Kurnalpi -Northern Operations Native Vegetation Clearing Permit Application

Supporting Document
March 2025

M28/7, M28/374, M28/375, M28/70, M28/76, M28/84, M28/92, L28/72

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1 Project Summary

This document has been prepared in support of an application for a Native Vegetation Clearing Permit under Part V of the *Environmental Protection Act 1986* (EP Act).

This supporting document outlines the key activities associated with proposed clearing, the existing environment of the clearing permit application area, and an assessment of the native vegetation clearing proposed compared to the ten clearing principles (DER, 2014).

Project Name: Kurnalpi Gold Project (the Project, Kurnalpi)

Project Location: Mining Leases M28/7, M28/374, M28/375, M28/70, M28/76, M28/84, M28/92 and Miscellaneous Lease L28/72. Located approximately 75 km northeast of Kalgoorlie Boulder.

Purpose: This report has been prepared to provide an assessment of the ten clearing principles and supporting information to accompany an application for a Native Vegetation Clearing Permit (NVCP), which is required for the removal of native vegetation. Approval of the NVCP will facilitate the construction of infrastructure for gold mining operations by Northern Star.

Clearing area: This application seeks to clear up to 580 ha (rounded from 577.8 ha for the Indicative Disturbance Footprint / Clearing Footprint) within the proposed Purpose Permit Area (PPA) of 1,442.2 ha.

Timing of Clearing: Clearing is planned to commence in mid-2025, following the approval of this NVCP application.

Contact details: Cliff Bennison – Principal Environmental Advisor
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Vegetation, flora and fauna surveys, and a targeted Malleefowl survey have been completed to identify and describe vegetation within the clearing permit application area.

A vegetation clearing impact assessment has been conducted for the clearing permit application area, and determined the proposed clearing is not at variance, or unlikely to be at variance, with all 10 clearing principles. A detailed assessment of the proposed clearing against the 10 clearing principles is provided in Section 7.

2 Project Description

Northern Star Resources Limited (NSR) proposes to develop the Kurnalpi Gold Project (the Project) located approximately 75 km northeast of Kalgoorlie in the Eastern Goldfields region of Western Australia (Figure 1). The Project is an open pit gold mining operation that will supplement ore feed and act as a satellite operation to NSR's currently operating Carouse Dam Project located approximately 40km northeast of the Project. Access to site from the City of Kalgoorlie Boulder is by road via Yarri Road and the Kurnalpi Pinjin Road.

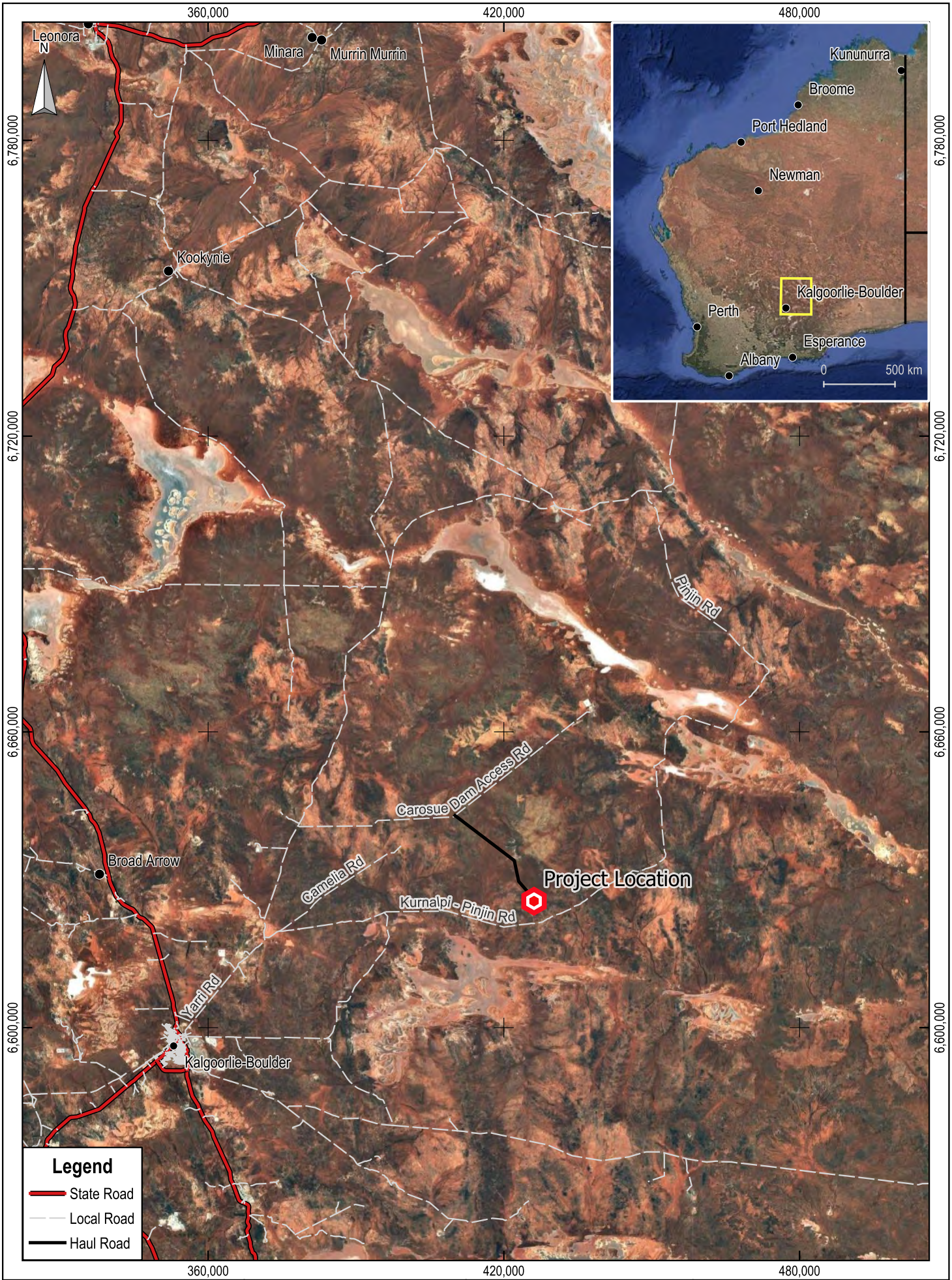
The Project area covers the historical Kurnalpi Mining Centre, which was discovered in 1894 and was renowned for its alluvial and deep lead gold with prospectors working shallow deposits for 'alluvial' gold with some success. Since 1989, the Project area has been subject to modern exploration from multiple company owners, with extensive exploration drilling defining six gold deposits: Brilliant, Sparkle, Dazzle, Scottish Lass, Halfway Hill, and Discovery Hill.

The Project is expected to have a life of mine (LOM) of 34 months. Proposed activities at Kurnalpi consist of:

- Development of two open cut pits (Brillant and Dazzle).
- Establishment of two associated Waste Rock Dumps (North and South WRD's).
- Development of three Run-of Mine (ROM) Pads.
- Mobile Crushing and Screening Plant
- Two Double Dams (Turkey's nest 1 and 2)
- Establishment of an internal haul road linking the Kurnalpi Project to the existing Carosue Dam Project.
- Transport of ore from Kurnalpi to Carosue Dam for processing (via the Carosue Dam Access Road).
- Establishment of support infrastructure such as offices and ablutions, accommodation camp, power generation facilities, workshops and fuel storage facilities, laydown areas, explosives magazine, topsoil / subsoil stockpiles, diversion channels and drains and internal roads and tracks.

The purpose of this document is to support application for a NVCP under Part V of the *Environmental Protection Act 1986* (EP Act) to permit clearing of up to 580 ha of native vegetation, within the 1,442.2 ha PPA.

This application is being submitted to the Department of Mines, Energy, Industry Regulation and Safety (DEMIRS) and will be submitted alongside a Mining Proposal (MP) and Mine Closure Plan (MCP), which will evaluate risk and develop management strategies to limit environmental and social impacts associated with the Project. The MP and MCP are anticipated to be submitted to DEMIRS in Q1 2025.



Scale: 1:1000000
Original Size: A4
Aerial Imagery: Google Satellite
Grid: GDA2020 / MGA zone 51
0 10 20 km

Northern Star Resources Limited

Figure 1

Project Location

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W:\Northern Star\Kurnalpi\GIS\NorthernStar_Kurnalpi_LocationPlan.qgz 17/01/2025

3 Tenure and Land Use

The Project will be developed across seven active Mining Lease tenements and one Miscellaneous Licence Tenement as outlined in Table 1 and shown in Figure 2, Tenure is owned by Northern Star. The Project overlies the Hampton Pastoral Station (PL N049710).

Evidence of tenement ownership is provided in Appendix A.

Table 1: Kurnalpi Project Tenements

Tenement	Tenement Holder	Area (ha)	Grant	Expiry
M28/7	Northern Star (Carosue Dam) Pty Ltd	16.27	14/06/1983	21/06/2025
M28/374		404.55	13/11/2012	12/11/2033
M28/375		286.15	13/11/2012	12/11/2033
M28/70		5.78	18/10/1989	19/10/2031
M28/76		10.62	19/02/1991	18/02/2033
M28/84		103.30	09/08/1992	11/08/2034
M28/92		123.20	01/06/1994	02/06/2036
L28/72		497.74	03/03/2022	02/03/2043

3.1 Land Use

The current land uses for the Project area are:

- Mining.
- Pastoral.
- Recreational/Tourism (mainly prospecting).
- Aboriginal use.

The Project is located within the City of Kalgoorlie-Boulder (the City) and overlies the Hampton Hill Pastoral Station (PL N049710). NSR has sought authorisation from Hampton Hill Pastoralists to undertake associated mining activities on the lease. NSR has ongoing engagement with Hampton Hill Pastoralists to ensure they are well informed of the Company's proposed activities at Kurnalpi, and to provide opportunity for feedback. NSR also has ongoing engagement with the City and will continue to consult on proposed activities at Kurnalpi as required.

The Project is located in the Kakarra Part A Native Title Claim Area. There are currently no agreements in place with the Kakarra Native Title Group. NSR will continue to work with representatives from Kakarra to manage Aboriginal Cultural Heritage at the Project.

The proposed post-mining land use is 'Pastoral activity' as this is currently the underlying land use in the Project area, with other uses being transient to the area and not generally in conflict with the primary pastoral use.

4 Proposed Land Clearing

The Project will require clearing of up to 580 ha of native vegetation (Indicative Disturbance Footprint / Clearing Footprint) within the PPA of 1,442.2 ha. An overview of the proposed Disturbance Footprint contextualised within the PPA is shown in Figure 2.

Clearing is anticipated to commence in mid-2025 to facilitate construction of the mine site.

Shapefiles are provided for the PPA with this NVCP application. There may be minor variations made to the precise location and area of site infrastructure within this area.

424,000 426,000 428,000

6,626,000

6,624,000

6,622,000

N

L26/72

M 28/374

M 28/84

M 28/76

M 28/70

M 28/92

M 28/7

M 28/375

Carosue Dam Access Rd

Haul Road

Kurnalpi - Pinjin Rd

0 2.5 5 km

Kurnalpi - Pinjin Rd

Legend

- Project Tenements
- Purpose Permit Area
- Indicative Disturbance Footprint
- Hampton Hill Pastoral Station
- Local Road

424,000 426,000 428,000

Scale: 1: 20,000
Original Size: A3
Aerial Imagery: Kurnalpi Nov 2024
Grid: GDA2020 / MGA zone 51 (EPSG:7851)

0 0.5 1 km

Northern Star Resources Limited

Figure 2

Purpose Permit Area and Indicative Site Plan

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\\mbssvr\working\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 20/02/2025 F02 Purpose Permit Area and Indicative Site Plan

5 Clearing of Native Vegetation

5.1 Measures to Avoid, Minimise and Mitigate Clearing Impacts

NSR operates on a hierarchy of avoid, minimise, rehabilitate, and offset. This hierarchy is achieved primarily through changes in design during mine planning and implementation. Measures to avoid, minimise and mitigate clearing impacts are outlined below.

5.1.1 Avoid

It will not be possible to avoid the proposed clearing as disturbance will be required to accommodate the mining infrastructure.

5.1.2 Minimise

Design considerations to minimise clearing requirements for this project are summarised below. These will be implemented as far as practicable.

Where possible, clearing requirements will be reduced further during detailed design and implementation. Considerations to minimise clearing include:

- Project design to avoid Malleefowl nesting mounds and minimise the area of clearing within suitable habitat as far as practicable to facilitate the Project.
- Utilisation of existing tracks and disturbance from past exploration activities conducted in the area, particularly for the design of the haul road.
- Route selection for the proposed haul road to minimise clearing of vegetation associated with ephemeral drainage channels.
- Multiple lifts of the waste rock dumps to reduce the overall footprint and the amount of clearing required.

5.1.3 Rehabilitate

Native vegetation clearing will be rehabilitated in accordance with mine closure obligations under the *Mining Act 1978*.

While some clearing such as that for mining voids will be permanent (and have applicable closure obligations upon mine closure), other areas, such as supporting infrastructure and waste rock dumps, will be rehabilitated at closure.

5.1.4 Offset

The proposed native vegetation clearing will not result in any significant residual impacts to the environment and, therefore, an offset is not required.

5.2 Vegetation Management

Clearing will be implemented in accordance with Northern Star Environmental Management System (EMS) and management conditions outlined in the Clearing Permit approval. As a minimum, the following vegetation management conditions will be adhered to (unless otherwise stated in the approved Permit):

- Avoid, minimise and reduce the impacts and extent of clearing

  In determining the amount of native vegetation to be cleared under this Permit, the Permit Holder must apply the following principles, set out in descending order of preference:

  (a) avoid the clearing of native vegetation;

  (b) minimise the amount of native vegetation to be cleared; and

  (c) reduce the impact of clearing on any environmental value.

- Weed control

  When undertaking any 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:

  (a) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;

  (b) ensure that no known weed-affected soil, mulch, fill or other material is brought into the area to be cleared; and

  (c) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.

- Vegetation Management

  (a) where practicable the Permit Holder shall avoid clearing riparian vegetation; and

  (b) where a watercourse is to be impacted by clearing, the Permit Holder shall ensure that the existing surface flow is maintained.

- Fauna Management – Malleefowl

  Where clearing authorised under this Permit is to occur between 1 September and 31 January, the Permit Holder shall:

  (a) Within two weeks prior to undertaking any clearing, engage an environmental specialist to conduct an inspection of the area to be cleared to identify active (in use) Malleefowl (*Leipoa ocellata*) mounds.

  (b) Where an active (in use) Malleefowl mound is identified , the Permit Holder shall ensure that no clearing occurs within 50 m of the mound, during the months of September through to January, unless first approved by the CEO.

- Flora Management

  Where Priority flora have been identified and their written locations provided to the CEO, the Permit Holder shall ensure that:

  (a) no clearing of identified Priority flora occurs; and

  (b) no clearing occurs within 10 metres of identified Priority flora, unless first approved by the CEO.

6 Environmental Setting

6.1 Climate

The Goldfields region is arid to semi-arid with average annual rainfall decreasing from about 250 mm in the southwest to 200 mm in the northeast. The area experiences hot summers and mild winters with cold nights. Rainfall varies widely between years and droughts are common. Remnants of tropical cyclones occasionally bring heavy summer rain and can cause flooding to the area. The area transitions between desert summer and winter dominated rainfall and desert: non-seasonal bioclimatic (Beard, 1990).

The closest Bureau of Meteorology (BoM) weather station to the Project with comprehensive data collection and recent historic climate data is Kalgoorlie-Boulder Airport (012038).

Rainfall recorded at the Kalgoorlie-Boulder Station is shown in Figure 3 and long-term climate statistics for Kalgoorlie are shown in Table 2.

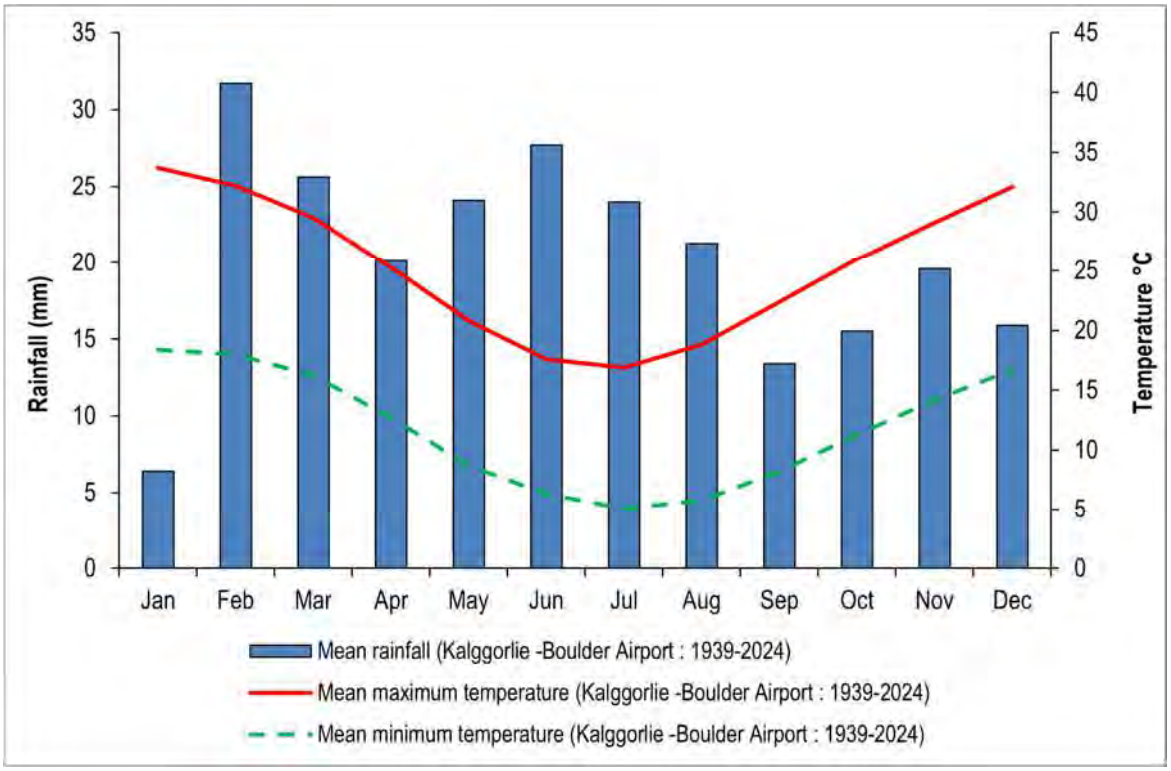


Figure 3: Climate Data (1939-2024) from Kalgoorlie-Boulder Airport Weather Station (012038)

Annual rainfall varies from around 150 mm up to 450 mm, with an average of approximately 270 mm/year. Rainfall is distributed fairly evenly throughout the year with an average monthly rainfall of approximately 22 mm, whilst pan evaporation is greatest in the summer months and lowest during winter.

Pan evaporation greatly exceeds rainfall with an average annual pan evaporation of around 2,600 mm. Although the average pan evaporation exceeds rainfall for the majority of the year, intense rainfall events associated with cyclonic activity results in monthly rainfalls often exceeding pan evaporation. Pan evaporation data has been unavailable for this climate station since 2006.

Table 2: Climate Statistics for Kalgoorlie-Boulder (012038) BOM Station

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Temperature														
Mean maximum temperature (°C)	33.7	32.2	29.5	25.3	20.8	17.6	16.9	18.8	22.4	26.0	29.1	32.1	25.4	1939–2024
Mean minimum temperature (°C)	18.4	18.0	16.2	12.7	8.7	6.3	5.1	5.8	8.2	11.3	14.2	16.7	11.8	1939–2024
Rainfall														
Mean rainfall (mm)	26.4	31.7	25.6	20.1	24.1	27.7	24.0	21.3	13.4	15.5	19.6	15.9	265.5	1939–2024

6.2 Soils and Landscape

The Project lies within the East Murchison bioregion which is characterised by internal drainages and extensive areas of elevated red desert sandplains with minimal dune development. The salt lake systems are associated with the occluded paleodrainage system.

6.2.1 Land Systems and Landscape Units

The Department of Primary Industries and Regional Development (DPIRD) provides broad scale (1:250,000) soil landscape system mapping delineating the landscape patterns, landforms and associated major soil groups and vegetation types of WA. The PPA intersects the Kambalda Zone of Western Australian which is described as having flat to undulating plains (with hills, ranges, and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton (DPIRD 2023a). The predominant soil types are calcareous loamy earths and red loamy earths, along with salt lake soils, red-brown hardpan shallow loams, and red sandy duplexes.

The Kambalda Zone is further broken down into seven land systems which have varying landforms and soil types as described in Table 3 and shown in Figure 4. The majority of the proposed clearing and subsequent mining infrastructure is proposed to be located within the Gundockerta, Leonora, and Campsite systems. The Leonora system extends across most of the eastern side of the mining area, while the western side is divided into the Campsite system in the north and the Gundockerta system in the south. The Campsite and Gundockerta systems are generally dominated by undulating plains whilst the Leonora system is characterised by low greenstone hills. All three systems are generally dominated by loamy calcareous and red earths.

The Brillant Pit is situated at the convergence of these three land systems and the Haul Road is divided roughly in equal parts, with the Kirgella system in the northern half and the Yowie system in the southern half.

Table 3: Soil and Landscape Systems

Soil and Landscape Systems	Description	Geomorphology	Mapped Extent within PPA (ha)
Campsite System	Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.	Alluvial plains, un-channelled drainage tracts and higher areas of stony plains.	348.11
Gundockerta System	Basalt and greenstone rises and low hills supporting eucalypt woodlands with prominent saltbush and bluebush understoreys.	Deeply weathered, low rounded hills and rises. Very gentle inclined foot slopes with pebble mantles and narrow alluvial tracts receiving tributary flow off higher units. Relief up to 40m.	224.09
Kirgella System	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.	Extensive, gently undulating plains generally with abundant stony mantles and less extensive lower alluvial plains with narrow central zones receiving more concentrated run-on, relief usually less than 15m.	210.30
Leonora System	Hardpan plains and central drainage tracts with mulga shrublands and minor chenopod shrublands.	Very gentle inclined to level plains subject to sheet flow with central drainage tracks receiving more concentrated run-on.	337.88
Moriarty System	Low greenstone hills and stony plains supporting mixed chenopod shrublands.	Low, rounded hills and very gently inclined fringing plains with stone mantles and narrow, generally unincised tributary drainage tracts. Relief up to 40m.	4.35
Waguin System	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.	Low rises to 20 m relief, locally with ferruginious duricrust, gently undulating lower plans with pebble mantles and level to very gently inclined alluvial plains; poorly defined, sparse drainage patterns.	12.17
Yowie System	Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.	Extensive level plains subject to very diffuse sheet flow.	305.27
Total			1,442.2

6.2.2 Project Specific Soil Characterisation

Environmental Innovations were commissioned by Northern Star Resources (NSR) to undertake a soil characterisation for the proposed Kurnalpi Gold Project. The purpose of this

assessment was to identify and characterise all surficial soil materials within the disturbance area and suggest management strategies for their handling and utilisation. The report is attached in Appendix B.

Three distinct Soil Mapping Unit's (SMU) were defined for the Project: deep red sands and alluvial gravels, sandy loam duplex and shallow calcareous loamy earths. The relationship between these SMU definitions and the major soil groups of Western Australia (Schoknecht 2001) and the Australian Soil Classification (Isbell 1996) is shown in Table 4.

Table 4: SMU and Recognised Soil Classification Schemes

SMU	Major Soil Group, WA (Schoknecht, 2001)	Australian Soil Classification (Isbell, 1996)
Shallow calcareous loamy earths	Calcareous shallow loam	Calcic Kandosol
Sandy loam duplex	Red Loamy Duplex	Red Tenosol
Deep red sands & alluvial gravels	Red Deep Sand	Orthic Tenosol

6.2.2.1 *SMU 1 (shallow calcareous loamy earths)*

All soils within SMU 1 are moderately alkaline to alkaline, with an average pH of 8.5 and have an average EC of only 85 mS/m (slightly saline).

SMU 1 soils can be considered nutrient-poor as they display low levels of mineralised nitrogen and phosphorus; but moderate to high levels of potassium.

Extractable sulfur was low in three of the four samples analysed but was high in the fourth sample. The higher sulfur value was found at the greatest depth analysed and may be caused by increased rock fragments within the sample matrix.

The soils in SMU 1 are classified as non-sodic (ESP < 6%) and reported a moderate to low CEC (average 10 meq/100g), indicating that the non-reactive clay mineral kaolinite is the dominant clay mineral type.

6.2.2.2 SMU2 (sandy loam duplex)

All of the measured soils within SMU 2 are moderately alkaline to alkaline, with an average pH of 8.5 and have an average EC of 135 mS/m (considered slightly saline).

The soils within SMU can generally be considered to display moderate nutrient levels. The average reported nitrogen content of the soils is low, whilst in contrast the plant available phosphorous and potassium levels are considered moderate to high.

SMU 2 soils are generally considered non-dispersive, although some dispersion may occur if these soils are disturbed (e.g. excavated during mining). The appreciable gravel fraction will tend to mitigate this instability, meaning these soils can be used to rehabilitate sloping land if stored and handled correctly.

The measured ESP for all but one of the soil samples tested from this SMU were below 6% (generally regarded as a cut-off for sodic soils) with sodium generally making up a negligible proportion of the exchangeable cations present within the soil medium. This indicates that

flocculation of finer clay particles in suspension will occur quickly, reducing the potential for dispersion and hard-setting to occur in response to disturbance.

The reported moderate CEC (average 18 meq/100g), indicates that the non-reactive clay mineral of kaolinite is the dominant clay mineral type within the finer <2µm fraction.

6.2.2.3 SMU3: (deep red sands and alluvial gravels)

This soil type is restricted to drainage lines, one of which dissects the Project area into northern and southern halves. It has formed in response to prolonged colluvial deposition and erosion of fine particles within partially dissected stream beds and therefore has a deeper profile than both SMU 1 and 2. The dissecting drainage line is a minor flow line which merges into a large flow line which flows southwards along the western fringe of the Project area and empties into the nearby Lake Yindarlgooda which is an ephemeral salt lake basin.

The soil profiles contained a lower silt + clay fraction, indicating that higher energy surface water has flowed through these drainage lines in the past, reducing the finer particle size percentage somewhat within the soil profile which remained behind.

Soils in SMU 3 have high gravel contents; average >50% gravel, with gravel content generally increasing with depth. The gravels in SMU 3 are predominately pisolithic shape (i.e. small < 5 mm diameter and well rounded). The fine fraction is classified as a sand to sandy loam, with an average of 90% sand and 10% silt + clay.

pH values show that both profiles investigated had more variation in the pH throughout, with pH varying between 7.1 and 9. The lower pH value is likely caused by loss of calcium carbonate materials as compared to surrounding soil because of higher historical water throughput.

The mineralised nitrogen content of the topsoil is very low, whilst the plant available potassium and phosphorous are low to moderate. Organic content and extractable sulfur can also be considered relatively low. The exchangeable cation content is dominated by calcium ions as with all soil across the Project area, and the CEC shows that kaolinite will be the dominant clay mineral within the <2 µm fraction.

413,000
420,000
427,000
6,643,000
6,636,000
6,629,000
6,622,000
N
Kirgella System
Waguin System
Waguin System
Yowie System
Campsite System
Campsite System
Moriarty System
Graves System
Gundockerta System
Moriarty System
Campsite System
Moriarty System
Illaara System
Campsite System
Leonora System
Campsite System
Moriarty System
Graves System
Moriarty System
Gundockerta System
Yilgangi System
Campsite System
Helag System
Leonora System
Campsite System
egie System
Legend
Purpose Permit Area
413,000
420,000
427,000

Scale: 1: 80,000
Original Size: A3
Aerial Imagery: Google Satellite
Grid: GDA2020 / MGA zone 51 (EPSG:7851)
0 1 2 km

Northern Star Resources Limited

Figure 4

Soils and Landscape Systems

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6.3 Flora and Vegetation

Three flora and vegetation studies were conducted for the Project area and surrounds between 2011 and 2022. These are listed in Table 5, with studies provided in Appendix C, Appendix F, and Appendix G respectively.

Table 5: Baseline Flora and Vegetation Studies

Study	Date	Consultant	Survey Location
Level 2 Flora and Vegetation Survey	November 2011	Botanica Consulting Pty Ltd	Carrick Gold tenements
Reconnaissance Flora & Fauna survey	June 2018	Botanica Consulting Pty Ltd	Kurnalpi Project Site
Reconnaissance Flora and Basic Fauna Assessment	January 2022	Botanica Consulting Pty Ltd	Kurnalpi North Project Site

The flora and vegetation surveys were undertaken in accordance with:

- EPA Technical Guidance Statement 51 (EPA 2004) during earlier surveys (pre-2016).
- Environmental Factor Guideline: Flora and Vegetation (EPA 2016b).
- EPA Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a).
- Statement of Environmental Principles, Factors and Objectives (EPA 2020).

In 2021, Botanica Consulting Pty Ltd (Botanica, 2022) was commissioned by Northern Star Resources Ltd. to undertake a reconnaissance flora/ vegetation survey and basic fauna survey of Kurnalpi North Project area (referred to as the 'survey area'). This area consists of a polygon of approximately 1,096 ha, and a transport corridor of approximately 25 km length and 200 m width (approximately 495 ha). The total extent of the survey area is approximately 1,591 ha. Botanica's study included a detailed literature review of the previous flora and fauna surveys undertaken for the site.

6.3.1 Flora

The field survey identified 145 vascular flora taxa within the survey area. These taxa represented 71 genera across 29 families, with the most diverse families being Myrtaceae and Fabaceae (23 species each), followed Scrophulariaceae (16 species). Dominant genera include Eucalyptus (16 species) and Eremophila and Acacia (15 species each).

No introduced (weed) species were recorded.

6.3.2 Vegetation Communities

A total of ten broad-scale vegetation communities were identified within the survey area. Vegetation community descriptions and extent are listed in Table 6 and shown in Figure 5.

Table 6: Mapped Vegetation Communities

Landform	NVIS Major Vegetation Group	Code	Vegetation Type	Area
Clay-Loam Plain	Acacia low forest/ woodland	CLP-AFW1	*Acacia caesaneura* low forest/ woodland over mixed shrubland over *Ptilotus obovatus* low open shrubland	196 ha (12.3%)
	Eucalyptus woodland	CLP-EW1	*Eucalyptus salubris* and *E. transcontinentalis* open woodland over *Eremophila scoparia* shrubland	29 ha (1.8%)
	Eucalyptus woodland	CLP-EW2	*Eucalyptus salmonophloia* low open woodland over *Atriplex nummularia* and *Maireana sedifolia* low open shrubland	230 ha (14.5%)
	Eucalyptus woodland	CLP-EW3	*Eucalyptus salmonophloia and E. salubris* low woodland over *E. oleosa* open mallee shrubland over mixed low shrubland	549 ha (34.5%)
	Eucalyptus mallee woodland	CLP-MW1	*Eucalyptus oleosa* low open mallee woodland over *Acacia caesaneura* and *A.* sp. narrow phyllode	81 ha (5.1%)
Open Depression	Eucalyptus low woodland	OD-MW1	*E. loxophleba* subsp. *lissophloia* low woodland over *Ptilotus obovatus* low open shrubland	10 ha (0.6%)
Rocky Plain	Acacia low woodland	RH-AW1	*Acacia caesaneura* low open woodland over *A.* sp. narrow phyllode, *A. quadrimarginea* and *A. colletioides* shrubland	132 ha (15.3%)
	Eucalyptus low woodland	RH-EW1	*Eucalyptus lesouefii* low woodland over *Maireana sedifolia* low open shrubland	244 ha (15.3%)
Sandy-Loam Plain	Eucalyptus mallee woodland	SLP-MW1	*Eucalyptus horistes* and *E. concinna* low mallee woodland over *Westringia cephalantha, Grevillea oncogyne* and *Triodia scariosa* low open shrubland/ hummock grassland	77 ha (4.8%)
Sandplain	Casuarina low open woodland	SP-CW1	*Casuarina pauper* low open woodland over *Ptilotus obovatus* low open shrubland	36 ha (2.3%)

The survey found Eucalyptus mallee woodland on clay-loam plain (CLP-MW1) was the most widespread community in the survey area, occupying 549 ha, while Eucalyptus low woodland (OD-MW1) was the most restricted with 10 ha. The most diverse vegetation community was Eucalyptus mallee woodland on sandy-loam plain (SLP-MW1) with 60 species, while the least diverse was Eucalyptus woodland (CLP-EW1), with 25 species.

Based on the vegetation condition rating scale adapted from Keighery (1994), native vegetation within the survey area was categorised as 'good'. Disturbances within the survey area include vegetation clearing for mining and exploration, access roads and cumulative historical impacts such as grazing and fire events.

413,000
420,000
427,000
6,643,000
6,636,000
6,629,000
6,622,000
N

Legend

Purpose Permit Area

Vegetation Communities

- Cleared
- CLP-AFW1
- CLP-EW1
- CLP-EW2
- CLP-EW3
- CLP-MW1
- OD-MW1
- RH-AW1
- RH-EW1
- SLP-MW1
- SP-CW1

Scale: 1: 80,000
Original Size: A3
Aerial Imagery: Google Satellite
Grid: GDA2020 / MGA zone 51 (EPSG:7851)
0 1 2 km

Northern Star Resources Limited

Figure 5

Vegetation Communities

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MBS ENVIRONMENTAL

\\mbssvr\working\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 20/02/2025 F05 Vegetation Communities

6.3.3 Threatened and Priority Flora

The assessment of the DBCA Priority/Threatened flora database records (DBCA 2019a), NatureMap (DBCA 2021) and Protected Matters searches (DAWE 2021) and previous relevant literature identified 10 significant flora species recorded within a 40 km radius of the survey area. These consist of one Threatened, three Priority 1, four Priority 2 and two Priority 3 flora taxa.

These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment did not identify any taxa as likely to occur within the survey area. The assessment identified one Priority species, *Austrostipa blackii* (P3), as previously recorded within the survey area. In addition, three taxa were identified as possibly occurring in the survey area; consisting of one Priority 1, one Priority 2 and two Priority 3 flora taxa:

- Ptilotus procumbens (P1)
- Thryptomene eremaea (P2)
- Micromyrtus serrulata and Austrostipa blackii (P3)

No Threatened, Priority or otherwise significant flora species were recorded within the survey area.

The previously recorded *Austrostipa blackii* (P3) (Botanica, 2011) was not observed within the survey area, despite a focused search at the location of the previous record and within areas of suitable habitat. Vegetation in the vicinity of the previous record was observed to be heavily grazed (Botanica, 2022).

6.3.4 Threatened and Priority Ecological Communities

The Protected Matters search (DAWE 2021) did not identify any Threatened Ecological Communities recorded within 40 km of the survey area.

Analysis of the Priority Ecological Communities within the Goldfields region (DBCA 2017) did not identify any significant vegetation assemblages as likely or possibly occurring within the survey area.

Subsequent field surveys identified no Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) listed under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) or the Biodiversity Conservation Act 2016 (BC Act).

6.3.5 Groundwater Dependant Ecosystems

Groundwater Dependent Ecosystems (GDE) includes biological assemblages of species such as wetlands or woodlands that use groundwater either opportunistically or as their primary water source. A GDE is defined as any vegetation community that derives part of its water budget from groundwater and must be assumed to have some degree of groundwater dependency (Botanica 2021). In accordance with the BoM Atlas of Groundwater Dependent Ecosystems (BoM, 2020b) database, there are two moderate-potential and five low-potential terrestrial GDE's within the surveyed area, these are described in Table 7.

There are no potential aquatic GDEs within the survey area (Botanica 2022).

Table 7: Potential GDE in Surveyed Area

Geomorphology	Potential	Vegetation Description
Undulating plains with some sandplains, ferruginous breakaways; ridges of metamorphic rocks and granitic hills and rises; calcretes, large salt lakes and dunes along valleys.	Moderate	Alluvial plains, supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.
		Sandplains and stripped granite or laterite surfaces with low fringing breakaways and lower plains; supports bowgada and mulga shrublands with wanderrie grasses.
	Low	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.
		Extensive sandplain, with scattered granite outcrop supporting mainly spinifex hummock grasslands and mulga and mallee shrublands.
		Low greenstone hills and stony plains supporting mixed stony chenopod shrublands.
		Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.
		Sandy plains supporting shrublands of mulga and bowgada with patchy wanderrie grasses.

6.4 Fauna

Four reconnaissance and basic (includes Level 1) fauna assessments have been completed for the Project, with the most recent study produced in January 2022. The four assessments have been provided as Appendix F, Appendix G, Appendix D, and Appendix E, and are listed in Table 8.

Table 8: Baseline Fauna and Habitat Surveys

Survey/Study	Date	Consultant	Survey Location
Level 1 Terrestrial Fauna Survey	February 2012	Greg Harewood	Kurnalpi Project Site
Level 1 Terrestrial Fauna Survey of the Arcoona Haul Road	March 2013	Greg Harewood	Arcoona Haul Road of Kurnalpi Project
Reconnaissance Flora & Fauna survey	June 2018	Botanica Consulting Pty Ltd	Kurnalpi Project Site
Reconnaissance Flora and Basic Fauna Assessment	January 2022	Botanica Consulting Pty Ltd	Kurnalpi North Project Site

6.4.1 Fauna Habitat

Based on vegetation and associated landforms assessed during the flora and vegetation assessment, eight broad scale terrestrial fauna habitats were identified as occurring within the survey area (Botanica 2022). Fauna habitats are described in Table 9 and depicted in Figure 6.

Table 9: Mapped Fauna Habitats

Fauna Habitat	Description	Mapped Area (ha)
Acacia woodland on clay-loam plain	*Acacia caesaneura woodland over Ptilotus obovatus mixed low shrubland*	196
Eucalyptus woodland on clay-loam plain	*Eucalyptus open woodland over Atriplex, Eremophila and Maireana mixed shrubland*	644
Eucalyptus mallee woodland on clay-loam plain	*Eucalyptus open mallee woodland over over mixed low shrubland*	245
Eucalyptus mallee woodland in open depression	*Eucalyptus open mallee woodland over mixed low shrubland*	9
Acacia low woodland on rocky hillslope	*Acacia woodland and shrubland*	132
Eucalyptus woodland on rocky hillslope	*Eucalyptus woodland over Maireana low shrubland*	244
Eucalyptus mallee woodland on sandy-loam plain	*Eucalyptus open mallee woodland over mixed low shrubland*	78
Casuarina woodland on sandplain	*Eucalyptus open mallee woodland over Ptilotus obovatus low shrubland*	36
Cleared*	-	7

** For the purpose of this assessment the 'cleared' extent has been included in the area requested to be cleared, as recent google imagery (November 2024) suggests this area has been revegetated since the Botanica (2022) survey. The extent of fauna habitat classified as 'cleared' within the proposed clearing area accounts for < 1 ha.*

413,000 420,000 427,000

6,643,000 6,636,000 6,629,000 6,622,000

N

Legend

Purpose Permit Area

Fauna Habitat

- Acacia low woodland on rocky hillslope
- Acacia woodland on clay-loam plain
- Casuarina woodland on sandplain
- Cleared
- Eucalyptus mallee woodland in open depression
- Eucalyptus mallee woodland on clay-loam plain
- Eucalyptus mallee woodland on sandy-loam plain
- Eucalyptus woodland on clay-loam plain
- Eucalyptus woodland on rocky hillslope

Scale: 1: 80,000
Original Size: A3
Aerial Imagery: Google Satellite
Grid: GDA2020 / MGA zone 51 (EPSG:7851)

0 1 2 km

Northern Star Resources Limited

Figure 6

Fauna Habitat

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MBS ENVIRONMENTAL

\\mbssvr\working\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 20/02/2025 F06 Fauna Habitat

6.4.2 Fauna Assemblage

A total of 131 terrestrial vertebrate fauna taxa were recorded within 40 km of the survey area, consisting of 69 bird, 20 mammal, 40 reptile and two amphibian taxa (Botanica, 2022). This total includes five introduced (feral) species (3.8%).

6.4.3 Significant Fauna Species

According to the EPA Environmental Factor Guideline for Terrestrial Fauna (EPA, 2016c) significant fauna includes:

- Fauna being identified as a Threatened or Priority species;
- Fauna species with restricted distribution;
- Fauna subject to a high degree of historical impact from threatening processes; and
- Fauna providing an important function required to maintain the ecological integrity of a significant ecosystem.

Habitat and distribution data was used to determine the likelihood of occurrence within the survey area (Botanica, 2022). The assessment identified three significant fauna species as potentially occurring in the survey area, consisting of two Vulnerable and one Specially Protected taxa.

The current status of some species on site and/or in the general area is difficult to determine, however, based on the habitats present and, in some cases, direct observations or recent nearby records, the following species of conservation significance can be regarded as possibly utilising the survey area for some purpose at times, these being:

- Grey Falcon (Falco hypoleucos) - Vulnerable (EPBC Act and BC Act)

This species is sparsely recorded throughout inland Australia. Suitable habitat may be present but is unlikely to represent critical habitat. Significant impact is considered unlikely.

- Peregrine Falcon (Falco peregrinus) – Specially Protected (EPBC Act)

This species potentially utilises some sections of the survey area as part of a much larger home range, though records in this area are uncommon. It is considered unlikely to breed within the survey area. Significant impact is considered unlikely.

- Malleefowl (Leipoa ocellata) - Vulnerable (EPBC Act and BC Act)

This species is occasionally recorded in the Eastern Goldfields subregion. The majority of habitat within the survey area appears marginal/or unsuitable for breeding due to the open nature of the vegetation. However, the presence of activity within an inactive mound indicates that the species persists within the local area. Significant local impacts may occur.

Further targeted surveys, light detection and ranging (LiDAR) analyses, and Malleefowl mound surveys confirmed the presence of habitat suitable for foraging and breeding, as well as 16 Malleefowl mounds (only three were recorded as active) within the PPA. Further details of Malleefowl studies and their findings are presented in Section 6.4.4.

6.4.4 Malleefowl

In addition to the reconnaissance and basic fauna surveys undertaken for the Project, further targeted surveys and analysis have been undertaken to determine the presence, habitat

suitability and potential impact of the Proposal on Malleefowl. These are presented in Table 10 and included as Appendix H, Appendix I, and Appendix J.

Table 10: Targeted Malleefowl Surveys and Analysis

Survey/Study	Date	Consultant	Survey Location
Kurnalpi Malleefowl Mound Detection via LIDAR	May 2022	Anditi Pty Ltd	Kurnalpi Project site
Malleefowl habitat assessment and targeted survey for Miscellaneous Licence L28/072	April 2023	Phoenix Environmental Services	Kurnalpi Haul Road Project site
Kurnalpi Haul Road Project - Significant Fauna Impact Assessment	October 2024	Phoenix Environmental Services	Kurnalpi Haul Road Project site
Kurnalpi Malleefowl Mound Analysis via LIDAR	January 2025	Anditi Pty Ltd	Kurnalpi Haul Road Project site

6.4.4.1 *Habitat Assessment and Targeted Survey 2023*

Phoenix Environmental Services (2023) were engaged to undertake a targeted Malleefowl Survey for the Kurnalpi Haul Road Project. The desktop review identified a total of 83 Malleefowl records within 40 km of the study area, 60 from Phoenix's biological database, one from the Botanica (2022) survey, and 22 potential mounds from the Anditi Pty Ltd (2022) LiDAR survey. Of the records from Phoenix's biological database, two records from secondary evidence were within the study area near the intersection with the Carosue Dam Haul Road. Most of the records were along roads and in the vicinity of Carosue Dam infrastructure.

All three habitat types recorded in the subject area (Acacia shrubland, Open Eucalyptus woodland and Open Acacia shrubland) were found to be suitable for Malleefowl with the level of suitability dependant on their structure. Based on the sites assessed, 787.5 ha (78.6%) of the habitat in the study area was classified as High suitability habitat (critical habitat with potential for nesting as well as primary foraging; score of six or more) and 207.3 ha (20.7%), was classified as Medium suitability habitat (foraging and dispersal habitat; score of 4 or 5). Cleared areas, 7.7 ha (0.8%) such as roads were not assessed for Malleefowl suitability as they lacked the necessary native vegetation for Malleefowl use. Most of the critical breeding habitat was in Acacia shrubland, the most widespread habitat covering over 60% of the study area. Open Eucalyptus woodland, covering over 30% of the study area, and Open Acacia shrubland, just under 5%, also contained areas of critical breeding habitat. Based on the aerial imagery, all broad fauna habitats occurring within the study area extend outside and are widespread in the region.

During the transects, one Extinct mound and several sets of tracks were recorded throughout the study area. A Malleefowl was also seen approximately 2.5 km from the study area while travelling. As searches did not cover the entirety of the study area, it is probable that additional signs of use by Malleefowl were not detected during the field survey, particularly in areas of densely vegetated suitable habitat. Based on the desktop and field survey results, it is evident there is a resident breeding population of Malleefowl that utilise almost the entirety of the study area.

Introduced predators are a critical threat to Malleefowl. Secondary evidence of cats and dingos or dogs was recorded at multiple sites on or nearby vehicle access tracks. While no signs of foxes were recorded during the field survey, they are likely in the area but can be difficult to detect.

All habitat in the study area is suitable for Malleefowl with the highest rated habitat primarily in Acacia shrubland habitat. Almost 80% of the habitat within the study area was classified as critical breeding habitat with the potential for nesting. All habitat types extend outside the study area and are widespread in the region. Malleefowl were recorded by secondary evidence throughout the study area, and it is evident there is a breeding population resident in the area.

6.4.4.2 *Significant Fauna Impact Assessment 2024*

Phoenix were engaged to undertake a Significant Fauna Impact Assessment to assess the Proposed Action against the EEPBC Act Significant Impact Guidelines and determine whether referral under EPBC Act would be required (Phoenix 2024).

The Impact Assessment found at least 7 Malleefowl nesting mounds are present in the survey area, 5 within L28/72 (Botanica Consulting 2022; Northern Star Resources 2022; Phoenix 2023); one is classified as extinct, one inactive (likely to have been used in the last 5 years, based on fig 5-7 of Botanica Consulting 2022), but the activity status of the others has not been assessed (Northern Star Resources 2022). Inactive mounds may be re-used in future years, so activity assessment applies only to the current season. The targeted survey found that almost all of the survey area (L28/72 + 100 m buffer; 98.4%) represents suitable Malleefowl habitat, comprising (Phoenix 2023):

- 787.5 ha (78.6% of the survey area) classified as critical breeding habitat.
- 207.3 ha (20.7%) classified as foraging and dispersal habitat.

The broader scale mapping undertaken (Figure 8) found that most habitat within a 10 km radius of the survey area (79%) was also suitable for Malleefowl, with 64,038 ha mapped as suitable or suitable (mosaic) at the 10 km scale. The proportion of suitable (including mosaic) habitat reduces as the buffer distance is increased due to greater variability in landform and habitat types.

Suitable habitat for Malleefowl appears to be much more abundant in the northern half of the 40 km buffer area (Figure 8). Suitable habitat in the survey area is contiguous with that outside in most directions; there is particularly good connectivity to the north and northwest. Vegetation south of the survey area is typically sparser and more open.

The survey area intersects a large contiguous patch of suitable (non-mosaic) habitat, that covers approximately 31,615 ha of the surrounding area and extends approximately 7 km south west and 11 km north east of the survey area. In contrast, most of the suitable habitat mapped outside the 10 km buffer (i.e. between 10 and 40 km) is mosaic habitat.

6.4.4.3 *LiDAR Malleefowl Mound Analysis and Field Verification 2025*

In 2025, Anditi was engaged to construct a digital elevation model (DEM) and undertake a LiDAR data analysis to identify potential Malleefowl mounds at Kurnalpi. This analysis superseded the 2022 LiDAR mound detection by Anditi (2022). The Anditi Malleefowl mound analysis algorithms look for ground features in the point cloud that best approximate

a typical Malleefowl mound shape. Based on the algorithm match to shape and manual checks, a mound is classed from 1 to 4. This classification reflects the likelihood of the shape being a Malleefowl mound (1 being highly likely and 4 being low).

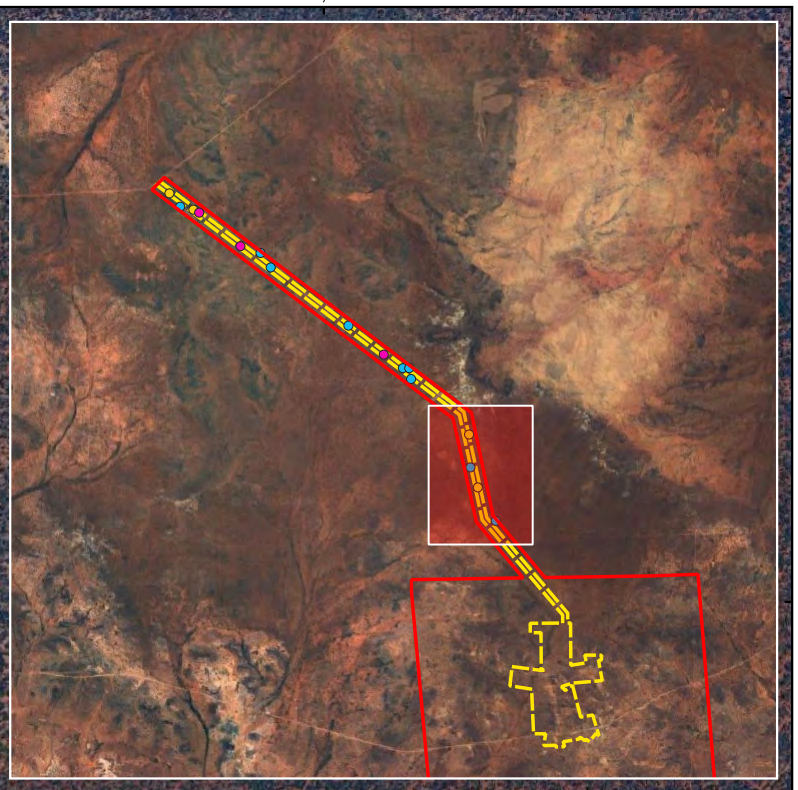
Northern Star Resources conducted field surveys following Anditi's LiDAR results to verify if sites identified as having mound-like features were Malleefowl mounds and record their status (active, inactive, or long unused). The most recent field survey was conducted on 28-29 January 2025.

The January 2025 field survey confirmed the presence of 16 Malleefowl mounds, of which only three were found to be active, four were recorded as long unused, and the remaining nine were inactive. All three active mounds occurred inside the haul road extent of the PPA (Figure 7). A review of the mound locations found that the haul road can be designed within the bounds of the PPA to effectively avoid Malleefowl mounds.

421,000 422,000 423,000 424,000

6,634,000 6,633,000 6,632,000 6,631,000 6,630,000 6,629,000

N



Legend

- Anditi Survey Boundary
- Purpose Permit Area

Malleefowl Mound Status

- Inactive
- Long Unused

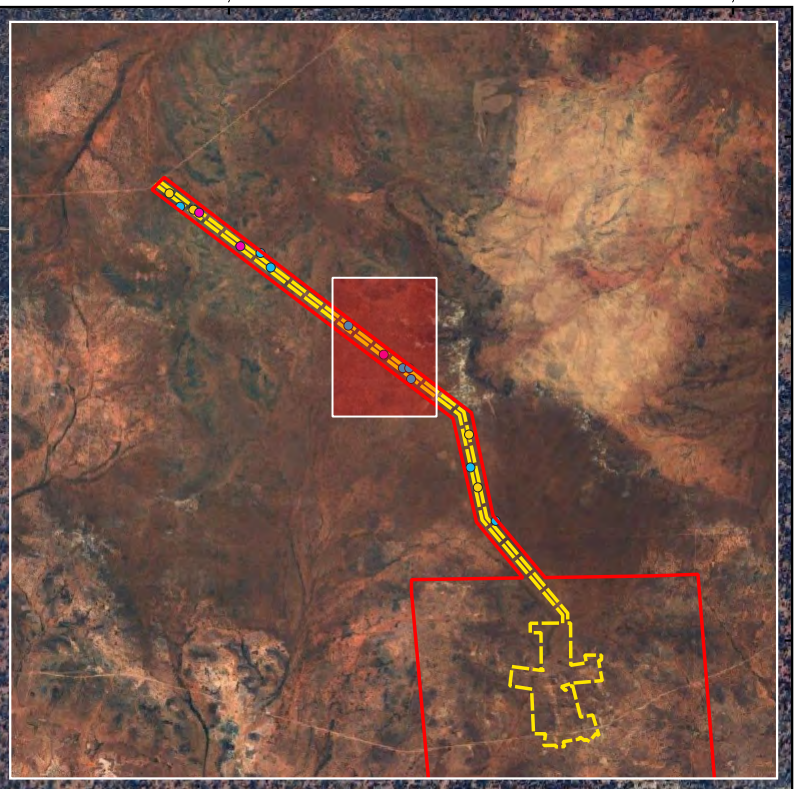
Scale: 1: 15,000 Original Size: A3 Aerial Imagery: Kurnalpi Nov 2024 Grid: GDA2020 / MGA zone 51 (EPSG:7851) 0 250 500 m	Northern Star Resources Limited	**Figure 7a** **Confirmed Malleefowl Mound Locations**	Martinick Bosch Sell Pty Ltd 4 Cook St West Perth WA 6005 Australia t: +61 8 9226 3166 info@mbsenvironmental.com.au www.mbsenvironmental.com.au MBS ENVIRONMENTAL

W:\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 05/03/2025 F07a Confirmed Malleefowl Mound Locations

417,000 418,000 419,000 420,000 421,000

6,639,000 6,638,000 6,637,000 6,636,000 6,635,000 6,634,000

N



Legend

- Anditi Survey Boundary
- Purpose Permit Area

Malleefowl Mound Status

- Active
- Inactive

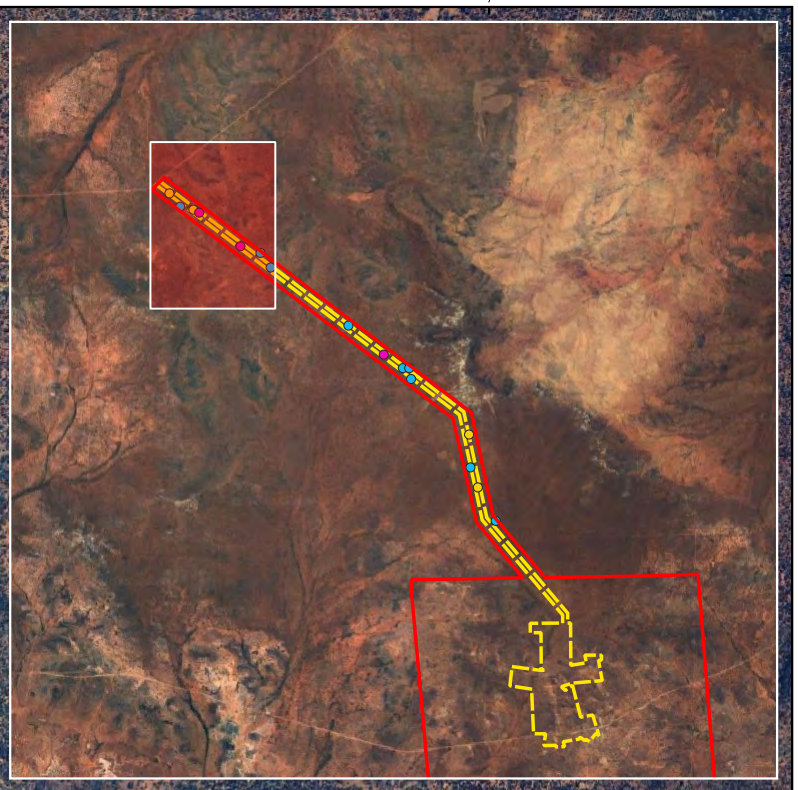
Scale: 1: 15,000 Original Size: A3 Aerial Imagery: Kurnalpi Nov 2024 Grid: GDA2020 / MGA zone 51 (EPSG:7851) 0 250 500 m	Northern Star Resources Limited	**Figure 7b** **Confirmed Malleefowl Mound Locations**	Martinick Bosch Sell Pty Ltd 4 Cook St West Perth WA 6005 Australia t: +61 8 9226 3166 info@mbsenvironmental.com.au www.mbsenvironmental.com.au MBS ENVIRONMENTAL

W:\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 05/03/2025 F07b Confirmed Malleefowl Mound Locations

410,000 412,000 414,000

6,644,000 6,642,000 6,640,000

N



Legend

- Anditi Survey Boundary
- Purpose Permit Area

Malleefowl Mound Ststus

- Active
- Inactive
- Long Unused

410,000 412,000 414,000

Scale: 1: 18,000
Original Size: A3
Aerial Imagery: Kurnalpi Nov 2024
Grid: GDA2020 / MGA zone 51 (EPSG:7851)
0 250 500 m

Northern Star Resources Limited

Figure 7c

Confirmed Malleefowl Mound Locations

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W:\Northern Star\Kurnalpi\Approvals\NVCP\GIS\NorthernStar_Kurnalpi_NVCP_2025.qgz 05/03/2025 F07c Confirmed Malleefowl Mound Locations

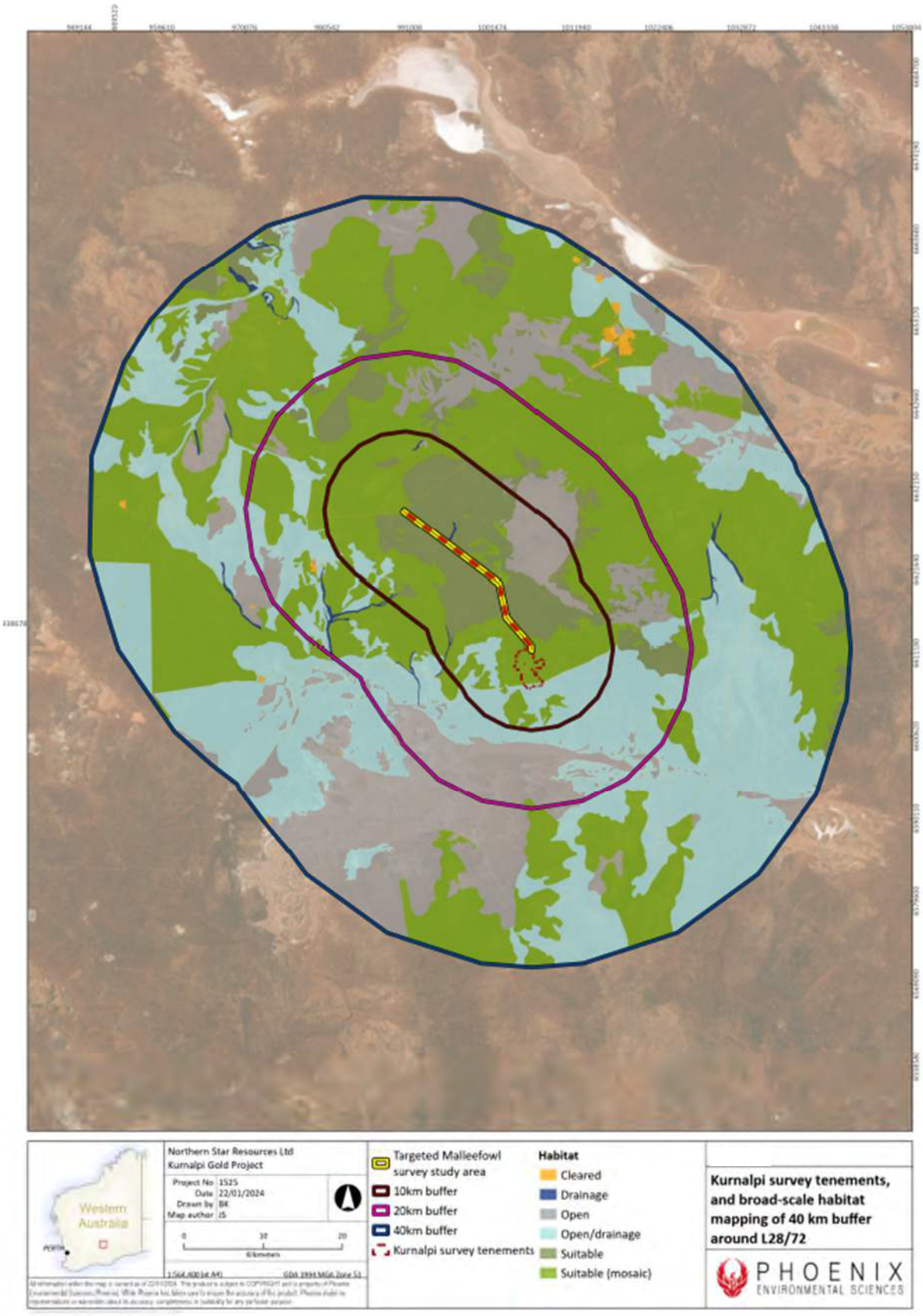


Figure 8: Kurnalpi survey tenements, and broad-scale habitat mapping of 40 km buffer around L28/72

6.4.5 Subterranean Fauna

Phoenix Environmental were engaged by NSR to conduct a desktop assessment for subterranean fauna within the Kurnalpi project area. The report is provided in Appendix K.

The key finding s of the assessment determined that:

Given the lack of suitable geological and hydrogeological features within the study area (ie. porous geologies such as calcrete, and the low proportion of alluvium and colluvium), the study area is unlikely to support a high diversity of troglofauna, if any.

The combination of saline water and very low porosity habitat within the study area limits the likelihood of stygofauna occurring. While stygofauna have been recorded in high salinities (Bennelongia 2020), this is uncommon and highly diverse and abundant communities are only likely to occur in combination with highly suitable geologies. This is further supported by the lack of records from the desktop review search area. While few surveys have been undertaken, the ones that have suggest no subterranean fauna are present.

The research suggests stygofauna in the region are restricted to areas of suitable habitat above 29° south, with significant stygofauna communities appearing from 200 km north/ northwest/ northeast of the study area (Bennelongia 2020; Biologic 2021; Humphreys 1998).

Given the above, the risk to subterranean fauna from the proposed clearing for Kurnalpi is low (Phoenix 2025).

6.5 Surface Water

6.5.1 Hydrology

The East Murchison subregion is characterised by its internal drainage and salt lake system associated with the occluded palaeodrainage systems (Cowan 2001).

The region is typified by north-westerly trending saline lake drainage systems which flow parallel to and cross the stratigraphy. Surface water flows within the catchment areas of these lakes is via sheet flow and drainage lines.

The Project lies within the southern extent of the Raeside-Ponton hydrographic catchment (DWER dataset), approximately 8 km north of Lake Yindarlgooda. The Project is in an area of mostly subdued topography, generally sloping to the west and consists of small local catchments. Surface water run-off from the Project area is via not well-defined channels that flow to the main watercourse running approximately northeast to southwest along the west side of the Project to discharge at Lake Yindarlgooda. The local catchment, delineated in RPS (2022) has a total size of 96.5 km^2. All drainages are ephemeral, with intermittent stream flow occurring only after major rainfall.

As a registered Aboriginal heritage place, Lake Yindarlgooda is a known cultural receptor downstream of the Project area (DPLH dataset). Therefore, run-off associated with construction and operational activities needs to be assessed and managed to avoid adverse environmental and cultural impacts (flow and water quality discharging to the lake).

The Project is not located within a proclaimed Surface Water Area under the *Rights in Water and Irrigation Act 1914* (RIWI Act).

6.5.2 Hydrological and Hydraulic Modelling

Northern Star commissioned RPS to undertake a hydrological assessment for the Project (Appendix L). This included estimation of peak flood flows, depths and velocities in the main and local drainages. The objective was to identify flood risks and mitigation measures required for Project infrastructure and to minimise the environmental impact of the Project on the natural drainage systems.

To estimate peak flows, two hydrological rainfall run-off routing models (RORB and RAFTS) were used to calculate flood hydrographs from input parameters such as rainfall, channel inputs, and catchment area. Design rainfalls were estimated using the methodologies described in Australian Rainfall and Runoff (ARR 2019). Climate change was not factored in rainfall depths. Results of peak flow estimates (for critical duration) by the RORB model was considered more appropriate for flood assessment of rarer events and use in hydraulic modelling for the Project.

Hydraulic modelling to describe the water level and velocity characteristics of the hydrologically derived flood flows was completed for 10 % and 1 % 1-in-100 Annual Exceedance Probability (AEP) flood events. The key findings are summarised as follows:

Based on flood extent mapping, the North WRD as well as the western ends of the topsoil stockpile north of the WRD and North ROM Pad, encroach into the Kurnalpi Creek floodplain. A flood protection bund is proposed along the western toe of the WRD to protect the landform from scouring and erosion. This bund will only marginally increase flood levels and will remain post-closure. Flood protection bunds will also be constructed to protect the topsoil stockpiles and ROM Pad North.

The southern drainage line crosses the north-south road and passes between the two ROMs and then the Brilliant and Dazzle Pits. During operations, a minor diversion channel is proposed to direct this water between the two WRDs. A settling pond may be constructed to limit transported sediments from the mining area being discharged to Kurnalpi Creek. Given, the small upstream catchment area, the pits will have minimal surface water impact at closure and standard pit abandonment bunds will be sufficient.

Ancillary mining facilities are only impacted by sheet flow and require minor surface water protection.

The east to west road to the magazine building intersects Kurnalpi Creek, and a culvert or floodway is required at this creek crossing.

The open pits will hold water and the WRDs will trap run-off on top, and hence there will be a minor proportional reduction in contributing catchment area downstream. However, in a landscape of broad catchments and creeks, with natural large seasonal and annual variations in catchment runoff, this reduction in catchment area and in effective run-off loss is not considered to be environmentally significant. The proposed surface water management infrastructure, (RPS 2022) indicate that the Project will have no adverse effects on surface and groundwater hydrological patterns / flows, water levels and water quality.

6.6 Groundwater

6.6.1 Regional Hydrogeology

The Goldfields region is comprised of highly weathered and fractured Archean bedrock, overlain locally by palaeochannel deposits and by widespread alluvial and lake deposits. The bedrock forms part of the Yilgarn Goldfields fractured-rock groundwater province. Groundwater salinity is highly variable with the lower salinities beneath catchment divides, and higher salinities along the palaeodrainages. Nitrate levels can be elevated in the region and arsenopyrite mineralisation (associated with gold mineralisation) can result in elevated Arsenic levels (Johnson et al. 1999).

The fractured bedrock is characterised by secondary permeability resulting from chemical weathering of tectonic and decompression fracture systems. Fractured rock aquifers are developed in greenstone rocks, such as mafic and ultramafic volcanic rocks, with minor groundwater supplies present within fractured granitoid rocks (Johnson et al. 1999). They tend to exhibit heterogeneity and anisotropy, with water yield and quality varying spatially. The storativity and hydraulic conductivity of fractured rock aquifers is predominantly related to the extent of fracture density. The greenstone rocks are generally more prospective compared to the granitoids, which are typically more homogenous and sparsely fractured (Johnson et al. 1999).

The base of the Tertiary sedimentary sequence in the palaeochannels is marked by a fluvial sand aquifer confined beneath a dense clay layer. The palaeochannel sand is highly permeable and contains significant supplies of groundwater, which are fresh to brackish in the tributaries and saline to hypersaline in the main trunk drainages. The sand, however, has limited groundwater storage with most groundwater abstracted being the result of induced leakage from overlying sediments and surrounding fractured-rock aquifers (Johnson et al. 1999).

Groundwater within the major palaeodrainages flows towards the numerous salt lakes. Hydraulic gradients along the palaeodrainages are generally very low, with steeper gradients occurring in the upper reaches of the catchments, and where the palaeochannel crosses greenstone ridges.

Groundwater recharge constitutes a very small proportion of rainfall, with most recharge likely to occur during heavy rainfall when it is augmented by recharge from surface runoff and local flooding. Groundwater discharge occurs mainly by evaporation from playa lakes, and a relatively small amount by throughflow within the palaeochannels.

The Roe Palaeodrainage is an integrated drainage system comprising a number of palaeochannels incised into Archaean bedrock and infilled with Tertiary sediments across the Kalgoorlie region. The principal aquifer in the region is the Wollubar Sandstone which occurs in the palaeochannels (Commander et al. 1992).

The Wollubar Sandstone consists predominantly of unconsolidated, very coarse to fine, subangular to subrounded, moderately to poorly sorted, and poorly cemented quartz. The sandstone forms a discrete sinuous aquifer underlain by weathered igneous and metamorphic rocks and confined over large areas by relatively impermeable shale (Perkolilli Shale) (Commander et al. 1992).

Groundwater flow in the Wollubar Sandstone is along the axis of the palaeochannels. The hydraulic head in the formation is generally lower than in the Archaean bedrock indicating that the palaeochannels are regional drains receiving groundwater flow from the surrounding areas of bedrock. The elevation of the regional potentiometric surfaces in the Wollubar Sandstone falls from about 370 m in the west to 320 m in the east near Lake Yindarlgooda (Commander et al. 1992). Near Lake Yindarlgooda, hydraulic gradients are likely very low (20 m per day) and groundwater is hypersaline (Commander et al. 1992). The salt lakes act as throughflow lakes with areas of upstream groundwater discharge and areas of downstream recharge of more concentrated brines (Commander et al. 1992).

Groundwater abstraction of fractured rock aquifers adjacent to and underlying palaeochannels has resulted in water level declines in the Wollubar Sandstone owing to their hydraulic connection (Commander et al. 1992).

6.6.2 Local Hydrogeology

The Project is located within the Roe combined Fractured Rock West - Palaeochannel groundwater resource area of the proclaimed Goldfields Groundwater area. The Yindarlgooda North palaeochannel flows eastwards approximately 8.5 km south of the Project area through the northern extent of the Yindarlgooda playa lake. Alluvium and colluvium fans of the palaeochannel extend northwards to within 1.3 km of the Project. The Yilgangi and Avoca Shears bound the Project area to the east and west respectively.

The Avoca Shear is a composite reverse fault with dominant southwest dipping planes of movement and late-stage northeast striking ductile shears transect the sequence. Other fracture sets which trend north to south have been mapped within the region. Most gold mineralisation occurs along these north northwest trending faults (Northern Star 2024).

In 2021, Rockwater conducted a hydrogeological study using existing exploration drilling data to estimate dewatering requirements for each pit; the potential impacts of mining; and the nature of the final mine voids. None of the exploration drill holes used in the study intercepted the palaeotributaries.

The Rockwater 2021 study found that groundwater in the Pit footprints is generally encountered in the transition zone between weathered and fresh bedrock (predominantly basalt and ultramafic units). Standing groundwater levels recorded within the Brilliant Pit footprint in October 2021 were generally 36 m to 38 m (vertically) below ground level, with a relatively flat gradient at about 328 m AHD. Groundwater is inferred to flow to the west southwest to discharge at Lake Yindarlgooda.

Field Electrical Conductivity (EC) and pH measurements indicated that the groundwater is slightly to moderately saline, ranging from about 3,700 to 9,000 mg/L TDS, and slightly alkaline (pH 7.1 to 8.0). Laboratory analysis of a water sample taken from the water bore at Brilliant Pit showed that the water is of a sodium chloride type, with high sulphate (1,100 mg/L) and nitrate (84 mg/L).

Rockwater (2021) completed a simple numerical groundwater model incorporating the geological information, measurements of water levels and hydraulic conductivity, and estimated pit depths. The objective of the model was to estimate dewatering flow rates, the likely magnitude and extent of drawdowns around the pits, and to assess the nature of the final pit voids. The results of Rockwater (2021) are summarised as follows:

- Estimated dewatering flow rates are low, peaking in the third month of mining at 830 kL/d with mining occurring at a depth of 40 m (310 m AHD) in Brilliant Pit. Flow rates were estimated to decrease with depth, declining to 294 kL/d in month six when mining is at the pit's base (250 m AHD). Dewatering was estimated to be at a rate of 0 and 79 kL/d for the two months of mining below the water table at Dazzle Pit.
- At the end of mining, predicted water level drawdown at the rims of the pits were up to 15 m at the Brilliant Pit and 2 to 7 m at Dazzle Pit.
- Drawdowns of 1 m (or more) will extend no further than about 250 m from Brilliant Pit and less than 200 m from Dazzle Pit. There is no groundwater-dependent vegetation and no bores or wells that could be impacted by dewatering at the Project
- The pits will be permanent groundwater sinks post-mining. The final pit lake water level in Brilliant Pit was estimated to be at 271.2 m AHD, approximately 57 m below the pre-mining water table. The final pit lake level in Dazzle Pit is indicated to be at 316.5 m AHD, approximately 12 m below the pre-mining water table.
- Post mining, the salinity of water in both pits will gradually increase from 8,000 mg/L TDS to hypersaline after 100 years. Salinity at Brilliant Pit and Dazzle Pit were estimated to reach 62,000 mg/L TDS and 140,000 mg/L, respectively.

7 Assessment of Clearing Principles

7.1 Native Vegetation Clearing Principles

NVCP applications are assessed against the 10 principles outlined in Schedule 5 of the EP Act. These Principles aim to ensure that all potential impacts resulting from removal of native vegetation are assessed in an integrated method and consistently apply to all lands throughout Western Australia. The Clearing Principles address the four environmental areas of biodiversity significance, land degradation, conservation estate and ground and surface water quality.

The following sections discuss the potential impacts associated with clearing for the Project. A summary of the outcomes of the assessment against the ten Clearing Principles are provided in Table 11.

Table 11: Summary of Clearing Assessment Against Clearing Principles

Principle Number	Clearing Principle	Outcome
a	Native vegetation should not be cleared if it comprises a high level of biological diversity.	Not at variance
b	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Not at variance
c	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	Not at variance
d	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a Threatened Ecological Community (TEC).	Not at variance
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.	Not at variance
f	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	Unlikely to be at variance
g	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	Not at variance
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 areas.	Not at variance
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.	Unlikely to be at variance
j	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	Not at variance

7.2 Biodiversity

Clearing Principle a: Native vegetation should not be cleared if it comprises a high level of biological diversity.

Impacts to the biological diversity of native vegetation associated with clearing for the Project are limited to localised flora/habitat loss from clearing in the PPA.

A desktop assessment by Botanica (2022) identified four Priority flora species as possibly occurring in the Survey Area (*Ptilotus procumbens* (P1); *Thryptomene eremaea* (P2); *Micromyrtus serrulata* (P3); and *Austrostipa blackii* (P3)).

The field survey identified no Threatened or Priority flora or fauna species, TECs, or PECs within the PPA (Botanica 2022).

Botanica (2022) concluded that vegetation within the survey area is considered to be of low biological diversity and is well represented outside of the survey area.

Potential impacts from the proposed clearing to the vegetation communities mapped in the PPA are detailed in Table 12.

Table 12: Potential Impacts to Mapped Vegetation Communities

Vegetation Community	Description	Mapped Extent (ha)	Mapped Extent Within PPA (ha/%)	Mapped Extent Within Clearing Footprint (ha/%)
CLP-AFW1	*Acacia caesaneura* low forest/ woodland over mixed shrubland over *Ptilotus obovatus* low open shrubland	169	195.8 (13.6)	78.3 (13.6)
CLP-EW1	*Eucalyptus salubris* and *E. transcontinentalis* open woodland over *Eremophila scoparia* shrubland	29	28.8 (2)	4.4 (0.8)
CLP-EW2	*Eucalyptus salmonophloia* low open woodland over *Atriplex nummularia* and *Maireana sedifolia* low open shrubland	230	227.5 (15.8)	79.1 (13.7)
CLP-EW3	*Eucalyptus salmonophloia and E. salubris* low woodland over *E. oleosa* open mallee shrubland over mixed low shrubland	549	468.0 (32.5)	124.4 (21.5)
CLP-MW1	*Eucalyptus oleosa* low open mallee woodland over *Acacia caesaneura* and *A.* sp. narrow phyllode	81	66.5 (4.6)	28.9 (5.0)
OD-MW1	*E. loxophleba* subsp. *lissophloia* low woodland over *Ptilotus obovatus* low open shrubland	10	9.5 (0.7)	1.4 (0.2)
RH-AW1	*Acacia caesaneura* low open woodland over *A.* sp. narrow	132	95.9 (6.6)	40.8 (7.1)

Vegetation Community	Description	Mapped Extent (ha)	Mapped Extent Within PPA (ha/%)	Mapped Extent Within Clearing Footprint (ha/%)
	phyllode, *A. quadrimarginea* and *A. colletioides* shrubland			
RH-EW1	*Eucalyptus lesouefii* low woodland over *Maireana sedifolia* low open shrubland	244	230.0 (15.9)	202.4 (35)
SLP-MW1	*Eucalyptus horistes* and *E. concinna* low mallee woodland over *Westringia cephalantha, Grevillea oncogyne* and *Triodia scariosa* low open shrubland/ hummock grassland	77	77.7 (5.4)	11.7 (2)
SP-CW1	*Casuarina pauper* low open woodland over *Ptilotus obovatus* low open shrubland	36	36.1 (2.5)	5.4 (0.9)

To mitigate the impacts of the proposed clearing, the following measures will be implemented:

- Clearing of native vegetation within the PPA will not exceed 580 ha.
- Topsoil and vegetation will be stockpiled for use in future rehabilitation.
- Progressive rehabilitation will be undertaken as disturbed areas become available for rehabilitation. Stockpiled topsoil and vegetation will be spread to act as a seed source and mulch to protect the soil from erosion and provide habitat for fauna.
- Vehicle and equipment hygiene procedures will be implemented to minimise introduction and or spread of weeds in the PPA.
- An internal clearing register will be developed to record the amount of clearing undertaken and report the cumulative total in the Annual Environmental Report (AER) and NVCP Annual Clearing Report, submitted to DEMIRS.
- All clearing activities will be carried out in accordance with the conditions of the NVCP and best industry practices.
- Clearing areas will be delineated in the field with survey pegs and/or flagging tape.
- Vehicles will remain on established tracks and roads.
- All personnel will undertake a site induction which will include detail on the importance of flora and vegetation management.

Given none of the 'possibly' occurring Priority species were identified during the field survey, and vegetation within the survey area is considered to be of low biological diversity, the proposed clearing will not significantly impact biodiversity and, subsequently, is not at variance with Clearing Principle a.

7.3 Significant Fauna Habitat

Clearing Principle 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.

Potential impacts to overall mapped fauna habitats are detailed in Table 14.

Table 13: Potential Impacts to Fauna Habitats

Fauna Habitat	Mapped Extent (ha)	Mapped Extent Within PPA (ha/%)	Mapped Extent Within Proposed Clearing Footprint (ha/%)
Acacia low woodland on rocky hillslope	131.92	95.90 (6.65)	40.75 (7.05)
Acacia woodland on clay-loam plain	195.80	195.78 (13.58)	78.34 (13.56)
Casuarina woodland on sandplain	36.10	36.09 (2.50)	5.42 (0.94)
Cleared	6.74	6.36 (0.44)	0.95 (0.16)
Eucalyptus mallee woodland in open depression	9.51	9.51 (0.66)	1.43 (0.25)
Eucalyptus mallee woodland on clay-loam plain	245.43	199.09 (13.81)	49.41 (8.55)
Eucalyptus mallee woodland on sandy-loam plain	77.68	77.67 (5.39)	11.74 (2.03)
Eucalyptus woodland on clay-loam plain	643.86	591.57 (41.02)	187.34 (32.42)
Eucalyptus woodland on rocky hillslope	243.78	230.02 (15.95)	202.42 (35.03)
Total	1,590.82	1,441.99	577.78

Impacts to significant habitat for fauna are likely to be restricted to Malleefowl habitat, including foraging and breeding habitat.

The targeted Malleefowl Survey by Phoenix (2022) covered the proposed haul road for the Project. Almost all of the area in this survey extent (98.4%) represented suitable Malleefowl habitat, comprising critical breeding habitat (78.6%) and foraging and dispersal habitat (20.7%). While the targeted survey did not cover all of the Indicative Disturbance Footprint or PPA, broader scale mapping undertaken by Phoenix (2024) confirmed that a majority (> 80%) of the remaining PPA south of the haul road is also considered suitable (mosaic) habitat (Figure 8). Botanica's (2022) Reconnaissance Flora and Basic Fauna Assessment conducted across the entire PPA confirmed the presence of Malleefowl and habitat, but found it was unsuitable for breeding at the time of assessment.

While most of the habitat within the PPA and proposed clearing footprint is suitable Malleefowl habitat, broader scale mapping indicates that 79% of habitat within a 10 km radius of the surveyed area is also suitable for Malleefowl, with 64,038 ha mapped as suitable or suitable (mosaic) at the 10 km scale (Phoenix, 2024). Considering the habitat available in a 10 km radius, the proposed clearing of up to 580 ha is considered an insignificant portion (0.9%).

Therefore, while clearing habitat critical to survival can be expected to have some adverse effects on the habitat and population, these impacts would be local and temporary. Appropriate mitigation measures and post-closure remediation and/or natural regeneration will be effective at reducing residual impacts to a level that is not considered significant as

per the definition provided by the DoE (2013) i.e. is important, notable, or of consequence, having regard to its context or intensity (Phoenix, 2024).

