorded in reference bores and are not currently of conservation concern.

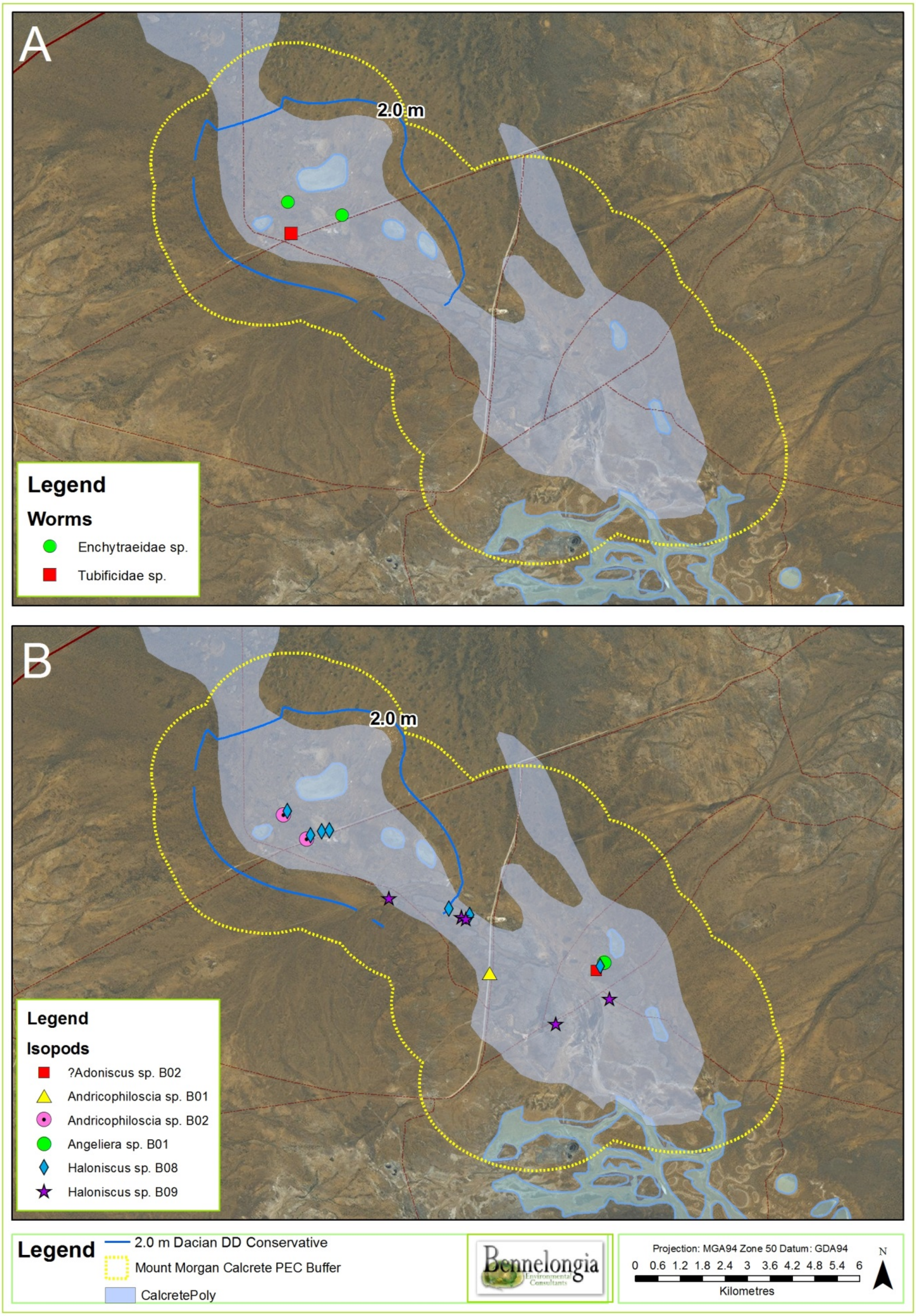

Figure 5. Collection locations of (A) oligochaetes and (B) isopods possibly restricted to the Project area.

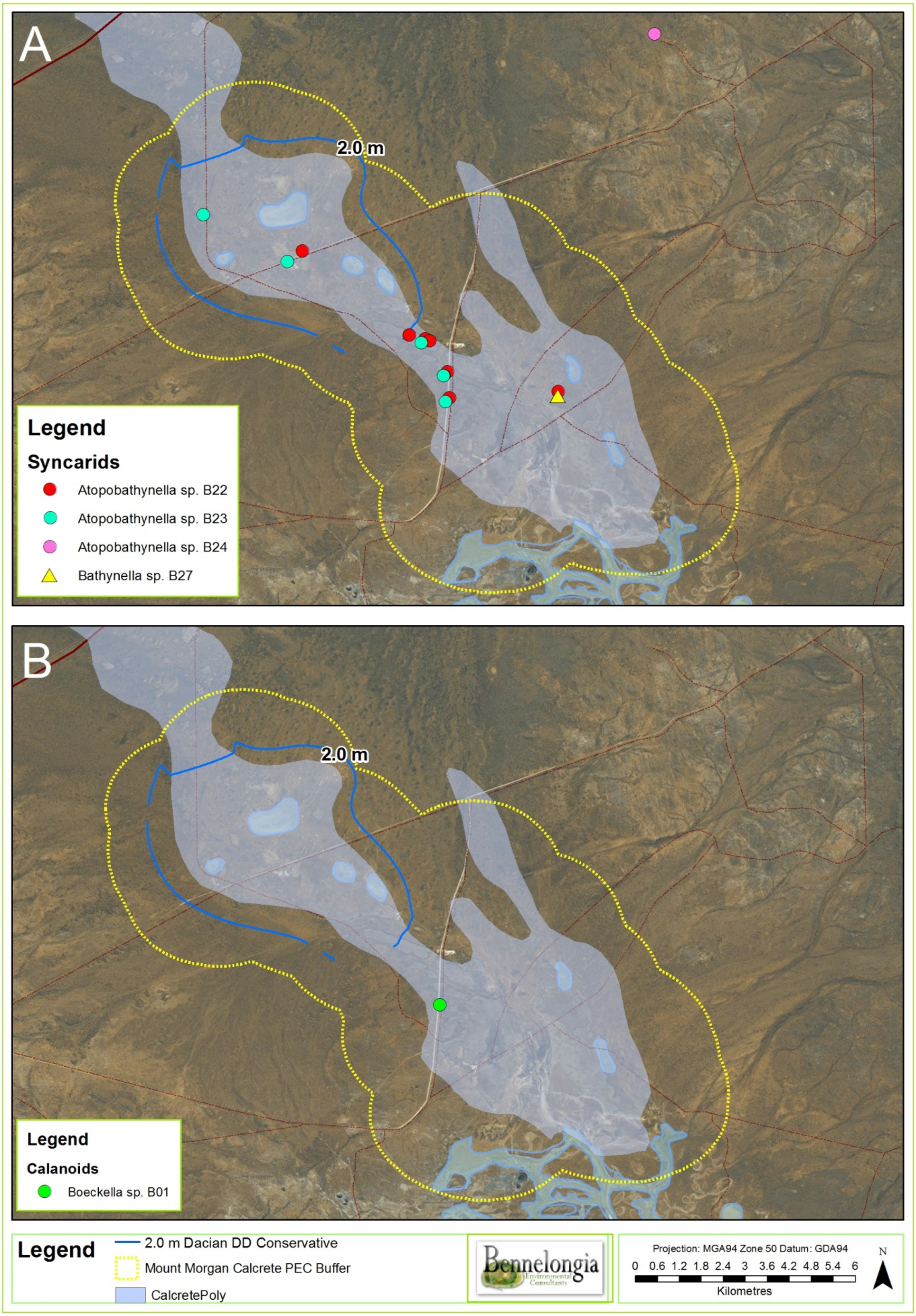

Figure 6. Collection locations of (A) syncarids and (B) calanoid copepods possibly restricted to the Project area.

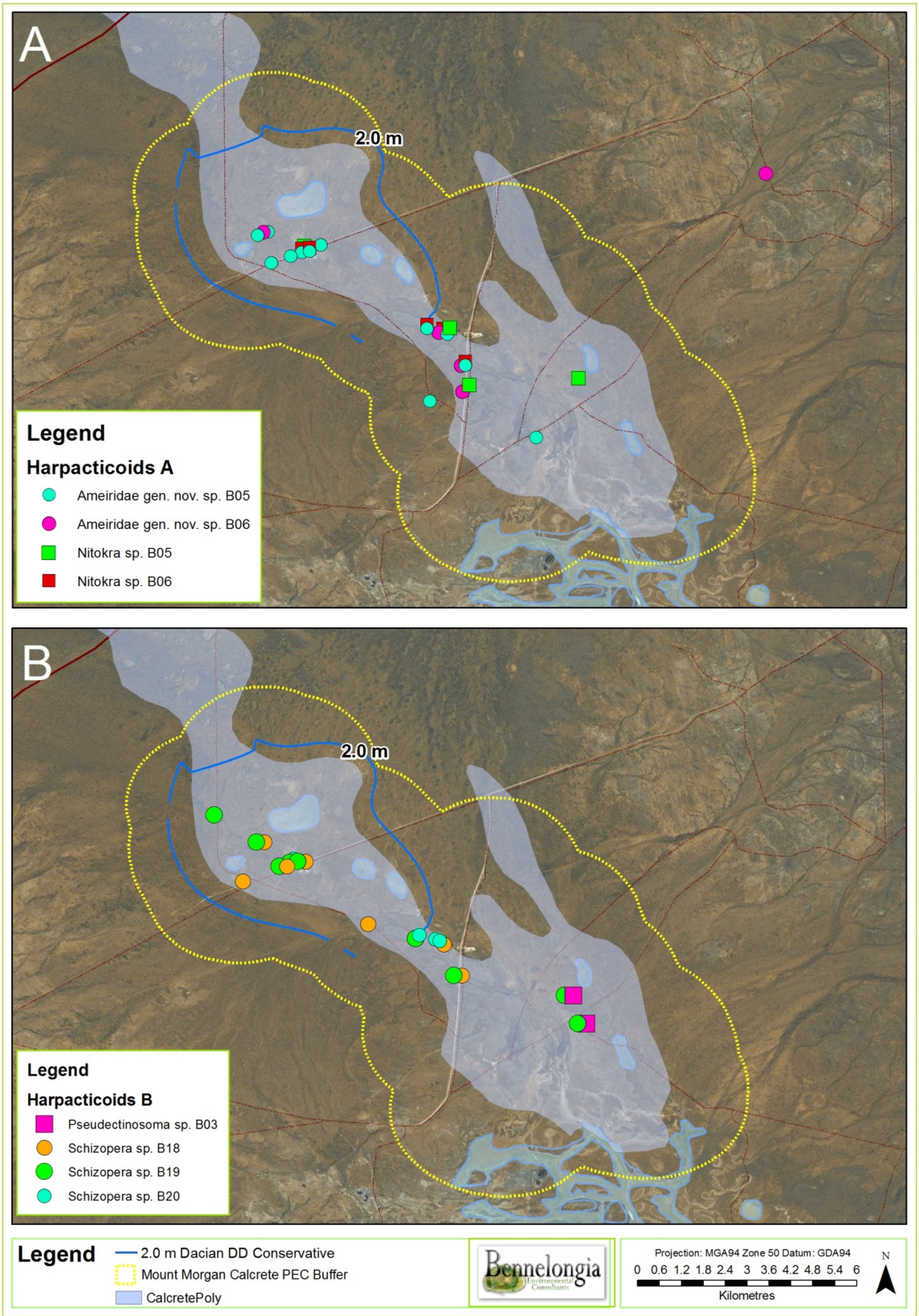

Figure 7. Collection locations of harpacticoid copepods (both panels) possibly restricted to the Project area.

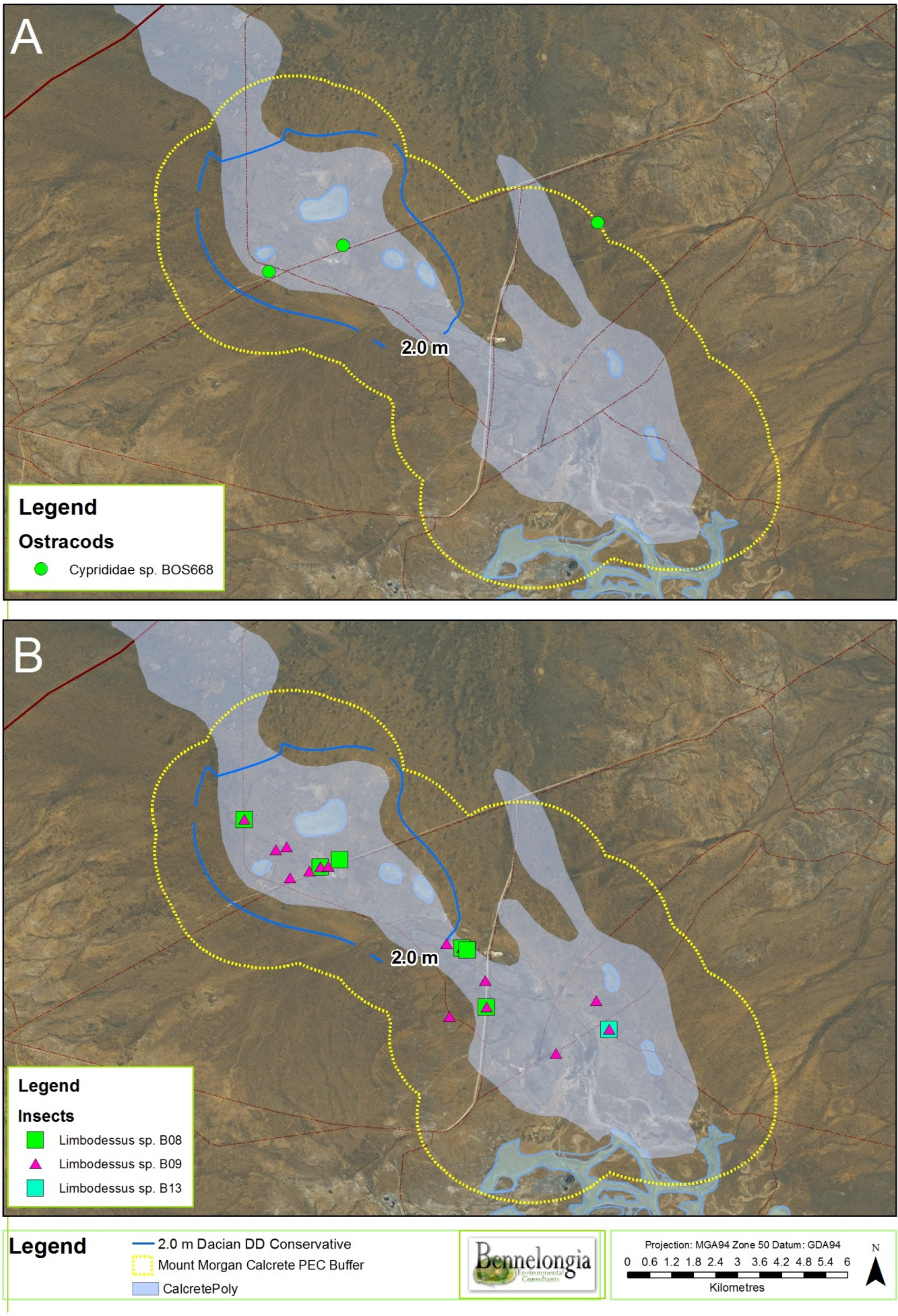

Figure 8. Collection locations of (A) ostracods and (B) dytiscid beetles possibly restricted to the Project area.