NSR's field survey in January 2025 confirmed the presence of 16 Malleefowl mounds from the potential mounds identified by Anditi (2025). Of the 16 mounds confirmed, only three were found to be active, four were recorded as long unused, and the remaining nine were inactive (Table 14). A total of 9 mounds occur in the PPA, including all three active mounds (within the haul road extent). The haul road can be designed within the bounds of the PPA to effectively avoid Malleefowl mounds. No Malleefowl mounds were confirmed within or surrounding the clearing footprint area south of the haul road that will comprise a majority of the mine activities (open cut pits, waste rock dumps, and other associated infrastructure).

Table 14: Potential Impacts to Malleefowl Mounds

Mound Status	Confirmed Malleefowl Mounds in Survey Area (count)*	Mapped Mounds Within PPA (count)	Mapped Extent Within Proposed Clearing Footprint (count)
Active	3	3	1
Inactive	9	3	0
Long Unused	4	3	1
Total	**16**	**9**	**2**

**NSR's 2025 field survey to confirm Malleefowl Mounds included validation of potential mounds identified by Anditi (2025) in the PPA and within a 200 m radius of the PPA boundary.*

While Grey Falcon (*Falco hypoleucos*) - Vulnerable and Peregrine Falcon (*Falco peregrinus*) – Specially Protected are also considered to potentially occur across the Project, Botanica (2022) found that none of the eight fauna habitats recorded during their survey were considered to represent critical habitat for these species.

It is noted that two Malleefowl mounds, including one active mound, occur inside the original proposed clearing footprint. NSR is committed to avoiding the disturbance of Malleefowl mounds where feasible and as such will be constructing the haul road to avoid these mounds.

To mitigate the impacts of the proposed clearing, the following measures will be implemented:

- Clearing of fauna habitat within the PPA will not exceed 580 ha.
- The haul road will be designed to avoid Malleefowl mounds will remaining within the PPA, ensuring a 50 m buffer is applied for Active Malleefowl mounds (i.e. Mound ID 58506).
- Pre-clearance inspections will be undertaken to ensure no new Malleefowl mounds are present within the proposed clearing footprint. If an active or recently active mound is identified, a 50 m avoidance buffer will be applied. A 50 m buffer is considered suitable where clearing is taking place outside of breeding season.
- Existing disturbed areas will be utilised where practicable to minimise additional impacts to fauna and habitat.
- Clearing activities will be carried out in accordance with the conditions of the approved NVCP, internal NSR Ground Disturbance Permit procedures.

- Clearing areas will be delineated in the field with survey pegs and/or flagging tape with QA/QC completed by means of post clearing UAV scans.
- An internal clearing register will be implemented to record the amount of clearing undertaken and report the cumulative total in the AER and NVCP Annual Clearing Report, submitted to DEMIRS.
- Suitable fauna habitat elements (i.e. logs, large trees) will be avoided and preserved where practicable or removed to be reused in rehabilitation activities.
- Vehicles will remain on established tracks and roads.
- All personnel will undertake a site induction which will include detail on the importance of flora and fauna management.

The fauna habitat within the PPA is widespread and common in the region. It is recognised that the comprises mostly suitable breeding habitat for the nationally threatened Malleefowl species, which is listed as vulnerable under the EPBC Act. The Project area is part of a much larger contiguous patch of suitable habitat for the species, where a resident population is present. Given the proposed management measures and knowledge that suitable Malleefowl habitat is present regionally, the proposed clearing is considered unlikely to be significant and is not at variance with Clearing Principle b.

7.4 Rare (Threatened) Flora

Clearing Principle c: Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare (Threatened) flora.

No Threatened flora species listed under the BC Act or the EPBC Act were recorded during the field surveys. Botanica (2022) identified one Threatened flora species during a desktop assessment, however this was subsequently excluded after assessing its distribution and known habitat in relation to the survey area. As such the proposed clearing will not be at variance with Clearing Principle c.

7.5 Threatened Ecological Communities

Clearing principle d: Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.

No TECs or PECs, as listed under either the EPBC Act or BC Act, have been identified within the Purpose Permit Area (DAWE 2020; DBCA 2017; Botanica 2022). No TECs are known to occur within 40 km of the survey area (DAWE 2020).

Based on the above findings, clearing for the Project will not be at variance with Principle d.

7.6 Remnant Vegetation

Clearing Principle e: Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

The EPA uses a standard level of native vegetation retention of at least 30% of the pre-clearing extent of an ecological community as a benchmark. The levels of native vegetation retention have been recognised in the National Objectives and Targets for Biodiversity Conservation 2001-2005, which suggests the retention of 30% or more, of the pre-clearing

extent of an ecological community is necessary if Australia's biological diversity is to be protected (DoEH 2001).

The PPA occurs entirely within Pre-European Vegetation Association 20, described as low woodland, open woodland or sparse woodland of Mulga (*Acacia aneura*) and associated species (DPIRD 2019). Pre-European Vegetation Association 20, its mapped extents, and percentage remaining post-clearing is detailed in Table 15.

Table 15: Pre-European Vegetation Association (20) Representation

Vegetation Description	Pre-European Extent (ha)	Current Extent (ha)	% Remaining After Clearing
Low woodland; mulga mixed with Allocasuarina cristata & Eucalyptus sp.	1,295,103.39	1,292,474.58	99.80

Source: Government of Western Australia (2019).

As the remaining extent of the vegetation association at the State-wide level exceeds 99%, the proposed clearing will not have a significant impact on pre-European vegetation and therefore will not be at variance with Clearing Principle e.

7.7 Watercourse or Wetland Environments

Clearing Principle f: Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

There are no permanent water bodies or wetland systems intersecting the PPA (Biologic 2022; Geoscience Australia 2015). The nearest permanent water body is Lake Yindarlgooda, located approximately 8 km south of the Project. Lake Yindarlgooda is a registered Aboriginal Place; as such it warrants structured and careful clearing practices to avoid adverse environmental and cultural impacts.

Minor ephemeral drainage lines are known to intersect the PPA (Geoscience Australia 2015).

Only one vegetation community (OD-MW1), mapped as 9.5 ha in the PPA and 1.4 ha in the clearing footprint (Table 12), was determined to be associated with an ephemeral drainage line crossing the proposed haul road.

To mitigate the impacts of the proposed clearing on vegetation associated with watercourses, the following measures will be implemented:

- The proposed site layout has been designed to minimise disturbance to vegetation community OD-MW1.
- Vehicle and equipment hygiene procedures will be implemented to minimise introduction and or spread of weeds that could spread to vegetation associated with ephemeral drainage lines.
- All personnel will undertake a site induction which will include detail on the importance of flora and fauna management.
- All clearing activities will be carried out in accordance with the conditions of the approved NVCP and best industry practice.
- An internal clearing register will be developed to record the amount of clearing undertaken and report the cumulative total in the Annual Environmental Report (AER) and NVCP Annual Clearing Report, submitted to DEMIRS.

- Clearing areas will be delineated in the field with survey pegs and/or flagging tape.
- Vehicles will remain on established tracks and roads.

In summary, the proposed clearing only intersects a very small portion of vegetation associated with minor ephemeral drainage lines (1.4 ha - OD-MW1). As such, the Project is not expected to significantly impact on native vegetation growing in association with any watercourses or wetlands and subsequently is unlikely to be at variance with Clearing Principle f.

7.8 Land Degradation

Clearing Principle g: Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Potential sources of land degradation from clearing activities include wind and water erosion of cleared areas, water erosion due to changes in surface water flow, soil compaction and contamination and the introduction and/or spread of weeds.

All native vegetation within the PPA was assessed as being in 'good' condition, with existing cleared areas assessed as 'completely degraded' condition (Botanica 2022). Disturbances noted from the survey include clearing for mining and exploration, access roads, and cumulative historical impacts such as grazing and fire events.

The surface soil assessment found the stability of SMU 1 and 2 is enhanced by the presence of a high cryptogam cover, which essentially forms a continuous crust of the surface and inhibits erosion and sediment loss. Disturbance of the cryptogam covers by vehicles or machinery can remove the crust and facilitate future erosion.

Due to the absence of major water courses within the PPA, land degradation from erosion and reshaping of the landscape from localised flooding would not be expected during typical weather conditions.

No introduced (weed) species were recorded within Botanica's (2022) survey. Past flora surveys by Botanica in 2011 and 2018 identified five and three weed species respectively (Botanica 2011; Botanica 2018).

To mitigate the impacts of the proposed clearing, the following measures will be implemented:

- All clearing activities will be carried out in accordance with the conditions of the approved NVCP and best industry practice.
- Progressive rehabilitation will be undertaken as disturbed areas become available for rehabilitation. Stockpiled topsoil and vegetation will be spread to act as a seed source and mulch to protect the soil from erosion.
- Vehicles will remain on established tracks and roads and speed limits implemented.
- Establishment of surface water management infrastructure to direct surface water flow to natural drainage channels.
- Monitoring of high-risk erosion events, such as extreme weather, to mitigate impacts as far as reasonably practicable.
- Dust suppression via water cart.

- Storing hydrocarbons and chemicals as per Dangerous Goods and relevant Australian Standards codes.
- Vehicle and equipment hygiene procedures will be implemented to minimise entry and or spread of weeds in the PPA.
- If weed populations/occurrences are identified in or around the site, these will be marked on internal ground disturbance maps for avoidance. Control programs will be implemented when occurrences are warranted.
- Compacted soil will be scarified prior to rehabilitation to promote water infiltration.
- Only materials with low erosion potential, SMU 1 and the upper portion (top duplex - ~0-75 cm) of SMU 2, are to be used on the surface of post-mining landforms, with the underlying material placed directly underneath this material where possible.

In the context the land systems, and intact vegetation on a local and regional scale, the extent of disturbance from the proposed clearing is not anticipated to increase land degradation. As such, the clearing will not be at variance with Clearing Principle g.

7.9 Conservation Estate

Clearing Principle h: Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

There are no Environmentally Sensitive Areas (ESAs) or Conservation Reserves intersecting the PPA. The nearest ESA is Bullock Holes Timber Reserve located approximately 33 km from the Project area (Figure 9). Three other parks and reserves were identified within a 100-km radius of the Project however all are too far from the Project for their environmental values to be impacted (Figure 9).

Due to the absence of conservation estate and reserves within and near to the PPA the proposed clearing will not be at variance with Clearing Principle h.

360,000 400,000 440,000 480,000 520,000

6,680,000

6,640,000

6,600,000

N

Goongarrie National Park

Bullock Holes Timber Reserve

Queen Victoria Spring Nature Reserve

Lake Yindarlgooda

Coonana Timber Reserve

Wallaby Rocks Timber Reserve

Emu Rocks Timber Reserve

Legend

- Purpose Permit Area
- Surface Hydrology Polygons GA

DBCA - Legislated Lands and Waters (DBCA-011)

- National Park
- Nature Reserve
- Section 5(1)(g) Reserve

360,000 400,000 440,000 480,000 520,000

Scale: 1: 500,000
Original Size: A3
Aerial Imagery: Google Satellite
Grid: GDA2020 / MGA zone 51 (EPSG:7851)
0 10 20 km

Northern Star Resources Limited

Figure 9

Nearby Conservation Estates

Martinick Bosch Sell Pty Ltd
4 Cook St
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7.10 Surface and Groundwater Quality

Clearing Principle i: Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Surface water quality has the potential to be affected by increased sedimentation caused by clearing and soil disturbance and removal of vegetation that acts to bind soil. This may result in a localised decrease in surface water quality.

There are no permanent water bodies or wetlands within the PPA with all drainage lines being ephemeral. The closest nearby permanent water body is Lake Yindarlgooda which is located 8 km to the south. The proposed clearing for access roads intersect several minor drainage paths and one crossing will be required at Kurnalpi Creek.

To prevent impacts on surface and groundwater quality, RPS (2022) has proposed the use of culverts or floodways at watercourse crossings to manage minor drainage paths and to maintain main creek flow as required. RPS (2022) determined that with proposed surface water management infrastructure installed, the Project will have no adverse effects on surface and groundwater hydrological patterns / flows, water levels and water quality.

As the Project is expected to have no adverse impacts on groundwater hydrological patterns, flows, or quality, the two moderate-potential and five low-potential terrestrial GDEs found within the area surveyed are considered unlikely to be impacted.

Management measures to prevent contamination of surface and groundwater quality include:

- Project design has considered locations of ephemeral drainages and minimised disturbance of these.
- Establishment of surface water management infrastructure to direct surface water flow to natural drainage channels, with existing flow paths maintained where possible.
- Monitoring of high-risk erosion events, such as extreme weather, to mitigate impacts as far as reasonably practicable.
- Storing hydrocarbons and chemicals as per Dangerous Goods and Australian Standards codes.
- Refuelling and maintenance activities to be conducted using drip trays, liners, bunds, or spill mats to minimise hydrocarbon spillage and contamination of surface and groundwater.
- Diversion drains will be constructed to direct surface water flow away from operational areas, to reduce localised pooling/flooding, at rates similar to natural flows.
- Surface water management infrastructure will be installed to direct surface water flow to natural drainage channels, with existing flow paths maintained where possible.
- Natural surface water drainage channels/patterns will be reinstated during rehabilitation where practicable.
- All personnel will undertake a site induction which will include detail on the importance surface water and groundwater management.
- Toe drains or sediment ponds will be installed as necessary, to minimise transport of sediment into ephemeral watercourses.

The proposed clearing is unlikely to significantly impact surface water and groundwater quality and subsequently is unlikely to be at variance with Clearing Principle i.

7.11 Flooding Potential

Clearing Principle j: Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

Removal of vegetation can increase flooding whereby uptake, infiltration, moisture retention and physical barriers to reduce flow velocities provided by vegetation are also removed.

Hydraulic modelling was undertaken by RPS (2022), in part to understand flooding potential of the landscape and flooding extent pre-development and identify what impacts clearing and development of infrastructure would have on this. The modelling indicated that as surface flows are not concentrated, flood impacts mainly result from the effects of sheet flow.

Clearing for the proposed access road would intersect several minor drainage paths and one crossing at Kurnalpi Creek. RPS (2022) proposed surface water management infrastructure (such as construction of floodways or culverts) to mitigate impacts to water quality, levels, and flooding from the proposed mine site infrastructure. Overall, it was found that with the proposed surface water management infrastructure, the Project will have no adverse effects on surface and groundwater hydrological patterns / flows, water levels and water quality. Thus clearing is not anticipated to exacerbate the incidence of flooding.

Management measures to mitigate impacts of flooding include:

- Project design has considered location of drainage lines and flood levels with the aim of minimising disturbance of these areas.
- Clearing activities will be carried out in accordance with the conditions of the approved NVCP and best industry practice.
- Existing natural surface water flow paths will be maintained where possible.
- Surface water infrastructure will be installed as per recommendations by RPS (2022).
- Diversion drains will be constructed to direct surface water flow away from operational areas, to reduce localised pooling/flooding.
- Diversions will be constructed such that surface water will flow into local drainage lines at rates similar to natural flows.
- Existing disturbance areas for the haul road have been incorporated in the Project design to minimise the amount of clearing required.
- Progressive rehabilitation of completed surfaces to minimise active areas exposed where possible.
- Natural surface water drainage channels/patterns will be reinstated where practicable during rehabilitation.

Based on the above assessment, the proposed clearing will not increase the flooding potential within the PPA and its immediate surrounds. Therefore, the proposed clearing will not be at variance with Clearing Principle j.

8 Roles and Responsibilities

The roles and responsibilities of NSR personnel associated with the proposed clearing vegetation are described below.

8.1 General/Mine Manager

- Ensure appropriate resources and systems are provided to implement the management and mitigation measures outlined in this document.
- Ensure all land clearing is conducted in compliance with this document and other regulatory requirements.
- Ensure adequate processes are established to communicate relevant information with internal and external stakeholders.

8.2 Environmental Superintendent/Manager

- Coordinate preparation and finalisation of the NVCP, in consultation with relevant government agencies, and ensure adequate systems and procedures are in place to facilitate compliance with NVCP requirements .
- Manage all pre-construction environmental surveys and post-implementation monitoring.
- Coordinate engagement with key stakeholders .
- Overall responsibility for ensuring that all supervisory, management employees and contractor personnel are aware of, and understand, their responsibilities under this NVCP.
- Oversee the implementation of any corrective and remedial actions arising from audits and incident investigations.
- Ensure all land clearing for the Project is conducted in compliance with this document and other regulatory requirements.
- Ensure all employees and contractors on site are aware of and adhere to obligations regarding clearing requirements.
- Ensure adequate processes are maintained to communicate relevant information with internal stakeholders.
- Conduct visits and inspections to ensure all work complies with commitments and management measures outlined in this NVCP.
- Record and report environmental incidents to the General Manager and Regulator.
- Undertake incident cause analysis method investigations where required and manage the implementation of corrective and remedial actions arising from audits and incident investigations.
- Review and approve all Vegetation Clearing Applications.
- Maintain the Internal Clearing Permit Register.
- Compile and collate vegetation clearing data for annual reporting in the Annual Environmental Report.

8.3 Project Manager

- Ensure management measures contained in this application and associated plans and procedures are implemented.
- Ensure that land clearing is undertaken only as authorised by the Vegetation Clearing Application.
- Conduct site walkovers of areas with clearing machinery operators prior to clearing.

- Ensure that post-clearing surveys are conducted, and that data is provided to the OHSE Officer.
- Report environmental incidents.

8.4 All Employees and Contractors

- Prevent contamination of vegetation, topsoil and subsoil stockpiles.
- Adhere to all obligations in relation to vegetation clearing procedures.
- Report environmental incidents and any non-compliance with the document to the supervisor.
- Keep to existing tracks unless following advice from their Supervisor.
- Adhere to standard soil hygiene practices and spill response when operating machinery.
- Aid in implementing and maintaining environmental impact minimisation programs when requested by the Environmental Superintendent/Manager.

9 Reporting and Auditing

Disturbance as a result of the proposed vegetation clearing will be reported yearly in the Kurnalpi AER, NVCP Annual report and Mine Rehabilitation Fund (MRF) reporting.

Upon approval of this Clearing Permit, subsequent environmental approvals will be sought to construct and develop the Project. These approvals will include additional conditions and commitments relating to environmental monitoring and reporting.

10 Conclusion

An assessment against the ten clearing principles was undertaken based on information collected from site specific baseline surveys and existing information of the wider area.

Assessment against the ten Clearing Principles determined the proposed clearing of 580 ha for the Project is overall, considered unlikely to be at variance with the Clearing Principles. Appropriate environmental management procedures will be implemented to ensure potential environmental impacts associated with the clearing are avoided or minimised where practicable.

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Appendices

Appendix B: Soil and Landform Assessment

ENVIRONMENTAL INNOVATIONS

ENVIRONMENTAL INNOVATIONS

KURNALPI GOLD PROJECT	
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			Originator	Reviewer	Approved
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B	01/02/21	Client Review	SC		

Revision Code*

A - Report issued for internal review

B - Draft report issued for client review

C - Final report issued to client

LIMITATIONS

The sole purpose of this report and the associated services performed by Environmental Innovations (EI) was to undertake a Soil Characterisation study for the proposed Kurnalpi Gold Project. This work was conducted in accordance with the Scope of Work presented to Northern Star Resources ('the Client'). EI performed the services in a manner consistent with the normal level of care and expertise exercised by members of the earth sciences profession. Subject to the Scope of Work, the Soil Characterisation study was confined to the Kurnalpi Gold Project (geographical extent). No extrapolation of the results and recommendations reported in this study should be made to areas external to this project area. In preparing this study, EI has relied on relevant published reports and guidelines, and information provided by the Client. All information is presumed accurate and EI has not attempted to verify the accuracy or completeness of such information. While normal assessments of data reliability have been made, EI assumes no responsibility or liability for errors in this information. All conclusions and recommendations are the professional opinions of EI personnel. EI is not engaged in reporting for the purpose of advertising, sales, promoting or endorsement of any client interests. No warranties, expressed or implied, are made with respect to the data reported or to the findings, observations and conclusions expressed in this report. All data, findings, observations and conclusions are based solely upon site conditions at the time of the investigation and information provided by the Client. This report has been prepared on behalf of and for the exclusive use of the Client, its representatives and advisors. EI accepts no liability or responsibility for the use of this report by any third party.

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1 INTRODUCTION

Environmental Innovations were commissioned by Northern Star Resources (NSR) to undertake a soil characterisation for the proposed Kurnalpi Gold Project. The purpose of this assessment was to identify and characterise all surficial soil materials within the disturbance area and suggest management strategies for their handling and utilisation. This information provides baseline data that can be used to assist in the handling and storage of these materials during operations, and in the construction and rehabilitation of post-mine landforms. Implementation of the soil management recommendations suggested in this report will ensure that only optimal materials are used in the construction of the outer surfaces of post-mine landforms, thus facilitating stability and revegetation, and ultimately successful closure.

1.1 OBJECTIVES

The objectives of this soil characterisation were to:

- Define the distribution of soil in the study area.
- Characterise the physical and chemical properties of the soils.
- Identify materials that may be beneficial to the rehabilitation of the waste dumps, and materials that may have an adverse impact on rehabilitation.
- Suggest management strategies for the handling and utilisation of these materials during mining and rehabilitation.

1.2 SCOPE OF WORKS

The Scope of Work completed by EI included:

- Collect soil samples from across the study area using shallow trench excavations.
- Describe the surface soil profiles throughout the study area and prepare a soils map for the area.
- Undertake field and laboratory analysis to characterise the physical and chemical properties of the surficial materials.
- Provide information on the different soil units encountered and recommendations for their handling and utilisation.

2 SITE DESCRIPTION

2.1 LOCATION

The proposed Kurnalpi Gold Project is located approximately 75 km northeast of Kalgoorlie. The disturbance footprint for this deposit covers an area of approximately 185 ha.

2.2 SITE LAYOUT

The Kurnalpi Gold Project is planned to be mined in a series of small scale pits at this stages using normal open pit techniques. The preliminary mine pit designs cover an area of approximately 6 ha with termination of mining likely to occur at the oxide/fresh rock contact for this phase of the project. Waste oxide material from the deposit will be excavated and stockpiled within a series of purpose-built waste rock landforms. The final positioning of these landforms has not been finalised but they are likely to be located to the west of their respective mine pits, whilst the mined ore will be processed at the nearby Carosue Dam mill.

2.3 CLIMATE

The climate for the Kalgoorlie Region (Kalgoorlie Airport – Station No. 012038) is classified as semi-arid with hot dry summers and moderately cool winters. Annual rainfall varies from around 150 mm up to 450 mm, with an average of approximately 270 mm/year (Figure 2.2). Rainfall is distributed fairly evenly throughout the year with an average monthly rainfall of approximately 23 mm, whilst pan evaporation is greatest in the summer months and lowest during winter.

Pan evaporation greatly exceeds rainfall with an average annual pan evaporation of around 2,600 mm. Although the average pan evaporation exceeds rainfall for the majority of the year intense rainfall events associated with cyclonic activity results in monthly rainfalls often exceeding pan evaporation. Pan evaporation data has been unavailable for this climate station since 2006.

2.4 REGIONAL SOILS

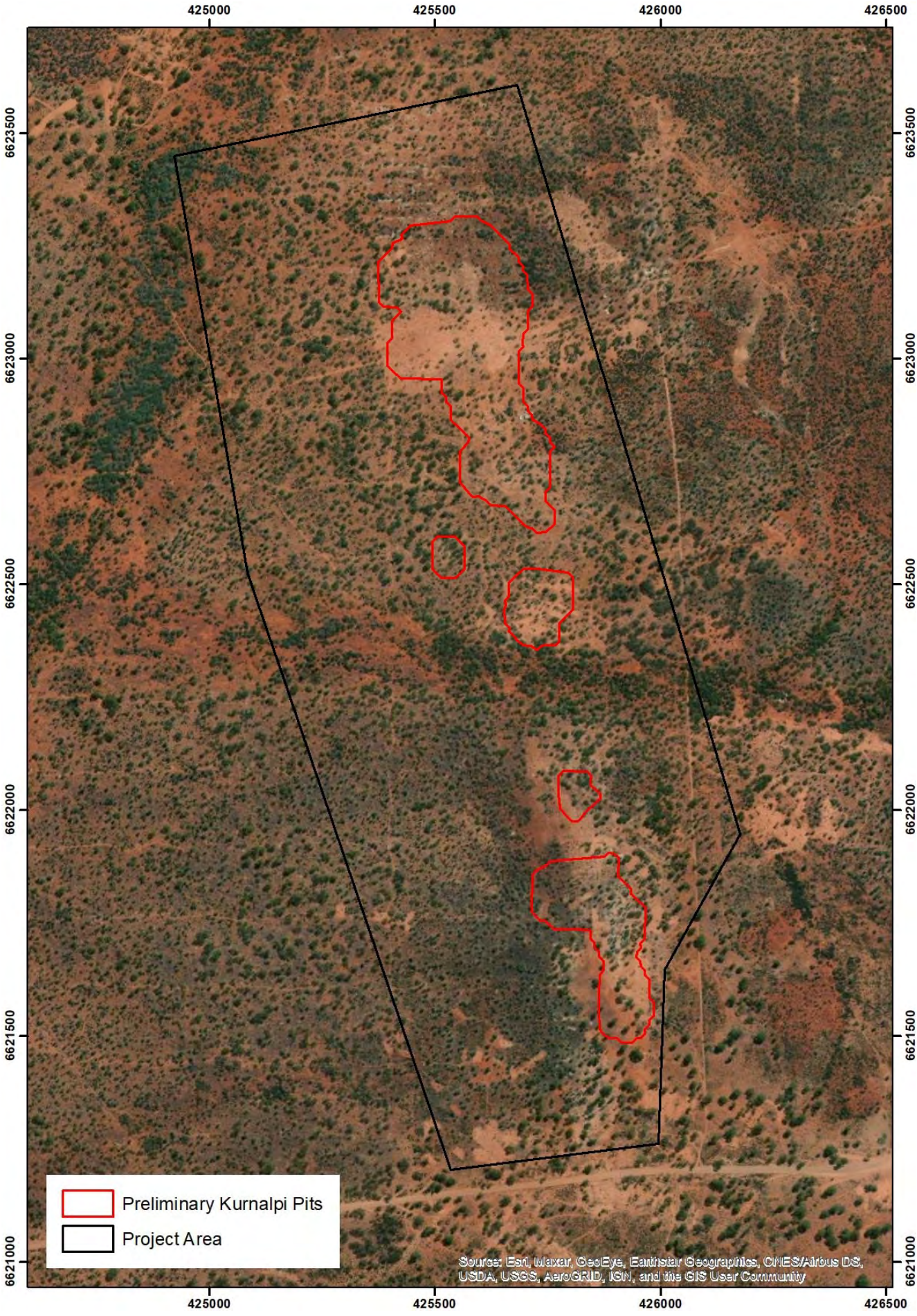
The soils across the Project Area have been mapped at a regional scale (1:250,000 scale) by the Western Australian Department of Agriculture, as part of the Goldfields Rangeland Survey. The regional soils distribution is shown in Figure 2.3.

The project area occurs solely within the Kambalda area of the Kalgoorlie Province (Zone 265), with the majority of the development occurring within soil-landscape units 265Cm (Campsite System) and 265Gu (Gundockerta System), with the eastern margin mapped within the soil-landscape unit 265Le (Leonora System). The Campsite and Gundockerta systems are generally dominated by undulating plains whilst the Leonora system is characterised by low greenstone hills. All three systems are generally dominated by loamy calcareous and red earths.

Table 2.1: Soil-landscape units surrounding the Myhree Gold Project region

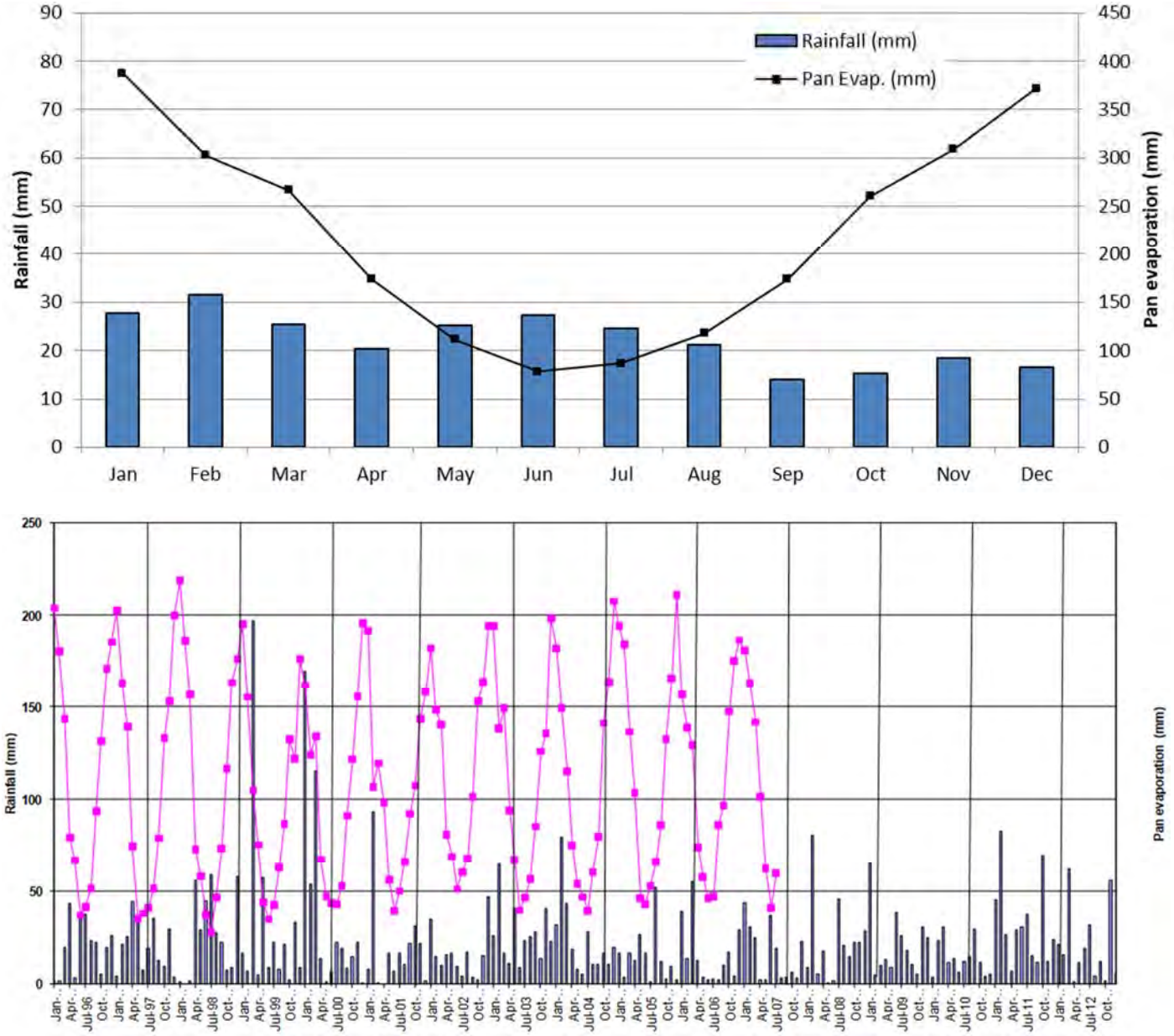
Map Unit	Name	Description
265Cm	Campsite System	Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands. Red loamy earth & Red/brown non-cracking clay

Map Unit	Name	Description
265Gu	Gundockerta System	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands. Calcareous loamy earth
265Hg	Helag System	Hardpan plains and central drainage tracts with mulga shrublands and minor chenopod shrublands. Red-brown hardpan shallow loam
265Le	Leonora System	Low greenstone hills and stony plains supporting mixed chenopod shrublands. Calcareous loamy earth, Red shallow sandy duplex & Red shallow loam
265Mo	Moriarty System	Low greenstone rises and stony plains overlain by shallow red loams and calcareous loamy earths Red shallow loam, Calcareous loamy earth & Red shallow sand

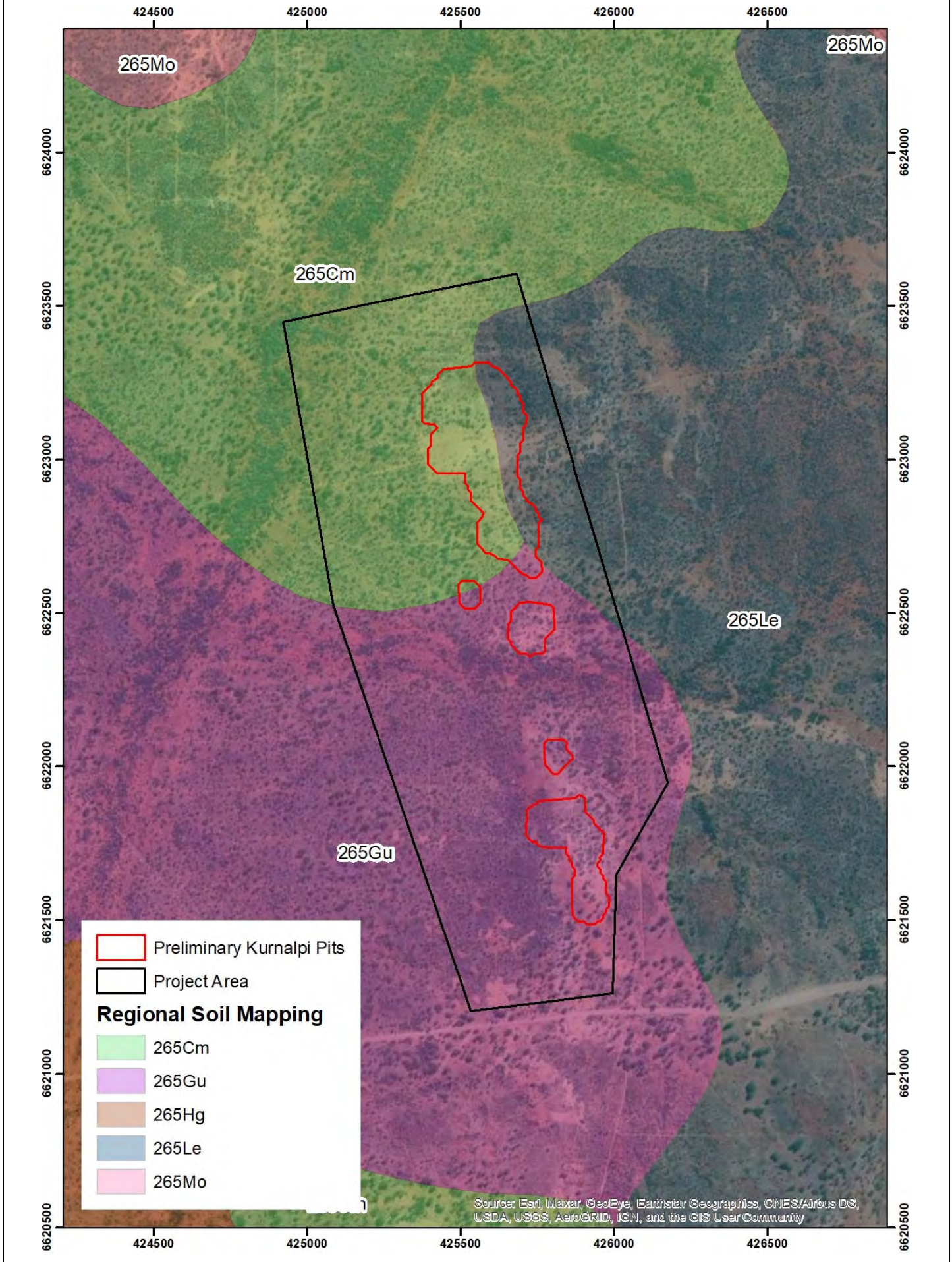


NORTHERN STAR RESOURCES	Figure 2.1: Site layout	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

PN: NST-022-1-8 Prepared by: SC Date: 01/12/21 Reviewed by: ASP Date: 01/14/21 Revision: 1



NORTHERN STAR RESOURCES	Figure 2.2: Kalgoorlie climate data	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		



NORTHERN STAR RESOURCES	Figure 2.3: Regional Soils	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

PN: NST-022-1-8 Prepared by: SC Date: 01/12/21 Reviewed by: ASP Date: 01/14/21 Revision: 1

3 STUDY METHODOLOGY

The soils throughout the Myhree Gold Project were investigated by trench excavation. A total of 14 sites were excavated to log and sample the surficial soil profile across the Project Area. At each site soil trenches were excavator to a maximum depth of 2 m or until refusal.

The sampling protocol at each location involved:

- Recording the location in a hand-held GPS.
- Recording surface features such as topography, vegetation and soil surface condition using field recording sheets and a digital camera.
- Describing the soil profile morphology in terms of colour, texture, structure and horizonation / layering. All field information was recorded using recording sheets and by digital camera. Field texture analysis was performed to estimate soil type (McDonald and Isbell, 2009) and subsequent identification of soil management units (SMUs).
- Discrete samples were collected down the exposed soil profile for subsequent laboratory analyses.
- Estimated root density was recorded using the semi-quantitative method of McDonald and Isbell (2009) (Table 3.1).

Table 3.1: Semi-quantitative assessment of plant roots used in this investigation.

Rating	Number of roots per 0.01 m2 (10 cm × 10 cm)	
	Very fine - fine roots (< 2 mm diameter)	Medium - coarse roots (> 2 mm diameter)
0 No roots	0	0
1 FSWC roots	1 - 10	1 - 2
2 Common roots	10 - 25	2 - 5
3 Many roots	25 - 200	> 5
4 Abundant roots	> 200	> 5

3.1 LABORATORY ANALYSIS

3.1.1 PHYSICAL AND CHEMICAL ANALYSES

The physical and chemical properties of the soil materials were assessed at Soilwater Analysis (SWA) and CSBP Laboratories in Perth. All samples collected in the field were analysed for pH and EC to initially screen samples for more detailed analyses and to establish key properties that may distinguish important soil characteristics (e.g. salinity limitations, texture, surface charge chemistry etc.). The remaining properties (Table 3.2) were assessed on a select number of samples that reflect the physical and chemical properties of soil materials within each of the major soil mapping units. The analytical methods for measuring the soil physical and chemical properties are detailed in McKenzie *et al.* (2002) and Rayment and Lyons (2010). The specific method used for each analysis is:

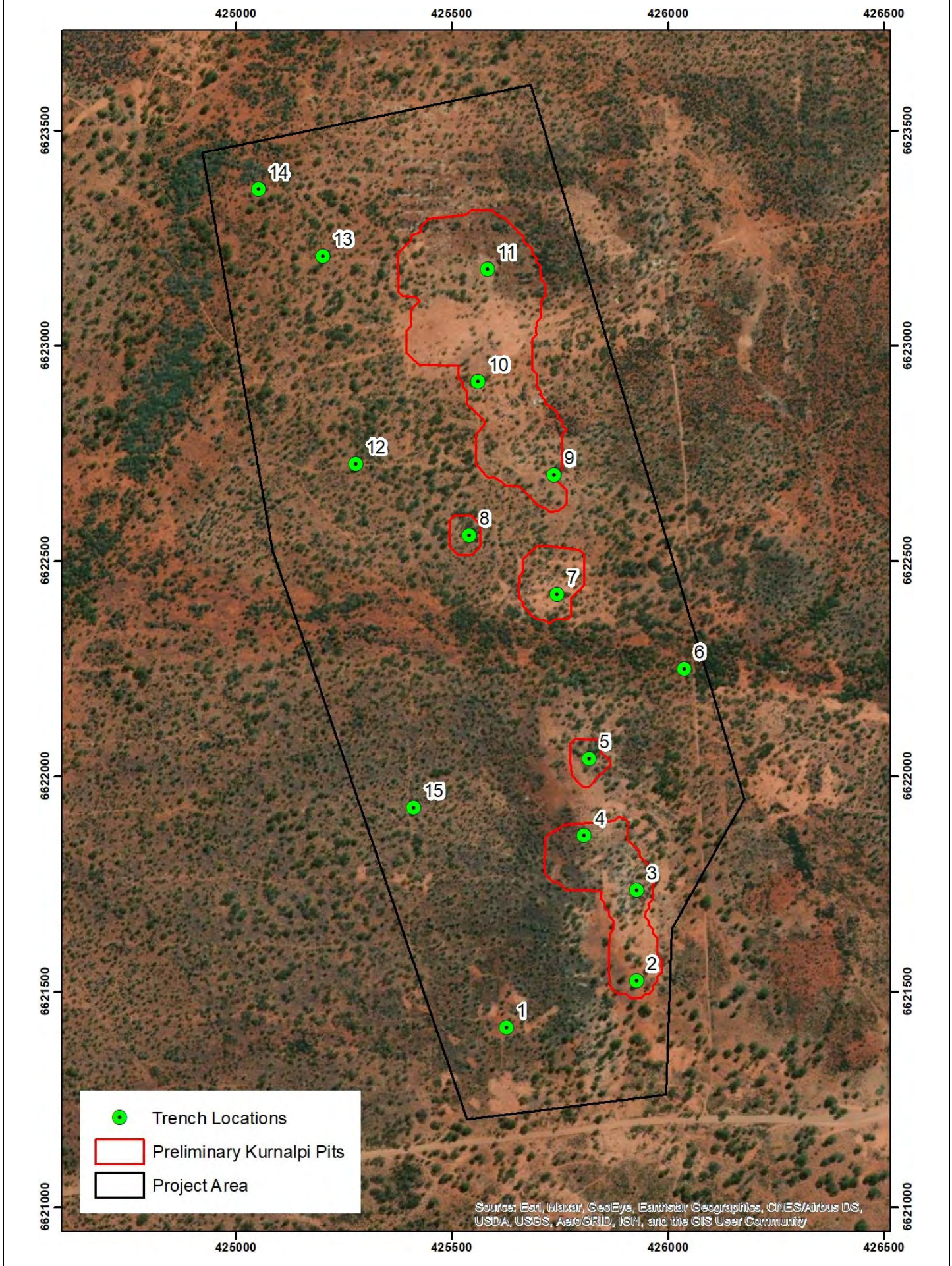
- pH and electrical conductivity (EC) measured on a 1:5 soil to water suspension (Method 4A1);
- Gravel content (>2.36 mm sieve);
- Field gravimetric water content;
- Inorganic nitrogen (ammonium and nitrate, (2M KCl Method 7C2);
- Exchangeable Al (Method 15G1),

- Exchangeable cations (no pre-wash, Method 15A2),
- Colwell P and K (Method 9B),
- Organic carbon (Walkley Black, Method 6A1),
- Available sulfur (KCl 40, Method 10D1);
- Particle size analysis (pipette method),
- Field bulk density (Intact Core Method 503.01);
- Aggregate dispersion index;
- Hardsetting potential;
- Soil water retention (Pressure Plate Method 504.02); and
- Saturated hydraulic conductivity (Intact Core – Constant Head Method).

The selection of samples provided materials from (1) varying soil types, (2) varying geomorphic units, and (3) from areas underlain by different geology.

Table 3.2: Physical and chemical properties of the soils measured in the laboratory.

Parameter	Method	Standard Reference
Soil Physical Properties		
Particle size distribution	Pipette sedimentation	McKenzie *et al*. (2002)
Gravel content	Sieve analysis (> 2 mm soil fraction)	
Bulk density	Constant volume	
Aggregate stability	Emerson dispersion	
Hardsetting Potential		Harper and Gilkes (1994)
Soil Hydraulic Properties		
Saturated hydraulic conductivity	Constant head permeameter	McKenzie *et al*. (2002)
Water retention characteristics	Pressure plate equipment	
Soil Chemical Properties		
pH	1:5 soil/water extraction	Rayment and Lyons (2010)
Electrical conductivity (EC; salinity))	1:5 soil/water extraction	
Macro-nutrients		
- Total Nitrogen (N)	Leco	
- Colwell Phosphorus (P)	$NaHCO_3$ extraction	
- Colwell Potassium (K)	$NaHCO_3$ extraction	
- Available Sulfur (S)	KCl extractable S/ICP	
Organic Carbon	Walkley Black Method	Rayment and Lyons (2010)
Exchangeable cations – Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K)	NH_4Cl extraction	Rayment and Lyons (2010)
Effective Cation Exchange Capacity (ECEC)	Sum of exchangeable cations	-
Exchangeable Sodium Percentage (ESP; sodicity)	ESP = (Ex. Na/CEC)×100	-



NORTHERN STAR RESOURCES	Figure 3.1: Soil trench investigation locations	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

PN: NST-022-1-8 Prepared by: SC Date: 01/12/21 Reviewed by: ASP Date: 01/14/21 Revision: 1

3.2 EROSION TESTING

Laboratory-scale erosion tests were undertaken on the following materials (Section 4):

- SMU 1 – Shallow calcareous loam
- SMU 2 – Red loam & clay

The objective of the testing was to establish the erosion potential for the range of soil materials most likely to be used as surface cover for post mine landforms.

3.2.1 RAINFALL SIMULATOR

A laboratory-scale rainfall simulator (Plate 3:1) was used to measure the interrill (raindrop impact) erodibility of each material. The rainfall simulator was designed to apply water at an intensity of approximately 85-100 mm/hr, with a raindrop size and spatial distribution closely resembling natural rainfall. An intensity of 85 mm/hr corresponds to a 1:10, 1:20 and 1:100 year ARI storm event of approximately 6, 10, and 20 min duration, respectively, for this region.

Prior to testing, each material was placed into a 0.75 x 0.75 x 0.20 m container and lightly compacted to approximate the expected field conditions. The base of the container was free draining to avoid saturated conditions and air entrapment within the samples. Each material was pre-treated by sequentially wetting and drying the surface to allow natural organisation and settling of the soil particles, with a final bulk density of approximately 1.8 g/cm^3 being achieved.

The container was set at a slope angle of 18°, and the materials were subjected to a simulated rainfall of approximately 95 mm/hr, with 10 samples of resulting surface runoff were collected at time intervals over a 4 hour period. Runoff volume and sediment loss in each sample were determined gravimetrically. Measurements from the rainfall simulator were used to calculate soil erodibility parameters required for the WEPP erosion model. The methods used for calculating these parameters are discussed further in Section 3.3.

Plate 3:1: Laboratory rainfall simulator.



3.2.1 RILL EROSION MEASUREMENTS

Laboratory scale testing was completed to measure the rill erodibility (K_r) and critical shear stress (τ_c) of the materials under overland flow conditions. The laboratory testing was designed to expose the materials to a range of overland flows to simulate storm events of different sizes, and to measure the resulting sediment content in the surface runoff, generated by rill erosion.

An erosion flume was used (Plate 3:2) to subject each material to 5 different overland flow rates, and the following measurements were made in triplicates for each:

- A timed sample of the resulting surface runoff was collected. Surface flow rate and sediment loss were then determined gravimetrically.
- A measurement of average flow velocity was made visually, using a blue dye and stopwatch according to the method described by Zhang *et al.* (2010).
- Measurements of rill width were made at three standardised locations along the rill.

Measurements from the erosion flume were used to calculate rill erodibility parameters required for the WEPP erosion model. The methods used for calculating these parameters are discussed further in Section 3.3.

Plate 3:2: Laboratory-scale rill erosion test.



3.3 EROSION MODELLING

The Watershed Erosion Prediction Project (WEPP) (Flanagan and Livingston, 1995) model was used to predict the long-term (100 year duration) erosion rates from the surface of the proposed waste rock landforms. The WEPP model used a series of input files describing the soils, climate, slope geometry, and land management regime for the site. Model input values and assumptions are discussed in the following sections.

3.3.1 CLIMATE DATA

A synthetic climate file was generated using the CLIGEN stochastic weather generator (Yu, 2003), and was used in the WEPP model to simulate 100 years of rainfall, runoff, and erosion. The following climate data was input to CLIGEN to generate this file (BOM station #12038, Kalgoorlie-Boulder):

- 0.5 hourly rainfall data (from Jan 1994 to May 2019)
- 30 year data set of daily values for rainfall, maximum and minimum temperatures, and solar radiation

Figure 3.2 and Figure 3.3 demonstrates that the 100 year synthetic CLIGEN file used in this investigation is generally consistent with the 30 years of measured data from which it was generated. Figure 3.2 compares the frequency of 24-hour rainfall totals, indicating that larger 24-hour storms occurred slightly more frequently in the measured data than in the CIGEN file. For example, the observed data shows an average 1:25 year, 24-hour event of approximately 40 mm, while the CLIGEN file includes an average event of approximately 38 mm at the same frequency.

Figure 3.3 compares the monthly and annual rainfall depths (respectively), and shows that the CLIGEN file captures a similar degree of variability in rainfall depths within and between years as was observed over a 30 year period at the

Kalgoorlie BOM station. The artificial climate file simulates a slightly smaller depth of rainfall, mainly in the November-March period. This is likely to result in minor underestimation of erosion during these months.

3.3.2 SOIL PARAMETERS

The soil parameters required by WEPP were derived from the laboratory testing undertaken at SWA Laboratories. These parameters include the particle size distribution, effective hydraulic conductivity (K_{eff}), interrill erodibility (K_i), rill erodibility (K_r), and soil critical shear stress (τ_C), and are summarised in Table 3.3.

Keff was estimated by fitting the Green-Ampt equation (Green and Ampt, 1911) to the measured infiltration rates using Equation 1:

$$F = K_{eff}(1 + Ns / F) \qquad \text{Equation 1}$$

where: f = infiltration rate (mm/h)

Keff = effective saturated hydraulic conductivity (mm/h)

Ns = effective matric potential at the wetting front (m), and

F = cumulative infiltration (m).

K_i was calculated from the inter-rill erosion rate measured in the rainfall simulator, according to Elliott *et al.* (1989) using Equation 2:

$$D_i = K_i I^2 S_f \qquad \text{Equation 2}$$

Where: D_i = interrill erosion rate (kg/(m^2 s)

K_i = interrill erodibility (kg s)/m^4

I = rainfall intensity (m/s), and

S_f = dimensionless slope factor (1.05 - 0.85 $^{-0.85 \sin(\alpha)}$)

K_r and τ_C were determined from the shear stress (τ) and rill erosion rate (D_c) measurements collected in the laboratory. This was done by a linear regression analysis according to the method described by Foster (1982) and Elliott *et al.* (1989). The rill erodibility parameters are related to the measured parameters τ and D_c by Equation 3:

$$D_c = K_r(\tau - \tau_C) \qquad \text{Equation 3}$$

where: D_c = measured erosion rate (kg/m2 s)

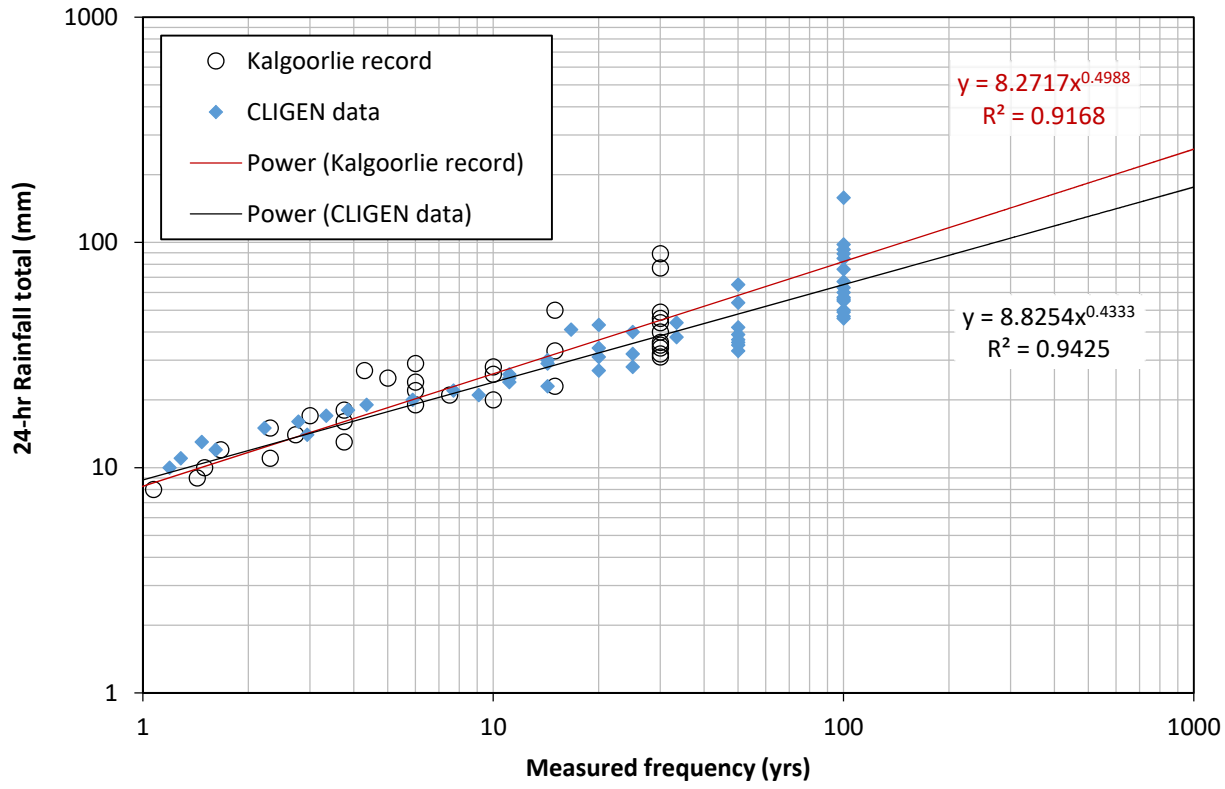
K_r = rill erodibility (s/m)

τ = measured shear stress (Pa), and

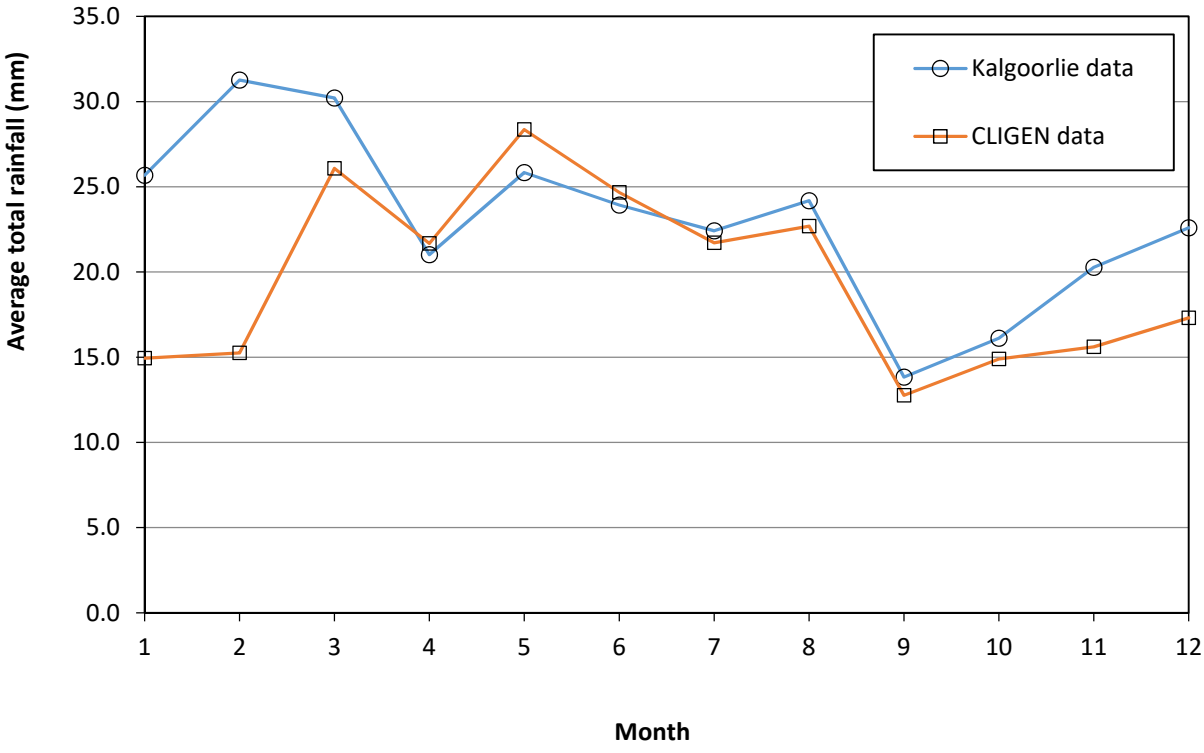
τ_C = critical shear stress (Pa).

D_c was plotted against τ for each of the flume measurements. The slope of the linear regression line was K_r, and the intercept with the horizontal axis was τ_C.

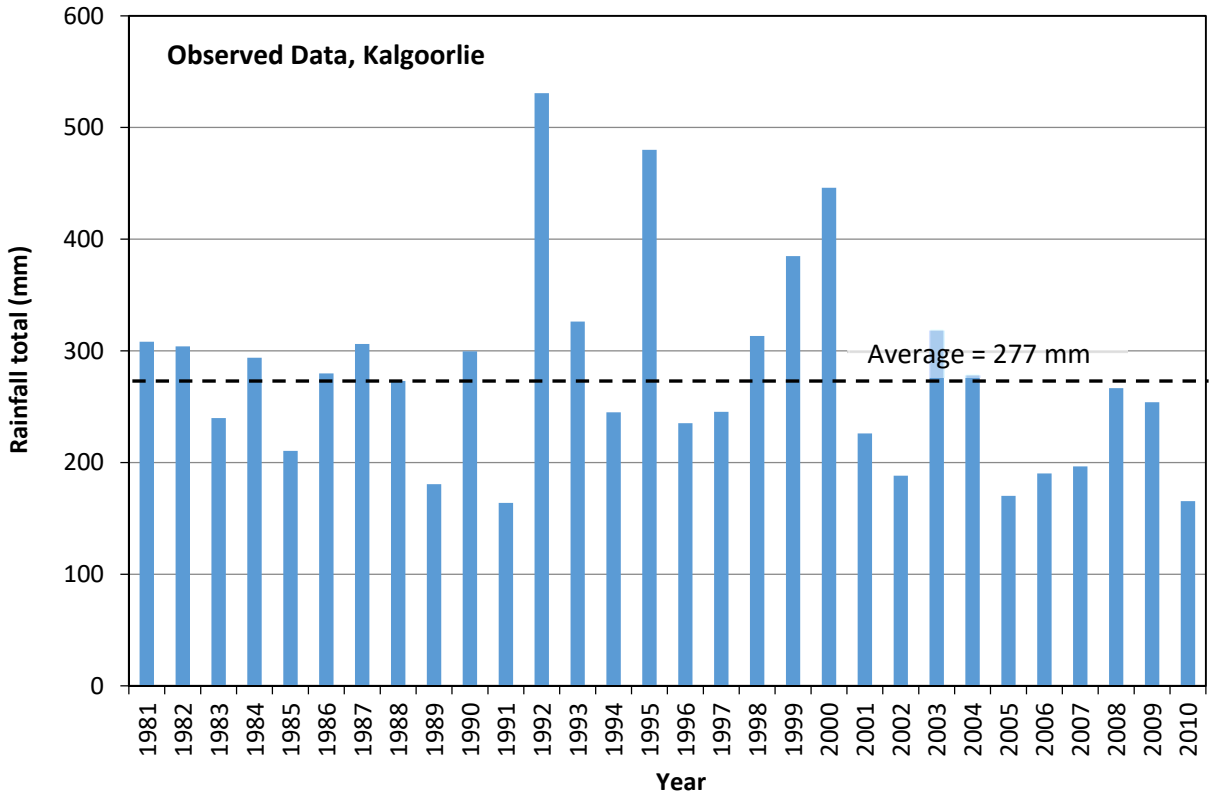
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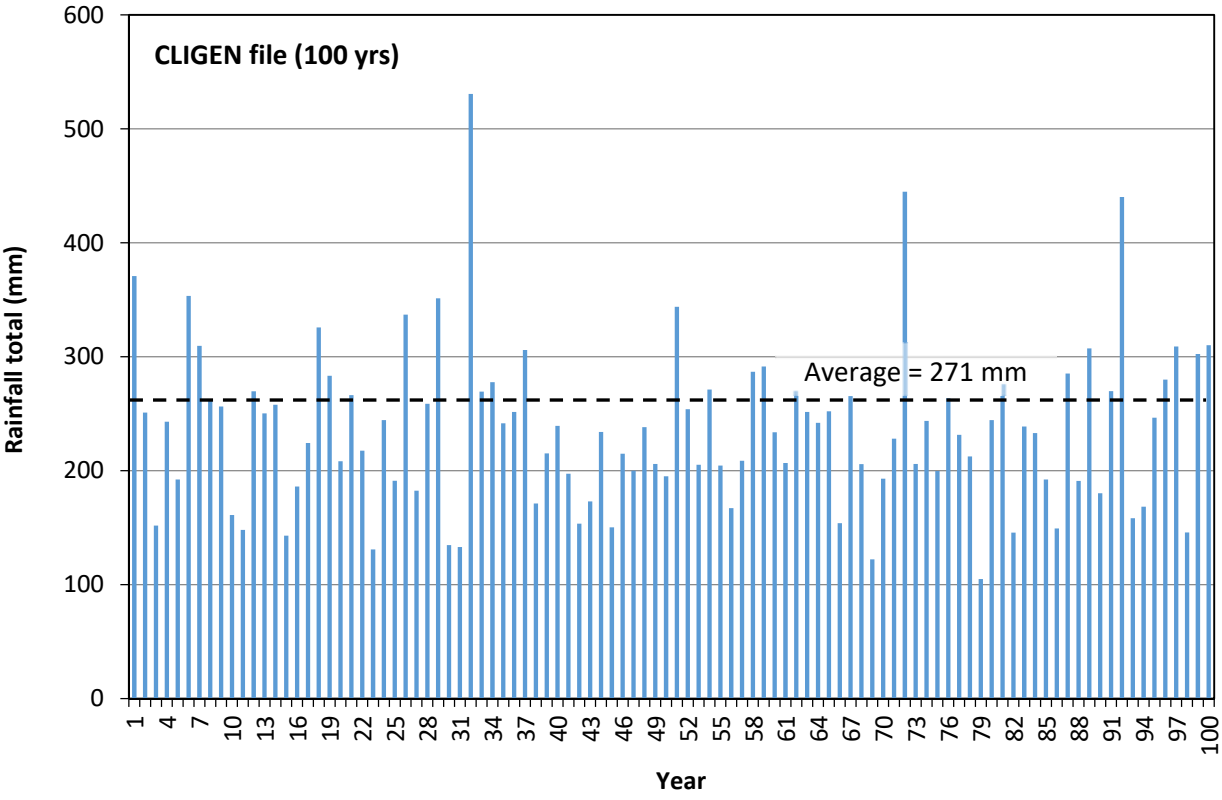


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NORTHERN STAR RESOURCES	Figure 3.2: a) 24-hour and b) mean monthly rainfall comparison	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		





NORTHERN STAR RESOURCES	Figure 3.3: Annual rainfall comparison	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

Table 3.3: Key soil parameters used in the WEPP model.

Material ID	Sand (%)	Clay (%)	OM (%)	CEC [meq/100g]	Keff (mm/hr)	Ki (Kg s / m4)	Kr (s / m)	τ C (Pa)
SMU 1	82	8	0.32	16	15.7	8.4×10^5	0.1036	4.48
SMU 2	77	16	0.2	18	5.7	2.7×10^5	0.0602	2.81

3.3.3 SLOPE PROPERTIES

Batter slopes were modelled assuming slope angles of 15° with lift heights of 10m, to simulate the most likely 'average' batter-berm configuration being considered for the Waste Dump design(s).

3.3.4 MANAGEMENT ASSUMPTIONS

The land management input file used in the WEPP model was designed to describe the expected conditions on the remediated waste rock landform. The key features of the input management file include:

- A pre-consolidated soil surface. This means that no further settling is simulated within the model, and that the measured infiltration rates and runoff characteristics apply for the duration of the model (i.e., no further changes in these properties with time). This is reasonable because the laboratory measurements (from which the input parameters were derived) were conducted on pre-consolidated soil samples.
- No vegetation. This assumption will result in conservative (i.e. "worst-case") erosion results, and will apply to the landform during the period prior to re-vegetation establishment. Subsequent vegetation growth is likely to act to enhance the stability of the landform by dissipating rainfall impact energy, producing leaf litter as a ground cover, and stabilising the sub-surface and improving infiltration with root growth. The degree of stabilisation will depend on the types of vegetation used, and their rates of establishment.
- Zero initial surface cover (i.e. no woody debris or plant litter). This means that no additional surface cover was expected to be added to the soil surface to reduce erosion rates. This assumption does not have any impact on the armouring effect of the rock and gravel fraction in the soil, which is already accounted for within the measured soil parameters discussed in Section 3.3.2.
- Expected rill geometry is adjusted internally in the model based on the input soil parameters and on the size of the erosion events encountered.

4 SOIL CHARACTERISATION

4.1 SOIL DISTRIBUTION

Based on the morphological characteristics of the soil profiles exposed by trench excavation three distinct Soil Mapping Unit's (SMU) were defined: deep red sands & alluvial gravels, sandy loam duplex and shallow calcareous loamy earths. The relationship between these SMU definitions and the major soil groups of Western Australia (Schoknecht, 2001) and the Australian Soil Classification (Isbell, 1996) are presented in Table 4.1.

Table 4.1: Relationship between identified SMU and recognised soil classification schemes.

SMU (present study)	Major soil group, WA (Schoknecht, 2001)	Australian soil classification (Isbell, 1996)
1: Shallow calcareous loamy earths	Calcareous shallow loam	Calcic Kandosol
2: Sandy loam duplex	Red Loamy Duplex	Red Tenosol
3: Deep red sands & alluvial gravels	Red Deep Sand	Orthic Tenosol

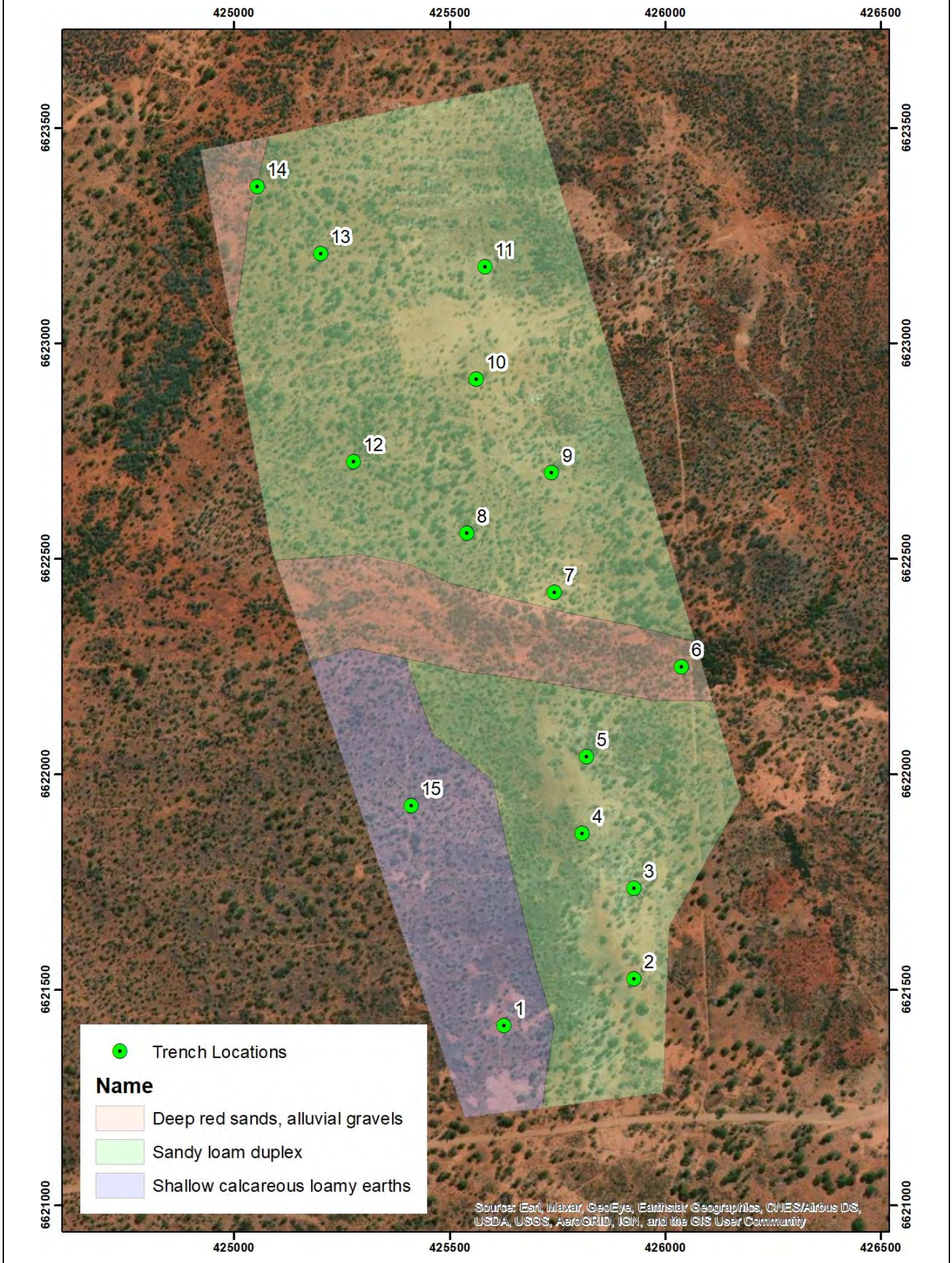
This SMU definition is generally consistent with the regional soil mapping discussed in Section 2.4 with minor variations based on landform and vegetation distribution coupled with trench investigation. The mapped distribution of the defined SMU's is shown in Figure 4.1.

4.2 SMU 1: SHALLOW CALCAREOUS LOAMY EARTHS

4.2.1 GENERAL SOIL DESCRIPTION

This soil type is associated with the slightly raised and undulating hills which are present on the western margin from the south to central portion of the Project Area. The two trenches within this SMU both showed a shallow layer of reddish-brown loamy sand averaging 80 cm in depth, overlying variably weathered basement rock. Further excavation was not possible due to refusal from the excavator. It is important to note that the soil profile (as accessed by vegetation) does not stop at the achieved trench depth but is likely to continue down several metres as roots exploit fractures within the rock formation to explore a greater volume of material and therefore gain access to higher volumes of water.

This SMU covers approximately 30 % of the Project Area and may provide a significant proportion of the materials available for rehabilitation. A characteristic soil profile for this SMU is shown in Figure 4.2.



NORTHERN STAR RESOURCES	Figure 4.1: Mapped SMU distribution	ENVIRONMENTAL INNOVATIONS
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0-20cm	Reddish brown silty loam topsoil, ~20% sub-rounded small 1-2cm diameter gravels. Abundant fine lateral roots throughout
20-40cm	Gravel rich reddish brown sandy loam sub-matrix set within highly fractured non-cohesive weathered rock fragments
40-70cm	Reddish brown silty loam mixed with fractured weathered rock transition zone to basement

NORTHERN STAR RESOURCES	Figure 4.2: Characteristic soil profile for SMU 1	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

4.2.2 MORPHOLOGICAL AND PHYSICAL PROPERTIES

The thickness of the calcareous loams varies from 70 to 100 cm, typically containing gravel contents of 20 – 40 % loosely held in a silty loam matrix (Table 4.2). The gravels generally have a particle size in the range of 0.2 – 2 cm in diameter and are sub – rounded to angular in form. Eluviation of clays from the surface soils has resulted in the formation of a common layer of ironstone lag. Root growth occurs throughout the surface soils due to its friable nature and lateral root development is commonly seen at the weathered rock boundary with further vertical exploration severely limited to areas of structural weaknesses. These soils have a relatively high saturated permeability (averaging slightly over, 3.8 m/day) which is due to the modest clay and silt content within the < 2 mm fraction. The soils are calculated to contain moderate water available for use by vegetation, averaging 12 % PAW (v/v).

Table 4.2: Gravel content and particle size distribution of soils in SMU 1

Trench ID	Depth (cm)	% Gravel (> 2mm soil fraction)	Particle size distribution (< 2 mm soil fraction)			
			% Sand	% Silt	% Clay	Texture
1	0-20	18.4	70.2	25.5	4.3	Silty loam
	40-60	42.2	78.2	11.5	10.3	Loamy sand
15	10-20	21.5	87.8	4.4	7.8	Loamy sand
	40-60	37.5	89.4	3.1	7.5	Loamy sand
	80-100	38.7	85.4	4.5	10.1	Loamy sand

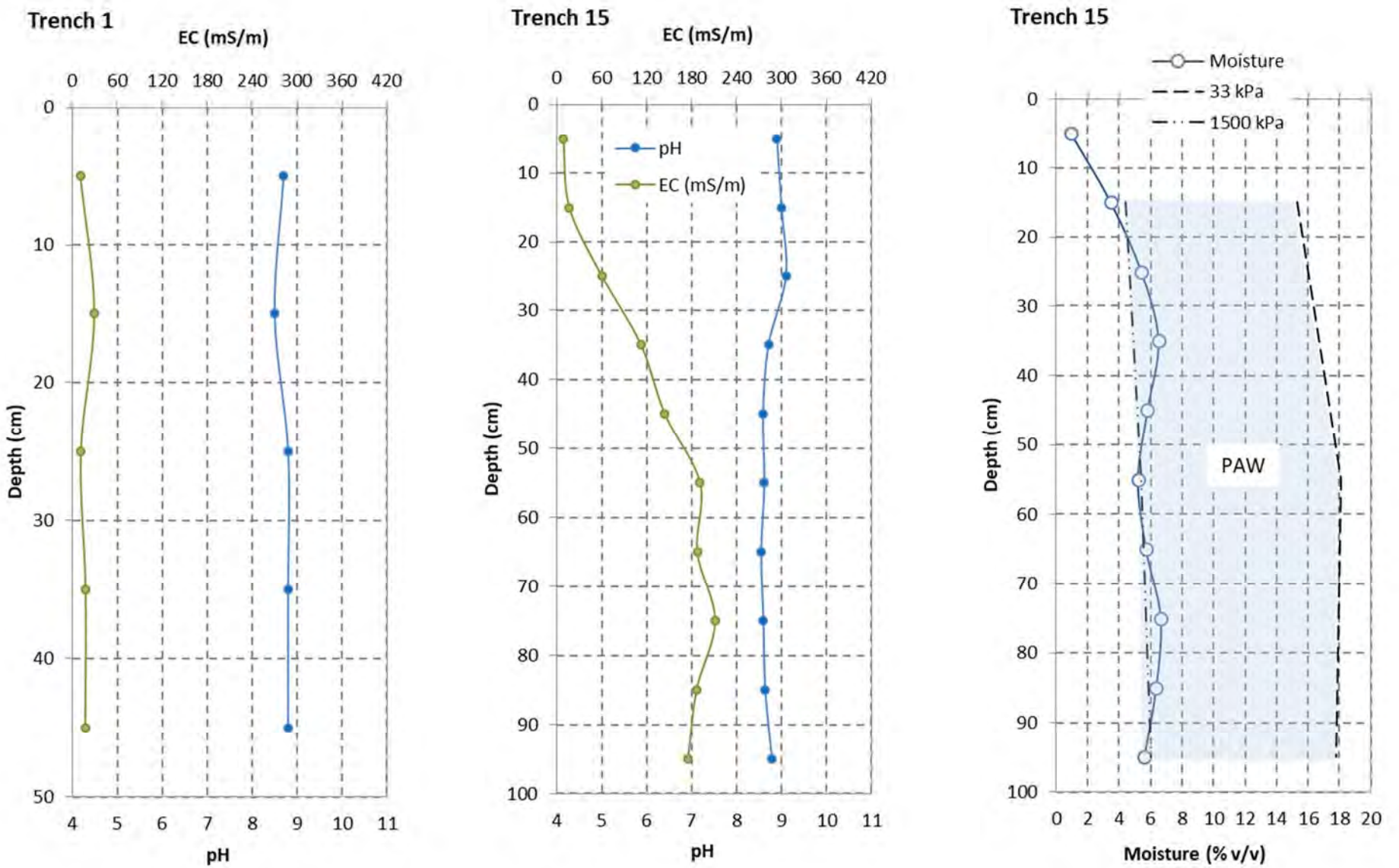
Table 4.3: Hydraulic characteristics (PAW not corrected for gravel content)

Trench ID	Depth (cm)	k Sat (m/day)	Volumetric water content (%)					PAW (%)*
			0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	
15	10-20	2.11	50.6	19.7	15.3	11.0	4.4	10.9
	40-60	-	50.3	19.5	18.1	11.1	5.4	12.7
	80-100	1.54	47.9	20.9	17.8	12.2	6.0	11.8

* PAW = Plant available water (PAW = 33 kPa – 1,500 kPa)

4.2.3 CHEMICAL PROPERTIES

The chemical properties of the soils in SMU 1 are provided in Table 4.4 and Table 4.5. The pH and EC measurements are presented as soil profiles in Figure 4.3 along with a moisture profile for Trench 15. All soils within SMU 1 are moderately alkaline to alkaline, with an average pH of 8.5. The soils range from non-saline to moderately saline, with the salinity increasing with depth in Trench 15. This increase in salts within the soils with depth may be driven by slight perching of infiltrating rainfall during higher rainfall events at the top of the weathered rock surface. The soils within the SMU have an average EC of only 85 mS/m (slightly saline).



NORTHERN STAR RESOURCES	Figure 4.3: Soil profiles for SMU 1	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

SMU 1 soils can be considered nutrient-poor as they display low levels of mineralised nitrogen (NH4-N + NO3-N < 10 mg/kg) and phosphorus (Colwell P ≤ 15 mg/kg); but moderate to high levels of potassium (average Colwell K = 440 mg/kg). Extractable sulfur was low in three of the four samples analysed from within SMU 1 (KCl ext. S < 6 mg/kg), but was high in the fourth sample. The higher sulfur value was found at the greatest depth analysed and may be caused by increased rock fragments within the sample matrix.

The soils in SMU 1 are classified as non-sodic (ESP < 6%) and reported a moderate to low CEC (average 10 meq/100g), indicating that the non-reactive clay mineral kaolinite is the dominant clay mineral type.

Table 4.4: Nutrient properties of the soils in SMU 1

Trench ID	Depth	Mineralised N (mg/kg)		Colwell P	Colwell K	KCl ext. S	Organic C
	(cm)	NH4-N	NO3-N	(mg/kg)	(mg/kg)	(mg/kg)	(%)
1	0-10	<1	<1	11	518	2.3	0.66
	20-30	<1	6	7	373	4.6	0.55
	40-50	<1	3	4	471	14.4	0.67
15	0-10	1	<1	12	395	1.8	0.52

Table 4.5: Exchangeable cation content of the soils in SMU 1

Trench ID	Depth	Exchangeable cations (meq/100g)				CEC	ESP (%)
	(cm)	Ca	Mg	K	Na	(meq/100g)	
1	0-10	13.53	1.56	0.89	<0.10	16.0	-
	20-30	17.04	1.93	0.82	<0.10	19.8	2.0
	40-50	13.46	2.72	0.90	0.35	17.4	-
15	0-10	11.59	1.11	0.68	<0.10	13.4	-

4.3 SMU 2: SANDY LOAM DUPLEX

4.3.1 General Soil Description

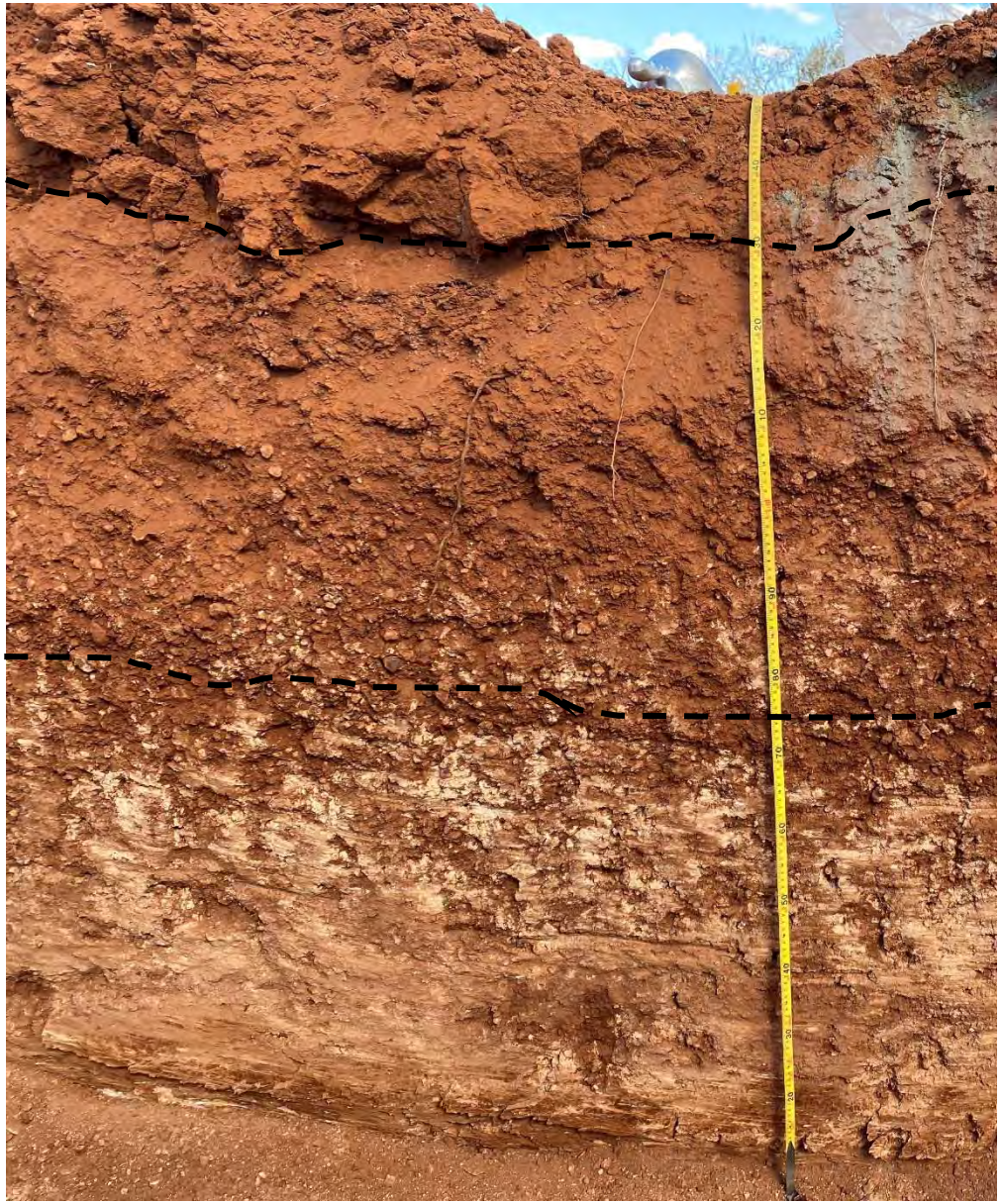
A characteristic soil profile is presented in Figure 4.4. The surface soils in this SMU are all reddish brown sandy loams, with varying amounts of gravel content occurring throughout. These soils have formed in response to colluvial and alluvial deposition of eroded greenstone and ironstone materials with small rounded ironstone gravels dominating the gravel fraction. This soil type occurs throughout a large portion of the study area, associated with the alluvial plains which support a mixture of eucalypt woodlands and acacia shrub (Plate 4:1). Cryptogam development in the upper topsoil is common and is associated with sheet-flow conditions (Plate 4:2).

Plate 4:1: Alluvial Plains of SMU 2



Plate 4:2: Cryptogam and lag on surface of SMU 2 soils





0-20cm	Reddish brown silty loam topsoil, ~30% sub-rounded small 1-2cm diameter gravels. Very dry and fine <2mm fraction.
20-80cm	Transition zone with increasing gravel, reddish brown sandy loam abundant fine roots and uncommon lateral roots 1-2cm in diameter.
80-160cm	Brownish red to off white talcy clay, common iron stain mottling. Low strength and plasticity. Large ironstone and quartz relicts throughout.

NORTHERN STAR RESOURCES	Figure 4.4: Characteristic profile for SMU 2	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

4.3.2 MORPHOLOGICAL AND PHYSICAL PROPERTIES

The physical and hydraulic properties of the soils within SMU 2 are provided in Table 4.6 and Table 4.7. Testing shows that the soils in SMU 2 typically contain ~ 30% gravel, with gravel content generally increasing with depth in the upper profile and tapering off within the underlying duplex. The gravels in SMU 2 are predominately pisolithic shape (i.e. small < 5 mm diameter and well rounded). The fine fraction (i.e. < 2 mm) is generally classified as a loamy sand or sandy loam within the upper 60 cm of the profile, with an average of 79% sand and 21% silt + clay. The deeper profile (i.e. > 60 cm depth) was found to consist of a sandy clay loam (averaging 71% sand, 29% silt + clay).

Table 4.6: Gravel content and particle size distribution of soils in SMU 2

Trench ID	Depth (cm)	% Gravel (> 2mm soil fraction)	Particle size distribution (< 2 mm soil fraction)			
			% Sand	% Silt	% Clay	Texture
4	20-40	27.9	82.1	11.1	6.8	Loamy Sand
	100-120	13.8	68.2	8.8	23.0	Clay Loam
7	0-10	16.5	84.5	3.2	12.3	Sandy Loam
	20-40	46.7	78.9	5.5	15.6	Sandy Loam
8	40-60	33.4	69.5	10.1	20.4	Loam
9	100-120	65.5	73.4	8.8	17.8	Sandy Loam
10	20-40	38.6	87.3	4.4	8.3	Loamy Sand
11	0-10	29.7	80.7	11.2	8.1	Loamy Sand
	20-40	48.2	73.1	5.0	21.9	Sandy Clay Loam
12	20-40	31.0	76.8	4.4	18.8	Sandy Loam
	100-120	32.5	72.3	7.4	20.3	Sandy Clay Loam

Many of the soils in SMU 2 are macro-structurally unstable (i.e. slaking when rewet). Some of these soils also appear to be susceptible to hard-setting when disturbed, and may require ripping prior to seeding. Given the relatively high silt + clay content, these soils have a high water holding capacity (i.e. field capacity – 10 kPa moisture contents of 40%) and PAW content (e.g. average PAW of 16%). Accounting for the average gravel content of these soils, a typical 1 m deep profile can contain approximately 110 mm of PAW.

Table 4.7: Hydraulic characteristics (PAW not corrected for gravel content)

Trench ID	Depth (cm)	k Sat (m/day)	Volumetric water content (%)					PAW (%)*
			0 kPa	10 kPa	33 kPa	100 kPa	1,500 kPa	
4	20-40	-	48.7	40.4	22.7	18.3	7.9	14.8
	100-120	-	50.2	40.5	25.4	21.0	9.9	15.5
7	20-40	-	51.1	44.5	24.5	17.5	11.0	13.5
8	40-60	0.85	50.7	42.1	24.9	19.6	13.8	11.1
9	100-120	1.10	48.6	40.1	23.8	18.9	12.1	11.7
10	20-40	1.35	48.7	42.5	26.2	22.2	8.8	17.4
11	20-40	-	47.8	38.7	30.5	30.5	12.0	18.5
12	20-40	0.80	49.7	39.8	26.9	26.9	10.6	16.3
	100-120	0.35	50.1	40.6	28.4	31.4	12.4	19.0

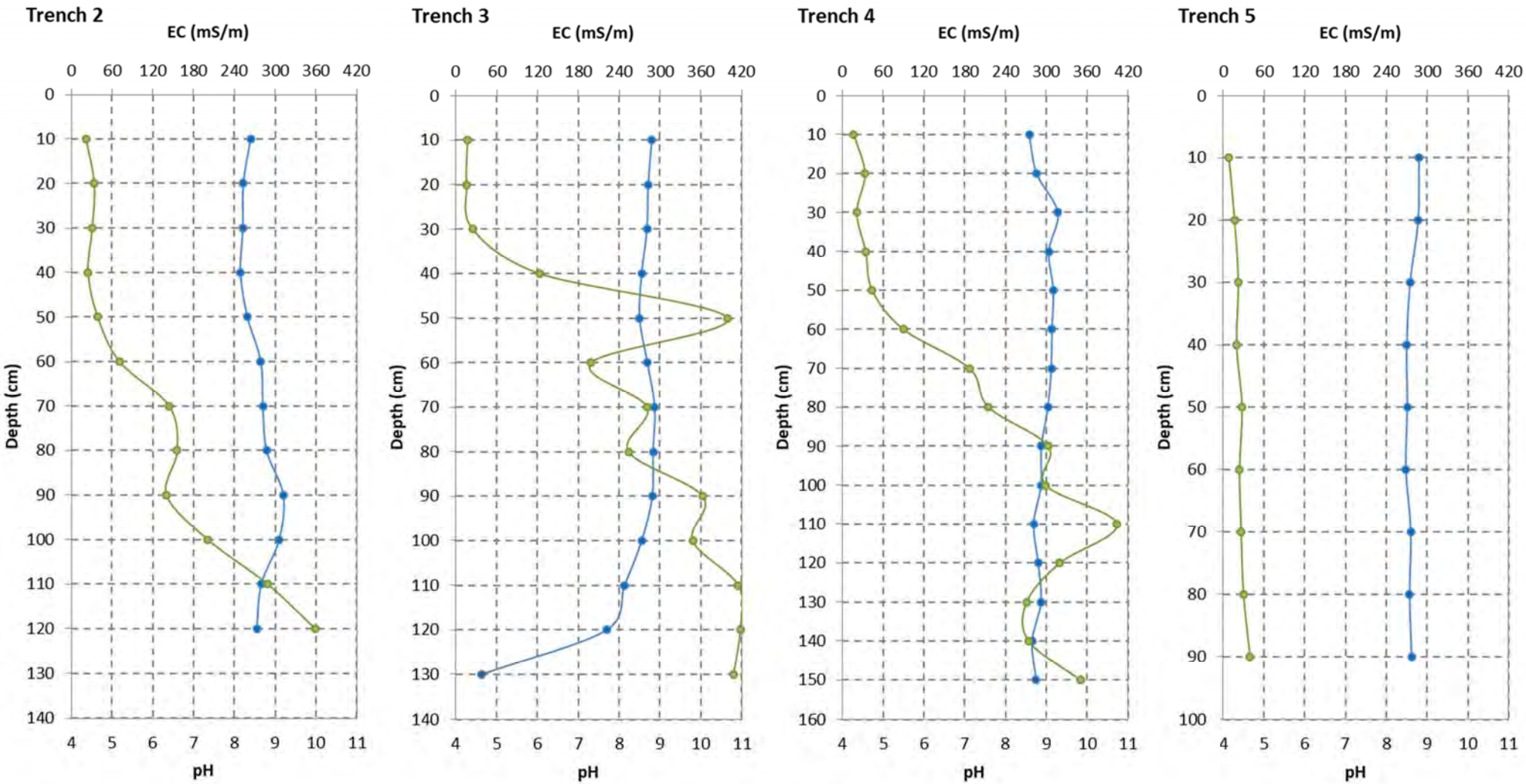
4.3.3 CHEMICAL PROPERTIES

The chemical properties of the soils in SMU 2 are provided in Table 4.8 and Table 4.9. The pH and EC measurements are presented as soil profiles in Figure 4.5 to Figure 4.7 with measured volumetric moistures profile for three trenches in Figure 4.8. All of the measured soils within SMU 2 are moderately alkaline to alkaline, with an average pH of 8.5. The soils show a considerable range in measured electrical conductivity, from non-saline to highly saline, with the salinity generally showing a trend of increasing with depth. This increase in salinity with depth corresponds to the talc rich clays which correspond to the lower layer of the duplex profile and are likely to be present primarily as calcium and magnesium salts. The soils within the SMU have an average EC of 135 mS/m (considered moderately saline).

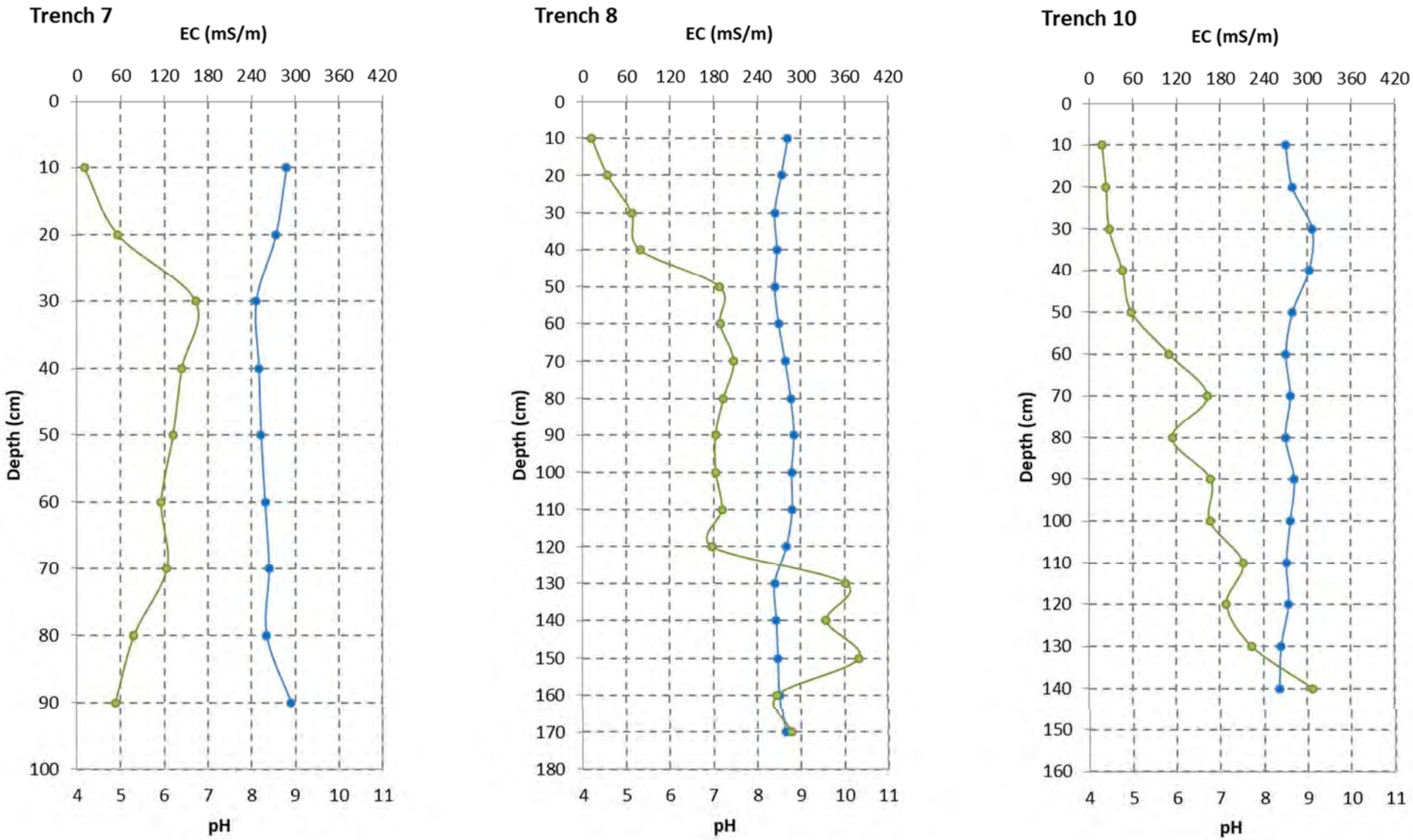
The soils within SMU can generally be considered to display moderate nutrient levels. The average reported nitrogen content of the soils is low, with mineralised N (NO3- + NH4+) contents generally <10 mg/kg, whilst in contrast the plant available Phosphorous and Potassium levels are considered moderate to high. As with results from SMU 1 higher nitrate and extractable S values are seen at greater depth within the profile, which is interpreted as reflecting either greater rock fragments (in the case of extractable S) or impacted topsoil from previous clearance activities (in the case of nitrates). The organic content of the soils is considered moderate, however where topsoil clearance activities have not occurred outside of the drilling areas, the topsoil organic accumulation is considerable. With trenches 2 and 10 both reporting topsoil organic C > 1% in the upper 10cm of the profile. This level of organic accumulation is quite high for semi-arid climates and reflects good nutrient cycling and topsoil health.

Table 4.8: Nutrient properties of the soils in SMU 2

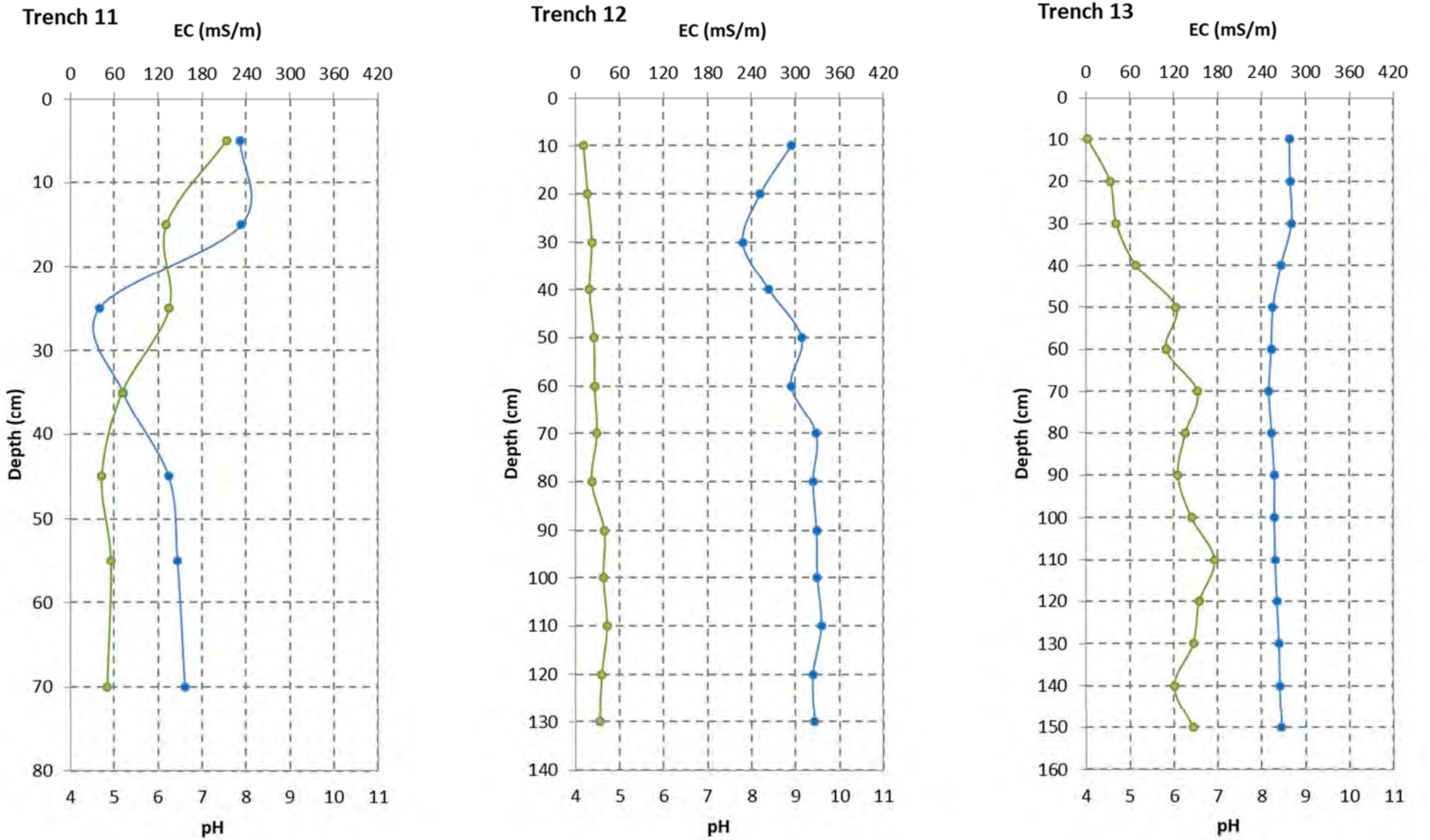
Trench ID	Depth	Mineralised N (mg/kg)		Colwell P	Colwell K	KCl ext. S	Organic C
	(cm)	NH4-N	NO3-N	(mg/kg)	(mg/kg)	(mg/kg)	(%)
2	0-10	1	3	14	890	6.3	1.57
	80-100	<1	4	2	45	239	0.23
3	0-10	<1	7	10	766	3.6	0.72
5	0-10	<1	2	12	200	1.9	0.79
7	0-10	<1	<1	9	277	3.1	0.55
8	0-10	1	4	6	390	4.7	0.62
	100-120	<1	86	3	87	574	0.13
10	0-10	<1	9	11	827	5.9	1.14
12	0-10	2	2	15	755	2.1	0.56
	20-40	<1	42	4	217	9.8	0.39



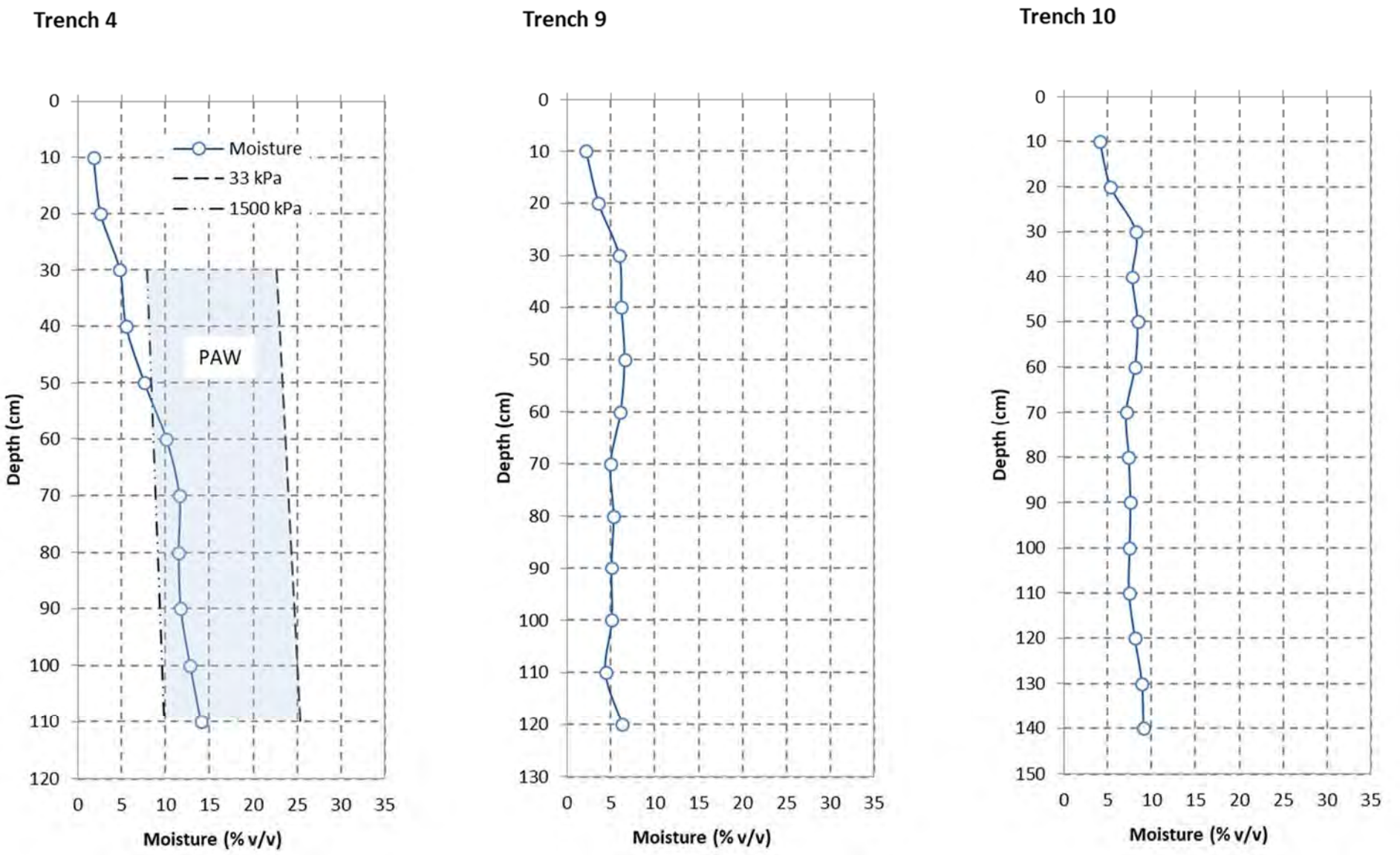
NORTHERN STAR RESOURCES	Figure 4.5: SMU 2 pH and EC profiles	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		



NORTHERN STAR RESOURCES	Figure 4.6: SMU 2 pH and EC profiles continued..	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		



NORTHERN STAR RESOURCES	Figure 4.7: SMU 2 pH and EC profiles continued..	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		



NORTHERN STAR RESOURCES	Figure 4.8: SMU 2 moisture profiles	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

SMU 2 soils are generally considered non-dispersive, although some dispersion may occur if these soils are disturbed (e.g. excavated during mining). The appreciable gravel fraction will tend to mitigate this instability, meaning these soils can be used to rehabilitate sloping land if stored and handled correctly. The measured ESP for all but one of the soil samples tested from this SMU were below 6% (generally regarded as a cut-off for sodic soils) with sodium generally making up a negligible proportion of the exchangeable cations present within the soil medium. This indicates that flocculation of finer clay particles in suspension will occur quickly, reducing the potential for dispersion and hard-setting to occur in response to disturbance.

The reported moderate CEC (average 18 meq/100g), indicates that the non-reactive clay mineral of kaolinite is the dominant clay mineral type within the finer <2µm fraction.

Table 4.9: Exchangeable cation content of the soils in SMU 2

Trench ID	Depth (cm)	Exchangeable cations (meq/100g)				CEC (meq/100g)	ESP (%)
		Ca	K	Mg	Na		
2	0-10	13.4	1.84	6.47	0.65	22.4	2.9
	80-100	8.82	0.07	9.05	1.99	19.9	10.0
3	0-10	13.43	1.53	5.65	0.12	20.7	0.6
5	0-10	14.74	0.35	1.02	<0.10	16.1	-
7	0-10	13.54	0.42	1.17	<0.10	15.1	-
8	0-10	13.18	0.60	1.81	<0.10	15.6	-
	100-120	8.44	0.15	5.28	0.83	14.7	5.6
10	0-10	17.9	1.43	2.94	0.26	22.5	1.2
12	0-10	10.49	1.02	1.00	<0.10	12.5	-
	20-40	17.49	0.47	3.27	<0.10	21.2	-

4.4 SMU 3: DEEP RED SANDS & ALLUVIAL GRAVELS

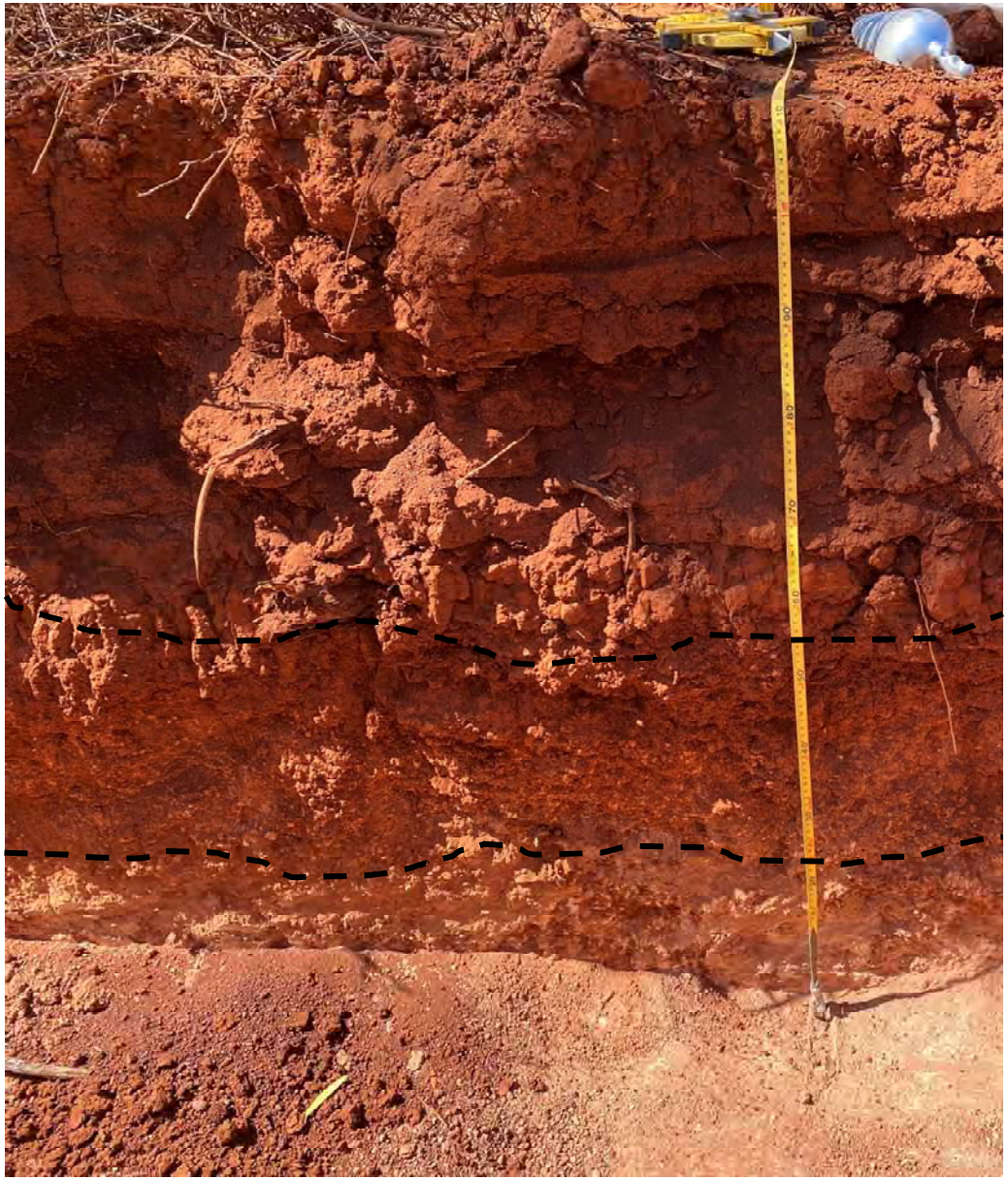
4.4.1 General Soil Description

This soil type is restricted to drainage lines, one of which dissects the Project Area into northern and southern halves (Figure 4.1). It has formed in response to prolonged colluvial deposition and erosion of fine particles within partially dissected stream beds (Plate 4:3) and therefore has a deeper profile than both SMU 1 and 2. The dissecting drainage line is a minor flow line which merges into a large flow line which flows southwards along the western fringe of the Project Area and empties into the nearby Lake Yindarlgooda which is an ephemeral salt lake basin. The soil profiles contained a lower silt + clay fraction, indicating that higher energy surface water has flowed through these drainage lines in the past, reducing the finer particle size percentage somewhat within the soil profile which remained behind.

A characteristic soil profile for this SMU is shown in Figure 4.9.

Plate 4:3: Dissected stream running through the Project Area





0-60cm	Massive structure reddish brown silty loam topsoil, ~30% sub-rounded small 1-2cm diameter gravel layer from 30cm depth. Abundant fine to medium diameter lateral roots throughout
60-90cm	Alluvial sub-rounded to rounded gravels 1-4cm in diameter set in a silty sand matrix.
90-110cm	Earthier fabric white to red talcy consolidated clay material.

NORTHERN STAR RESOURCES	Figure 4.9: Characteristic soil profile for SMU 3	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

4.4.2 MORPHOLOGICAL AND PHYSICAL PROPERTIES

The physical properties of the soils within SMU 2 are provided in Table 4.10. Testing shows that the soils in SMU 3 have high gravel contents; average >50% gravel, with gravel content generally increasing with depth. The gravels in SMU 3 are predominately pisolithic shape (i.e. small < 5 mm diameter and well rounded). The fine fraction is classified as a sand to sandy loam, with an average of 90% sand and 10% silt + clay.

Table 4.10: Gravel content and particle size distribution of soils in SMU 3

Trench ID	Depth (cm)	% Gravel	Particle size distribution (< 2 mm soil fraction)			
		(> 2mm soil fraction)	% Sand	% Silt	% Clay	Texture
6	0-10	32.5	89.4	8.9	1.7	Loamy Sand
	20-40	64.1	87.6	2.3	10.1	Sandy Loam
14	40-60	35.5	92.6	3.2	4.2	Sand

The soils within this SMU were tested and found to be macro-structurally stable and would not slake or disperse when wet.

4.4.3 CHEMICAL PROPERTIES

The chemical properties of the soils in SMU 3 are provided in Table 4.11 and Table 4.12, whilst the pH and EC measurements are presented as soil profiles in Figure 4.10. The pH values show that both profiles investigated had more variation in the pH throughout, with pH varying between 7.1 and 9. The lower pH value is likely caused by loss of calcium carbonate materials as compared to surrounding soil because of higher historical water throughput.

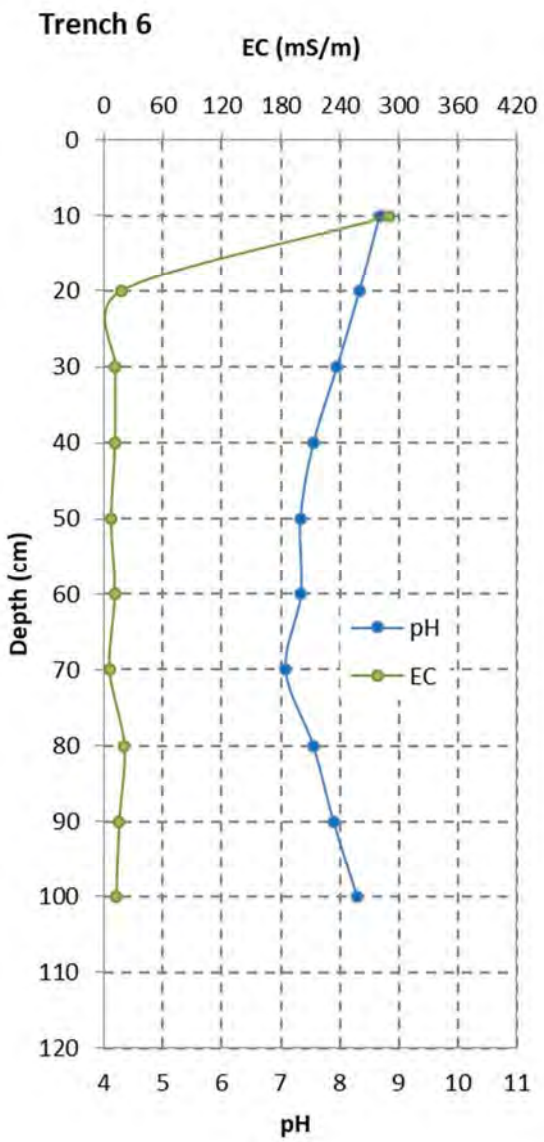
The mineralised nitrogen content of the topsoil is very low, whilst the plant available potassium and phosphorous are low to moderate. Organic content and extractable sulfur can also be considered relatively low. The exchangeable cation content is dominated by calcium ions as with all soil across the Project Area, and the CEC shows that kaolinite will be the dominant clay mineral within the <2µm fraction.

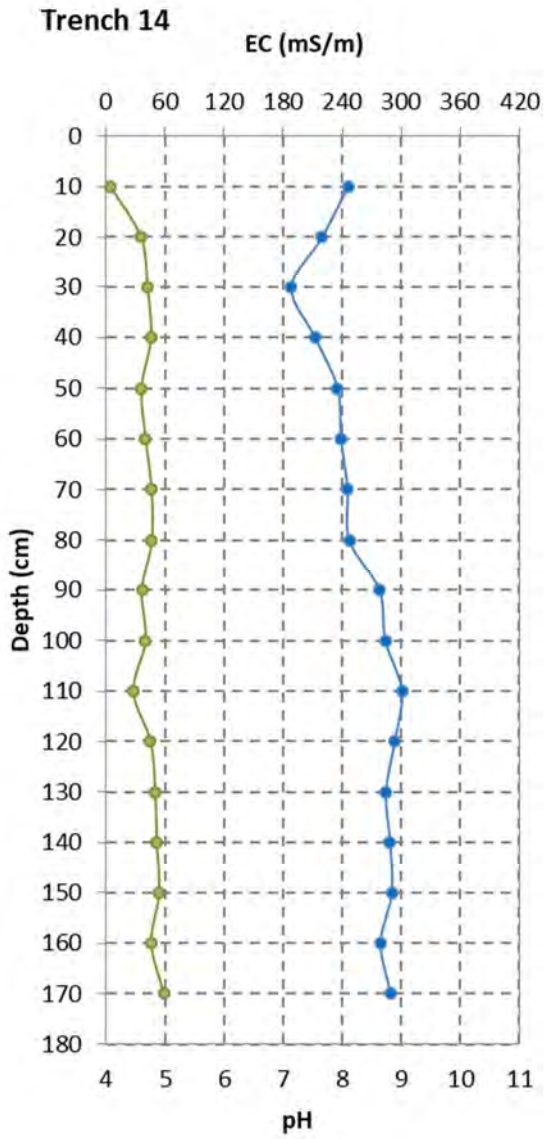
Table 4.11: Nutrient properties of the soils in SMU 3

Trench ID	Depth	Mineralised N (mg/kg)		Colwell P	Colwell K	KCl ext. S	Organic C
	(cm)	NH4-N	NO3-N	(mg/kg)	(mg/kg)	(mg/kg)	(%)
14	0-10	<1	1	13	433	1.8	0.34

Table 4.12: Exchangeable cation content of the soils in SMU 3

Trench ID	Depth	Exchangeable cations (meq/100g)				CEC	ESP (%)
	(cm)	Ca	K	Mg	Na	(meq/100g)	
14	0-10	6.25	2.49	0.77	<0.10	9.5	-





NORTHERN STAR RESOURCES	Figure 4.10: pH and EC profiles for SMU 3	ENVIRONMENTAL INNOVATIONS
KURNALPI GOLD PROJECT		

4.5 STABILITY OF SURFACE SOILS

4.5.1 FIELD OBSERVATIONS

Throughout the Project Areas the stability of the surface soils is controlled and minimised by the following factors:

- Significant surface lag in the form of fine ironstone gravels (SMU 1 and 2) – The presence of significant ironstone gravels on the surface gives these soils a self-armouring quality that results in a final land surface with a high surface roughness. This is clearly shown in Plate 4.2, whereby the micro-relief is approximately 1–2 cm, which limits the lateral movement of surface water somewhat whilst encouraging vertical infiltration into the profile.
- Cryptogam cover (SMU 1 and 2) – the stability of the surface soils is enhanced by the presence of a high cryptogam cover. Cryptogams hold the surface soils together and essentially form a continuous crust of the surface, which although decreases infiltration and thus increases surface runoff, prevents the detachment of surface soil particles and inhibits erosion and sediment loss. Cryptogam covers are easily disturbed by vehicles and machinery, and once the continuity of this crust is removed it actually facilitates future erosion and sediment loss by allowing the convergence of surface water flows and subsequent undercutting of downstream cryptogam crusts. In the absence of, or when the cryptogam crust is damaged, the surface soils in SMU 3 are highly erodible and etch appreciably.

4.5.2 POTENTIAL FOR DISPERSION

The surface soils associated with SMU 1, 2 and 3 have all been measured to be non-sodic and generally non-dispersive, both through the influence of considerable gravel content and ideal chemical properties of the soil matrix (i.e. ESP < 6%). The deeper soils within SMU 2 (i.e. below 75 cm) are generally non-dispersive, but have a greater mobile fine fraction, and contain generally lower gravel content to provide additional stability.

4.5.3 EROSION MODELLING RESULTS

Table 4.13 summarises the average runoff and sediment yield values predicted by the WEPP erosion model, given the input parameters previously summarised in Section 3.3.

The WEPP model indicated average sediment yields of ~4 t/ha/yr for SMU 1 material using a 10m high lift with the material and slope configurations tested, indicating that SMU 1 soil materials are generally suitable for use on slopes with this configuration, and would be expected to perform well on batter slopes of post-mine landforms. This loss of material equates to approximately 0.26mm per year in soil depth loss assuming uniform erosion.

The material tested from SMU 2 did not perform as well, with modelling estimating that approximately 8-10 t/ha/yr in erosion would be expected if these materials were used on similar post mine landforms batter slopes. This equates to a loss of approximately 0.6mm per year.

Whilst the deeper SMU 2 soils are not considered to be ideally suited to the slope configurations tested, they are likely to be important in providing rehabilitation vegetation sufficient plant available water during drier periods to ensure successful establishment and sustainability of the chosen vegetation communities. Based on the results of the erosion modelling, it is recommended that only SMU 1 and the upper portion (top duplex - ~0-75cm) of SMU 2 are used on the surface of post-mine landforms, with the underlying material placed directly underneath this material where possible.

Table 4.13: Summary of WEPP erosion modelling results for the J5 and Bungalbin East Deposits.

Material ID	Lift height (m)	Slope angle	Average annual runoff (mm/yr)	Average erosion rate (mm/yr)	Average erosion rate (t/ha/yr)
SMU 1 Shallow calcareous loams	10	15°	5	0.26	3.9
		18°	5	0.33	4.9
	20	15°	8	0.59	8.9
		18°	9	0.67	10.0
SMU 2 Red loams and clay	10	15°	6	0.55	8.2
		18°	14	0.68	10.2
	20	15°	9	1.02	15.3
		18°	18	1.15	17.3

5 SOIL MANAGEMENT

This section outlines management recommendations for the handling and utilisation of the surficial soil materials within the Kurnalpi gold deposit Project Area. These recommendations are suggested with the aim of:

- Maintaining optimal soil properties during the mining and rehabilitation process.
- Appropriate handling of soil materials that exhibit adverse physical and chemical properties to ensure no contamination with other 'good' or optimal materials.
- Minimising environmental impacts through appropriate handling and placement of soil materials that exhibit adverse properties.

5.1 TOPSOIL MATERIALS

All material in the upper 20 cm of the soil profile over the site should be treated as a homogenous "topsoil: material. Although topsoil has been impacted previously this should also include all areas disturbed by previous exploration activity to reduce complexity of stripping activities. These soils represent the most favourable available material for the re-establishment of plant growth on post-mine landforms due to:

- Relatively elevated organic matter and nutrient content
- Relative resistance to surface erosion processes, and
- The presence of a pre-existing seed store (i.e. geosporous species) that will be beneficial to the establishment and growth of revegetation species.

It is recommended that the upper 20 cm be stripped from all areas prior to planned disturbance and stockpiled as a resource for later use. To maintain the soils' biological components and nutrient sources, all topsoil stockpiles should not exceed 2m in height. Soil stockpile duration should be limited as far as possible. Saline water should not be used for dust suppression on stockpiled topsoil as this will structurally degrade these materials.

5.2 SUBSOIL MATERIALS

All soil materials below 20 cm depth within the pit boundary to the top of the *in situ* saprolite should be separated and saved for later use as an overburden material. This material will contain variable clay + silt and gravel fractions and will be marginal in terms of erodibility. Therefore it should not be placed on the outer surface of the WRL without additional management actions to prevent excessive erosion. Ideally this material would be placed underneath the topsoil or have an additional gravel or 'rock mulch' material added to it prior to placement on outer surfaces of post-mine landforms. Regardless of the erosion potential, the material represents a valuable water store for plant establishment on post-mine landforms and should be saved for this use.

Soil material below 20 cm depth should be considered as overburden materials, as they are:

- Able to contribute to a deeper total soil profile – thus enhancing the total soil water holding capacity, and providing more physical space for plant root exploration.
- Expected to be considerably less saline and less erodible than the underlying waste rock oxide materials, and
- Are able to form a barrier between the upper growth medium and potentially saline / erodible oxide waste material, without inhibiting growth of established revegetation species..

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Appendix C: Level 2 Flora and Vegetation Survey of the Project (2011)

Level 2 Flora and Vegetation Survey of the Kurnalpi Project

Final Report

Tenements: M28/66, M28/70, M28/72, M28/76, M28/84, M28/90, M28/92, M28/109, M28/7, P28/1067, P28/1098, P28/1099, P28/1109, P28/1110, P28/1119 & E28/1477

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Executive Summary

Botanica Consulting was commissioned by Carrick Gold Limited to undertake a Level 2 flora and vegetation survey of the Kurnalpi Project, located approximately 73km east from Kalgoorlie-Boulder. The Kurnalpi Project is being considered for development into an open pit mining operation and will likely become the second mine to be developed after Carrick Gold Limited Lindsay's Project. The flora survey was conducted on the 28th and 29th November 2011, covering an area of approximately 1,500ha. Twenty-two quadrats were established within the survey area.

No Declared Rare Flora, pursuant to Subsection 2 of Section 23F of *the Wildlife Conservation Act (1950)* and listed by the Department of Environment and Conservation (Atkins, 2010) were identified within the survey area. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within the survey area. This specimen has been provided to a taxonomic consultant for further identification.

Six broad vegetation communities were identified within the survey area: Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode*;* Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*; Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*. These vegetation communities were represented by a total of 25 Families, 57 Genera and 103 Species (including sub-species and variants).

The majority of allocations of quadrats into different vegetation communities in the field (based on visual comparisons of dominant taxa in each stratum), particularly of *Eucalyptus* vegetation communities, were supported by the PATN analysis. There was however a high degree of intermixing between the *Acacia* vegetation communities suggesting that species composition throughout the *Acacia* woodlands is homogenous.

None of the vegetation communities have National Environmental Significance as defined by the Commonwealth *Environment Protection* and *Biodiversity Conservation Act 1999*. No Threatened Ecological Communities or Priority Ecological Communities listed under Commonwealth legislation or listed by the Department of Environment and Conservation were recorded within the survey area. The survey area is not based within any Department of Environment and Conservation managed land.

Based on Keighery's vegetation health rating scale (1994), one of the six vegetation communities was given a health rating of 'very good' and the remaining five vegetation communities given a "good" health rating.

Six introduced species were identified within the survey area; *Agave americana, Carrichtera annua, Centaurea melitensis, Malva parviflora, Salvia verbenaca* and *Solanum nigrum.* According to the Department of Agriculture and Food Western Australia database, none of the species are listed as Declared Plants.

1 Introduction

1.1 Project Description

Botanica Consulting (BC) was commissioned by Carrick Gold Limited (Carrick) to undertake a Level 2 flora and vegetation survey of the Kurnalpi survey area. The flora survey was conducted over the following Carrick Gold tenements listed in Table 1 and shown in Figure 1. The aim of the survey was to produce a vegetation map (Appendix 2) and species list (Appendix 3) as well as to document and map locations of any Declared Rare or Priority listed flora species identified within the survey area, which covered an area of approximately 1,500ha.

Table 1: Carrick Gold tenements surveyed during the Level 2 flora and vegetation survey

Carrick Gold Limited
E28/1477
M28/66
M28/70
M28/72
M28/76
M28/84
M28/90
M28/92
M28/109
M28/7
P28/1067
P28/1098
P28/1099
P28/1109
P28/1110
P28/1119

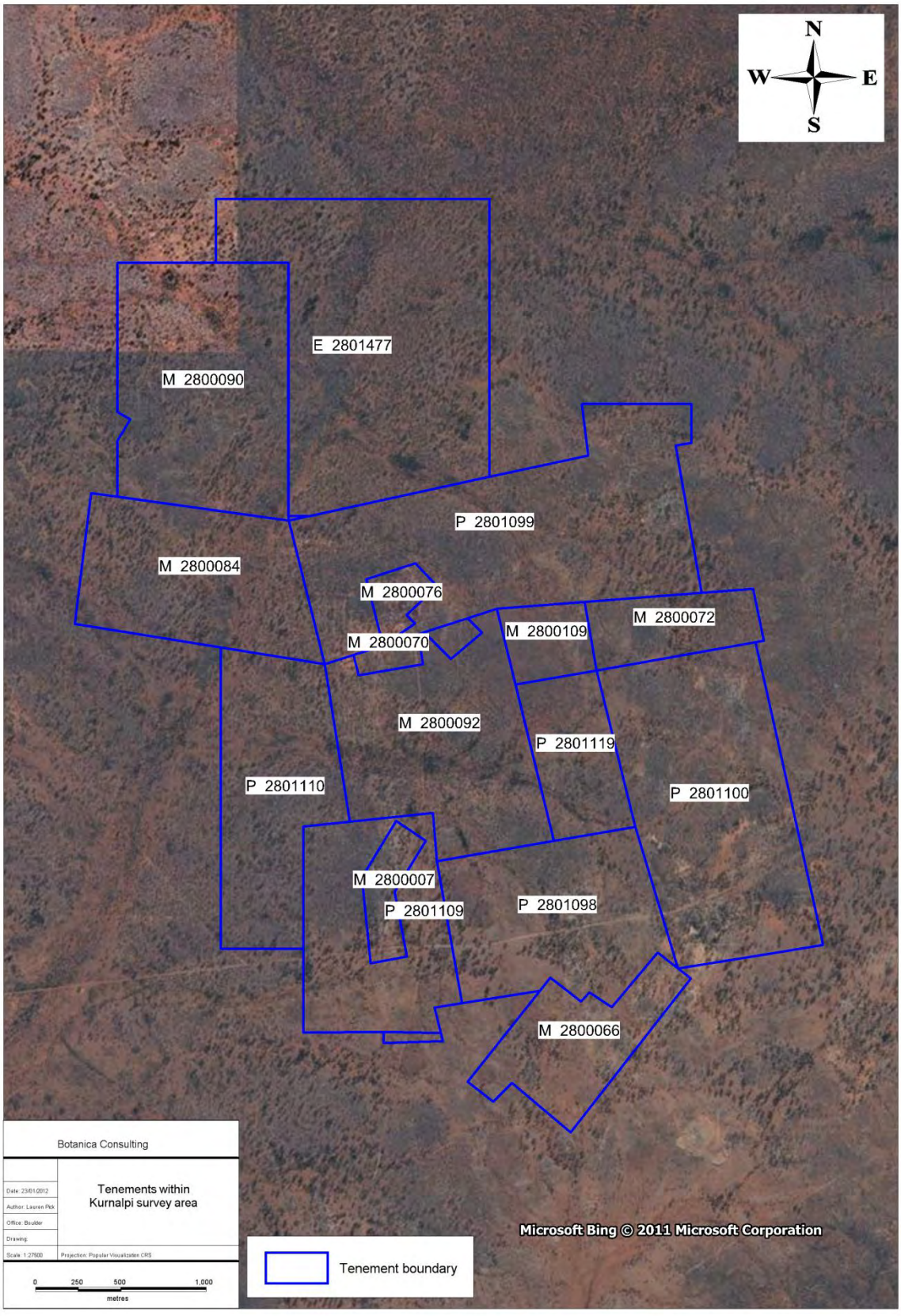


Figure 1: Tenements within the Kurnalpi survey area

The Kurnalpi Project is likely to become the second mine to be developed after the Lindsay's Project as Carrick's near-term goal is to continue exploration and increase the mineral resource beyond one million ounces of gold. The shallow gold deposits that have identified at the Kurnalpi Project should be amenable to open pit mining.

The Kurnalpi survey area is located approximately 73km east from Kalgoorlie-Boulder. A regional map of the survey area location is provided in Figure 2 and Appendix 1.

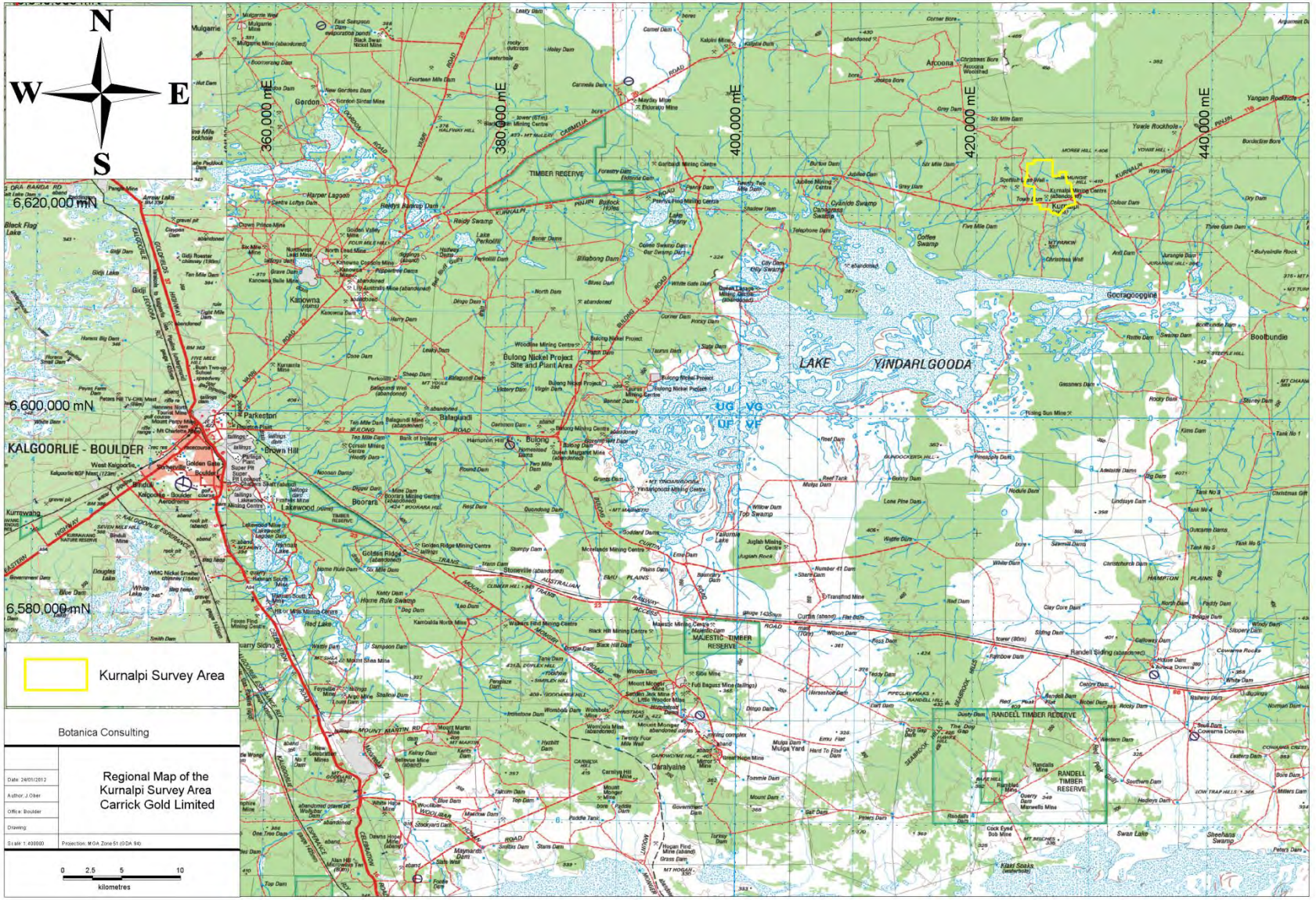


Figure 2: Regional map of the Kurnalpi survey (area not to scale)

1.2 Previous relevant surveys

***Biological survey of the Eastern Goldfields of Western Australia: Part 8 Kurnalpi to Kalgoorlie Study Area.* Keighery, Milewski & Hnatiuk, (1992).**

Between January 1980 and August 1983 a biological survey of the Kurnalpi-Kalgoorlie region covering approximately 26,500km² was conducted. Vegetation comprised mainly of trees (5-10 m high) which were only absent on parts of granite exposures, hills, salt lakes and sandplains in the northern half of the study area. Mallees (2-4 m high) and hummock grasslands occur on sandplains and sandy situations on other landforms. Hills and aprons of granite exposures, support tall shrubs (1.5-2.5 m high) and few low trees. Low shrubs (0.5 m high) without trees cover extensive areas only on salt lakes. Although vegetation is generally low on the isolated rocky landforms and salty depressions in the Study Area, it is not necessarily more open here than elsewhere. The density of the tree cover is slightly greater in the south than in the north. In the southern parts, some trees exceed 10 m in height and the main species are *Eucalyptus salmonophloia, E. lesouefii* and *E. oleosa*. This changes with a slightly drier climate and the occurrence of a hard pan to low trees, including patches of mallees, of *Casuarina cristata* (no longer listed on Florabase, 2011)*, Eucalyptus* spp. and *Acacia aneura.*

In the northeast of the study area only low trees of *Acacia aneura* remain. Soils containing lime near the surface have an understorey of *Maireana sedifolia,* especially in the north. In salty depressions succulent low shrubs of *Atriplex* occur, lightly wooded with low trees of *Casuarina cristata* in the south, grading to *Acacia aneura* in the north. Complex patches and mixtures of low shrubs, perennial grasses and other herbaceous plants occur in seasonally moist situations on breakaways, granite exposures, and the sandy banks associated with salt lakes. Ephemeral plants (mainly Asteraceae in winter and Poaceae in summer) are thinly sprinkled over all landforms in the south of the study area and form tall, dense carpets in the north, given adequate rains (Keighery, Milewski & Hnatiuk, 1992).

The Kurnalpi survey area is located within the eastern region of the Kurnalpi-Kalgoorlie study area.

1.3 Survey Objectives

The objectives of the survey undertaken were to:

- Compile a broad scale vegetation community flora map and species list of the survey area (Appendix 2);
- Document and map locations of any Declared Rare or Priority listed flora species located;
- Assess the regional and local conservation status of plant species and ecological communities within the survey area;
- Identify and map occurrences of any “Declared and Environmental” weeds within the survey area; and
- Provide plot based data as per Guidance Statement 51 (Environmental Protection Authority, EPA, 2004).

2 Regional Biophysical Environment

2.1 Regional Environment

The Kurnalpi survey area lies within the Murchison Region of the Eremaean Province of WA in a region known as the Austin Botanical District. The area consists of predominantly mulga low woodland on plains and reduces to scrub on hills (Beard, 1990). The Murchison Region is further divided into subregions, based on the Interim Biogeographic Regionalisation of Australia (IBRA), with the Kurnalpi survey area located within the Eastern Murchison (MUR1) subregion (Cowan , 2001) (Figure 3).

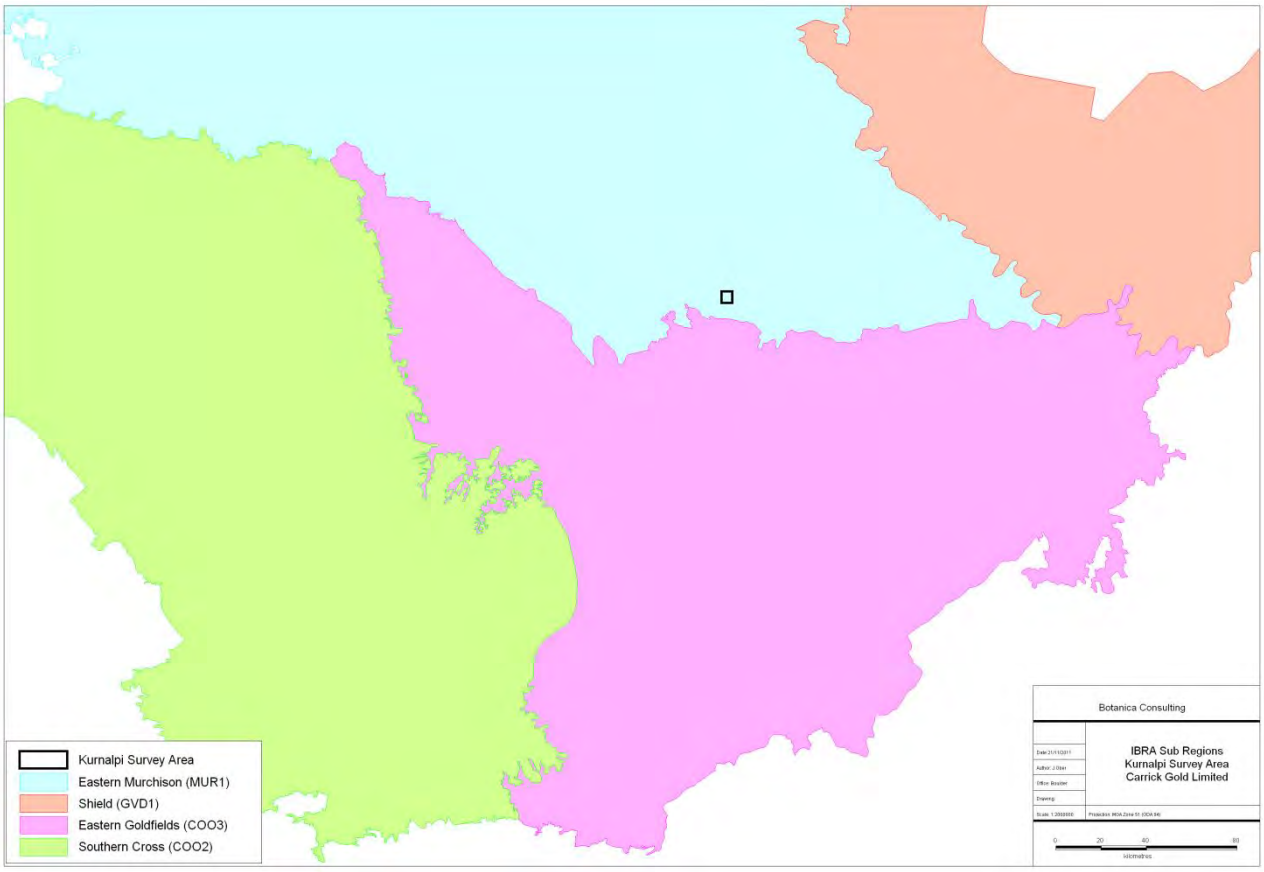


Figure 3: Location map of the IBRA subregions surrounding the Kurnalpi survey area (IBRA, 2011)

2.2 Topography & Soils

The East Murchison subregion lies on the northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. This subregion is characterised by its internal drainage and extensive area of elevated red desert sandplains (Cowan, 2001). Calcrete aquifers located in the northern part of the subregion are known to support a wide range of subterranean fauna. Another important feature of the system is the salt lake systems associated with the occluded Paleodrainage system. Beard (1990) describes the topography of the region as undulating with occasional ranges of low hills and extensive sandplains located in the East. The dominant soil type is a shallow earthy loam, overlying red-brown hardpan. Red earthy sands can be found on the sandplains.

2.3 Climate

The climate of the East Murchison subregion is characterised as an arid climate with mainly winter rainfall and annual rainfall of approximately 200mm (Beard, 1990; Cowan, 2001). Rainfall data for the Kalgoorlie-Boulder weather station (#012038) located approximately 73km west of the survey area is shown in Figure 4 (Bureau of Meteorology, BOM, 2011). Previous year's data has been provided to show the variability of the climate compared to the mean.

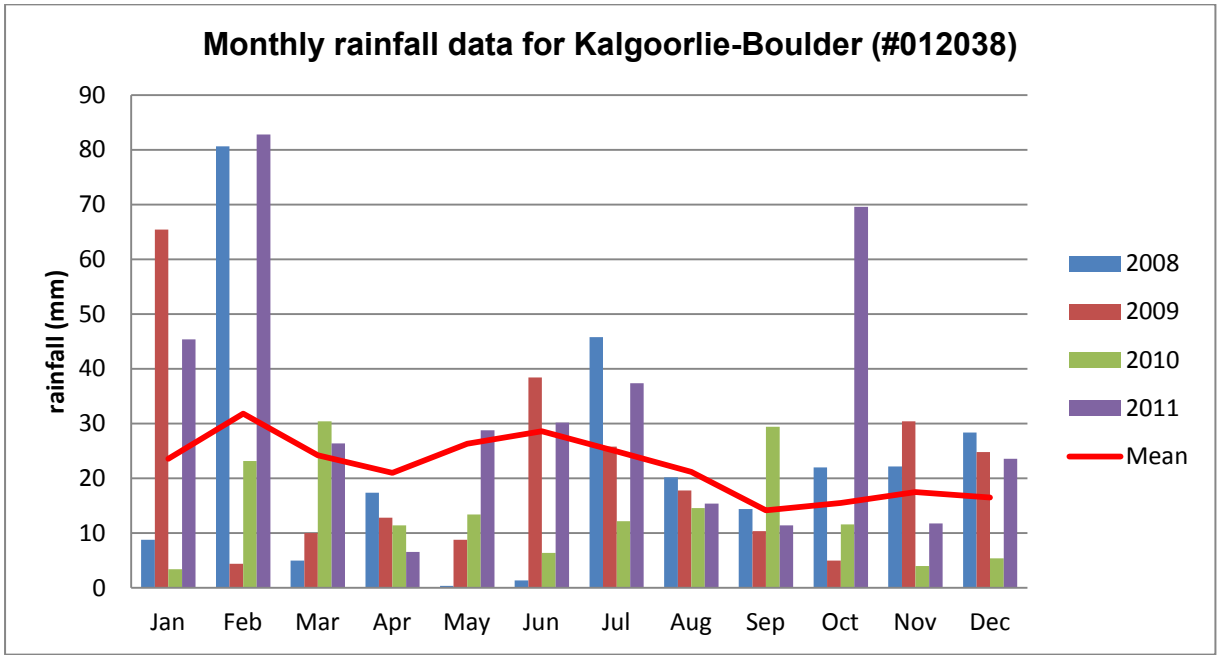


Figure 4: Mean monthly rainfall for the Kalgoorlie-Boulder Airport weather station (#12038) from January 2008 to December 2011 (BOM, 2011)

2.4 Vegetation

Vegetation of the East Murchison subregion in the Austin Botanical District is predominantly Mulga low woodlands on plains, often rich in ephemerals, which reduce to scrub on hills. It is also characterised by hummock grasslands, Saltbush shrublands and Tecticornia shrublands (Beard, 1990: Cowan, 2001).

The Department of Agriculture and Food WA (DAFWA) GIS file (DAFWA, 2007) indicates that the survey area is within Pre-European Beard vegetation association 20 of the Barlee System within the East Murchison subregion. The extent of this association as described by DAFWA, 2007 is shown in Table 2.

Table 2: Remaining Beard Vegetation Associations within Western Australia (DAFWA, 2007).

Veg association	Pre-European Extent (ha)	Current Extent (ha)	Current extent remaining (%)	% of Current extent within DEC managed lands	Vegetation Description (Beard, 1990)
Barlee 20	1,172,537.74	1,172,537.74	100	15	Low woodland; mulga mixed with *Allocasuarina cristata* & *Eucalyptus* spp.

Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered “endangered”. This vegetation association is not below the 30% threshold and activities within the Kurnalpi survey area will not significantly reduce the extent of this association.

2.5 Land Use

Based on the findings from its 2002 biodiversity audit, Cowan identified the dominant land uses of the MUR1 IBRA subregion as Grazing native pastures (85.47%), unallocated crown reserves (11.34%), conservation (1.4%) and mining (1.79%) (Cowan, 2001).

3 Survey Methodology

3.1 Desktop Assessment

Prior to the field survey, a combined search of the DEC’s Declared Rare and Priority Flora databases (DEC, 2011a) was undertaken and the results are provided in Appendix 4. These significant flora species were examined on the Western Australian Herbarium’s (WAHERB) web page prior to the survey to familiarise staff with their appearance.

Locations of DRF and Priority Flora species were overlaid on aerial photography of the area (Appendix 2). Vegetation descriptions and available images of the Priority Flora were also obtained from Florabase. Priority Flora and their respective vegetation types were targeted and all occurrences were traversed on foot specifically looking for the threatened flora associated with that vegetation description.

DRF species are gazetted under subsection 2 of Section 23F of the *Western Australian Wildlife Conservation Act* (1950) and as such it is an offence to damage or remove DRF. The Priority Flora list does not have the same legal status as the DRF Schedule, however Priority Flora are considered under the *Environmental Protection Act 1986* as enforced by the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*, when determining the biodiversity value of an area (DoIR, 2006). Table 3 lists the definitions of Declared Rare and Priority Flora ratings under the *Wildlife Conservation Act (1950)* as extracted from Florabase (WAHERB, 2011).

Table 3: **Definitions of Rare and Priority Flora Species (WAHERB, 2011)**

T: Declared Rare Flora – Extant Taxa Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X: Declared Rare flora – Presumed Extinct Taxa Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
1: Priority One – Poorly known Taxa Taxa that are known from one or a few collections or sight records (generally <five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes
2: Priority Two – Poorly Known Taxa Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes
3: Priority Three – Poorly known Taxa Taxa which are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities 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 localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4: Priority Four – Rare, near threatened or other species in need of monitoring 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. Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5: Priority Five – Conservation Dependant Species Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years

3.2 Sampling and Methodology

BC was commissioned by Carrick to conduct a Level 2 quadrat based flora and vegetation survey of 1,500ha for the Kurnalpi project. The fieldwork was completed from the 28th to 29th November 2011. A total of twenty-two quadrats were established within the survey area. The objective of the survey was to document all observed "Declared Rare and Priority Flora" species encountered and the occurrences of any "Environmental or Declared Weeds" observed within or adjacent to the survey area. The survey area was accessed by 4WD and traversed by two people on foot. Figure 5 provides a map of the areas traversed throughout the survey.

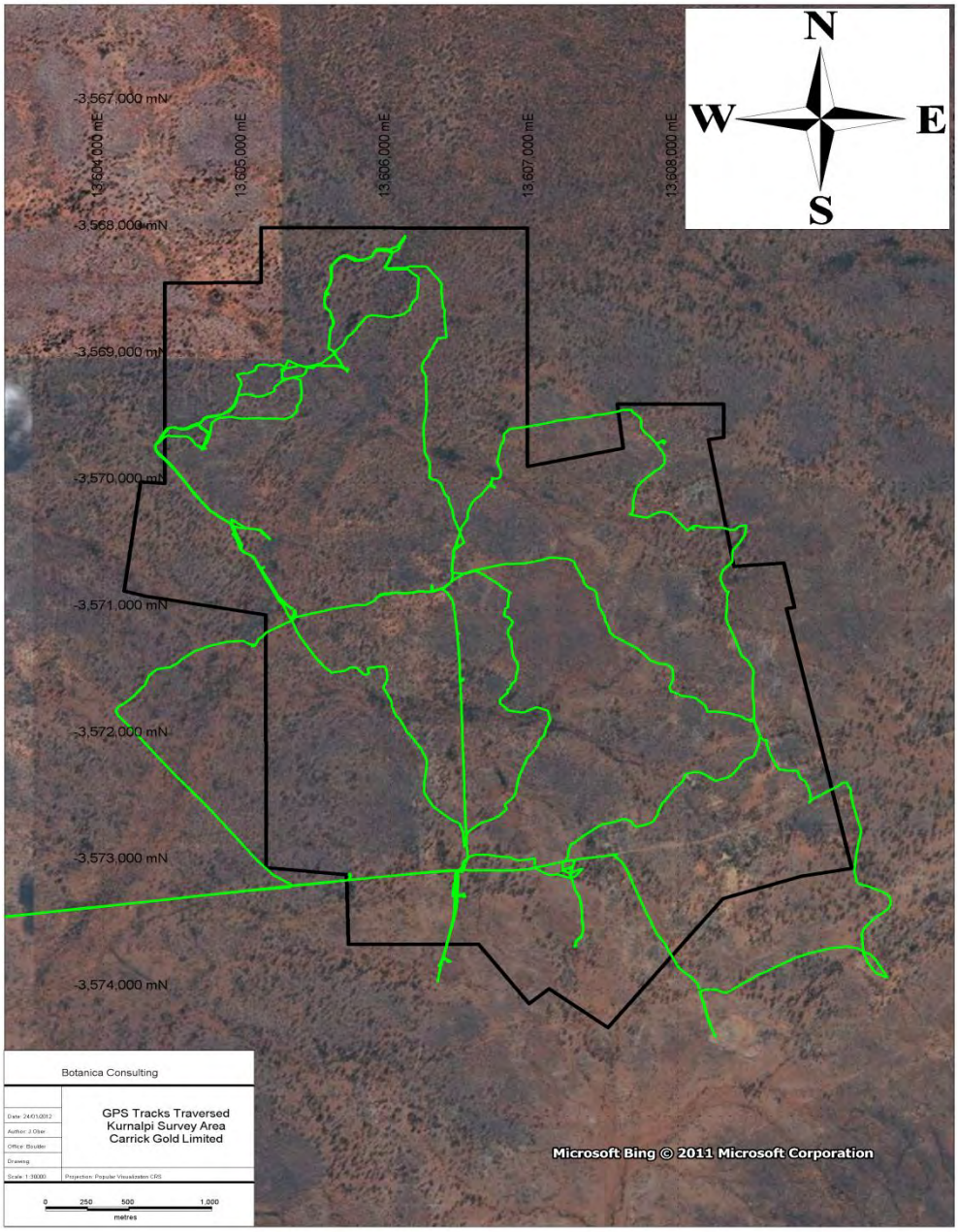


Figure 5: Map of the areas traversed throughout the survey

Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the co-ordinates of the boundaries between existing vegetation communities.

At each sample point, the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant species;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of Threatened Flora if encountered.

Unknown specimens collected during the survey were identified with the aid of samples housed at the BC Herbarium and the Western Australian Herbarium. Presence/absence data of species from sample sites of similar vegetation was then compiled forming the six best representative vegetation communities. Similar vegetation communities were recognised visually in the field.

3.2.1 20m X 20m Quadrats

Twenty-two 20m x 20m quadrats were established within the survey area, the objective being to have at least three quadrats per vegetation community to capture the floristic variations within the survey area. Where a vegetation community was insufficiently large to accommodate three quadrats, the maximum number of quadrats that would fit within that specific community was established.

The quadrats were established by inserting metal pickets in each corner, and measuring the length of the resultant boundaries to verify the quadrats were 20m square. Following their establishment and boundary verification, the location of each quadrat was recorded by GPS, photographed and all vascular plants within the quadrat were recorded. This included recording of dominant taxa from the upper, middle and lower stratum, and sampling of all unknown taxa. Unknown taxa were identified using BC's own reference herbarium and relevant taxonomical keys. Data on topographical position, percentage litter, percentage bare ground, percentage surface rock (bedrock and surface deposits), and vegetation structure were collected from each quadrat.

3.2.2 Personnel involved

Jim Williams - Environmental Consultant/Botanist (Diploma of Horticulture);
Samantha Stapleton - Environmental Consultant (BSc Hons)

3.2.3 Scientific licences

Table 4: Scientific Licences of Botanica Staff coordinating the survey

Licensed staff	Permit Number	Valid Until
Jim Williams	SL009438	3-4-2012

3.3 Data Analysis Tools

Once the survey was completed the data obtained was analysed to generate a vegetation map (Appendix 2). The statistical program PATN was used to complete a PATN analysis on the data obtained from the quadrats.

3.4 PATN Analysis

PATN is a software package that aims to display patterns in complex data. Complex in PATN's terms, means that further information is required for at least 6 objects (i.e. different species) with a suite of more than 4 variables (i.e. different quadrats) that describe the objects. This is achieved by grouping quadrats based on similarities in the flora species that are present or absent in each quadrat. This produces a quantitative estimate of the relationship between species composition of each quadrat.

Data must be in the form of a Microsoft Excel™ spreadsheet of rows (analysis data/species) and columns (variables/quadrats). The classifications are based upon a Bray-Curtis association matrix using a flexible UPGMA which standardses the data enabling the analysis to be completed. Once the program has completed the analysis it produces a dendrogram (see Figure 6) which represents the groupings of the different quadrats into vegetation communities based on how similar their species composition are. Separate vegetation communities are distinguished by different colours in the dendrogram (i.e. orange and blue). The values along the horizontal axis represent the level of similarity between quadrats ranging from low to high (i.e. low value means high similarity). For example in Figure 6 Quadrats 1 and 5 are most similar as the lines end at value 0.4167.

The dotted line running vertically down the dendrogram represents the point at which quadrats are divided into vegetation communities based on the number of species in common between quadrats.

The analysis also produces a stress value which is a measure of the ‘strength’ of the analysis (i.e. how well the quadrats are grouped together into the appropriate vegetation communities). The lower the stress value the greater the strength of the analysis with a value of less than 0.3 showing that the analysis grouped quadrats accordingly. A stress value greater than 0.3 suggests that the analysis was unable to group quadrats appropriately due to extraneous variables (i.e. other factors influencing differences in vegetation communities other than species composition e.g. fire, clearing disturbance etc.).

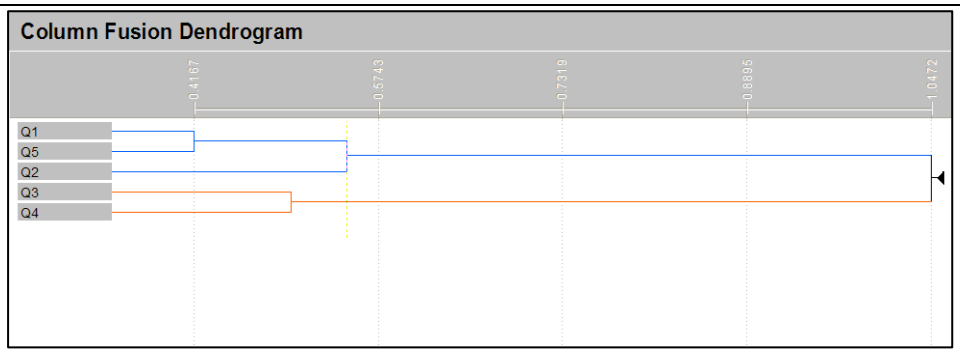


Figure 6: Example of a dendrogram produced from PATN analysis.

The PATN analysis was conducted on all perennial species present in each quadrat using a Flexible UPGMA and a beta value of -0.1. Species reconciliation eliminated those sterile species that could not be fully identified from the analysis.

3.5 Flora survey limitations and constraints

It is important to note that flora surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 5.

Table 5: Limitations and constraints associated with the flora and vegetation survey.

Variable	Impact on Survey outcomes
Access problems	The survey area was accessed by 4WD all terrain vehicle and traversed on foot. BC staff where able access the majority of the areas via existing access tracks and the less dense areas between the vegetation.
Experience levels	The BC personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Botanist:** Jim Williams **Field Staff:** Jim Williams & Samantha Stapleton **Data Interpretation:** Jim Williams, Andrea Williams, Lauren Pick and Samantha Stapleton
Timing of survey, weather & season	Fieldwork was completed during the EPA's recommended time periods (i.e., Spring) for detecting most ephemeral flora and when the majority of species are in flower. In accordance with EPA guidance statement 51 quadrats will be re-surveyed in Autumn 2012. As a result of exceptionally high rainfall preceding the survey (Figure 5) many species were in flower and there were several annual species present.
Sources of information	Information on the area was limited with BC only able to access results of one flora and vegetation survey conducted in the East Murchison subregion.
Mapping reliability	BC were unable to obtain high resolution ortho aerial images instead using Microsoft Bing aerials.
Area disturbance	The survey area has been subject to disturbances from historical exploration and mining.
Survey Intensity	Survey intensity was high with a Level 2 quadrat based survey conducted in Spring. Prior to the quadrats being established a reconnaissance of the survey area was conducted in order to identify vegetation communities and any Priority Flora species. Any DEC listed threatened flora locations near the survey area were also visited in order to confirm their presence.
Resources	Database searches for threatened flora, threatened and priority ecological communities were obtained by the DEC.
Completeness	In the opinion of BC the survey area was covered sufficiently in order to identify vegetation assemblages. Many of the plants during the spring survey were in flower due to the high rainfall received in the area and as a result majority of the flora species including annual species could be fully identified. It is estimated that approximately 95% of the flora within the survey area were able to be fully identified.

	The vegetation communities for this study were based on visual descriptions of locations in the field. The distribution of these vegetation communities outside the study area is not known, however vegetation communities identified were categorised via comparison to vegetation distributions throughout WA given on Australian Natural Resources Atlas (ANRA, 2011).
Data Analysis	BC staff conducting the PATN analyses are not statistical analysts and have basic statistics training. These analyses are able to provide basic information on the relationships between vegetation communities. More detailed assessment of vegetation community relationships will require further studies by an independent statistical analyst with expertise in that field.

4 Results

4.1 Summary

Six broad vegetation communities were identified within the survey area: Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode; Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea;* Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*. These vegetation communities were represented by a total of 25 Families, 57 Genera and 103 Species (including sub-species and variants).

Majority of the allocations of quadrats into different vegetation communities in the field (based on visual comparisons of dominant taxa in each stratum) particularly of *Eucalyptus* vegetation communities were supported by the PATN analysis. There was however a high degree of intermixing between the *Acacia* vegetation communities suggesting that species composition throughout the *Acacia* woodlands is homogenous.

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within the survey area. This specimen has been provided to a taxonomic consultant for further identification.

None of the six vegetation communities have National Environmental Significance as defined by the *EPBC Act 1999*. There are no TEC's as defined by the Commonwealth legislation or listed by the DEC recorded within the survey area (DEC, 2011c; DSEWPaC, 2011). There are also no PEC's as listed by the DEC within the survey area (DEC, 2011c). Any clearing within the survey area will not lower the Pre-European vegetation extent below the 30% threshold. The survey area is not located within any DEC managed land.

Based on Keighery's 1994 vegetation health rating scale, one of the six vegetation communities was given a 'very good' health rating; Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*. A "very good" health condition is defined as vegetation that has been altered due to obvious signs of disturbance. Five of the vegetation communities were rated as having a 'good' health condition: Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode; Open low woodland of *Acacia aneura* over *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*; and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*. A 'good' health condition is defined as the vegetation structure is affected by multiple disturbances but retains its basic structure and has the ability to regenerate.

Five introduced species were identified within the survey area; *Agave americana, Carrichtera annua, Centaurea melitensis, Malva parviflora* and *Salvia verbenaca*. According to the DAFWA, none of these species are listed as a Declared Plant (DAFWA, 2011).

4.2 Desktop Assessment

The results of a combined search of the DEC's Declared Rare and Priority Flora databases (DEC, 2011a) revealed 12 Priority Flora species within a 40km radius of the Kurnalpi survey area (Appendix 4). Table 6 lists the Priority Flora species present within a 40km radius of the Kurnalpi survey area, which have the potential to occur in the area, based on similar habitat requirements.