Table 4. Impact assessment of stygofauna species recorded in the Project area.
Grey shading indicates species that are known only from impact areas.

Taxonomy	Lowest Identification	No. of individuals	Bores	Impact	Reference	Comments on distribution
Platyhelminthes						
Turbellaria	Turbellaria sp.	10	PB5	10	0	Not currently assessed in EIA.
	Microturbellaria sp.	1	PB7	1	0	Not currently assessed in EIA.
Rotifera						
Bdelloidea	Bdelloidea sp. 2:2	304	Euro Well, Kelly Well, Red Flag Well, Shepherd Well, Siding Well	0	304	Morphospecies is widespread throughout WA but may contain multiple species. Group not currently assessed in EIA.
	Bdelloidea sp. 7:7	1	McKenzie Bore	0	1	Morphospecies is widespread throughout WA but may contain multiple species. Group not currently assessed in EIA.
Eurotatoria						
Monogononta						
Ploima	*Brachionus* sp.	4	Cameron Well, JP60	2	2	Linear range >1.5 km; recorded outside 2 m drawdown.
Nematoda						
	Nematoda sp.	9	Bore 4, PB1, Bore 6, Shepherd Well	3	6	Species range over 9 km including within southern bore area which will not be impacted by drawdown; group not currently assessed in EIA.
Annelida						
Aphanoneura	*Aeolosoma* sp.	25	Cameron Well	0	25	Not identified to species but genus widespread across WA. Recorded outside 2 m drawdown.
Clitellata						
Enchytraeida	Enchytraeidae sp.	6	PB8, Bore 6	6	0	Common family with incomplete taxonomy. Species tend to be restricted to single catchments (scales of tens to hundreds of kilometres), although some are widespread (Brown et al. 2015). Likely to occur in reference areas.
Haplotaxida	*Pristina aequiseta*	1	Pastoral Bore	1	0	Widespread species that occurs across WA.
	Phreodrilidae `with similar ventral chaetae`	3	Kelly Well	0	3	Morphospecies that is widely distributed across WA. Recorded outside drawdown.
	Tubificidae sp.	1	PB1	1	0	Not identified to species level but species of the family are usually widely distributed. Collected as singleton so range unclear, but likely to occur widely across study area.
Arthropoda						

Taxonomy	Lowest Identification	No. of individuals	Bores	Impact	Reference	Comments on distribution
Crustacea						
Malacostraca						
Isopoda	*Angeliera* sp. B01	4	DCN001	0	4	Probably endemic to Mt Morgan Calcrete. Recorded outside 2 m drawdown.
	?*Adoniscus* sp. B02		DCN001	0	1	Probably endemic to Mt Morgan Calcrete. Recorded outside 2 m drawdown.
	Andricophiloscia sp. B01	1	JP49	0	1	Probably endemic to Mt Morgan Calcrete. Recorded outside 2 m drawdown.
	Andricophiloscia sp. B02	3	Bore 6, PB6	3	0	Known linear range of <1 km; probably endemic to Mt Morgan calcrete.
	Haloniscus sp. B08	65	Bore 6, DCN001, JP60, CTB18, PB5, PB6, PB7	47	18	Species range over 7 km including southern bore area. Recorded outside predicted 2 m drawdown.
	Haloniscus sp. B09	21	Bore 5, Bore 7, JP19, JP50, CTB18	20	1	Species range over 7 km including southern bore area. Recorded outside predicted 2 m drawdown.
Syncarida	*Bathynella* sp. B27	2	DCN 001	0	2	Probably endemic to Mt Morgan Calcrete. Recorded outside 2 m drawdown.
	Atopobathynella sp. B22	54	DCN001, JP49, JP50, JP60, CTB18, PB8	3	51	Species range over 7.5 km including southern bore area. Recorded outside predicted 2 m drawdown.
	Atopobathynella sp. B23	17	Bore 1, CTB22, JP49, JP50, PB7	3	14	Species range over 7 km including within southern bore area. Recorded outside predicted 2 m drawdown.
	Atopobathynella sp. B24	9	Ghan Well	0	9	Probably range restricted; recorded at a single regional reference bore outside impact area.
Maxillopoda						
Calanoida	*Boeckella* sp. B01	17	JP49	0	17	Trogloxene; congeners known from surface waters. Recorded outside 2 m drawdown and probably widespread.
Cyclopoida	*Dussartcyclops uniarticulatus*	53	Pastoral Bore, Cameron Well, Kelly Well	1	52	Species distributed outside study area (Murchison region, Karanovic 2004). Presently recorded in reference bores.
	Fierscyclops (Fierscyclops) fiersi	262	Bore 1, Bore 3, Bore 4, Bore 6, Bore 7, DCN001, JP49, JP60, CTB18, PB1, PB2, PB3, PB5, PB6, PB7, PB8	220	42	Species known from outside study area (Murchison region; Karanovic 2004). Presently recorded from reference bores.
	Halicyclops eberhardi s.l.	28	CTB22, JP49, McKenzie Bore, JP50, JP60	22	6	Known from outside the study area (Murchison and Gascoyne regions; Karanovic 2004).

Taxonomy	Lowest Identification	No. of individuals	Bores	Impact	Reference	Comments on distribution
	Halicyclops kieferi	79	Bore 3, Bore 5, Bore 6, CTB22, JP19, JP49, JP50, JP60,CTB18, PB5, PB6, PB8	51	28	Species distributed outside study area (Murchison region, Karanovic 2004). Presently recorded in reference bores.
	Mesocyclops brooksi	52	Pastoral Bore, Cameron Well	51	1	Widespread across Australia (Australian Faunal Directory).
	Metacyclops superincidentis	1	JP49	0	1	Known from outside the study area (Murchison region, Karanovic 2004).
	Pescecyclops laurentiisae	5	JP19, PB7	5	0	Species known from locations outside the study area (Murchison region; Karanovic 2004).
Harpacticoida	Ameiridae gen. nov. sp. B05	470	Bore 3, Bore 5, Bore 6, Cameron Well, CTB18, CTB22, JP50, JP60, CTB18, PB1, PB5, PB6, PB7, PB8	402	68	Species range over 8.5 km including southern bore area which will not be pumped.
	Ameiridae gen. nov. sp. B06	28	Bore 6, CTB22, JP49, JP50, Siding Well	12	16	Species range over 6 km including southern bore area which will not be pumped.
	Nitokra lacustris pacifica	15	CTB22, PB2, PB5, PB6	14	1	Widely distributed in WA including Murchison (Karanovic 2004) and South West (Knott and Tang 2009), as well as abroad (Australian Faunal Directory)
	Nitokra sp. B05	8	JP49, CTB18, DCN001, PB5	1	7	Linear range over 4 km. Presence at both Jupiter and Mt Morgans impact areas suggests continuity of habitat between the two areas. Recorded in reference bores.
	Nitokra sp. B06	16	CTB22, JP50, JP60, PB5, PB7	7	9	Range over 3.5 km. Presence at both Jupiter and Mt Morgans impact areas suggests continuity of habitat between the two areas. Recorded in reference bore CTB22.
	Australocamptus similis	119	Aemotor Well, Cameron Well, GST1, Kelly Well, Red Flag Well, Pastoral Bore	1	118	Species distributed outside study area (Murchison region, Karanovic 2004). Presently recorded in reference bores.
	Pseudectinosoma sp. B03	3	Bore 7, DCN001	0	3	Known linear range of <1 km. Recorded in reference bores.
	Schizopera sp. B18	15	Bore 6, CTB22, CTB18, PB2, PB6, PB7, JP19	13	2	Range over 4 km. Recorded in reference bores.
	Schizopera sp. B19	52	Bore 1, Bore 6, Bore 7, DCN001, CTB22, JP60, PB5, PB6, PB7	21	31	Range over 7 km. Recorded in reference bores

Taxonomy	Lowest Identification	No. of individuals	Bores	Impact	Reference	Comments on distribution
	Schizopera sp. B20	11	CTB18, JP50, JP60, PB5	5	6	Range over 4 km. Presence at both Jupiter and Mt Morgans impact areas suggests continuity of habitat between the two areas. Recorded in reference bores.
Ostracoda						
	Cyprididae sp. BOS668	5	Kelly Well, PB2, PB8	2	3	Specimens incomplete or immature; may include genus *Cyprinotus*, a stygophile inhabiting both surface and subterranean aquatic habitats and consequently likely to be widespread.
	Sarscypridopsis aculeata	29	Cameron Well, Bore 2, Pastoral Bore, PB2	28	1	Cosmopolitan surface water species/stygophile (AFD)
	Sarscypridopsis orchracea	36	Cameron Well	0	36	Cosmopolitan surface water species/stygophile (e.g. Martens et al. 1996)
Hexapoda						
Insecta						
Coleoptera	*Limbodessus* sp. B08	49	Bore 1, JP49, JP50, CTB18, PB5, PB8	16	33	Range over 10 km including southern bore area which will not be pumped.
	Limbodessus sp. B09	210	Bore 1, Bore 3, Bore 6, Bore 7, Cameron Well, CTB22, DCN001, JP49, JP50, CTB18, PB1, PB5, PB6, PB7, PB8	111	99	Range over 10 km including southern bore area which will not be pumped.
	Limbodessus sp. B13	2	Bore 7	0	2	Recorded from single reference bore the southern bore area.

5. IMPACT ASSESSMENT AND MANAGEMENT OF SUBTERRANEAN FAUNA

5.1 Overview

Two types of mine-related impacts are recognised in this report: 1) *Primary Impacts* from proposed mining have the potential to threaten the persistence of subterranean fauna through direct removal of habitat, and 2) *Secondary Impacts* reduce population densities rather than threatening species persistence. Reduction in the quality of subterranean fauna habitat as a result of nutrient enrichment through increased surface inputs from sewerage, or increased turbidity from mine blasting, are examples of secondary impacts (Masciopinto *et al*. 2006; Scarsbrook and Fenwick 2003).

When assessing the threat to subterranean fauna species from the proposed Project, only primary impacts are considered, although it is recognized that the cumulative effect of secondary impacts may also be detrimental. A background on factors causing secondary impact is given in Appendix 2.

5.2 Troglofauna Impacts

Excavation of open pits is considered to be the main mining-related threat to troglofauna. Impacts at Westralia are limited to a small pit cutback and underground mine developments that will be accessed via existing pits. It is therefore not anticipated that there will be any impacts on troglofauna in the Westralia area.

Pit excavation at Jupiter has the potential to result in loss of troglofauna habitat. However, as previously stated, habitat for troglofauna is limited due to the narrow band of suitable substrate bounded between the surface and the high water table. The proposed mine pits are not expected to cover more than 80 ha (Figure 3), with considerable parts of this area already having been previously mined, so that it is highly unlikely mining would threaten any troglofaunal species at Jupiter. Even highly restricted troglofaunal species in habitats with strong topographical relied and the potential for barriers to dispersal usually have ranges larger than 100 ha.

Activities proposed within the production borefield are limited to groundwater abstraction, with no surface disturbance proposed. There are no troglofaunal impacts are expected within the borefield.

5.3 Stygofauna Impacts

Two activities lead to most of the stygofauna habitat loss associated with mining. These are:

(1) *Groundwater drawdown*. Drawdown of aquifers from dewatering of mine pits or the abstraction of groundwater for ore processing can threaten the persistence of any stygofauna species restricted to the area of drawdown.

(2) *Pit excavation*. Removal of stygofauna habitat when excavating mine pits can threaten the persistence of any stygofauna species restricted to the mine pit. This impact can be assessed when considering groundwater drawdown because the mine pits are contained within the area of drawdown.

Potential impacts to stygofauna and habitat associated with each project area are discussed below.

Westralia

Dacian proposes to develop three underground mines within the Westralia area, which will require dewatering to allow mining at depths below the water table. Although the groundwater quality is considered suitable for stygofauna, the low permeability of the surrounding geology suggests that significant stygofauna populations are unlikely to occur and that any drawdown associated with mine dewatering will be limited in terms of spatial extent.

Jupiter

Owing to the hypersaline nature of groundwater at Jupiter, combined with the low permeability of the surrounding geology, Jupiter is unlikely to support significant stygofauna populations. Dewatering at Jupiter is therefore not considered to present a potential impact to stygofauna.

Production Borefield

Reference and impact sites were classified based on predictive drawdown modelling conducted by Red Creek Water Solutions Pty Ltd (2016), whereby bores outside the predicted 2 m drawdown contour were deemed reference sites and those inside this contour were deemed impact sites.

Of the 45 stygofauna species recorded in the study area, 38 species were collected from bores in reference areas, while two species (*Pristina aequiseta* and *Pescesyclops laurentiisae*) were only recorded in the impact area but are known to occur outside the study area. These species are not of conservation significance, even though many of them also occur in the area of groundwater drawdown associated with the borefield. A further two species (flatworms Turbellaria sp. and Micorturbellaria sp.) were collected only in the impact area but belong to groups not assessed in environmental impacts assessments (EPA 2007).

The remaining three species are known only from the area of groundwater drawdown. They are the immature oligochaetes Enchytraeidae sp. and Tubificidae sp. and the isopod *Andricophiloscia* sp. B02. The occurrence of these species is discussed in detail below.

5.3.1 Assessment of taxa restricted to impact areas

Tubificidae sp. and Enchytraeidae sp.

The oligochaete Tubificidae sp. was damaged during collection from bore PB1, leaving the animal as a fragment that could be identified only to family level. Thus, there is little basis for inferring a likely species range. While some stygal tubificid species have large ranges (e.g. *Monopylephorus* sp. nov. WA29 and Tubificidae sp. WA21 which extend across large parts of the Pilbara, Halse *et al*. 2014), other species appear to more restricted, although this may be a sampling artefact (Pinder *et al*. 2006). Many of the wide-ranging species occur in both surface and groundwater. A study in Spain suggested a third of stygal oligochaetes in the region had tightly restricted distributions, almost another third had linear ranges of <240 km and the remaining species were widespread (Achurra *et al.* 2015).

The oligochaete Enchytraeidae sp. was recorded in low numbers at two impact sites, Bore 6 (five individuals) and PB8 (1 individual), resulting in an inferred minimum linear range of approximately 1.3 km. This is likely to be a substantial underestimation of the actual species range, which needs to be several kilometres larger to extend outside the area of drawdown.

While there is some genetic information from assessment reports that can be interpreted as suggesting enchtraeids have small ranges, it is considered that stygal oligochaetes, including enchytraeids, tend to

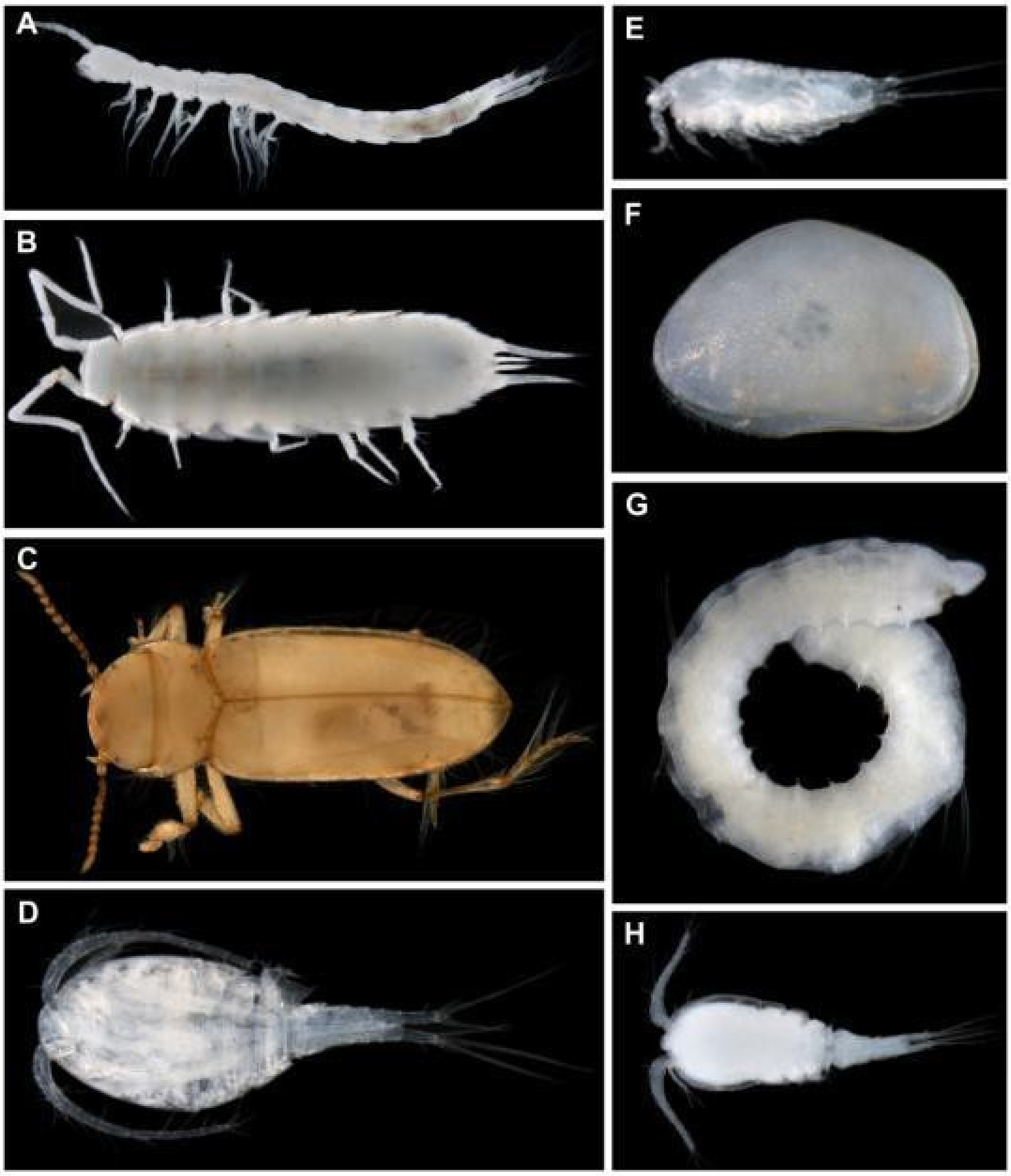

Figure 9. Exemplar taxa of the stygofauna recorded at the Project area.
A) *Atopobathynella* sp. B22; B) *Haloniscus* sp. B08; C) *Limbodessus* sp. B09; D) *Mesocyclops brooksi*; E) *Schizopera* sp. B18; F) *Sarscypridopsis ochracea*; G) *Pristina aequiseta*; and H) *Fierscyclops (Fierscyclops) fiersi*.

have catchment-scale distributions (i.e. tens to hundreds of kilometres in the Pilbara and, by analogy, the Yilgarn (Brown *et al*. 2015). However, haplotypes are typically restricted to single catchments (although some occur across multiple creek catchments and river basins), suggesting the level of dispersal is low (Brown *et al*. 2015). The current study area coincides with the Mt Morgan Calcrete PEC, which exhibits considerable transmissivity and, presumably, habitat continuity. It can therefore be reasonably expected that both Enchytraeidae sp. (as well as Tubificidae sp.) occur widely across the Project area and, therefore, are unlikely to be significantly impacted by groundwater abstraction.

***Andricophiloscia* sp. B02**

The oniscidean isopod *Andricophiloscia* sp. B02 was recorded from the impact Bore 6 (2 individuals) and PB6 (1 individual), giving an inferred linear range of approximately 0.8 km. Based on evidence from previous biogeographic studies of subterranean isopods in the Yilgarn, it is highly likely that this species is a short range endemic that is restricted to the Mt Morgan Calcrete. In a study of 12 calcrete aquifers along three palaeodrainages in the Yilgarn, Javidkar (2014) identified 28 discrete lineages of subterranean oniscidean isopods, each of which probably represents a new species. Furthermore, only three of these lineages were recorded from more than one calcrete, invariably from nearby calcretes within a single palaeodrainage, while the remaining species were restricted to individual aquifers.

These results exemplify the high incidence of short range endemism among subterranean isopods in Western Australia (see also Cooper *et al*. 2008). However, it is suggested that the range of *Andricophiloscia* sp. B02 is likely to extend outside the area of groundwater drawdown for two reasons. First, the high transmissivity of the calcrete aquifer provides continuous habitat between the area of drawdown and its surrounds. In regards to the distribution capabilities of stygal species, Guzik et al. (2009) suggested that population structure in a stygal dytiscid was influenced by body size, with smaller species having greater dispersal capabilities. *Andricophiloscia* sp. B02 has a much smaller body size than the more widely spread *Haloniscus* B08 and so could be expected to have a similar or greater distribution throughout the aquifer.

Second, the wider occurrence of the related *Haloniscus* sp. B08 (as well as *Haloniscus* sp. B09) provides biological evidence there is suitable continuous habitat for *Andricophiloscia* sp. B02 outside the drawdown area (Figure 5). *Haloniscus* sp. B08 occurs together with *Andricophiloscia* sp. B02 at both Bore 6 and PB6, as well as having a range extending south-east outside the area of groundwater drawdown. The occurrence of *Haloniscus* sp. B09 to the south-east is further evidence of suitable habitat for isopods outside the drawdown area. Thus, it is considered unlikely that *Andricophiloscia* sp. B02 will be significantly impacted by groundwater abstraction.

5.3.2 Stygofauna community composition between impact and reference sites

Further information about the likely level of threat to the potentially conservation significant species is provided by examination of the past effects of groundwater drawdown. Analyses of stygofauna data using *t*-tests (assuming equal or unequal variance as appropriate) reveal that there is no significant difference in mean abundance (df= 20.21, p= 0.32) or mean number of species (df= 37, p= 0.21) per bore between reference and impact sites (Table 5). This suggests that historical pumping has not had a significant impact on the abundance and diversity of stygofauna communities in the study area. For example, production bores JP60, PB5, 6 and 7, which were historically pumped, all recorded higher than average abundance (314, 235, 87 and 140 individuals, respectively) and richness (12, 13, 10 and 10 species, respectively) (Table 5).

Table 5. Summary table of stygofaunal communities at impact and reference sites.
Mean values are given as mean ± SE.

	Site type		All sites
	Reference	Impact	
No. of bores (n)	23	16	39
Total count (abundance)	1054	1125	2179
Mean abundance per bore	45.83 ± 9.08	70.31 ± 23.06	55.87 ± 10.67
Total richness	38	31	45
Mean richness per bore	4.57 ± 1.02	6.56 ± 1.14	5.38 ± 0.77
Number of species exclusive to site type	14	7	NA

5.3.3 Historic groundwater hydrology

Historic groundwater abstraction and water level data from March 1988 to May 1990 and July 1992 to June 1997 (the period during which the borefield operated) has been collated by GRM (2016) and used to assess the impacts from earlier groundwater production on the groundwater environment. A summary of the maximum drawdown and minimum saturation layer are included in Table 6. Key findings of the GRM assessment are given below, with the full memo report provided as Appendix 5.

Groundwater levels in all the bores show a good response to rainfall recharge. In particular, the rapid rise observed after Cyclone Bobby in February 1995, which delivered a three-day rainfall total of 225 mm locally resulted in a groundwater level rise of approximately 2–4 m.

Lower yielding bores, PB1 in particular, were severely impacted by pumping, with saturated thicknesses in the calcrete aquifer reduced by up to 80%, equivalent to a residual saturated thickness of about 1 m at PB1. These severe impacts were sustained over many months in response to continued pumping. Despite this, PB1 yielded five species and a total of 31 individuals. These values were comparable to overall averages for abundance and richness per bore, and were higher than yields obtained from Bores 2, Bore 7, JP19 and PB3, none of which was historically pumped. This indicates suggests that the inherent fauna may be robust to substantial drawdown. It is possible, however, that the low yields from the aforementioned bores are a consequence of their position or construction (Hahn and Matzke 2005; Halse et al. 2014).

The negligible drawdowns observed in non-pumping bore PB3, located about 400 m from PB1 and 200 m from PB2, suggest drawdown associated with abstraction will be localised around future operating production bores. This interpretation is consistent with the lack of impact seen in higher yielding bores PB5, 6 and 7 that were pumped consistently over the later period of mining, despite their proximity to each other (i.e. 270 m from PB5 to PB6; 200 m from PB5 to PB7). Overall, these results show that borefields at Mt Morgan have been able to sustain a combined mean pumping rate of around 26 L/s over a period of about 10 years, with a recorded maximum annual abstraction of approximately 1 GL.

Water levels in the aquifer appear to have recovered from historical pumping and depths to standing water levels are similar to the baseline values. Bores PB5, PB6 and PB7 have an average standing water level of 1.65 m higher than levels recorded prior to historical pumping, whereas bores JP60, PB1 and PB22 are on average 0.73 m lower (Table 6). It is also apparent from available data that pH values recorded before and after historical pumping are similar (Table 6).

The salinity in the calcrete aquifer varies considerably, both spatially and temporally. At the production bores, salinities range from 2,600–17,000 mg/L TDS based on records from 1996. Similar ranges in salinity were recorded by Bennelongia in 2016 (3,310–23,500 mg/L TDS). However, a maximum value of 28,100 mg/L was recorded at groundwater exploration hole JP45 at the southern end of the unit (MMA 1990). The impacts of dewatering on EC and salinity gradients (vertical and horizontal) are unclear, although five out of six historically pumped bores showed increases in EC of between 1.51 mS/cm and 8.44 mS/cm.

5.3.4 Management of Future Groundwater Abstraction from the Borefield

Dacian proposes to abstract groundwater from existing production bores, supplemented by additional bores constructed in the calcrete aquifer (all to be located within the survey area) to meet the Project raw water demands of about 105 L/s, or 9.1 ML/day over a period of eight years.

Drawdown modelling was completed by Red Creek Water Solutions Pty Ltd (2016). The modelling assumed a groundwater abstraction rate of 106 L/s from 20 production bores within the Calcrete Aquifer. The combined abstraction rate from the 20 production bores was 9100 m^3/d (106L/s). The volume of groundwater abstraction is about 3.3 GL per year and 26.7 GL over the 8 years of mining operations. The modelling included a base case scenario and a conservative scenario. The conservative (worst case) model has been used by Bennelongia to assess impacts to stygofauna. This model assumes that groundwater levels are sustained by rainfall recharge only (i.e. they do not include other hydrogeological processes such as groundwater inflow from the underlying palaeochannel). Additionally, the conservative model used to derive the 2 m drawdown contours in this assessment assumes that a large rainfall event does not occur until Year 7 during the 8 years of proposed operations.

After 7 years of operations and before the onset of the large rainfall event, groundwater levels are lowered by up to 4 m in the central portion of the borefield. Saturated thickness in the central areas of the borefield is predicted to be about 2 m (40% of the aquifer thickness). Saturated thickness at JP60 is predicted to be 2.5 m (50% of the aquifer thickness).

Groundwater levels outside of the central borefield area are predicted to be lowered gradually during the borefield operations, with slightly more than 0.5 m drawdown occurring after 2 years of operations, after which groundwater levels continue to lower during the remaining 5 year of operations. The southern region of the Calcrete Aquifer (i.e. 100 m south of JP60), is predicted to remain largely unaffected by drawdown (e.g. between 0.5 to 1.5 m drawdown). To the north, loss of saturated thickness as a result of drawdown is greater than to the south.

The model predicts that groundwater levels rapidly recover in response to the large rainfall event in year 7, with groundwater levels increasing by about 1.5 m. For the worst case modelling scenario, it is predicted that 70% of the saturated thickness of the calcrete aquifer will be retained for the duration of operations. Additionally, a layer of sand underlies the calcrete and will remain saturated during and after the dewatering period.

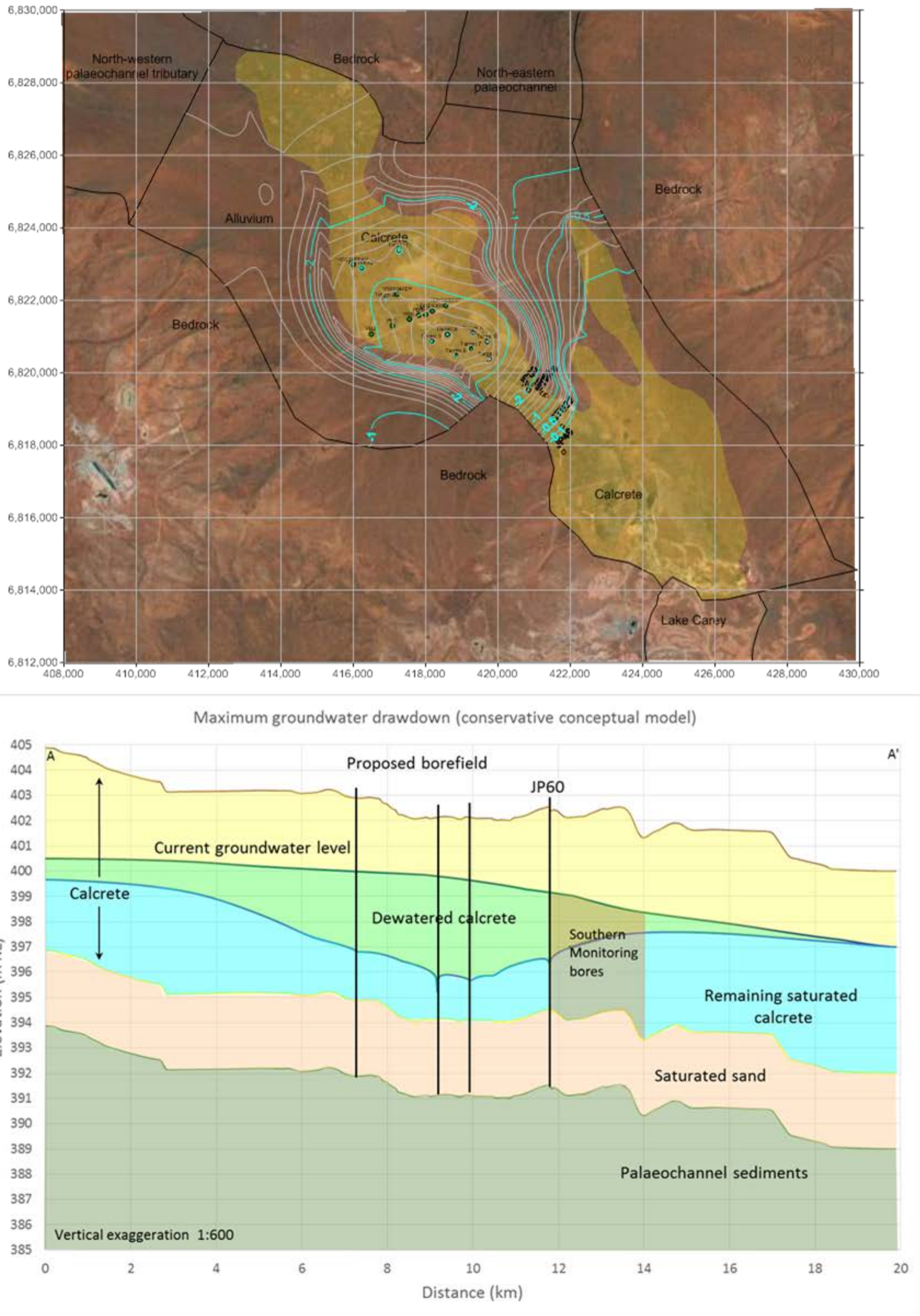

Figure 10. (From top) Predicted drawdown and long-section of the Mt Morgan Calcrete 7 years after the commencement of dewatering from the proposed production borefield under base case scenario.