Table 6: **Priority Flora with the potential to occur within the survey area (WAHERB, 2011)**

Species	Conservation Code	Description (WAHERB, 2011)
Dicrastylis cundeeleensis	P4	Woolly shrub, 0.2-0.5 m high. Yellow sand, red or reddish-yellow sand. Sandplains.
Eremophila praecox	P1	Broom-like shrub, 1.5-3 m high. Fl. purple, Oct or Dec. Red/brown sandy loam. Undulating plains.
Eucalyptus kruseana	P4	Straggly mallee, 2-3.5 m high, bark smooth. Fl. yellow, Jun to Sep. Sandy loam. Granite outcrops & hills.
Eucalyptus x brachyphylla	P4	Mallee or tree, to 4 m high, bark rough, flaky. Fl. white, Jun. Sandy loam. Granite outcrops.
Grevillea phillipsiana	P1	Prickly shrub, 0.8-1.5 m high. Fl. red/red & orange, Jul to Sep. Red sand, stony loam. Granite hills.
Jacksonia lanicarpa	P1	Shrub, to 2 m high. Fl. orange, Nov. Red sand.
Micromyrtus serrulata	P3	Erect or somewhat spreading shrub, 0.4-1.5 m high. Fl. white, Jun to Nov. Brownish sandy and clayey soils over granite.

Species	Conservation Code	Description (WAHERB, 2011)
Ptilotus rigidus	P1	No Description available from WAHERB
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2	No Description available from WAHERB
Tecticornia flabelliformis	P1	Erect shrub, to 0.2 m high. Clay. Saline flats.
Thryptomene eremaea	P2	Erect open shrub, 0.5-1.5 m high. Fl. pink/white, Jul to Sep. Red or yellow sand. Sandplains.
Trachymene pyrophila	P2	Annual, herb, 0.1-0.5 m high, indumentum of patent glandular hairs. Fl. white, Nov to Dec or Jan to Mar. Yellow or orange sand. Sandplains; germinating after fire or other disturbances such as mining.

4.3 Flora of Conservation Significance

No DRF pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were found in the area surveyed. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within the survey area. This specimen has been provided to a taxonomic consultant for further identification. There were no DEC listed locations of DRF species or Priority Flora species within the Kurnalpi survey area. The nearest DEC listed location of a Priority Flora species occurs approximately 10 km south of the Kurnalpi survey area.

4.3.1 *Austrostipa ?blackii* (P3)

This species is described as a tufted perennial, grass-like or herb to 1 m high and flowering in September to November. This is not a known DEC population. A sample collected, which is possibly this species, was recorded in the Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia* vegetation community at GPS location 51J 427442 6623543 (GDA94). This species is not listed by the DEC as occurring within a 40km radius of the survey area.



Plate 1: Image of *Austrostipa ?blackii* (P3)

4.4 Vegetation Communities

Six broad vegetation communities were identified within the survey area. These included*:*

1. Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*;
2. Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub;;
3. Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode;
4. Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea;*
5. Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and
6. Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*.

These six vegetation communities were represented by a total of 25 Families, 57 Genera and 103 Species (including sub-species and variants). No DRF were identified within the survey area. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within the survey area. This specimen has been provided to a taxonomic consultant for further identification.

Table 7: Summary of vegetation communities and their areas

Vegetation Community	Area (ha)
Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	199
Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub	377.5
Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	57
Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	143.5
Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	290
Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	433
Total Area (ha)	**1500**

4.5 Low woodland of *Acacia aneura* over dwarf scrub of *Ptilotus obovatus*

4.5.1 Flora

The total flora recorded within this vegetation community was represented by a total of 16 Families, 23 Genera and 36 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. No Priority Flora species were identified within this vegetation community during the survey. Only one introduced species, *Salvia verbenaca*, was recorded in this vegetation community. This species is not classified as a Declared Plant by the DAFWA (2011).

4.5.2 Vegetation

The flora recorded within this vegetation community was representative of Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus* (Plate 2). The species in the upper storey included *Acacia aneura, Eremophila longifolia* and *Amyema maidenii*.

The mid-storey species included *Eremophila clarkei, Acacia tetragonophylla* and *Senna artemisioides* subsp. *filifolia.* The understorey species included *Ptilotus obovatus, Abutilon cryptopetalum, Solanum lasiophyllum, Goodenia mimuloides, Ptilotus gaudichaudii, Enchylaena tomentose, Maireana triptera, Maireana sedifolia* and *Euphorbia drummondii.* Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 8. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 8: Vegetation assemblage for Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus* within the survey area (Muir, 1977).

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	*Acacia aneura*
Shrub 1-1.5m	10-30%	*Eremophila clarkei*
Shrub 0.25-0.5m	10-30%	*Ptilotus obovatus*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the *Acacia* forests and woodlands vegetation community which, according to the Australian Natural Resources Atlas (ANRA), covers 15.9% of WA (ANRA, 2011).



Plate 2: Low woodland of *Acacia aneura* over dwarf scrub of *Ptilotus obovatus* within the survey area

4.6 Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub

4.6.1 Flora

The total flora recorded within this vegetation community was represented by a total of 12 Families, 16 Genera and 24 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. No Priority Flora species were identified within this vegetation community during the survey. No introduced species were recorded in this vegetation community.

4.6.2 Vegetation

The flora recorded within this vegetation community was representative of Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub (Plate 3). The species in the upper storey included *Eucalyptus oleosa, Eucalyptus salmonophloia, Eucalyptus salubris* and *Acacia aneura*. The mid-storey species included *Eremophila scoparia* and *Alectryon oleifolius*. The understorey species included *Atriplex vesicaria, Frankenia setosa, Olearia muelleri, Maireana triptera, Maireana pentatropis, Eriochiton sclerolaenoides, Austrostipa nitida* and *Maireana sedifolia*. Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 9. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 9: Vegetation assemblage for Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub within the survey area (Muir, 1977).

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	*Eucalyptus salmonophloia* *Eucalyptus salubris*
Mallee Tree Form	10-30%	*Eucalyptus oleosa*
Tree 2m	10-30%	*Eremophila scoparia*
Shrub 0.25-0.5m	30-70%	*Atriplex vesicaria* *Frankenia setosa*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the *Eucalyptus* woodlands vegetation community which, according to the ANRA, covers 3.5% of WA (ANRA, 2011).



Plate 3: Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub within the survey area

4.7 Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode

4.7.1 Flora

The total flora recorded within this vegetation community was represented by a total of 17 Families, 24 Genera and 41 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. No Priority Flora species were identified within this vegetation community during the survey. No introduced species were recorded in this vegetation community.

4.7.2 Vegetation

The flora recorded within this vegetation community was representative of Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode (Plate 4). The species in the upper storey included *Eucalyptus oleosa*, *Casuarina pauper*, *Acacia aneura* and *Grevillea nematophylla*. The mid-storey species included *Acacia* sp. narrow phyllode*, Acacia hemiteles, Exocarpos aphyllus, Eremophila alternifolia, Acacia tetragonophylla, Santalum spicatum, Atriplex nummularia, Eremophila scoparia* and *Alectryon oleifolius*.

The understorey species included *Senna artemisioides* subsp. *filifolia, Eremophila clarkei, Maireana sedifolia, Maireana triptera, Ptilotus obovatus, Eremophila glabra, Ptilotus exaltatus, Triodia scariosa, Eremophila parvifolia, Acacia colletioides, Solanum plicatile* and *Austrostipa nitida*. Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 10. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 10: Vegetation assemblage for Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode within the survey area (Muir, 1977).

Life Form/Height Class	Canopy Cover	Dominant species present
Mallee Tree Form	20-30%	*Eucalyptus oleosa*
Tree <5m	2-10%	*Acacia aneura* *Casuarina pauper*
Shrub >2m	10-30%	*Acacia* sp. narrow phyllode
Shrub 0.5-1m	30-70%	*Senna artemisioides* subsp. *filifolia* *Eremophila clarkei*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the Mallee woodlands and shrublands vegetation community which, according to the ANRA, covers 2% of WA (ANRA, 2011).



Plate 4: Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode within the survey area

4.8 Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/ *Acacia quadrimarginea*

4.8.1 Flora

The total flora recorded within this vegetation community was represented by a total of 17 Families, 27 Genera and 39 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. No Priority Flora species were identified within this vegetation community during the survey. No introduced species were recorded in this vegetation community.

4.8.2 Vegetation

The flora recorded within this vegetation community was representative of Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea* (Plate 5). The species in the upper storey included *Acacia quadrimarginea*, *Acacia aneura*, *Acacia* sp. narrow phyllode, *Casuarina pauper* and *Brachychiton gregorii*. The mid-storey species included *Senna artemisioides* subsp. x *artemisioides, Eremophila clarkei*, *Scaevola spinescens, Acacia tetragonophylla* and *Dodonaea lobulata.* The understorey species included *Ptilotus obovatus, Maireana sedifolia, Austrostipa nitida, Goodenia pinifolia, Velleia rosea, Ptilotus helipteroides, Podolepis capillaris, Chrysocephalum puteale, Halgania andromedifolia, Cephalipterum drummondii, Sida calyxhymenia, Solanum lasiophyllum, Maireana triptera* and *Aristida holathera*. Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 11. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 11: Vegetation assemblage for Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/ *Acacia quadrimarginea* within the survey area (Muir, 1977).

Life Form/Height Class	Canopy Cover	Dominant species present
Tree <5m	2-10%	*Acacia aneura*
Shrub >2m	10-30%	*Acacia quadrimarginea* *Acacia* sp. narrow phyllode
Shrub 1-1.5m	10-30%	*Senna artemisioides* subsp. x *artemisioides* *Eremophila clarkei*
Shrub 0.25-0.5m	2-10%	*Ptilotus obovatus*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the *Acacia* open woodlands vegetation community which, according to the ANRA, covers 0.1% of WA (ANRA, 2011).



Plate 5: Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea* within the survey area

4.9 Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*

4.10 Flora

The total flora recorded within this vegetation community was represented by a total of 15 Families, 22 Genera and 35 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. No Priority Flora species were identified within this vegetation community during the survey. Only one introduced species, *Carrichtera annua*, was recorded in this vegetation community. This species is not classified as a Declared Plant by the DAFWA (2011).

4.10.1 Vegetation

The flora recorded within this vegetation community was representative of Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia* (Plate 6). The species in the upper storey included *Eucalyptus lesouefii, Eucalyptus salubris, Eucalyptus salmonophloia, Casuarina pauper, Alectryon oleifolius, Grevillea nematophylla, Eremophila oldfieldii subsp. angustifolia, Eucalyptus griffithsii* and *Eucalyptus transcontinentalis*. The mid-storey species included *Eremophila scoparia*, *Senna artemisioides* subsp. *filifolia, Scaevola spinescens, Exocarpos aphyllus, Atriplex nummularia* and *Eremophila pustulata*.

The understorey species *Maireana sedifolia, Olearia muelleri, Maireana pentatropis, Sclerolaena uniflora, Zygophyllum eremaeum, Austrostipa nitida, Eremophila parvifolia, Enchylaena tomentosa, Rhodanthe floribunda, Ptilotus exaltatus, Ptilotus obovatus* and *Leucochrysum fitzgibbonii*. Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 12. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 12: **Vegetation assemblage for Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia* within the survey area (Muir, 1977).**

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	10-30%	*Eucalyptus lesouefii*
Shrub 2m	2-10%	*Eremophila scoparia*
Shrub 0.5-1m	10-30%	*Maireana sedifolia*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the *Eucalyptus* woodlands vegetation community which, according to the ANRA, covers 3.5% of WA (ANRA, 2011).



Plate 6: Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia* within the survey area

4.11 Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*

4.11.1 Flora

The total flora recorded within this vegetation community was represented by a total of 16 Families, 33 Genera and 53 Species (Appendix 3).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC (Atkins, 2010), were identified within the survey area. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within this vegetation community. This specimen has been provided to a taxonomic consultant for further identification. Five weed species, *Agave americana, Centaurea melitensis, Malva parviflora*, *Salvia verbenaca* and *Solanum nigrum* were recorded in this vegetation community. According to the DAFWA none of these species are listed as a Declared Plant (DAFWA, 2011).

4.11.2 Vegetation

The flora recorded within this vegetation community was representative of Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia* (Plate 7). The species in the upper storey included *Eucalyptus salmonophloia*, *Casuarina pauper*, *Eucalyptus salubris, Brachychiton gregorii, Eucalyptus ravida* and *Eucalyptus transcontinentalis*. The mid-storey species included *Eremophila interstans, Acacia* sp. narrow phyllode*, Alectryon oleifolius, Marsdenia australis, Eremophila longifolia* and *Acacia murrayana*. The understorey species included *Maireana sedifolia*, *Atriplex nummularia, Angianthus tomentosus, Senna artemisioides* subsp. x *artemisioides*, *Eremophila decipiens, Acacia hemiteles*, *Sclerolaena diacantha, Sida intricata*, *Ptilotus* exaltatus, *Ptilotus obovatus, Eremophila parvifolia, Rhodanthe floribunda, Cratystylis subspinescens, Enneapogon caerulescens, Salsola tragus, Acacia eremaea, Atriplex acutibractea, Swainsona canescens, Lycium australe* and *Tecticornia disarticulata* . Dominant species from the vegetation assemblage according to Muir (1977) are shown in Table 13. The Muir Life Form and Height Class sheet is located in Appendix 5.

Table 13: Vegetation assemblage for Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia* within the survey area (Muir, 1977).

Life Form/Height Class	Canopy Cover	Dominant species present
Tree 5-15m	2-10%	*Eucalyptus salmonophloia*
Shrub 1-1.5m	2-10%	*Eremophila interstans*
Shrub 0.5-1m	10-30	*Atriplex nummularia* *Maireana sedifolia* *Senna artemisioides* subsp. x *artemisioides*

No broad scale clearing for agricultural purposes has occurred within this vegetation community within the survey area. This vegetation community is best represented by the *Eucalyptus* open woodlands vegetation community which, according to the ANRA, covers 1.3% of WA (ANRA, 2011).



Plate 7: Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia* within the survey area

4.12 Vegetation of Conservation Significance

No vegetation communities within the Kurnalpi survey area were found to have National Environmental Significance as defined by the Commonwealth *EPBC Act 1999*. There were no TECs or PECs listed under Commonwealth legislation or as defined by the DEC found within the survey area (DEC 2011b; DSEWPaC, 2011). The nearest PEC is the Priority 3 '*Mount Belches Acacia quadrimarginea / Ptilotus obovatus banded ironstone community'* which is located approximately 50km south from the Kurnalpi survey area.

The nearest DEC managed land is the Bullock Holes Timber Reserve located approximately 33km south east of the Kurnalpi survey area. Any mining related activities that occur within the survey area should not pose any threat to this timber reserve.

4.13 Vegetation condition

Based on Keighery's 1994 vegetation health rating scale (Appendix 6), one of the six vegetation communities was given a 'very good' health rating; Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*. A "very good" health condition is defined as vegetation that has been altered due to obvious signs of disturbance, in this instance from historic exploration. The five remaining vegetation communities were rated as having a 'good' health condition: Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode; Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*; and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*. A 'good' health condition is defined as the vegetation structure is affected by multiple disturbances, including but retains its basic structure and has the ability to regenerate.

4.14 Introduced Species

Five introduced species were identified within the survey area, *Agave americana, Carrichtera annua, Centaurea melitensis, Salvia verbenaca* and *Solanum nigrum.* According to the DAFWA database, none of these species are listed as a Declared Plant (DAFWA, 2011).

4.14.1 *Agave americana* (Century Plant)

This species is described as a rhizomatous, perennial tree-like monocot that grows up to 6m high. It has fleshy, spine-tipped leaves and it has yellow flowers in January or April (Plate 8). It grows in sand and it is occasionally cultivated around old habitations and along roadsides (WAHERB, 2011). *Agave americana* was only recorded within one vegetation community, Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/*Maireana sedifolia.*



Plate 8: Image of *Agave americana* (Century plant)

4.14.2 *Carrichtera annua* (Ward's Weed)

This species is described as an erect annual herb that grows anywhere from 0.05 to 0.4m high (Plate 9). It has yellow flowers from September to November and its preferred habitat is anywhere in semi-arid regions (WAHERB, 2011). *Carrichtera annua* was recorded within only one vegetation community, Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia.*

.



Plate 9: Image of *Carrichtera annua* (Ward's Weed)

4.14.3 *Centaurea melitensis* (Maltese Cockspur)

This species is described as an erect annual or biennial herb that grows up to heights of 0.2 – 1m. It produces yellow flowers from September to December or from January to March (Plate 10). It prefers to grow along roadsides, cultivated areas or anywhere there has been disturbance (WAHERB, 2011). *Centaurea melitensis* was only recorded within the one vegetation community, Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/Maireana sedifolia*.



Plate 10: Image of *Centaurea melitensis* (Maltese Cockspur)

4.14.4 *Malva parviflora* (Marshmallow)

This species is described as an erect or decumbent, annual or perennial herb, which grows up to heights of 0.05-1.2m. It produces blue-purple/pink/white flowers in March or July to November (Plate 11). It prefers to grow in sandy or clayey soils (WAHERB, 2011). *Malva parviflora* was only recorded within the one vegetation community, Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/*Maireana sedifolia.*



Plate 11: Image of *Malva parviflora* (Marshmallow)

4.14.5 *Salvia verbenaca* (Wild sage)

This species is described as a slightly aromatic annual herb that grows to 0.1-1 m high (Plate 12). It has blue-pink-purple flowers in April or July to October and is often along roadsides (WAHERB, 2011). *Salvia verbenaca* was recorded within two vegetation communities; Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/*Maireana sedifolia*.



Plate 12: Image of *Salvia verbenaca* (Wild Sage)

4.14.6 *Solanum nigrum* (Blackberry nightshade)

This species is described as an erect perennial, herb or shrub which grows between 0.3-1 m high (Plate 13). It produces white flowers from January to December (WAHERB, 2011). .This species was identified within one of the vegetation communities, Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/*Maireana sedifolia*.



Plate 13: Image of *Solanum nigrum* (Blackberry nightshade)

4.15 PATN Analysis on the Kurnalpi survey area Quadrats

This analysis was used to determine the similarities or differences between and within delineated vegetation communities. Figure 7 shows the dendrogram for all perennial species recorded. The quadrats are represented as Q1-Q22. Table 14 lists the vegetation community that each quadrat was located within.

Table 14: The six surveyed vegetation communities with corresponding quadrats.

Vegetation Community	Quadrat
Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	20, 21, 22
Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub	15, 16, 18
Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	8, 9, 14, 17
Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	2, 5, 10, 19
Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	1, 7, 11, 13,
Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	3, 4, 6, 12

All of the Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia* quadrats were consolidated together into an individual group. All of the Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia* quadrats were also consolidated together into an individual group.

Three, Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub quadrats were consolidated together with one of the Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode quadrats (Q14). The composition of understorey species of these quadrats was similar, which may be a result of the close proximity of Q14 to the Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub quadrats, compared to quadrats of the respective vegetation community.

Two Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode quadrats (Q8 and Q9) were consolidated into an intermixed group with all four of the Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea* quadrats (Q2, Q5, Q10 and Q19). This result is not surprising as these vegetation communities both contained an upper stratum of *Acacia aneura* and had a similar composition of understorey species.

The remaining Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode quadrat (Q17) was paired with one of the Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus* quadrat (Q20) sharing four common species.

The remaining two Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus* quadrats (Q21 and Q22) were paired together as an individual group. This appears to be due to the isolation of these quadrats from the other quadrats of this vegetation community, which has resulted in variation of species composition within this vegetation community.

Majority of the allocations of quadrats into different vegetation communities in the field (based on visual comparisons of dominant taxa in each stratum) particularly of Eucalypt vegetation communities were supported by the PATN analysis. There was however a high degree of intermixing between the *Acacia* vegetation communities suggesting that species composition throughout the *Acacia* woodlands is homogenous.

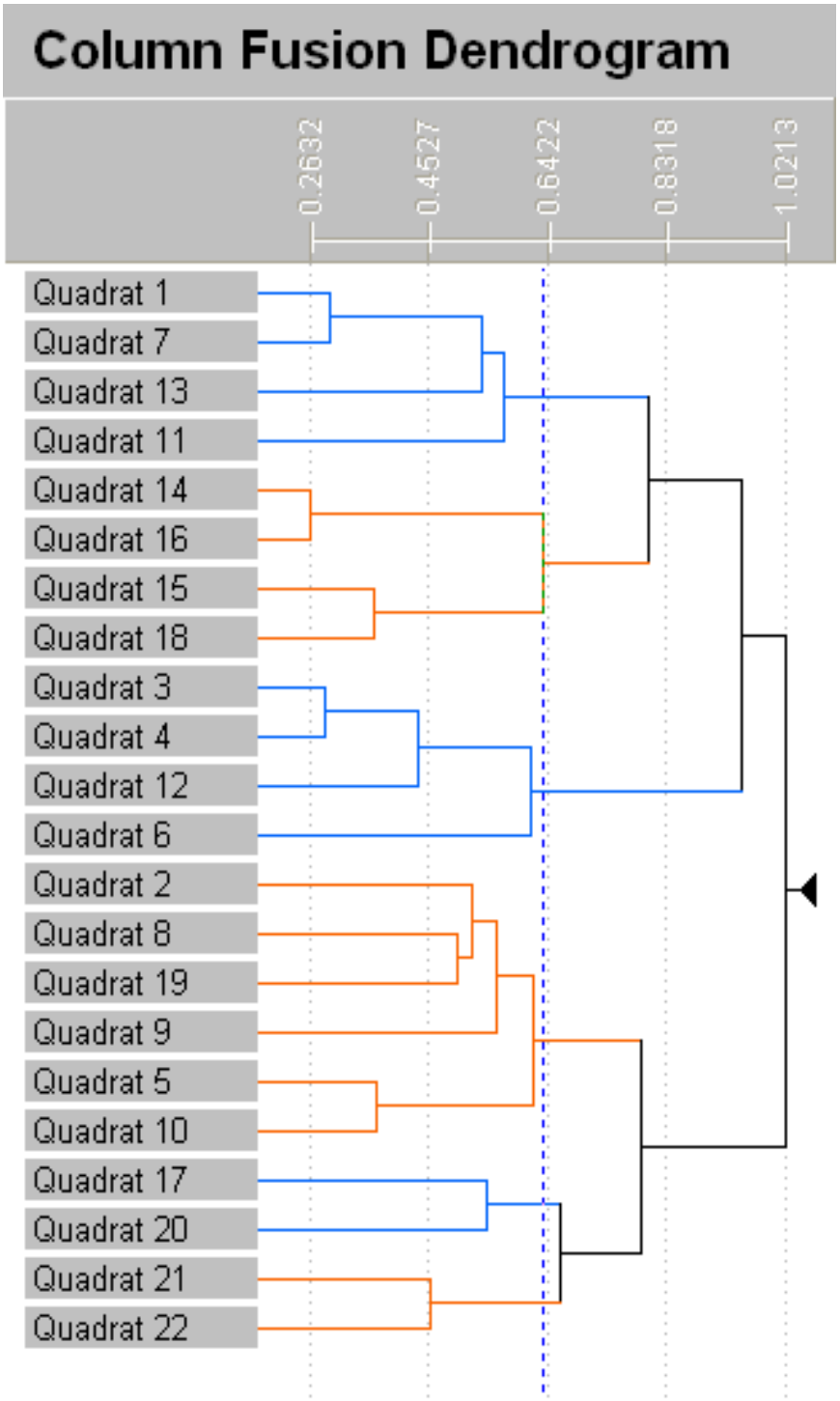


Figure 7: Dendrogram of PATN analysis for all perennial species Spring 2011 (Beta value -0.1)

5 Relevant Legislation and Compliance with Recognised Standards

5.1 Commonwealth Legislation

Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The aim of this Act is to protect matters of national environmental significance and is used by the Commonwealth DSEWPaC to list threatened species and ecological communities into categories based on the criteria set out in the Act (www.environment.gov.au/epbc/index.html). The Act provides a national environmental assessment and approval system for proposed developments and enforces strict penalties for unauthorised actions that may affect matters of national environmental significance.

The survey area does not have national environmental significance under the *EPBC Act 1999.*

5.2 State Legislation

Clearing of Native Vegetation

The *Environmental Protection (Clearing of Native Vegetation) Regulations WA* 2004 establish that any clearing of native vegetation in Western Australia requires a permit from the DEC. Under Section 51A of the WA *Environmental Protection Act*, *1986 (EP Act 1986)* native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent. Section 51A of the EP Act defines clearing as "*the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above*".

Regulation 6 of the 2004 Regulations defines Environmentally Sensitive Areas (ESA) as "*the area covered by vegetation within 50 m of Rare Flora, to the extent to which the vegetation is continuous with the vegetation in which the Rare Flora is located*".

A clearing permit must be granted prior to any clearing within a minimum of 50 m surrounding all populations of Rare Flora. The area covered by a TEC is also considered an ESA wherein clearing cannot occur unless a clearing permit is granted. Exploration activities are exempt from the requirement for clearing permits if undertaken pursuant to a Mining Act approval, for example through a "Programme of Work" provided the area involved does not occur in an ESA.

The survey area is not located within an ESA (as listed by the DEC) and does not contain any DRF.

Environmental Protection Act WA 1986

The *EP Act (1986)* includes requirements relating to the protection of DRF and TEC, and to the assessment of applications for clearing permits. TEC are protected even where exemptions for a clearing permit may apply. The *EP Act (1986)* enforces both financial and/or imprisonment penalties on those who unlawfully damage a TEC.

The survey area does not contain any TEC or DRF listed under the *EPBC Act 1999* or by the DEC.

Wildlife Conservation Act WA 1950

The DEC uses the provisions of this Act to list flora taxa as protected and the level of protection assigned to such flora. Flora species are classified as DRF when their populations are geographically restricted or are threatened by local processes. Under this Act, all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) are protected throughout the State. Financial penalties pursuant to the Act can be imposed if threatened plant species are collected without an appropriate licence.

DEC Priority lists

The DEC lists 'Priority' flora species which are under consideration for declaration as Rare Flora. Species classed as Priority 1-3 are in urgent need of further survey, whereas Priority 4 species are considered to have been adequately surveyed but may become vulnerable or rare in future years. Priority 4 species are also species that have been removed from the threatened species list in the past 5 years. Priority 5 species are those species which are not currently threatened but are likely to become threatened within 5 years if not subject to a specific conservation program. The DEC also lists PEC as a mechanism for identifying communities that may need monitoring before possible nomination for TEC status. These priority species and communities have no formal legal protection until they are endorsed by the Minister as being Declared Rare Flora and TEC respectively.

Results from the DEC database searches identified 12 Priority Flora species recorded within a 40km radius of the survey area. The nearest DEC listed location of a Priority Flora species occurs approximately 10 km south from the Kurnalpi survey area. A specimen that is potentially the Priority Flora species *Austrostipa ?blackii* (P3) was identified within the survey area. This specimen has been sent to a taxonomic consultant for further identification.

The survey area contains no TECs or PECs (DEC 2011a). The nearest PEC is the Priority 3 '*Mount Belches Acacia quadrimarginea / Ptilotus obovatus banded ironstone community'* which is located approximately 50km south from the Kurnalpi survey area.

5.3 EPA Position Statements

The EPA develops Position Statements to inform the public about environmental issues facing Western Australia and the plans for the future to ensure protection and ecological sustainability of environmentally important ecosystems. It provides a set of principles to assist the public and decision-makers on their responsibilities for managing land with care. These principles also provide the basis for the Environmental Protection Authority to evaluate and report upon achieving environmental and ecological sustainability and the protection of natural resources.

Position Statement No. 2 *Environmental Protection of Native Vegetation in Western Australia* (EPA 2000) outlines EPA policy on the protection of native vegetation in Western Australia, particularly in the agricultural area. It identifies basic elements that the EPA should consider when assessing proposals that impact on biological diversity. These include comparison of all proposal options; avoidance of species and community extinctions; an expectation that implementing the proposal will not take a vegetation type below the "threshold level" of 30%; and that proponents should demonstrate that on- and off-site impacts can be managed.

The survey area does not contain any DRF or TEC suggesting that clearing within the survey area will meet the EPA standards outlined in Position statement No. 2. According to DAFWA (2007) the survey area occurs in the pre-European Beard vegetation association Barlee 20, of which 100% of the original vegetation extent remains.

Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection* establishes that the EPA has adopted the definition and principles of biological diversity as defined in the *National Strategy for the Conservation of Australia's Biological Diversity* (Commonwealth of Australia, 1996), and has stipulated the following requirements:

- The quality of information and scope of field surveys should meet standards, requirements and protocols as determined and published by the EPA; and
- The IBRA regionalisations should be used as the largest unit for environmental impact assessment (EIA) decision-making in relation to the conservation of biodiversity.

Pursuant to the IBRA regionalisations, 26 bioregions in WA, which are affected by a range of different threatening processes and have varying levels of sensitivity to impact, have been identified. Terrestrial biological surveys should provide sufficient information to address both biodiversity conservation and ecological functional values within the context of proposals and the results of surveys should be publicly available.

The flora survey of the study area was planned and implemented as far as practicable according to the EPA Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004). Also, the IBRA regionalisations have been used in preparing the report to identify the conservation status of the area and identify the main threats to the biodiversity of plant species in the region.

6 Conclusions and Recommendations

6.1 Conclusions

The Level 2 Flora survey conducted within the Kurnalpi survey area (approximately 1,500ha) identified six broad vegetation communities within the survey area; Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode*;* Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*; Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*. These vegetation communities were represented by a total of 25 Families, 57 Genera and 103 Species (including sub-species and variants).

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC were identified within the survey area. A specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) was identified within this vegetation community. This specimen has been provided to a taxonomic consultant for further identification.

Majority of the allocations of quadrats into different vegetation communities in the field (based on visual comparisons of dominant taxa in each stratum), particularly of Eucalypt vegetation communities were supported by the PATN analysis. There was however a high degree of intermixing between the *Acacia* vegetation communities, suggesting that species composition throughout the *Acacia* woodlands is homogenous.

None of the six vegetation communities have National Environmental Significance as defined by the *EPBC Act 1999*. There are no TEC's as defined by the Commonwealth legislation or listed by the DEC recorded within the survey area. There are also no PEC's as listed by the DEC within the survey area. Any clearing within the survey area will not lower the pre-European vegetation extent below the 30% threshold. The survey area is not based within any DEC managed land.

Based on Keighery's vegetation health rating scale (1994), one of the six vegetation communities was given a health rating of 'very good' and the remaining five vegetation communities given a "good" health rating. Five introduced species were identified within the survey area; *Agave americana, Carrichtera annua, Centaurea melitensis, Malva parviflora* and *Salvia verbenaca.* According to the DAFWA database, none of the species are listed as a Declared Plant.

6.2 Recommendations

- No clearing should take place until the specimen that is potentially a Priority Flora species, *Austrostipa ?blackii* (P3) is formally identified. If this specimen is identified as a Priority Flora species a targeted search for this species in areas proposed to be cleared is required in order to identify and avoid all locations of this plant. If locations of this plant cannot be avoided consultation with the DEC is recommended.
- Prior to any clearing within the area implementation of a weed management plan is recommended to control and prevent further spread of weeds.

6.3 Native Vegetation Clearing Principles

Based on the outcomes from the survey undertaken, as presented in this report, BC provides the following comments regarding the native vegetation clearing principles:

Native vegetation should not be cleared if it comprises a high level of biological diversity.

The East Murchison subregion is rich and diverse in its flora, however most species (excluding Priority Flora species) are wide ranging and usually occur in at least one, and often several, adjoining subregions (Cowan, 2001).

Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.

No DRF species, pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* and as listed by the DEC were identified within the survey area

Native vegetation should not be cleared if it comprises the whole or part of, or is necessary for the maintenance of a threatened ecological community (TEC).

No TEC listed under the *EPBC Act 1999* (DSEWPaC, 2011) or by the DEC (2010b) occur in the survey area.

Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

According to DAFWA (2007) the survey area occurs in the pre-European Beard vegetation association Barlee 20, of which 100% of the original vegetation extent remains.

Native vegetation should not be cleared if it is growing, in, or in association with, an environment associated with a watercourse or wetland

There was no vegetation found to be growing in, or in association with and environment associated with a watercourse or wetland within the survey area.

Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

The survey area is not located within a conservation area. The nearest DEC managed land is the Bullock Holes Timber Reserve located approximately 33km south east of the Kurnalpi survey area. Any mining related activities that occur within the survey area should not pose any threat to this timber reserve.

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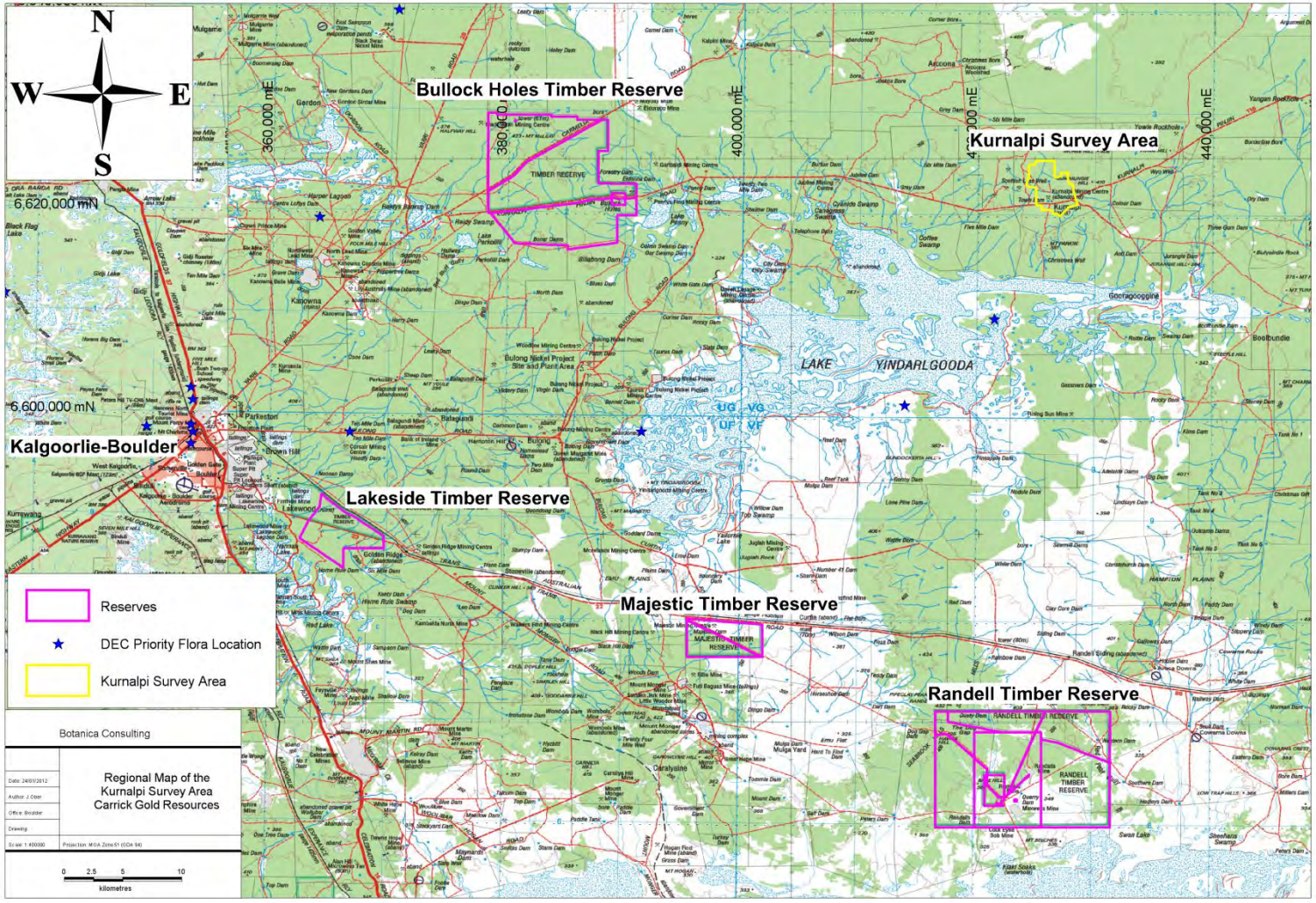
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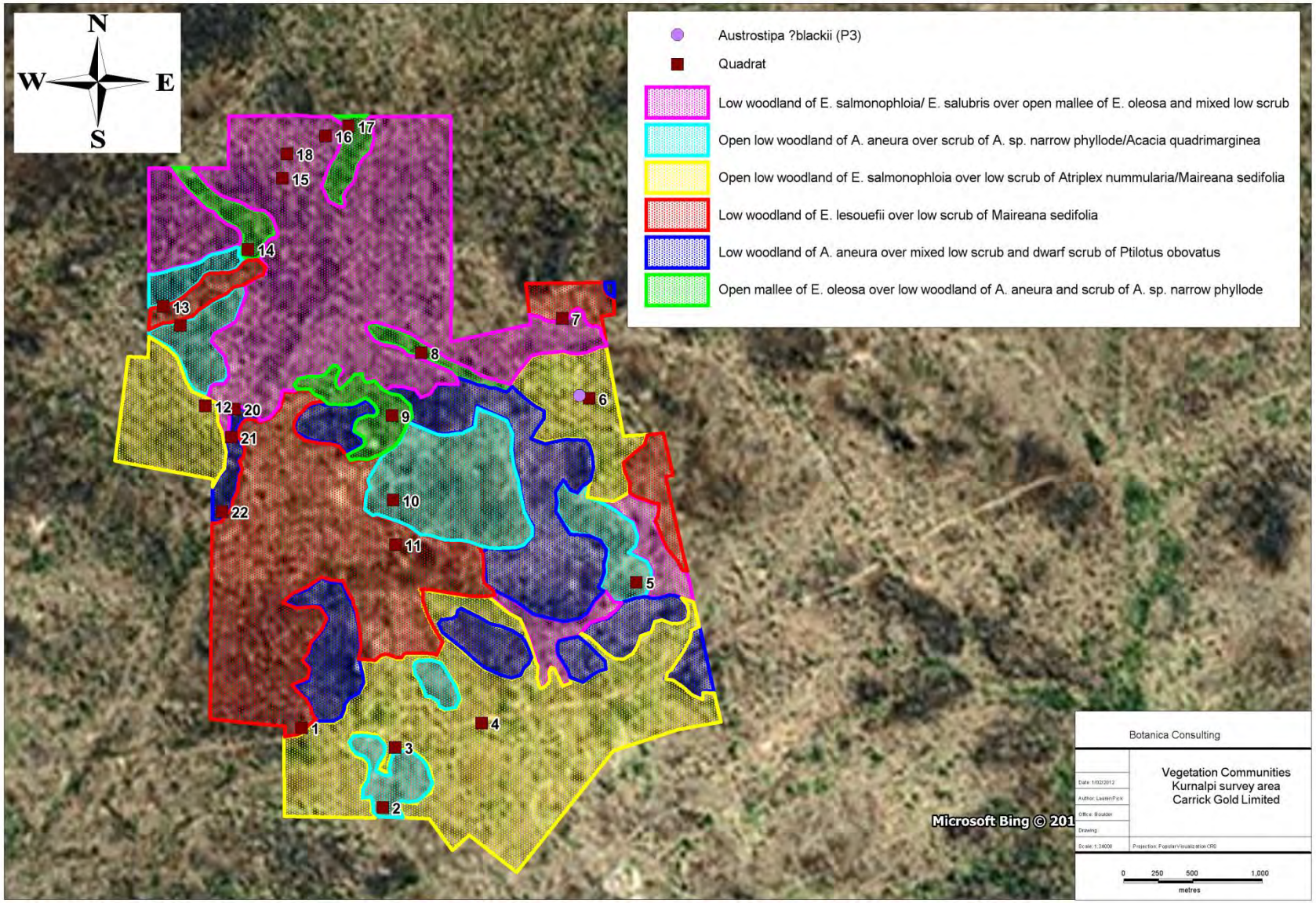
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8 Appendices

Appendix 1: Regional map of the Kurnalpi survey area including areas of conservation significance



Appendix 2: Vegetation Map of the Kurnalpi survey area



Appendix 3: List of all species identified within each vegetation community

(A) Denotes annual species; (W) denotes introduced species (listed as alien on Florabase); (P) denotes Priority Flora species

Family	Genus	Species	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	Low woodland of *E. salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub	Open mallee of *E. oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia*	Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Amaranthaceae	*Ptilotus*	*exaltatus* (A)			*		*	*
Amaranthaceae	*Ptilotus*	*gaudichaudii* (A)	*					
Amaranthaceae	*Ptilotus*	*helipteroides* (A)	*			*		
Amaranthaceae	*Ptilotus*	*holosericeus*		*				*
Amaranthaceae	*Ptilotus*	*obovatus*	*		*	*	*	*
Apocynaceae	*Marsdenia*	*australis*		*	*			*
Asparagaceae	*Agave*	*americana* (W)						*
Asteraceae	*Angianthus*	*tomentosus* (A)						*
Asteraceae	*Centaurea*	*melitensis* (W)						*
Asteraceae	*Cephalipterum*	*drummondii* (A)				*		
Asteraceae	*Chrysocephalum*	*puteale*				*		
Asteraceae	*Cratystylis*	*subspinescens*			*			*
Asteraceae	*Gnephosis*	sp. (sterile)	*					
Asteraceae	*Leucochrysum*	*fitzgibbonii* (A)					*	
Asteraceae	*Olearia*	*muelleri*		*	*	*	*	*
Asteraceae	*Podolepis*	*capillaris* (A)				*		
Asteraceae	*Rhodanthe*	*floribunda* (A)					*	*
Boraginaceae	*Halgania*	*andromedifolia*				*		
Brassicaceae	*Carrichtera*	*annua* (W)					*	
Casuarinaceae	*Casuarina*	*pauper*			*	*	*	*
Chenopodiaceae	*Atriplex*	*acutibractea*						*

Family	Genus	Species	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	Low woodland of *E. salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub	Open mallee of *E. oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia*	Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Chenopodiaceae	*Atriplex*	*codonocarpa* (A)						*
Chenopodiaceae	*Atriplex*	*nummularia*		*	*	*	*	*
Chenopodiaceae	*Atriplex*	*vesicaria*		*		*		*
Chenopodiaceae	*Enchylaena*	*tomentosa*	*				*	
Chenopodiaceae	*Eriochiton*	*sclerolaenoides*		*				
Chenopodiaceae	*Maireana*	*georgei*	*	*		*	*	
Chenopodiaceae	*Maireana*	*oppositifolia*	*					
Chenopodiaceae	*Maireana*	*pentatropis*		*	*		*	
Chenopodiaceae	*Maireana*	*sedifolia*	*	*	*	*	*	*
Chenopodiaceae	*Maireana*	*triptera*	*	*	*	*		*
Chenopodiaceae	*Rhagodia*	*eremaea*				*		*
Chenopodiaceae	*Salsola*	*tragus* (A)			*			*
Chenopodiaceae	*Sclerolaena*	*diacantha*	*					*
Chenopodiaceae	*Sclerolaena*	*uniflora*		*	*		*	
Chenopodiaceae	*Tecticornia*	*disarticulata*						*
Euphorbiaceae	*Euphorbia*	*drummondii*	*					
Fabaceae	*Acacia*	*aneura*	*	*	*	*		
Fabaceae	*Acacia*	*colletioides*			*		*	
Fabaceae	*Acacia*	*eremaea*					*	*
Fabaceae	*Acacia*	*hemiteles*			*			*
Fabaceae	*Acacia*	*murrayana*						*
Fabaceae	*Acacia*	*quadrimarginea*	*		*	*		
Fabaceae	*Acacia*	*ramulosa*				*		
Fabaceae	*Acacia*	sp. narrow phyllode			*	*		*
Fabaceae	*Acacia*	*tetragonophylla*	*		*	*		

Family	Genus	Species	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	Low woodland of *E. salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub	Open mallee of *E. oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia*	Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Fabaceae	*Senna*	*artemisioides* subsp. x *artemisioides*	*		*	*		*
Fabaceae	*Senna*	*artemisioides* subsp. *filifolia*	*	*	*		*	*
Fabaceae	*Swainsona*	*canescens*	*					*
Frankeniaceae	*Frankenia*	*setosa*		*				
Goodeniaceae	*Goodenia*	*mimuloides* (A)	*					
Goodeniaceae	*Goodenia*	*pinifolia* (A)	*			*		
Goodeniaceae	*Scaevola*	*spinescens*	*	*	*	*	*	*
Goodeniaceae	*Velleia*	*rosea* (A)				*		
Haloragaceae	*Haloragis*	*trigonocarpa* (A)	*		*	*		
Lamiaceae	*Prostanthera*	*althoferi*				*		
Lamiaceae	*Salvia*	*verbenaca* (W)	*					*
Lamiaceae	*Westringia*	*rigida*					*	
Loranthaceae	*Amyema*	*preissii*	*					
Malvaceae	*Abutilon*	*cryptopetalum*	*					
Malvaceae	*Brachychiton*	*gregorii*				*		*
Malvaceae	*Malva*	*parviflora* (W)						*
Malvaceae	*Radyera*	*farragei*						*
Malvaceae	*Sida*	*calyxhymenia*	*			*		
Malvaceae	*Sida*	*intricata*	*		*			*
Myrtaceae	*Eucalyptus*	*griffithsii*					*	
Myrtaceae	*Eucalyptus*	*lesouefii*			*		*	
Myrtaceae	*Eucalyptus*	*oleosa*		*	*	*		
Myrtaceae	*Eucalyptus*	*ravida*						*
Myrtaceae	*Eucalyptus*	*salmonophloia*		*		*	*	*
Myrtaceae	*Eucalyptus*	*salubris*		*			*	*

Family	Genus	Species	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	Low woodland of *E. salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub	Open mallee of *E. oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia*	Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Myrtaceae	*Eucalyptus*	*transcontinentalis*					*	*
Nyctaginaceae	*Boerhavia*	*coccinea* (A)	*					
Poaceae	*Aristida*	*contorta* (A)				*		
Poaceae	*Aristida*	*holathera* (A)	*			*		
Poaceae	*Austrostipa*	*elegantissima*		*				
Poaceae	*Austrostipa*	*nitida*	*	*	*	*	*	
Poaceae	*Austrostipa*	*?blackii* (P3)						*
Poaceae	*Enneapogon*	*caerulescens*						*
Poaceae	*Triodia*	*scariosa*			*			
Proteaceae	*Grevillea*	*acuaria*				*		
Proteaceae	*Grevillea*	*nematophylla*			*		*	
Santalaceae	*Exocarpos*	*aphyllus*			*		*	
Santalaceae	*Santalum*	*spicatum*			*		*	
Sapindaceae	*Alectryon*	*oleifolius*		*	*		*	*
Sapindaceae	*Dodonaea*	*lobulata*	*			*		*
Scrophulariaceae	*Eremophila*	*alternifolia*			*			
Scrophulariaceae	*Eremophila*	*clarkei*	*		*	*		
Scrophulariaceae	*Eremophila*	*decipiens*				*		*
Scrophulariaceae	*Eremophila*	*glabra*			*			*
Scrophulariaceae	*Eremophila*	*interstans*					*	*
Scrophulariaceae	*Eremophila*	*ionantha*				*		
Scrophulariaceae	*Eremophila*	*longifolia*	*					*
Scrophulariaceae	*Eremophila*	*oldfieldii* subsp. *angustifolia*	*				*	*
Scrophulariaceae	*Eremophila*	*oldfieldii* subsp. *oldfieldii*					*	
Scrophulariaceae	*Eremophila*	*parvifolia*		*	*		*	*

Family	Genus	Species	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	Low woodland of *E. salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub	Open mallee of *E. oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia*	Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Scrophulariaceae	*Eremophila*	*pustulata*			*		*	
Scrophulariaceae	*Eremophila*	*scoparia*		*	*		*	*
Solanaceae	*Lycium*	*australe*						*
Solanaceae	*Solanum*	*lasiophyllum*	*		*	*		
Solanaceae	*Solanum*	*nigrum* (W)						*
Solanaceae	*Solanum*	*orbiculatum*	*		*			*
Solanaceae	*Solanum*	*plicatile*			*			
Zygophyllaceae	*Zygophyllum*	*eremaeum* (A)	*	*	*	*	*	*

Appendix 4: Results of DEC threatened flora database search within 40km radius of the Kurnalpi survey area (DEC, 2011a)

Species	Conservation Code
Dicrastylis cundeeleensis	P4
Eremophila praecox	P1
Eucalyptus kruseana	P4
Eucalyptus x brachyphylla	P4
Grevillea phillipsiana	P1
Jacksonia lanicarpa	P1
Micromyrtus serrulata	P3
Ptilotus rigidus	P1
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2
Tecticornia flabelliformis	P1
Thryptomene eremaea	P2
Trachymene pyrophila	P2

Appendix 5: Muir Life Form/Height Class (Muir, 1977).

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE 70% -100%	**MID DENSE 30% - 70%**	**SPARSE 10% - 30%**	**VERY SPARSE 2% -10%**
Trees > 30m Trees 15 – 30m Trees 5 – 15m Trees < 5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
Mallee Tree Form Mallee Shrub Form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
Shrubs > 2m Shrubs 1.5 – 2m Shrubs 1 – 1.5m Shrubs 0.5 – 1m Shrubs 0 – 0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
Mat Plants Hummock Grass Bunch grass >0.5m Bunch grass < 0.5m Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-dense Hummock Grass Tall Grass Low Gras Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs
Sedges > 0.5m Sedges < 0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
Ferns Mosses, liverworts	Dense ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses

Appendix 6: Keighery (1994) Health Ratings

Health Rating	Health Description	Definition
6	Pristine	No obvious signs of disturbance
5	Excellent	Vegetation intact despite disturbance affect, weeds are non-aggressive individual species
4	Very Good	Vegetation altered due to obvious signs of disturbance
3	Good	Structure affected multiple disturbances. Retains basic structure, has ability to regenerate
2	Degraded	Structure severely disturbed. Can regeneration to good condition, but requires intensive management
1	Completely Degraded	Completely bare no native species

Appendix 7: GPS locations of all quadrats within the Kurnalpi survey area

way point	Quadrat	Vegetation community	Zone	Easting	Northing
2	1	Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	51 J	425388	6621169
3	2	Open low woodland of *Acacia aneura* over *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	51 J	425975	6620603
4	3	Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	51 J	426062	6621033
5	4	Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	51 J	426683	6621212
9	5	Open low woodland of *Acacia aneura* over *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	51 J	427792	6622229
10	6	Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	51 J	427442	6623543
11	7	Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	51 J	427244	6624116
12	8	Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	51 J	426229	6623862
13	9	Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	51 J	426022	6623411
14	10	Open low woodland of *Acacia aneura* over *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	51 J	426036	6622806
15	11	Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	51 J	426056	6622486
18	12	Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*	51 J	424678	6623470
19	13	Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*	51 J	424368	6624182
20	14	Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	51 J	424978	6624595
21	15	Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub	51 J	425222	6625105
22	16	Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub	51 J	425530	6625411
24	17	Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode	51 J	425695	6625484
25	18	Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub	51 J	425251	6625282
26	19	Open low woodland of *Acacia aneura* over *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*	51 J	424494	6624046
27	20	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	51 J	424886	6623450
28	21	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	51 J	424865	6623248
29	22	Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*	51 J	424803	6622715

Appendix 8: Level 2 quadrat data sheets Spring 2011

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 1
Quadrat size: 20x20	
WP: 2	**Vegetation group:** Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*
Photo number: 4-6	
Landform: L/M/HLS	
Land surface/disturbance: 1	
Coarse fragments on the surface (abundance/size/shape): 5/1/ST	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MC/F	
%Cover leaf litter: 40	
%Cover bare ground: 60	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** N/A	**Growth form:** Shrub
Height: 6-12m	**Height:** N/A	**Height:** 0.5-1m
Crown cover %: <10	**Crown cover %:** N/A	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus lesouefii	N/A	*Maireana sedifolia*

ALL SPECIES
Acacia eremaea
Eremophila parvifolia
Eremophila scoparia
Eucalyptus lesouefii
Maireana sedifolia
Olearia muelleri
Ptilotus exaltatus (A)
Scaevola spinescens
Zygophyllum eremaeum (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 2
Quadrat size: 20x20	
WP: 3	**Vegetation group:** Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*
Photo number: 7-8	
Landform: M/M/HSL	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 4/3/ST	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/ZL/F	
%Cover leaf litter: 5	
%Cover bare ground: 80	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Shrub	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <1m
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia quadrimarginea	*Senna artemisioides* subsp. x *artemisioides*	*Ptilotus obovatus*

ALL SPECIES
Acacia quadrimarginea
Acacia sp. narrow phyllode
Austrostipa nitida
Chrysocephalum puteale
Eremophila clarkei
Halgania andromedifolia
Maireana georgei
Maireana sedifolia
Podolepis capillaris (A)
Prostanthera althoferi
Ptilotus helipteroides (A)
Ptilotus obovatus
Scaevola spinescens
Senna artemisioides subsp. x *artemisioides*
Solanum lasiophyllum
Velleia rosea (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 3
Quadrat size: 20x20	
WP: 4	**Vegetation group:** Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Photo number: 17-19	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MC/F	
%Cover leaf litter: 70	
%Cover bare ground: 75	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** 10-30	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Atriplex nummularia*	*Ptilotus obovatus*

ALL SPECIES
Atriplex nummularia
Atriplex vesicaria
Eremophila decipiens
Eucalyptus salmonophloia
Maireana sedifolia
Ptilotus obovatus
Rhagodia eremaea

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 4
Quadrat size: 20x20	
WP: 5	**Vegetation group:** Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Photo number: 20-22	
Landform: F/B/PLA	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 4/2/A	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MC/F	
%Cover leaf litter: 30	
%Cover bare ground: 45	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Maireana sedifolia*	*Ptilotus obovatus*

ALL SPECIES
Atriplex nummularia
Atriplex vesicaria
Eucalyptus salmonophloia
Maireana sedifolia
Ptilotus obovatus
Salsola tragus (A)
Sclerolaena diacantha
Senna artemisioides subsp. x *artemisioides*
Zygophyllum eremaeum (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 5
Quadrat size: 20x20	
WP: 9	**Vegetation group:** Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*
Photo number: 25-26	
Landform:	
Land surface/disturbance:	
Coarse fragments on the surface (abundance/size/shape):	
Rock outcrop (abundance/runoff):	
Soil (profile/field texture/soil surface):	
%Cover leaf litter:	
%Cover bare ground:	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Shrub	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** 10-30	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia quadrimarginea	*Dodonaea lobulata*	*Ptilotus obovatus*

ALL SPECIES
Acacia aneura
Acacia quadrimarginea
Acacia tetragonophylla
Aristida holathera (A)
Dodonaea lobulata
Eremophila clarkei
Maireana sedifolia
Ptilotus obovatus
Sida calyxhymenia
Solanum lasiophyllum

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 6
Quadrat size: 20x20	
WP: 10	**Vegetation group:** Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*
Photo number: 27-29	
Landform: F/B/PLA	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 0	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 70	
%Cover bare ground: 80	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Senna artemisioides* subsp. *filifolia*	*Maireana sedifolia*

ALL SPECIES
Acacia colletioides
Atriplex vesicaria
Eremophila glabra
Eremophila oldfieldii subsp. *angustifolia*
Eucalyptus salmonophloia
Maireana sedifolia
Olearia muelleri
Ptilotus exaltatus (A)
Ptilotus obovatus
Scaevola spinescens
Senna artemisioides subsp. *filifolia*
Sida intricata
Solanum orbiculatum

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 7
Quadrat size: 20x20	
WP: 11	**Vegetation group:** Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*
Photo number: 32-34	
Landform: L/M/HSL	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 4/3/AT	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/ZL/F	
%Cover leaf litter: 70	
%Cover bare ground: 70	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 6-12m	**Height:** 0.5-1m
Crown cover %:	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus lesouefii	*Acacia quadrimarginea*	*Maireana sedifolia*

ALL SPECIES
Acacia quadrimarginea
Eremophila glabra
Eremophila parvifolia
Eremophila scoparia
Eucalyptus lesouefii
Exocarpos aphyllus
Maireana sedifolia
Olearia muelleri
Ptilotus obovatus
Scaevola spinescens

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 8
Quadrat size: 20x20	
WP: 12	**Vegetation group:** Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode
Photo number: 35-37	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 1/2/ST	
Rock outcrop (abundance/runoff):	
Soil (profile/field texture/soil surface): 0/3	
%Cover leaf litter: 20	
%Cover bare ground: 30	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <1	**Crown cover %:** <1m
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Acacia* sp. narrow phyllode	*Ptilotus obovatus*

ALL SPECIES
Acacia aneura
Acacia sp. narrow phyllode
Acacia tetragonophylla
Atriplex nummularia
Austrostipa nitida
Eremophila clarkei
Eremophila glabra
Eucalyptus oleosa
Maireana sedifolia
Marsdenia australis
Ptilotus obovatus
Sclerolaena uniflora
Solanum lasiophyllum

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 9
Quadrat size: 20x20	
WP: 13	**Vegetation group:** Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode
Photo number: 42-44	
Landform: F/B/PLA	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 4/1/R	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/LMC/R	
%Cover leaf litter: 40	
%Cover bare ground: 50	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree Mallee Form	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <1	**Crown cover %:** 10-30
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Acacia* sp. narrow phyllode	*Senna artemisioides* subsp. x artemisioides

ALL SPECIES
Acacia sp. narrow phyllode
Acacia tetragonophylla
Alectryon oleifolius
Atriplex nummularia
Austrostipa nitida
Casuarina pauper
Cratystylis subspinescens
Eremophila alternifolia
Eremophila clarkei
Eremophila scoparia
Eucalyptus oleosa
Ptilotus exaltatus (A)
Ptilotus obovatus
Salsola tragus (A)
Scaevola spinescens
Senna artemisioides subsp. x *artemisioides*
Sida intricata
Solanum orbiculatum
Zygophyllum eremaeum (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 10
Quadrat size: 20x20	
WP: 14	**Vegetation group:** Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*
Photo number: 45-47	
Landform: M/M/HSL	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 4/3/A	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/LMC/F	
%Cover leaf litter: 5	
%Cover bare ground: 10	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <10	**Crown cover %:** 10-30	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia quadrimarginea	*Senna artemisioides* subsp. *filifolia*	*Ptilotus obovatus*

ALL SPECIES
Acacia aneura
Acacia quadrimarginea
Acacia ramulosa
Acacia tetragonophylla
Dodonaea lobulata
Eremophila clarkei
Haloragis trigonocarpa (A)
Maireana georgei
Ptilotus helipteroides (A)
Ptilotus obovatus
Scaevola spinescens
Senna artemisioides subsp. *filifolia*
Zygophyllum eremaeum (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 11
Quadrat size: 20x20	
WP: 15	**Vegetation group:** Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*
Photo number: 48-50	
Landform: L/M/HSL	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 4/2/R	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/LMC/F	
%Cover leaf litter: 60	
%Cover bare ground: 70	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: 10-30	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus lesouefii	*Eremophila interstans*	*Atriplex nummularia*

ALL SPECIES
Acacia colletioides
Atriplex nummularia
Eremophila interstans
Eremophila parvifolia
Eucalyptus lesouefii
Maireana sedifolia
Olearia muelleri
Scaevola spinescens
Westringia rigida
Zygophyllum eremaeum (A)

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 12
Quadrat size: 20x20	
WP: 18	**Vegetation group:** Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia*/ *Maireana sedifolia*
Photo number: 53-54	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 70	
%Cover bare ground: 80	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus salmonophloia	*Eremophila scoparia*	*Maireana sedifolia*

ALL SPECIES
Atriplex nummularia
Atriplex vesicaria
Dodonaea lobulata
Eremophila parvifolia
Eremophila scoparia
Eucalyptus salmonophloia
Lycium australe
Maireana sedifolia
Ptilotus holosericeus
Ptilotus obovatus
Sclerolaena diacantha
Senna artemisioides subsp. *filifolia*

Project Name:	
Date: 28/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 13
Quadrat size: 20x20	
WP: 19	**Vegetation group:** Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*
Photo number: 55-57	
Landform: L/M/HSL	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 2/3/S	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/LC/F	
%Cover leaf litter: 20	
%Cover bare ground: 40	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <1	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus lesouefii	*Eremophila oldfieldii*	*Ptilotus obovatus*

ALL SPECIES
Austrostipa nitida
Casuarina pauper
Eremophila oldfieldii
Eremophila parvifolia
Eucalyptus lesouefii
Leucochrysum fitzgibbonii (A)
Olearia muelleri
Ptilotus exaltatus (A)
Ptilotus obovatus
Santalum spicatum
Scaevola spinescens
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 14
Quadrat size: 20x20	
WP: 58-60	**Vegetation group:** Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode
Photo number: 58-59	
Landform: F/B/PLA	
Land surface/disturbance: 3	
Coarse fragments on the surface (abundance/size/shape): 1/1/R	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/LMC/F	
%Cover leaf litter: 20	
%Cover bare ground: 35	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <1	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Eremophila scoparia*	*Eremophila parvifolia*

ALL SPECIES
Acacia sp. narrow phyllode
Austrostipa nitida
Eremophila parvifolia
Eremophila scoparia
Eremophila pustulata
Eucalyptus oleosa
Haloragis trigonocarpa (A)
Marsdenia australis
Olearia muelleri
Scaevola spinescens
Senna artemisioides subsp. *filifolia*
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 15
Quadrat size: 20x20	
WP: 21	**Vegetation group:** Low woodland of *Eucalyptus salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub
Photo number: 60-62	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/MC/S	
%Cover leaf litter: 40	
%Cover bare ground: 50	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree Mallee Form	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** 10-30
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa *Eucalyptus salubris*	*Eremophila scoparia*	*Atriplex vesicaria*

ALL SPECIES
Acacia aneura
Atriplex vesicaria
Austrostipa elegantissima
Austrostipa nitida
Eremophila scoparia
Eucalyptus oleosa
Eucalyptus salubris
Frankenia setosa
Maireana georgei
Maireana triptera
Ptilotus holosericeus
Sclerolaena uniflora
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 16
Quadrat size: 20x20	
WP: 22	**Vegetation group:** Low woodland of *Eucalyptus salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub
Photo number: 67-68	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 1/1/R **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/LMC/F	
%Cover leaf litter: 30	
%Cover bare ground: 50	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Shrub Mallee Form	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Eremophila scoparia*	*Olearia muelleri*

ALL SPECIES
Atriplex nummularia
Atriplex vesicaria
Eremophila parvifolia
Eremophila scoparia
Eucalyptus oleosa
Marsdenia australis
Olearia muelleri
Scaevola spinescens
Senna artemisioides subsp. *filifolia*
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 17
Quadrat size: 20x20	
WP: 24	**Vegetation group:** Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode
Photo number: 69-71	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/LMC/F	
%Cover leaf litter: 10	
%Cover bare ground: 20	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Shrub Mallee Form	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 3-6m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** <10	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Acacia* sp. narrow phyllode	*Ptilotus obovatus*

ALL SPECIES
Acacia aneura
Acacia sp. narrow phyllode
Aristida contorta (A)
Eremophila clarkei
Eremophila decipiens
Eremophila ionantha
Eucalyptus oleosa
Grevillea acuaria
Maireana triptera
Olearia muelleri
Ptilotus obovatus
Solanum orbiculatum
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 18
Quadrat size: 20x20	
WP: 25	**Vegetation group:** Low woodland of *Eucalyptus salmonophloia/ E. salubris* over open mallee of *E. oleosa* and mixed low scrub
Photo number: 72-74	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 3/1/R **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/MHC/S	
%Cover leaf litter: 30	
%Cover bare ground: 45	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <1	**Crown cover %:** 10-30	**Crown cover %:** 10-30
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Eucalyptus oleosa	*Atriplex nummularia*	*Atriplex vesicaria*

ALL SPECIES
Atriplex nummularia
Atriplex vesicaria
Austrostipa nitida
Eremophila scoparia
Eucalyptus oleosa
Frankenia setosa
Olearia muelleri
Ptilotus holosericeus
Scaevola spinescens
Sclerolaena uniflora
Zygophyllum eremaeum (A)

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 19
Quadrat size: 20x20	
WP: 26	**Vegetation group:** Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*
Photo number: 75-76	
Landform: L/B/HSL	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 5/3/AT	
Rock outcrop (abundance/runoff): 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 5	
%Cover bare ground: 90	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Shrub	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: 10-30	**Crown cover %:** 10-30	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia sp. narrow phyllode	*Dodonaea lobulata*	*Ptilotus obovatus*

ALL SPECIES
Acacia sp. narrow phyllode
Acacia tetragonophylla
Austrostipa nitida
Dodonaea lobulata
Maireana sedifolia
Ptilotus obovatus
Scaevola spinescens

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 20
Quadrat size: 20x20	
WP: 27	**Vegetation group:** Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*
Photo number: 77-79	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 10	
%Cover bare ground: 15	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height: 1-3m**	**Height:** 0.5-1m
Crown cover %: <10	**Crown cover %: 10-30**	**Crown cover %:** <1
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia aneura	*Eremophila clarkei*	*Ptilotus obovatus*

ALL SPECIES
Abutilon cryptopetalum
Acacia aneura
Austrostipa nitida
Enchylaena tomentosa
Eremophila clarkei
Gnephosis sp. (sterile)
Goodenia pinifolia
Maireana triptera
Ptilotus obovatus
Ptilotus gaudichaudii (A)
Sclerolaena diacantha
Solanum lasiophyllum
Solanum orbiculatum

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 21
Quadrat size: 20x20	
WP: 28	**Vegetation group:** Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*
Photo number: 83-85	
Landform: F/B/PLA	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 5	
%Cover bare ground: 10	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 3-6m	**Height:** 1-3m	**Height:** 0.5-1m
Crown cover %: <10	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia aneura	*Eremophila oldfieldii* subsp. *angustifolia*	*Ptilotus obovatus*

ALL SPECIES
Abutilon cryptopetalum
Acacia aneura
Amyema maidenii
Austrostipa nitida
Eremophila oldfieldii subsp. *angustifolia*
Euphorbia drummondii
Gnephosis sp. (sterile)
Maireana georgei
Maireana oppositifolia
Ptilotus gaudichaudii (A)
Ptilotus obovatus
Senna artemisioides subsp. x *artemisioides*
Sida intricata
Solanum lasiophyllum

Project Name:	
Date: 29/11/11	**Botanist:** JW & SS
Location: Kurnalpi	**Quadrat:** 22
Quadrat size: 20x20	
WP: 29	**Vegetation group:** Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*
Photo number: 86-88	
Landform: F/B/VLF	
Land surface/disturbance: 2	
Coarse fragments on the surface (abundance/size/shape): 0 **Rock outcrop (abundance/runoff):** 0/3	
Soil (profile/field texture/soil surface): U/MHC/F	
%Cover leaf litter: 5	
%Cover bare ground: 10	

Tallest stratum	**Mid-stratum**	**Lower stratum**
Growth form: Tree	**Growth form:** Shrub	**Growth form:** Shrub
Height: 6-12m	**Height:** 1-3	**Height:** 0.5-1m
Crown cover %: 30-70	**Crown cover %:** <10	**Crown cover %:** <10
Dominant taxa:	**Dominant taxa:**	**Dominant taxa:**
Acacia aneura	*Eremophila decipiens*	*Ptilotus obovatus*

ALL SPECIES
Abutilon cryptopetalum
Acacia aneura
Amyema maidenii
Austrostipa nitida
Boerhavia coccinea (A)
Dodonaea lobulata
Eremophila decipiens
Euphorbia drummondii
Gnephosis sp. (sterile)
Maireana triptera
Ptilotus obovatus
Salvia verbenaca (W)

Appendix 9: Images of each quadrat Spring 2011



Quadrat 1



Quadrat 2





Quadrat 3





Quadrat 4





Quadrat 5





Quadrat 6





Quadrat 7





Quadrat 8





Quadrat 9





Quadrat 10





Quadrat 11





Quadrat 12





Quadrat 13





Quadrat 14





Quadrat 15





Quadrat 16





Quadrat 17





Quadrat 18





Quadrat 19





Quadrat 20





Quadrat 21





Quadrat 22

Appendix D: Level 1 Terrestrial Fauna Survey Kurnalpi Project (2012)

Terrestrial Fauna Survey
(Level 1)

of the

Kurnalpi Project

Carrick Gold Limited

February 2012
Version 1

On behalf of:
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PLATE 6: Low woodland of *A. aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus.*

APPENDICES

APPENDIX A: Conservation Categories

APPENDIX B: Fauna Observed or Potentially in Study Area

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This fauna assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Greg Harewood ("the Author"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints. In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

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EXECUTIVE SUMMARY

This report details the results of a Level 1 fauna assessment of Carrick Gold Limited's Kurnalpi Project area. The study site is located about 75 kilometres east of Kalgoorlie and has a total area of about 1,449 ha (Figures 1 & 2).

The scope of works was to conduct a level 1 fauna survey as defined by the Environmental Protection Authority (EPA 2004). The assessment has included a desktop study and a site reconnaissance survey. The site survey work was carried out by Greg Harewood (B.Sc. Zoology) on the 12 January, 2012.

The extent of the broadly defined fauna habitats within the study area are shown in Figure 3 with a description of each given below. Additional information of the vegetation units present within the study area can be found in the vegetation and flora report for the site (Botanica Consulting 2012).

- Low woodland of *Euclayptus salmonophloia/E. salubris* over open mallee of *E. oleosa* and mixed low scrub.
- Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea.*
- Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/Maireana sedifolia.*
- Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia.*
- Low woodland of *A. aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*.
- Open mallee of *E. oleosa* over low woodland of *A. aneura* and scrub of *Acacia* sp. narrow phyllode.

Plates 1 to 6 illustrate the nature of fauna habitats existing within the study area.

The results of the opportunistic fauna survey are summarised in Table 1 and listed in Appendix B. A total of 42 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the reconnaissance survey carried out in January 2012. Evidence of three introduced species utilising the area was also observed.

No evidence of any listed threatened, migratory or the Department of Environment and Conservation's (DEC's) priority fauna species was found within the project area.

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) threatened fauna list, DEC's Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified 19 specially protected, priority

or migratory vertebrate fauna species as potentially occurring in the general vicinity of the study area.

In summary, no fauna species of conservation significance (as listed on state or federal threatened/migratory species lists or DEC priority species) were positively identified as utilising the study area during the Level 1 reconnaissance survey carried out in January 2012.

The current status on site and/or in the general area of potential species of conservation significance can be difficult to determine because they were not sighted during the survey period or evidence of use of the study area was not found. However, based on the habitats present and, in some cases, recent nearby records, six species of conservation significance can be regarded as possibly utilising the study area for some purpose at times, these being:

- *Leipoa ocellata* Malleefowl - S1 *(WC Act),* Vulnerable & Migratory *(EPBC Act)*
  WAM and DEC records from near Kurnalpi in 1992 and 2007 respectively. Some additional records from 2009 and 2010 about 30km north of the Project Area (DEC 2011). More recently a chick at Kanowna (60km west) (2011 pers comms Botanica Consulting). These wide spaced, infrequent records suggest that the species may occur at times though it should be noted that no nest mounds (active, inactive or degraded condition) have been observed in the Project area as far as the Author is aware. Most likely to only occur occasionally as transient ("migratory") individuals.

- *Falco peregrinus* Peregrine Falcon - S4 (*WC Act*)
  The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. No potential nest sites in trees observed.

- *Ardeotis australis* Australian Bustard - P4 (DEC Priority Species)
  May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

- *Apus pacificus* Fork-tailed Swift – S3 (*WC Act*), Migratory (*EPBC Act*)
  Very rare seasonal visitor. May forage in air space above the area but very unlikely to roost.

- *Merops ornatus* Rainbow Bee-eater – Migratory (*EPBC Act*)
  Common seasonal visitor to southern half of WA. Would only occur as individuals or small groups.

- *Nyctophilus major tor* Central Long-eared Bat - P4 *(*DEC Priority Species)
  Extreme northern limit of documented range. This species has been recorded during bat surveys at the Kanowna Belle mine site 60km south west. Exact status in the study area difficult to determine. May be present but probability can be considered to be low.

Note: Habitat onsite for some of the species listed above, while considered possibly suitable, may be marginal in extent/quality and species listed above may only visit the area for short periods or as rare/uncommon vagrants.

A number of other species of conservation significance, while possibly present in the general area and/or the wider region are not listed as potential species due to the study area being outside of their currently recognised range, a lack of suitable habitat or known/very likely local or regional extinction (and no subsequent recruitment from adjoining areas).

The impact on the significant species listed as potentially being present will vary depending on their current degree of utilisation/population densities and preferred habitat requirements (e.g. quantity and quality of potential foraging and breeding habitat that is affected).

The exact extent of development within the study area is not fully known at this stage however the possible impact on specific species of conservation significance previously recorded in the general area is provided in Table 2 below. Additional information on specific fauna species is provided in Appendix D.

Likelihood of Occurrence and Possible Impacts – Fauna Species of Conservation Significance (continues on following pages)

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Southern Carpet Python *Morelia spilota imbricata*	-	S4	P4	No/Marginal	Unlikely. No recent records in general area.	No impact.
Malleefowl *Leipoa ocellata*	Vulnerable	S1	-	Yes	Possible.	Loss/modification of small areas of potential habitat.
Great Egret *Ardea alba*	Migratory	S3	-	No	Unlikely.	No impact.
Grey Falcon *Falco hypoleucos*	-	-	P4	Yes/Marginal	Unlikely. Outside normal range. May occur very rarely.	No impact.
Peregrine Falcon *Falco peregrinus*	-	S4	-	Yes	Possible.	No significant impact likely. Modification of some foraging habitat.
Australian Bustard *Ardeotis australis*	-	-	P4	Yes	Possible. Would only occur very rarely	Loss/modification of a small area of potential habitat.
Bush Stone Curlew *Burhinus grallarius*	-	-	P4	Yes/Marginal	Unlikely. Species appears to be locally extinct	No impact.

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Hooded Plover *Charadrius rubricollis*	-	-	P4	No	Unlikely.	No impact.
Major Mitchell's Cockatoo *Cacatua leadbeateri*	-	S4	-	No	Unlikely. Outside normal range but may occur very rarely.	No impact.
Princess Parrot *Polytelis alexandrae*	-	-	P4	No	Unlikely. Just outside normal range, but may occur very rarely.	No impact.
Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*	-	S1	-	No	Unlikely. Outside normal range.	No impact.
Fork-tailed Swift *Apus pacificus*	Migratory	S3	-	Yes	Flyover only.	No impact.
Rainbow Bee-eater *Merops ornatus*	Migratory	S3	-	Yes	Possible.	Loss/modification of a small area of potential habitat.
Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*	-	-	P4	No	Unlikely. No suitable habitat. Locally extinct.	No impact.
Slender-billed Thornbill (western ssp) *Acanthiza iredalei iredalei*	VU	-	-	Yes/Marginal	Unlikely. Species appears to be locally extinct.	No impact.
Bilby *Macrotis lagotis*	Vulnerable	S1	-	No	Unlikely. Species appears to be locally extinct.	No Impact.
Chuditch *Dasyurus geoffroii*	Vulnerable	S1	-	Yes	Unlikely. Species appears to be locally extinct.	No impact.
Numbat *Myrmecobius fasciatus*	Vulnerable	S1	-	No/Marginal	Unlikely. Species is locally and regionally extinct.	No impact.
Central Long-eared Bat *Nyctophilus major tor*	-	-	P4	Yes	Possible.	Loss/modification of a small area of potential habitat.

Based on habitat preferences, previous detailed survey results and currently documented distributions it has been concluded to be unlikely that any threatened (vulnerable, endangered, rare or likely to become extinct) species frequent the study area except possibly as transient individuals or vagrants, on rare occasions.

The assessment suggests that two fauna species considered in need of special protection under state/federal legislation may possibly utilise the study area at times (albeit infrequently) with an additional two DEC priority species also having some

potential of being present at times. Two migratory bird species may also frequent the area though only one is likely to be present on a regular (seasonal) basis.

The fauna habitats present within the proposal area have been identified as being common and widespread in the general area and the faunal assemblage identified as potentially present is unlikely to be different to that found in similar habitats located elsewhere in the region. It can therefore be concluded that the project area does not contain habitat of high ecological significance from a faunal perspective or contain faunal assemblages that are ecologically significant. Clearing principles, as defined under the state *Environmental Protection Act* (*EP Act*) relating specifically to fauna, are therefore considered unlikely to be compromised by the proposal proceeding.

The assessment results also suggest that no species of conservation significance has the potential to be directly affected to any significant degree by the proposal. Available evidence suggests that a significant proportion of the species discussed are locally extinct or unlikely to use the site due to a lack of suitable habitat. Those species that potentially utilise the site are relatively wide ranging and/or will persist in adjoining unaffected areas. No significant impact on any EPBC Act threatened species is anticipated, principally because none can be considered likely to be using the site to any significant degree. The site also does not appear to contain habitat that could be considered critical for the recovery of any listed threatened species.

Any proposed development will necessarily require the clearing of some existing fauna habitat. Planning should take into account the potential presence of some species of conservation significance and fauna in general so that any impacts can be minimised or offset. Existing management plans and protocols that aim to minimise impact on fauna should be employed where relevant with specific attention being paid to those facets highlighted in Section 6.2, when considered reasonable and practical to implement.

1. INTRODUCTION

This report details the results of a Level 1 fauna assessment of Carrick Gold Limited's Kurnalpi Project area. The study site is located about 75 kilometres north east of Kalgoorlie and is centred at approximately 30.53088°S and 122.23184°E. The project area totals about 1,449 ha in size (Figures 1 & 2).

2. SCOPE OF WORKS

The scope of works was designed to comply with requirements of a Level 1 terrestrial fauna survey as defined in EPA Guidance Statement 56 (EPA 2004):

- Background research or 'desktop' study

  The purpose is to gather background information on the target area (usually at the locality scale). This involves a search of all sources for literature, data and map-based information.

- Reconnaissance survey

  The purposes are:

  i) to verify the accuracy of the background study;

  ii) to further delineate and characterise the fauna and faunal assemblages present in the target area; and

  iii) to identify potential impacts.

  The reconnaissance survey involves a site visit by suitably qualified personnel to undertake selective, low intensity sampling of the fauna and faunal assemblages, and to provide habitat descriptions and habitat maps of the project area (EPA 2004).

3. METHODOLOGY

3.1 POTENTIAL FAUNA INVENTORY - DESKTOP STUDY

3.1.1 Database Searches

Searches of the following databases were undertaken to aid in the compilation of a list of vertebrate fauna potentially occurring within the study area:

- Department of Environment and Conservation's (DEC's) NatureMap Database (combined data from DEC, Western Australian Museum and Birds Australia) (DEC 2012); and

- Protected matters search tool (Department of Sustainability, Environment, Water, Population and Communities - DSEWPaC 2012).

It should be noted that these lists are based on observations from a broader area than the study site and therefore may include species that would only ever occur as vagrants in the actual study area due to a lack of suitable habitat or the presence of only marginal habitat. The databases also often included very old records and in some cases the species in question have become locally or regionally extinct.

Information from these sources should therefore be taken as indicative only and local knowledge and information needs also to be taken into consideration when determining what actual species may be present within the specific area being investigated.

3.1.2 Previous Fauna Surveys in the Area

Fauna surveys, assessments and reviews have been undertaken in nearby areas in the past, though not all are publically available and could not be referenced. The most significant of those available have been used as the primary reference material for compiling the potential fauna assemblage for the general area. The main reports referred to included, but was not limited to:

- McKenzie, N.L. and Hall, N.J. (1992). The Biological Survey of the Eastern Goldfields of WA - Pt 8: Kurnalpi – Kalgoorlie study area. Records of the WAM, Supplement 41: 1 – 125.

As with the databases searches some reports refer to species that would not occur in the study area due to a lack of suitable habitat (extent and/or quality) and this fact was taken into consideration when compiling the potential fauna species list for the study area. It should also be noted that the NatureMap database is likely to include some records from previous fauna surveys in the area including some of those listed above.

3.1.3 Existing Publications

The following represent the main publications used to identify and refine the potential fauna species list for the study area:

- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). The New Atlas of Australian Birds. Royal Australasian Ornithologists Union, Victoria.

- Churchill, S. (2008). Australian Bats. Second Edition, Allen & Unwin.

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3.1.4 Fauna of Conservation Significance

The conservation significance of fauna species has been assessed using data from the following sources:

- *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). Administered by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC);

- *Wildlife Conservation Act 1950 (WC Act).* Administered by the Western Australian Department of Environment and Conservation (DEC);

- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List - the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no

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

- DEC Priority Fauna list. A non-legislative list maintained by the DEC for management purposes.

The *EPBC Act* also requires the compilation of a list of migratory species that are recognised under international treaties including the:

- Japan Australia Migratory Bird Agreement 1981 (JAMBA);
- China Australia Migratory Bird Agreement 1998 (CAMBA);
- Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA); and
- Bonn Convention 1979 (The Convention on the Conservation of Migratory Species of Wild Animals).

(Note - Species listed under JAMBA are also protected under Schedule 3 of the *WC Act*.)

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as matters of national environmental significance (NES) under the *EPBC Act*.

The conservation status of all vertebrate fauna species listed as occurring or possibly occurring in the vicinity of the Project area has been assessed using the most recent lists published in accordance with the above-mentioned instruments and is indicated as such in the fauna listings of this report. A full listing of conservation codes are provided in Appendix A.

3.1.5 Invertebrates

It can be difficult to identify what may be significant invertebrate species (e.g. Short Range Endemics - SREs) as there are uncertainties in determining the range-restrictions of many species due to lack of surveys, lack of taxonomic resolutions within target taxa and problems in identifying certain life stages. Where invertebrates are collected during surveys, a high percentage are likely to be unknown, or for known species there can be limited knowledge or information on their distribution (Harvey 2002).

For this project, the assessment for conservation significant invertebrates has been limited to those listed by the DEC and *EPBC Act* database searches (which rely on distribution records and known habitat preferences). No assessment of the potential for SRE invertebrates to be present has been made.