Table 6. Comparison of historical and current water properties at monitoring bores.

	JP60		PB1		PB2		PB5		PB6		PB7	
Location	Jupiter borefield		Mt Morgans Borefield		Mt Morgans Borefield		Mt Morgans Borefield		Mt Morgans Borefield		Mt Morgans Borefield	
Period of operation	Feb 95- Jun 97		Feb 88- Apr 96		Feb 88 – Dec 95		Aug 89 – Jun 97		Aug 89 – Jun 97		Jul 92 - Jun 97	
Max drawdown (m)	1		4		3		3		3		3	
Min saturated thickness (m)	4		1		2		2		3		6	
	Historical	2016	Historical	2016	Historical	2016	Historical	2016	Historical	2016	Historical	2016
SWL (m)	3.00	3.75	2.75	3.40	2.75	3.53	4.10	2.77	3.75	2.78	5.00	2.36
DWL difference	-0.75		-0.65		-0.78		1.33		0.97		2.64	
EC (μs/cm)	14,000	22,440	8,500	10,010	2,600	6,290	13,000	17,785	9,400	13,980	17,000	14,535
EC difference	8,440		1,510		3,690		4,785		4,580		-2,465	
pH [+]	7.55	7.05	7.4	7.26	7.36	8.00	7.38	7.12	7.34	7.24		7.43
Temp °C		23.23		25.35		25.15		25.10		25.60		24.85

Note: salinities were taken from the 1996 to 1997 wellfield assessment (Woodward-Clyde 1996); historical SWL data are estimated from figures provided in GRM 2016 and values represent SWL prior to pumping, where possible. Data for 2016 are means of values recorded during stygofauna sampling phases 1, 2 and 3.

Bore PB3 was never historically pumped, but was also monitored between 1988 – 1990 due to its close proximity to PB1 (400 m) and PB2 (200 m). The drawdowns observed at the bore were negligible over the limited period of record.

6. CONCLUSIONS

This report collated the findings of a desktop review on subterranean fauna and a comprehensive stygofauna assessment for the Mt Morgans Gold Project. Troglofauna survey was not considered to be necessary because the available information suggested that no significant troglofauna community is likely to occur.

The most prospective habitat for stygofauna occurs within the production borefield which is located within a calcrete aquifer that covers an area of about 60 km^2 and forms an elongate unit that broadly trends northwest from the northern margin of Lake Carey. The unit is thin, sub-cropping close to surface with a maximum depth of about 10 m. It comprises vuggy carbonate rock interbedded with alluvium and silcrete and was identified to be good habitat for stygofauna. The calcrete aquifer comprises the Priority 1 PEC, '*Mt Morgan calcrete groundwater assemblage type on Carey paleodrainage on Mount Weld Station*'.

Habitat for troglofauna may be present above the water table at Westralia although this area will only be mined underground and therefore will not impact widely on any troglofauna communities. At Jupiter, habitat for troglofauna is limited because the geology is predominantly syenite and basaltic rock types, with a general absence of vugs and voids in substrate above the water table. At the production borefield there is only a low-moderate likelihood of troglofauna due the shallow depth to water (ranging between 3 to 6 mbgl) which is likely to constrain the extent of habitat available to troglofauna in the area. More importantly, there will be no disturbance of habitat above the water table in the production borefield. Considering also that only eleven troglofauna species were identified in the desktop assessment within the search area, troglofaunal is not considered to be a relevant assessment factor at the Project.

Field sampling of stygofauna yielded a total of 2,179 specimens belonging to at least 45 species of stygofauna. Crustaceans were by far the most diverse group with 31 species in six orders: harpacticoid copepods (10 species), cyclopoid copepods (7), isopods (6), ostracods (2), syncarids (4) and calanoid copepods (1). Forty of these species are known to occur outside the predicted area of groundwater drawdown. Two species of flatworm were recorded from the 2 m drawdown area only, but are currently not assessed in EIA. A further three species are known only from the drawdown area: the worms Tubificidae sp. and Echytraeidae sp. and the isopod *Andricophiloscia* sp. B02. While it is difficult to determine the ranges of species identified only to family level, both worm species are considered likely to be widespread at the Project scale and not threatened by drawdown. The isopod *Andricophiloscia* sp. B02 is likely to be restricted to the Mt Morgan calcrete. However, it is likely to extend beyond the area of groundwater drawdown because of high habitat connectedness across the calcrete, as shown by the wider distribution of the biological surrogate Haloniscus sp. B09. Accordingly, *Andricophiloscia* sp. B02 is unlikely to be threatened by Project-related groundwater drawdown.

Further confidence that drawdown will not significantly affect the stygofauna community in the Project area is provided by analysis of stygofauna communities inside and outside the area affected by previous pumping of up to 1 GL annually. Both mean abundance and species richness per bore are similar between sites inside and outside the previous drawdown, which suggests that stygofauna were not impacted by historic pumping of the borefield.

Based on drawdown modelling, the predicted loss of calcrete aquifer habitat as a result of groundwater abstraction associated with the Project is not likely to exceed 30 %.. A layer of saturated calcrete of 1.5–2 m thick will also persist throughout the most heavily impacted zones surrounding the production borefield. At JP60, a maximum of 2.5 m drawdown is predicted with a remaining saturated thickness of 2.5 m. The saturated layer of underlying sand will not be affected by pumping and may provide refuge/additional habitat for stygofauna.

6.1 Recommendations

In order to protect the habitat and species richness within the Mt Morgans PEC, Bennelongia recommends the following management framework should be adopted by Dacian:

- Ecological monitoring bores to be established within 500 m of production bores.
- Standing Water Level (SWL) measurements to be taken on a quarterly basis when bores are being pumped.
- Where SWLs measured in ecological monitoring bores indicate a trending decline in aquifer saturated thickness, monitoring of SWL to increase to a monthly frequency.
- Where monthly SWL monitoring suggests an ongoing reduction in saturated thickness, pumping rates of the production bore(s) to be reduced to maintain the groundwater levels predicted in the hydrogeological studies associated with this assessment.

Additionally, the potential impacts of groundwater abstraction at the Project on spatial and temporal patterns in salinity are unknown. Four of five bores historically pumped showed increases in electrical conductance (EC) of between 1.51 mS cm^{-1} and 8.44 mS cm^{-1}. Therefore, changes to EC in the dewatering impact zone and ecological monitoring bores should be monitored during and after groundwater abstraction, with follow up stygofauna monitoring if excessive changes in EC are observed.

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8. APPENDICES

Appendix 1 – Photographic assessment of diamond collars for subterranean habitat

To determine if there are suitable fissures or voids to support subterranean fauna at the Project, Bennelongia assessed photographs from three diamond collars (16JUDD0229; 16JUDD0251 and 16JURD0372) supplied by Dacian. In all, 30 photographs of approximately 204.05 m of core were assessed (example photographs are provided in Figure 10). Bennelongia has previously undertaken assessment of diamond collars in relation to the occurrence of troglofauna in the Pilbara and Yilgarn (Bennelongia 2008a; Bennelongia 2012a; Bennelongia 2012b). Experience from these previous assessments was incorporated into our interpretation of prospective troglofauna habitat.

Within the three collars reviewed, two showed some evidence of the types of vugs and voids observed when significant stygofauna and troglofauna communities are found (Figure 10). There was some apparent fracturing of the rocks at greater depths, but it is unlikely that these features represent subterranean fauna habitat. It is most likely the fissures and cracking are associated with the drilling process breaking the rock. One of the proposed pit areas at the Jupiter project has already been excavated in historical mining activities and thus while subterranean habitat may be present in the areas identified for pit extension, the impact to troglofauna communities is expected to be minimal.

16JUDD0229

16JURD372

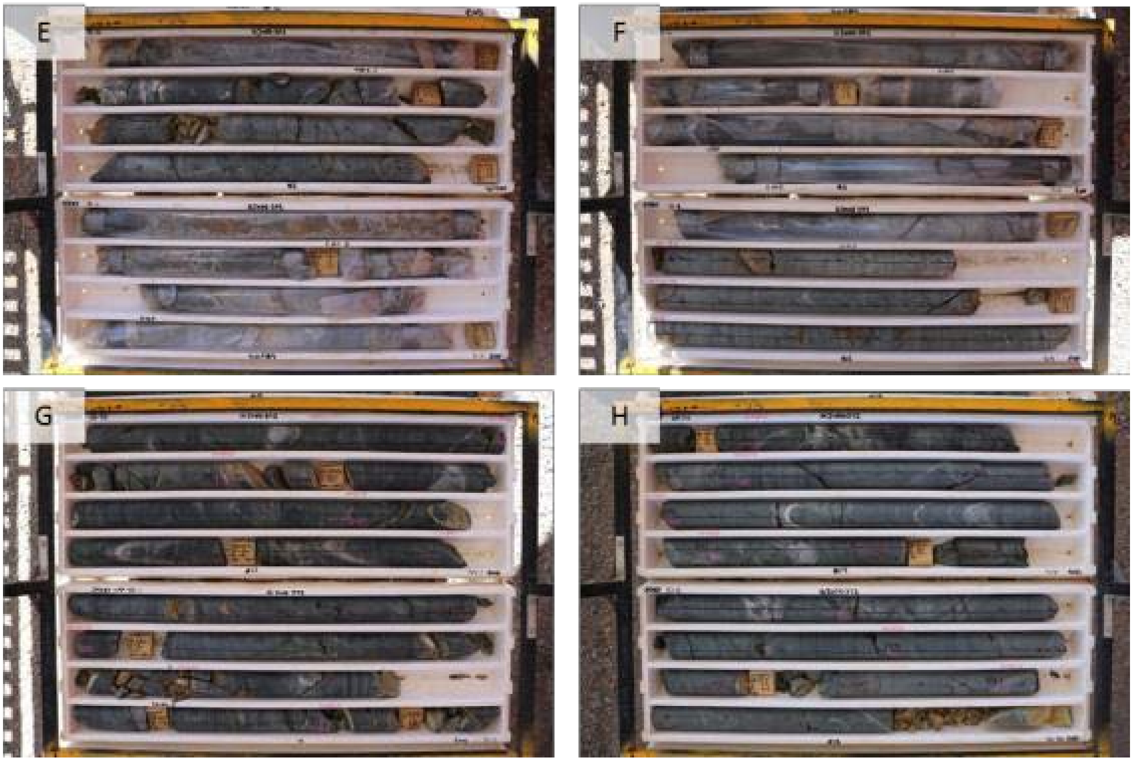

Figure 11. Examples of diamond collars.
(A) 16JUDD0229 at 0 m; (B) 16JUDD0229 at 10.4 m; (C) 16JUDD0229 at 35.6 m; (D) 16JUDD0229 at 55.5 m; (E) 16JURD372 at 3.4 m; (F) 16JURD372 at 9.4 m; (G) 16JURD372 at 28.7 m; (H) 16JURD372 at 43.35 m.

Appendix 2 - Secondary Impact of Mining on Subterranean Fauna

Mining activities that may result in secondary impacts to subterranean fauna include:

1. *De-watering below troglofauna habitat*. The impact of a lowered water table on subterranean humidity and, therefore, the quality of troglofauna habitat is poorly studied but it may represent risk to troglofauna species in some cases. The extent to which humidity of the vadose zone is affected by depth to the watertable is unclear. Given that pockets of residual water probably remain trapped throughout de-watered areas and keep the overlying substrate saturated with water vapour, de-watering may have minimal impact on the humidity in the unsaturated zone. In addition, troglofauna may be able to avoid undesirable effects of a habitat drying out by moving deeper into the substrate if suitable habitat exists at depth. Overall, de-watering outside the proposed mine pits is not considered to be a significant risk to troglofauna.
2. *Percussion from blasting*. Impacts on both stygofauna and troglofauna may occur through the physical effect of explosions. Blasting may also have indirect detrimental effects through altering underground structure (usually rock fragmentation and collapse of voids) and transient increases in groundwater turbidity. The effects of blasting are often referred to in grey literature but are poorly quantified and have not been related to ecological impacts. Any effects of blasting are likely to dissipate rapidly with distance from the pit and are not considered to be a significant risk to either stygofauna or troglofauna outside the proposed mine pits.
3. *Overburden stockpiles and waste dumps*. These artificial landforms may cause localised reduction in rainfall recharge and associated inflow of dissolved organic matter and nutrients because water runs off stockpiles rather than infiltrating through them and into the underlying ground. The effects of reduced carbon and nutrient input are likely to be expressed over many years and are likely to be greater for troglofauna than stygofauna (because lateral movement of groundwater should bring in carbon and nutrients). The extent of impacts on troglofauna will largely depend on the importance of chemoautotrophy in driving the subterranean system compared with infiltration-transported surface energy and nutrients. Stockpiles are unlikely to cause species extinctions, although population densities of species may decrease under them.
4. *Aquifer recharge with poor quality water*. It has been observed that the quality of recharge water declines during, and after, mining operations as a result of rock break up and soil disturbance (Gajowiec 1993; McAuley and Kozar 2006). Impacts can be minimised through management of surface water and installing drainage channels, sumps and pump in the pit to prevent of recharge though the pit floor.
5. *Contamination of groundwater by hydrocarbons*. Any contamination is likely to be localised and may be minimised by engineering and management practices to ensure the containment of hydrocarbon products.

Appendix 3 – Location and properties of bores sampled by Bennelongia

Values for *in situ* water chemistry and, SWL and EOH are means of all sampling phases.

Bore Code	Site Classification	Sample Phase	Latitude	Longitude	SWL (m)	EOH (m)	EC (µs cm^{-1})	pH	Temp (°C)	No. of taxa	No. of individuals	Historically pumped
Aemotor Well	Reference	3	-28.7674	121.9521	6.69	16.00	4190	7.63	22.9	1	63	No
Bore 4	Reference	1, 3	-28.7621	122.2355	2.98	10.00	14910	7.50	27.0	2	31	No
Bore 5	Reference	1, 3	-28.7762	122.2161	2.72	10.00	31900	7.40	25.3	4	39	No
Bore 7	Reference	1, 2, 3	-28.7702	122.2291	3.80	10.67	29363	7.26	25.5	7	23	No
Bore 9	Reference	3	-28.7291	122.0799	12.84	15	3700	7.31	25.9	0	0	No
Cameron Well	Reference	1, 2, 3	-28.7672	122.1899	6.36	7.62	3383	8.16	22.9	10	103	No
CTB18	Reference	1, 2, 3	-28.7507	122.1943	3.89	9.00	25077	7.44	24.5	12	64	No
CTB22	Reference	1, 2, 3	-28.7584	122.1987	3.13	11.00	25630	7.13	25.2	13	107	No
DCN001	Reference	2, 3	-28.7631	122.2259	3.21	9.00	40560	7.10	24.9	12	31	No
Eight Foot Well	Reference	3	-28.6732	122.1393	2.73	5.00	914	7.16	22.1	0	0	No
Euro Well	Reference	3	-28.7621	122.2354	30.44	32.00	3090	7.58	24.2	1	100	No
Ghan Well	Reference	3	-28.6762	122.2486	10.78	16.50	1713	7.26	24.7	1	9	No
GST1	Reference	3	-28.7609	122.2473	3.24	70.00	255	6.63	26.7	1	1	No
JP49	Reference	1, 2, 3	-28.7648	122.1991	3.49	10.76	35867	7.53	25.9	14	69	No
JP50	Reference	2, 3	-28.7502	122.1932	3.24	11.64	25810	7.44	22.5	12	126	No
Kelly Well	Reference	3	-28.7231	122.2256	4.51	16.00	12590	7.65	21.6	6	80	No
McKenzie Bore	Reference	3	-28.7215	122.0055	10.61	17.50	1207	6.80	27.3	2	2	No
Red Flag Well	Reference	3	-28.7263	122.3044	14.16	20.00	1465	7.90	22.1	2	102	No
Shepherd Well	Reference	3	-28.7120	122.2054	3.47	4.00	12290	7.65	21.6	3	3	No
Siding Well	Reference	3	-28.7110	122.2738	20.92	23.00	928	6.76	25.8	2	101	No
Smith Well	Reference	3	-28.8269	122.0673	5.07	10	1620	7.77	24.2	0	0	No
Trig Well	Reference	3	-28.8010	122.3096	16.19	19	4700	7.5	29.0	0	0	No
Well Well	Reference	3	-28.8014	122.1267	4.82	11	4630	7.31	25.6	0	0	No
Bore 1	Impact	1, 2	-28.7187	122.1397	2.34	9.08	7380	367.17	25.7	6	70	No

Bore Code	Site Classification	Sample Phase	Latitude	Longitude	SWL (m)	EOH (m)	EC (µs cm^{-1})	pH	Temp (°C)	No. of taxa	No. of individuals	Historically pumped
Bore 2	Impact	1, 2*	-28.7188	122.1397	2.25	11.00	2150	5.12	25.5	1	1	No
Bore 3	Impact	1, 2	-28.7263	122.1475	2.17	8.00	5235	4.30	25.5	6	30	No
Bore 6	Impact	1, 2	-28.7255	122.1500	2.47	9.00	17490	7.19	26.4	13	57	No
Bore 10	Impact	3	-28.7086	122.1422	2.89	9	1045	3.43	26.8	0	0	No
CTB13	Impact	2, 3	-28.7494	122.1785	3.29	7.00	5300	7.84	25.2	1	1	No
JP19	Impact	1, 2	-28.7457	122.1757	2.49	9.79	6415	7.42	24.1	6	11	No
JP60	Impact	1, 2, 3	-28.7493	122.1893	3.75	9.24	22440	7.05	23.2	12	314	Yes
Pastoral bore	Impact	1, 2*	-28.7286	122.1400	2.54	5.00	6075	8.66	25.2	5	61	No
PB1	Impact	1, 2	-28.7331	122.1509	3.40	10.17	10010	7.26	25.4	5	31	Yes
PB2	Impact	1, 2	-28.7351	122.1449	3.53	13.00	6290	8.00	25.2	6	54	Yes
PB3	Impact	2	-28.7342	122.1478	2.63	9.00	6520	7.35	25.1	1	1	No
PB5	Impact	1, 2	-28.7305	122.1584	2.77	9.00	17785	7.12	25.1	13	235	Yes
PB6	Impact	1, 2	-28.7314	122.1557	2.78	10.00	13980	7.24	25.6	10	87	Yes
PB7	Impact	1, 2	-28.7303	122.1603	2.36	8.94	14535	7.43	24.9	10	140	Yes
PB8	Impact	1, 2	-28.7287	122.1631	2.73	8.79	21390	7.13	25.0	10	32	No

*Only water chemistry data collected.

Appendix 4 – Higher order taxa removed from list of species to avoid artificial inflation.

Taxonomy	Lowest Identification	No. of individuals	Bores	Impact	Reference	Regional reference (no. of individuals)	Comments on Taxonomy
Insecta							
Coleoptera	Limbodessus sp.	40	Bore 1, Bore 6, Bore 7, JP19, JP49, JP50, JP60, PB2, PB5, PB6, PB8	29	11	-	Larval specimens, likely to associate with one of three species recorded as adults from the Project area. All species recorded in reference bores.
Crustacea							
Isopoda	Haloniscus sp.	4	CTB18, JP49, Bore 3	1	3	-	Likely to belong to either *Haloniscus* sp. B08 or *Haloniscus* sp. B09.
Maxillopoda							
Cyclopoida	*Halicyclops* sp.	1	DCN001	0	1	-	Likely to belong to either *Halicyclops eberhardi* or *Halicyclops kieferi*.
Harpacticoida	Ameiridae sp.	14	CTB22	0	14	-	Likely to belong to either Ameiridae gen. nov. sp. B05 or Ameiridae gen. nov. sp. B06.
	Nitokra sp.	2	CTB22	0	2	-	Likely to belong to *Nitokra* sp. B05 or *Nitokra* sp. B06.
	Schizopera sp.	1	PB8	1	0	-	Likely to belong to one of three congeners recorded, all of which occurred in reference bores.

Appendix 5 – Historic groundwater production impacts (GRM 2016)

MEMORANDUM

From: Rob Garnham	Date: 16 March 2016	Project: J150010M02
To: James Howard	Company: Dacian Gold	
Re: Historic groundwater production impacts		

Background

Dacian Gold Ltd (Dacian) is undertaking a Feasibility Study (FS) for their Mt Morgan's Project near Laverton and has engaged Groundwater Resource Management Pty Ltd (GRM) to assist in the groundwater and surface water study components. This includes an investigation to identify a suitable project water supply, which is currently focussing on groundwater abstraction from a large calcrete unit located on Dacian's tenements north of the Jupiter prospect and east of the historical Mt Morgan's mining centre.

The calcrete aquifer has historically supplied make up water to the former Mt Morgan's process plant and a dump leach facility located at the Jupiter prospect. These supplies were drawn from two borefields: the Process Borefield comprising five production bores (PB1, 2, 5, 6 and 7) located along the Old Laverton Road and one bore (JP60) at the Jupiter borefield located about 3.5 km to the south east. The Process Borefield was operated for about 10 years from 1988 to 1998 and bore JP60 for about four years from 1995 to 1998.

Historic groundwater abstraction and water level data from March 1988 to May 1990 and July 1992 to June 1997 have been collected from annual aquifer reviews prepared for the Department of Water (DoW)[1]. These records have been used to assess the impacts from earlier groundwater production upon the groundwater environment.

Local Hydrogeology and Borefield Configuration

The calcrete aquifer at the project covers an area of about 60 km^2 and forms an elongate unit that broadly trends northwest from the northern margin of Lake Carey (Figure 1). The unit is thin, sub-cropping close to surface with a maximum depth of about 10 m. It comprises vuggy carbonate rock interbedded with alluvium and silcrete. Dissolution of the carbonate is common, which results in the development of secondary porosity and on occasion good aquifer yields. The results of earlier groundwater field programmes indicates higher permeabilities generally occur on the western side of the calcrete unit.

Groundwater flows in the calcrete are likely to be towards the east and south, ultimately discharging to the Carey trunk palaeochannel and Lake Carey respectively. The aquifer is subject to direct rainfall recharge resulting in rapid groundwater level rises after major storm events

[1] References are provided at the end of this memo.

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Table 1: Schedule of Previously Operated Mine Production Bores

Production Bore ID	Location mE (MGA Zn 51)	Location mN (MGA Zn 51)	Collar RL (mAHD)	Casing Diameter (mm)	Cased Depth (mbgl)	Screened Interval (mbgl)	Salinity (mg/L TDS)	Aquifer Type
PB1	417,080	6,821,291	403.46	155	7.4	2-6.5	8,500	Calcrete & alluvium
PB2	416,495	6,821,064	403.74	155	8.0	2-8	2,600	Calcrete & alluvium
PB5	417,804	6,821,584	402.66	155	7.9	-	13,000	Calcrete & alluvium
PB6	417,548	6,821,476	402.78	155	9.0	-	9,400	Calcrete & alluvium
PB7	417,999	6,821,608	402.25	155	12.0	6-12	17,000	Calcrete & alluvium
JP60	420,844	6,819,522	403.00	155	8.3	2.3-8.3	14,000	Calcrete & fractured basalt

Note: salinities were taken from the 1996 to 1997 wellfield assessment (Woodward-Clyde 1997).

At least 14 mine production bores have been completed targeting the calcrete aquifer, although records indicate only six have been operated. A schedule for the six mine bores is provided in Table 1 and their locations shown on Figure 1. All the previously operated mine production bores predominantly draw water from the calcrete aquifer, although the drill-hole at JP60 also intersects fractured basalt below 8 m depth.

The salinity in the calcrete aquifer varies considerably, both laterally and temporally. At the mine production bores salinities range from 2,600 to 17,000 mg/L Total Dissolved Solids (TDS) based upon the record from 1996. However, a maximum value of 28,100 mg/L was recorded at groundwater exploration hole JP45 at the southern end of the unit (Mackie Martin 1990). Temporally variations of up to a factor of 2 have also been observed, most likely in response to rainfall recharge.

Groundwater Abstraction and Levels

The recorded pumping rates for the mine production bores and PB3, which was not pumped and used as an observation bore, are shown as time series plots in Figures 2 to 5. The figures also present the groundwater level data and the base of screened interval in each bore, which is generally considered analogous to the depth of the calcrete aquifer.

The plots show the following:

- PB1 – maximum drawdowns of about 4 m, resulting in a saturated thickness in the bore of approximately 1 m.
- PB2 – maximum drawdowns of about 3 m, resulting in a saturated thickness in the bore of approximately 2 m.
- PB3 – the drawdowns observed at the bore were negligible over the limited period of record.
- PB5 – maximum drawdowns of about 3 m, resulting in a saturated thickness in the bore of approximately 2 m.
- PB6 – maximum drawdowns of about 3 m, resulting in a saturated thickness in the bore of approximately 3 m.
- PB7 – maximum drawdowns of about 3 m, resulting in a saturated thickness in the bore of approximately 6 m.
- JP60 – maximum drawdowns of about 1 m, resulting in a saturated thickness in the bore of approximately 4 m.
- Groundwater levels in all the bores show a good response to rainfall recharge. In particular the rapid rise observed after Cyclone Bobby in February 1995, which delivered a three-day rainfall total of 225 mm locally, and resulted in a groundwater level rise of between about 2 and 4 m.

Discussion

Overall the results show the lower yielding bores, bore PB1 in particular, were severely impacted by pumping, with saturated thicknesses in the calcrete aquifer reduced by up to 80%, equivalent to a residual saturated thickness of about 1 m at PB1. These severe impacts were sustained over many months in response to continued pumping.

The negligible drawdowns observed in non-pumping bore PB3 located about 400 m from PB1 and 200 m from PB2 indicate even severe impacts from abstraction are localised and unlikely to affect the groundwater environment away from operating production bores. This interpretation is consistent with the lack of interference effects seen in higher yielding bores PB5, 6 and 7; which were pumped consistently over the later period of mining. This is despite their proximity to each other, i.e. 270 m from PB5 to PB6 and 200 m from PB5 to PB7.

Based on these outcomes it appears unlikely that even sustained groundwater production from the calcrete aquifer will have a long-term impact upon the groundwater environment.

References

Coffey 1990. "Mt Morgans Gold Mine groundwater review 1989/90", report number 1990/000079 dated July 1990. Unpublished report prepared by Coffey Partners International Pty Ltd for Dominion Mining Ltd.

Coffey 1993. "Mt Morgans Gold Mine borefield licensing annual performance report 1992/93", report number 1993/000078 dated September 1993. Unpublished report prepared by Coffey Partners International Pty Ltd for Dominion Mining Ltd.

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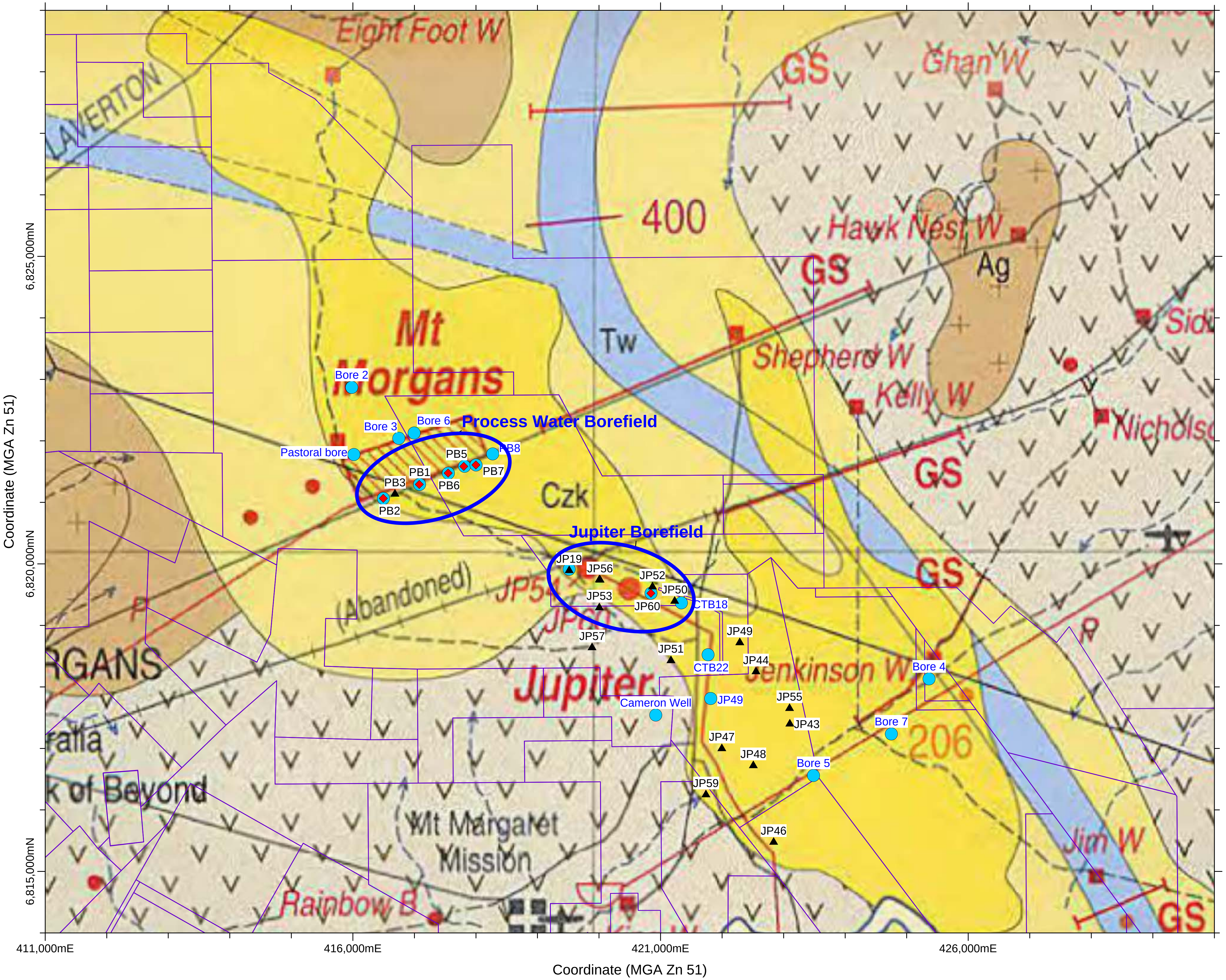