3.1.6 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report is generally taken from the DEC's WA Fauna Census Database which is assumed to follow

Aplin and Smith (2001) for amphibians and reptiles, How *et al*. (2001) for mammals and Johnstone (2001) for birds.

Common names are taken from the Western Australia Museum (WAM) recognised primary common name listings when specified, though where common names are not provided they have been acquired from other publications. Sources include Wilson and Swan (2010), Van Dyck & Strahan (2008), Christidis and Boles (2008), Bush *et al* (2007), Bush *et al* (2002), Tyler *et al.* (2000), and Glauret (1961). Not all common names are generally accepted.

3.2 SITE SURVEYS

Field survey work was carried out by Greg Harewood (B.Sc. Zoology) within a one day period on the 12 January, 2012.

3.2.1 Fauna Habitat Assessment

Vegetation units identified during the flora and vegetation survey, carried out by Botanica Consulting (2012), have been used to define broad fauna habitat types across the site. This information has been supplemented with observations made during the fauna survey.

The main aim of the habitat assessment was to determine if it was likely that any species of conservation significance would be utilising the areas that maybe impacted on as a consequence of the proposal proceeding. The habitat information obtained was also used to aid in finalising the overall potential fauna list.

As part of the desktop literature review, available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area was researched. During the field survey the habitats within the study area were assessed and specific elements identified, if present, to determine the likelihood of listed threatened species utilising the area and its significance to them.

3.2.2 Opportunistic Fauna Observations

Opportunistic observations of fauna species were made during the site reconnaissance survey which involved traversing the study area several times on foot. This included searching microhabitats such as logs, rocks, leaf litter and observations of bird species with binoculars.

4. SURVEY CONSTRAINTS

The conclusions presented are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of

the field assessments. Also it should be recognised that site conditions can change with time. No seasonal sampling has been carried out as part of this fauna assessment.

Some fauna species are reported as potentially occurring within the study area based on there being suitable habitat (quality and extent) within the study area or immediately adjacent. With respect to opportunistic observations, the possibility exists that certain species may not have been detected during field investigations due to:

- seasonal inactivity during the field survey;
- species present within micro habitats not surveyed;
- cryptic species able to avoid detection; and
- transient wide-ranging species not present during the survey period.

Lack of observational data on some species should therefore not necessarily be taken as an indication that a species is absent from the site.

The habitat requirements and ecology of many of the species known to occur in the wider area are often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitat or microhabitat within the study area. As a consequence of this limitation the potential fauna list produced is most likely an overestimation of those species that actually utilise the study area for some purpose. Some species may be present in the general area but may only use the study area itself on rare occasions or as vagrants.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any fauna species that would possibly occur within the study area (or immediately adjacent), as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of the Author, has been assumed to potentially occur in the study area.

5. RESULTS

5.1 POTENTIAL FAUNA INVENTORY - DESKTOP STUDY

A list of expected fauna species likely to occur in the study area was compiled from information obtained during the desktop study and is presented in Appendix B. This listing was refined after information gathered during the site reconnaissance survey was assessed. The results of some previous fauna surveys carried out in the general area are summarised in this species listing as are the DEC NatureMap database search results. The raw database search

results from NatureMap (DEC 2012) and the Protected Matters Search Tool (DSEWPaC 2012) are contained within Appendix C.

The list of potential fauna takes into consideration that firstly the species in question is not known to be locally extinct and secondly that suitable habitat for each species, as identified during the habitat assessment, is present within the study area, though compiling an accurate list has limitations (see Section 4 above).

5.2 SITE SURVEYS

5.2.1 Fauna Habitat Assessment

The project area is situated near the southern boundary of the East Murchison bioregion (MUR1 subregion - Cowan 2001). The East Murchison subregion is described as:

"The northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. Characterised by its internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake systems associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and Halosarcia shrublands. Arid climate, with mainly winter rainfall (200 mm). The subregional area for MUR1 is 7,847,996 ha.)" (Cowan 2001).

Beard (1990) locates the survey area within the Austin Botanical District. The typical sequence of vegetation within the Austin Botanical District is Mulga (*Acacia aneura*) woodlands on plains reduced to shrubs on hills and *Eucalyptus* sp. tree steppe on sand plains with *Triodia* sp. (Beard, 1990)

The broad scale fauna habitats within the study area are based mainly on vegetation structure as mapped by Botanica Consulting (2012). The extent of the broadly defined fauna habitats within the study area are shown in Figure 3 with a description of each given below. Additional information of the vegetation units present within the study area can be found in the vegetation and flora report for the site (Botanica Consulting 2012).

- Low woodland of *Euclayptus salmonophloia/E. salubris* over open mallee of *E. oleosa* and mixed low scrub.

- Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea.*

- Open low woodland of *E. salmonophloia* over low scrub of *Atriplex nummularia/Maireana sedifolia.*

- Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia.*
- Low woodland of *A. aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*.
- Open mallee of *E. oleosa* over low woodland of *A. aneura* and scrub of *Acacia* sp. narrow phyllode.

Plates 1 to 6 illustrate the nature of fauna habitats existing within the study area.

5.2.2 Opportunistic Fauna Surveys

The results of the opportunistic fauna survey are summarised in Table 1 and listed in Appendix B. A total of 42 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the reconnaissance survey carried out in January 2012. Evidence of three introduced species utilising the area was also observed.

No evidence of any listed threatened, migratory or DEC priority fauna species was found within the project area.

5.3 FAUNA INVENTORY – SUMMARY

5.3.1 Vertebrate Fauna

Table 1 summarises the numbers of potential species based on vertebrate class considered likely to be present in the general vicinity of the study area. A complete list of vertebrate fauna possibly inhabiting or frequenting the region is held in Appendix B. The results of the DEC NatureMap fauna database search and the *EPBC Act* database search are held in Appendix C.

Details on specially protected and priority species expected and/or listed as potentially occurring in the general area are given in Appendix D.

Not all species listed in existing databases and publications as potentially occurring within the region (i.e. *EPBC Act's* Threatened Fauna and Migratory species lists, DEC's NatureMap Fauna Database and various publications) are likely to be present within the study area. Some species have been excluded from this list based on the lack of suitable habitat or known/highly likely local extinction even if suitable habitat is present.

It should be noted that even if some additional species are omitted from the listing for the specific study area the resulting list would still very likely represent an over estimation of the fauna species utilising the site (either on a regular of infrequent basis) as a result of the precautionary approach adopted for the assessment.

Table 1: Summary of Potential Vertebrate Fauna Species (as listed in Appendix B)

Group	Total number of potential species	Potential number of specially protected species	Potential number of migratory species	Potential number of priority species	Number of species observed Level 1 Survey
Amphibians	4	0	0	0	0
Reptiles	60	0	0	0	0
Birds	102	2	2	1	39
Non-Volant Mammals	20[6]	0	0	0	6[3]
Volant Mammals (Bats)	10	0	0	1	0
Total	196[6]	2	2	2	45[3]

Superscript = number of introduced species included in total.

A review of the *EPBC Act* threatened fauna list, DEC's Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified 19 specially protected, priority or migratory vertebrate fauna species as potentially occurring in the general vicinity of the study area.

In summary, no fauna species of conservation significance (as listed on state or federal threatened/migratory species lists or DEC priority species) were positively identified as utilising the study area during the Level 1 reconnaissance survey carried out in January 2012.

The current status on site and/or in the general area of potential species of conservation significance can be difficult to determine because they were not sighted during the survey period or evidence of use of the study area was not found. However, based on the habitats present and, in some cases, recent nearby records, six species of conservation significance can be regarded as possibly utilising the study area for some purpose at times, these being:

- *Leipoa ocellata* Malleefowl - S1 *(WC Act),* Vulnerable & Migratory *(EPBC Act)*
  WAM and DEC records from near Kurnalpi in 1992 and 2007 respectively. Some additional records from 2009 and 2010 about 30km north of the Project Area (DEC 2011). More recently a chick at Kanowna (60km west) (2011 pers comms Botanica Consulting). These wide spaced, infrequent records suggest that the species may occur at times though it should be noted that no nest mounds (active, inactive or

degraded condition) have been observed in the Project area as far as the Author is aware. Most likely to only occur occasionally as transient ("migratory") individuals.

- *Falco peregrinus* Peregrine Falcon - S4 (*WC Act*)
  The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. No potential nest sites in trees observed.

- *Ardeotis australis* Australian Bustard - P4 (DEC Priority Species)
  May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

- *Apus pacificus* Fork-tailed Swift – S3 (*WC Act*), Migratory (*EPBC Act*)
  Very rare seasonal visitor. May forage in air space above the area but very unlikely to roost.

- *Merops ornatus* Rainbow Bee-eater – Migratory (*EPBC Act*)
  Common seasonal visitor to southern half of WA. Would only occur as individuals or small groups.

- *Nyctophilus major tor* Central Long-eared Bat - P4 (DEC Priority Species)
  Extreme northern limit of documented range. This species has been recorded during bat surveys at the Kanowna Belle mine site 60km west. Exact status in the study area difficult to determine. May be present but probability can be considered to be low.

Note: Habitat onsite for some of the species listed above, while considered possibly suitable, may be marginal in extent/quality and species listed above may only visit the area for short periods or as rare/uncommon vagrants.

The following species of conservation significance, while possibly present in the general area and/or the wider region are not listed as potential species due to the study area being outside of their currently recognised range, a lack of suitable habitat or known/very likely local or regional extinction (and no subsequent recruitment from adjoining areas):

- *Morelia spilota imbricata* Southern Carpet Python - S4 (*WC Act*) - P4 (DEC Priority Species)
  Status onsite difficult to determine but given the paucity of records north of Kalgoorlie in recent times it is unlikely to be present. Not listed as a potential species for this reason.

- *Ardea alba* Great Egret - Migratory *(EPBC Act)*
  No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

- *Falco hypoleucos* Grey Falcon - P4 (DEC Priority Species)
  The study area is outside this species current documented range. May occur on rare occasions.

- *Burhinus grallarius* Bush Stone Curlew - P4 (DEC Priority Species)
  No recent or historical records suggest this species is very unlikely to be present in the study area despite apparent suitable habitat, though may occur very occasionally.

- *Charadrius rubricollis* Hooded Plover – P4 (DEC Priority Species)
  No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

- *Cacatua leadbeateri* Major Mitchell's Cockatoo –- S4 (*WC Act*)
  Study area is just outside of this species main documented range and the paucity of records in the local area suggests habitat is generally unsuitable for this species to persist. May occur very occasionally.

- *Polytelis alexandrae* Princess Parrot – P4 (DEC Priority Species), Vulnerable *(EPBC Act)*
  The study area is just outside this species current documented range. The species is nomadic and may occur occasionally but would not be specifically attracted to the study area.

- *Platycercus icterotis xanthogenys* Western Rosella (Inland ssp) – S1 *(WC Act)*
  DEC database record, but this is likely to be an old, individual sighting. No recent records (e.g. Birds Australia database) suggest this species rarely frequents areas this far east.

- *Acanthiza iredalei iredalei* Slender-billed Thornbill (western ssp) - Vulnerable *(EPBC Act)*
  Despite the presence of some apparently suitable habitat (low scrub/Chenopod shrubland - mainly bluebush *Maireana sedifolia*, and saltbush *Atriplex nummularia*) the lack of actual records (historical and more recent) suggest it is absent from the general area. Not listed as a potential species.

- *Amytornis textilis textilis* Thick-billed Grass-wren (western ssp) - P4 (DEC Priority Species)
  Available evidence suggests this species is locally and regionally extinct.

- *Macrotis lagotis* Bilby - S1 (*WC Act*), Vulnerable (*EPBC Act*)
  Available evidence suggests this species is locally and regionally extinct.

- *Dasyurus geoffroii* Chuditch - S1 *(WC Act),* Vulnerable *(EPBC Act)*
  Available evidence suggests this species is locally and regionally extinct.

- *Myrmecobius fasciatus* Numbat – S1*(WC Act),* Vulnerable *(EPBC Act)*
  Available evidence suggests this species is locally and regionally extinct.

Additional details on significant species that potentially utilise the study area are given in Appendix D.

5.3.2 Invertebrate Fauna

No conservation significant invertebrate species appeared in the DEC or *EPBC Act* database searches (DEC 2012, DSEWPaC 2012).

6. ECOLOGICAL IMPACTS AND MANAGEMENT

6.1 POTENTIAL IMPACTS

In general the most significant potential impacts to fauna of any development include:

- Loss of vegetation/fauna habitat that is used for foraging, breeding, roosting, or dispersal (includes loss of hollow bearing trees),
- Fragmentation of vegetation/fauna habitat which may restrict the movement of some fauna species,
- Modifications to surface hydrology, siltation of creek lines,
- Changes to fire regimes,
- Pollution (e.g. oil spills),
- Noise/Light/Dust,
- Spread of plant pathogens (e.g. dieback) and weeds,
- Potential increase in the number of predatory feral species (e.g. foxes, cats), and
- Death or injury of fauna during clearing and construction.

The most likely/inevitable impacts of the proposed development are:

- The loss of fauna habitat, some of which is or maybe utilised by fauna of conservation significance,
- Death or injury of fauna during clearing and construction.

The impact on the significant species listed as potentially being present will vary depending on their current degree of utilisation/population densities and preferred habitat requirements (e.g. quantity and quality of potential foraging and breeding habitat that is affected).

The exact extent of development within the study area is not fully known at this stage however the possible impact on specific species of conservation

significance previously recorded in the general area is provided in Table 2 below. Additional information on specific fauna species is provided in Appendix D.

Table 2: Likelihood of Occurrence and Possible Impacts – Fauna Species of Conservation Significance (continues on following pages)

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Southern Carpet Python *Morelia spilota imbricata*	-	S4	P4	No/Marginal	Unlikely. No recent records in general area.	No impact.
Malleefowl *Leipoa ocellata*	Vulnerable	S1	-	Yes	Possible.	Loss/modification of small areas of potential habitat.
Great Egret *Ardea alba*	Migratory	S3	-	No	Unlikely.	No impact.
Grey Falcon *Falco hypoleucos*	-	-	P4	Yes/Marginal	Unlikely. Outside normal range. May occur very rarely.	No impact.
Peregrine Falcon *Falco peregrinus*	-	S4	-	Yes	Possible.	No significant impact likely. Modification of some foraging habitat.
Australian Bustard *Ardeotis australis*	-	-	P4	Yes	Possible. Would only occur very rarely	Loss/modification of a small area of potential habitat.
Bush Stone Curlew *Burhinus grallarius*	-	-	P4	Yes/Marginal	Unlikely. Species appears to be locally extinct	No impact.
Hooded Plover *Charadrius rubricollis*	-	-	P4	No	Unlikely.	No impact.
Major Mitchell's Cockatoo *Cacatua leadbeateri*	-	S4	-	No	Unlikely. Outside normal range but may occur very rarely.	No impact.
Princess Parrot *Polytelis alexandrae*	-	-	P4	No	Unlikely. Just outside normal range, but may occur very rarely.	No impact.
Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*	-	S1	-	No	Unlikely. Outside normal range.	No impact.
Fork-tailed Swift *Apus pacificus*	Migratory	S3	-	Yes	Flyover only.	No impact.
Rainbow Bee-eater *Merops ornatus*	Migratory	S3	-	Yes	Possible.	Loss/modification of a small area of potential habitat.
Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*	-	-	P4	No	Unlikely. No suitable habitat. Locally extinct.	No impact.

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Slender-billed Thornbill (western ssp) *Acanthiza iredalei iredalei*	VU	-	-	Yes/Marginal	Unlikely. Species appears to be locally extinct.	No impact.
Bilby *Macrotis lagotis*	Vulnerable	S1	-	No	Unlikely. Species appears to be locally extinct.	No Impact.
Chuditch *Dasyurus geoffroii*	Vulnerable	S1	-	Yes	Unlikely. Species appears to be locally extinct.	No impact.
Numbat *Myrmecobius fasciatus*	Vulnerable	S1	-	No/Marginal	Unlikely. Species is locally and regionally extinct.	No impact.
Central Long-eared Bat *Nyctophilus major tor*	-	-	P4	Yes	Possible.	Loss/modification of a small area of potential habitat.

The fauna habitats present within the development area are common and widespread in the wider area and the faunal assemblage identified as potentially present is unlikely to be different to that found in similar habitat located elsewhere in the region. It can therefore be concluded that the project area does not contain habitat of high ecological significance from a faunal perspective or contain faunal assemblages that are ecologically significant.

Despite the loss of some potential fauna habitat, the assessment suggests that no species of conservation significance has the potential to be affected to any significant degree by any proposed development or clearing. Available evidence suggests that a significant proportion of the species discussed are locally extinct or unlikely to use the site due to a lack of suitable habitat. Those species that potentially utilise the site are relatively wide ranging and/or will persist in adjoining unaffected areas.

6.2 MINIMISING IMPACTS

Carrick Gold Limited have a series of environmental management plans and protocols in place that aim to minimise potential environmental impacts during all facets of their operations. The implementation of these standard plans and protocols will ensure impacts of the proposed activities at the site are minimised as far as reasonable and practical while allowing development to progress.

The following proposed management recommendations are considered most important and while likely to form part of existing procedures and protocols should be made a priority during site development and operation. It is recommended that:

- Planning for development should aim to minimise as much as reasonable and practical the area of remnant vegetation requiring removal. Existing cleared areas/tracks should be used in preference to clearing additional areas.

- During site works, areas requiring clearing should be clearly marked and access to other areas restricted to prevent accidental clearing of areas to be retained.

- No dead, standing or fallen timber should be removed unnecessarily. Logs (hollow or not) and other debris resulting from land clearing should be used to enhance fauna habitat in untouched and rehabilitated areas if possible.

- Disruption to surface and sub-surface hydrology should be minimised where possible and levees and drains designed to mimic natural drainage flows where disruptions will occur.

- A Construction and Operations Fire Management Plan should be prepared to reduce the risk of unplanned fires and provide contingency measures to minimise any associated impacts. The plan will include a contingency and response plan in the event of any bushfires that commence as a result of the works on site.

- All staff working on site should be made aware that native fauna is protected. Personnel working on the project should not be allowed to bring firearms, other weapons or pets onsite.

- If practical, prior to any significant clearing operations a suitably experienced “fauna clearing person” should be employed to inspect logs and hollow trees (where possible) before clearing to reduce likelihood of injury to fauna. If feasible any fauna encountered should be relocated to nearby retained suitable habitat. The fauna clearing person should also record the location of any potential malleefowl mounds so they can be avoided.

- Native fauna injured during clearing or normal site operations should be taken to a designated veterinary clinic or a DEC nominated wildlife carer.

- Any holes, pits or trenches required for services should be kept open for only as long as necessary and suitable escape ramps (45° batter) and bridging provided if the site is to be left unattended for extended periods. Significant sized holes, pits or trenches should be inspected for fauna immediately prior to filling.

7. LEGISLATIVE OBLIGATIONS

7.1 WILDLIFE CONSERVATION ACT 1950

The objective of the *Wildlife Conservation Act 1950* (*WC Act*) is to provide for the protection of wildlife. The Act is administered by the Executive Director of the Department of Environment and Conservation, under the direction and control of the Minister for the Environment. Under section 14, "Protection of Fauna", of this Act, all fauna is wholly protected throughout the State at all times, unless declared by the Minister by notice in the Government Gazette. Under section 14(2)(ba) of The Act, Fauna Notices are made by the Minister for the Environment listing specially protected fauna.

Disturbance or destruction of any native fauna over and above that reasonably required for construction works and access is considered an offence under the *WC Act* and the proponent should take the necessary steps to inform all those involved in sites works of this fact. As discussed in the previous section the proponent should also, as part of their management plan implement procedures that will reduce the chances of wildlife being injured or killed during clearing, construction and operations at the site.

7.2 ENVIRONMENTAL PROTECTION ACT 1986

The purpose of the *Environmental Protection Act (1986)* (*EP Act*) is "...*to provide for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection enhancement and management of the environment and for matters incidental to or connected with the foregoing*".

The powers of the *Environmental Protection Act 1986* are administered by the Department of Environment and Conservation (DEC), which in relevant cases advises to the Environmental Protection Authority (EPA). The jurisdiction of the DEC comprises the protection of environmental systems, pollution prevention and waste management. In particular, the DEC manages and protects rivers, streams, creeks, estuaries, drains, wetlands and groundwater, but not marine waters, of Western Australia.

Legislation proclaimed on 8 July 2004 protects all native vegetation in Western Australia. Under the law, clearing native vegetation is prohibited, unless a clearing permit is granted by the DEC, or the clearing is for an exempt purpose. These exemptions ensure that low impact day to day activities involving clearing can be undertaken. People that wish to clear are required to submit an application if an exemption does not apply.

Any future development at the site will be assessed against the ten clearing principles related to native vegetation in the *EP Act*. These principles provide a

guide for when native vegetation should not be cleared. The DEC must consider these principles in making a decision on whether or not to issue a clearing permit. The DEC has set out the minimum requirements and standards for addressing each of the ten principles in detail in its assessment methodology.

Native vegetation should not be cleared if:

(a) it comprises a high level of biological diversity;

(b) it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;

(c) it includes, or is necessary for the continued existence of, rare flora;

(d) it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community;

(e) it is significant as a remnant of native vegetation in an area that has been extensively cleared;

(f) it is growing in, or in association with, an environment associated with a watercourse or wetland;

(g) the clearing of the vegetation is likely to cause appreciable land degradation;

(h) the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;

(i) the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; or

(j) clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

One purpose of the assessment reported on here is to provide information relevant to principle (a) & (b). Based on the assessment results and despite the fact that the area is or is possibly being utilised by some species of conservation significance it is the Author's opinion that the site is unlikely to have what would be considered a high level of biological diversity or constitute the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.

This opinion is based on the fact that the overall area of impact is likely to be relatively small and fauna habitats present within the development area are common and widespread in the general area. The faunal assemblage identified as potentially present is unlikely to be different to that found in similar habitats located elsewhere in the region. It can therefore be concluded that the Project

area does not contain habitats of high ecological significance from a faunal perspective or contain faunal assemblages that are ecologically significant.

7.3 COMMONWEALTH ENVIRONMENT PROTECTION & BIODIVERSITY CONSERVATION ACT 1999

A number of fauna species known to or potentially present within the study area are listed under the federal *Environment Protection and Biodiversity Conservation Act* (*EPBC Act, 1999*). The objective of the *EPBC Act* is to provide for the protection of the environment, especially those aspects that are of national significance, promote ecologically sustainable development, the conservation of biodiversity and a cooperative approach to the protection and management of the environment.

Development proposals ("actions") that are likely to have a significant impact on any listed species should be referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for assessment. The aim of a referral is to provide certainty about whether a proposal does or doesn't need approval under the *EPBC Act*. The proposed action should be considered at its broadest possible scope. This includes all stages and components of the action, all related activities, and all related infrastructure such as roads and powerlines, if applicable.

It is the proponent's responsibility to determine if their proposed action (e.g. clearing and development of an area of native bushland) requires referral. To aid in determining if a proposal is likely to have a significant impact DSEWPaC provide a series of Significant Impact Guidelines (DEH 2006). These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required.

The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. The criteria are not intended to be exhaustive or definitive. If a proponent is unsure whether their proposed action is likely to have a significant impact on a matter of national environmental significance it should be referred to the DSEWPaC for a binding decision on whether approval is required (DEH 2006).

7.3.1 Listed Threatened Species

The only listed *EPBC Act* threatened fauna species considered by the Author to possibly be utilising the study area to any degree is the Malleefowl (Vulnerable). No evidence of this species using the area was found and the conclusion that it may occasionally be present in the Project area at times is based on a small number of infrequent observations of the species in the wider area.

An action is deemed by DSEWPaC as likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Given the fact that Malleefowl are only likely to be present at the site or in nearby adjacent areas on rare occasions as transient individuals none of the above criteria are likely to be compromised by any proposed development in the Project area. Generally projects of this type would only be considered likely to have a significant impact (as defined by DSEWPaC) on the Malleefowl if active nest mounds of the species or large areas of suitable habitat surrounding known breeding areas were to be impacted on by any proposed development or clearing. There is no evidence to suggest the species has ever constructed nest mounds in any section of the Project area and therefore significant impact on this species, despite the fact that it may occasionally be present in the general area, can be considered to be very unlikely to occur.

7.3.2 Listed Migratory Species

EPBC Act listed migratory fauna species identified as being present in the general area of the development site at times were:

- *Apus pacificus* Fork-tailed Swift – Migratory
- *Merops ornatus* Rainbow Bee-eater – Migratory

An action has, will have, or is likely to have a significant impact on migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species; or

- result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species; or

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;

- habitat that is of critical importance to the species at particular life-cycle stages;

- habitat utilised by a migratory species which is at the limit of the species range; or

- habitat within an area where the species is declining.

To have a significant impact on a migratory species as defined under the DSEWPC Significant Impact Guidelines (DEH 2006), any proposed development would need to trigger at least one of the abovementioned significant impact criteria thresholds. Each of these is briefly assessed below.

Substantially modify, destroy or isolate an area of important habitat of the migratory species

The study are does not represent important habitat for any of the migratory species listed as potentially utilising the site.

The Fork-tailed swift is an aerial species that rarely roosts. It would not be specifically attracted to the area and if ever present would only stay temporarily. Rainbow Bee-eaters are seasonally widespread and common in southern WA and utilise both natural and totally degraded habitats. They potentially use the site and adjoining areas for foraging, roosting and possibly breeding but they would not be specifically attracted to the site. The percentage of the population present at any one time would be very small and insignificant as they rarely congregated in colonies.

This criteria will therefore not be compromised by the development proceeding.

Result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species

There is no evidence available to suggest that sections of the study area represents important habitat to any of the migratory species listed as potentially utilising the site. It is extremely unlikely that the proposed development of the land would result in an invasive species that is harmful to migratory species becoming established on the site or in the vicinity.

This criteria will not be compromised by the development proceeding.

Seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.

There is no evidence available to suggest that sections of the study area represents important habitat to any of the migratory species listed as potentially utilising the site. The proposal area or adjoining areas do not support, at any time of the year, a significant proportion of the population of any migratory species.

This criteria will not be compromised by the development proceeding.

In all cases it is considered unlikely that the impact caused by any proposed development at the Project site would trigger any of the abovementioned criteria.

8. CONCLUSION

The Level 1 fauna survey at the Kurnalpi Project area was undertaken in January 2012 for the purposes of delineating and characterising the fauna habitats and faunal assemblages present in the target area and to identify potential impacts.

With respect to native vertebrate fauna, 24 mammals (includes ten bats species), 102 bird, 60 reptile and four frog species have previously been recorded in the general area, some of which have the potential to occur in or utilise at times, the Project area. Based on habitat preferences, previous detailed survey results and currently documented distributions it has been concluded to be unlikely that any threatened (vulnerable, endangered, rare or likely to become extinct) species frequent the study area except possibly as transient individuals or vagrants, on rare occasions.

The assessment suggests that two fauna species considered in need of special protection under state/federal legislation may possibly utilise the study area at times (albeit infrequently) with an additional two DEC priority species also having some potential of being present at times. Two migratory bird species may also frequent the area though only one is likely to be present on a regular (seasonal) basis.

The fauna habitats present within the proposal area have been identified as being common and widespread in the general area and the faunal assemblage identified as potentially present is unlikely to be different to that found in similar habitats located elsewhere in the region. It can therefore be concluded that the project area does not contain habitat of high ecological significance from a faunal perspective or contain faunal assemblages that are ecologically significant. Clearing principles, as defined under the *EP Act* relating specifically to fauna, are therefore considered unlikely to be compromised by the proposal proceeding.

The assessment results also suggest that no species of conservation significance has the potential to be directly affected to any significant degree by the proposal. Available evidence suggests that a significant proportion of the species discussed are locally extinct or unlikely to use the site due to a lack of suitable habitat. Those species that potentially utilise the site are relatively wide ranging and/or will persist in adjoining unaffected areas. No significant impact on any *EPBC Act* threatened species is anticipated, principally because none can be considered likely to be using the site to any significant degree. The site also does not appear to contain habitat that could be considered critical for the recovery of any listed threatened species.

Any proposed development will necessarily require the clearing of some existing fauna habitat. Planning should take into account the potential presence of some species of conservation significance and fauna in general so that any impacts can be minimised or offset. Existing management plans and protocols that aim to minimise impact on fauna should be employed where relevant with specific attention being paid to those facets highlighted in Section 6.2, when considered reasonable and practical to implement.

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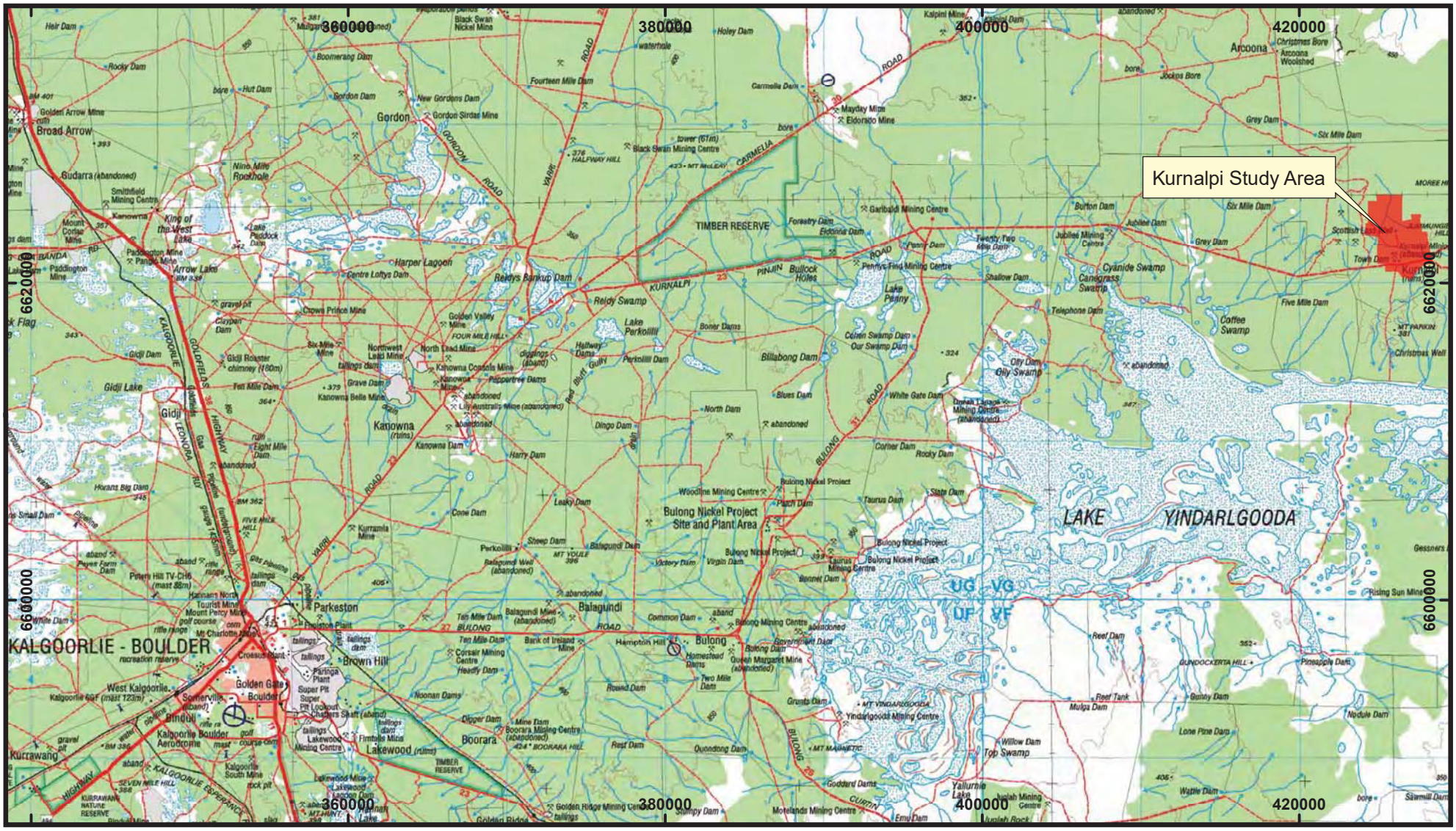
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FIGURES



Legend

Survey Area

0 5 10 15 20

Kilometres

MGA Zone 51

Fauna Survey

Carrick Gold Limited

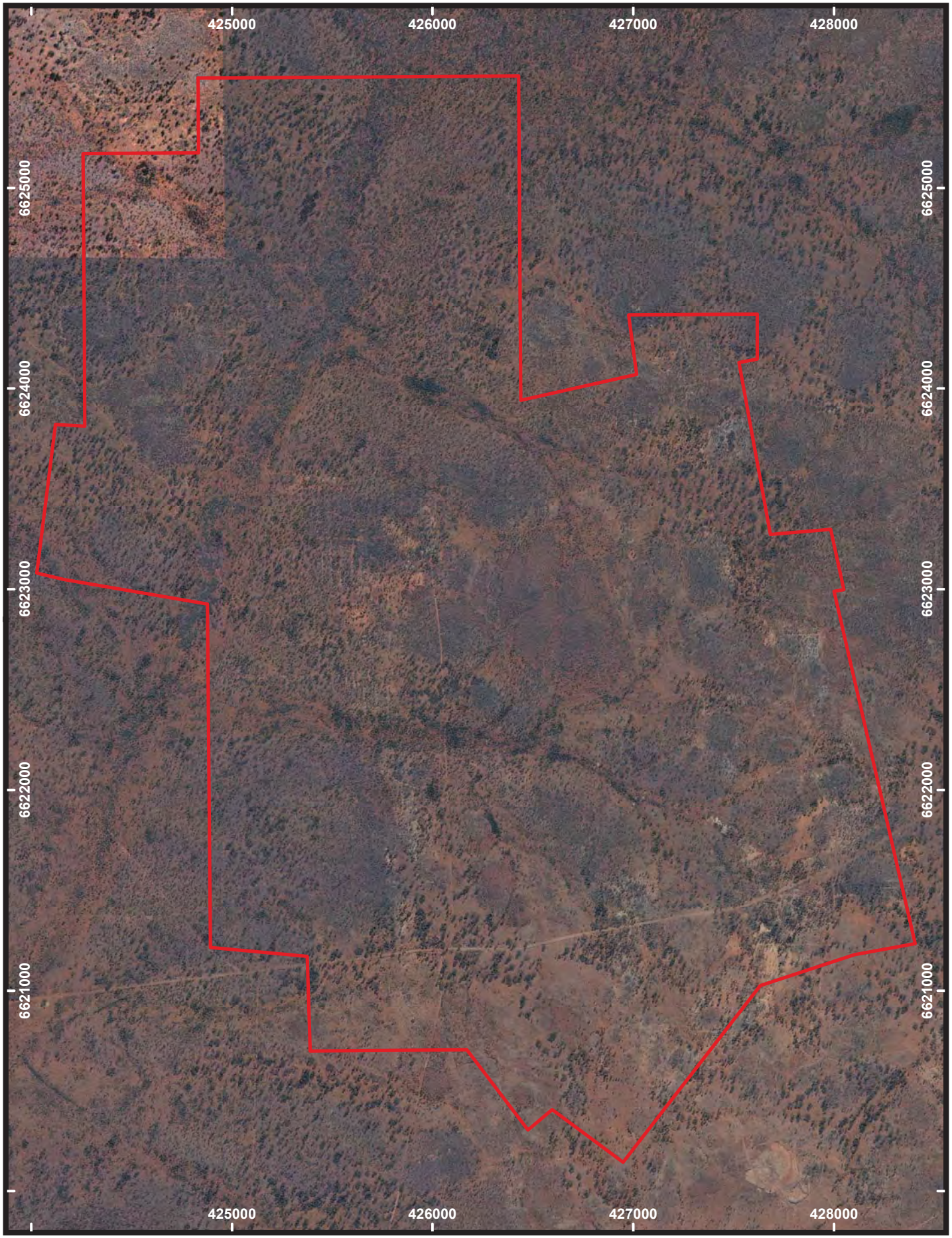
Study Area and Surrounds

DRAWN:G Harewood

DATE : Feb 2012

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Figure: 1



Legend

Survey Area

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Metres

MGA Zone 51

Fauna Survey

DRAWN:G Harewood

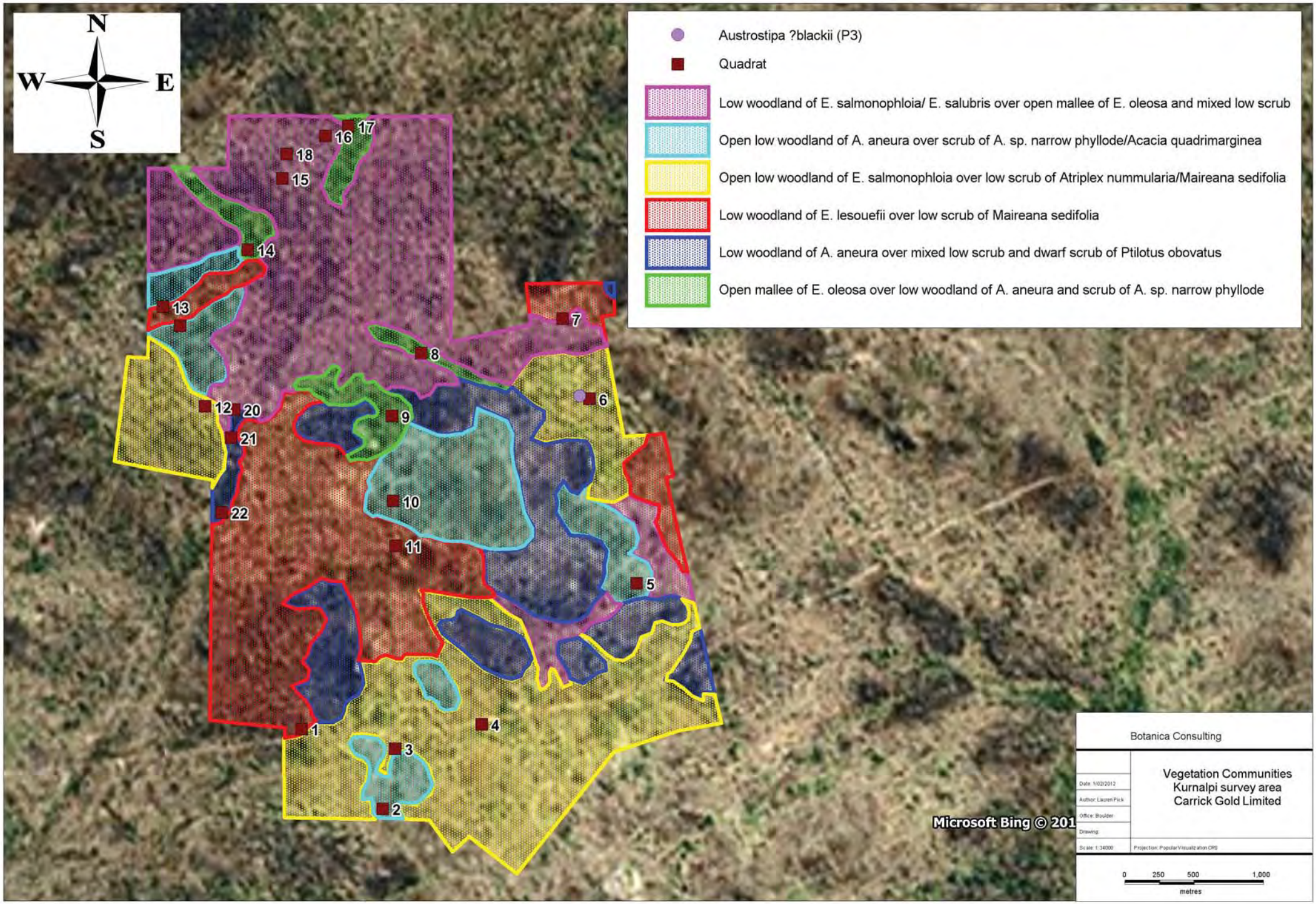
DATE : Feb 2012

SCALE: 1:25,000

Carrick Gold Limited

Study Area Air Photo

Figure: 2


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Austrostipa ?blackii (P3)
Quadrat
Low woodland of E. salmonophloia/ E. salubris over open mallee of E. oleosa and mixed low scrub
Open low woodland of A. aneura over scrub of A. sp. narrow phyllode/Acacia quadrimarginea
Open low woodland of E. salmonophloia over low scrub of Atriplex nummularia/Maireana sedifolia
Low woodland of E. lesouefii over low scrub of Maireana sedifolia
Low woodland of A. aneura over mixed low scrub and dwarf scrub of Ptilotus obovatus
Open mallee of E. oleosa over low woodland of A. aneura and scrub of A. sp. narrow phyllode
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Botanica Consulting
Vegetation Communities
Kurnalpi survey area
Carrick Gold Limited
Date: 1/02/2012
Author: Lauren Pick
Office: Boulder
Drawing:
Scale 1:34000
Projection: Popular Visualization CRS
0
250
500
1,000
metres

PLATES



Plate 1: Open low woodland of *Euclayptus salmonophloia* over low scrub of *Atriplex nummularia/Maireana sedifolia.*



Plate 2: Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea*.



Plate 3: Low woodland of *E. lesouefii* over low scrub of *Maireana sedifolia.*



Plate 4: Open mallee of *E. oleosa* over low woodland of *A. aneura* and scrub of *Acacia* sp. narrow phyllode.



Plate 5: Low woodland of *E. salmonophloia/E. salubris* over open mallee of *E. oleosa* and mixed low scrub.



Plate 6: Low woodland of *A. aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus.*

APPENDIX A

CONSERVATION CATEGORIES

EPBC Act (1999) Threatened Fauna Categories

Category	Code	Description
Extinct	E	There is no reasonable doubt that the last member of the species has died.
*Extinct in the wild	EW	A species (a) is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
*Critically endangered	CE	A species is facing an extremely high risk of extinction in the wild in the immediate future.
*Endangered	EN	A species: (a) is not critically endangered; and (b) is facing a very high risk of extinction in the wild in the near future.
*Vulnerable	VU	A species (a) is not critically endangered or endangered; and (b) is facing a high risk of extinction in the wild in the medium-term future.
Conservation dependent	CD	A species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered
*Migratory	Migratory	(a) all migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and (c) all native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Marine	Ma	Species in the list established under s248 of the EPBC Act

Note: Only species in those categories marked with an asterix are matters of national environmental significance under the *EPBC Act*.

Western Australian Wildlife Conservation Act (1950) Threatened Fauna Categories

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct Threatened fauna (Schedule 1) are further ranked by the DEC according to their level of threat using IUCN Red List criteria: **CR: Critically Endangered** - considered to be facing an extremely high risk of extinction in the wild. **EN: Endangered** - considered to be facing a very high risk of extinction in the wild. **VU: Vulnerable** - considered to be facing a high risk of extinction in the wild.
Schedule 2	S2	Fauna which is presumed extinct
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction
Schedule 4	S4	Fauna that is otherwise in need of special protection

Western Australian DEC Priority Fauna Categories

Category	Code	Description
Priority 1	P1	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes..
Priority 2	P2	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
Priority 3	P3	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
Priority 4	P4	(a) **Rare**. Taxa 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 taxa are usually represented on conservation lands. (b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Priority 5	P5	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

IUCN Red List Threatened Species Categories

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last individual has died.
Extinct in the Wild	EW	Taxa which is known only to survive in cultivation, in captivity or and as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically Endangered	CR	Taxa facing an extremely high risk of extinction in the wild.
Endangered	EN	Taxa facing a very high risk of extinction in the wild.
Vulnerable	VU	Taxa facing a high risk of extinction in the wild.
Near Threatened	NT	Taxa which has been evaluated but does not qualify for CR, EN or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	LC	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data Deficient	DD	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

A full list of categories and their meanings are available at:

http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

APPENDIX B

FAUNA OBSERVED OR POTENTIALLY IN STUDY AREA

Fauna Recorded or Potentially in Region of Study Area

Compiled by Greg Harewood - Feb 2012

Recorded (Captured/Sighted/Heard/Signs) = X

Kurnalpi, W.A.

Approximate centroid - 30.53088°S and 122.23184°E

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DEC (2012). NatureMap Database Search – "By Circle" Centre 122°14' 17" E,30°32' 03" S (plus 40km buffer). Accessed 20th Feb 2012.

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Amphibia					
Myobatrachidae Ground or Burrowing Frogs					
Neobatrachus kunapalari	Kunapalari Frog	LC			X
Neobatrachus sutor	Shoemaker Frog	LC			
Neobatrachus wilsmorei	Plonking Frog	LC			
Pseudophryne occidentalis	Western Toadlet	LC			
Reptilia					
Carphodactylidae Knob-tailed Geckos					
Nephrurus laevissimus	Smooth Knob-tail				
Nephrurus milii	Barking Gecko			X	X
Nephrurus vertebralis	Midline Knob-tailed Gecko				

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Diplodactylidae Geckoes					
Diplodactylus conspicillatus	Fat-tailed Gecko				
Diplodactylus granariensis	Western Stone Gecko				
Diplodactylus pulcher	Western Saddled Ground Gecko			X	X
Lucasium maini	Mains Ground Gecko			X	
Oedura reticulata	Reticulated Velvet Gecko				
Rhynchoedura ornata	Beaked Gecko			X	X
Strophurus assimilis	Goldfields Spiny-tailed Gecko				
Strophurus elderi	Jewelled Gecko				
Gekkonidae Geckoes					
Gehyra purpurascens	Purple Arid Dtella				X
Gehyra variegata	Variegated Dtella			X	X
Heteronotia binoei	Bynoe's Gecko			X	X
Pygopodidae Legless Lizards					
Delma butleri	Unbanded Delma				X
Lialis burtonis	Burton’s Legless Lizard			X	X
Pygopus nigriceps	Hooded Scaly Foot				

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Agamidae Dragon Lizards					
Caimanops amphiboluroides	Mulga Dragon				
Ctenophorus cristatus	Bicycle Dragon			X	X
Ctenophorus fordi	Mallee Sand Dragon			X	X
Ctenophorus reticulatus	Western Netted Dragon			X	X
Ctenophorus scutulatus	Lozenge-marked Bicycle Dragon			X	X
Moloch horridus	Thorny Devil			X	X
Pogona minor	Western Bearded Dragon			X	X
Tympanocryptis cephalus	Pebble Dragon				
Varanidae Monitor's or Goanna's					
Varanus caudolineatus	Stripe-tailed Pygmy Monitor			X	X
Varanus gouldii	Bungarra or Sand Monitor			X	X
Varanus tristis	Racehorse Monitor				X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Scincidae Skinks					
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink			X	
Cryptoblepharus carnabyi	Spiny-palmed Fence Skink				
Ctenotus atlas	Southern Malle Ctenotus			X	X
Ctenotus leonhardii	Leonhardi's Skink				X
Ctenotus schomburgkii	Barred Wedge-snout Ctenotus			X	X
Ctenotus uber	Spotted Ctenotus			X	X
Cyclodomorphus melanops elongatus	Eastern Slender Blue-tongue			X	X
Egernia depressa	Pygmy Spiny-tailed Skink			X	X
Egernia formosa	Goldfields Crevise Skink			X	X
Egernia inornata	Desert Skink				X
Eremiascincus richardsonii	Broad-banded Sand Swimmer				
Lerista kingi	Common Mulch Skink			X	X
Lerista picturata	Goldfields Robust Lerista				
Menetia greyii	Dwarf Skink			X	X
Morethia butleri	Woodland Dark-flecked Morethia			X	X
Tiliqua occipitalis	Western Bluetongue			X	X
Tiliqua rugosa	Bobtail			X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Typhlopidae Blind Snakes					
Ramphotyphlops bicolor	Dark-spined Blind Snake				
Ramphotyphlops bituberculatus	Prong-snouted Blind Snake				
Ramphotyphlops hamatus	Northern Hook-snouted Blind Snake				
Ramphotyphlops waitii	Common Beaked Blind Snake				
Elapidae Elapid Snakes					
Acanthophis pyrrhus	Desert Death Adder				
Brachyurophis fasciolata	Narrow-banded Shovel-nosed Snake				
Demansia psammophis	Yellow-faced Whipsnake				
Furina ornata	Moon Snake				
Neelaps bimaculatus	Black-naped Snake				
Parasuta monachus	Monk Snake			X	X
Pseudechis australis	Mulga Snake				X
Pseudonaja modesta	Ringed Brown Snake			X	X
Pseudonaja nuchalis	Gwardar				
Simoselaps bertholdi	Jan's Banded Snake				
Suta fasciata	Rosen's Snake				

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Aves					
Casuariidae Emus, Cassowarries					
Dromaius novaehollandiae	Emu	LC	X		X
Megapodiidae Moundbuilders					
Leipoa ocellata	Malleefowl	S1 VU VU A2bce+3ce		X	X
Accipitridae Kites, Goshawks, Eagles, Harriers					
Accipiter cirrocephalus	Collared Sparrowhawk	LC			
Accipiter fasciatus	Brown Goshawk	LC			X
Aquila audax	Wedge-tailed Eagle	LC			X
Aquila morphnoides	Little Eagle	LC			
Circus assimilis	Spotted Harrier	LC			
Elanus caeruleus	Black-shouldered Kite	LC			
Haliastur sphenurus	Whistling Kite	LC			
Hamirostra isura	Square-tailed Kite	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Falconidae Falcons					
Falco berigora	Brown Falcon	LC		X	X
Falco cenchroides	Australian Kestrel	LC	X	X	X
Falco longipennis	Australian Hobby	LC			
Falco peregrinus	Peregrine Falcon	S4 LC			X
Otididae Bustards					
Ardeotis australis	Australian Bustard	P4 NT			
Turnicidae Button-quails					
Turnix velox	Little Button-quail	LC			
Columbidae Pigeons, Doves					
Ocyphaps lophotes	Crested Pigeon	LC	X		
Phaps chalcoptera	Common Bronzewing	LC		X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Psittacidae Parrots					
Cacatua roseicapilla	Galah	LC	X	X	X
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	LC	X	X	
Melopsittacus undulatus	Budgerigar	LC		X	
Nymphicus hollandicus	Cockatiel	LC	X		
Platycercus varius	Mulga Parrot	LC		X	X
Platycercus zonarius	Australian Ringneck	LC	X	X	X
Cuculidae Parasitic Cuckoos					
Cacomantis flabelliformis	Fan-tailed Cuckoo	LC			
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	LC		X	X
Chrysococcyx osculans	Black-eared Cuckoo	LC		X	
Cuculus pallidus	Pallid Cuckoo	LC		X	
Strigidae Hawk Owls					
Ninox novaeseelandiae	Boobook Owl	LC			
Tytonidae Barn Owls					
Tyto alba	Barn Owl	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Podargidae Frogmouths					
Podargus strigoides	Tawny Frogmouth	LC			X
Caprimulgidae Nightjars					
Eurostopodus argus	Spotted Nightjar	LC			
Aegothelidae Owlet-nightjars					
Aegotheles cristatus	Australian Owlet-nightjar	LC		X	X
Apodidae Swifts, Swiftlets					
Apus pacificus	Fork-tailed Swift	S3 Mig CA JA RK LC			
Halcyonidae Tree Kingfishers					
Todiramphus pyrrhopygia	Red-backed Kingfisher	LC	X		
Todiramphus sanctus	Sacred Kingfisher	LC			
Meropidae Bee-eaters					
Merops ornatus	Rainbow Bee-eater	S3 Mig JA LC		X	X
Climacteridae Treecreepers					
Climacteris affinis	White-browed Treecreeper	LC			
Climacteris rufa	Rufous Treecreeper	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Maluridae Fairy Wrens, GrassWrens					
Malurus lamberti	Variegated Fairy-wren	LC		X	X
Malurus leucopterus	White-winged Fairy-wren	LC	X		X
Malurus splendens	Splendid Fairy-wren	LC	X		X
Acanthizidae Thornbills, Geryones, Fieldwrens & Whitefaces					
Acanthiza apicalis	Broad-tailed Thornbill	LC	X	X	X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	LC	X	X	X
Acanthiza robustirostris	Slaty-backed Thornbill	LC	X	X	
Acanthiza uropygialis	Chestnut-rumped Thornbill	LC	X	X	X
Aphelocephala leucopsis	Southern Whiteface	LC		X	
Gerygone fusca	Western Gerygone	LC			
Pyrrholaemus brunneus	Redthroat	LC	X	X	X
Smicrornis brevirostris	Weebill	LC	X	X	X
Pardalotidae Pardalotes					
Pardalotus striatus	Striated Pardalote	LC	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Meliphagidae Honeyeaters, Chats					
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	LC	X	X	X
Anthochaera carunculata	Red Wattlebird	LC	X		X
Certhionyx niger	Black Honeyeater	LC			
Certhionyx variegatus	Pied Honeyeater	LC			
Epthianura albifrons	White-fronted Chat	LC			
Epthianura tricolor	Crimson Chat	LC			
Lichenostomus leucotis	White-eared Honeyeater	LC	X	X	X
Lichenostomus ornatus	Yellow-plumed Honeyeater	LC	X	X	X
Lichenostomus plumulus	Grey-fronted Honeyeater	LC		X	
Lichenostomus virescens	Singing Honeyeater	LC	X	X	X
Lichmera indistincta	Brown Honeyeater	LC	X	X	X
Manorina flavigula	Yellow-throated Miner	LC	X	X	X
Melithreptus brevirostris	Brown-headed Honeyeater	LC		X	X
Phylidonyris albifrons	White-fronted Honeyeater	LC	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Petroicidae Australian Robins					
Drymodes brunneopygia	Southern Scrub-robin	LC			X
Microeca fascinans	Jacky Winter	LC	X	X	X
Petroica cucullata	Hooded Robin	LC			
Petroica goodenovii	Red-capped Robin	LC		X	X
Pomatostomidae Babblers					
Pomatostomus superciliosus superciliosus	White-browed Babbler (central/northern)	LC	X	X	X
Cinclosomatidae Whipbirds, Wedgebills, Quail Thrushes					
Cinclosoma castanotus	Chestnut Quail-thrush	LC			X
Neosittidae Sitellas					
Daphoenositta chrysoptera	Varied Sittella	LC			X
Pachycephalidae Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers					
Colluricincla harmonica	Grey Shrike-thrush	LC	X	X	X
Oreoica gutturalis pallescens	Crested Bellbird (central/northern)	LC	X	X	
Pachycephala inornata	Gilbert's Whistler	LC			X
Pachycephala rufiventris	Rufous Whistler	LC	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Dicruridae Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo					
Grallina cyanoleuca	Magpie-lark	LC			X
Rhipidura fuliginosa	Grey Fantail	LC			X
Rhipidura leucophrys	Willie Wagtail	LC	X		X
Campephagidae Cuckoo-shrikes, Trillers					
Coracina maxima	Ground Cuckoo-shrike	LC	X		X
Coracina novaehollandiae	Black-faced Cuckoo-shrike	LC	X	X	X
Lalage tricolor	White-winged Triller	LC		X	X
Artamidae Woodswallows, Butcherbirds, Currawongs					
Artamus cinereus	Black-faced Woodswallow	LC			X
Artamus cyanopterus	Dusky Woodswallow	LC			
Artamus minor	Little Woodswallow	LC			
Artamus personatus	Masked Woodswallow	LC			X
Cracticidae Currawongs, Magpies & Butcherbirds					
Cracticus nigrogularis	Pied Butcherbird	LC	X	X	X
Cracticus tibicen	Australian Magpie	LC	X		X
Cracticus torquatus	Grey Butcherbird	LC	X	X	X
Strepera versicolor	Grey Currawong	LC	X	X	X

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Corvidae Ravens, Crows					
Corvus bennetti	Little Crow	LC			X
Corvus coronoides	Australian Raven	LC	X		X
Corvus orru	Torresian Crow	LC			
Corvus sp	Corvid sp.			X	
Motacillidae Old World Pipits, Wagtails					
Anthus australis	Australian Pipit	LC			
Estrilidae Grass Finches & Mannikins					
Taeniopygia guttata	Zebra Finch	LC			
Dicaeidae Flowerpeckers					
Dicaeum hirundinaceum	Mistletoebird	LC		X	X
Hirundinidae Swallows, Martins					
Cheramoeca leucosternus	White-backed Swallow	LC			
Hirundo ariel	Fairy Martin	LC			
Hirundo neoxena	Welcome Swallow	LC			
Hirundo nigricans	Tree Martin	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Sylviidae Old World Warblers					
Cincloramphus cruralis	Brown Songlark	LC	X		
Cincloramphus mathewsi	Rufous Songlark	LC			
Mammalia					
Tachyglossidae Echidnas					
Tachyglossus aculeatus	Echidna	LC	X		X
Dasyuridae Carnivorous Marsupials					
Ningaui ridei	Wongai Ningaui	LC		X	X
Ningaui yvonneae	Southern Ningaui	LC			
Sminthopsis crassicaudata	Fat-tailed Dunnart	LC		X	X
Sminthopsis dolichura	Little long-tailed Dunnart	LC		X	X
Burramyidae Pygmy Possums					
Cercartetus concinnus	Western Pygmy-possum	LC			
Macropodidae Kangaroos, Wallabies					
Macropus fuliginosus	Western Grey Kangaroo	LC	X		X
Macropus robustus	Euro	LC			
Macropus rufus	Red Kangaroo	LC	X		X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Emballonuridae Sheath-tailed Bats					
Taphozous hilli	Hill's Sheathtail-bat	LC			X
Molossidae Freetail Bats					
Mormopterus sp 3	Inland Freetail-bat	LC			X
Tadarida australis	White-striped Freetail-bat	LC		X	X
Vespertilionidae Ordinary Bats					
Chalinolobus gouldii	Gould's Wattled Bat	LC		X	X
Chalinolobus morio	Chocolate Wattled Bat	LC		X	X
Nyctophilus geoffroyi	Lesser Long-eared Bat	LC			X
Nyctophilus major tor	Central Long-eared Bat	P4			
Scotorepens balstoni	Inland Broad-nosed Bat	LC		X	X
Vespadelus baverstocki	Inland Forest Bat	LC			X
Vespadelus regulus	Southern Forest Bat	LC		X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Muridae Rats, Mice					
Mus musculus	House Mouse	Introduced		X	X
Notomys alexis	Spinifex Hopping-mouse	LC			
Notomys mitchellii	Mitchell's Hopping-mouse	LC		X	
Pseudomys bolami	Bolam's Mouse	LC			X
Pseudomys hermannsburgensis	Sandy Inland Mouse	LC		X	X
Canidae Dogs, Foxes					
Canis lupus dingo	Dingo	LC			X
Felidae Cats					
Felis catus	Cat	Introduced			X
Bovidae Horned Ruminants					
Bos taurus	European Cattle	Introduced	X		X
Capra hircus	Goat	Introduced	X		X
Ovis aries	Sheep	Introduced			
Leporidae Rabbits, Hares					
Oryctolagus cuniculus	Rabbit	Introduced	X		X

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

APPENDIX C

DEC NATUREMAP & EPBC ACT DATABASE SEARCH RESULTS

NatureMap
Mapping Western Australia's biodiversity

NatureMap - Kurnalpi - Frogs

Created By Greg Harewood on 20/02/2012

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Amphibians
Method	'By Circle'
Centre	122°14' 17" E,30°32' 03" S
Buffer	40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	25425	*Neobatrachus kunapalari (Kunapalari Frog)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap
Mapping Western Australia's biodiversity

NatureMap - Kurnalpi - Reptiles

Created By Greg Harewood on 20/02/2012

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Species Group Reptiles
Method 'By Circle'
Centre 122°14' 17" E,30°32' 03" S
Buffer 40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	30886	*Cryptoblepharus australis*			
2.	24871	*Ctenophorus cristatus (Bicycle Dragon)*			
3.	24873	*Ctenophorus fordi (Mallee Sand Dragon)*			
4.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
5.	24888	*Ctenophorus salinarum (Salt Pan Dragon)*			
6.	24889	*Ctenophorus scutulatus*			
7.	25026	*Ctenotus atlas*			
8.	25052	*Ctenotus leonhardii*			
9.	25074	*Ctenotus schomburgkii*			
10.	25080	*Ctenotus uber subsp. uber*			
11.	25089	*Cyclodomorphus melanops subsp. elongatus*			
12.	24997	*Delma butleri*			
13.	24940	*Diplodactylus pulcher*			
14.	25092	*Egernia depressa (Pygmy Spiny-tailed Skink)*			
15.	25094	*Egernia formosa*			
16.	25095	*Egernia inornata*			
17.	24957	*Gehyra purpurascens*			
18.	24959	*Gehyra variegata*			
19.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
20.	30927	*Lerista kingi*			
21.	25155	*Lerista muelleri*			
22.	25005	*Lialis burtonis*			
23.	25184	*Menetia greyii*			
24.	24904	*Moloch horridus (Thorny Devil)*			
25.	25190	*Morethia butleri*			
26.	30941	*Nephrurus milii (Barking Gecko)*			
27.	25254	*Parasuta monachus*			
28.	24907	*Pogona minor subsp. minor*			
29.	25261	*Pseudechis australis (Mulga Snake)*			
30.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
31.	24982	*Rhynchoedura ornata (Beaked Gecko)*			
32.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
33.	25519	*Tiliqua rugosa*			
34.	25207	*Tiliqua rugosa subsp. rugosa*			
35.	25211	*Varanus caudolineatus*			
36.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
37.	25526	*Varanus tristis (Racehorse Monitor)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap
Mapping Western Australia's biodiversity

NatureMap - Kurnalpi - Birds

Created By Greg Harewood on 20/02/2012

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Species Group Birds
Method 'By Circle'
Centre 122°14' 17" E,30°32' 03" S
Buffer 40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
5.	25536	*Accipiter fasciatus (Brown Goshawk)*			
6.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
7.	24541	*Amytornis textilis subsp. textilis*		P4	
8.	24561	*Anthochaera carunculata (Red Wattlebird)*			
9.	24285	*Aquila audax (Wedge-tailed Eagle)*			
10.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
11.	24356	*Artamus personatus (Masked Woodswallow)*			
12.	25715	*Cacatua roseicapilla (Galah)*			
13.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
14.	30956	*Cinclosoma castanotus (Chestnut Quail-thrush)*			
15.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
16.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
17.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
18.	24416	*Corvus bennetti (Little Crow)*			
19.	25592	*Corvus coronoides (Australian Raven)*			
20.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
21.	25595	*Cracticus tibicen (Australian Magpie)*			
22.	25596	*Cracticus torquatus (Grey Butcherbird)*			
23.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
24.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
25.	24470	*Dromaius novaehollandiae (Emu)*			
26.	24650	*Drymodes brunneopygia (Southern Scrub-robin)*			
27.	25621	*Falco berigora (Brown Falcon)*			
28.	25622	*Falco cenchroides (Australian Kestrel)*			
29.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
30.	24443	*Grallina cyanoleuca (Magpie-lark)*			
31.	24367	*Lalage tricolor (White-winged Triller)*			
32.	24557	*Leipoa ocellata (Malleefowl)*		T	
33.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
34.	24577	*Lichenostomus ornatus (Yellow-plumed Honeyeater)*			
35.	24581	*Lichenostomus virescens (Singing Honeyeater)*			
36.	25661	*Lichmera indistincta (Brown Honeyeater)*			
37.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
38.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
39.	25654	*Malurus splendens (Splendid Fairy-wren)*			
40.	24583	*Manorina flavigula (Yellow-throated Miner)*			
41.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
42.	24598	*Merops ornatus (Rainbow Bee-eater)*			
43.	25693	*Microeca fascinans (Jacky Winter)*			
44.	24619	*Pachycephala inornata (Gilbert's Whistler)*			
45.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
46.	25682	*Pardalotus striatus (Striated Pardalote)*			
47.	24630	*Pardalotus striatus subsp. westraliensis*			
48.	24659	*Petroica goodenovii (Red-capped Robin)*			
49.	24409	*Phaps chalcoptera (Common Bronzewing)*			
50.	24593	*Phylidonyris albifrons (White-fronted Honeyeater)*			
51.	24748	*Platycercus varius (Mulga Parrot)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
52.	25721	*Platycercus zonarius (Australian Ringneck)*			
53.	25703	*Podargus strigoides (Tawny Frogmouth)*			
54.	25722	*Polytelis anthopeplus (Regent Parrot)*			
55.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
56.	24278	*Pyrrholaemus brunneus (Redthroat)*			
57.	25613	*Rhipidura fuliginosa (Grey Fantail)*			
58.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
59.	30948	*Smicrornis brevirostris (Weebill)*			
60.	25597	*Strepera versicolor (Grey Currawong)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap - Kurnalpi - Mammals

Created By Greg Harewood on 20/02/2012

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Mammals
Method	'By Circle'
Centre	122°14' 17" E,30°32' 03" S
Buffer	40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24251	*Bos taurus (European Cattle)*			
2.	25454	*Canis lupus*			
3.	24253	*Capra hircus (Goat)*			
4.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
5.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
6.	24041	*Felis catus (Cat)*			
7.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
8.	24136	*Macropus rufus (Red Kangaroo)*			
9.	24184	*Mormopterus planiceps (Southern Freetail-bat)*			
10.	24223	*Mus musculus (House Mouse)*			
11.	24094	*Ningaui ridei (Wongai Ningaui)*			
12.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
13.	24085	*Oryctolagus cuniculus (Rabbit)*			
14.	24232	*Pseudomys bolami (Bolam's Mouse)*			
15.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
16.	24199	*Scotorepens balstoni (Inland Broad-nosed Bat)*			
17.	24108	*Sminthopsis crassicaudata (Fat-tailed Dunnart)*			
18.	24109	*Sminthopsis dolichura (Little long-tailed Dunnart)*			
19.	24207	*Tachyglossus aculeatus (Echidna)*			
20.	24185	*Tadarida australis (White-striped Freetail-bat)*			
21.	24176	*Taphozous hilli (Hill's Sheathtail-bat)*			
22.	24202	*Vespadelus baverstocki (Inland Forest Bat)*			
23.	24206	*Vespadelus regulus (Southern Forest Bat)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Australian Government

Department of Sustainability, Environment, Water, Population and Communities

EPBC Act Protected Matters Report

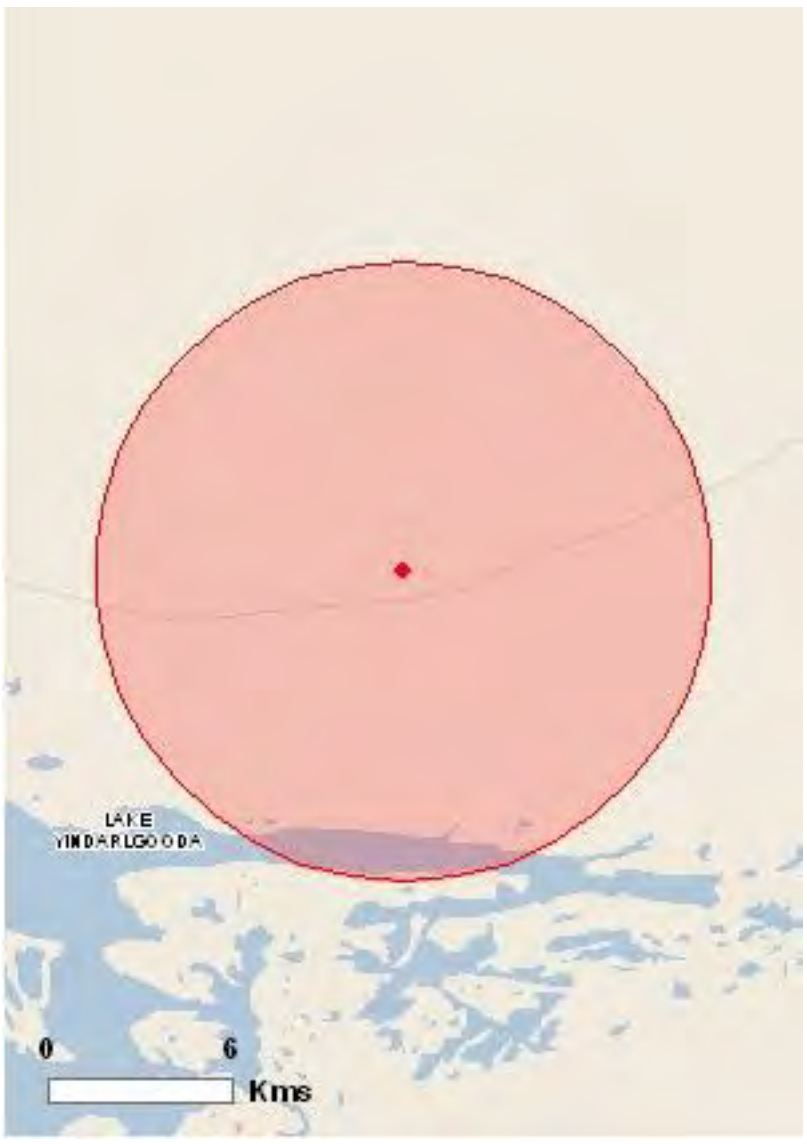
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

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 about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Report created: 16/02/12 19:09:24

Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



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

Coordinates

Buffer: 10.0Km



Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None
Threatened Species:	2
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 and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html

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.

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. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	6
Nationally Important Wetlands:	None

Details

Matters of National Environmental Significance

Threatened Species		[Resource Information]
Name	Status	Type of Presence
BIRDS		
Acanthiza iredalei iredalei		
Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area

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 may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		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 may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		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,

Name	Status	Type of Presence
Mammals		
Capra hircus Goat [2]		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 likely to occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

Coordinates

-30.53088 122.23184

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 Heritage and Register of National Estate properties, Wetlands of International 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

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

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.

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:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA 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
-State Forests of NSW
-Other groups and individuals

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

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

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APPENDIX D

SIGNIFICANT SPECIES PROFILES

Southern Carpet Python *Morelia spilota impricata*

Status and Distribution: The south western population is classified as Priority 4 by the DEC and is also listed in Schedule 4 under the *WC Act*. This subspecies has wide distribution within the south west but is uncommon. Occurs north to Geraldton and Yalgoo and east to Pinjin, Kalgoorlie, Fraser Range and Eyre (Storr *et al* 2002).

Habitat: This species has been recorded from semi-arid coastal and inland habitats, Banksia woodland, Eucalypt woodlands, and grasslands. Most often found utilising hollow logs in addition the burrows of other animals for shelter. Often arboreal and will also use tree hollows for refuge.

Likely presence in study area: Status onsite difficult to determine but given the paucity of records north of Kalgoorlie in recent times it is unlikely to be present. Not listed as a potential species.

Potential impact of development: No impact on this species is anticipated as it is unlikely to be present.

Malleefowl *Leipoa ocellata*

Status and Distribution: This species is listed as Schedule 1 under the *WC Act* and as Vulnerable and Migratory under the *EPBC Act*. Originally common, but now generally rare to uncommon and patchily distributed.

Current distribution mainly southern arid and semi-arid zones, north to Shark Bay, Jingemarra, Colga Downs and Yeelirrie, east to Earnest Giles Range, Yeo Lake, lower Ponton Creek and to Eucla and west and south to Cockleshell Gully, the Wongan Hills, Stirling Range, Beaufort Inlet, Hatters Hill, Mt Ragged and Point Malcolm (Johnstone and Storr 1998).

Habitat: Mainly scrubs and thickets of mallee *Eucalyptus* spp., boree *Melaleuca lanceolata* and bowgada *Acacia linophylla*, also dense litter forming shrublands.

Likely presence in study area: WAM and DEC records from near Kurnalpi in 1992 and 2007 respectively. Some additional records from 2009 and 2010 about 30km north of the Project Area (DEC 2011). More recently a chick at Kanowna (60km west) (2011 pers comms Botanica Consulting). These wide spaced, infrequent records suggest that the species may occur at times though it should be noted that no nest mounds (active, inactive or degraded condition) have been observed in the Project area as far as the Author is aware. Most likely to only occur occasionally as transient (“migratory”) individuals.

Potential impact of development: No impact on this species is anticipated as it is considered unlikely to use the study area except on rare occasions while in transit to other locations. While available evidence suggests that it is unlikely that Malleefowl breed in the Project area, it is recommended that areas to be cleared should be inspected for potential nest mounds prior to works commencing.

Great Egret *Ardea alba*

Status and Distribution: This species of egret is listed as Schedule 3 under the *WC Act* and as Migratory under the *EPBC Act* including international agreements to which Australia is a signatory. The Great Egret is common and very widespread in any suitable permanent or temporary habitat (Morcombe, 2003).

Habitat: Wetlands, flooded pasture, dams, estuarine mudflats, mangroves and reefs (Morcombe 2003).

Likely presence in study area: No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as it is unlikely to use the project area for any purpose.

Peregrine Falcon *Falco peregrinus*

Status and Distribution: This species is listed as Schedule 4 under the *WC Act*. Individuals of this species are uncommon/rare but wide ranging across Australia. Moderately common at higher levels of the Stirling Range, uncommon in hilly, north west Kimberley, Hamersley and Darling Ranges; rare or scarce elsewhere (Johnstone and Storr 1998).

Habitat: Diverse from rainforest to arid shrublands, from coastal heath to alpine (Morcombe 2003). Mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes (Johnstone and Storr 1998). The species utilises the ledges, cliff faces and large hollows/broken spouts of trees for nesting. It will also occasionally use the abandoned nests of other birds of prey. Also known to utilise decommissioned open cut pit walls for nesting.

Likely presence in study area: The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. Known to utilise decommissioned pit walls for nesting where suitable crevices present. No potential nest sites in trees observed.

Potential impact of development: No impact anticipated.

Grey Falcon *Falco hypoleucos*

Status and Distribution: Listed as Priority 4 by the DEC. Within WA found in the northern half south to about 26°S (Gascoyne, Lake Carnegie and Warburton), casual further south (Johnstone and Storr 1998).

Habitat: Lightly treed plains, gibber deserts, sand ridges, pastoral lands, timbered water courses but seldom in driest deserts (Pizzey & Knight 2006).

Likely presence in study area: The study area is outside this species current main documented range though it may occur very rarely. Not listed as a potential species.

Potential impact of proposed development: No impact on this species is anticipated.

Australian Bustard *Ardeotis australis*

Status and Distribution: This species is listed as Priority 4 by DEC. A nomadic species that is common away from settled areas over much of Australia (Morcombe, 2003).

Habitat: Grasslands, especially tussock grasses, like speargrass, Mitchell grass, spinifex; arid scrub with saltbush, bluebush; open dry woodland of mulga, mallee and, heath (Morcombe, 2003).

Likely presence in study area: May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

Potential impact of development: Loss of an area of potential habitat though no significant impact on this species is anticipated as it is likely to be present only infrequently, in low numbers. There are vast areas of suitable habitat in surrounding areas.

Bush Stone Curlew *Burhinus grallarius*

Status and Distribution: Listed as Priority 4 by DEC. Occurs over much of the western half of the state (and Kimberley) but rare to uncommon in the south of its range due to fox predation (Johnstone and Storr 1998).

Habitat: Lightly wooded country (including partly cleared forests) near daytime shelter e.g. thickets or long grass (Johnstone and Storr 1998).

Likely presence in study area: No recent or historical records suggest this species is very unlikely to be present in the study area despite apparent suitable habitat, though it may occur very occasionally.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding as it is considered unlikely to be present.

Hooded Plover *Charadrius rubricollis*

Status and Distribution: Listed as Priority 4 by DEC. In south west WA, coastally west from Israelite Bay north to Jurien Bay and inland salt lakes. In eastern Australia confined to suitable habitat from Jervis Bay (NSW) through Bass Strait and Tasmanian and west to Great Australian Bight in South Australia.

Habitat: Broad sandy ocean beaches and bays, coastal and inland salt lakes (Pizzey & Knight 2006).

Likely presence in study area: No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as it is unlikely to use the project area for any purpose.

Princess Parrot *Polytelis alexandrae*

Status and Distribution: This species is listed as Priority 4 by the DEC and as Vulnerable under the *EPBC Act*. Rare, highly nomadic (Pizzey & Knight 2006). Found in the eastern deserts north to the Edgar Ranges, west to the Gregory Range, Well 18, Mt Bates, Lake Throssell and Mt Luck and south to Queen Victoria Spring and Carlisle Lakes, casual further north (Fossil Downs, Bohemia Downs) and west (head of Gascoyne, head of the Murchison, Wiluna, Wanjarri, Sandstone, Laverton, Kookynie, Menzies, Kanowna). Also deserts of eastern Australia (Johnstone and Storr 1998).

Habitat: Arid shrubland, particularly mulga, Desert Oak and Spinifex country including trees along watercourses (Simpson and Day 2004).

Likely presence in study area: The study area is just outside this species current documented range though it may occur very rarely. No recent records. Not listed as a potential species.

Potential impact of proposed development: No impact on this species or its preferred habitat is anticipated.

Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*

Status and Distribution: The inland sub species of the Western Rosella is listed as Scheduled 1 under the *WC Act*. At present rare to moderately common (Johnstone and Storr 1998). Local extinctions have occurred in 25% of local government authorities, representing about 40% of the total range, mostly in the north and east (Saunders and Curry 1990, Saunders and Ingram 1995, Mawson and Long 1996, Mawson and Johnstone 1997). Still declining in wheatbelt, but stable in western woodland and forest (Mawson and Johnstone 1997). Semiarid southern interior: Wongan Hills (formerly), Kununoppin, Moorine Rock, Parker Range, Yardina Rock and Ten Mile Rocks, west to Toodyay, the Dale River, Mt Saddleback and Kojonup, and south to the Stirling Range, lower Fitzgerald River, Ravensthorpe, Frank Hann National Park and Red Lake; casual further north (Mt Jackson, Karalee, Gnarlbine Rock) (Johnstone and Storr 1998).

Habitat: Mainly eucalypt and casuarina woodlands and scrubs, especially of wandoo, flooded gum, salmon gum, tall mallees and *Allocasuarina huegeliana*. Attracted to seeding *E wandoo*, *A. huegeliana*, *Glischrocaryon flavescens* and *Olearia revoluta* and to flowering *Melaleuca acuminata* and *Eucalyptus eremophilrx* (Johnstone and Storr 1998).

Likely presence in study area: There is a DEC NatureMap database record for this species in the general area (DEC 2012), but this is likely to be an old, individual sighting. The study site is outside of the currently documented range of this sub-species and it is therefore considered unlikely to frequent the area.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Major Mitchell's Cockatoo *Cacatua leadbeateri*

Status and Distribution: Classified as Schedule 4 under the *WC Act*. Sedentary, generally uncommon and of patchy occurrence. Widespread but disjunct in arid and semi arid zones. Found across the arid and semi-arid inland, from south-western Queensland south to north-west Victoria, through most of South Australia, north into the south-west Northern Territory and across to the west coast between Shark Bay and Jurien Bay south to Queen Victoria Spring (Johnstone and Storr 1998).

Habitat: Lightly or sparsely wooded country near water and tall eucalypts (Johnstone and Storr 1998).

Likely presence in study area: Study area is just outside of this species main documented range and the paucity of records in the local or regional area

suggests habitat is generally is unsuitable for this species to persist. May occur very occasionally

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Fork-tailed Swift *Apus pacificus*

Status and Distribution: The Fork-tailed Swift is listed as Schedule 3 under the *WC Act* and as Migratory under the *EPBC Act* including international agreements to which Australia is a signatory. It is a summer migrant (Oct-Apr) to Australia (Morcombe 2003).

Habitat: Low to very high airspace over varied habitat from rainforest to semi desert (Morcombe 2003).

Likely presence in study area: This species is potentially a very occasional summer visitor to the wider area but is entirely aerial and largely independent of terrestrial habitats and it would not be specifically attracted to the project area.

Potential impact of development: No impact on this species is anticipated.

Rainbow Bee-eater *Merops ornatus*

Status and Distribution: This species is listed as Schedule 3 under the *WC Act* and as migratory under the *EPBC Act* including international agreements to which Australia is a signatory. The Rainbow Bee-eater is a common summer migrant to southern Australia but in the north they are resident (Morcombe 2003).

Habitat: Open Country, of woodlands, open forest, semi arid scrub, grasslands, clearings in heavier forest, farmlands (Morcombe 2003). Breeds underground in areas of suitable soft soil firm enough to support tunnel building. Nest is a burrow usually dug at a slight angle in flat ground, sometimes into sandy banks or cuttings and often on margins of roads and tracks (Johnstone and Storr 1998).

Likely presence in study area: Observed just south of the project area prior to the site survey. Common seasonal visitor to southern half of WA. A small possibility that breeding would take place in some sections of the study area where ground conditions are suitable. Population levels would however not be significant as it usually breeds in pairs, rarely in small colonies (Johnstone and Storr, 1998).

Potential impact of development: No significant impact on this species is anticipated.

Slender-billed Thornbill (western) *Acanthiza iredalei iredalei*

Status and Distribution: This subspecies is listed as Vulnerable under the *EPBC Act.* Distribution is disjunct in southern arid zone: vicinity of mid west coast from Lake Macleod south to Wooramel, Hamelin and on Peron Peninsula and Edel land: margins of salt lakes from Lake Annean, Lake Austin, Lake Violet and Lake Throssell south to Lake Barlee and Lake Goongarrie. Also within areas of the southern Nullarbor Plain. Moderately common to common on mid-west coast (e.g. between Carnarvon and Long Point); uncommon, rare or extinct elsewhere (Johnstone and Storr 2004).

Habitat: Chenopod shrub steppe, mainly bluebush *Maireana sedifolia*, saltbush *Atriplex* spp. and samphire *Halosarcia* spp. In treeless or sparsely wooded flatlands; also samphire, dwarf mangroves and low melaleuca and other stunted near coastal shrubs (Johnstone and Storr 2004).

Likely presence in study area: Despite the presence of some apparently suitable habitat (low scrub/Chenopod shrubland - mainly bluebush *Maireana sedifolia*, and saltbush *Atriplex nummularia*) the lack of actual records (historical and more recent) suggest it is absent from the general area. Not listed as a potential species.

Potential impact of development: No impact on this species is anticipated as is considered unlikely to be present.

Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*

Status and Distribution: Listed as Priority 4 by DEC and vulnerable under the *EPBC Act*. Historically, the 'western' Thick-billed Grasswren was found in the Shark Bay area, including Peron Peninsula and Dirk Hartog Island, at Wongan Hills, east of Broomehill, between Beverley and Narembeen, Mt Magnet, Lake Austin, Lake Way and Lake Violet, Yalgoo, Kalgoorlie and Laverton. There is some doubt as to the extent of the Thick-billed Grasswren over the Nullarbor Plain. Currently restricted to the Shark Bay region including Peron Peninsula and the nearby pastoral stations of Nanga, Hamelin, Woodleigh and Carbla (Cale 2000).

Habitat: Occurs in acacia-dominated shrublands, dense shrub associations in drainage depressions, and *Triodia* spinifex with acacia shrubland components. All these habitats feature recumbent shrubs where the foliage extends to the ground. In acacia-dominated shrublands, shrub clumps of high foliage density appear important determinants of Thick-billed Grasswren presence. These shrub clumps may provide the Thick-billed Grasswren with ideal nesting sites (Cale 2000).

Likely presence in study area: No suitable habitat. Species is considered to be locally extinct in the wider area.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Bilby *Macrotis lagotis*

Status and Distribution: The Bilby is listed as Schedule 1 under the *WC Act* and Vulnerable under the *EPBC Act*. Current distribution in suitable habitat from Tanami Desert west to near Broome and south to Warburton. Former distribution extended south to Margaret River, though apparently absent from coastal plain (Burbidge 2004).

Habitat: Current habitat included Acacia shrublands, spinifex and hummock grassland (Menkhorst *et* al., 2001).

Likely presence in study area: This species is locally and regionally extinct.

Potential impact of proposed development: No impact on this species will occur.

Chuditch *Dasyurus geoffroii*

Status and Distribution: Listed as Scheduled 1 under the *WC Act* and as Vulnerable under the *EPBC Act.* Formerly occurred over nearly 70 per cent of Australia. The Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of southwest Western Australia. Also occurs in very low numbers in the Midwest, Wheatbelt and South Coast Regions with records from Moora to the north, Yellowdine to the east and south to Hopetoun.

Habitat: Chuditch are known to have occupied a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts. Riparian vegetation appears to support higher densities of Chuditch, possibly because food supply is better or more reliable and better cover is offered by dense vegetation. Chuditch appear to utilise native vegetation along road sides in the wheatbelt (CALM 1994). The estimated home range of a male Chuditch is over 15 km^2 whilst that for females is 3-4 km^2 (Sorena and Soderquist 1995).

Likely presence in study area: No records in area suggest this species is locally and regionally extinct. It is unlikely that a population of this species exists in or near the study area. Even if habitat within the study area was suitable, the

absence of any feral predator control or possible recruitment from adjoining areas means it is unlikely to be persists in the area under normal circumstances.

Potential impact of development: No impact on this species will occur as a result of the proposed development.

Numbat *Myrmecobius fasciatus*

Status and Distribution: Listed as Scheduled 1 under the *WC Act* and as Vulnerable under the *EPBC Act*. Once occurred across much of arid and semi arid southern Australia, now restricted to a few remnant forests of Wandoo, Powderbark Wandoo or jarrah in South West WA (Menkhorst & Knight 2001). Rare, scattered. Found only at Dryandra, Perup and six other translocation sites (Van Dyck & Strahan 2008).

Habitat: Generally dominated by eucalypts that provide hollow logs and branches for shelter and termites for food (Van Dyck & Strahan 2008).

Likely presence in study area: Available evidence suggests this species is locally and regionally extinct.

Potential impact of development: No impact on this species is anticipated.

Central Long-eared Bat *Nyctophilus major tor*

Status and Distribution: Listed as Priority 4 by DEC. Historical distribution included the Coolgardie, Hampton and northern Avon Bioregions in Western Australia, Gawler Bioregion and western part of the 'Eyre and York Blocks' Bioregion in South Australia. A specimen from Ooldea in the Great Victoria Desert Bioregion of South Australia. One other specimen from a car grill after a night-time drive from Marla (Stony Plains Bioregion of SA) to Alice Springs in the Northern Territory via the Stuart Highway in c.1985. No historical data on abundance.

Currently known from 15 localities in Western Australia and 19 in South Australia. No evidence that range has contracted, but it is apparently rare in Great Victoria Desert, Nullarbor and Stony Plains Bioregions while it is locally common in Coolgardie, Hampton, Gawler and western Eyre-York Block Bioregions (Duncan *et al* (ed) 1999).

Habitat: Gleans ground, bark and foliage surfaces; forages in and against cluttered airspaces. The species is often netted, and sometimes caught in pit traps, in heavy eucalypt woodlands and tall woodlands of the Coolgardie Bioregion of Western Australia with a tall shrub understorey of *Melaleuca*

lanceolata, M. pauperiflora, M. quadrifaria, Eremophila spp. etc. Less common in open woodlands. Has been netted at dams in the Coolgardie and Hampton Bioregions of Western Australia while in South Australia has been associated with a range of mallee (*Eucalyptus*) species, *Acacia papyrocarpa*, *A. ramulosa, Casuarina cristata* and found to the fringes of the treeless Nullarbor Plain (Duncan *et al* (ed) 1999). Roosts in tree cavities, in foliage and under loose bark (Churchill 2008).

Likely presence in study area: This species has been recorded during bat surveys at the Kanowna Belle mine site 60km west of the Project area. Exact status in the study area difficult to determine. Listed as a potential species but can be considered to have a low probability of being present.

Potential impact of development: If present clearing will result in the loss/modification of some foraging and potential roosting habitat but this is unlikely to alter the status of the species on a local or regional scale.

Appendix E: Level 1Terrestrial Fauna Survey of the Arcoona Haul Road (2013)

Terrestrial Fauna Survey
(Level 1)

of the

Arcoona Haul Road

KalNorth Gold Mines Limited

March 2013
Version 1

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DISCLAIMER

This fauna assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Greg Harewood ("the Author"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints. In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

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SUMMARY

This report details the results of a Level 1 fauna assessment of the proposed Arcoona haul road route that will provide a link between KalNorth Gold Mines Limited's Project areas. The proposed haul road has a total length of approximately 29km. The study area was comprised of a 100m wider buffer either side of the haul road's proposed centre line and has a total area of about 349 ha, only some of which will require clearing to achieve the desired road width (Figures 1, 2 & 3).

The scope of works was to conduct a level 1 fauna survey as defined by the Environmental Protection Authority (EPA 2004). The assessment has included a desktop study and a site reconnaissance survey. The site survey work was carried out by Greg Harewood (B.Sc. Zoology) on the 25 September, 2012.

The extent of the broadly defined fauna habitats within the study area are shown in Figure 4, 5 and 6 with a description of each given below. Additional information of the vegetation units present within the study area can be found in the vegetation and flora report for the site (Botanica Consulting 2013).

- Low woodland of *Casuarina pauper* over mixed low scrub and dwarf scrub of *Ptilotus obovatus;*
- Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub;
- Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*;
- Low woodland of *Acacia caesaneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*;
- Open mallee of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and scrub of *Acacia* sp.;
- Open tree mallee of *Eucalyptus horistes/Eucalyptus concinna* over low scrub of *Westringia cephalantha/Grevillea oncogyne* and hummock grass of *Triodia scariosa.*

The entire area exhibited soil characteristics typical of the regional land system mapping (Van Vreeswyk *et al.* 1994) these primarily being a mosaic of sandplains, alluvial and stony plains and low rocky basalt/greenstone rises.

Plates 1 to 5 illustrate the nature of fauna habitats existing within the study area.

The results of the opportunistic fauna survey are summarised in Table 1 and listed in Appendix B. A total of 32 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the

reconnaissance survey. Evidence of two introduced species utilising the area was also obtained.

Evidence of one listed threatened species was observed (malleefowl – several tracks within and near the study area, recently utilise mound just outside (~20m) the boundary of the study area). The location of all malleefowl observations are shown in Figure 7. Evidence of one migratory species was recorded (five rainbow-bee-eaters foraging in mallee). No evidence of any DEC priority species using the area was found.

A review of the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) threatened fauna list, Department of Environment and Conservation's (DEC's) Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified 20 specially protected, priority or migratory vertebrate fauna species as potentially occurring in the general vicinity of the study area.

In summary, two fauna species of conservation significance (as listed on state or federal threatened/migratory species lists or DEC priority species) were positively identified as utilising the study area during the Level 1 reconnaissance survey carried out in September 2012, these being:

- *Leipoa ocellata* Malleefowl - S1 *(WC Act),* Vulnerable & Migratory *(EPBC Act)*
  Several footprints of this species were found in and near the study area and a recently used nest mound was located 20m outside the boundary of the study area at 409765 mE 6642042 mN (MGA Zone 51).

- *Merops ornatus* Rainbow Bee-eater – Migratory (*EPBC Act*)
  Five individuals observed in the central section of the study area. This species is a common, widespread seasonal visitor to southern half of WA.

The current status on site and/or in the general area of other potential species of conservation significance can be difficult to determine because they were not sighted during the survey period or evidence of use of the study area was not found. However, based on the habitats present and, in some cases, recent nearby records, four other species of conservation significance can be regarded as possibly utilising the study area for some purpose at times, these being:

- *Falco peregrinus* Peregrine Falcon - S4 (*WC Act*)
  The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. No potential nest sites in trees observed.

- *Morelia spilota imbricata* Southern Carpet Python - S4 (*WC Act*) - P4 *(*DEC Priority Species)
  A dead southern carpet python was found by the Author 10km south west of the study area on the day of the field reconnaissance survey, indicating that a population of the species persists in the general area.

- *Ardeotis australis* Australian Bustard - P4 (DEC Priority Species)
  May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

- *Nyctophilus major tor* Central Long-eared Bat - P4 *(*DEC Priority Species)
  Extreme northern limit of documented range. This species has been recorded during bat surveys at the Kanowna Belle mine site 50km south west. Exact status in the study area difficult to determine. May be present but probability can be considered to be low.

Note: Habitat onsite for some of the species listed above, while considered possibly suitable, may be marginal in extent/quality and species listed above may only visit the area for short periods or as rare/uncommon vagrants.

A number of other species of conservation significance, while possibly present in the general area and/or the wider region are not listed as potential species due to the study area being outside of their currently recognised range, a lack of suitable habitat or known/very likely local or regional extinction (and no subsequent recruitment from adjoining areas).

The impact on the significant species listed as potentially being present will vary depending on their current degree of utilisation/population densities and preferred habitat requirements (e.g. quantity and quality of potential foraging and breeding habitat that is affected).

The possible impact on specific species of conservation significance previously recorded in the general area is provided in the table below. Additional information on specific fauna species is provided in Appendix D.

Likelihood of Occurrence and Possible Impacts – Fauna Species of Conservation Significance (continues on following pages)

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Southern Carpet Python *Morelia spilota imbricata*	-	S4	P4	Yes	Possible	Loss/modification of a small area of potential habitat
Malleefowl *Leipoa ocellata*	Vulnerable	S1	-	Yes	Known to occur.	Loss of habitat used for breeding and foraging.
Great Egret *Ardea alba*	Migratory	S3	-	No	Unlikely.	No impact.
Cattle Egret *Ardea ibis*	Migratory	S3	-	No	Unlikely.	No impact.

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Grey Falcon *Falco hypoleucos*	-	S1	-	Yes/Marginal	Unlikely. Outside normal range. May occur very rarely.	No impact.
Peregrine Falcon *Falco peregrinus*	-	S4	-	Yes	Possible.	No significant impact likely. Modification of some foraging habitat.
Australian Bustard *Ardeotis australis*	-	-	P4	Yes	Possible. Would only occur very rarely	Loss/modification of a small area of potential habitat.
Bush Stone Curlew *Burhinus grallarius*	-	-	P4	Yes/Marginal	Unlikely. May occur very occasionally.	No impact.
Hooded Plover *Charadrius rubricollis*	-	-	P4	No	Unlikely.	No impact.
Major Mitchell's Cockatoo *Cacatua leadbeateri*	-	S4	-	No	Unlikely. Outside normal range but may occur very rarely.	No impact.
Princess Parrot *Polytelis alexandrae*	-	-	P4	No	Unlikely. Just outside normal range, but may occur very rarely.	No impact.
Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*	-	-	P4	No	Unlikely. Outside normal range.	No impact.
Fork-tailed Swift *Apus pacificus*	Migratory	S3	-	Yes	Flyover only.	No impact.
Rainbow Bee-eater *Merops ornatus*	Migratory	S3	-	Yes	Know to occur.	Loss/modification of a small area of potential habitat.
Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*	-	-	P4	No	Unlikely. No suitable habitat. Locally extinct.	No impact.
Slender-billed Thornbill (western ssp) *Acanthiza iredalei iredalei*	VU	-	-	No	Unlikely. Species appears to be locally extinct.	No impact.
Bilby *Macrotis lagotis*	Vulnerable	S1	-	No	Unlikely. Species appears to be locally extinct.	No Impact.
Chuditch *Dasyurus geoffroii*	Vulnerable	S1	-	Yes	Unlikely. Species appears to be locally extinct.	No impact.
Numbat *Myrmecobius fasciatus*	Vulnerable	S1	-	No/Marginal	Unlikely. Species is locally and regionally extinct.	No impact.
Central Long-eared Bat *Nyctophilus major tor*	-	-	P4	Yes/Marginal	Possible but at extreme limit of known range.	Loss/modification of a small area of potential habitat.

The malleefowl, a threatened species classified as vulnerable under state and federal legislation, was identified as utilising sections of the proposed haul route. Two species considered in need of special protection under state legislation may possibly utilise the study area at times (peregrine falcon and carpet python) and two DEC priority species (Australian bustard and central long-eared bat) also has some potential of being present at times. One migratory species (the rainbow bee-eater) was observed in the study area though it would generally only be present temporally, and then only a seasonal basis.

The presence of malleefowl within the area will need to be taken into consideration during future planning and during mine operations so as to minimise potential impacts on the species and areas of most likely habitat.

It is recommended that a targeted malleefowl survey be carried out preferably during the central period of the main malleefowl breeding season (October to December) to better determine the significance of the area and some adjoining areas to the species. The results of this work should be used to formulate a malleefowl management plan and implemented as part of future operation of the haul road with the main aim of minimising the likelihood of road kills, unnecessary clearing of suitable habitat and the risk of unplanned fires.

It is also recommended that an assessment of the need for a referral to Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) to ensure compliance with the EPBC Act should be carried out when planning is further advanced and additional survey results and expert advice are obtained.

With respect to fauna in general, existing management plans and protocols that aim to minimise impact should be employed where relevant with specific attention being paid to those facets highlighted in Section 7.2, when considered reasonable and practical to implement.

1. INTRODUCTION

This report details the results of a Level 1 fauna assessment of the proposed Arcoona haul road route that will provide a link between KalNorth Gold Mines Limited's Project areas. The study site is located about 70 kilometres north east of Kalgoorlie and is centred at approximately 30.441900°S and 122.123100°E. The proposed haul road has a total length of approximately 29km. The study area was comprised of a 100m wider buffer either side of the haul road's proposed centre line and had a total area of about 349 ha, only some of which will require clearing to achieve the desired road width (Figures 1, 2 & 3).

2. SCOPE OF WORKS

The scope of works was designed to comply with requirements of a Level 1 terrestrial fauna survey as defined in EPA Guidance Statement 56 (EPA 2004):

- Background research or 'desktop' study

  The purpose is to gather background information on the target area (usually at the locality scale). This involves a search of all sources for literature, data and map-based information.

- Reconnaissance survey

  The purposes are:

  i) to verify the accuracy of the background study;

  ii) to further delineate and characterise the fauna and faunal assemblages present in the target area; and

  iii) to identify potential impacts.

  The reconnaissance survey involves a site visit by suitably qualified personnel to undertake selective, low intensity sampling of the fauna and faunal assemblages, and to provide habitat descriptions and habitat maps of the project area (EPA 2004).

3. BIOGEOGRAPHICAL SETTING

The project area is situated near the southern boundary of the East Murchison bioregion (MUR1 subregion - Cowan 2001). The East Murchison subregion is described as:

"The northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. Characterised by its internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake

systems associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and Halosarcia shrublands. Arid climate, with mainly winter rainfall (200 mm). The subregional area for MUR1 is 7,847,996 ha.)" (Cowan 2001).

Beard (1990) locates the survey area within the Austin Botanical District. The typical sequence of vegetation within the Austin Botanical District is Mulga (*Acacia aneura*) woodlands on plains reduced to shrubs on hills and *Eucalyptus* sp. tree steppe on sand plains with *Triodia* sp. (Beard 1990)

Van Vreeswyk *et al.* (1994) undertook a regional inventory of the goldfields region to document the land systems present and their condition. Six of the land systems defined by Van Vreeswyk *et al.* (1994) fall within the study area, these being:

- Kirgella Land System - Extensive sandplain, occasional dunes with scattered granite outcrop supporting mainly spinifex hummock grasslands, and mulga and mallee shrublands.

- Yowie Land System - Sandy plains supporting Acacia shrublands of mulga and bowgada with patchy wanderrie grasses.

- Moriarty Land System - Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.

- Campsite Land System - Alluvial plains, supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.

- Graves Land System - Basalt and greenstone rises and low hills supporting eucalypt or Acacia woodlands with prominent saltbush and bluebush understoreys.

- Leonora Land System - Low greenstone hills and stony plains supporting eucalypt or acacia woodlands and mixed stony chenopod shrublands.

4. METHODS

4.1 POTENTIAL FAUNA INVENTORY - DESKTOP STUDY

4.1.1 Database Searches

Searches of the following databases were undertaken to aid in the compilation of a list of vertebrate fauna potentially occurring within the study area:

- Department of Environment and Conservation's (DEC's) NatureMap Database (combined data from DEC, Western Australian Museum and Birds Australia) (DEC 2012); and
- Protected matters search tool (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2012).

It should be noted that these lists are based on observations from a broader area than the study site and therefore may include species that would only ever occur as vagrants in the actual study area due to a lack of suitable habitat or the presence of only marginal habitat. The databases also often included very old records and in some cases the species in question have become locally or regionally extinct.

Information from these sources should therefore be taken as indicative only and local knowledge and information needs also to be taken into consideration when determining what actual species may be present within the specific area being investigated.

4.1.2 Previous Fauna Surveys in the Area

Fauna surveys, assessments and reviews have been undertaken in nearby areas in the past, though not all are publically available and could not be referenced. The most significant of those available have been used as the primary reference material for compiling the potential fauna assemblage for the general area. The main reports referred to included, but was not limited to:

- McKenzie, N.L. and Hall, N.J. (1992). The Biological Survey of the Eastern Goldfields of WA - Pt 8: Kurnalpi – Kalgoorlie study area. Records of the WAM, Supplement 41: 1 – 125.

As with the databases searches some reports refer to species that would not occur in the study area due to a lack of suitable habitat (extent and/or quality) and this fact was taken into consideration when compiling the potential fauna species list for the study area. It should also be noted that the NatureMap database is likely to include some records from previous fauna surveys in the area including some of those listed above.

4.1.3 Existing Publications

The following represent the main publications used to identify and refine the potential fauna species list for the study area:

- Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). The New Atlas of Australian Birds. Royal Australasian Ornithologists Union, Victoria.
- Churchill, S. (2008). Australian Bats. Second Edition, Allen & Unwin.
- Johnstone, R.E. and Storr, G.M. (1998). Handbook of Western Australian Birds: Volume 1 – Non-passerines (Emu to Dollarbird). Western Australian Museum, Perth Western Australia.
- Johnstone, R.E. and Storr, G.M. (2004). Handbook of Western Australian Birds: Volume 2 – Passerines (Blue-winged Pitta to Goldfinch). Western Australian Museum, Perth Western Australia.
- Menkhorst, P. and Knight, F. (2011). A Field Guide to the Mammals of Australia. Third Edition, Oxford University Press, Melbourne.
- Storr, G.M., Smith, L.A. and Johnstone R.E. (1983). Lizards of Western Australia II: Dragons and Monitors. WA Museum, Perth.
- Storr, G.M., Smith, L.A. and Johnstone R.E. (1990). Lizards of Western Australia III: Geckos and Pygopods. WA Museum, Perth.
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- Storr, G.M., Smith, L.A. and Johnstone R.E. (2002). Snakes of Western Australia. Revised Edition, WA Museum, Perth.
- Thompson, S & Thompson, G (2006). Reptiles of the Western Australian Goldfields. Published by the Goldfields Environmental Management Group.
- Tyler M.J. & Doughty P. (2009). Field Guide to Frogs of Western Australia, Fourth Edition, WA Museum, Perth.
- Van Dyck, S. & Strahan, R. Eds (2008). The Mammals of Australia. Third edition. Queensland Museum.
- Wilson, S. and Swan, G. (2010). A Complete Guide to Reptiles of Australia. Third Edition, Reed, New Holland, Sydney.

4.1.4 Fauna of Conservation Significance

The conservation significance of fauna species has been assessed using data from the following sources:

- *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). Administered by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC);

- *Wildlife Conservation Act 1950 (WC Act).* Administered by the Western Australian Department of Environment and Conservation (DEC);

- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List - the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria; and the

- DEC Priority Fauna list. A non-legislative list maintained by the DEC for management purposes.

The *EPBC Act* also requires the compilation of a list of migratory species that are recognised under international treaties including the:

- Japan Australia Migratory Bird Agreement 1981 (JAMBA);

- China Australia Migratory Bird Agreement 1998 (CAMBA);

- Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA); and

- Bonn Convention 1979 (The Convention on the Conservation of Migratory Species of Wild Animals).

(Note - Species listed under JAMBA are also protected under Schedule 3 of the *WC Act*.)

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as matters of national environmental significance (NES) under the *EPBC Act*.

The conservation status of all vertebrate fauna species listed as occurring or possibly occurring in the vicinity of the Project area has been assessed using the most recent lists published in accordance with the above-mentioned instruments and is indicated as such in the fauna listings of this report. A full listing of conservation codes are provided in Appendix A.

4.1.5 Invertebrate Fauna

It can be difficult to identify what may be significant invertebrate species (e.g. Short Range Endemics - SREs) as there are uncertainties in determining the

range-restrictions of many species due to lack of surveys, lack of taxonomic resolutions within target taxa and problems in identifying certain life stages. Where invertebrates are collected during surveys, a high percentage are likely to be unknown, or for known species there can be limited knowledge or information on their distribution (Harvey 2002).

For this project, the assessment for conservation significant invertebrates has been limited to those listed by the DEC and *EPBC Act* database searches (which rely on distribution records and known habitat preferences). No assessment of the potential for SRE invertebrates to be present has been made.

4.1.6 Taxonomy and Nomenclature

Taxonomy and nomenclature for fauna species used in this report is generally taken from the DEC's WA Fauna Census Database which is assumed to follow Aplin and Smith (2001) for amphibians and reptiles, How *et al*. (2001) for mammals and Johnstone (2001) for birds.

Common names are taken from the Western Australia Museum (WAM) recognised primary common name listings when specified, though where common names are not provided they have been acquired from other publications. Sources include Wilson and Swan (2010), Van Dyck & Strahan (2008), Christidis and Boles (2008), Bush *et al.* (2007), Bush *et al.* (2002), Tyler *et al.* (2000), and Glauret (1961). Not all common names are generally accepted.

4.2 SITE SURVEYS

Field survey work was carried out by Greg Harewood (B.Sc. Zoology) on the 25 September 2012.

4.2.1 Fauna Habitat Assessment

Vegetation units identified during the flora and vegetation survey, carried out by Botanica Consulting (2013), have been used to define broad fauna habitat types across the site. This information has been supplemented with observations made during the fauna survey.

The main aim of the habitat assessment was to determine if it was likely that any species of conservation significance would be utilising the areas that maybe impacted on as a consequence of the proposal proceeding. The habitat information obtained was also used to aid in finalising the overall potential fauna list.

As part of the desktop literature review, available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area was researched. During the field survey the habitats within the study area were assessed and specific elements identified, if present, to

determine the likelihood of listed threatened species utilising the area and its significance to them.

4.2.2 Opportunistic Fauna Observations

Opportunistic observations of fauna species were made during the site reconnaissance survey which involved traversing the study area several times on foot. This included searching microhabitats such as logs, rocks, leaf litter and observations of bird species with binoculars.

5. SURVEY CONSTRAINTS

The conclusions presented are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. Also it should be recognised that site conditions can change with time. No seasonal sampling has been carried out as part of this fauna assessment.

Some fauna species are reported as potentially occurring within the study area based on there being suitable habitat (quality and extent) within the study area or immediately adjacent. With respect to opportunistic observations, the possibility exists that certain species may not have been detected during field investigations due to:

- seasonal inactivity during the field survey;
- species present within micro habitats not surveyed;
- cryptic species able to avoid detection; and
- transient wide-ranging species not present during the survey period.

Lack of observational data on some species should therefore not necessarily be taken as an indication that a species is absent from the site.

The habitat requirements and ecology of many of the species known to occur in the wider area are often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitat or microhabitat within the study area. As a consequence of this limitation the potential fauna list produced is most likely an overestimation of those species that actually utilise the study area for some purpose. Some species may be present in the general area but may only use the study area itself on rare occasions or as vagrants.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any fauna species that would possibly occur within the study area (or immediately adjacent), as identified through ecological databases,

publications, discussions with local experts/residents and the habitat knowledge of the Author, has been assumed to potentially occur in the study area.

6. RESULTS

6.1 POTENTIAL FAUNA INVENTORY - DESKTOP STUDY

A list of expected fauna species likely to occur in the study area was compiled from information obtained during the desktop study and is presented in Appendix B. This listing was refined after information gathered during the site reconnaissance survey was assessed. The results of some previous fauna surveys carried out in the general area are summarised in this species listing as are the DEC NatureMap database search results. The raw database search results from NatureMap (DEC 2012) and the Protected Matters Search Tool (DSEWPaC 2012) are contained within Appendix C.

The list of potential fauna takes into consideration that firstly the species in question is not known to be locally extinct and secondly that suitable habitat for each species, as identified during the habitat assessment, is present within the study area, though compiling an accurate list has limitations (see Section 5 above).

6.2 SITE SURVEYS

6.2.1 Fauna Habitat Assessment

The broad scale fauna habitats within the study area are based mainly on vegetation structure as mapped by Botanica Consulting (2013). The extent of the broadly defined fauna habitats within the study area are shown in Figure 4, 5 and 6 with a description of each given below. Additional information of the vegetation units present within the study area can be found in the vegetation and flora report for the site (Botanica Consulting 2013).

- Low woodland of *Casuarina pauper* over mixed low scrub and dwarf scrub of *Ptilotus obovatus;*
- Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub;
- Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia*;
- Low woodland of *Acacia caesaneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*;
- Open mallee of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and scrub of *Acacia* sp.;

- Open tree mallee of *Eucalyptus horistes/Eucalyptus concinna* over low scrub of *Westringia cephalantha/Grevillea oncogyne* and hummock grass of *Triodia scariosa.*

The entire area exhibited soil characteristics typical of the regional land system mapping (Van Vreeswyk *et al.* 1994) these primarily being a mosaic of sandplains, alluvial and stony plains and low rocky basalt/greenstone rises.

Plates 1 to 5 illustrate the nature of fauna habitats existing within the study area.

6.2.2 Opportunistic Fauna Surveys

The results of the opportunistic fauna survey are summarised in Table 1 and listed in Appendix B. A total of 32 native fauna species were observed (or positively identified from foraging evidence, scats, tracks, skeletons or calls) within the study area during the reconnaissance survey. Evidence of two introduced species utilising the area was also obtained.

Evidence of one listed threatened species was observed (malleefowl – several tracks within and near the study area, recently utilise mound just outside (~20m) the boundary of the study area). The location of all malleefowl observations are shown in Figure 7. Evidence of one migratory species was recorded (five rainbow-bee-eaters foraging in mallee). No evidence of any DEC priority species using the area was found.

6.3 FAUNA INVENTORY – SUMMARY

6.3.1 Vertebrate Fauna

Table 1 summarises the numbers of potential species based on vertebrate class considered likely to be present in the general vicinity of the study area. A complete list of vertebrate fauna possibly inhabiting or frequenting the region is held in Appendix B.

Details on specially protected and priority species expected and/or listed as potentially occurring in the general area are given in Appendix D.

Not all species listed in existing databases and publications as potentially occurring within the region (i.e. *EPBC Act's* Threatened Fauna and Migratory species lists, DEC's NatureMap Fauna Database and various publications) are likely to be present within the study area. Some species have been excluded from this list based on the lack of suitable habitat or known/highly likely local extinction even if suitable habitat is present.

It should be noted that even if some additional species are omitted from the listing for the specific study area the resulting list would still very likely represent an over estimation of the fauna species utilising the site (either on a regular of

infrequent basis) as a result of the precautionary approach adopted for the assessment

Table 1: Summary of Potential Vertebrate Fauna Species (as listed in Appendix B)

Group	Total number of potential species	Potential number of specially protected species	Potential number of migratory species	Potential number of priority species	Number of species observed Level 1 Survey
Amphibians	3	0	0	0	0
Reptiles	63	1	0	0	2
Birds	101	2	1	1	27
Non-Volant Mammals	20[6]	0	0	0	5[2]
Volant Mammals (Bats)	10	0	0	1	0
Total	**197[6]**	**3**	**1**	**2**	**34[2]**

Superscript = number of introduced species included in total.

A review of the *EPBC Act* threatened fauna list, DEC's Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified 20 specially protected, priority or migratory vertebrate fauna species as potentially occurring in the general vicinity of the study area.

In summary, two fauna species of conservation significance (as listed on state or federal threatened/migratory species lists or DEC priority species) were positively identified as utilising the study area during the Level 1 reconnaissance survey carried out in September 2012, these being:

- *Leipoa ocellata* Malleefowl - S1 *(WC Act),* Vulnerable & Migratory *(EPBC Act)*
  Several footprints of this species were found in and near the study area and a recently used nest mound was located 20m outside the boundary of the study area at 409765 mE 6642042 mN (MGA Zone 51).

- *Merops ornatus* Rainbow Bee-eater – Migratory (*EPBC Act*)
  Five individuals observed in the central section of the study area. This species is a common, widespread seasonal visitor to southern half of WA.

The current status on site and/or in the general area of other potential species of conservation significance can be difficult to determine because they were not

sighted during the survey period or evidence of use of the study area was not found. However, based on the habitats present and, in some cases, recent nearby records, four other species of conservation significance can be regarded as possibly utilising the study area for some purpose at times, these being:

- *Falco peregrinus* Peregrine Falcon - S4 (*WC Act*)
  The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. No potential nest sites in trees observed.

- *Morelia spilota imbricata* Southern Carpet Python - S4 (*WC Act*) - P4 *(*DEC Priority Species)
  A dead southern carpet python was found by the Author 10km south west of the study area on the day of the field reconnaissance survey, indicating that a population of the species persists in the general area.

- *Ardeotis australis* Australian Bustard - P4 (DEC Priority Species)
  May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

- *Nyctophilus major tor* Central Long-eared Bat - P4 *(*DEC Priority Species)
  Extreme northern limit of documented range. This species has been recorded during bat surveys at the Kanowna Belle mine site 50km south west. Exact status in the study area difficult to determine. May be present but probability can be considered to be low.

Note: Habitat onsite for some of the species listed above, while considered possibly suitable, may be marginal in extent/quality and species listed above may only visit the area for short periods or as rare/uncommon vagrants.

The following species of conservation significance, while possibly present in the general area and/or the wider region are not listed as potential species due to the study area being outside of their currently recognised range, a lack of suitable habitat or known/very likely local or regional extinction (and no subsequent recruitment from adjoining areas):

- *Ardea alba* Great Egret - Migratory *(EPBC Act)*
  No suitable habitat. Not listed as a potential species.

- *Ardea ibis Cattle* Egret - Migratory *(EPBC Act)*
  No suitable habitat. Not listed as a potential species.

- *Falco hypoleucos* Grey Falcon – S1 (WC Act)
  The study area is outside this species current documented range. May occur on rare occasions.

- *Burhinus grallarius* Bush Stone Curlew - P4 (DEC Priority Species)
  No recent or historical records suggest this species is very unlikely to be present in the study area despite apparent suitable habitat, though may occur very occasionally.

- *Charadrius rubricollis* Hooded Plover – P4 (DEC Priority Species)
  No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

- *Cacatua leadbeateri* Major Mitchell's Cockatoo –- S4 (*WC Act*)
  Study area is just outside of this species main documented range and the paucity of records in the local area suggests habitat is generally unsuitable for this species to persist. May occur very occasionally.

- *Polytelis alexandrae* Princess Parrot – P4 (DEC Priority Species), Vulnerable *(EPBC Act)*
  The study area is just outside this species current documented range. The species is nomadic and may occur occasionally but would not be specifically attracted to the study area.

- *Platycercus icterotis xanthogenys* Western Rosella (Inland ssp) – P4 (DEC Priority Species)
  DEC database record, but this is likely to be an old, individual sighting. No recent records (e.g. Birds Australia database) suggest this species rarely frequents areas this far north/east.

- *Acanthiza iredalei iredalei* Slender-billed Thornbill (western ssp) - Vulnerable *(EPBC Act)*
  No suitable habitat. This, combined with the lack of actual records (historical and more recent) suggest it is absent from the general area. Not listed as a potential species.

- *Amytornis textilis textilis* Thick-billed Grass-wren (western ssp) - P4 (DEC Priority Species)
  Available evidence suggests this species is locally and regionally extinct.

- *Apus pacificus* Fork-tailed Swift – S3 (*WC Act*), Migratory (*EPBC Act*)
  Very rare seasonal visitor. Probability of ever occurring is very low and then it would only be present briefly while flying overhead.

- *Macrotis lagotis* Bilby - S1 (*WC Act*), Vulnerable (*EPBC Act*)
  Available evidence suggests this species is locally and regionally extinct.

- *Dasyurus geoffroii* Chuditch - S1 *(WC Act),* Vulnerable *(EPBC Act)*
  Available evidence suggests this species is locally and regionally extinct.

- *Myrmecobius fasciatus* Numbat – S1*(WC Act),* Vulnerable *(EPBC Act)*
  Available evidence suggests this species is locally and regionally extinct.

Additional details on significant species that potentially utilise the study area are given in Appendix D.

6.3.2 Invertebrate Fauna

No conservation significant invertebrate species appeared in the DEC or *EPBC Act* database searches (DEC 2012, DSEWPaC 2012).

7. ECOLOGICAL IMPACTS AND MANAGEMENT

7.1 POTENTIAL IMPACTS

In general the most significant potential impacts to fauna of any development include:

- Loss of vegetation/fauna habitat that is used for foraging, breeding, roosting, or dispersal (includes loss of hollow bearing trees),
- Fragmentation of vegetation/fauna habitat which may restrict the movement of some fauna species,
- Modifications to surface hydrology, siltation of creek lines,
- Changes to fire regimes,
- Pollution (e.g. oil spills),
- Noise/Light/Dust,
- Spread of plant pathogens (e.g. dieback) and weeds,
- Potential increase in the number of predatory feral species (e.g. foxes, cats),
- Increase in the frequency of road kills; and
- Death or injury of fauna during clearing and construction.

In this instance the most likely/inevitable impacts of the proposed haul road construction and operation are considered to be:

- The loss of fauna habitat, some of which is or maybe utilised by fauna of conservation significance,
- Death or injury of fauna during clearing and construction.

The impact on the significant species listed as potentially being present will vary depending on their current degree of utilisation/population densities and preferred habitat requirements (e.g. quantity and quality of potential foraging and breeding habitat that is affected).

The possible impact on specific species of conservation significance previously recorded in the general area is provided in Table 2 below. Additional information on specific fauna species is provided in Appendix D.

Table 2: Likelihood of Occurrence and Possible Impacts – Fauna Species of Conservation Significance (continues on following pages)

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Southern Carpet Python *Morelia spilota imbricata*	-	S4	P4	Yes	Possible	Loss/modification of a small area of potential habitat
Malleefowl *Leipoa ocellata*	Vulnerable	S1	-	Yes	Known to occur.	Loss of habitat used for breeding and foraging.
Great Egret *Ardea alba*	Migratory	S3	-	No	Unlikely.	No impact.
Cattle Egret *Ardea ibis*	Migratory	S3	-	No	Unlikely.	No impact.
Grey Falcon *Falco hypoleucos*	-	S1	-	Yes/Marginal	Unlikely. Outside normal range. May occur very rarely.	No impact.
Peregrine Falcon *Falco peregrinus*	-	S4	-	Yes	Possible.	No significant impact likely. Modification of some foraging habitat.
Australian Bustard *Ardeotis australis*	-	-	P4	Yes	Possible. Would only occur very rarely	Loss/modification of a small area of potential habitat.
Bush Stone Curlew *Burhinus grallarius*	-	-	P4	Yes/Marginal	Unlikely. May occur very occasionally.	No impact.
Hooded Plover *Charadrius rubricollis*	-	-	P4	No	Unlikely.	No impact.
Major Mitchell's Cockatoo *Cacatua leadbeateri*	-	S4	-	No	Unlikely. Outside normal range but may occur very rarely.	No impact.
Princess Parrot *Polytelis alexandrae*	-	-	P4	No	Unlikely. Just outside normal range, but may occur very rarely.	No impact.
Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*	-	-	P4	No	Unlikely. Outside normal range.	No impact.
Fork-tailed Swift *Apus pacificus*	Migratory	S3	-	Yes	Flyover only.	No impact.
Rainbow Bee-eater *Merops ornatus*	Migratory	S3	-	Yes	Know to occur.	Loss/modification of a small area of potential habitat.

Species	Conservation Status (see Appendix A for codes)			Habitat Present	Likelihood of Occurrence	Maximum Possible Impact
	EPBC Act	WC Act	DEC Priority			
Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*	-	-	P4	No	Unlikely. No suitable habitat. Locally extinct.	No impact.
Slender-billed Thornbill (western ssp) *Acanthiza iredalei iredalei*	VU	-	-	No	Unlikely. Species appears to be locally extinct.	No impact.
Bilby *Macrotis lagotis*	Vulnerable	S1	-	No	Unlikely. Species appears to be locally extinct.	No Impact.
Chuditch *Dasyurus geoffroii*	Vulnerable	S1	-	Yes	Unlikely. Species appears to be locally extinct.	No impact.
Numbat *Myrmecobius fasciatus*	Vulnerable	S1	-	No/Marginal	Unlikely. Species is locally and regionally extinct.	No impact.
Central Long-eared Bat *Nyctophilus major tor*	-	-	P4	Yes/Marginal	Possible but at extreme limit of known range.	Loss/modification of a small area of potential habitat.

The main identified constraint on haul road construction will be the identified presence of malleefowl in the area. Malleefowl maybe utilising sections of the study area as breeding and foraging habitat and the proposed haul route has the potential to directly impact on these areas. The future operation of the haul road also has the potential to increase the likelihood of road kills. The presence of breeding malleefowl within the area will need to be taken into consideration during future planning and during mine operations so as to minimise potential impacts on the species and areas of most likely habitat.

7.2 MINIMISING IMPACTS

KalNorth Gold Mines Limited has a series of environmental management plans and protocols in place that aim to minimise potential environmental impacts during all facets of their operations. The implementation of these standard plans and protocols will ensure impacts of the proposed activities at the site are minimised as far as reasonable and practical while allowing development to progress.

The following proposed management recommendations are considered most important and while likely to form part of existing procedures and protocols should be made a priority during site development and operation. It is recommended that:

- A targeted malleefowl survey should be carried preferably during the central period of the main malleefowl breeding season (October to December) to better determine the significance of the area to the species. The recently completed level 1 survey was conducted just outside of the species main documented breeding season and did not adequately cover all sections of the haul route where nesting is a possibility. The species has an identified preference for scrubs and thickets of mallee and also dense litter forming shrublands. A sandy substrate and abundance of leaf litter are clear requirements for the construction of the birds' incubator-nests. Habitats containing these elements should be a priority for targeted searches.

  It may also be prudent to examine nearby potential habitat areas (i.e. outside of the proposed haul route area) to gain a better understanding of malleefowl activity in adjoining locations so as to place potential impacts in perspective

- The proposed haul road should avoid all identified nest mounds (active or inactive) by at least a 50m wide buffer if possible. If avoiding nest mounds is not feasible, permission to remove them will need to be obtained from the DEC.

- A malleefowl management plan should be formulated and implemented as part of future operation of the haul road with the main aim of minimising the likelihood of road kills, unnecessary clearing of suitable habitat and the risk of unplanned fires. This should include a register of all opportunistic observations of the species.

- Planning for haul road should aim to minimise as much as reasonable and practical the area of remnant vegetation requiring removal. Existing cleared areas/tracks should be used in preference to clearing additional areas.

- During site works, areas requiring clearing should be clearly marked and access to other areas restricted to prevent accidental clearing of areas to be retained. Unauthorised off-track driving and parking should be prohibited.

- No dead, standing or fallen timber should be removed unnecessarily. Logs (hollow or not) and other debris resulting from land clearing should be used to enhance fauna habitat in untouched and rehabilitated areas if possible.

- Disruption to surface and sub-surface hydrology should be minimised where possible and levees and drains designed to mimic natural drainage flows where disruptions will occur.

- A Construction and Operations Fire Management Plan should be prepared to reduce the risk of unplanned fires and provide contingency measures to minimise any associated impacts. The plan will include a contingency and response plan in the event of any bushfires that commence as a result of the works on site.

- All staff working on site should be made aware that native fauna is protected. Personnel working on the project should not be allowed to bring firearms, other weapons or pets onsite.

- If practical, prior to any significant clearing operations a suitably experienced "fauna clearing person" should be employed to inspect logs and hollow trees (where possible) before clearing to reduce likelihood of injury to fauna. If feasible any fauna encountered should be relocated to nearby retained habitat.

- Native fauna injured during clearing or normal site operations should be taken to a designated veterinary clinic or a DEC nominated wildlife carer.

- Any holes, pits or trenches required for services should be kept open for only as long as necessary and suitable escape ramps (45° batter) and bridging provided if the site is to be left unattended for extended periods. Significant sized holes, pits or trenches should be inspected for fauna immediately prior to filling.

8. LEGISLATIVE OBLIGATIONS

8.1 WILDLIFE CONSERVATION ACT 1950

The objective of the *Wildlife Conservation Act 1950* (*WC Act*) is to provide for the protection of wildlife. The Act is administered by the Executive Director of the Department of Environment and Conservation, under the direction and control of the Minister for the Environment. Under section 14, "Protection of Fauna", of this Act, all fauna is wholly protected throughout the State at all times, unless declared by the Minister by notice in the Government Gazette. Under section 14(2)(ba) of The Act, Fauna Notices are made by the Minister for the Environment listing specially protected fauna.

Disturbance or destruction of any native fauna over and above that reasonably required for construction works and access is considered an offence under the *WC Act* and the proponent should take the necessary steps to inform all those involved in sites works of this fact. As discussed in the previous section the proponent should also, as part of their management plan implement procedures that will reduce the chances of wildlife being injured or killed during clearing, construction and operations at the site.

8.2 ENVIRONMENTAL PROTECTION ACT 1986

The purpose of the *Environmental Protection Act (1986)* (*EP Act*) is "*...to provide for an Environmental Protection Authority, for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection enhancement and management of the environment and for matters incidental to or connected with the foregoing*".

The powers of the *Environmental Protection Act 1986* are administered by the Department of Environment and Conservation (DEC), which in relevant cases advises to the Environmental Protection Authority (EPA). The jurisdiction of the DEC comprises the protection of environmental systems, pollution prevention and waste management. In particular, the DEC manages and protects rivers, streams, creeks, estuaries, drains, wetlands and groundwater, but not marine waters, of Western Australia.

Legislation proclaimed on 8 July 2004 protects all native vegetation in Western Australia. Under the law, clearing native vegetation is prohibited, unless a clearing permit is granted by the DEC, or the clearing is for an exempt purpose. These exemptions ensure that low impact day to day activities involving clearing can be undertaken. People that wish to clear are required to submit an application if an exemption does not apply.

Any future development at the site will be assessed against the ten clearing principles related to native vegetation in the *EP Act*. These principles provide a guide for when native vegetation should not be cleared. The DEC must consider these principles in making a decision on whether or not to issue a clearing permit. The DEC has set out the minimum requirements and standards for addressing each of the ten principles in detail in its assessment methodology.

Native vegetation should not be cleared if:

(a) it comprises a high level of biological diversity;

(b) it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;

(c) it includes, or is necessary for the continued existence of, rare flora;

(d) it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community;

(e) it is significant as a remnant of native vegetation in an area that has been extensively cleared;

(f) it is growing in, or in association with, an environment associated with a watercourse or wetland;

(g) the clearing of the vegetation is likely to cause appreciable land degradation;

(h) the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;

(i) the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; or

(j) clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.

One purpose of the assessment reported on here is to provide information relevant to principle (a) & (b).

It comprises a high level of biological diversity

The results of the desktop study and based on fauna habitats present at the site, it is estimated that up to 191 native fauna species have the potential or are likely to utilise the study for some purpose at times. Thirty two (~17%) of the predicted native species were observed within the study area during the one day field reconnaissance survey.

With respect to fauna alone the site probably does not qualify as having a high level of biodiversity as the predicted species list is most likely an overestimation and the number of species actually present would be lower than this figure. Fauna assemblages in adjoining areas are also likely to be similar.

Therefore clearing of the haul road may not be seen by the DEC as being in variance to this principle. The assessment of this criterion also needs to take into account plant community and flora diversity which are beyond the scope of this fauna report.

It comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia

The study area contains habitat that is used or is potentially used for some purpose by an estimated six fauna species of conservation significance (state or federally listed threatened, migratory or DEC priority species). One species, the malleefowl, was confirmed as using the site. The presence of this species may justify the DEC considering the clearing of the proposed haul road as being in variance to this principle.

The DEC will need to consider all available information relating to all 10 clearing principles including those relating to fauna. The demonstrated use of the study area by a fauna species of conservation significance and the potential presence of several others will influence the DEC decision making process. It is however difficult to predict a specific outcome in this case as some discretion is exercised by the DEC when assessing specific projects, and decisions are made on a case

by case basis. The results of any vegetation and flora surveys will also be taken into consideration.

8.3 COMMONWEALTH ENVIRONMENT PROTECTION & BIODIVERSITY CONSERVATION ACT 1999

A number of fauna species known to or potentially present within the study area are listed under the federal *Environment Protection and Biodiversity Conservation Act* (*EPBC Act, 1999*). The objective of the *EPBC Act* is to provide for the protection of the environment, especially those aspects that are of national significance, promote ecologically sustainable development, the conservation of biodiversity and a cooperative approach to the protection and management of the environment.

Development proposals ("actions") that are likely to have a significant impact on any listed species should be referred to the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) for assessment. The aim of a referral is to provide certainty about whether a proposal does or doesn't need approval under the *EPBC Act*. The proposed action should be considered at its broadest possible scope. This includes all stages and components of the action, all related activities, and all related infrastructure such as roads and power lines, if applicable.

It is the proponent's responsibility to determine if their proposed action (e.g. clearing and development of an area of native bushland) requires referral. To aid in determining if a proposal is likely to have a significant impact DSEWPaC provide a series of Significant Impact Guidelines (DEWHA 2009). These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required.

The criteria are intended to provide general guidance on the types of actions that will require approval and the types of actions that will not require approval. The criteria are not intended to be exhaustive or definitive. If a proponent is unsure whether their proposed action is likely to have a significant impact on a matter of national environmental significance it should be referred to the DSEWPaC for a binding decision on whether approval is required (DEWHA 2009).

8.3.1 Listed Threatened Species

The only listed *EPBC Act* threatened fauna species considered by the Author to be utilising the study area is the malleefowl (Vulnerable/Migratory).

An action is deemed by DSEWPaC as likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;

- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

It is understood that the exact route of the haul road is still be determined so it is not possible to state with confidence whether referral of the project (with respect to likely impacts on the malleefowl) to the DSEWPaC is required to ensure compliance with the *EPBC Act.* DSEWPaC's significant impact guidelines for vulnerable species are generic (to cover many different species) and assessing potential impact on malleefowl is difficult at this point in time. It is possibly unlikely that any of the abovementioned "significant impact" criteria would be compromised if no active malleefowl mounds are impacted on and this should be a priority for planning the final haul road route.

It is therefore recommended that an assessment of the need for a referral should be carried out when planning is further advanced and additional survey results and expert advice are obtained.

8.3.2 Listed Migratory Species

EPBC Act listed migratory fauna species identified as being present in the general area of the development site at times (excluding the malleefowl discussed above) was limited to one species this being:

- *Merops ornatus* Rainbow Bee-eater – Migratory

An action has, will have, or is likely to have a significant impact on migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species; or

- result in invasive species that is harmful to the migratory species becoming established in an area of important habitat of the migratory species; or

- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;

- habitat that is of critical importance to the species at particular life-cycle stages;

- habitat utilised by a migratory species which is at the limit of the species range; or

- habitat within an area where the species is declining.

To have a significant impact on a migratory species as defined under the DSEWPaC Significant Impact Guidelines (DEWHA 2009) any proposed development would need to trigger at least one of the abovementioned significant impact criteria thresholds.

It is considered extremely unlikely that any of these thresholds relating to migratory species will be compromised by development at the site at any scale. The habitat within the study area likely to be used by migratory species does not represent “important habitat” and the number of individuals utilising the study area at any time would not, under any circumstances, represent an ecologically significant proportion of the population of the species in question.

9. CONCLUSION

The Level 1 fauna survey at the Arcoona haul road area was undertaken in September 2012 for the purposes of delineating and characterising the fauna habitats and faunal assemblages present in the target area and to identify potential impacts.

With respect to native vertebrate fauna, 25 mammals (includes ten bats species), 101 bird, 63 reptile and three frog species have previously been recorded in the general area, some of which have the potential to occur in or utilise at times, the study area.

The malleefowl, a threatened species classified as vulnerable under state and federal legislation, was identified as utilising sections of the proposed haul route.

Two species considered in need of special protection under state legislation may possibly utilise the study area at times (peregrine falcon and carpet python) and two DEC priority species (Australian bustard and central long-eared bat) also has some potential of being present at times. One migratory species (the rainbow bee-eater) was observed in the study area though it would generally only be present temporally, and then only a seasonal basis.

The presence of malleefowl within the area will need to be taken into consideration during future planning and during ongoing haul road use so as to minimise potential impacts on the species and areas of most likely habitat.

It is recommended that a targeted malleefowl survey be carried out preferably during the central period of the main malleefowl breeding season (October to December) to better determine the significance of the area and some adjoining areas to the species. The results of this work should be used to formulate a malleefowl management plan and implemented as part of future operation of the haul road with the main aim of minimising the likelihood of road kills, unnecessary clearing of suitable habitat and the risk of unplanned fires.

It is also recommended that an assessment of the need for a referral should be carried out when planning is further advanced and additional survey results and expert advice are obtained.

With respect to fauna in general, existing management plans and protocols that aim to minimise impact should be employed where relevant with specific attention being paid to those facets highlighted in Section 7.2, when considered reasonable and practical to implement.

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FIGURES



Legend

Arcoona Haul Road Study Area (100 m Buffer)

0 5 10

Kilometres

MGA Zone 51

Fauna Survey

DRAWN:G Harewood

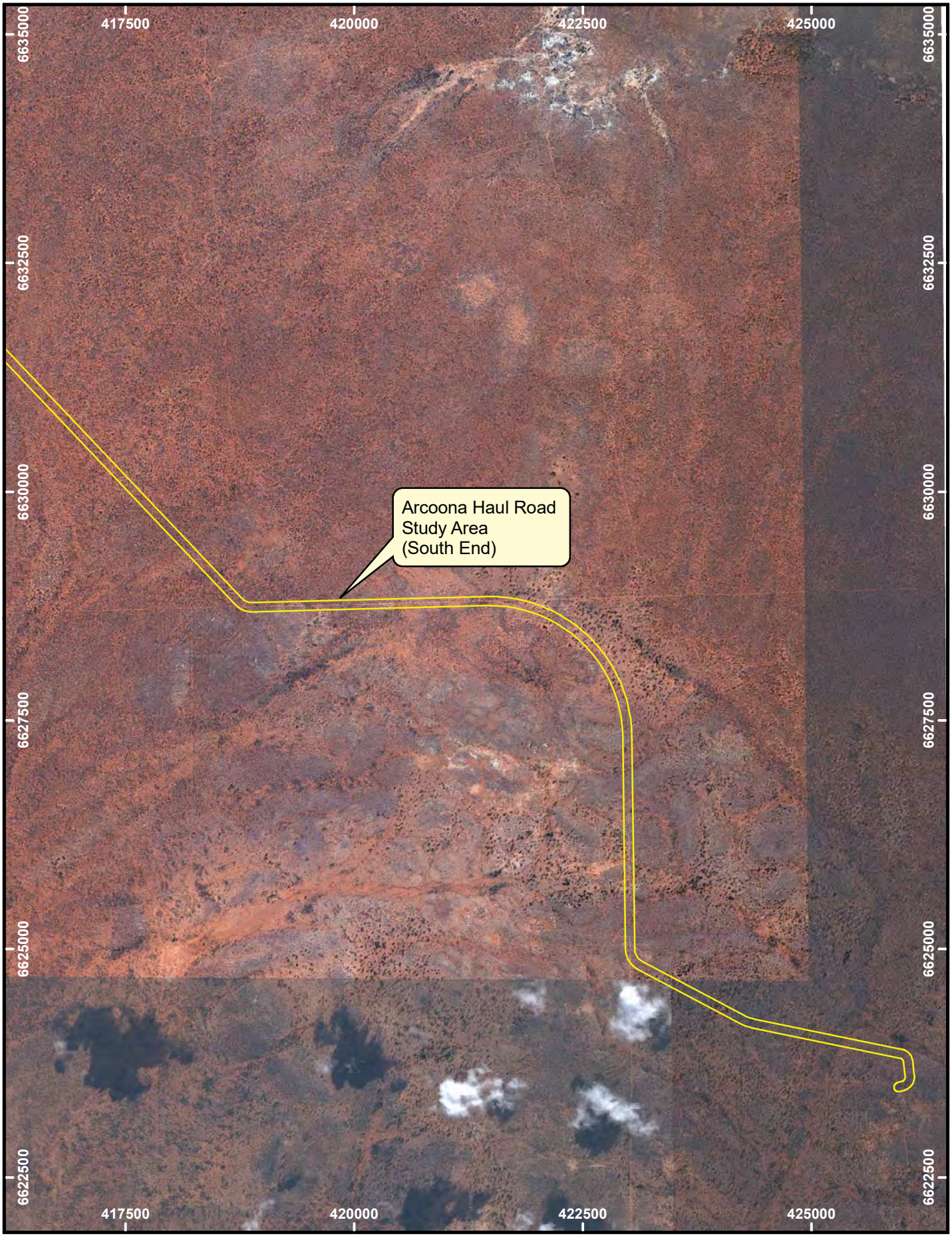
DATE : Oct 2012

SCALE: 1:200,000

KalNorth Gold Mines Ltd
Arcoona Haul Road

Study Area and Surrounds

Figure: 1



Legend

Arcoona Haul Road Study Area (100 m Buffer)

N

0 1 2

Kilometres

MGA Zone 51

Fauna Survey

DRAWN:G Harewood

DATE : Sept 2012

SCALE: 1:55,000

KalNorth Gold Mines Ltd
Arcoona Haul Road

Study Area Air Photo (Sth End)

Figure: 2



Legend

Arcoona Haul Road Study Area (100 m Buffer)

0 1 2

Kilometres

MGA Zone 51

Fauna Survey

DRAWN:G Harewood

DATE : Sept 2012

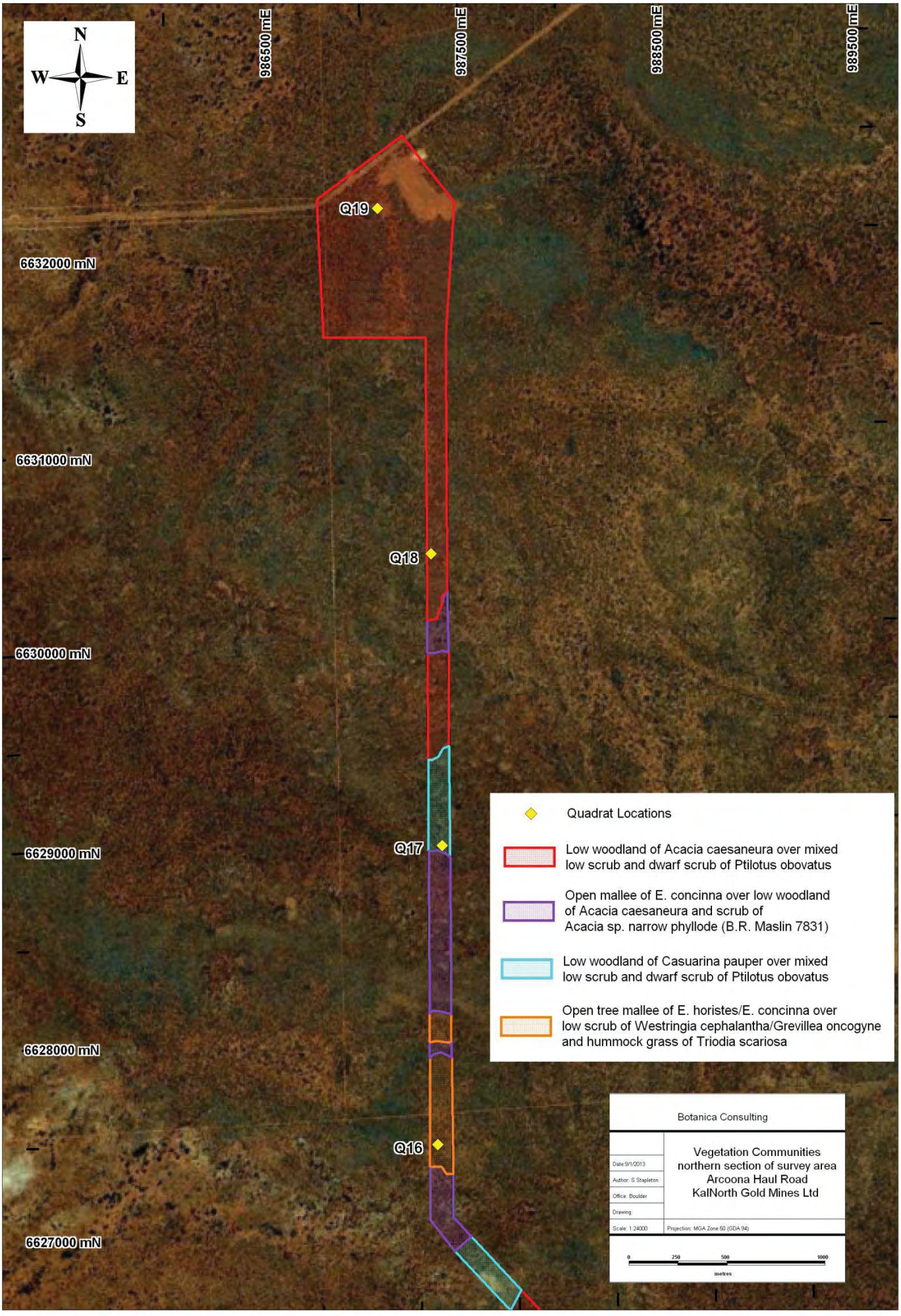
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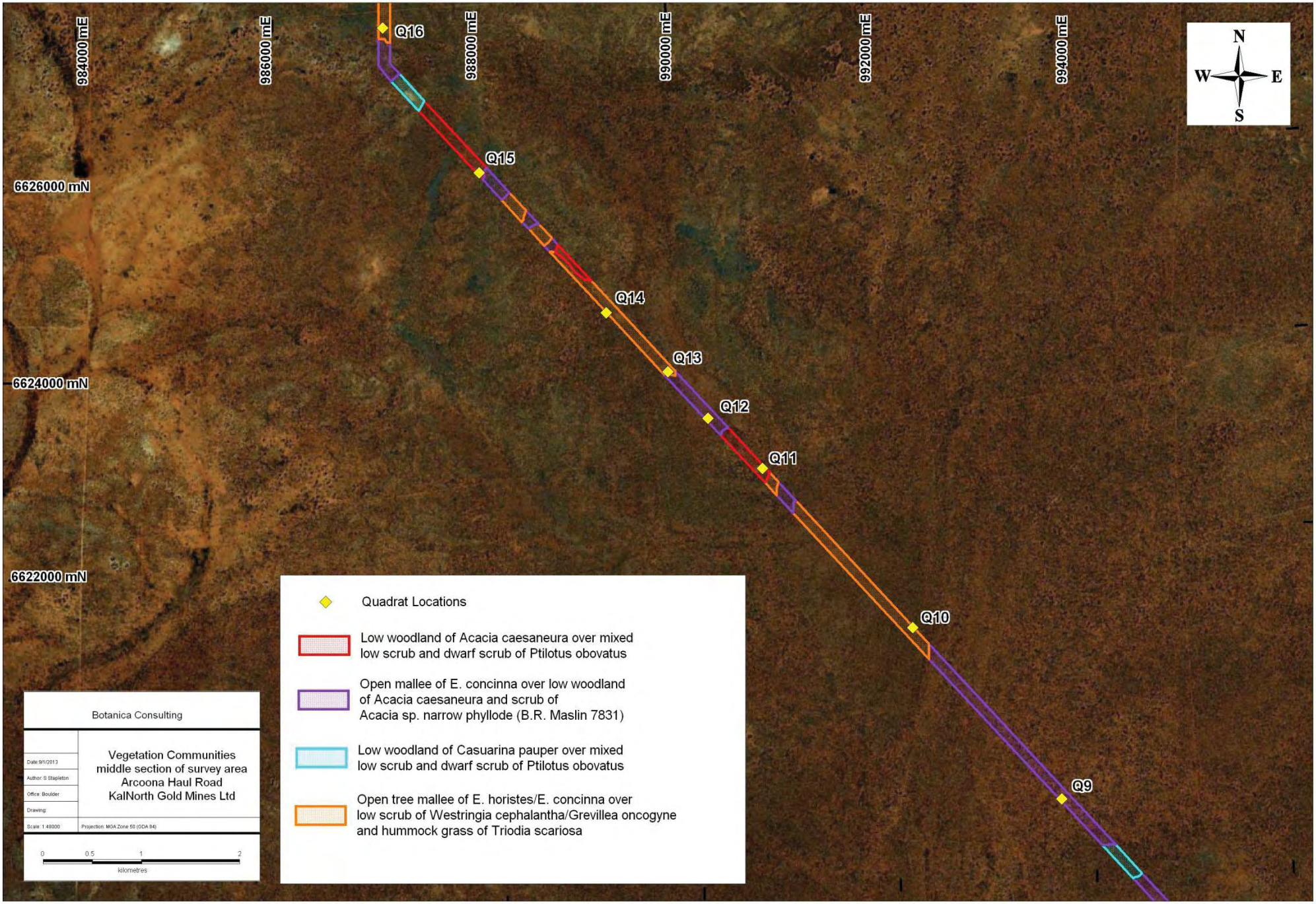
KalNorth Gold Mines Ltd
Arcoona Haul Road

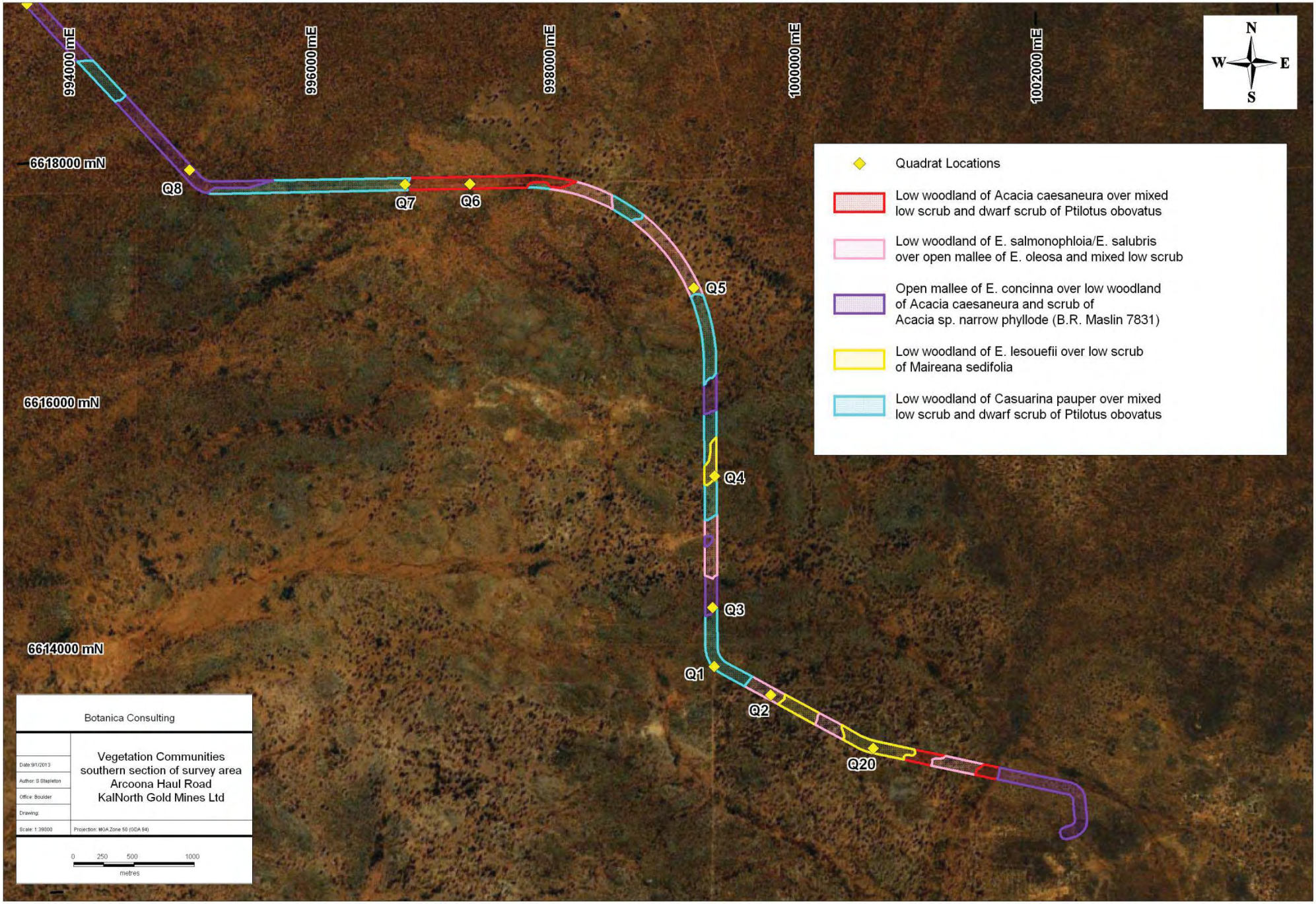
Study Area Air Photo (Nth End)

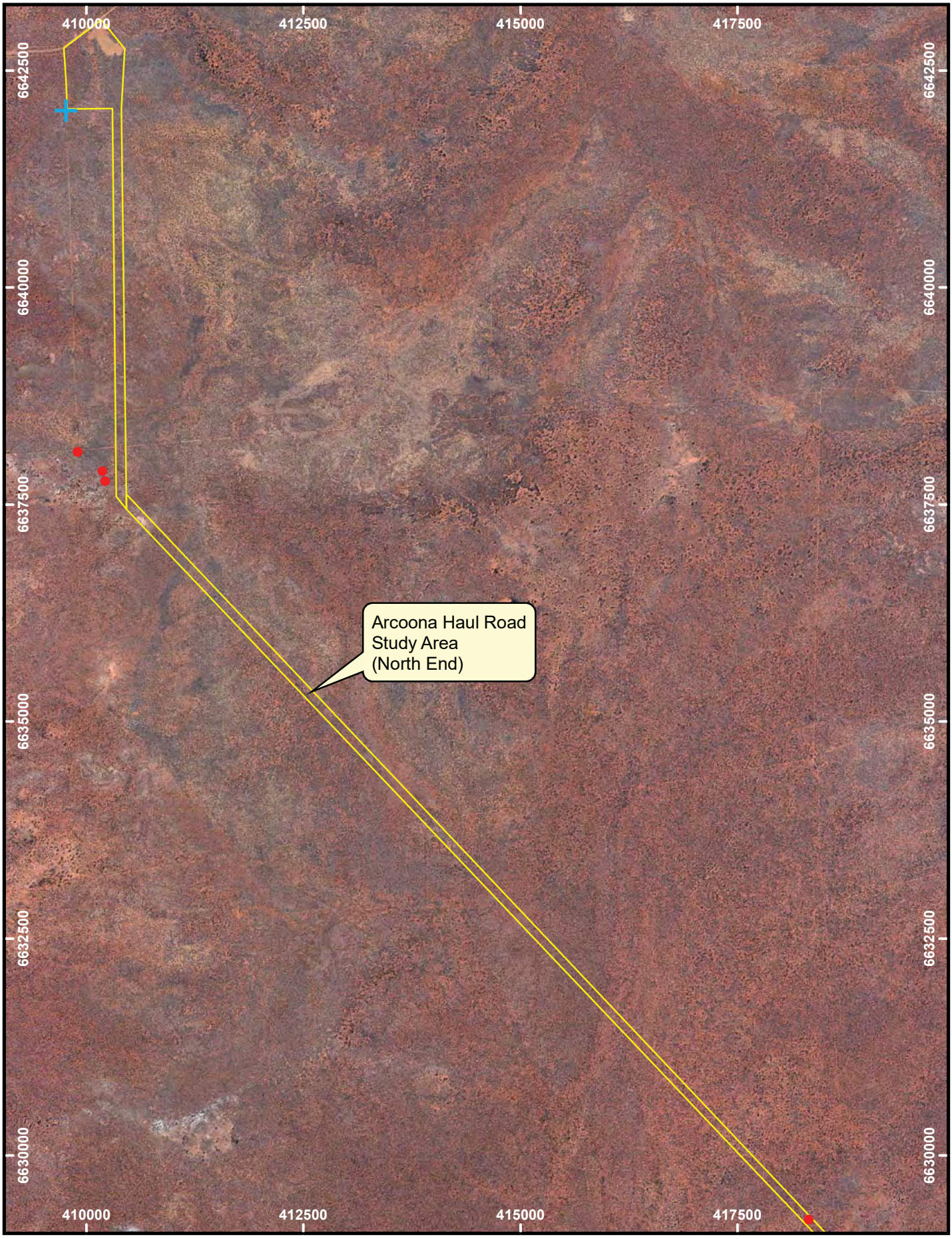
Figure: 3

Vegetation maps including Quadrat locations in the Arcoona Haul Road survey area




984000 mE
986000 mE
988000 mE
990000 mE
992000 mE
994000 mE
6626000 mN
6624000 mN
6622000 mN
N
W
E
S
Q16
Q15
Q14
Q13
Q12
Q11
Q10
Q9
Quadrat Locations
Low woodland of Acacia caesaneura over mixed low scrub and dwarf scrub of Ptilotus obovatus
Open mallee of E. concinna over low woodland of Acacia caesaneura and scrub of Acacia sp. narrow phyllode (B.R. Maslin 7831)
Low woodland of Casuarina pauper over mixed low scrub and dwarf scrub of Ptilotus obovatus
Open tree mallee of E. horistes/E. concinna over low scrub of Westringia cephalantha/Grevillea oncogyne and hummock grass of Triodia scariosa
Botanica Consulting
Vegetation Communities
middle section of survey area
Arcoona Haul Road
KalNorth Gold Mines Ltd
Date: 9/1/2013
Author: S Stapleton
Office: Boulder
Drawing:
Scale: 1:48000
Projection: MGA Zone 50 (GDA 94)
0
0.5
1
2
kilometres


994000 mE
996000 mE
998000 mE
1000000 mE
1002000 mE
N
W
E
S
6618000 mN
6616000 mN
6614000 mN
Q8
Q7
Q6
Q5
Q4
Q3
Q1
Q2
Q20
Quadrat Locations
Low woodland of Acacia caesaneura over mixed low scrub and dwarf scrub of Ptilotus obovatus
Low woodland of E. salmonophloia/E. salubris over open mallee of E. oleosa and mixed low scrub
Open mallee of E. concinna over low woodland of Acacia caesaneura and scrub of Acacia sp. narrow phyllode (B.R. Maslin 7831)
Low woodland of E. lesouefii over low scrub of Maireana sedifolia
Low woodland of Casuarina pauper over mixed low scrub and dwarf scrub of Ptilotus obovatus
Botanica Consulting
Vegetation Communities
southern section of survey area
Arcoona Haul Road
KalNorth Gold Mines Ltd
Date:9/1/2013
Author: S Stapleton
Office: Boulder
Drawing:
Scale: 1:39000
Projection: MGA Zone 50 (GDA 94)
0 250 500 1000
metres



Legend

Arcoona Haul Road Study Area (100 m Buffer)

Malleefowl Tracks

Malleefowl Mound

N

0 1 2

Kilometres

MGA Zone 51

Fauna Survey

DRAWN:G Harewood

DATE : Sept 2012

SCALE: 1:58,000

KalNorth Gold Mines Ltd
Arcoona Haul Road

Location of Malleefowl Observations

Figure: 7

PLATES



Plate 1: Low woodland of *Casuarina pauper* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*



Plate 2: Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub



Plate 3: Low woodland of *Acacia caesaneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*



Plate 4: Open mallee of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and scrub of *Acacia* sp.



Plate 5: Open tree mallee of *Eucalyptus horistes/Eucalyptus concinna* over low scrub of *Westringia cephalantha/Grevillea oncogyne* and hummock grass of *Triodia scariosa*

APPENDIX A

CONSERVATION CATEGORIES

EPBC Act (1999) Threatened Fauna Categories

Category	Code	Description
Extinct	E	There is no reasonable doubt that the last member of the species has died.
*Extinct in the wild	EW	A species (a) is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
*Critically endangered	CE	A species is facing an extremely high risk of extinction in the wild in the immediate future.
*Endangered	EN	A species: (a) is not critically endangered; and (b) is facing a very high risk of extinction in the wild in the near future.
*Vulnerable	VU	A species (a) is not critically endangered or endangered; and (b) is facing a high risk of extinction in the wild in the medium-term future.
Conservation dependent	CD	A species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered
*Migratory	Migratory	(a) all migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and (c) all native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Marine	Ma	Species in the list established under s248 of the EPBC Act

Note: Only species in those categories marked with an asterix are matters of national environmental significance under the *EPBC Act*.

Western Australian Wildlife Conservation Act (1950) Threatened Fauna Categories

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct Threatened fauna (Schedule 1) are further ranked by the DEC according to their level of threat using IUCN Red List criteria: **CR: Critically Endangered** - considered to be facing an extremely high risk of extinction in the wild. **EN: Endangered** - considered to be facing a very high risk of extinction in the wild. **VU: Vulnerable** - considered to be facing a high risk of extinction in the wild.
Schedule 2	S2	Fauna which is presumed extinct
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction
Schedule 4	S4	Fauna that is otherwise in need of special protection

Western Australian DEC Priority Fauna Categories

Category	Code	Description
Priority 1	P1	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes..
Priority 2	P2	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
Priority 3	P3	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
Priority 4	P4	(a) **Rare**. Taxa 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 taxa are usually represented on conservation lands. (b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Priority 5	P5	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

IUCN Red List Threatened Species Categories

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last individual has died.
Extinct in the Wild	EW	Taxa which is known only to survive in cultivation, in captivity or and as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically Endangered	CR	Taxa facing an extremely high risk of extinction in the wild.
Endangered	EN	Taxa facing a very high risk of extinction in the wild.
Vulnerable	VU	Taxa facing a high risk of extinction in the wild.
Near Threatened	NT	Taxa which has been evaluated but does not qualify for CR, EN or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	LC	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data Deficient	DD	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

A full list of categories and their meanings are available at:

http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

APPENDIX B

FAUNA OBSERVED OR POTENTIALLY IN STUDY AREA

Fauna Recorded or Potentially in Region of Study Area

Compiled by Greg Harewood - Feb 2013

Recorded (Captured/Sighted/Heard/Signs) = X

Arcoona Haul Road , W.A.

Approximate centroid - 30.441900°S and 122.123100°E

Harewood G (2013). Terrestrial Fauna Survey (Level 1) Arcoona Haul Road. Unpublished report for KalNorth Gold Mines Ltd. Feb 2013.

WAM (1992). The Biological Survey of the Eastern Goldfields of Western Australia. Part 8. The Kurnalpi - Kalgoorlie Study Area. Rec. West. Aust. Mus. Supplement No. 41.

DEC (2012). NatureMap Database Search – "By Area" Study Area (plus 10km buffer). Accessed 20th Sept 2012.