LEGEND

- Existing Production Bores
- Stygofauna Sample Bores
- Other Bores/ Exploration Holes
- Dacian Tenements
- Palaeochannel Deposit
- Czk Calcrete Unit

SCALE 1:65,000

0m 1,000m 2,000m 3,000m

Mt Morgan FS (J150010M02)		
Dacian Gold		
RG	Mar 16	**FIGURE 1**

EXISTING PRODUCTION BORE AND STYGOFAUNA SAMPLING BORE LOCATIONS

GROUNDWATER RESOURCE MANAGEMENT

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FIGURE 2

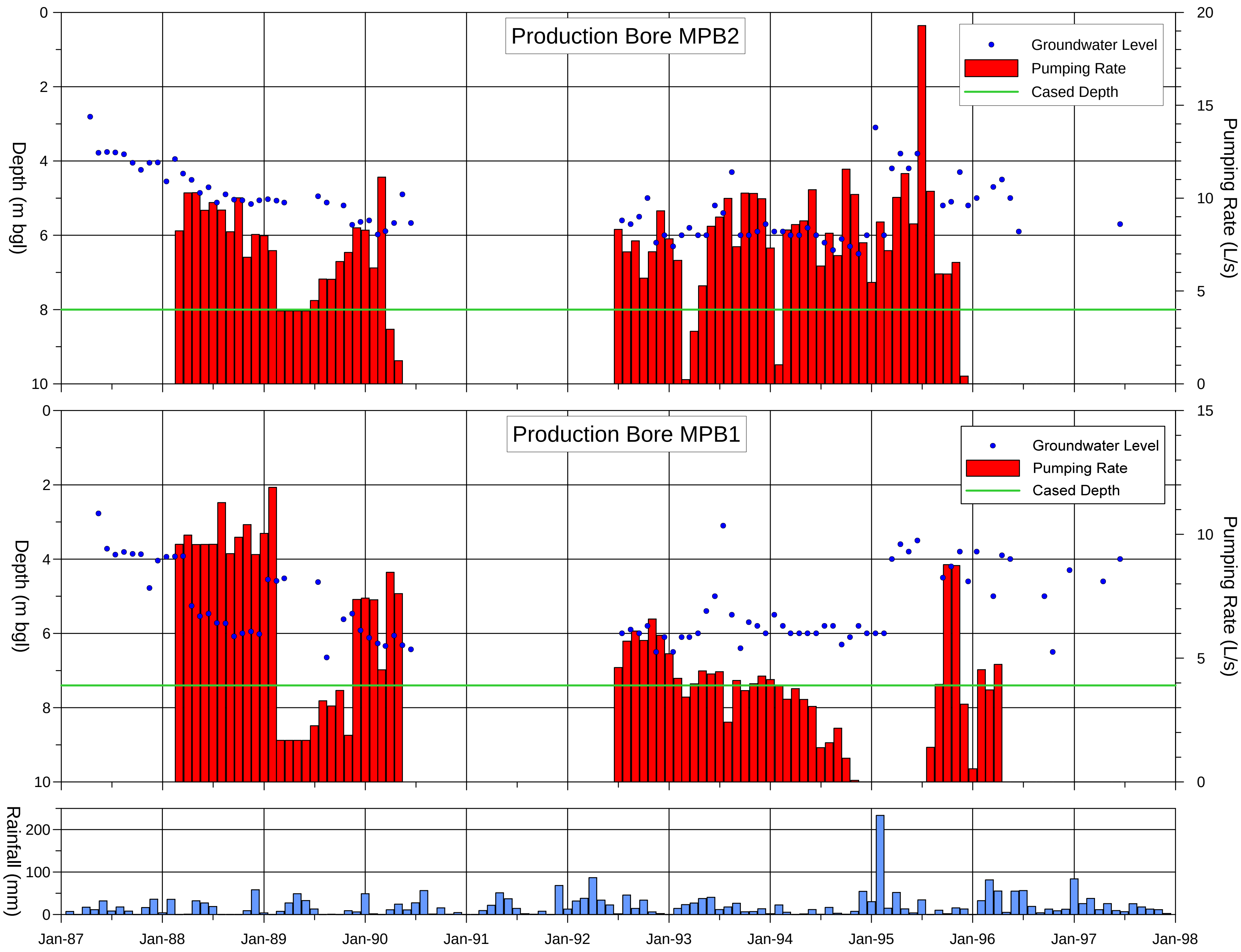
RECORDED GROUNDWATER LEVELS AND PUMPING RATES BORE MPB1 AND MPB2

Mt Morgan FS (J150010M02)

Dacian Gold

RG | Mar 16

GROUNDWATER RESOURCE MANAGEMENT



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Mar 16

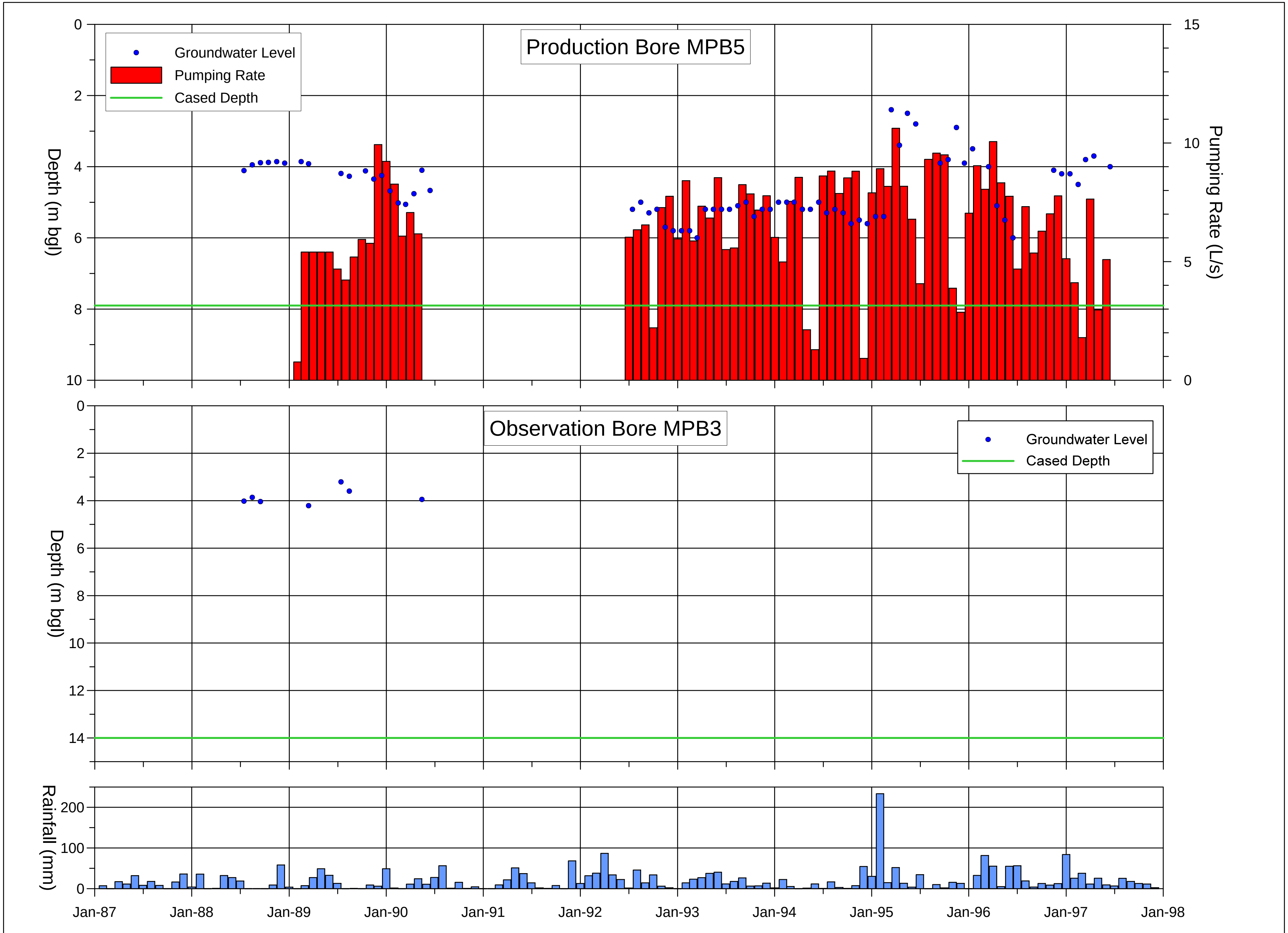
FIGURE 3

Dacian Gold

Mt Morgan FS (J150010M02)

RECORDED GROUNDWATER LEVELS AND PUMPING RATES BORE MPB3 AND MPB5

GROUNDWATER RESOURCE MANAGEMENT



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Mt Morgan FS (J150010M02)

Dacian Gold

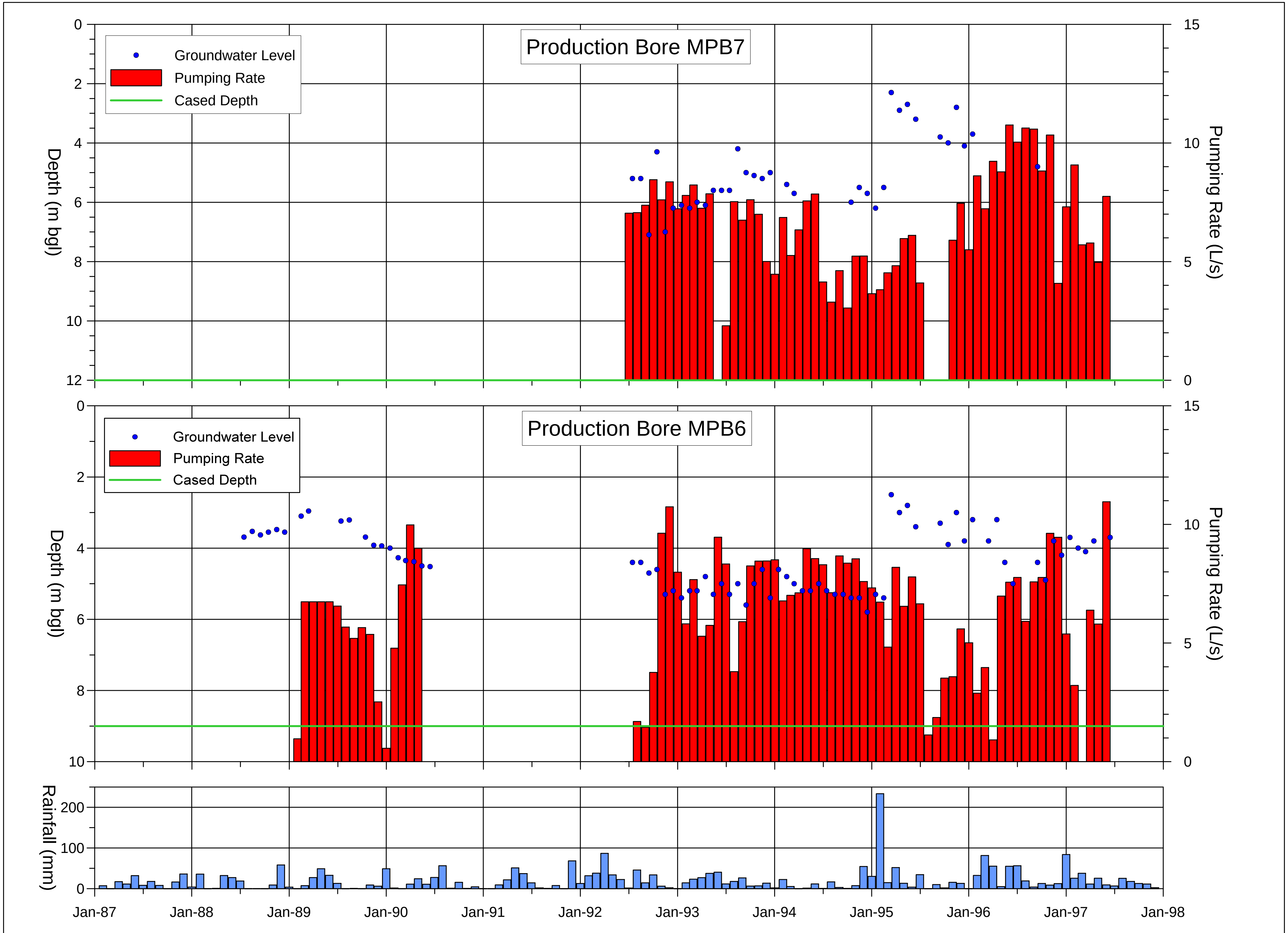
RG

Mar 16

FIGURE 4

RECORDED GROUNDWATER LEVELS AND PUMPING RATES BORE MPB6 AND MPB7

GROUNDWATER RESOURCE MANAGEMENT



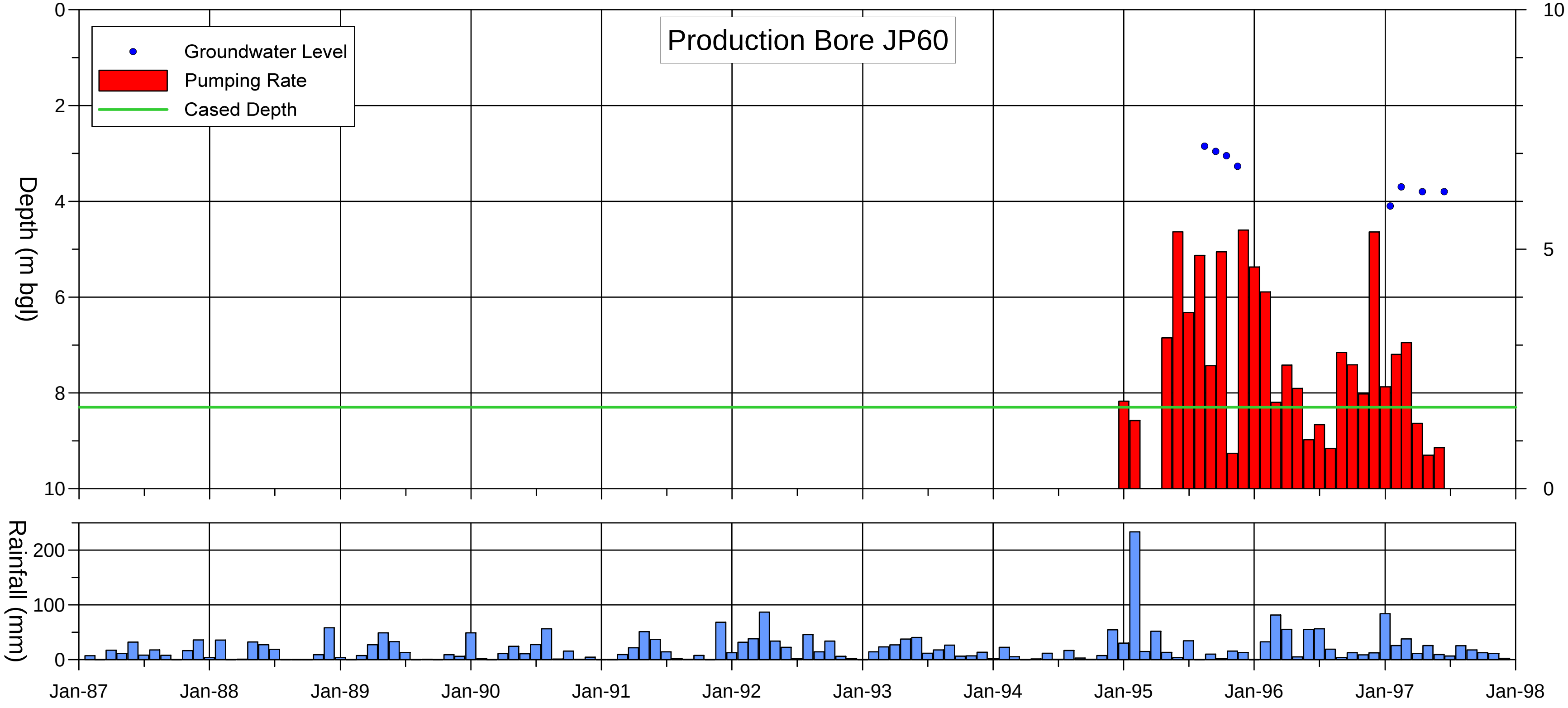


FIGURE 5

RECORDED GROUNDWATER LEVELS AND PUMPING RATES BORE JP60

Mt Morgan FS (J150010M02)

Dacian Gold

RG

Mar 16

GROUNDWATER RESOURCE MANAGEMENT

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APPENDIX 7: LAND CLEARING AND TOPSOIL DISTURBANCE MANAGEMENT PLAN

MT MORGANS WA MINING PTY LTD
A WHOLLY OWNED SUBSIDIARY OF DACIAN GOLD LIMITED

LAND CLEARING AND TOPSOIL MANAGEMENT PLAN

FOR:

Mt Morgans Gold Project

Document ID:	MTM-PLN_403	Revision No.:	Rev A	Date:	14/06/2017
Prepared by		**Owner**		**Approved by**	
Marie Labrosciano		Lizzy Von Perger		Siobhan Pelliccia	

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APPENDICES

1. Introduction

The Mount Morgans Gold Project (MMGP) is located in the north eastern goldfields of Western Australia and includes the project areas of Westralia and Jupiter (Figure 1). The MMGP is owned by Mt Morgans WA Mining Pty Ltd (MMWM), a wholly owned subsidiary of Dacian Gold Limited (Dacian).

MMWM is committed to managing and minimising the environmental impacts resulting from its operations and committed to the successful rehabilitation of cleared and disturbed areas. Land clearing can have significant impacts on flora and fauna species and their habitats, sites of cultural significance and soil and water resources. All clearing required to be undertaken within the MMGP operations will be minimised where possible, occur only in approved areas and be tightly controlled through the use of the internal MMGP 'Clearing Request Form' (CRF).

Vegetation and topsoil will be stripped from cleared areas and stockpiled separately and appropriately. Topsoil contains accumulated native seeds, organic matter, plant nutrients, and soil micro-organisms and is therefore a valuable resource for the rehabilitation of areas disturbed by mining operations.

No land clearing or vegetation/topsoil stripping shall take place in association with the MMGP without regulatory approval and written authorisation from the site Environmental Advisor through the CRF application process.

1.1. Purpose

This Land Clearing and Topsoil Management Plan (LCTMP) has been prepared to ensure that all clearing activities required for the MMGP are undertaken in accordance with approvals and legislative requirements.

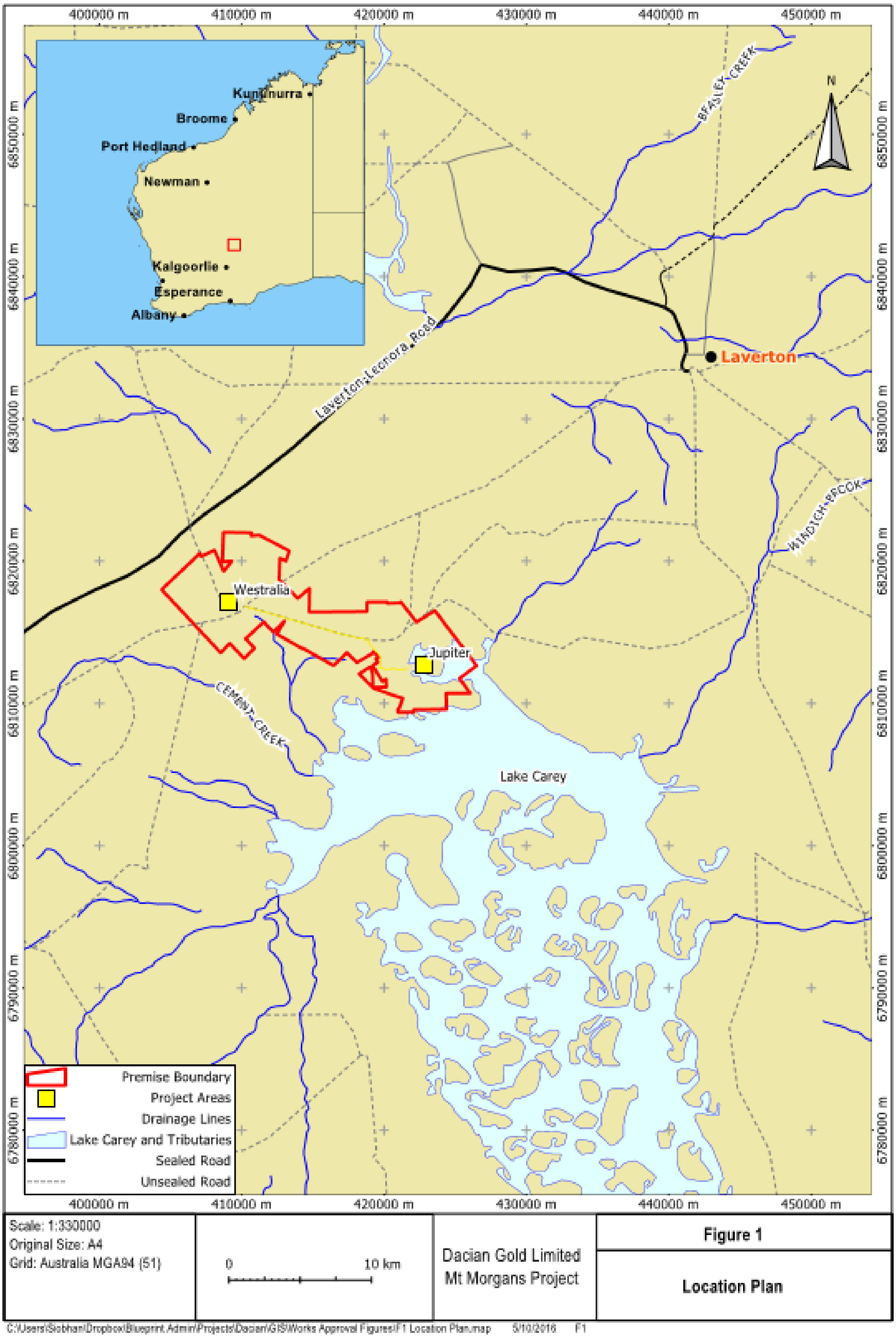
Compliance with this LCTMP will ensure:

- Areas of proposed clearing are approved through the correct regulatory processes, including surveys for priority flora and threatened species.
- Clearing is conducted in accordance with tenement conditions, regulations, and licence conditions, commitments made in environmental approval documents and incorporates industry best practice.
- All personnel display a duty of care to the environment and to site standards by adhering to all obligations within this management plan.
- Clearing is kept to a minimum and is strictly controlled.
- Unnecessary harm to fauna, flora and vegetation is minimised.
- The floristic values of the project area are maintained.

1.2. Scope

The LCTMP is applicable to all employees of Mt Morgans WA Mining Pty Ltd (MMWM), contractors and visitors. It applies to all stages of exploration, construction, operation, rehabilitation and closure. It is in place to manage the process for clearing, thereby minimising incidental disturbance, unnecessary harm to flora and fauna and inevitably reducing rehabilitation and financial liabilities.

Figure 1: Location Plan



2. Guidelines

2.1. Risk Management

Responsible health, safety, environmental and community management is a core company value and all individuals associated with the MMGP have a responsibility to ensure that the impact on individuals and the environment is minimised. As part of each individuals' duty of care, all risks are to be reviewed to minimise harm. Should any significant environmental, health or safety hazards be identified through the application of risk assessment tools, relevant supervisors are to be informed before work commences or continues.

2.2. Legal & Other Requirements

Clearing activities in Western Australia are regulated via the *Environmental Protection Act 1986* (EP Act). In accordance with this Act, clearing activities may only be conducted where approval/s have been obtained. Native Vegetation Clearing Permits are required under the *Environmental Protection Act 1986*, prior to undertaking clearing of native vegetation. The granting and administration of these permits are regulated under the *Environmental Protection (Clearing of Native Vegetation) Regulations, 2004*. Clearing Permits may be obtained from the Department of Mines, Industry Regulation and Safety (DMIRS), Environment Division. Agreement exists between DMIRS and the Department of Water and Environmental Regulation (DWER) for DMIRS to assess land clearing applications related to mining activities.

Not all clearing requires regulatory approval. Exemptions include:

- Clearing for exploration purposes if conducted under an approved Programme of Work (PoW).
- Activities authorised under an approved Mining Proposal for clearing up to 10 ha per tenement per financial year.
- Licences to Construct or Alter Wells issued by Department of Water.
- Activities approved under Part IV of the EP Act in a Ministerial Statement.
- Clearing for maintenance in existing cleared areas, providing the land was lawfully cleared within the previous ten years.
- Clearing for maintenance in existing transport corridors.

These exemptions do not apply in Environmentally Sensitive Areas (ESA's); however, no ESA's have been identified at the MMGP.

Failure to comply with regulatory requirements and this management plan may have a detrimental impact on native flora, fauna and aesthetics of the landscape. Additionally, failure to comply may result in non-compliance with approvals and legislation which could result in personal and/or company prosecution.

In addition to legislative requirements, MMWM also has site specific legal requirements regarding land clearing and topsoil disturbance identified in regulatory approval documents such as DMIRS Clearing Permit conditions, Mining Proposals commitments and tenement conditions.

Legislative and site specific requirements in regards to land clearing and topsoil management are detailed in Table 1.

Table 1: Legislative and site specific legal requirements (Land Clearing & Topsoil Disturbance)

<table>
<tr><th colspan="2">Legislation</th></tr>
<tr><td colspan="2">Environmental Protection Act 1984
Environmental Protection (Clearing of Native Vegetation) Regulations 2004
Soil and Land Conservation Act 1945
Conservation and Land Management Act 2002
Conservation and Land Management Regulations 2002</td></tr>
<tr><th>DER Environmental Licence</th><th>Reference</th></tr>
<tr><td>Nil</td><td>L9010/2016/1</td></tr>
<tr><th>DER Works Approval</th><th></th></tr>
<tr><td>Nil</td><td>W6008/2016/1</td></tr>
<tr><th>DMP Mining Proposals</th><th>Reference</th></tr>
<tr><td>• Areas approved for establishment of site infrastructure will be clearly delineated and all clearing activities will be undertaken in accordance with the Native Vegetation Clearing Permit.
• All available topsoil and subsoil will be stripped from surfaces that will be disturbed and appropriately stored for use in rehabilitation.
• Cleared vegetation will be stockpiled with access to stockpiles restricted to minimise potential for introduction of weeds.
• All vehicles and equipment arriving on site will be in a clean condition, free of soil and vegetative matter.
• Dacian will ensure that all proposed operations are carried out in accordance with the provisions of the Aboriginal Heritage Act 1972.</td><td>Registration ID 60641 (Mining), 61287 (Infrastructure Corridors), 63911 (Production Borefield)</td></tr>
<tr><th>DMP Clearing Permits</th><th>Reference</th></tr>
<tr><td>• When undertaking clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of weeds:
i. Clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared.
ii. Ensure that no weed-affected soil, mulch, fill or other material is brought into the area to be cleared.
iii. Restrict the movement of machines and other vehicles to the limits of the areas to be cleared.
• In relation to the clearing of native vegetation authorised under this permit:
i. The location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees.
ii. The date the area was cleared.
iii. The size of the area cleared (in hectares).
iv. Purpose for which clearing was undertaken.
• The Permit Holder shall provide a report to the Director Operations, Environment, DMP by 31 July each year of the life of this Permit, demonstrating adherence to all conditions of this Permit, and setting out the records required under Condition 7 of this permit in relation to clearing carried out between 1 July and 30 June of the previous financial year.</td><td>CPS 7408/1, CPS 7428/1</td></tr>
</table>

• Prior to 31 December 2024, the Permit Holder must provide to the Director Operations, Environment, DMP a written report of records required under Condition 7 of this Permit where these records have not already been provided under Condition 8 (a) of this Permit.	
Tenement Conditions	**Reference**
Unless the written approval of the Environmental Officer, DMP is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface clearing or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.	**M39/236, M39/395, M39/390, M39/272,M39/228, M39/264, M39/304, M39/240, M39/248, M39/513, M39/305, M39/273**
No developmental or productive mining or construction activity being commenced until the tenement holder has submitted a plan of the proposed operations and measures to safeguard the environment to the Director, Environment, DoIR for assessment; and until his written approval has been obtained.	**M39/236, M39/272, M39/228, M39/264, M39/304, M39/240, M39/248, M39/305, M39/273**
The development and operation of the project being carried out in such a manner so as to create the minimum practicable disturbance to the existing vegetation and natural landform.	**M39/236, M39/395, M39/390, M39/272, M39264, M39/304, M39/240, M39/248, M39/513, M39/305, M39/273, L39/57**
The development and operation of the project being carried out in such a manner so as to create the minimum practicable disturbance to the existing vegetation and natural landform, to the satisfaction of an Environmental Officer, DMP.	**M39/18, M39/228**
All topsoil and vegetation being removed ahead of all mining operations and being stockpiled appropriately for later respreading or immediately respread as rehabilitation progresses.	**M39/236, M39/395, M390, M39/272, M39/18, M39/228, M39/264, M39/304, M39/240, M39/248, M39/513, M39/305, M39/273, L39/57**
Compliance with the provisions of the Aboriginal Heritage Act, 1972 to ensure that no action is taken which would interfere with or damage any Aboriginal site.	**M39/236, M39/272, M39/228, M39/264, M39/240, M39/248, M39/273**
Compliance with the provisions of the Aboriginal Heritage Act, 1972 to ensure that no action is taken which is likely to interfere with or damage any sacred site.	**M39/18**
Where saline water is used for dust suppression, all reasonable care being taken to avoid any detrimental effects to surrounding vegetation and topsoil stockpiles.	**M39/236, M39/395, M39/390, M39/272, M39/264, M39/304, M39/240, M39/248, M39/513, M39/305, M39/273, L39/57**
Where saline water is used for dust suppression, all reasonable measures being taken to avoid any detrimental effects to surrounding vegetation and topsoil stockpiles, to the satisfaction of an Environmental Officer, DMP.	**M39/18**

2.3. Required Competencies

All MMGP employees and contractors are required to undergo a site environmental and safety induction prior to commencement of duties. This induction includes an explanation of the land clearing authorisation requirements (clearly describing the CRF process) and other obligations as described in this LCTMP.