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Amphibia						
Myobatrachidae Ground or Burrowing Frogs						
Neobatrachus kunapalari	Kunapalari Frog	LC				X
Neobatrachus sutor	Shoemaker Frog	LC			X	
Neobatrachus wilsmorei	Plonking Frog	LC			X	
Reptilia						
Carphodactylidae Knob-tailed Geckos						
Nephrurus laevissimus	Smooth Knob-tail					
Nephrurus milii	Barking Gecko			X	X	X
Nephrurus vertebralis	Midline Knob-tailed Gecko				X	

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Diplodactylidae Geckoes						
Diplodactylus conspicillatus	Fat-tailed Gecko					
Diplodactylus granariensis	Western Stone Gecko				X	
Diplodactylus pulcher	Western Saddled Ground Gecko			X	X	X
Lucasium maini	Mains Ground Gecko			X	X	
Oedura reticulata	Reticulated Velvet Gecko				X	
Rhynchoedura ornata	Beaked Gecko			X	X	X
Strophurus assimilis	Goldfields Spiny-tailed Gecko					
Strophurus elderi	Jewelled Gecko				X	
Gekkonidae Geckoes						
Gehyra purpurascens	Purple Arid Dtella					X
Gehyra variegata	Variegated Dtella			X	X	X
Heteronotia binoei	Bynoe's Gecko			X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Pygopodidae Legless Lizards						
Delma australis	Marble-faced Delma				X	
Delma butleri	Unbanded Delma				X	X
Lialis burtonis	Burton's Legless Lizard			X	X	X
Pygopus nigriceps	Hooded Scaly Foot					
Agamidae Dragon Lizards						
Caimanops amphiboluroides	Mulga Dragon					
Ctenophorus cristatus	Bicycle Dragon			X	X	X
Ctenophorus fordi	Mallee Sand Dragon			X	X	X
Ctenophorus reticulatus	Western Netted Dragon			X	X	X
Ctenophorus scutulatus	Lozenge-marked Bicycle Dragon		X	X	X	X
Moloch horridus	Thorny Devil			X	X	X
Pogona minor	Western Bearded Dragon			X		X
Tympanocryptis cephalus	Pebble Dragon					

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Varanidae Monitor's or Goanna's						
Varanus caudolineatus	Stripe-tailed Pygmy Monitor			X	X	X
Varanus gouldii	Bungarra or Sand Monitor			X	X	X
Varanus tristis	Racehorse Monitor					X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Scincidae Skinks						
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink			X	X	
Cryptoblepharus carnabyi	Spiny-palmed Fence Skink					
Ctenotus atlas	Southern Mallee Ctenotus			X	X	X
Ctenotus leonhardii	Leonhardi's Skink				X	X
Ctenotus schomburgkii	Barred Wedge-snout Ctenotus			X	X	X
Ctenotus uber	Spotted Ctenotus			X	X	X
Cyclodomorphus melanops elongatus	Eastern Slender Blue-tongue			X	X	
Egernia depressa	Pygmy Spiny-tailed Skink			X		X
Egernia formosa	Goldfields Crevise Skink			X	X	X
Egernia inornata	Desert Skink				X	
Eremiascincus richardsonii	Broad-banded Sand Swimmer					
Hemiergis initialis initialis	Sth Five-toed Mulch Skink		X			
Lerista kingi	Common Mulch Skink			X	X	X
Lerista picturata	Goldfields Robust Lerista				X	
Menetia greyii	Dwarf Skink			X	X	X
Morethia butleri	Woodland Dark-flecked Morethia			X		X
Tiliqua occipitalis	Western Bluetongue			X	X	X

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Tiliqua rugosa	Bobtail			X	X	X
Typhlopidae Blind Snakes						
Ramphotyphlops bicolor	Dark-spined Blind Snake					
Ramphotyphlops bituberculatus	Prong-snouted Blind Snake					
Ramphotyphlops hamatus	Northern Hook-snouted Blind Snake					
Ramphotyphlops waitii	Common Beaked Blind Snake					
Boidae Pythons, Boas						
Morelia spilota imbricata		S4 P4 LR/NT				

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Elapidae Elapid Snakes						
Acanthophis pyrrhus	Desert Death Adder					
Brachyurophis fasciolata	Narrow-banded Shovel-nosed Snake					
Demansia psammophis	Yellow-faced Whipsnake					
Furina ornata	Moon Snake					
Neelaps bimaculatus	Black-naped Snake					
Parasuta monachus	Monk Snake			X	X	X
Pseudechis australis	Mulga Snake					X
Pseudonaja modesta	Ringed Brown Snake			X	X	X
Pseudonaja nuchalis	Gwardar				X	
Simoselaps bertholdi	Jan's Banded Snake					
Suta fasciata	Rosen's Snake					
Aves						
Casuariidae Emus, Cassowarries						
Dromaius novaehollandiae	Emu	LC	X		X	X
Megapodiidae Moundbuilders						
Leipoa ocellata	Malleefowl	S1 VU VU A1bce	X	X		X

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Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Accipitridae Kites, Goshawks, Eagles, Harriers						
Accipiter cirrocephalus	Collared Sparrowhawk	LC				
Accipiter fasciatus	Brown Goshawk	LC				X
Aquila audax	Wedge-tailed Eagle	LC				X
Aquila morphnoides	Little Eagle	LC				
Circus assimilis	Spotted Harrier	LC				
Elanus caeruleus	Black-shouldered Kite	LC				
Haliastur sphenurus	Whistling Kite	LC				
Hamirostra isura	Square-tailed Kite	LC				
Falconidae Falcons						
Falco berigora	Brown Falcon	LC		X	X	X
Falco cenchroides	Australian Kestrel	LC		X		X
Falco longipennis	Australian Hobby	LC				
Falco peregrinus	Peregrine Falcon	S4 LC				X
Otididae Bustards						
Ardeotis australis	Australian Bustard	P4 NT				

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Turnicidae Button-quails						
Turnix velox	Little Button-quail	LC				
Columbidae Pigeons, Doves						
Ocyphaps lophotes	Crested Pigeon	LC	X		X	X
Phaps chalcoptera	Common Bronzewing	LC		X		X
Psittacidae Parrots						
Cacatua roseicapilla	Galah	LC		X	X	X
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	LC		X	X	
Melopsittacus undulatus	Budgerigar	LC		X		
Nymphicus hollandicus	Cockatiel	LC			X	
Pezoporus wallicus flaviventrus		S1				
Platycercus varius	Mulga Parrot	LC	X	X	X	X
Platycercus zonarius	Australian Ringneck	LC	X	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Cuculidae Parasitic Cuckoos						
Cacomantis flabelliformis	Fan-tailed Cuckoo	LC				
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	LC		X	X	X
Chrysococcyx osculans	Black-eared Cuckoo	LC		X		
Cuculus pallidus	Pallid Cuckoo	LC		X	X	
Strigidae Hawk Owls						
Ninox novaeseelandiae	Boobook Owl	LC				X
Tytonidae Barn Owls						
Tyto alba	Barn Owl	LC				
Podargidae Frogmouths						
Podargus strigoides	Tawny Frogmouth	LC				X
Caprimulgidae Nightjars						
Eurostopodus argus	Spotted Nightjar	LC				
Aegothelidae Owlet-nightjars						
Aegotheles cristatus	Australian Owlet-nightjar	LC		X		X

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Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Halcyonidae Tree Kingfishers						
Todiramphus pyrrhopygia	Red-backed Kingfisher	LC				
Todiramphus sanctus	Sacred Kingfisher	LC				
Meropidae Bee-eaters						
Merops ornatus	Rainbow Bee-eater	S3 Mig JA LC	X	X	X	X
Climacteridae Treecreepers						
Climacteris affinis	White-browed Treecreeper	LC				
Climacteris rufa	Rufous Treecreeper	LC			X	
Maluridae Fairy Wrens, GrassWrens						
Malurus lamberti	Variegated Fairy-wren	LC		X		X
Malurus leucopterus	White-winged Fairy-wren	LC			X	X
Malurus splendens	Splendid Fairy-wren	LC	X			X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Acanthizidae Thornbills, Geryones, Fieldwrens & Whitefaces						
Acanthiza apicalis	Broad-tailed Thornbill	LC	X	X	X	X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	LC	X	X	X	X
Acanthiza robustirostris	Slaty-backed Thornbill	LC		X		X
Acanthiza uropygialis	Chestnut-rumped Thornbill	LC	X	X	X	X
Aphelocephala leucopsis	Southern Whiteface	LC		X		X
Gerygone fusca	Western Gerygone	LC				
Pyrrholaemus brunneus	Redthroat	LC		X		X
Smicrornis brevirostris	Weebill	LC	X	X	X	X
Pardalotidae Pardalotes						
Pardalotus striatus	Striated Pardalote	LC	X	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Meliphagidae Honeyeaters, Chats						
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	LC	X	X	X	X
Anthochaera carunculata	Red Wattlebird	LC	X		X	X
Certhionyx niger	Black Honeyeater	LC				
Certhionyx variegatus	Pied Honeyeater	LC				
Epthianura albifrons	White-fronted Chat	LC				
Epthianura tricolor	Crimson Chat	LC				X
Lichenostomus leucotis	White-eared Honeyeater	LC	X	X	X	X
Lichenostomus ornatus	Yellow-plumed Honeyeater	LC		X		X
Lichenostomus plumulus	Grey-fronted Honeyeater	LC		X		
Lichenostomus virescens	Singing Honeyeater	LC	X	X	X	X
Lichmera indistincta	Brown Honeyeater	LC	X	X	X	X
Manorina flavigula	Yellow-throated Miner	LC	X	X	X	X
Melithreptus brevirostris	Brown-headed Honeyeater	LC		X		X
Phylidonyris albifrons	White-fronted Honeyeater	LC		X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Petroicidae Australian Robins						
Drymodes brunneopygia	Southern Scrub-robin	LC				X
Microeca fascinans	Jacky Winter	LC	X	X	X	X
Petroica cucullata	Hooded Robin	LC			X	
Petroica goodenovii	Red-capped Robin	LC		X	X	X
Pomatostomidae Babblers						
Pomatostomus superciliosus superciliosus	White-browed Babbler (central/northern)	LC	X	X	X	X
Cinclosomatidae Whipbirds, Wedgebills, Quail Thrushes						
Cinclosoma castanotus	Chestnut Quail-thrush	LC	X			X
Neosittidae Sitellas						
Daphoenositta chrysoptera	Varied Sittella	LC	X		X	X
Pachycephalidae Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers						
Colluricincla harmonica	Grey Shrike-thrush	LC		X	X	X
Oreoica gutturalis pallescens	Crested Bellbird (central/northern)	LC	X	X	X	
Pachycephala inornata	Gilbert's Whistler	LC				X
Pachycephala rufiventris	Rufous Whistler	LC		X		X

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Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Dicruridae Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo						
Grallina cyanoleuca	Magpie-lark	LC				X
Rhipidura fuliginosa	Grey Fantail	LC				X
Rhipidura leucophrys	Willie Wagtail	LC				X
Campephagidae Cuckoo-shrikes, Trillers						
Coracina maxima	Ground Cuckoo-shrike	LC				X
Coracina novaehollandiae	Black-faced Cuckoo-shrike	LC		X	X	X
Lalage tricolor	White-winged Triller	LC		X	X	X
Artamidae Woodswallows, Butcherbirds, Currawongs						
Artamus cinereus	Black-faced Woodswallow	LC			X	X
Artamus cyanopterus	Dusky Woodswallow	LC				
Artamus minor	Little Woodswallow	LC				
Artamus personatus	Masked Woodswallow	LC				X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Cracticidae Currawongs, Magpies & Butcherbirds						
Cracticus nigrogularis	Pied Butcherbird	LC	X	X	X	X
Cracticus tibicen	Australian Magpie	LC			X	X
Cracticus torquatus	Grey Butcherbird	LC	X	X	X	X
Strepera versicolor	Grey Currawong	LC		X	X	X
Corvidae Ravens, Crows						
Corvus bennetti	Little Crow	LC				X
Corvus coronoides	Australian Raven	LC				X
Corvus orru	Torresian Crow	LC				
Corvus sp	Corvid sp.		X	X	X	
Motacillidae Old World Pipits, Wagtails						
Anthus australis	Australian Pipit	LC			X	
Estrilidae Grass Finches & Mannikins						
Taeniopygia guttata	Zebra Finch	LC				
Dicaeidae Flowerpeckers						
Dicaeum hirundinaceum	Mistletoebird	LC		X		X

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Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Hirundinidae Swallows, Martins						
Cheramoeca leucosternus	White-backed Swallow	LC				
Hirundo ariel	Fairy Martin	LC				
Hirundo neoxena	Welcome Swallow	LC	X		X	
Hirundo nigricans	Tree Martin	LC			X	
Sylviidae Old World Warblers						
Cincloramphus cruralis	Brown Songlark	LC			X	
Cincloramphus mathewsi	Rufous Songlark	LC				
Mammalia						
Tachyglossidae Echidnas						
Tachyglossus aculeatus	Echidna	LC	X			X
Dasyuridae Carnivorous Marsupials						
Ningaui ridei	Wongai Ningaui	LC		X		X
Ningaui yvonneae	Southern Ningaui	LC				
Sminthopsis crassicaudata	Fat-tailed Dunnart	LC		X	X	X
Sminthopsis dolichura	Little long-tailed Dunnart	LC		X	X	X

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Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Burramyidae Pygmy Possums						
Cercartetus concinnus	Western Pygmy-possum	LC			X	
Macropodidae Kangaroos, Wallabies						
Macropus fuliginosus	Western Grey Kangaroo	LC	X		X	X
Macropus robustus	Euro	LC				
Macropus rufus	Red Kangaroo	LC			X	X
Emballonuridae Sheath-tailed Bats						
Taphozous hilli	Hill's Sheathtail-bat	LC				X
Molossidae Freetail Bats						
Mormopterus sp 3	Inland Freetail-bat	LC			X	
Tadarida australis	White-striped Freetail-bat	LC		X	X	X

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Vespertilionidae Ordinary Bats						
Chalinolobus gouldii	Gould's Wattled Bat	LC		X	X	X
Chalinolobus morio	Chocolate Wattled Bat	LC		X	X	X
Nyctophilus geoffroyi	Lesser Long-eared Bat	LC			X	X
Nyctophilus major tor	Central Long-eared Bat	P4				
Scotorepens balstoni	Inland Broad-nosed Bat	LC		X	X	X
Vespadelus baverstocki	Inland Forest Bat	LC				X
Vespadelus regulus	Southern Forest Bat	LC		X	X	X
Muridae Rats, Mice						
Mus musculus	House Mouse	Introduced		X	X	X
Notomys alexis	Spinifex Hopping-mouse	LC				
Notomys mitchellii	Mitchell's Hopping-mouse	LC		X		
Notomys sp.	Hopping-mouse		X			
Pseudomys hermannsburgensis	Sandy Inland Mouse	LC		X		X
Canidae Dogs, Foxes						
Canis lupus dingo	Dingo	LC				

WC Act Status - S1 to S4, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DEC Priority Status - P1 to P5, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992 (Kurnalpi)	WAM 1992 (Black Flag)	DEC 2012
Felidae Cats						
Felis catus	Cat	Introduced				X
Bovidae Horned Ruminants						
Bos taurus	European Cattle	Introduced				X
Capra hircus	Goat	Introduced				X
Ovis aries	Sheep	Introduced	X			
Leporidae Rabbits, Hares						
Oryctolagus cuniculus	Rabbit	Introduced	X			X

APPENDIX C

DEC NATUREMAP & EPBC ACT DATABASE SEARCH RESULTS

NatureMap - Kurnalpi HR - Frogs

Created By Greg Harewood on 20/09/2012

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Amphibians
Method	'By Circle'
Centre	122°07' 24" E,30°26' 30" S
Buffer	40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	25425	*Neobatrachus kunapalari (Kunapalari Frog)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap
Mapping Western Australia's biodiversity

NatureMap - Kurnalpi HR - Reptiles

Created By Greg Harewood on 20/09/2012

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Species Group Reptiles
Method 'By Circle'
Centre 122°07' 24" E,30°26' 30" S
Buffer 40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	30886	*Cryptoblepharus australis*			
2.	24871	*Ctenophorus cristatus (Bicycle Dragon)*			
3.	24873	*Ctenophorus fordi (Mallee Sand Dragon)*			
4.	24886	*Ctenophorus reticulatus (Western Netted Dragon)*			
5.	24889	*Ctenophorus scutulatus*			
6.	25026	*Ctenotus atlas*			
7.	25052	*Ctenotus leonhardii*			
8.	25074	*Ctenotus schomburgkii*			
9.	25080	*Ctenotus uber subsp. uber*			
10.	25089	*Cyclodomorphus melanops subsp. elongatus*			
11.	24997	*Delma butleri*			
12.	24940	*Diplodactylus pulcher*			
13.	25092	*Egernia depressa (Pygmy Spiny-tailed Skink)*			
14.	25094	*Egernia formosa*			
15.	24957	*Gehyra purpurascens*			
16.	24959	*Gehyra variegata*			
17.	24961	*Heteronotia binoei (Bynoe's Gecko)*			
18.	30927	*Lerista kingi*			
19.	25155	*Lerista muelleri*			
20.	25005	*Lialis burtonis*			
21.	25184	*Menetia greyii*			
22.	24904	*Moloch horridus (Thorny Devil)*			
23.	25190	*Morethia butleri*			
24.	30941	*Nephrurus milii (Barking Gecko)*			
25.	25254	*Parasuta monachus*			
26.	24907	*Pogona minor subsp. minor*			
27.	25261	*Pseudechis australis (Mulga Snake)*			
28.	25263	*Pseudonaja modesta (Ringed Brown Snake)*			
29.	24982	*Rhynchoedura ornata (Beaked Gecko)*			
30.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
31.	25519	*Tiliqua rugosa*			
32.	25207	*Tiliqua rugosa subsp. rugosa*			
33.	25211	*Varanus caudolineatus*			
34.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
35.	25526	*Varanus tristis (Racehorse Monitor)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap - Kurnalpi HR - Birds

Created By Greg Harewood on 20/09/2012

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Species Group Birds
Method 'By Circle'
Centre 122°07' 24" E,30°26' 30" S
Buffer 40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	24264	*Acanthiza robustirostris (Slaty-backed Thornbill)*			
5.	24265	*Acanthiza uropygialis (Chestnut-rumped Thornbill)*			
6.	25536	*Accipiter fasciatus (Brown Goshawk)*			
7.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
8.	24541	*Amytornis textilis subsp. textilis (Thick-billed Grasswren (western))*		P4	
9.	24561	*Anthochaera carunculata (Red Wattlebird)*			
10.	25528	*Aphelocephala leucopsis (Southern Whiteface)*			
11.	24285	*Aquila audax (Wedge-tailed Eagle)*			
12.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
13.	24356	*Artamus personatus (Masked Woodswallow)*			
14.	25715	*Cacatua roseicapilla (Galah)*			
15.	24376	*Charadrius rubricollis (Hooded Plover)*		P4	
16.	24321	*Chenonetta jubata (Australian Wood Duck)*			
17.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
18.	30956	*Cinclosoma castanotus (Chestnut Quail-thrush)*			
19.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
20.	24361	*Coracina maxima (Ground Cuckoo-shrike)*			
21.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
22.	24416	*Corvus bennetti (Little Crow)*			
23.	25592	*Corvus coronoides (Australian Raven)*			
24.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
25.	25595	*Cracticus tibicen (Australian Magpie)*			
26.	25596	*Cracticus torquatus (Grey Butcherbird)*			
27.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
28.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
29.	24470	*Dromaius novaehollandiae (Emu)*			
30.	24650	*Drymodes brunneopygia (Southern Scrub-robin)*			
31.	24570	*Epthianura tricolor (Crimson Chat)*			
32.	25621	*Falco berigora (Brown Falcon)*			
33.	25622	*Falco cenchroides (Australian Kestrel)*			
34.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
35.	24443	*Grallina cyanoleuca (Magpie-lark)*			
36.	24367	*Lalage tricolor (White-winged Triller)*			
37.	24557	*Leipoa ocellata (Malleefowl)*		T	
38.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
39.	24577	*Lichenostomus ornatus (Yellow-plumed Honeyeater)*			
40.	24581	*Lichenostomus virescens (Singing Honeyeater)*			
41.	25661	*Lichmera indistincta (Brown Honeyeater)*			
42.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
43.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
44.	25654	*Malurus splendens (Splendid Fairy-wren)*			
45.	24583	*Manorina flavigula (Yellow-throated Miner)*			
46.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
47.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
48.	25693	*Microeca fascinans (Jacky Winter)*			
49.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
50.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
51.	24618	*Oreoica gutturalis (Crested Bellbird)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
52.	24619	*Pachycephala inornata (Gilbert's Whistler)*			
53.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
54.	25682	*Pardalotus striatus (Striated Pardalote)*			
55.	24659	*Petroica goodenovii (Red-capped Robin)*			
56.	24409	*Phaps chalcoptera (Common Bronzewing)*			
57.	24593	*Phylidonyris albifrons (White-fronted Honeyeater)*			
58.	24748	*Platycercus varius (Mulga Parrot)*			
59.	25721	*Platycercus zonarius (Australian Ringneck)*			
60.	25703	*Podargus strigoides (Tawny Frogmouth)*			
61.	25722	*Polytelis anthopeplus (Regent Parrot)*			
62.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
63.	24278	*Pyrrholaemus brunneus (Redthroat)*			
64.	25613	*Rhipidura fuliginosa (Grey Fantail)*			
65.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
66.	30948	*Smicrornis brevirostris (Weebill)*			
67.	25597	*Strepera versicolor (Grey Currawong)*			
68.	24331	*Tadorna tadornoides (Australian Shelduck)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

NatureMap - Kurnalpi HR - Mammals

Created By Greg Harewood on 20/09/2012

Kingdom	Animalia
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	Mammals
Method	'By Circle'
Centre	122°07' 24" E,30°26' 30" S
Buffer	40km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24251	*Bos taurus (European Cattle)*			
2.	25454	*Canis lupus*			
3.	24253	*Capra hircus (Goat)*			
4.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
5.	24187	*Chalinolobus morio (Chocolate Wattled Bat)*			
6.	24041	*Felis catus (Cat)*			
7.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
8.	24136	*Macropus rufus (Red Kangaroo)*			
9.	24184	*Mormopterus planiceps (Southern Freetail-bat)*			
10.	24223	*Mus musculus (House Mouse)*			
11.	24094	*Ningaui ridei (Wongai Ningaui)*			
12.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
13.	24085	*Oryctolagus cuniculus (Rabbit)*			
14.	24232	*Pseudomys bolami (Bolam's Mouse)*			
15.	24237	*Pseudomys hermannsburgensis (Sandy Inland Mouse)*			
16.	24199	*Scotorepens balstoni (Inland Broad-nosed Bat)*			
17.	24108	*Sminthopsis crassicaudata (Fat-tailed Dunnart)*			
18.	24109	*Sminthopsis dolichura (Little long-tailed Dunnart)*			
19.	24207	*Tachyglossus aculeatus (Echidna)*			
20.	24185	*Tadarida australis (White-striped Freetail-bat)*			
21.	24176	*Taphozous hilli (Hill's Sheathtail-bat)*			
22.	24202	*Vespadelus baverstocki (Inland Forest Bat)*			
23.	24206	*Vespadelus regulus (Southern Forest Bat)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

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: 19/09/12 20:42:23

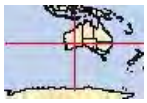
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



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

Coordinates
Buffer: 10.0Km



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 Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	3
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 and the heritage values of a place on the Register of the National Estate.

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.

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:	4
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

Place on the RNE:	None
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	6
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		
Acanthiza iredalei iredalei		
Slender-billed Thornbill (western) [25967]	Vulnerable	Species or species habitat likely to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Plants		
Gastrolobium graniticum		
Granite Poison [14872]	Endangered	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 may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Migratory Terrestrial Species		
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		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 may occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat may occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area

Extra Information

Invasive Species	[Resource Information]

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

Name	Status	Type of Presence
Mammals		

Name	Status	Type of Presence
Capra hircus		
Goat [2]		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 likely to occur within area
Cenchrus ciliaris		
Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

Coordinates

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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 EPBC Act. It holds information regarding matters of National Environmental Significance that may occur in, or may relate to, the area you requested. Maps of Commonwealth land are 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 the absence of a species does not mean that it does not occur in the area you have requested. Likewise, the inclusion of a species on the report is a general guide only. Where available, data supporting mapping of presence 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.

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:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA 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
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

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

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APPENDIX D

SIGNIFICANT SPECIES PROFILES

Southern Carpet Python *Morelia spilota imbricata*

Status and Distribution: The south western population is classified as Priority 4 by the DEC and is also listed in Schedule 4 under the *WC Act*. This subspecies has wide distribution within the south west but is uncommon. Occurs north to Geraldton and Yalgoo and east to Pinjin, Kalgoorlie, Fraser Range and Eyre (Storr *et al.* 2002).

Habitat: This species has been recorded from semi-arid coastal and inland habitats, Banksia woodland, Eucalypt woodlands, and grasslands. Most often found utilising hollow logs in addition the burrows of other animals for shelter. Often arboreal and will also use tree hollows for refuge.

Likely presence in study area: A dead southern carpet python was found by the Author 10km south west of the study area on the day of the field reconnaissance survey, indicating that a population of the species persists in the general area.

Potential impact of development: Loss of an area of potential habitat though no significant impact on this species is anticipated given the linear shape of the proposed clearing, along with the large amount of vegetation remaining in the local area.

Malleefowl *Leipoa ocellata*

Status and Distribution: This species is listed as Schedule 1 under the *WC Act* and as Vulnerable and Migratory under the *EPBC Act*. Originally common, but now generally rare to uncommon and patchily distributed.

Current distribution mainly southern arid and semi-arid zones, north to Shark Bay, Jingemarra, Colga Downs and Yeelirrie, east to Earnest Giles Range, Yeo Lake, lower Ponton Creek and to Eucla and west and south to Cockleshell Gully, the Wongan Hills, Stirling Range, Beaufort Inlet, Hatters Hill, Mt Ragged and Point Malcolm (Johnstone and Storr 1998).

Habitat: Mainly scrubs and thickets of mallee *Eucalyptus* spp., boree *Melaleuca lanceolata* and bowgada *Acacia linophylla*, also dense litter forming shrublands. A sandy substrate and abundance of leaf litter are clear requirements for the construction of the birds' incubator-nests (Frith 1959, 1962).

Likely presence in study area: Several footprints of this species were found in and near the study area and a recently used nest mound was located 20m outside the boundary of the study area at 409765 mE 6642042 mN (MGA Zone 51).

Potential impact of development: Malleefowl may be using utilising sections of the study area as breeding and foraging habitat and the proposed haul route has the

potential to directly impact on these areas. The future operation of the haul road also has the potential to increase the likelihood of road kills. The presence of breeding malleefowl within the area will need to be taken into consideration during future planning and during future use of the haul road so as to minimise potential impacts on the species and areas of most likely habitat.

Great Egret *Ardea alba*

Status and Distribution: This species of egret is listed as Schedule 3 under the *WC Act* and as Migratory under the *EPBC Act* including international agreements to which Australia is a signatory. The Great Egret is common and very widespread in any suitable permanent or temporary habitat (Morcombe 2003).

Habitat: Wetlands, flooded pasture, dams, estuarine mudflats, mangroves and reefs (Morcombe 2003).

Likely presence in study area: No suitable habitat. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as it is unlikely to use the project area for any purpose.

Cattle Egret *Ardea ibis*

Status and Distribution: This species of egret is listed Scheduled 3 under the *WC Act (1950),* as migratory under the *EPBC Act 1999* and under international agreements to which Australia is a signatory. The Cattle Egret is common in the north sections of its range but is an irregular visitor to the better watered parts of the state (Johnstone and Storr 1998). The population is expanding (Morcombe 2003).

Species or species habitat listed as likely to occur in general area within EPBC database search.

Habitat: Moist pastures with tall grasses, shallow open wetlands and margins, mudflats (Morcombe 2003).

Likely presence in study area: No suitable habitat. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as it is unlikely to use the project area for any purpose.

Peregrine Falcon *Falco peregrinus*

Status and Distribution: This species is listed as Schedule 4 under the *WC Act*. Individuals of this species are uncommon/rare but wide ranging across Australia. Moderately common at higher levels of the Stirling Range, uncommon in hilly, north

west Kimberley, Hamersley and Darling Ranges; rare or scarce elsewhere (Johnstone and Storr 1998).

Habitat: Diverse from rainforest to arid shrublands, from coastal heath to alpine (Morcombe 2003). Mainly about cliffs along coasts, rivers and ranges and about wooded watercourses and lakes (Johnstone and Storr 1998). The species utilises the ledges, cliff faces and large hollows/broken spouts of trees for nesting. It will also occasionally use the abandoned nests of other birds of prey. Also known to utilise decommissioned open cut pit walls for nesting.

Likely presence in study area: The species potentially utilises some sections of the study area as part of a much larger home range, though records in this area are rare. No potential nest sites in trees observed.

Potential impact of development: No impact anticipated.

Grey Falcon *Falco hypoleucos*

Status and Distribution: This species is listed as Schedule 1 under the *WC Act*. Within WA found in the northern half south to about 26°S (Gascoyne, Lake Carnegie and Warburton), casual further south (Johnstone and Storr 1998).

Habitat: Lightly treed plains, gibber deserts, sand ridges, pastoral lands, timbered water courses but seldom in driest deserts (Pizzey & Knight 2012).

Likely presence in study area: The study area is outside this species current main documented range though it may occur very rarely. Not listed as a potential species.

Potential impact of development: No impact on this species is anticipated.

Australian Bustard *Ardeotis australis*

Status and Distribution: This species is listed as Priority 4 by DEC. A nomadic species that is common away from settled areas over much of Australia (Morcombe 2003).

Habitat: Grasslands, especially tussock grasses, like speargrass, Mitchell grass, spinifex; arid scrub with saltbush, bluebush; open dry woodland of mulga, mallee and, heath (Morcombe, 2003).

Likely presence in study area: May infrequently traverse the area but it would not be specifically attracted to the site and would only ever be present as individuals or very small groups for small periods of time.

Potential impact of development: Loss of an area of potential habitat though no significant impact on this species is anticipated as it is likely to be present only infrequently, in low numbers. There are vast areas of suitable habitat in surrounding areas.

Bush Stone Curlew *Burhinus grallarius*

Status and Distribution: Listed as Priority 4 by DEC. Occurs over much of the western half of the state (and Kimberley) but rare to uncommon in the south of its range due to fox predation (Johnstone and Storr 1998).

Habitat: Lightly wooded country (including partly cleared forests) near daytime shelter e.g. thickets or long grass (Johnstone and Storr 1998).

Likely presence in study area: No recent or historical records suggest this species is very unlikely to be present in the study area despite apparent suitable habitat, though it may occur very occasionally.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding as it is considered unlikely to be present.

Hooded Plover *Charadrius rubricollis*

Status and Distribution: Listed as Priority 4 by DEC. In south west WA, coastally west from Israelite Bay north to Jurien Bay and inland salt lakes. In eastern Australia confined to suitable habitat from Jervis Bay (NSW) through Bass Strait and Tasmanian and west to Great Australian Bight in South Australia.

Habitat: Broad sandy ocean beaches and bays, coastal and inland salt lakes (Pizzey & Knight 2012).

Likely presence in study area: No suitable habitat within the project area. Rarely recorded in this section of the Goldfields. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as it is unlikely to use the project area for any purpose.

Princess Parrot *Polytelis alexandrae*

Status and Distribution: This species is listed as Priority 4 by the DEC and as Vulnerable under the *EPBC Act*. Rare, highly nomadic (Pizzey & Knight 2012). Found in the eastern deserts north to the Edgar Ranges, west to the Gregory Range, Well 18, Mt Bates, Lake Throssell and Mt Luck and south to Queen Victoria Spring and Carlisle Lakes, casual further north (Fossil Downs, Bohemia Downs) and west (head of Gascoyne, head of the Murchison, Wiluna, Wanjarri, Sandstone, Laverton,

Kookynie, Menzies, Kanowna). Also deserts of eastern Australia (Johnstone and Storr 1998).

Habitat: Arid shrubland, particularly mulga, Desert Oak and Spinifex country including trees along watercourses (Simpson and Day 2010).

Likely presence in study area: The study area is just outside this species current documented range though it may occur very rarely. No recent records. Not listed as a potential species.

Potential impact of development: No impact on this species or its preferred habitat is anticipated.

Western Rosella (Inland ssp) *Platycercus icterotis xanthogenys*

Status and Distribution: The inland sub species of the Western Rosella is listed as Priority 4 by the DEC. Rare to moderately common (Johnstone and Storr 1998). Local extinctions have occurred in 25% of local government authorities, representing about 40% of the total range, mostly in the north and east (Saunders and Curry 1990, Saunders and Ingram 1995, Mawson and Long 1996, Mawson and Johnstone 1997). Still declining in wheatbelt, but stable in western woodland and forest (Mawson and Johnstone 1997). Semiarid southern interior: Wongan Hills (formerly), Kununoppin, Moorine Rock, Parker Range, Yardina Rock and Ten Mile Rocks, west to Toodyay, the Dale River, Mt Saddleback and Kojonup, and south to the Stirling Range, lower Fitzgerald River, Ravensthorpe, Frank Hann National Park and Red Lake; casual further north (Mt Jackson, Karalee, Gnarlbine Rock) (Johnstone and Storr 1998).

Habitat: Mainly eucalypt and casuarina woodlands and scrubs, especially of wandoo, flooded gum, salmon gum, tall mallees and *Allocasuarina huegeliana*. Attracted to seeding *E wandoo*, *A. huegeliana*, *Glischrocaryon flavescens* and *Olearia revoluta* and to flowering *Melaleuca acuminata* and *Eucalyptus eremophilrx* (Johnstone and Storr 1998).

Likely presence in study area: The study site is outside of the currently documented range of this sub-species and it is therefore considered unlikely to frequent the area.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Major Mitchell's Cockatoo *Cacatua leadbeateri*

Status and Distribution: Classified as Schedule 4 under the *WC Act*. Sedentary, generally uncommon and of patchy occurrence. Widespread but disjunct in arid and

semi arid zones. Found across the arid and semi-arid inland, from south-western Queensland south to north-west Victoria, through most of South Australia, north into the south-west Northern Territory and across to the west coast between Shark Bay and Jurien Bay south to Queen Victoria Spring (Johnstone and Storr 1998).

Habitat: Lightly or sparsely wooded country near water and tall eucalypts (Johnstone and Storr 1998).

Likely presence in study area: Study area is just outside of this species main documented range and the paucity of records in the local or regional area suggests habitat is generally is unsuitable for this species to persist. May occur very occasionally

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Fork-tailed Swift *Apus pacificus*

Status and Distribution: The Fork-tailed Swift is listed as Schedule 3 under the *WC Act* and as Migratory under the *EPBC Act* including international agreements to which Australia is a signatory. It is a summer migrant (Oct-Apr) to Australia (Morcombe 2003).

Habitat: Low to very high airspace over varied habitat from rainforest to semi desert (Morcombe 2003).

Likely presence in study area: This species is potentially a very occasional summer visitor to the wider area but is entirely aerial and largely independent of terrestrial habitats and it would not be specifically attracted to the project area. . Probability of ever occurring is very low and then it would only be present briefly while flying overhead. Not listed as a potential species.

Potential impact of development: No impact on this species is anticipated.

Rainbow Bee-eater *Merops ornatus*

Status and Distribution: This species is listed as Schedule 3 under the *WC Act* and as Migratory under the *EPBC Act* including international agreements to which Australia is a signatory. The Rainbow Bee-eater is a common summer migrant to southern Australia but in the north they are resident (Morcombe 2003).

Habitat: Open Country, of woodlands, open forest, semi arid scrub, grasslands, clearings in heavier forest, farmlands (Morcombe 2003). Breeds underground in areas of suitable soft soil firm enough to support tunnel building. Nest is a burrow

usually dug at a slight angle in flat ground, sometimes into sandy banks or cuttings and often on margins of roads and tracks (Johnstone and Storr 1998).

Likely presence in study area: Five individuals observed in the central section of the study area during the field survey. This species is a common, widespread seasonal visitor to southern half of WA. Population levels at any one location would however not be significant as it usually breeds in pairs, rarely in small colonies (Johnstone and Storr, 1998).

Potential impact of development: No significant impact on this species is anticipated.

Slender-billed Thornbill (western) *Acanthiza iredalei iredalei*

Status and Distribution: This subspecies is listed as Vulnerable under the *EPBC Act.* Distribution is disjunct in southern arid zone: vicinity of mid west coast from Lake Macleod south to Wooramel, Hamelin and on Peron Peninsula and Edel land: margins of salt lakes from Lake Annean, Lake Austin, Lake Violet and Lake Throssell south to Lake Barlee and Lake Goongarrie. Also within areas of the southern Nullarbor Plain. Moderately common to common on mid-west coast (e.g. between Carnarvon and Long Point); uncommon, rare or extinct elsewhere (Johnstone and Storr 2004).

Habitat: Chenopod shrub steppe, mainly bluebush *Maireana sedifolia*, saltbush *Atriplex* spp. and samphire *Halosarcia* spp. In treeless or sparsely wooded flatlands; also samphire, dwarf mangroves and low melaleuca and other stunted near coastal shrubs (Johnstone and Storr 2004).

Likely presence in study area: No suitable habitat. This, combined with the lack of actual records (historical and more recent) suggest it is absent from the general area. Not listed as a potential species.

Potential impact of development: No impact on this species is anticipated as is considered unlikely to be present.

Thick-billed Grass-wren (western ssp) *Amytornis textilis textilis*

Status and Distribution: Listed as Priority 4 by DEC and vulnerable under the *EPBC Act*. Historically, the 'western' Thick-billed Grasswren was found in the Shark Bay area, including Peron Peninsula and Dirk Hartog Island, at Wongan Hills, east of Broomehill, between Beverley and Narembeen, Mt Magnet, Lake Austin, Lake Way and Lake Violet, Yalgoo, Kalgoorlie and Laverton. There is some doubt as to the extent of the Thick-billed Grasswren over the Nullarbor Plain. Currently restricted to

the Shark Bay region including Peron Peninsula and the nearby pastoral stations of Nanga, Hamelin, Woodleigh and Carbla (Cale 2000).

Habitat: Occurs in acacia-dominated shrublands, dense shrub associations in drainage depressions, and *Triodia* spinifex with acacia shrubland components. All these habitats feature recumbent shrubs where the foliage extends to the ground. In acacia-dominated shrublands, shrub clumps of high foliage density appear important determinants of Thick-billed Grasswren presence. These shrub clumps may provide the Thick-billed Grasswren with ideal nesting sites (Cale 2000).

Likely presence in study area: Species is considered to be locally extinct in the wider area. Not listed as a potential species.

Potential impact of development: No impact on this species will occur as a result of the proposal proceeding.

Bilby *Macrotis lagotis*

Status and Distribution: The Bilby is listed as Schedule 1 under the *WC Act* and Vulnerable under the *EPBC Act*. Current distribution in suitable habitat from Tanami Desert west to near Broome and south to Warburton. Former distribution extended south to Margaret River, though apparently absent from coastal plain (Burbidge 2004).

Habitat: Current habitat includes Acacia shrublands, spinifex and hummock grassland (Menkhorst *et al.* 2011).

Likely presence in study area: This species is considered to be locally and regionally extinct.

Potential impact of development: No impact on this species will occur.

Chuditch *Dasyurus geoffroii*

Status and Distribution: Listed as Scheduled 1 under the *WC Act* and as Vulnerable under the *EPBC Act.* Formerly occurred over nearly 70 per cent of Australia. The Chuditch now has a patchy distribution throughout the Jarrah forest and mixed Karri/Marri/Jarrah forest of southwest Western Australia. Also occurs in very low numbers in the Midwest, Wheatbelt and South Coast Regions with records from Moora to the north, Yellowdine to the east and south to Hopetoun.

Habitat: Chuditch are known to have occupied a wide range of habitats from woodlands, dry sclerophyll (leafy) forests, riparian vegetation, beaches and deserts. Riparian vegetation appears to support higher densities of Chuditch, possibly

because food supply is better or more reliable and better cover is offered by dense vegetation. Chuditch appear to utilise native vegetation along road sides in the wheatbelt (CALM 1994). The estimated home range of a male Chuditch is over 15 km^2 whilst that for females is 3-4 km^2 (Sorena and Soderquist 1995).

Likely presence in study area: No records in area suggest this species is locally and regionally extinct. It is unlikely that a population of this species exists in or near the study area. Even if habitat within the study area was suitable, the absence of any feral predator control or possible recruitment from adjoining areas means it is unlikely to be persists in the area under normal circumstances.

Potential impact of development: No impact on this species will occur as a result of the proposed development.

Numbat *Myrmecobius fasciatus*

Status and Distribution: Listed as Scheduled 1 under the *WC Act* and as Vulnerable under the *EPBC Act*. Once occurred across much of arid and semi arid southern Australia, now restricted to a few remnant forests of Wandoo, Powderbark Wandoo or jarrah in South West WA (Menkhorst & Knight 2001). Rare, scattered. Found only at Dryandra, Perup and six other translocation sites (Van Dyck & Strahan 2008).

Habitat: Generally dominated by eucalypts that provide hollow logs and branches for shelter and termites for food (Van Dyck & Strahan 2008).

Likely presence in study area: Available evidence suggests this species is locally and regionally extinct.

Potential impact of development: No impact on this species is anticipated.

Central Long-eared Bat *Nyctophilus major tor*

Status and Distribution: Listed as Priority 4 by DEC. Historical distribution included the Coolgardie, Hampton and northern Avon Bioregions in Western Australia, Gawler Bioregion and western part of the 'Eyre and York Blocks' Bioregion in South Australia. A specimen from Ooldea in the Great Victoria Desert Bioregion of South Australia. One other specimen from a car grill after a night-time drive from Marla (Stony Plains Bioregion of SA) to Alice Springs in the Northern Territory via the Stuart Highway in c.1985. No historical data on abundance.

Currently known from 15 localities in Western Australia and 19 in South Australia. No evidence that range has contracted, but it is apparently rare in Great Victoria Desert,

Nullarbor and Stony Plains Bioregions while it is locally common in Coolgardie, Hampton, Gawler and western Eyre-York Block Bioregions (Duncan *et al* (ed) 1999).

Habitat: Gleans ground, bark and foliage surfaces; forages in and against cluttered airspaces. The species is often netted, and sometimes caught in pit traps, in heavy eucalypt woodlands and tall woodlands of the Coolgardie Bioregion of Western Australia with a tall shrub understorey of *Melaleuca lanceolata, M. pauperiflora, M. quadrifaria, Eremophila spp*. etc. Less common in open woodlands. Has been netted at dams in the Coolgardie and Hampton Bioregions of Western Australia while in South Australia has been associated with a range of mallee (*Eucalyptus*) species, *Acacia papyrocarpa*, *A. ramulosa, Casuarina cristata* and found to the fringes of the treeless Nullarbor Plain (Duncan *et al.* (ed) 1999). Roosts in tree cavities, in foliage and under loose bark (Churchill 2008).

Likely presence in study area: This species has been recorded during bat surveys at the Kanowna Belle mine site about 50km south west of the Project area. Exact status in the study area difficult to determine. Listed as a potential species but can be considered to have a low probability of being present.

Potential impact of development: If present clearing will result in the loss/modification of some foraging and potential roosting habitat but this is unlikely to alter the status of the species on a local or regional scale.

Appendix F: Reconnaissance Flora & Fauna survey Kurnalpi Project (2018)

Reconnaissance Flora & Fauna survey
Kurnalpi Project
Prepared For
KalNorth Gold Mines Limited





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Version 1

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An internal quality review process has been implemented to each project task undertaken by BC. Each document and its contents are carefully reviewed by core members of the Consultancy team and signed off at Director Level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

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Glossary

Acronym	Description
ANCA	Australian Nature Conservation Agency.
BA	Birdlife Australia (Formerly RAOU, Birds Australia).
BAM Act	Biosecurity and Agriculture Management Act 2007, WA Government.
BC	Botanica Consulting.
BoM	Bureau of Meteorology.
CAMBA	China Australia Migratory Bird Agreement 1998.
DAFWA	Department of Agriculture and Food (now DPIRD), WA Government.
DBCA	Department of Biodiversity, Conservation and Attractions (formerly DPaW), WA Government.
DEC	Department of Environment and Conservation (now DBCA), WA Government.
DER	Department of Environment Regulation (now DWER), WA Government.
DMIRS	Department of Mines, Industry Regulation and Safety (formerly DMP), WA Government
DMP	Department of Mines and Petroleum (now DMIRS), WA Government.
DotEE	Department of the Environment and Energy (formerly DSEWPaC), Australian Government.
DoW	Department of Water (now DWER), WA Government.
DPaW	Department of Parks and Wildlife (now DBCA), WA Government.
DPIRD	Department of Primary Industries and Regional Development, WA Government
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (now DotEE,), Australian Government.
DWER	Department of Water and Environmental Regulation (formerly EPA, DER and DoW), WA Government
EP Act	Environmental Protection Act 1986, WA Government.
EP Regulations	Environmental Protection (Clearing of Native Vegetation) Regulations 2004, WA Government.
EPA	Environmental Protection Authority, WA Government.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999, Australian Government.
ESA	Environmentally Sensitive Area.
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.
JAMBA	Japan Australia Migratory Bird Agreement 1981.
KalNorth	KalNorth Gold Mines Limited
Km	Kilometre (1,000 metres).
MVG	Major Vegetation Groups.
NVIS	National Vegetation Information System.
OEPA	Office of the Environmental Protection Authority (now DWER), WA Government.
PEC	Priority Ecological Community.
RAOU	Royal Australia Ornithologist Union.
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement 2007.

Acronym	Description
KalNorth	KalNorth Gold Mines
SRE	Short Range Endemic.
SSC	Species Survival Commission, International.
Survey Area	KalNorth Gold Mines Tenements
TEC	Threatened Ecological Community.
WA	Western Australia.
WAHERB	Western Australian Herbarium.
WAM	Western Australian Museum, WA Government.
WC Act	Wildlife Conservation Act 1950, WA Government.

Executive Summary

Botanica Consulting (BC) was commissioned by KalNorth Gold Mines Limited (KalNorth) to undertake a reconnaissance flora survey and fauna survey of the Kurnalpi Project (referred to as the 'survey area'). The survey area is located approximately 90 km north-east of Kalgoorlie-Boulder. The survey was conducted in autumn 2018, covering an area of 4,795 ha.

Nine vegetation types were identified within the survey area. These vegetation types were located within three different landform types and comprised of five major vegetation groups, which were represented by a total of 18 Families, 31 Genera and 83 taxa. The broad scale terrestrial flora habitats within the survey area have been identified as comprising a mosaic of clay-loam plain, open depression, and rocky hillslopes.

Results of the literature review identified 28 mammals (including 9 bat species), 101 birds, 60 reptiles and four frog species that have previously been recorded in the general area, some of which have the potential to occur subject to the identified habitats being suitable. Forty-six fauna species were recorded during the field surveys.

No Threatened Flora, Threatened Fauna, Migratory Fauna or Threatened Ecological Communities (TEC) as listed under the Western Australian *Wildlife Conservation (WC) Act 1950*[1] or Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* were identified within the survey area. No Priority Flora taxa as listed on the Department of Biodiversity, Conservation and Attractions (DBCA) database were identified within the survey area. No Priority Fauna as listed by DBCA were recorded within the survey area.

A review of the EPBC Act threatened fauna list, DBCA's Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified a number of specially protected, migratory or priority fauna species as having been previously recorded or as being potentially present in the general vicinity of the survey area. However, no fauna of conservation significance is likely to be significantly impacted on by the proposed development. This conclusion is primarily based on the lack of suitable habitats, the known local extinction of some species, the relatively small size of the impact footprint and the extensive habitat connectivity with adjoining areas. Impacts on fauna and fauna habitat are therefore anticipated to be localised, small/negligible and as a consequence manageable.

No Priority Ecological Communities (PEC) were identified within the survey area. The survey area does not contain any world or national heritage places and does not occur within a Bush Forever site. There are no wetlands of international importance (Ramsar Wetlands), national importance (Australian Nature Conservation Agency (ANCA) Wetlands) or conservation category wetlands within the survey area.

The survey area does not contain any Environmentally Sensitive Areas (ESA) listed under the *Environmental Protection (EP) Act 1986*. The survey area is not located within DBCA managed land. The closest conservation reserve is the Bullock Holes Timber Reserve, which is located approximately 30km west of the survey area.

Based on the vegetation condition rating scale adapted from Keighery, 1994 and Trudgen, 1988 (ranging from 'pristine' to 'completely degraded'), one vegetation type was rated as 'good' and the remaining eight vegetation types were rated as 'very good'. Three introduced taxa were identified within the survey area.

[1] *Biodiversity Conservation Act 2016* received assent on 21 September 2016 with Parts of the Act coming into effect on 3 December 2016. Once fully enacted with enabling subsidiary regulations, it will replace the *Wildlife Conservation Act 1950*.

According to the Department of Primary Industries and Regional Development (DPIRD), these taxa are not listed as a Declared Plant under the *Biosecurity and Agriculture Management (BAM) Act 2007*.

1 Introduction

1.1 Project Description

Botanica Consulting (BC) was commissioned by KalNorth Gold Mines Limited (KalNorth) to undertake a reconnaissance flora survey and fauna survey of the Kurnalpi Project (referred to as the 'survey area'). The survey area is located approximately 90 km north-east of Kalgoorlie-Boulder (Figure 1-1). The survey was conducted in Autumn (14th, 15th and 21st May 2018), covering an area of 4,795 ha.

1.2 Objectives

The flora assessment was conducted in accordance with the requirements of a reconnaissance flora survey as defined in *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016a). The objectives of the assessment were to:

- gather background information on flora and vegetation in the target area (literature review, database and map-based searches);
- identify significant flora, vegetation/ecological communities and assess the potential sensitivity to impact;
- conduct a field survey to verify / ground truth the desktop assessment findings through survey;
- undertake floristic community mapping to a scale appropriate for the bioregion and described according to the National Vegetation Information System (NVIS) structure and floristics;
- undertake vegetation condition mapping;
- assess the project area's plant species diversity, density, composition, structure and weed cover, using NVIS classification system for vegetation description;
- assess Matters of National Environmental Significance (MNES) and indicate whether potential impacts on MNES as protected under the EPBC Act are likely to require referral of the project to the Commonwealth DotEE; and
- determine the State legislative context of environmental aspects required for the assessment.

The fauna assessment was conducted in accordance with the requirements of a reconnaissance terrestrial fauna survey as defined in *Technical Guidance - Terrestrial Fauna Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016b). The objectives of the assessment were to:

- Gather background information on fauna in the survey area (literature review, database and map-based searches);
- Delineate and characterise the faunal assemblages and fauna habitats present in the survey area;
- Document and map locations of any Threatened or Priority listed fauna species located; and
- Assess the regional and local conservation status of fauna species and fauna habitats within the survey area.

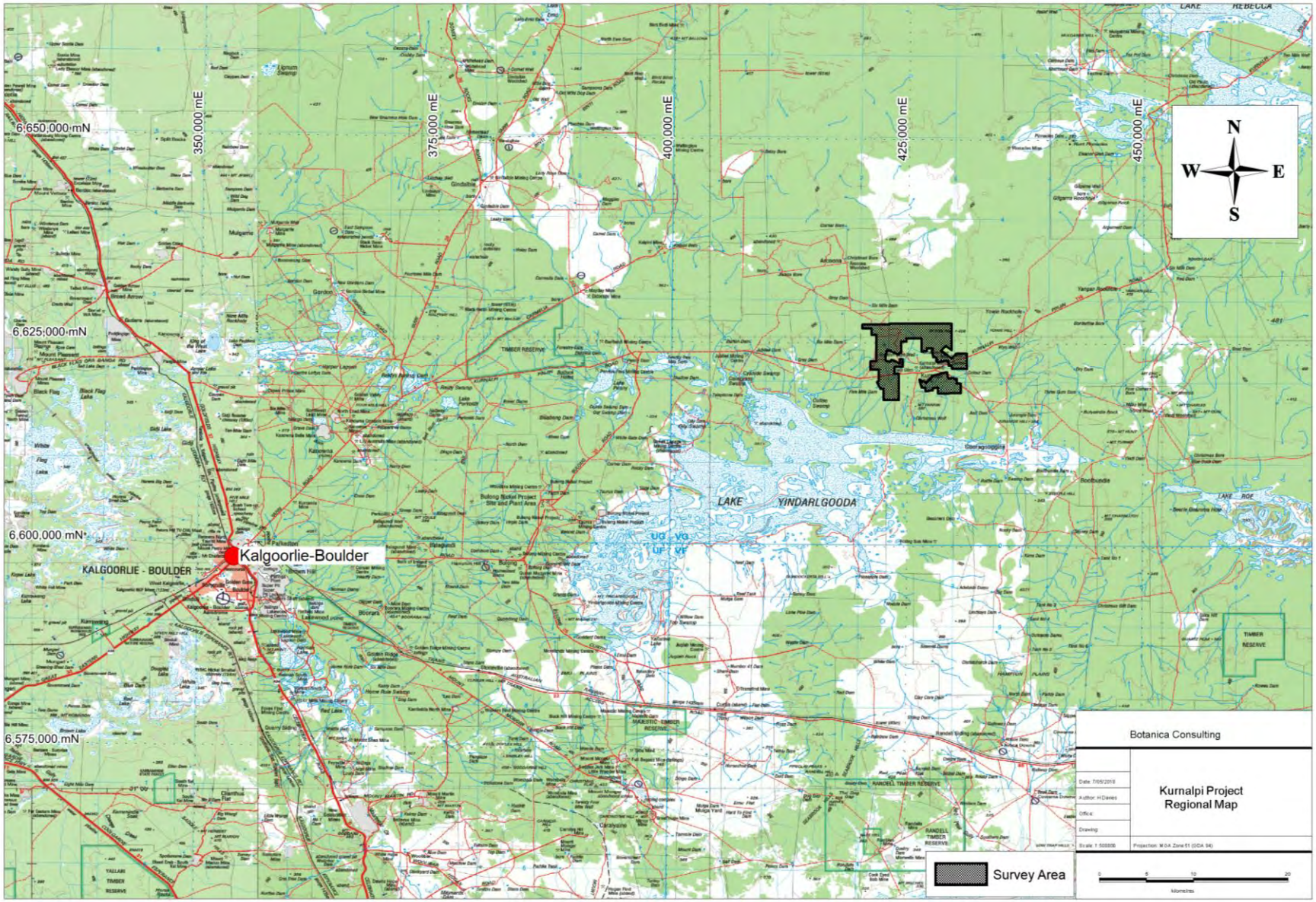


Figure 1-1: Regional map of the survey area

2 Regional Biophysical Environment

2.1 Regional Environment

The Kurnalpi survey area lies within the Murchison Region of the Eremaean Province of WA in a region known as the Austin Botanical District. Based on the Interim Biogeographic Regionalisation of Australia (Figure 2-1)(IBRA, Version 7 (DotEE, 2012). The area consists of predominantly mulga low woodland on plains and reduces to scrub on hills (Beard, 1990). The Murchison Region is further divided into subregions, based on the Interim Biogeographic Regionalisation of Australia (IBRA), with the Kurnalpi survey area located within the Eastern Murchison (MUR1) subregion (Cowan, 2001)

The landscape of the Murchison bioregion comprises low hills, mesas of duricrust separated by flat colluvium and alluvial plains (Commonwealth Government, 2008). It is dominated by the Archaean (over 2500 million years ago) granite greenstone terrain of the Yilgarn Craton (Commonwealth Government, 2008). Alluvial soils and sands mantle the granitic and greenstone units of the Yilgarn Craton. These soils are shallow, sandy and infertile. Underlying the soils in low areas is a red-brown siliceous hard pan (Curry et al. 1994). The soils in the eastern half of the bioregion are typically red sands, lithosols, calcareous red earth soil, duplex soil and clays. There are 41 vegetation associations (hummock grasslands, succulent steppe or low woodlands) that have at least 85 per cent of their total area in the bioregion. The bioregion is rich and diverse in both its flora and fauna but most species are wide ranging and usually occur in adjoining regions (McKenzie, May and McKenna, 2002).

The Eastern Murchison subregion comprises the northern parts of the craton's Southern Cross and Eastern Goldfields Terrains and is characterised by internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt Lake systems are associated with the occluded paleodrainage system. Broad plains of red-brown soils and breakaways complexes as well as red sandplains are widespread. Vegetation is dominated by Mulga woodlands and is often rich in ephemerals, hummock grasslands, saltbush shrublands and Samphire shrublands (McKenzie *et. al.,* 2002). The Eastern Murchison subregion comprises diverse mulga woodlands, which occur on low greenstone belts. The sand plains have red loamy earths and red deep sands are found on the sandy banks.

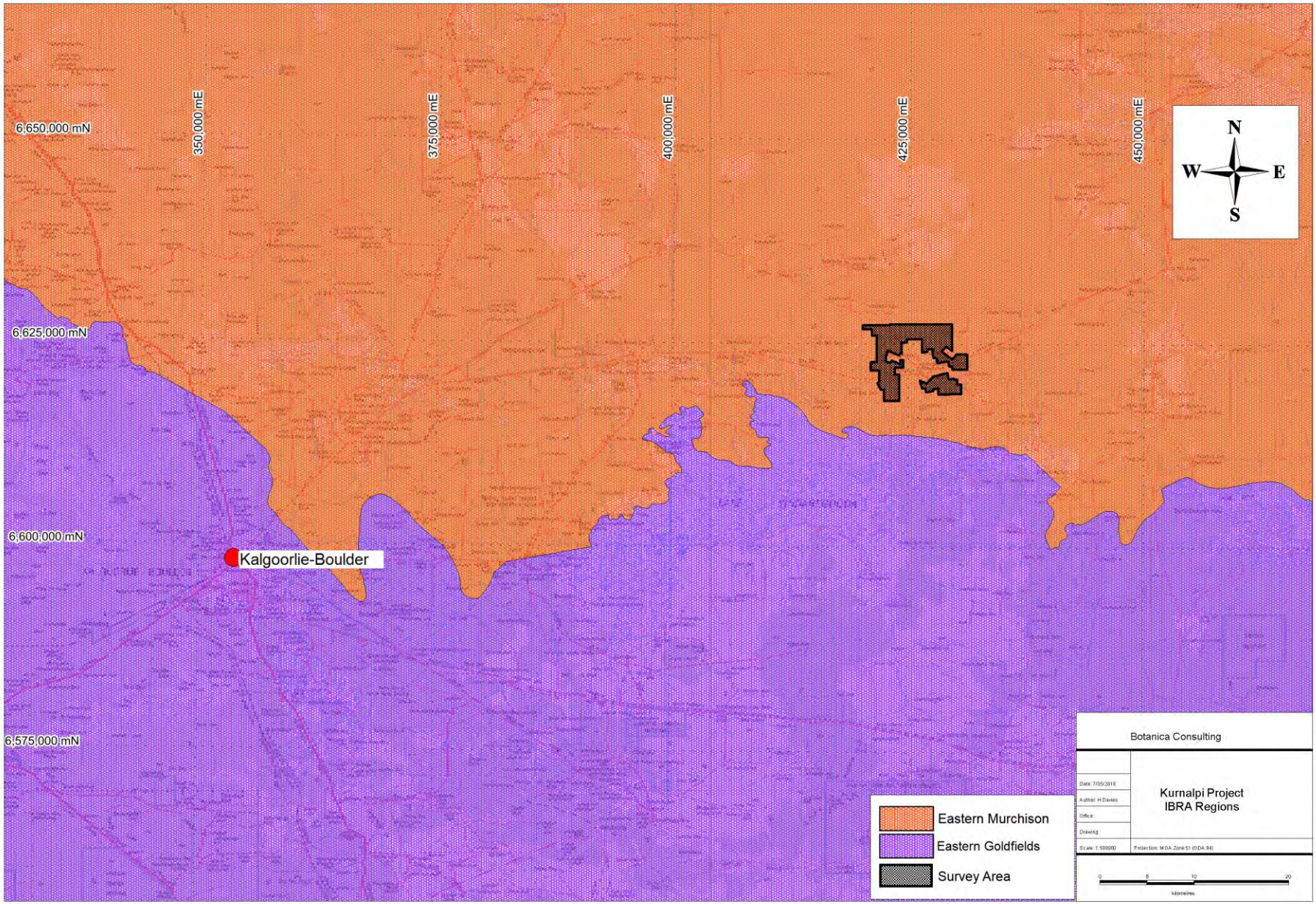


Figure 2-1: Map of IBRA Subregions in relation to the survey area

2.2 Soils and Landscape Systems

The survey area lies within the Kalgoorlie Province, which is characterised by Undulating plains (with some sandplains, hills and salt lakes) on the granitic rocks and greenstone of the Yilgarn Craton. Soils comprise of calcareous loamy earths and red loamy earths with some salt lake soils, red deep sands, yellow sandy earths, shallow loams and loamy duplexes. Vegetation is dominated by Eucalypt woodlands with some acacia-casuarina thickets, mulga shrublands, halophytic shrublands and spinifex grasslands. This Province is located in the southern Goldfields between Paynes Find, Menzies, Southern Cross and Balladonia (Tille, 2006).

The Kalgoorlie Province is further divided into six soil-landscape zones, with the survey area located within the Kambalda Zone (265). The Kambalda Zone comprises of flat to undulating plains (with hills, ranges and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton. Soils include calcareous loamy earths and red loamy earths with salt lakes soils and some red-brown hardpan shallow loams and red sandy duplexes. Vegetation includes red mallee-blackbutt- salmon gum-gimlet woodlands with mulga and halophytic shrublands (and some spinifex grasslands). Located in the south-eastern Goldfields between Menzies, Norseman and the Fraser Range (Tille, 2006). The Kambalda Zone is further divided into soil landscape systems, with the survey area located within seven soil landscape systems Table 2-1 and Figure 2-2 below.

Table 2-1: Soil Landscape Systems within the survey area

Landscape System/ Mapping Unit	Description
Campsite System / 265Cm	Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.
Graves System / 265Gr	Basalt and greenstone rises and low hills supporting eucalypt woodlands with prominent saltbush and bluebush understoreys.
Gundockerta System / 265Gu	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.
Helag System / 265Hg	Hardpan plains and central drainage tracts with mulga shrublands and minor chenopod shrublands.
Leonora System / 265Le	Low greenstone hills and stony plains supporting mixed chenopod shrublands.
Moriarty System / 265Mo	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.
Yowie System / 265Yo	Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.

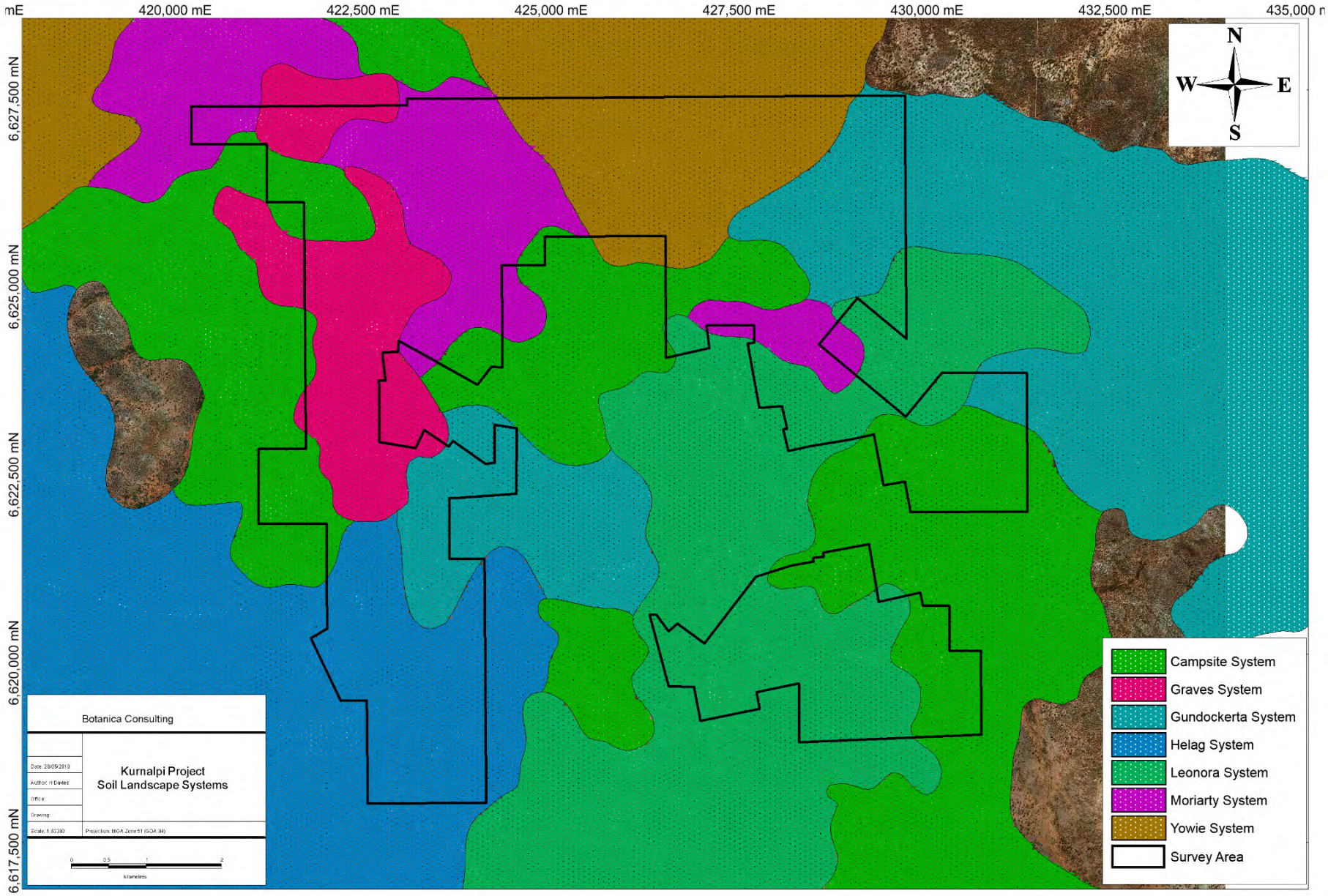


Figure 2-2: Map of Soil Landscape Systems within the survey area

2.3 Remnant Vegetation

Vegetation of the Eastern Murchison subregion in the Austin Botanical District is predominantly Mulga low woodlands on plains, often rich in ephemerals, which reduce to scrub on hills. It is also characterised by hummock grasslands, saltbush shrublands and Samphire shrublands (Beard, 1990; Cowan, 2001).

The Department of Agriculture and Food Western Australia (DAFWA) GIS file (2011) indicates that the survey area is located within Pre-European Beard vegetation association Barlee 20. The extent of this vegetation association, as specified in the 2015 Statewide Vegetation Statistics (DPaW, 2015) is provided in Table 2-2 and Figure 2-3.

Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered “endangered” (EPA, 2000). Development within the survey area will not significantly reduce the extent of pre-European vegetation.

Table 2-2: Pre-European Vegetation Associations within the survey area

Vegetation association	Pre-European Extent (ha)	Current Extent (ha)	Pre-European extent remaining (%)	% of Current extent within DBCA managed lands	Vegetation Description (Beard, 1990)
Barlee 20	1,172,537.74	1,172,537.74	100	15	Low woodland; mulga mixed with *Allocasuarina cristata* & *Eucalyptus* sp

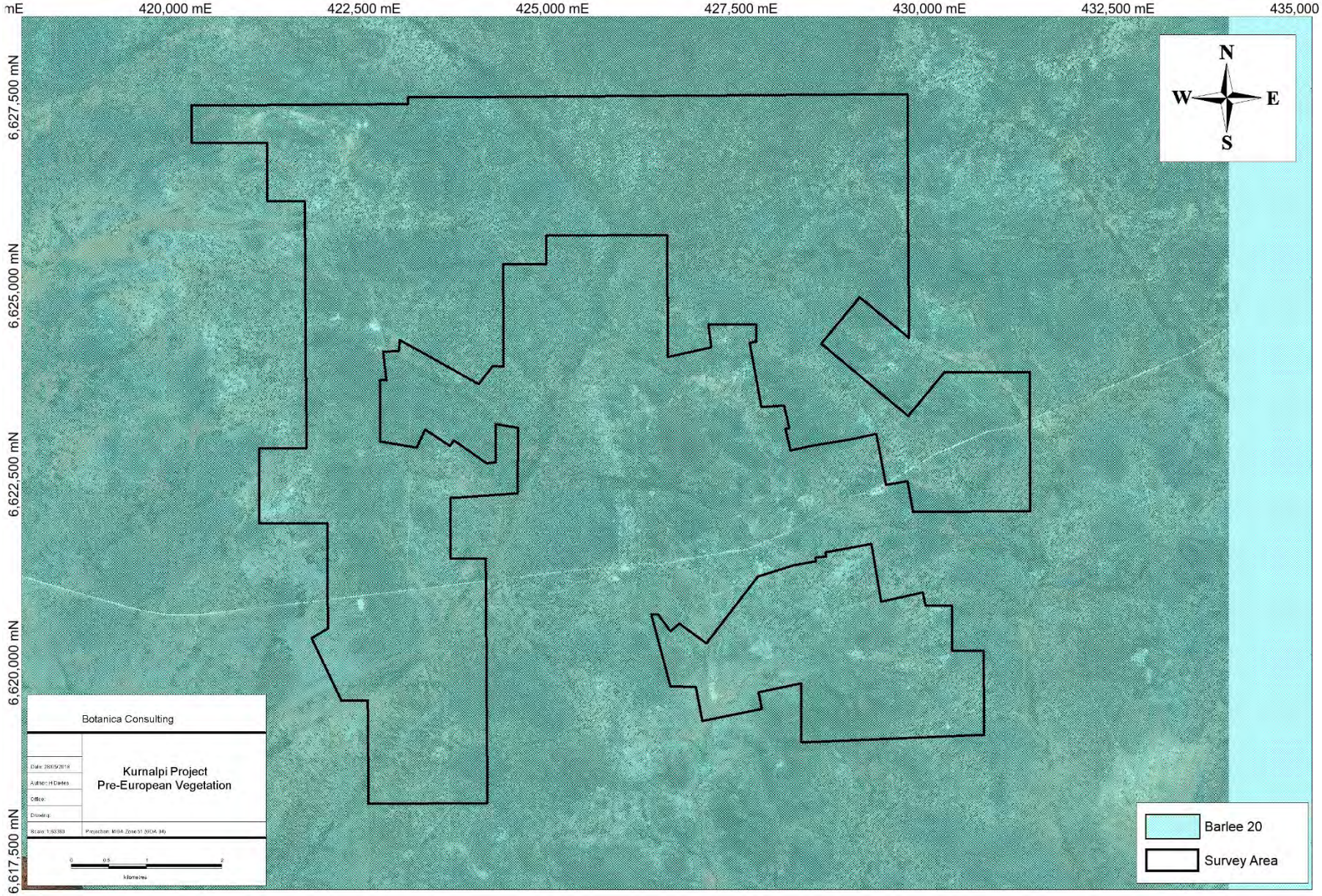


Figure 2-3: Pre-European Vegetation Associations within the survey area

2.4 Climate

The climate of the Eastern Murchison subregion is characterised as an arid climate with mainly winter rainfall and annual rainfall of approximately 200mm (Beard, 1990; Cowan, 2001). Average climate data for the Kalgoorlie-Boulder weather station (#12038), located approximately 90 km south-west of the survey area, is shown in Figure 2-4 and the monthly rainfall data from January 2014 to April 2018 is shown in Figure 2-5 (BOM, 2018). In the months preceding the survey (March and April 2018), rainfall was below average however summer rainfall was above average (Figure 2-5).

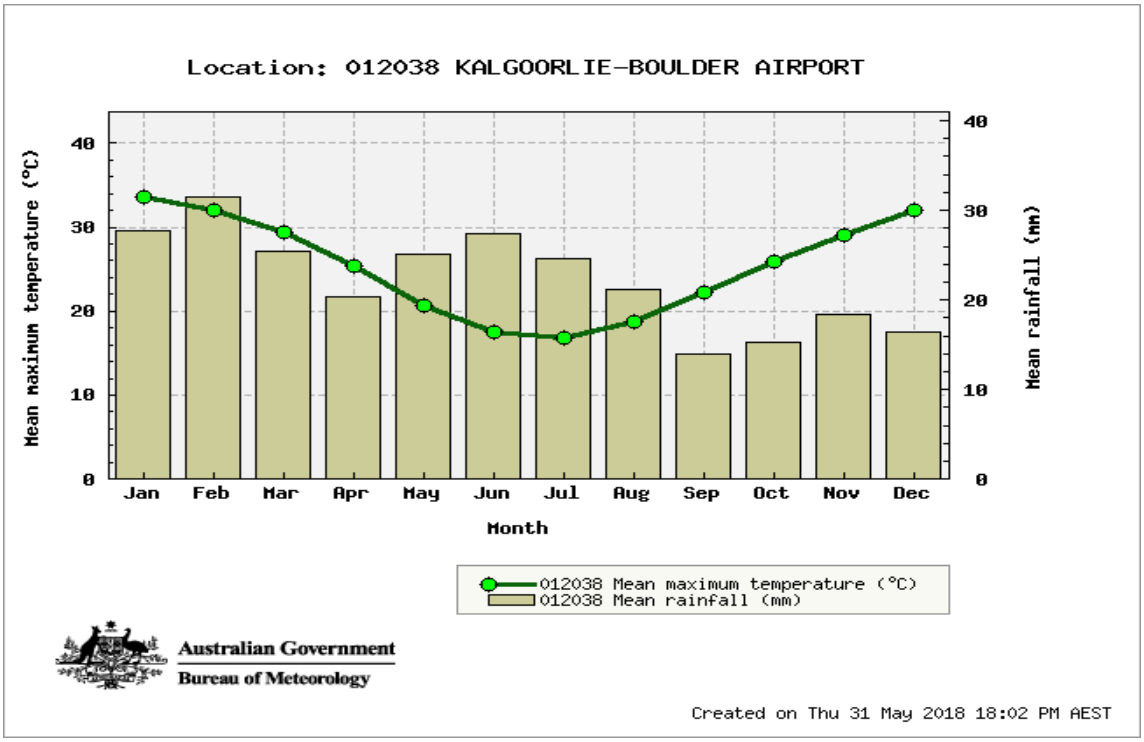


Figure 2-4: Average climate data (January 1935 to April 2018) for the Kalgoorlie Aero weather station #12038 (BoM, 2018)

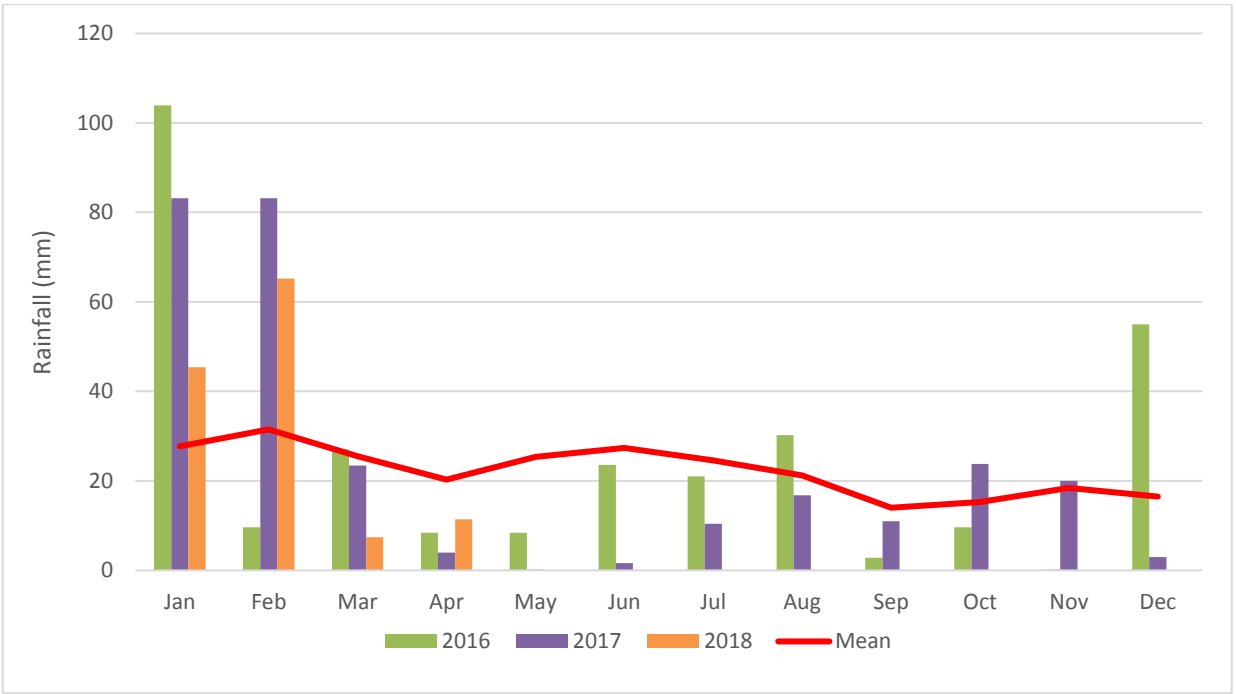


Figure 2-5: Monthly rainfall (Jan 2016-April 2018) for the Kalgoorlie Aero weather station #012038 (BoM, 2018)

2.5 Hydrology

The survey area is located 5 km to the north of the Lake Yindarlgooda system, with the local drainage following a north–south direction. Saline lake drainage systems typify the region, with Lake Lefroy located a further 65 km to the south of the survey area. Saline lake systems which flow parallel to and cross the stratigraphy, are non-permanent and occasionally fill after prolonged rainfall events. The far south-western region of the survey area is located within the Rebecca Paleochannel area (Figure 2-6).

According to the Geoscience Australia database (2001) there are no inland waters (salt lakes) within the survey area. Two non-perennial/ intermittent drainage lines intersect the southern portion of the survey area (Figure 2-6).

According to the Atlas of Groundwater Dependent Ecosystems (BoM, 2018b), the area does not contain any aquatic Groundwater Dependent Ecosystems (GDEs) and has low potential for terrestrial GDEs.

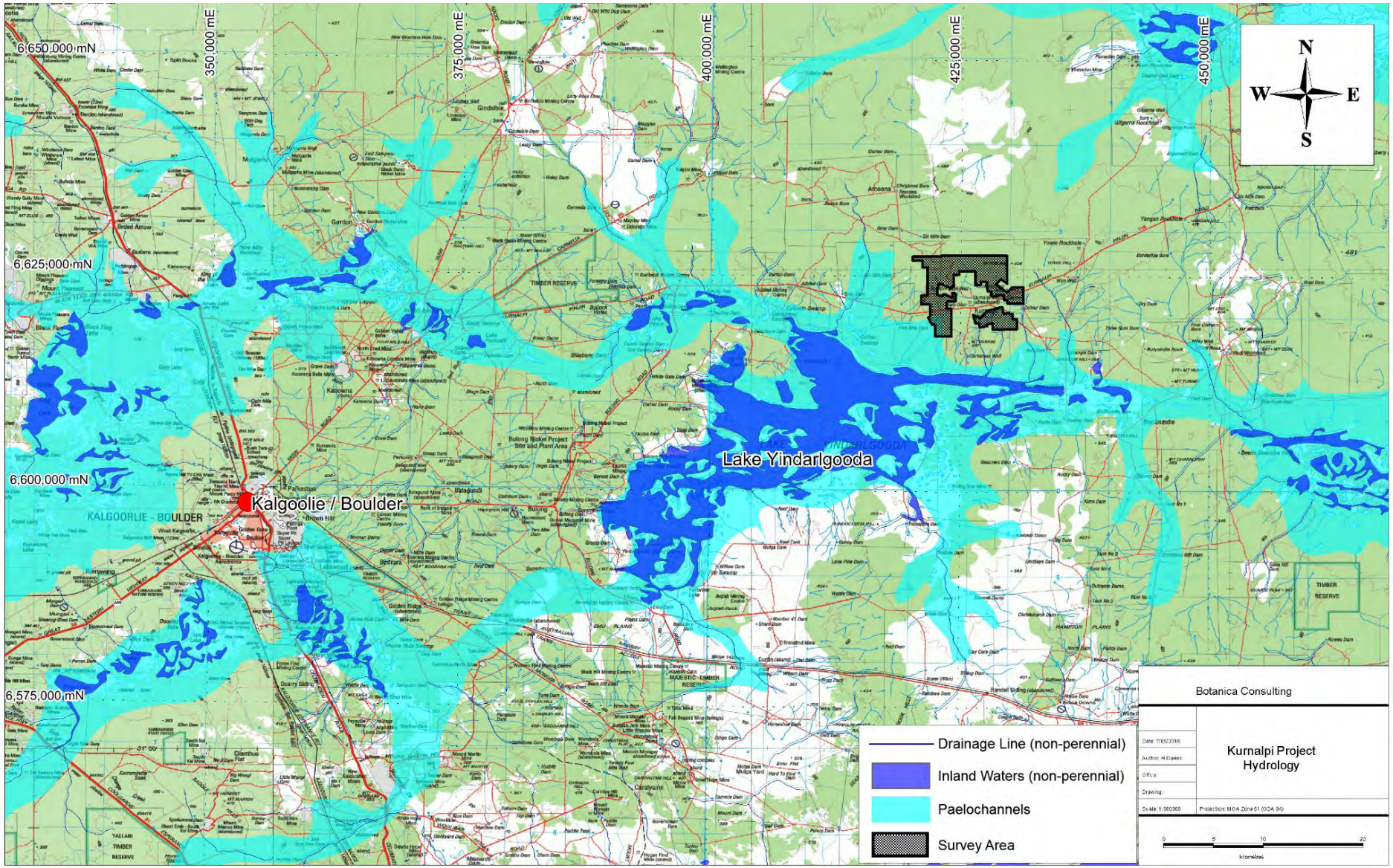


Figure 2-6: Hydrology of the survey area (data obtained from Geoscience Australia, 2001)

2.6 Land Use

The dominant land uses of the Eastern Murchison subregion include grazing native pastures (85.47%), unallocated crown reserves (11.34%), conservation (1.4%) and mining (1.79%) (Cowan, 2001).

3 Survey Methodology

3.1 Desktop Assessment

Prior to the field assessment a literature review was undertaken of previous flora and fauna assessments conducted within the local region. Documents reviewed included:

- Barrick Gold Corporation (2011). Miscellaneous Fauna Survey Records 2006 - 2011. Kanowna Belle Area. Unpublished internal data. Acquired May 2011.
- BC (2009) Bellevue Flora and Vegetation Survey (M24/804, M24/231, M24/255, M24/403, M24/303). Botanica Consulting
- BC (2011a), *Level 1 Flora and Vegetation Survey: Bullant,* Botanica Consulting
- BC (2011b), *Level 1 Flora and Vegetation Survey: Proposed Anthill open pit operation,* Botanica Consulting
- BC (2011c), *Level 2 Flora and Vegetation Survey: Kurnalpi Project.,* Botanica Consulting
- BC (2013a) Golden Flag Level 1 Flora and Vegetation survey. Botanica Consulting
- BC (2013b), *Level 2 Flora and Vegetation Survey for the Castle Hill Project.* Botanica Consulting
- BC (2014), *Level 2 Flora and Vegetation Survey for the Burgundy Project survey area,* Botanica Consulting
- BC (2015) Level 1 Flora and Vegetation Survey Racetrack, Mulgarrie Well & Mt Jewell Western/ Eastern Haul Road. Botanica Consulting
- BC (2016), *Level 1 Flora & Vegetation Survey of the Carbine Mining Area*. Botanica Consulting.
- GHD (2009) Paddington Gold Pty Ltd – Enterprise Development Activities Flora and Fauna Assessment
- Harewood G (2010a). Terrestrial Fauna Survey (Level 1) of the proposed Isabella Mine Area. Unpublished report for Barrick (Kanowna) Ltd. January 2010.
- Harewood G (2010b). Terrestrial Fauna Survey (Level 1) of the proposed Golden Valley Mine Area. Unpublished report for Barrick (Kanowna) Ltd. January 2010.
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- Jim's Seeds Weeds and Trees (2005), *Carbine and Paradigm Flora and Vegetation survey.* Prepared for Barrick
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- KLA (2009b). Barrick (Kanowna) Crossroads Project Level 1 Fauna Survey. Unpublished report for Barrick (Kanowna) Ltd. January 2009.
- KLA (2009c). Barrick (Kanowna) Moonlight Project Level 1 Fauna Survey. Unpublished report for Barrick (Kanowna) Ltd. March 2009.
- McKenzie, N.L. and Hall, N.J. (1992). The Biological Survey of the Eastern Goldfields of WA - Pt 8: Kurnalpi – Kalgoorlie study area. Records of the WAM, Supplement 41: 1 – 125.

In addition to the literature review, searches of the following databases were undertaken to aid in the compilation of a list of flora and fauna taxa within the survey area:

- DBCA's NatureMap Database (DBCA, 2018a);
- DotEE Protected matters search tool (DotEE, 2018a); and
- DBCA's Threatened and Priority Flora search (DBCA, 2018b).