It is essential that supervisors and operators are diligent and follow the approved CRF and associated conditions.

3. Land Clearing Management

3.1. Regulatory Approval

No clearing activity is to commence until a Native Vegetation Clearing Permit, PoW or exemption for the area has been approved by DMIRS. For mining and processing related disturbances, a mining proposal also needs to be approved by DMIRS. As part of the Native Vegetation Clearing Permit process, a field vegetation survey by a suitably qualified professional will always be completed which will include a search for priority flora and threatened species.

The Applicant requesting clearing authorisation must ensure designs, footprints and GPS coordinates are based on accurate information and have been approved by all relevant MMWM personnel.

A cross check of approved designs must be obtained to confirm area of disturbance, buffers, constraints and the most current approval information/maps/dimensions are being used.

3.2. Requesting Clearing Authorisation

To obtain approval, the ‘Application’ section of the CRF (Appendix 1) must be filled out appropriately and completely by the Applicant and submitted to the site Environmental Advisor for assessment.

As part of completing the ‘Application’ section of the CRF, the Applicant will:

- Undertake a visual inspection of the proposed disturbance area and take photographs as necessary.
- Provide the reason for clearing and planned commencement and completion dates.
- Provide a plan or map with coordinates and spatial file of the proposed clearing area.
- Provide the tenements on which clearing will be undertaken and a breakdown of the proposed area per tenement.

This form is to be completed and forwarded to the Environmental Advisor for assessment at least 7 days prior to the commencement of proposed clearing.

3.3. Assessment and Approval

Once the CRF has been received by the site Environmental Advisor, the following will be assessed:

- Is the proposed disturbance area within an approved clearing footprint (Native Vegetation Clearing Permit or PoW) or satisfies exemptions under the *Environmental Protection Act?*
- Is the proposed disturbance area located within or near communities of known priority flora or threatened species? (None currently located within the approved Project location)
- Are there any known heritage and culturally significant areas within the proposed disturbance area?
- Will the proposed disturbance directly impact on watercourses? What management measures are in place?

The Environmental Advisor is responsible for assessing the above information in order to determine whether the clearing can go ahead. The Environmental Advisor will inform the Applicant if further information is required or if there are unexpected delays to the assessment and approval process. Conditions of clearing and vegetation/topsoil stripping requirements arising from the assessment process will be placed in writing on all CRF's. The Environmental Advisor will then communicate to the Applicant that the clearing boundary may be clearly marked out by survey in the field.

3.4. Pre-Disturbance Survey

Once given the go-ahead by the Environmental Advisor, it is the responsibility of the Applicant to ensure that the approved disturbance area is clearly marked in the field using appropriate GPS equipment and flagging/pegs are based on approved spacial data. Infrastructure areas and topsoil stockpile areas must also be clearly delineated.

3.5. Familiarisation, Sign-off, and Distribution

The Environmental Advisor, the Applicant, the Area Supervisor and the operator/s who will be responsible for conducting the clearing are to walk the boundary of the area to be cleared to familiarise themselves with the area and to ensure flagging is visible and logical.

Once all parties are satisfied with the CRF conditions and the marked boundary, the CRF is to be signed by the Applicant, the Area Supervisor, the Operator/s and finally by the Environmental Advisor.

Once all parties have signed the CRF, it is the responsibility of the Environmental Advisor to copy and distribute both the CRF and a map of the area to be cleared to the signatories. The original hard copy is to be filed by the Environmental Advisor.

3.6. Land Clearing

3.6.1. Weed Management

MMWM Area Supervisors will ensure that all machinery/equipment involved with land clearing and topsoil/vegetation removal activities is clear of soil, mud and vegetation that may have been brought in from outside of the Project Area. This will be achieved through the use of the MMGP Soil and Seed Inspection Form (Appendix 2). This form must be completed for all new earth-moving equipment and machinery arriving on site, prior to commencement of work.

The site Environmental Advisor and MMWA Supervisors have the right to turn away any machinery/equipment arriving on site that does not pass the Soil and Seed Inspection.

3.6.2. Removal and Stockpiling of Vegetation

- Vegetation is to be removed separately from topsoil wherever practicable. Smaller shrubs and grasses can be stripped with the topsoil.
- Vegetation is to be cleared with a raised blade where the purpose for ground disturbance allows i.e. short term access tracks, drill pads, temporary pipelines.
- Where possible, branches should be pruned rather than whole trees removed.
- Cleared vegetation shall be placed in stockpiles for later use in rehabilitation activities. Care should be taken to ensure stockpiles do not impede drainage or present a fire hazard for later work to be undertaken in the area.

3.6.3. Removal and Stockpiling of Topsoil

- Topsoil is to be stripped to a minimum depth of 100 mm. A further 300 mm of subsoil is also to be harvested where practical.
- Topsoil stripping, loading and dumping must be conducted during periods of low wind speed. Particular attention is to be given to the minimisation of dust generation when stripping topsoil in close proximity to the Mount Margaret Community.
- Topsoil is to be stockpiled in mounds no more than 2.5 metres in height to maintain seed viability within the topsoil. Topsoil is not to be stockpiled where it could be contaminated by spraying of saline water or lost by erosion (if placed in a drainage line).
- Designated topsoil stockpile storage areas documented in DMIRS approval documents will be used.
- Topsoil stockpiles are to be surveyed and must not be used for roads, bunds or windrows.
- Topsoil stripping, loading and dumping is to be conducted when soils are not saturated, this can lead to compaction, loss of structure and premature spouting of seeds within the stockpile;

3.7. Post Disturbance Survey

A reconciliation of actual cleared area against proposed areas will be completed. The Applicant is responsible for ensuring the area cleared is re-surveyed within one month of the completion of earthworks. GPS equipment set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings, must be used. The spacial file is then to be forwarded to the Environmental Advisor who will complete the ‘Post Clearing’ section of the CRF, update the GIS Land Clearing Register and sign-off the CRF as closed.

3.8. Monitoring

Monitoring of land clearing activities is covered in the CRF process, as described above.

Topsoil and vegetation stockpile monitoring will be conducted on an annual basis by the site Environmental Advisor. The ‘Topsoil and Vegetation Stockpile Inspection Form’ will be completed and covers the presence of weeds, signage, and erosion and drainage aspects (Appendix 3).

3.9. Awareness Programs

All MMGP Employees and contractors will be required to undergo a site environmental induction prior to the commencement of work duties. This induction includes an explanation of the land clearing authorisation process and requirements.

Site environmental posters, newsletters and toolbox talks will be used as tools to re-enforce site land clearing processes and keep employees and contractors updated on any issues and changes that may have arisen.

4. Responsibilities

Table 2: Responsibilities – implementation of the LCTMP

Position	Responsibility
All Personnel including Contractors	• Ensure requirements of the LCTMP are adhered to. • Ensure that CRF's are completed and submitted to the Environmental Advisor for assessment and approval before any clearing activities are undertaken. • Ensure a copy of the signed CRF and associated map is on hand when conducting clearing activities. • Report unapproved clearing to the Environmental Advisor.
Supervisors/Managers	• Ensure the requirements of the LCTMP are adhered to. • Ensure the clearing operator/s conducting the clearing have a clear understanding of the job required and have a signed copy of the CRF (with map). • Ensure unapproved clearing is reported to the Environmental Advisor in a timely manner and corrective/preventative actions are implemented. • Ensure Soil and Seed Inspections are completed on all new machinery/equipment arriving on site, prior to commencing work.
Environmental Advisor	• Ensure DMIRS regulatory approvals are sought for all areas of proposed clearing as required. • Ensure vegetation field surveys required as part of the regulatory approvals process are conducted by suitably qualified consultants. • Ensure all employees and contractors are aware of their obligations in relation to the LCTMP. • Provide advice and guidance to those requiring authorisation for clearing. • Undertake assessments of CRF's • Manage all land clearing related data. • Ensure a copy of the original CRF is filed and copies distributed to all signatories. • Ensure post clearing sign-off completed. • Review the LCTMP as required. • Ensure the GIS land clearing register is maintained. • Ensure the annual total amount of clearing is reported to the required regulators (Section 5). • Complete annual topsoil and vegetation stockpile inspections.

5. Reporting

5.1. Incident Reporting – Unauthorised Clearing

If any employee determines unapproved clearing has occurred, they are responsible for bringing it to their Supervisor or relevant Manager's attention as soon as possible.

Where an Applicant or other employee determines clearing has not been conducted in compliance with the approved Request Form, they are responsible for bringing it to their Supervisor or relevant Manager's attention as soon as possible.

The Supervisor or relevant Manager when notified of either unauthorised clearing or non- compliance with approved clearing, shall:

- Determine if the clearing has occurred within an area where regulatory approval exists (PoW or Clearing Permit) – with assistance with the Environmental Advisor.
- Ensure the unauthorised activity has been documented on an Incident Report Form and an investigation initiated.
- Review the results of the Incident Investigation and ensure appropriate remedial and preventative actions are implemented.

The Environmental Advisor will then:

- Determine external reporting needs, if ground disturbance/clearing has occurred outside of an authorised area i.e. reporting to DMIRS – in consultation with the MMWM Registered Manager.

5.2. Department of Mines, Industry Regulation and Safety (DMIRS)

5.2.1. Clearing Permit Reporting

The Environmental Advisor is responsible for ensuring that an annual report against conditions of DMIRS Clearing Permits contain the following information:

- The location where clearing occurred - GPS (GDA94, Easting and Northings).
- Date clearing took place.
- Size of cleared area (hectares)
- Purpose of clearing.

The DMIRS annual Clearing Permit reporting period will be from the 1 July – 30 June each year with the report to be submitted to the Director, Operations DMIRS by the 31 July each year.

5.2.2. Annual Environmental Report (AER)

The Environmental Advisor is responsible for ensuring that the AER, which reports against tenement conditions and commitments made in mining proposals, contains the following information:

- The total amount of clearing per tenement and categorisation of the land disturbance type.
- Land disturbance/rehabilitation mapping.
- Compliance against mining proposal commitments and tenement conditions.
- Description of future clearing activities to be completed.

The DMIRS annual environmental reporting period will be from the 1 August – 31 July each year with the report to be submitted online by the 31 August each year.

6. Related Documents

Table 3: Other documents related to the LCTMP

Document Number	Document Title
TBA	Environmental and Social Management System
MTM-FRM-406	Clearing Request Form
MTM-FRM-401	Soil and Seed Inspection Form
MTM-FRM-403	Topsoil and Vegetation Stockpile Inspection Form

Appendix 1: Clearing Request Form

This form is to be completed by either a relevant supervisor or by the MMGP Environmental Department for any heavy vehicle or earth moving equipment arriving to site prior to the commencement of work activities.

APPLICATION DETAILS - *Applicant to complete this section			
Permit No:			
Reason for clearing:		**Application Date:**	Click or tap to enter a date.
Requested by:		**Project Area:**	
Plan/Map Attached:		**DXF provided:**	
Commencement Date:	Click or tap to enter a date.	**Completion Date:**	Click or tap to enter a date.
Tenement:		**Proposed Area (Ha):**	
Tenement:		**Proposed Area (Ha):**	
Tenement:		**Proposed Area (Ha):**	

SITE ASSESSMENT – *Environmental Dept. to complete this section	
Is this clearing part of a Programme of works (PoW), Mining Proposal (MP) or Clearing Permit (CPS):	YES ☐ NO ☐ Reference Number:
Does clearing fall within approved areas?	YES ☐ NO ☐ Comments:
Is the clearing in proximity to any drainage lines?	☐ YES ☐ NO
If yes, detail surface water management measures in conditions	
Is the clearing in close proximity to Heritage Sites?	☐ YES ☐ NO
If yes, have these Heritage sites been clearly marked in the field?	
Has a physical inspection of the area been completed or photos viewed?	YES ☐ NO ☐ Comments:
Has the Land clearing register and spatial data layers been updated?	YES ☐ NO ☐ Comments:

CLEARING APPROVAL CONDITIONS - *Environmental Dept. to complete this section
*Topsoil and vegetation will be stripped and stockpiled separately and appropriately in designated areas.

ACCEPTANCE – *All relevant parties to complete this section			
All parties agree to the conditions of this form. Expiry is 3 months from date of authorisation			
APPLICANT -			
Name:		**Date:**	Click or tap to enter a date.
Signature:			

CONTRACT SUPERVISOR -			
Name:		**Date:**	Click or tap to enter a date.
Signature:			
MACHINE OPERATOR -			
Name:		**Date:**	Click or tap to enter a date.
Signature:			

AUTHORISATION - *Environment Dept. to compete this section	
Copies (incl. clearing plan) distributed to ALL Signatories ?	YES ☐ NO ☐ **If no, state reason:**

ENVIRONMENT DEPT -			
Name:		**Date:**	Click or tap to enter a date.
Signature:			

POST CLEARING SURVEY - *Environment Dept. to complete this section	
Final Pick-up of cleared area completed by survey?	YES ☐ Comments:
Have the land clearing register and spatial data layers been updated for final cleared area?	YES ☐ Comments:

ENVIRONMENT DEPT. SIGN-OFF -			
Name:		**Date:**	Click or tap to enter a date.
Signature:			

Appendix 2: Soil and Seed Inspection Form

This form is to be completed by either a relevant supervisor or by the MMGP Environmental Department for any heavy vehicle or earth moving equipment arriving to site prior to the commencement of work activities.

EQUIPMENT/MACHINE DETAILS		
Equipment Owner:		
MMGP Department:		
Inspection Date:		
Equipment Type:		
Previous Location:		
Registration:		
Work Area:		
Is the exterior free of dirt, mud and vegetative matter (check chassis, tyres, mud guards etc.):	Yes ☐ No ☐	*Details:*
Is the interior free of dirt, mud and vegetative matter:	Yes ☐ No ☐	*Details:*
Is auxiliary equipment (where applicable) free of dirt, mud and vegetative matter:	Yes ☐ No ☐	*Details:*
Are there any oil leaks evident?	Yes ☐ No ☐	*Details:*
Is further action required:	Yes ☐ No ☐	*Details:*

APPROVAL			
Name:			
Comments:			
Signature:		***Date:***	

Once completed form to be forwarded to the MMGP Environmental Department.

Appendix 3: Topsoil and Vegetation Stockpile Inspection Form

This form is to be completed annually (June each year) by the MMGP Environmental Department for all topsoil and vegetation stockpiles located within the MMGP.
Photos are to be taken for each stockpile in addition to this form

1. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

2. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

3. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

4. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

5. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

6. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

7. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	

8. STOCKPILE NAME:	
Weed Species Present?	YES ☐ NO ☐ Details:
Signage Visible?	YES ☐ NO ☐ Details:
Signs of Erosion?	YES ☐ NO ☐ Details:
Drainage Control?	YES ☐ NO ☐ Details:
Evidence of Fauna damage?	YES ☐ NO ☐ Details:
Further Comments:	