The searches were conducted for an area encompassing a 20 km radius of the centre coordinates – 121° 59' 42" E, 30° 33' 17" S. It should be noted that these lists are based on observations from a broader area than the survey area (20km radius) and therefore may include taxon not present. The databases also often included very old records that may be incorrect or, in some cases, the taxa in question have become locally or regionally extinct. Information from these sources should, therefore, be taken as indicative only and local knowledge and information also needs to be taken into consideration when determining what actual species may be present within the specific area being investigated.

Prior to the field survey, a combined search of the DBCA's Flora of Conservation Significance databases (DBCA, 2018b) was undertaken within a 20km radius of the survey area. These significant flora species were examined on the Western Australian Herbarium's (WAHERB) web page prior to the survey, to familiarise staff with their appearance. Locations of Threatened Flora and Priority Flora were overlaid on aerial photography of the area. Vegetation descriptions and available images of the Priority Flora were also obtained from Florabase.

The conservation significance of flora and fauna taxa was assessed using data from the following sources:

- EPBC Act. Administered by the Australian Government (DotEE);
- WC Act. Administered by the WA Government (DBCA);
- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List – the acronym derived from its former name of the International Union for Conservation of Nature and Natural

Resources). The Red List has no legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria; and

- Priority Flora/ Fauna list. A non-legislative list maintained by DBCA for management purposes (DBCA).

The EPBC Act also requires the compilation of a list of migratory species that are recognised under international treaties including the:

- Japan Australia Migratory Bird Agreement 1981 (JAMBA)[2];
- China Australia Migratory Bird Agreement 1998 (CAMBA);
- Republic of Korea-Australia Migratory Bird Agreement 2007 (ROKAMBA); and
- Bonn Convention 1979 (The Convention on the Conservation of Migratory Species of Wild Animals).

Most migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as Matters of National Environmental Significance (MNES) under the EPBC Act.

Table 3-1 and Table 3-2 below provide the definitions of conservation significant flora and fauna.

Table 3-1: **Definitions of Conservation Significant Flora**

Code	Category
State categories of threatened and priority species	
T	Threatened Flora "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."
P1	Priority One – Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora' but are in urgent need of further survey."
P2	Priority Two – Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P3	Priority Three – Poorly Known Taxa "Taxa which are known from several populations and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey."
P4	Priority Four – Rare Taxa "Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5 – 10 years."
Commonwealth categories of threatened species	
Extinct	Taxa where there is no reasonable doubt that the last member of the species has died.

[2] Some species listed under JAMBA are also specially protected under Schedule 5 of the WC Act.

Code	Category
Extinct in the wild	Taxa where it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered	Taxa that are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	Taxa which are not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent	Taxa which are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table 3-2: Definitions of Conservation Significant Fauna

Code	Category
State categories of threatened and priority species	
Schedule 1	Critically Endangered – Threatened species considered to be facing an extremely high risk of extinction in the wild.
Schedule 2	Endangered – Threatened species considered to be facing a very high risk of extinction in the wild.
Schedule 3	Vulnerable – Threatened species considered to be facing a high risk of extinction in the wild.
Schedule 4	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died.
Schedule 5	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.
Schedule 6	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
Schedule 7	Fauna otherwise in need of special protection to ensure their conservation.
P1	Priority One – Poorly Known Taxa 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 Taxa 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

Code	Category
	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 Taxa 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 do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Commonwealth categories of threatened species	
Extinct	Taxa where there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa where it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	Taxa that are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	Taxa which are not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Near Threatened	Taxa which has been evaluated but does not qualify for CR, EN or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data Deficient	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

A search of the DBCA PEC and TEC database was also conducted within a 20 km radius of the survey area (DBCA, 2018c). Table 3-3 represents the definitions of Threatened and Priority Ecological Communities.

Table 3-3: Definition of conservation significant communities

Category Code	Category
State categories of Threatened Ecological Communities (TEC)	
PTD	**Presumed Totally Destroyed** An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies: records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or; all occurrences recorded within the last 50 years have since been destroyed.
CE	**Critically Endangered** An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting any one of the following criteria: The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification; The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; The ecological community is highly modified with potential of being rehabilitated in the immediate future.
E	**Endangered** An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. The ecological community must meet any one of the following criteria: The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short-term future, or is unlikely to be substantially rehabilitated in the short-term future due to modification; The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area; The ecological community is highly modified with potential of being rehabilitated in the short-term future.
V	**Vulnerable** An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria: The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated; The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution; The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.

Category Code	Category
Commonwealth categories of Threatened Ecological Communities (TEC)	
CE	**Critically Endangered** If, at that time, an ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).
E	**Endangered** If, at that time, an ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).
V	**Vulnerable** If, at that time, an ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).
Priority Ecological Communities (PEC)	
P1	**Poorly-known ecological communities** Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist.
P2	**Poorly-known ecological communities** Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, un-allocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.
P3	**Poorly known ecological communities** Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Ecological communities that are adequately known, rare but not threatened** or meet criteria for near threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
P5	**Conservation Dependent ecological communities** Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

3.2 Field Assessment

Botanica conducted a reconnaissance flora and fauna survey covering an area of 4,795 ha. The survey was conducted in Autumn 2018 (14th, 15th and 21st May 2018), with the area traversed on foot and 4WD by three staff members. A previous fauna survey was carried out over parts of the area in February 2012 (Harewood 2012b), the results of which are also incorporated into this report.

3.2.1 Flora Assessment

Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the coordinates of the boundaries between existing vegetation communities. At each sample point, the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant taxa for each stratum;
- All vascular taxa (including annual taxa);
- Landform classification;
- Vegetation condition rating;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of flora of conservation significance if encountered.

Unknown specimens collected during the survey were identified with the aid of samples housed at the BC Herbarium and WAHERB. Vegetation was classified in accordance with the NVIS Vegetation Type classification.

3.2.2 Fauna Assessment

Vegetation and landform units identified during the flora assessment have been used to define broad fauna habitat types across the site. This information has been supplemented with observations made during the fauna assessment.

The main aim of the fauna habitat assessment was to determine if it was likely that any species of conservation significance would be utilising the areas that maybe impacted on as a consequence of development at the site. The habitat information obtained was also used to aid in finalising the overall potential fauna list.

As part of the desktop literature review, available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area was researched. During the field survey, the habitats within the study area were assessed and specific elements identified, if present, to determine the likelihood of listed threatened species utilising the area and its significance to them.

Opportunistic observations of fauna species were made during all field survey work which involved a series of transects across the study area during the day while searching microhabitats such as logs, rocks, leaf litter and observations of bird species with binoculars. Secondary evidence of a species presence such as tracks, scats, skeletal remains, foraging evidence or calls were also noted if observed/heard.

3.2.3 Personnel involved

Jim Williams - Environmental Consultant/ Director (Diploma of Horticulture)
Lauren Pick - Senior Environmental Consultant (Bachelor Science Zoology/Conservation Biology)
Haydn Davies - Environmental Consultant (Bachelor Environmental Management)
Greg Harewood - Zoologist (Bachelor of Science-Zoology)

3.2.4 Scientific licences

Table 3-4: Scientific Licences of Botanica Staff coordinating the survey

Licensed staff	Permit Number	Valid Until
Jim Williams	SL012116	21-05-18
Lauren Pick	SL012117	21-05-18

3.3 Survey limitations and constraints

It is important to note that flora surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 3-5.

The conclusions presented in this report are based upon field data and environmental assessments and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. Also, it should be recognised that site conditions can change with time. Information not available at the time of this assessment which may subsequently become available may alter the conclusions presented.

Some species are reported as potentially occurring based on there being suitable habitat (quality and extent) within the survey area or immediately adjacent. The habitat requirements and ecology of many of the species known to occur in the wider area are however often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitats or microhabitats within the survey area. As a consequence of this limitation, the potential species list produced is most likely an overestimation of those species that actually utilise the survey area for some purpose.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any flora and fauna species that would possibly occur within the survey area (or immediately adjacent), as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of the author, has been listed as having the potential to occur.

Table 3-5: Limitations and constraints associated with the flora and vegetation survey

Variable	Potential Impact on Survey	Details
Access problems	Not a constraint	The survey was conducted via 4WD and on foot. Numerous tracks were located within the survey area, providing ease of access.
Competency/ Experience	Not a constraint	The BC personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Botanist/ Zoologist:** Jim Williams, & Greg Harewood **Data Interpretation:** Jim Williams, Lauren Pick, Haydn Davies & Greg Harewood.
Timing of survey, weather & season	Not a constraint	Fieldwork was completed within the EPA's recommended primary survey time periods (i.e., 6-8 weeks post wet season (March – June) for the Eremaean Province.
Area disturbance	Minor constraint	The area has been disturbed from exploration and pastoral activities.
Survey Effort/ Extent	Not a constraint	Survey intensity was appropriate for the size/significance of the area with a reconnaissance survey completed to identify vegetation types/fauna habitat and areas of Conservation Significance
Availability of contextual information at a regional and local scale	Not a constraint	Threatened flora database searches provided by the DBCA were used to identify any potential locations of Threatened/Priority taxa. BoM, DWER, DPIRD, DBCA and DotEE databases were reviewed to obtain appropriate regional desktop information on the biophysical environment of the local region. Environmental assessments within the local region have been limited however BC was able to obtain information about the area from previous flora/ fauna assessments conducted within the Murchison region and previous reconnaissance surveys conducted by BC which provided context on the local environment.
Completeness	Minor constraint	In the opinion of BC, the survey area was covered sufficiently in order to identify vegetation assemblages. Few of the plants during the survey were in flower however annual species present. It is estimated that approximately 90% of the flora within the survey area were able to be fully identified.

Variable	Potential Impact on Survey	Details
		The vegetation types for this study were based on visual descriptions of locations in the field. The distribution of these vegetation communities/ fauna habitats outside the study area is not known, however vegetation types identified were categorised via comparison to vegetation distributions throughout WA specified in the NVIS Major Vegetation Groups (DotEE, 2017b).

4 Results

4.1 Desktop Assessment

Flora and fauna surveys, assessments and reviews have been undertaken in nearby areas in the past, though not all are publicly available and could not be referenced. The most significant of those available have been used as the primary reference material for the current assessment (Table 4-1).

Table 4-1: Previous surveys within the surrounding area

Author and Year	Vegetation/Landforms/Fauna Habitats	Flora/Fauna of Conservation Significance
Keighery, Milewski & Hnatiuk, 1992	Between January 1980 and August 1983, a biological survey of the Kurnalpi-Kalgoorlie region covering approximately 26,500km² was conducted. Vegetation comprised mainly of trees (5-10 m high) which were only absent on parts of granite exposures, hills, salt lakes and sandplains in the northern half of the study area. Mallees (2-4 m high) and hummock grasslands occur on sandplains and sandy situations on other landforms.	No Threatened Flora.
Botanica Consulting, 2009	Five vegetation groups were identified within the survey area: 1. *Eucalyptus salmonophloia* Woodland 2. Open *Eucalyptus clelandii* Woodland 3. *Acacia acuminata* Woodland 4. Open *Eucalyptus salubris* Woodland Open Chenopod Shrubland	No Threatened or Priority Flora taxa were identified within the survey area.
GHD, 2009	The Study Area is considered to be dominated by eucalypt –*Casuarina* woodlands, interspersed with *Acacia* shrublands. The vegetation of the survey area was classified into ten vegetation types. Vegetation within the Study Area is considered to be moderately diverse. A total of 148 taxa from 41 families were recorded from the Study Area. Of these, 137 taxa were native plant species.	No Threatened Flora taxa were identified. One Priority Flora *Gnephosis intonsa* (P3)[3] was identified within the survey area
Botanica Consulting, 2011a	Seven vegetation communities were identified within the survey area: 1. Mixed *Eucalyptus* woodland over *Eremophila scoparia* and *Olearia muelleri* 2. *Eucalyptus clelandii* woodland over *Maireana sedifolia* 3. *Eucalyptus salubris* woodland over mixed shrubs 4. *Casuarina pauper* woodland over *Acacia colletioides* 5. *Eucalyptus salmonophloia* woodland over *Eremophila alternifolia* 6. *Eucalyptus clelandii* woodland over *Triodia scariosa* *Eucalyptus ravida* thicket	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2011b	Three vegetation communities and one sub-community were identified within the survey area; 1. Mixed *Eucalyptus* woodland over *Eremophila interstans* subsp. *interstans* 2. *Eucalyptus salmonophloia* woodland over *Eremophila scoparia* 3. *Eucalyptus ravida* woodland over mixed shrubs sub-community *Eucalyptus salubris / Eucalyptus clelandii* thicket.	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2011c	The findings of the report revealed that there was no Declared Rare Flora or Priority Flora species found to occur with the Kurnalpi project area.	No Threatened or Priority Flora taxa were identified within the

[3] *Gnephosis intonsa* (P3) has been revised and is currently listed as *Notisia intonsa* (P3) on Florabase (WAHERB, 2018).

Author and Year	Vegetation/Landforms/Fauna Habitats	Flora/Fauna of Conservation Significance
		survey area.
Botanica Consulting, 2011d	Twelve broad vegetation communities were identified within the survey area: 1. Scrub of *Acacia aneura*/*Acacia burkittii*/*Acacia ramulosa* over low scrub of *Dodonaea lobulata* 2. Low woodland of *Eucalyptus lesouefii* over low mixed scrub 3. Low woodland of *Eucalyptus salmonophloia*/*Eucalyptus salubris* over heath of mixed chenopods 4. Low woodland of *Eucalyptus salmonophloia*/*Eucalyptus salubris* over low mixed scrub 5. Low woodland of *Eucalyptus salmonophloia*/*Eucalyptus salubris* over low scrub of *Maireana sedifolia* 6. Scrub of *Acacia ramulosa* over low scrub of *Senna artemisioides subsp. filifolia*/*Senna artemisioides subsp. x artemisioides* 7. Very open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura*/ *Acacia oswaldii*/*Acacia ramulosa*/*Acacia* sp. narrow phyllode 8. Mallee of *Eucalyptus concinna*/*Eucalyptus oleosa* over low scrub of *Senna artemisioides subsp. filifolia* and dwarf scrub of *Ptilotus obovatus* 9. Open low woodland of *Casuarina pauper* over low scrub of *Senna artemisioides subsp. filifolia* and dwarf scrub of *Ptilotus obovatus* 10. Low woodland of *Casuarina pauper* over low scrub of *Maireana sedifolia* and dwarf scrub of *Ptilotus obovatus* 11. Low woodland of *Acacia aneura*/*Acacia burkittii*/*Acacia ramulosa* in drainage area; and 12. Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia* on rocky rise These vegetation communities were represented by a total of 26 Families, 46 Genera and 100 Species. One introduced species was identified within the survey area *Centaurea melitensis.*	No declared rare flora. No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting 2012	Six broad vegetation communities were identified within the survey area: 1. Low woodland of *Acacia aneura* over mixed low shrub and dwarf scrub of *Ptilotus obovatus*; 2. Low woodland of *Eucalyptus salmonophloia/Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub; 3. Open mallee of *Eucalyptus salubris* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. Narrow phyllode 4. Open low woodland of *Acacia aneura* over scrub of Acacia sp. narrow phyllode/*Acacia quadrimarginea* 5. Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and 6. Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*. These vegetation communities were represented by a total of 25 Families, 57 Genera, and 103 Species. Six introduced species were present within the survey area: *Agave americana, Carrichtera annua, Centaurea melitensis, Malva parviflora, Salvia verbenaca* and *Solanum nigrum*	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2013a	Three vegetation communities were identified within the survey area. 1. Open low woodland of *Eucalyptus salmonophloia* and *Eremophila longifolia* over low scrub of *Cratystylis subspinescens, Maireana pyramidata* and *Senna artemisioides* subsp. filifolia in drainage line; 2. Low woodland of *Casuarina pauper* over low scrub of *Maireana pyramidata* and *Maireana sedifolia;* and 3. Low woodland of *Eucalyptus salmonophloia* over low scrub of *Scaevola spinescens* and *Senna artemisioides* subsp. *filifolia.*	
Botanica Consulting, 2013b	Twelve vegetation communities were identified within the survey area: 1. Scrub of *Acacia* sp. narrow phyllode over low scrub of *Eremophila alternifolia*; 2. Low woodland of *E. campaspe* and *E. salmonophloia* over low scrub of *Atriplex nummularia, Eremophila dempsteri* and dwarf	No Threatened or Priority Flora taxa were identified within the survey area.

Author and Year	Vegetation/Landforms/Fauna Habitats	Flora/Fauna of Conservation Significance
	scrub of *Atriplex vesicaria*; 3. Open low woodland of *E. campaspe* over low scrub of *Eremophila dempsteri* and dwarf scrub of *Atriplex vesicaria*; 4. Low woodland of *E. clelandii* over scrub of *Acacia* sp. narrow phyllode and low scrub of *Acacia erinacea, Atriplex vesicaria* and *Eremophila pustulata*; 5. Low woodland of *E. campaspe* over low scrub of *Eremophila scoparia* and dwarf scrub of *Atriplex vesicaria*; 6. Very open shrub mallee of *E. griffithsii* over low scrub of *Dodonaea lobulata* and *Eremophila scoparia* over dwarf scrub of *Scaevola spinescens*; 7. Scrub of *Allocasuarina acutivalvis/Casuarina pauper* over low scrub of *Philotheca brucei* and dwarf scrub of *Prostanthera grylloana*; 8. Low woodland of *Acacia quadrimarginea* over scrub of *Acacia* sp. narrow phyllode, low scrub of *Dodonaea lobulata* and dwarf scrub of *Ptilotus obovatus*; 9. Low woodland of *E. ravida* over low scrub of *Atriplex nummularia/Eremophila scoparia* over dwarf scrub of *Atriplex vesicaria*; 10. Low woodland of *Eucalyptus clelandii/Eucalyptus torquata* over low scrub of *Eremophila interstans* subsp. *virgata*; 11. Low scrub of *Atriplex nummularia* subsp. *spatulata* and *Eremophila dempsteri* over open low grass of *Austrostipa nitida*; and 12. Low woodland of *Eucalyptus clelandii* over low scrub of *Eremophila interstans* subsp. *virgata/Eremophila scoparia.*	
Botanica Consulting, 2014	Five vegetation communities were identified within the survey area: 1. Low Woodland of *Eucalyptus salmonophloia* over open low scrub of *Atriplex nummularia* subsp. *spatulata* and dwarf scrub of *Tecticornia disarticulata*; 2. Low Woodland of *Eucalyptus clelandii* over open low scrub of *Atriplex nummularia* subsp. *spatulata* and dwarf scrub of *Atriplex vesicaria/ Maireana pentatropis* and *Olearia muelleri*; 3. Low Woodland of *Eucalyptus griffithsii* over low scrub of *Acacia acuminata/ Dodonaea lobulata* and dwarf scrub of *Olearia muelleri* and *Ptilotus obovatus*; 4. Low woodland of *Eucalyptus campaspe* and *E. salmonophloia* over low scrub of *Atriplex nummularia* subsp. *spathulata, Eremophila dempsteri* and dwarf scrub of *Atriplex vesicaria*; and 5. Open Low Woodland of *Eucalyptus clelandii/ E. griffithsii/ Casuarina pauper* over low scrub of *Dodonaea lobulata/ Scaevola spinescens/ Eremophila oldfieldii* subsp. *angustifolia* and *Hakea kippistiana* and dwarf scrub of *Olearia muelleri* and *Ptilotus obovatus* on breakaway.	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2015	Level 1 Reconnaissance Flora Survey was completed in March 2015 for an area of 1,260 ha, of which 4 ha had previously been cleared. A total of 28 vegetation communities were identified within the four survey areas. These were represented by a total of 26 Families, 56 Genera and 130 Taxon including sub-species and variants.	*Ricinocarpos* sp. Eastern Goldfields (A. Williams 3) (P1)
Botanica Consulting, 2016	Level 1 Reconnaissance Flora Survey was completed in July 2016 for an area of 2,776 ha, located 53 km north-west of Kalgoorlie-Boulder. A total of 19 broad vegetation communities were identified within the survey area. These communities comprised of five different landform types and three major vegetation groups. The communities were represented by a total of 24 Families, 47 Genera and 112 Taxa (including subspecies and variants)	No Threatened Flora or Priority Flora.
GHD, 2009	The Study Area is considered to be dominated by eucalypt –*Casuarina* woodlands, interspersed with *Acacia* shrublands. The vegetation of the	No Threatened Flora taxa were identified.

Author and Year	Vegetation/Landforms/Fauna Habitats	Flora/Fauna of Conservation Significance
	survey area was classified into ten vegetation types. Vegetation within the Study Area is considered to be moderately diverse. A total of 148 taxa from 41 families were recorded from the Study Area. Of these, 137 taxa were native plant species.	One Priority Flora *Gnephosis intonsa* (P3)[4] was identified within the survey area
Botanica Consulting, 2011a	Seven vegetation communities were identified within the survey area: 7. Mixed *Eucalyptus* woodland over *Eremophila scoparia* and *Olearia muelleri* 8. *Eucalyptus clelandii* woodland over *Maireana sedifolia* 9. *Eucalyptus salubris* woodland over mixed shrubs 10. *Casuarina pauper* woodland over *Acacia colletioides* 11. *Eucalyptus salmonophloia* woodland over *Eremophila alternifolia* 12. *Eucalyptus clelandii* woodland over *Triodia scariosa* *Eucalyptus ravida* thicket	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2011b	Three vegetation communities and one sub-community were identified within the survey area; 4. Mixed *Eucalyptus* woodland over *Eremophila interstans* subsp. *interstans* 5. *Eucalyptus salmonophloia* woodland over *Eremophila scoparia* 6. *Eucalyptus ravida* woodland over mixed shrubs sub-community *Eucalyptus salubris / Eucalyptus clelandii* thicket.	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2011c	Six vegetation communities were identified within the survey area; 1. Low woodland of *Acacia aneura* over mixed low scrub and dwarf scrub of *Ptilotus obovatus*; 2. Low woodland of *Eucalyptus salmonophloia/ Eucalyptus salubris* over open mallee of *Eucalyptus oleosa* and mixed low scrub;; 3. Open mallee of *Eucalyptus oleosa* over low woodland of *Acacia aneura* and scrub of *Acacia* sp. narrow phyllode; 4. Open low woodland of *Acacia aneura* over scrub of *Acacia* sp. narrow phyllode/*Acacia quadrimarginea;* 5. Low woodland of *Eucalyptus lesouefii* over low scrub of *Maireana sedifolia;* and 6. Open low woodland of *Eucalyptus salmonophloia* over low scrub of *Atriplex nummularia/ Maireana sedifolia*.	No Threatened Flora. One Priority Flora taxon; *Austrostipa blackii* (P3).
Botanica Consulting, 2013a	Three vegetation communities were identified within the survey area. 4. Open low woodland of *Eucalyptus salmonophloia* and *Eremophila longifolia* over low scrub of *Cratystylis subspinescens, Maireana pyramidata* and *Senna artemisioides* subsp. filifolia in drainage line; 5. Low woodland of *Casuarina pauper* over low scrub of *Maireana pyramidata* and *Maireana sedifolia;* and 6. Low woodland of *Eucalyptus salmonophloia* over low scrub of *Scaevola spinescens* and *Senna artemisioides* subsp. *filifolia.*	
Botanica Consulting, 2013b	Twelve vegetation communities were identified within the survey area: 13. Scrub of *Acacia* sp. narrow phyllode over low scrub of *Eremophila alternifolia*; 14. Low woodland of *E. campaspe* and *E. salmonophloia* over low scrub of *Atriplex nummularia, Eremophila dempsteri* and dwarf scrub of *Atriplex vesicaria*; 15. Open low woodland of *E. campaspe* over low scrub of *Eremophila dempsteri* and dwarf scrub of *Atriplex vesicaria*; 16. Low woodland of *E. clelandii* over scrub of *Acacia* sp. narrow phyllode and low scrub of *Acacia erinacea, Atriplex vesicaria* and *Eremophila pustulata*; 17. Low woodland of *E. campaspe* over low scrub of *Eremophila scoparia* and dwarf scrub of *Atriplex vesicaria*; 18. Very open shrub mallee of *E. griffithsii* over low scrub of *Dodonaea lobulata* and *Eremophila scoparia* over dwarf scrub of *Scaevola spinescens*; 19. Scrub of *Allocasuarina acutivalvis/Casuarina pauper* over low scrub of *Philotheca brucei* and dwarf scrub of *Prostanthera grylloana*;	No Threatened or Priority Flora taxa were identified within the survey area.

[4] *Gnephosis intonsa* (P3) has been revised and is currently listed as *Notisia intonsa* (P3) on Florabase (WAHERB, 2018).

Author and Year	Vegetation/Landforms/Fauna Habitats	Flora/Fauna of Conservation Significance
	20. Low woodland of *Acacia quadrimarginea* over scrub of *Acacia* sp. narrow phyllode, low scrub of *Dodonaea lobulata* and dwarf scrub of *Ptilotus obovatus*; 21. Low woodland of *E. ravida* over low scrub of *Atriplex nummularia/Eremophila scoparia* over dwarf scrub of *Atriplex vesicaria*; 22. Low woodland of *Eucalyptus clelandii/Eucalyptus torquata* over low scrub of *Eremophila interstans* subsp. *virgata*; 23. Low scrub of *Atriplex nummularia* subsp. *spatulata* and *Eremophila dempsteri* over open low grass of *Austrostipa nitida*; and 24. Low woodland of *Eucalyptus clelandii* over low scrub of *Eremophila interstans* subsp. *virgata/Eremophila scoparia.*	
Botanica Consulting, 2014	Five vegetation communities were identified within the survey area: 6. Low Woodland of *Eucalyptus salmonophloia* over open low scrub of *Atriplex nummularia* subsp. *spatulata* and dwarf scrub of *Tecticornia disarticulata*; 7. Low Woodland of *Eucalyptus clelandii* over open low scrub of *Atriplex nummularia* subsp. *spatulata* and dwarf scrub of *Atriplex vesicaria/ Maireana pentatropis* and *Olearia muelleri*; 8. Low Woodland of *Eucalyptus griffithsii* over low scrub of *Acacia acuminata/ Dodonaea lobulata* and dwarf scrub of *Olearia muelleri* and *Ptilotus obovatus*; 9. Low woodland of *Eucalyptus campaspe* and *E. salmonophloia* over low scrub of *Atriplex nummularia* subsp. *spathulata, Eremophila dempsteri* and dwarf scrub of *Atriplex vesicaria*; and 10. Open Low Woodland of *Eucalyptus clelandii/ E. griffithsii/ Casuarina pauper* over low scrub of *Dodonaea lobulata/ Scaevola spinescens/ Eremophila oldfieldii* subsp. *angustifolia* and *Hakea kippistiana* and dwarf scrub of *Olearia muelleri* and *Ptilotus obovatus* on breakaway.	No Threatened or Priority Flora taxa were identified within the survey area.
Botanica Consulting, 2015	Level 1 Reconnaissance Flora Survey was completed in March 2015 for an area of 1,260 ha, of which 4 ha had previously been cleared. A total of 28 vegetation communities were identified within the four survey areas. These were represented by a total of 26 Families, 56 Genera and 130 Taxon including sub-species and variants.	*Ricinocarpos* sp. Eastern Goldfields (A. Williams 3) (P1)
Botanica Consulting, 2016	Level 1 Reconnaissance Flora Survey was completed in July 2016 for an area of 2,776 ha, located 53 km north-west of Kalgoorlie-Boulder. A total of 19 broad vegetation communities were identified within the survey area. These communities comprised of five different landform types and three major vegetation groups. The communities were represented by a total of 24 Families, 47 Genera and 112 Taxa (including subspecies and variants)	No Threatened Flora or Priority Flora.

The results of the literature review, combined search of the DBCA's Flora of Conservation Significance databases (DBCA, 2018b) and DotEE protected matters search recorded no Threatened Flora or Priority Flora within the survey area. One Threatened Flora and a total of 17 Priority Flora taxa were listed on the databases as occurring within a 20km radius of the survey area (map of flora locations provided in Appendix 1). These taxa were assessed and ranked for their likelihood of occurrence within the survey area (Table 4-2). The rankings and criteria used were:

- Unlikely: Area is outside of the currently documented distribution for the species/no suitable habitat (type, quality and extent) was identified as being present during the field/desktop assessment.

- Possible: Area is within the known distribution of the species in question and habitat of at least marginal quality was identified as being present during the field/desktop assessment, supported in some cases by recent records being documented from within or near the area.

- Known to Occur: The species in question was positively identified as being present during current or previous field surveys.

Table 4-2: Likelihood of occurrence for Flora of Conservation Significance within the survey area

Taxon	Conservation Code	Description (WAHERB, 2018)	Likelihood of Occurrence
Allocasuarina eriochlamys subsp. *grossa*	P3	Dioecious or monoecious shrub, 1-3m high, bracteoles prominently exceeding cone. Stony loam, laterite clay. Granite outcrops.	Unlikely
Austrostipa blackii	P3	Tufted perennial, grass-like or herb, 1 m high. Fl. Sep to Nov.	Possible[5]
Darwinia sp. Gibson (R.D. Royce 3569)	P1	Compact shrub, to 0.4 m high. Fl yellow/orange, Jun to July, Grey-brown sandy clay, white sand. Margins salt lakes, road verges.	Unlikely
Dicrastylis cundeeleensis	P4	Woolly shrub, 0.2-0.5 m high. Yellow sand, red or reddish-yellow sand. Sandplains.	Unlikely
Eremophila praecox	P1	Broom-like shrub, 1.5-3 m high. Fl. purple, Oct or Dec. Red/brown sandy loam. Undulating plains.	Possible
Eucalyptus kruseana	P4	Straggly mallee, 2-3.5 m high, bark smooth. Fl. yellow, Jun to Sep. Sandy loam. Granite outcrops & hills.	Unlikely
Eucalyptus x brachyphylla	P4	Mallee or tree, to 4 m high, bark rough, flaky. Fl. white, Jun. Sandy loam. Granite outcrops.	Unlikely
Eucalyptus jutsonii subsp. *jutsonii*	P4	(Mallee), 4-7 m high, bark rough over most stems, grey to light grey-brown. Red to pale orange deep sands. Undulating areas and on dunes.	Unlikely
Gastrolobium graniticum	Threatened Flora (EN)	Erect open shrub, to 2.5m high. Fl, yellow & orange & red, Aug to Sep, Sand, sandy loam, granite, Margins of rock outcrops, along drainage lines	Unlikely
Grevillea phillipsiana	P1	Prickly shrub, 0.8-1.5 m high. Fl. red/red & orange, Jul to Sep. Red sand, stony loam. Granite hills.	Unlikely
Jacksonia lanicarpa	P1	Shrub, to 2 m high. Fl. orange, Nov. Red sand.	Unlikely
Micromyrtus serrulata	P3	Erect or somewhat spreading shrub, 0.4-1.5 m high. Fl. white, Jun to Nov. Brownish sandy and clayey soils over granite.	Unlikely
Ptilotus rigidus	P1	No Description available from WAHERB	Possible
Ptilotus procumbens	P1	Spreading procumbent annual, herb, ca 0.1 m high, Fl pink-white, Nov Red clay.	Possible
Styphelia sp. Great Victoria Desert (N. Murdoch 44)	P2	No Description available from WAHERB	Possible

[5] Identified in previous flora survey adjacent to the current survey area (BC, 2011c)

Taxon	Conservation Code	Description (WAHERB, 2018)	Likelihood of Occurrence
Tecticornia flabelliformis	P1[6]	Erect shrub, to 0.2 m high. Clay. Saline flats.	Unlikely
Thryptomene eremaea	P2	Erect open shrub, 0.5-1.5 m high. Fl. pink/white, Jul to Sep. Red or yellow sand. Sandplains.	Unlikely
Trachymene pyrophila	P2	Annual, herb, 0.1-0.5 m high, indumentum of patent glandular hairs. Fl. white, Nov to Dec or Jan to Mar. Yellow or orange sand. Sandplains; germinating after fire or other disturbances such as mining	Unlikely

Fauna of conservation significance identified during the literature review as previously being recorded in the general area were assessed and ranked for their likelihood of occurrence within the survey area itself (Table 4-2). The rankings and criteria used were:

- Would Not Occur: There is no suitable habitat for the species in the survey area and/or there is no documented record of the species in the general area since records have been kept and/or the species is generally accepted as being locally/regionally extinct (supported by a lack of recent records).
    - Locally Extinct: Populations no longer occur within a small part of the species natural range, in this case within 10 or 20km of the survey area. Populations do however persist outside of this area.
    - Regionally Extinct: Populations no longer occur in a large part of the species natural range, in this case within the northern goldfields region. Populations do however persist outside of this area.

- Unlikely to Occur: The survey area is outside of the currently documented distribution for the species in question, or no suitable habitat (type, quality and extent) was identified as being present during the field assessment. Individuals of some species may occur occasionally as vagrants/transients especially if suitable habitat is located nearby but the site itself would not support a population or part population of the species

- Possibly Occurs: Survey area is within the known distribution of the species in question and habitat of at least marginal quality was identified as likely to be present during the field survey and literature review, supported in some cases by recent records being documented in literature from within or near the survey area. In some cases, while a species may be classified as possibly being present at times, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

- Known to Occur: The species in question has been positively identified as being present (for sedentary species) or as using the survey area as habitat for some other purpose (for non-sedentary/mobile species) during field surveys within or near the survey area. This information may have been obtained by direct observation of individuals or by way of secondary evidence (e.g. tracks, foraging debris, scats). In some cases, while a species may be classified as known to occur, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

[6] Listed as Threatened (Vulnerable) under the EPBC Act

Table 4-3: Likelihood of Occurrence – Fauna Species of Conservation Significance

Species	Conservation Status			Potential Habitats Within Survey Area			Likelihood of Occurrence/Degree of Impact
	EPBC Act	WC Act	DBCA Priority	Foraging Habitat	Breeding Habitat	Total Extent (ha)	
Malleefowl *Leipoa ocellata*	VU	S3	-	Clay-Loam Plains/ Open Depressions/Rocky Hillslopes	None Identified	4,786 ha (99.8% of total area).	Unlikely to Occur. Breeding habitat absent/very marginal. No recent, nearby records. Very occasional transients only/No impact anticipated.
Peregrine Falcon *Falco peregrinus*	-	S7	-	Air space above all habitats.	Large open spouts in eucalyptus trees	4,795 ha (100% of total area).	Possibly Occurs but probably only rarely. Unlikely to breed in the area/Negligible impact anticipated.
Migratory Shorebirds (Various species)	Mig	S5	-	None Identified		0 ha	Would Not Occur. No suitable habitat/No impact anticipated.
Hooded Plover *Thinornis rubricollis*	-	-	P4	None Identified		0 ha	Would Not Occur. No suitable habitat/No impact anticipated.
Grey Wagtail *Motacilla cinerea*	Mig	S5	-	None Identified		0 ha	Would Not Occur. Never recorded in goldfields region/No impact anticipated.
Fork-tailed Swift *Apus pacificus*	Mig	S5	-	Air space above all habitats.	None Identified	4,795 ha (100% of total area).	Unlikely to Occur. Very occasional vagrants only for very brief periods. /Negligible impact anticipated.
Night Parrot *Pezoporus occidentalis*	EN	S1	-	Chenopod Shrubland	None Identified	82 ha (2% of total area).	Unlikely to Occur. No recent records nearby and possibly locally extinct. Limited area of habitat appears marginal/No impact anticipated.
Thick-billed Grass Wren *Amytornis textilis textilis*	-	-	P4	Clay-Loam Plains/Open Depressions/ Rocky Hillslopes		4,786 ha (99.8% of total area).	Would not Occur. A small number of very old records – species likely to be regionally extinct/No impact anticipated.
Chuditch *Dasyurus geoffroii*	VU	S3	-	Clay-Loam Plains/ Open Depressions/ Quartz Rocky Plains/ Rocky Hillslopes/ Sand Plains		4,331 ha (98.7% of total area).	Would not Occur. No recent records nearby and very likely to be regionally extinct/No impact anticipated.

The current status of some species on site and/or in the general area is difficult to determine, however, based on the habitats present and, in some cases, direct observations or recent nearby records, the following species of conservation significance can be regarded as possibly utilising the survey area for some purpose at times, these being:

- **Peregrine Falcon *Falco peregrinus*** – S7 (*WC Act*)
  The species potentially utilises some sections of the survey area as part of a much larger home range, though records in this area are rare and therefore it is likely to be present occasionally. No potential nest sites observed. No impact on this species is considered likely.

It should be noted that while habitats onsite for the species listed above are considered possibly suitable, some or all may be marginal in extent/quality and therefore the fauna species considered as possibly occurring may in fact only visit the area for short periods as infrequent vagrants.

A number of other species of conservation significance, while possibly present in the general area and/or the Goldfields region are not listed as potential species due to the survey area being outside of their currently recognised range, a lack of suitable habitat or known/very likely local or regional extinction (and no subsequent recruitment from adjoining areas).

4.2 Field Assessment

4.2.1 Vegetation Types

Nine broad vegetation types were identified within the survey area. These vegetation types were identified within three landform types and comprised of five major vegetation groups according to the NVIS, Major Vegetation Group (MVG) definition (Table 4-4). These were represented by a total of 18 Families, 31 Genera and 83 taxa as listed in Appendix 2. A map showing the vegetation types present in the survey area is provided in Figure 4-1.

Table 4-4: Summary of vegetation types within the survey area

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Area (ha)	Area (%)
Clay-Loam Plain	Acacia Forests and Woodland (MVG 6)	CLP-AFW1	Low woodland of *Acacia caesaneura/ A. incurvaneura* over mid open shrubland of *Sida* sp. Golden calyces glabrous (H.N. Foote 32)/ *Eremophila oldfieldii* subsp. *angustifolia* and low shrubland of *Ptilotus obovatus* on clay-loam-plain	270	5.6
	Chenopod Shrubland (MVG22)	CLP-CS1	Low chenopod shrubland of *Maireana sedifolia/ M. pyramidata* over low shrubland of *Ptilotus obovatus* on clay-loam-plain	83	1.7
	Eucalypt Woodland (MVG 5)	CLP-EW1	Low woodland of *Eucalyptus salmonophloia* over open shrubland of *Senna artemisioides* subsp. *filifolia* and low chenopod shrubland of *Atriplex vesicaria* on clay-loam-plain	1470	30.7
	Mallee Woodlands and Shrublands (MVG14)	CLP-MWS1	Mid open mallee shrubland of *Eucalyptus concinna* over shrubland of *Senna artemisioides* subsp. *filifolia* and low open shrubland of *Ptilotus obovatus* on clay-loam plain	775	16.2
Open Depression	Mallee Woodlands and Shrublands (MVG14)	OD-MWS1	Mid mallee shrubland of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and shrubland of *Acacia ramulosa* var. *ramulosa* over low shrubland of *Ptilotus obovatus* in open depression	51	1.1

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Area (ha)	Area (%)
Rocky Hillslope	Acacia Forests and Woodlands (MVG6)	RH-AFW1	Mid open woodland of *Acacia caesaneura/ A. mulganeura/ A. quadrimarginea* over open shrubland of *Acacia ramulosa* var. *ramulosa/ Dodonaea lobulata* and low open shrubland of *Ptilotus obovatus* on rocky-hillslope	553	11.5
	Casuarina Forests and Woodlands (MVG8)	RH-CFW1	Mid woodland of *Casuarina pauper* over mid shrubland of *Scaevola spinescens/ Dodonaea lobulata* and low shrubland of *Ptilotus obovatus* on rocky-hillslope	1480	30.9
	Eucalypt Woodland (MVG5)	RH-EW1	Mid woodland of *Eucalyptus lesouefii* over open low shrubland of *Scaevola spinescens/ Eremophila parvifolia* and *Ptilotus obovatus* on a rocky-hillslope	70	1.5
	Mallee Woodlands and Shrublands (MVG14)	RH-MWS1	Mid mallee shrubland of *Eucalyptus celastroides* over low shrubland of *Acacia ramulosa* var. *ramulosa* and low hummock grassland of *Triodia scariosa* on rocky-hillslope	35	0.7
N/A	N/A	CV	Cleared Vegetation	10	0.2
Total				**4795**	**100**

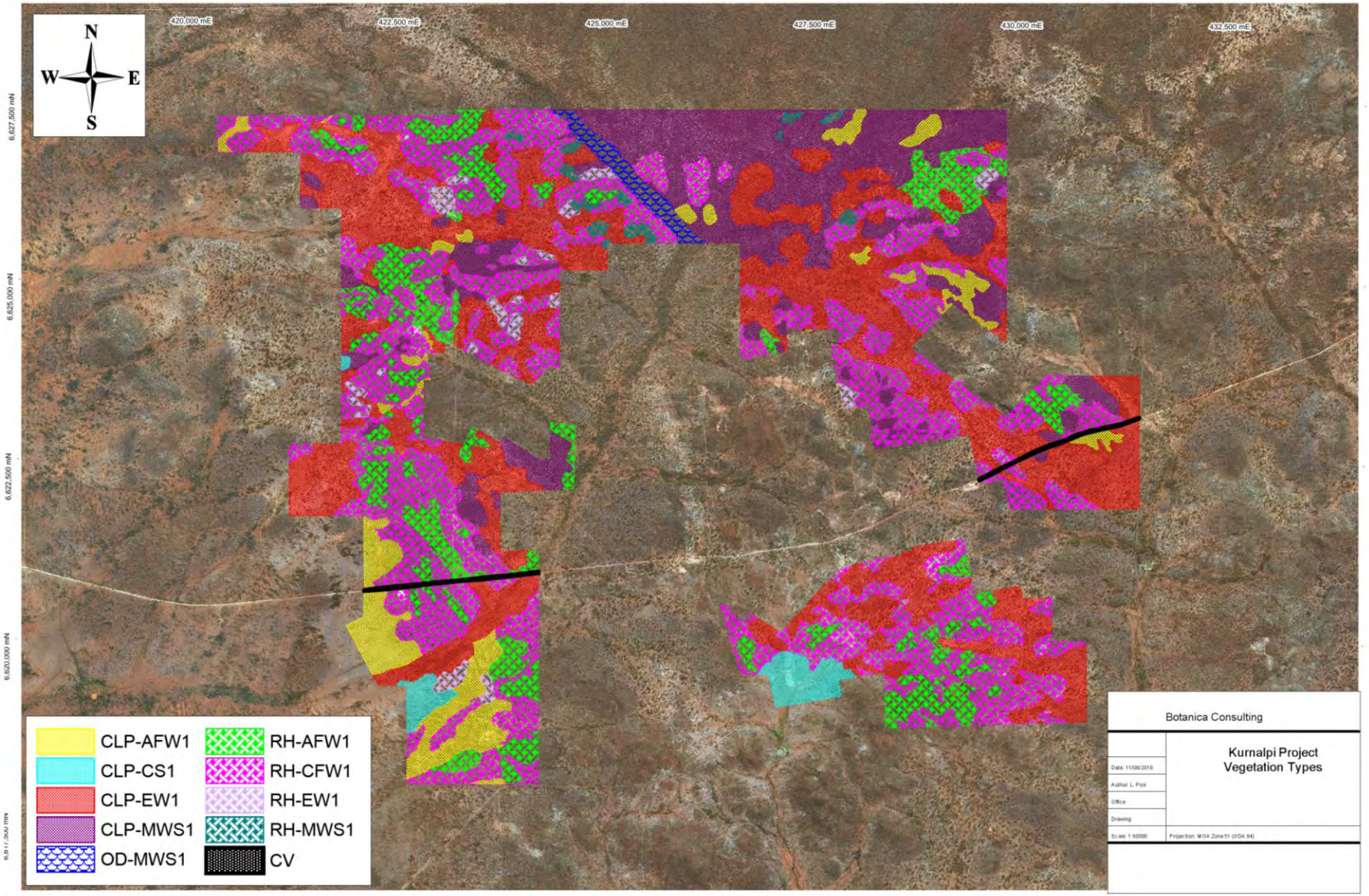


Figure 4-1: Vegetation types within the survey area

Clay-Loam Plain: Acacia Forests and Woodlands

4.2.1.1 Low woodland of *Acacia caesaneura*/ *A. incurvaneura* over mid open shrubland *Sida* sp. Golden calyces glabrous (H.N. Foote 32)/ *Eremophila oldfieldii* subsp. *angustifolia* and low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-AFW1)

The total flora recorded within this vegetation type was represented by a total of 13 Families, 15 Genera and 32 Taxa (Plate 4-2). Dominant taxa are shown in Table 4-5. According to the NVIS, this vegetation type is best represented by the MVG 6-Acacia Forests and Woodlands (DotEE, 2017b).

Table 4-5: Low woodland of *Acacia caesaneura*/ *A. incurvaneura* over mid open shrubland *Sida* sp. Golden calyces glabrous (H.N. Foote 32)/ *Eremophila oldfieldii* subsp. *angustifolia* and low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-AFW1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <10m	10-30%	*Acacia caesaneura* *Acacia incurvaneura*
Shrub 1-2m	30-70%	*Sida* sp. Golden calyces glabrous (H.N. Foote 32) *Eremophila oldfieldii* subsp. *angustifolia*
Shrub <1m	10-30%	*Ptilotus obovatus*



Plate 4-1: Low woodland of *Acacia caesaneura*/ *A. incurvaneura* over mid open shrubland *Sida* sp. Golden calyces glabrous (H.N. Foote 32)/ *Eremophila oldfieldii* subsp. *angustifolia* and low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-AFW1)

Clay-Loam Plain: Chenopod Shrubland

4.2.1.2 Low chenopod shrubland of *Maireana sedifolia/ M. pyramidata* over low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-CS1)

The total flora recorded within this vegetation type was represented by a total of 13 Families, 16 Genera and 28 Taxa (Plate 4-3). Dominant taxa are shown in Table 4-6. According to the NVIS, this vegetation type is best represented by the MVG 22 – Chenopod Shrubland (DotEE, 2017b).

Table 4-6: Low chenopod shrubland of *Maireana sedifolia/ M. pyramidata* over low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-CS1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Chenopod Shrub 1-2m	30-70%	*Maireana sedifolia* *Maireana pyramidata*
Shrub <1m	10-30%	*Ptilotus obovatus*



Plate 4-2: Low chenopod shrubland of *Maireana sedifolia/ M. pyramidata* over low shrubland of *Ptilotus obovatus* on clay-loam-plain (CLP-CS1)

Clay-Loam Plain: Eucalypt Woodland

4.2.1.3 Low woodland of *Eucalyptus salmonophloia* over open shrubland of *Senna artemisioides subsp. filifolia* and low chenopod shrubland of *Atriplex vesicaria* on clay-loam-plain (CLP-EW1)

The total flora recorded within this vegetation type was represented by a total of 12 Families, 17 Genera and 38 Taxa (Plate 4-4). Dominant taxa are shown in Table 4-7. According to the NVIS, this vegetation type is best represented by the MVG 5 – Eucalypt Woodland (DotEE, 2017b).

Table 4-7: Low woodland of *Eucalyptus salmonophloia* over open shrubland of *Senna artemisioides subsp. filifolia* and low chenopod shrubland of *Atriplex vesicaria* on clay-loam-plain (CLP-EW1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <10m	10-30%	*Eucalyptus salmonophloia*
Shrub 1-2m	10-30%	*Senna artemisioides* subsp. *filifolia*
Chenopod Shrub <1m	>70%	*Atriplex vesicaria*



Plate 4-3: Low woodland of *Eucalyptus salmonophloia* over open shrubland of *Senna artemisioides subsp. filifolia* and low chenopod shrubland of *Atriplex vesicaria* on clay-loam-plain (CLP-EW1)

Clay-Loam Plain: Mallee Woodlands and Shrublands

4.2.1.4 Mid open mallee shrubland of *Eucalyptus concinna* over shrubland of *Senna artemisioides* subsp. *filifolia* and low open shrubland of *Ptilotus obovatus* on clay-loam plain (CLP-MWS1)

The total flora recorded within this vegetation type was represented by a total of 14 Families, 20 Genera and 46 Taxa (Plate 4-6). Dominant taxa are shown in Table 4-8. According to the NVIS, this vegetation type is best represented by the MVG14 – Mallee Woodlands and Shrublands (DotEE, 2017b).

Table 4-8: Mid open mallee shrubland of *Eucalyptus concinna* over shrubland of *Senna artemisioides* subsp. *filifolia* and low open shrubland of *Ptilotus obovatus* on clay-loam plain (CLP-MWS1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <1om	10-30%	*Eucalyptus concinna*
Shrub 1-2m	10-30%	*Acacia ramulosa* var. *ramulosa* *Senna artemisioides* subsp. *filifolia*
Shrub <1m	10-30%	*Ptilotus obovatus*



Plate 4-4: Mid open mallee shrubland of *Eucalyptus concinna* over shrubland of *Senna artemisioides* subsp. *filifolia* and low open shrubland of *Ptilotus obovatus* on clay-loam plain (CLP-MWS1)

Open Depression: Mallee Woodlands and Shrublands

4.2.1.5 Mid mallee shrubland of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and shrubland of *Acacia ramulosa* var*. ramulosa* over low shrubland of *Ptilotus obovatus* in open depression (OD-MWS1)

The total flora recorded within this vegetation type was represented by a total of 13 Families, 18 Genera and 44 Taxa (Plate 4-5). Dominant taxa are shown in Table 4-8. According to the NVIS, this vegetation type is best represented by the MVG14 – Mallee Woodlands and Shrublands (DotEE, 2017b).

Table 4-9: Mid mallee shrubland of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and shrubland of *Acacia ramulosa* var*. ramulosa* over low shrubland of *Ptilotus obovatus* in open depression (OD-MWS1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Shrub Mallee 3-10m	10-30%	*Eucalyptus concinna*
Tree <10m	10-30%	*Acacia caesaneura*
Shrub 1-2m	10-30%	*Acacia ramulosa* var. *ramulosa*
Shrub <1m	10-30%	*Ptilotus obovatus*



Plate 4-5: Mid mallee shrubland of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and shrubland of *Acacia ramulosa* var*. ramulosa* over low shrubland of *Ptilotus obovatus* in open depression (OD-MWS1)

Rocky Hillslope: Acacia Forests and Woodlands

4.2.1.6 Mid open woodland of *Acacia caesaneura/ A. mulganeura/ A. quadrimarginea* over open shrubland of *Acacia ramulosa* var. *ramulosa/ Dodonaea lobulata* and low open shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-AFW1)

The total flora recorded within this vegetation type was represented by a total of 12 Families, 16 Genera and 29 Taxa (Plate 4-7). Dominant taxa are shown in Table 4-10. According to the NVIS, this vegetation type is best represented by the MVG 6- Acacia Forests and Woodlands (DotEE, 2017b).

Table 4-10: Mid open woodland of *Acacia caesaneura/ A. mulganeura/ A. quadrimarginea* over open shrubland of *Acacia ramulosa* var. *ramulosa/ Dodonaea lobulata* and low open shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-AFW1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <10m	10-30%	*Acacia quadrimarginea* *Acacia caesaneura* *Acacia mulganeura*
Shrub >2m	10-30%	*Acacia ramulosa* var. *ramulosa*
Shrub 1-2m	10-30%	*Dodonaea lobulata*
Shrub <1m	10-30%	*Ptilotus obovatus*



Plate 4-6: Mid open woodland of *Acacia caesaneura/ A. mulganeura/ A. quadrimarginea* over open shrubland of *Acacia ramulosa* var. *ramulosa/ Dodonaea lobulata* and low open shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-AFW1)

Rocky Hillslope: Casuarina Forests and Woodlands

4.2.1.7 Mid woodland of *Casuarina pauper* over mid shrubland of *Scaevola spinescens/ Dodonaea lobulata* and low shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-CFW1)

The total flora recorded within this vegetation type was represented by a total of 16 Families, 23 Genera and 42 Taxa (Plate 4-8). Dominant taxa are shown in Table 4-11. According to the NVIS, this vegetation type is best represented by the MVG 8 – Casuarina Forests and Woodlands (DotEE, 2017b).

Table 4-11: Mid woodland of *Casuarina pauper* over mid shrubland of *Scaevola spinescens/ Dodonaea lobulata* and low shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-CFW1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <10m	10-30%	*Casuarina pauper*
Shrub 1-2m	30-70%	*Scaevola spinescens* *Dodonaea lobulata*
Shrub <1m	30-70%	*Ptilotus obovatus*



Plate 4-7: Mid woodland of *Casuarina pauper* over mid shrubland of *Scaevola spinescens/ Dodonaea lobulata* and low shrubland of *Ptilotus obovatus* on rocky-hillslope (RH-CFW1)

Rocky Hillslope: Eucalypt Woodlands

4.2.1.8 Mid woodland of *Eucalyptus lesouefii* over open low shrubland of *Scaevola spinescens/ Eremophila parvifolia* and *Ptilotus obovatus* on a rocky-hillslope (RH-EW1)

The total flora recorded within this vegetation type was represented by a total of 10 Families, 15 Genera and 27 Taxa (Plate 4-9). Dominant taxa are shown in Table 4-12. According to the NVIS, this vegetation type is best represented by the MVG 5- Eucalypt Woodlands (DotEE, 2017b).

Table 4-12: Mid woodland of *Eucalyptus lesouefii* over open low shrubland of *Scaevola spinescens/ Eremophila parvifolia* and *Ptilotus obovatus* on a rocky-hillslope (RH-EW1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Tree <10m	10-30%	*Eucalyptus lesouefii*
Shrub 1-2m	5-10%	*Scaevola spinescens*
Shrub <1m	10-30%	*Eremophila parvifolia* *Ptilotus obovatus*



Plate 4-8: Mid woodland of *Eucalyptus lesouefii* over open low shrubland of *Scaevola spinescens/ Eremophila parvifolia* and *Ptilotus obovatus* on a rocky-hillslope (RH-EW1)

Rocky Hillslope: Mallee Woodlands and Shrublands

4.2.1.9 Mid mallee shrubland of *Eucalyptus celastroides* over low shrubland of *Acacia ramulosa* var. *ramulosa* and low hummock grassland of *Triodia scariosa* on rocky-hillslope (RH-MWS1)

The total flora recorded within this vegetation type was represented by a total of 12 Families, 15 Genera and 25 Taxa (Plate 4-9). Dominant taxa are shown in Table 4-12. According to the NVIS, this vegetation type is best represented by the MVG 14 – Mallee Woodlands and Shrublands (DotEE, 2017b).

Table 4-13: Mid mallee shrubland of *Eucalyptus celastroides* over low shrubland of *Acacia ramulosa* var. *ramulosa* and low hummock grassland of *Triodia scariosa* on rocky-hillslope (RH-MWS1)

Life Form/Height Class	Canopy Cover	Dominant taxa present
Shrub Mallee 3-10m	10-30%	*Eucalyptus celastroides*
Shrub >2m	10-30%	*Acacia ramulosa* var. *ramulosa*
Hummock Grassland <1m	30-70%	*Triodia scariosa*

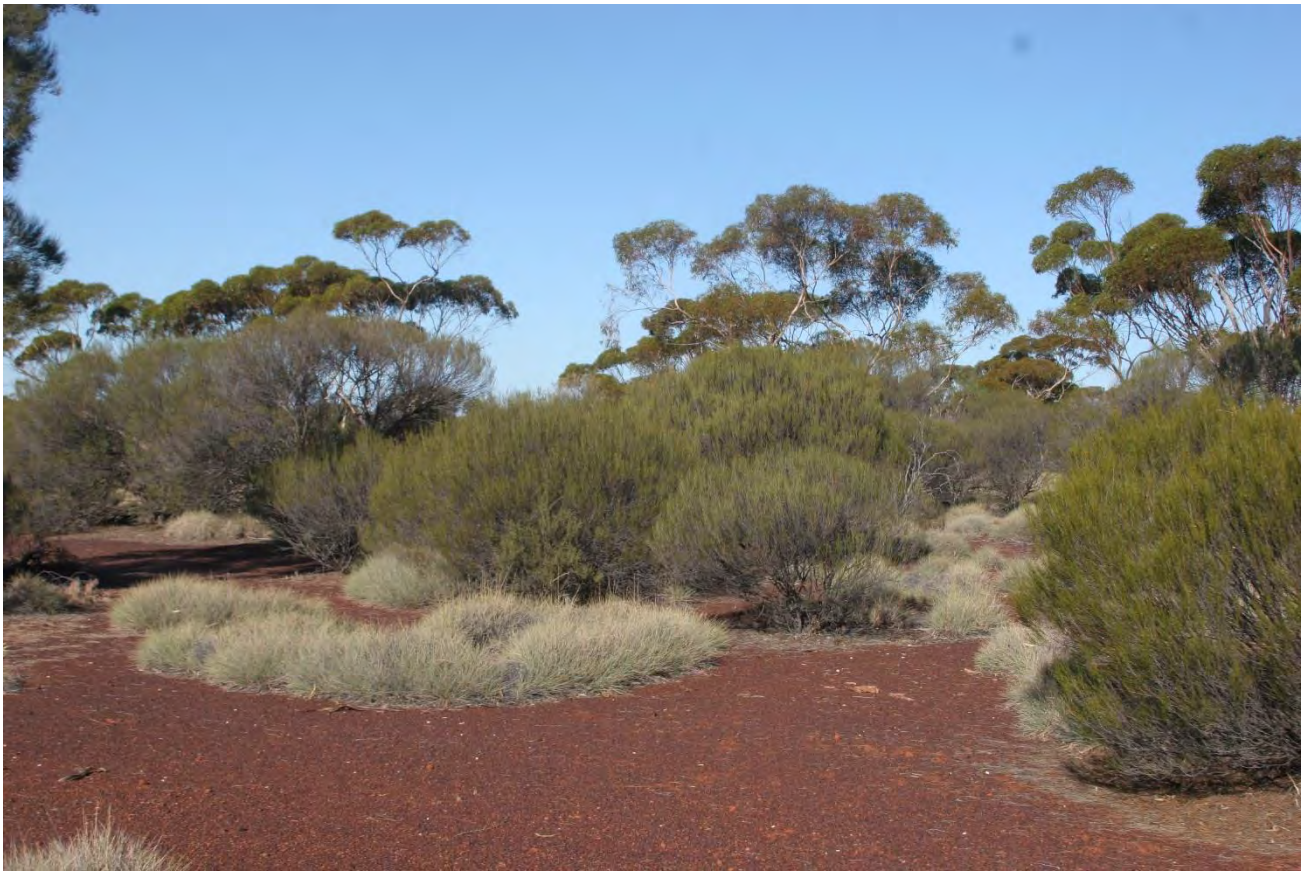


Plate 4-9: Mid mallee shrubland of *Eucalyptus celastroides* over low shrubland of *Acacia ramulosa* var. *ramulosa* and low hummock grassland of *Triodia scariosa* on rocky-hillslope (RH-MWS1)

4.2.2 Vegetation Condition

Based on the vegetation condition rating scale adapted from Keighery, 1994 and Trudgen, 1988 (Appendix 3), one vegetation type was rated as 'good' and the remaining eight vegetation types had a vegetation condition rating of 'very good' (Table 4-13). A map of the vegetation condition within the survey area is provided in Figure 4-2.

'Good' condition depicts that vegetation structure has been significantly altered by very obvious signs of multiple disturbances, however it retains its basic vegetation structure or has ability to regenerate it. Disturbance to vegetation structure can be caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

'Very Good' condition depicts that vegetation structure has been altered by obvious signs of disturbance, caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Table 4-14: Vegetation Condition Rating of the survey area

Landform	Major Vegetation Group	Vegetation Code	Vegetation Type	Vegetation Condition
Clay-Loam Plain	Acacia Forests and Woodland (MVG 6)	CLP-AFW1	Low woodland of *Acacia caesaneura/ A. incurvaneura* over mid open shrubland of *Sida* sp. Golden calyces glabrous (H.N. Foote 32)/ *Eremophila oldfieldii* subsp. *angustifolia* and low shrubland of *Ptilotus obovatus* on clay-loam-plain	Very Good
	Chenopod Shrubland (MVG22)	CLP-CS1	Low chenopod shrubland of *Maireana sedifolia/ M. pyramidata* over low shrubland of *Ptilotus obovatus* on clay-loam-plain	Very Good
	Eucalypt Woodland (MVG 5)	CLP-EW1	Low woodland of *Eucalyptus salmonophloia* over open shrubland of *Senna artemisioides* subsp. *filifolia* and low chenopod shrubland of A*triplex vesicaria* on clay-loam-plain	Very Good
	Mallee Woodlands and Shrublands (MVG14)	CLP-MWS1	Mid open mallee shrubland of *Eucalyptus concinna* over shrubland of *Senna artemisioides* subsp. *filifolia* and low open shrubland of *Ptilotus obovatus* on clay-loam-plain	Good
Open Depression	Mallee Woodlands and Shrublands (MVG14)	OD-MWS1	Mid mallee shrubland of *Eucalyptus concinna* over low woodland of *Acacia caesaneura* and shrubland of *Acacia ramulosa* var. *ramulosa* over low shrubland of *Ptilotus obovatus* in open depression	Very Good
Rocky Hillslope	Acacia Forests and Woodlands (MVG6)	RH-AFW1	Mid open woodland of *Acacia caesaneura/ A. mulganeura/ A. quadrimarginea* over open shrubland of *Acacia ramulosa* var. *ramulosa/ Dodonaea lobulata* and low open shrubland of *Ptilotus obovatus* on rocky-hillslope	Very Good
	Casuarina Forests and Woodlands (MVG8)	RH-CFW1	Mid woodland of *Casuarina pauper* over mid shrubland of *Scaevola spinescens/ Dodonaea lobulata* and low shrubland of *Ptilotus obovatus* on rocky-hillslope	Very Good
	Eucalypt Woodland (MVG5)	RH-EW1	Mid woodland of *Eucalyptus lesouefii* over open low shrubland of *Scaevola spinescens/ Eremophila parvifolia* and *Ptilotus obovatus* on a rocky-hillslope	Very Good
	Mallee Woodlands and Shrublands (MVG14)	RH-MWS1	Mid mallee shrubland of *Eucalyptus celastroides* over low shrubland of *Acacia ramulosa* var. *ramulosa* and low hummock grassland of *Triodia scariosa* on rocky-hillslope	Very Good
N/A	N/A	CV	Cleared Vegetation	Completely Degraded

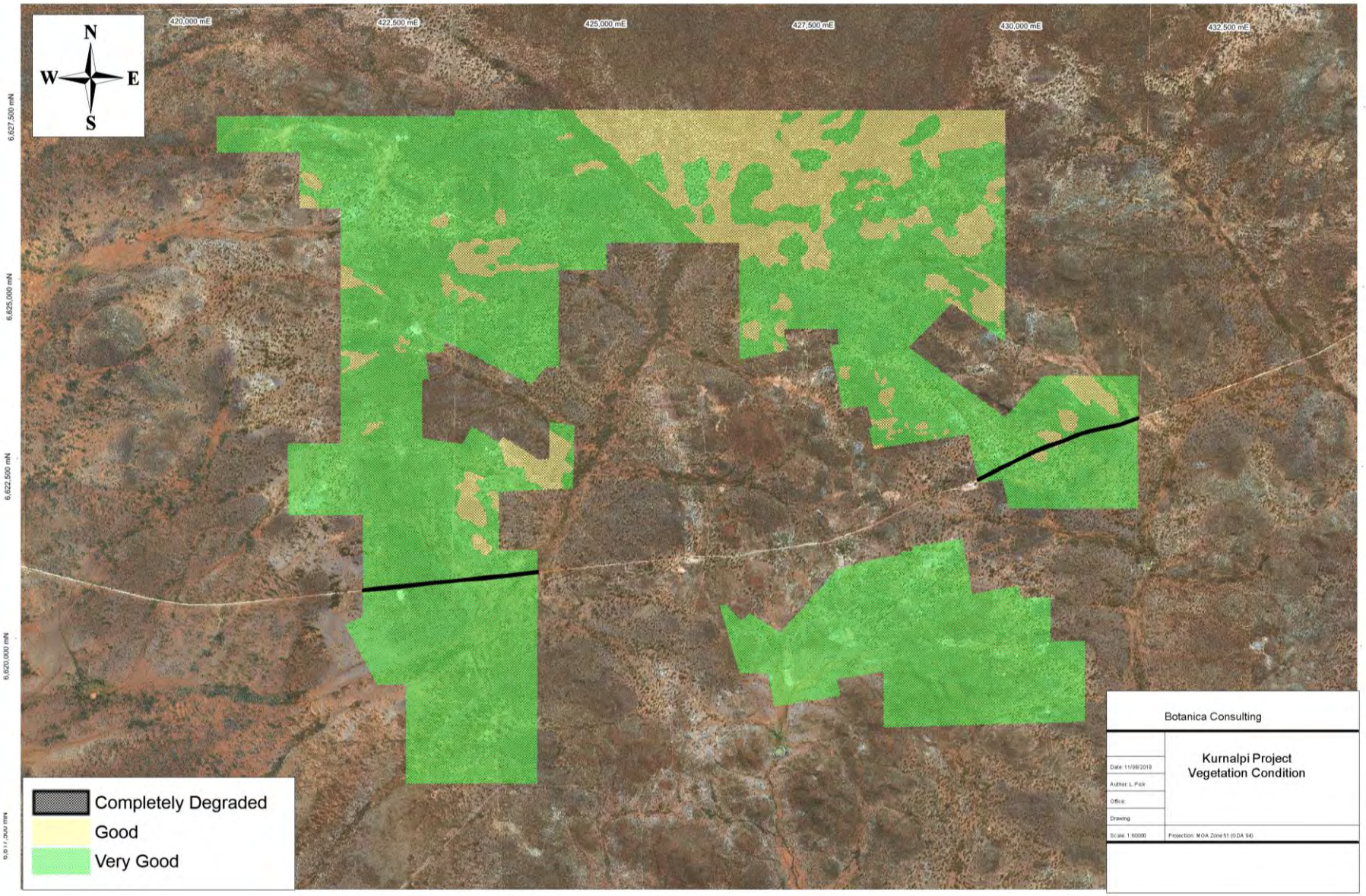


Figure 4-2: Vegetation Condition Rating of the survey area

4.2.3 Introduced Plant Species

Three introduced species were identified in the survey area:

1. *Citrullus lanatus* (Pie Melon)
2. *Cucumis myriocarpus* (Prickly Paddy Melon)
3. *Salvia verbenaca* (Wild Sage).

According to the DPRID, none of these taxa are listed as a Declared Plant under Section 22 of the *BAM Act 2007* (DPIRD, 2017). A map showing the introduced species locations recorded during the survey is provided in Figure 4-3.

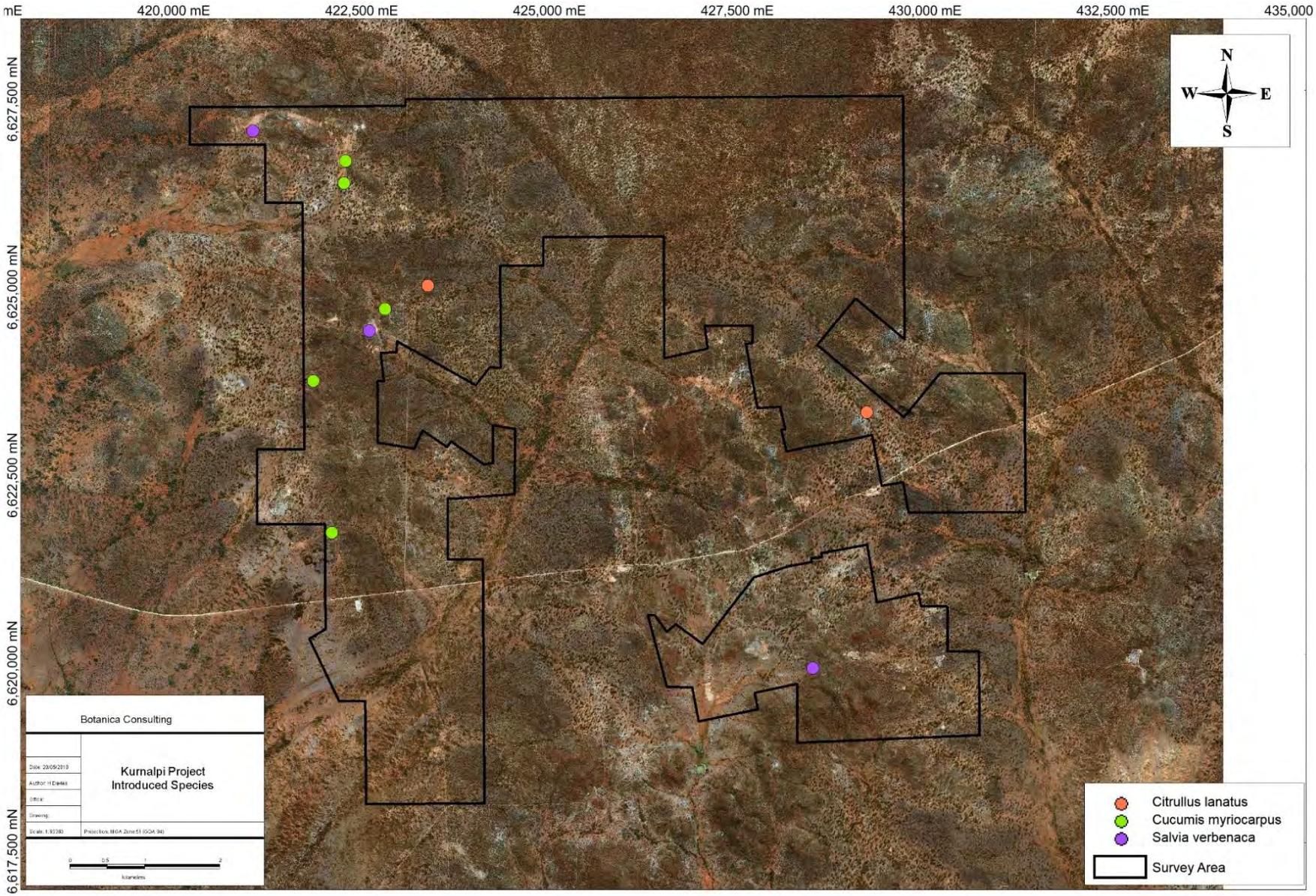


Figure 4-3: Introduced species locations within the survey area

4.2.3.1 *Citrullus lanatus* (Pie Melon)

This taxon is described as a trailing annual, herb or climber. It produces yellow flowers from January to December (Plate 4-10). It occurs on sandy gravelly soil, loam and clay soils of plains, river banks, centers of dry lakes, drainage areas and disturbed areas (WAHERB, 2018). This taxon was identified in one vegetation type; RH-CFW1.



Plate 4-10: *Citrullus lanatus* (Pie Melon)

4.2.3.2 *Cucumis myriocarpus* (Prickly Paddy Melon)

This species is described as a prostrate, annual herb. It produces yellow flower from January to February, or April to May (Plate 4-11). It is found in disturbed areas (WAHERB, 2018). This taxon was identified in one vegetation type; CLP-EW1.



Plate 4-11: *Cucumis myriocarpus* (Prickly Paddy Melon)

4.2.3.3 *Salvia verbenaca* (Wild Sage)

This species is described as a slightly aromatic perennial, herb which grows to 1m high. It produces blue, pink and purple flowers from April to October. This species often occurs along road verges (WAHERB, 2018). This taxon was identified in one vegetation type; CLP-EW1.



Plate 4-12: *Salvia verbenaca* (Wild Sage)

4.2.4 Fauna Habitat

The broad scale terrestrial fauna habitats within the survey area presented below are based on vegetation and associated landforms identified during the flora and vegetation assessment. The extent of the identified fauna habitats and a summary description of each are provided in Table 4-15 below.

Table 4-15: Main Terrestrial Fauna Habitats within the survey area

Fauna Habitat Description	Example Image
Clay-Loam Plains: Acacia Forests and Woodlands/Chenopod Shrublands/Eucalypt Woodlands and Mallee Woodlands and Shrublands. (approximate area = 2,600 ha; 54.2%).	
Open Depression: Mallee Woodlands and Shrublands (approximate area = 51 ha; 1.0%).	
Rocky Hillslopes Acacia/Casuarina Forests and Woodlands, Eucalypt Woodlands, Mallee Woodlands and Shrublands (approximate area = 2,138 ha; 45%).	
Existing Disturbed Areas (approximate area = 10 ha; 0.2%).	

A list of expected vertebrate fauna species likely to occur in the survey area was compiled from information obtained during the literature review and is presented in Appendix 4. The results of some previous fauna surveys carried out in the general area are also summarised in this species listing as are the DBCA NatureMap database search results.

Table 4-16 summarises the numbers of potential species based on vertebrate class considered likely to be present in the general vicinity of the survey area based on the complete list held Appendix 4.

Not all species listed in existing databases and publications as potentially occurring within the region (i.e. *EPBC Act* Threatened Fauna and Migratory species lists, DBCA NatureMap Fauna Database and various publications) are considered likely to be present within the survey area. The list of potential fauna takes into consideration that firstly the species in question is not known to be locally/regionally extinct and secondly that suitable habitat for each species, as identified during the habitat assessment, is present within the survey area, though compiling an accurate list has limitations (see **Section 3.3**).

Table 4-16: Summary of Potential Vertebrate Fauna Species

Group	Total number of potential species	Potential number of specially protected species	Potential number of migratory species	Potential number of priority species
Amphibians	4	0	0	0
Reptiles	60	0	0	0
Birds	101	0	0	0
Non-Volant Mammals	19[6]	0	0	0
Volant Mammals (Bats)	9	0	0	0
Total	**193[6]**	**20**	**0**	**0**

Superscript = number of introduced species included in the total. Note: Where a species state and federal conservation status is different, the highest category is used.

Despite the omission of some species it should be noted that the list provided is still very likely an over estimation of the fauna species utilising the survey area (either on a regular or infrequent basis) as a result of the precautionary approach adopted for the assessment. At any one time only, a subset of the listed potential species is likely to be present within the bounds of the study area.

A combined total of forty-six fauna species (~24% of the potential species) were observed/recorded during the field surveys carried out January 2012 (Harewood 2012) and in May 2018. No fauna of conservation significance were recorded, with most animals observed being relatively common widespread bird species.

4.2.5 Flora of Conservation Significance

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) flora of conservation significance includes:

- flora being identified as threatened or priority species
- locally endemic flora or flora associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
- new species or anomalous features that indicate a potential new species
- flora representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids
- flora with relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

No flora of conservation significance were identified within the survey area. A map showing regional Threatened and Priority Flora known records in relation to the survey area is provided in Appendix 1.

4.2.6 Fauna of Conservation Significance

According to the EPA *Environmental Factor Guideline for Terrestrial Fauna* (EPA, 2016d) fauna of conservation significance includes:

- Fauna being identified as a threatened or priority species
- Fauna species with restricted distribution
- Fauna subject to a high degree of historical impact from threatening processes
- Fauna providing an important function required to maintain the ecological integrity of a significant ecosystem.

No fauna of conservation significance was identified within the survey area.

4.2.7 Vegetation of Conservation Significance

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) vegetation of conservation significance includes:

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

No vegetation of conservation significance was identified within the survey area.

4.2.8 Matters of National Environmental Significance

None of the following matters of national environmental significance as defined by the Commonwealth EPBC Act were identified within the survey area:

- world heritage properties
- national heritage places
- wetlands of international importance (often called ‘Ramsar’ wetlands after the international treaty under which such wetlands are listed)
- nationally threatened species and ecological communities
- Commonwealth marine areas

- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mining) a water resource, in relation to coal seam gas development and large coal mining development.

4.2.9 Matters of State Environmental Significance

There are no wetlands of national importance (Ramsar or ANCA Wetlands) or conservation category wetlands within the survey area. The survey area does not contain any TEC as listed under the WC Act or EP Act. No Threatened Flora taxon listed under the WC Act were recorded within the survey area. The survey area does not contain any ESA listed under the EP Act; however, a Schedule 1 area as listed under the EP Act is located in the south-eastern region of the survey area. The survey is not located within DBCA managed land. The closest conservation reserve is the Bullock Holes Timber Reserve which is located approximately 30km west of the survey area.

A map showing areas of conservation significance in relation to the survey area is provided in Appendix 1.

4.3 Native Vegetation Clearing Principles

Based on the outcomes from the survey undertaken, as presented in this report, Botanica provides the following comments regarding the native vegetation clearing principles listed under Schedule 5 of the EP Act (Table 4-17).

Table 4-17: Assessment of development within the survey area against native vegetation clearing principles

Letter	Principle	Assessment	Outcome
(a)	Native vegetation should not be cleared if it comprises a high level of biological diversity.	Vegetation identified within the survey area is not considered to be of high biological diversity and is well represented outside of the proposed impact area.	Development within the survey area is unlikely to be at variance to this principle
(b)	Native vegetation should not be cleared it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	No significant fauna habitat identified within the project area. Fauna habitats are well represented outside of the project area. No significant fauna were observed within the survey area.	Development within the survey area is unlikely to be at variance to this principle
(c)	Native vegetation should not be cleared if it includes or is necessary for the continued existence of rare flora.	No Threatened Flora taxa, pursuant to the WC Act and the EPBC Act were identified within the survey area.	Development within the survey area is unlikely to be at variance to this principle
(d)	Native vegetation should not be cleared if it comprises the whole or part of or is necessary for the maintenance of a threatened ecological community (TEC).	No TEC listed under the EPBC Act or by the WC Act occur within the survey area.	Development within the survey area is unlikely to be at variance to this principle
(e)	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	According to DAFWA (2011), the survey area occurs in pre-European Beard vegetation associations Barlee 20, which retains approximately 100% of the original vegetation extent.	Development within the survey area is unlikely to be at variance to this principle

Letter	Principle	Assessment	Outcome
(f)	Native vegetation should not be cleared if it is growing, in, or in association with, an environment associated with a watercourse or wetland.	According to the Geoscience Australia GIS database, there are two intermittent/ non-perennial drainage lines within the survey area. No riparian vegetation was identified within the survey area.	Development within the survey area is unlikely to be at variance to this principle
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	According to DAFWA (2011), the survey area occurs in pre-European Beard vegetation associations Barlee 20, which retains approximately 100% of the original vegetation extent. Clearing within this vegetation association is not likely to lead to land degradation issues such as salinity, water logging or acidic soils.	Development within the survey area is unlikely to be at variance to this principle
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The survey area is not located within a Conservation Area. The closest conservation area is the Bullock Holes Timber Reserve which is located approximately 30km west of the survey area.	Development within the survey area is unlikely to be at variance to this principle
(i)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	According to the Geoscience Australia GIS database, there are two intermittent/ non-perennial drainage lines within the survey area. No riparian vegetation was identified within the survey area. The survey area is located in an arid to semi-arid environment with most rainfall lost by evaporation or surface runoff. Only a small portion infiltrates the soil and recharges the groundwater.	Development within the survey area is unlikely to be at variance to this principle
(j)	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding	Rainfall is unreliable and highly variable with an average rainfall of 200-300mm and an evaporation rate of 2400 mm. The region is not prone to flooding and does not contain riparian vegetation.	Development within the survey area is unlikely to be at variance to this principle

5 Summary

Nine vegetation types were identified within the survey area. These communities were located within three different landform types and comprised of five major vegetation groups, which were represented by a total of 18 Families, 31 Genera and 83 taxa. The broad scale terrestrial fauna habitats within the survey area have been identified as comprising a mosaic of clay-loam plain, open depression and rocky hillslopes.

Results of the literature review identified 28 mammals (including 9 bat species), 101 birds, 60 reptiles and four frog species that have previously been recorded in the general area, some of which have the potential to occur subject to the identified habitats being suitable. Forty-six fauna species were recorded during the field survey.

No Threatened Flora, Threatened Fauna, Migratory Fauna or TEC as listed under the WC Act or Commonwealth EPBC Act 1999 were identified within the survey area. Priority Flora taxa listed on the DBCA database occurred within the survey area.

A review of the EPBC Act threatened fauna list, DBCA's Threatened Fauna Database and Priority List, unpublished reports and scientific publications identified a number of specially protected, migratory or priority fauna species as having been previously recorded or as being potentially present in the general vicinity of the survey area. However, no fauna of conservation significance is likely to be significantly impacted on by the proposed development. This conclusion is primarily based on the lack of suitable habitats, the known local extinction of some species, the relatively small size of the impact footprint and the extensive habitat connectivity with adjoining areas. Impacts on fauna and fauna habitat are therefore anticipated to be localised, small/negligible and as a consequence manageable.

No PECs were identified within the survey area. The survey area does not contain any world or national heritage places and does not occur within a Bush Forever site. There are no wetlands of international importance (Ramsar Wetlands), national importance (ANCA Wetlands) or conservation category wetlands within the survey area.

The survey area does not contain any ESA listed under the EP Act; however, a Schedule 1 area as listed under the EP Act is located in the south-eastern region of the survey area. The survey is not located within DBCA managed land. The closest conservation reserve is the Bullock Holes Timber Reserve which is located approximately 30km west of the survey area.

Vegetation condition ranged from 'good' to 'very good'. Three introduced taxa were identified within the survey area, none of which are listed as a Declared Plant under the BAM Act.

5.1 Recommendations

- Where possible utilise the existing tracks and disturbed areas within the survey area;
- Avoid clearing of mature Eucalypts where possible;
- Implement weed management/ vehicle hygiene procedures during clearing/ site access to prevent spread of introduced species.

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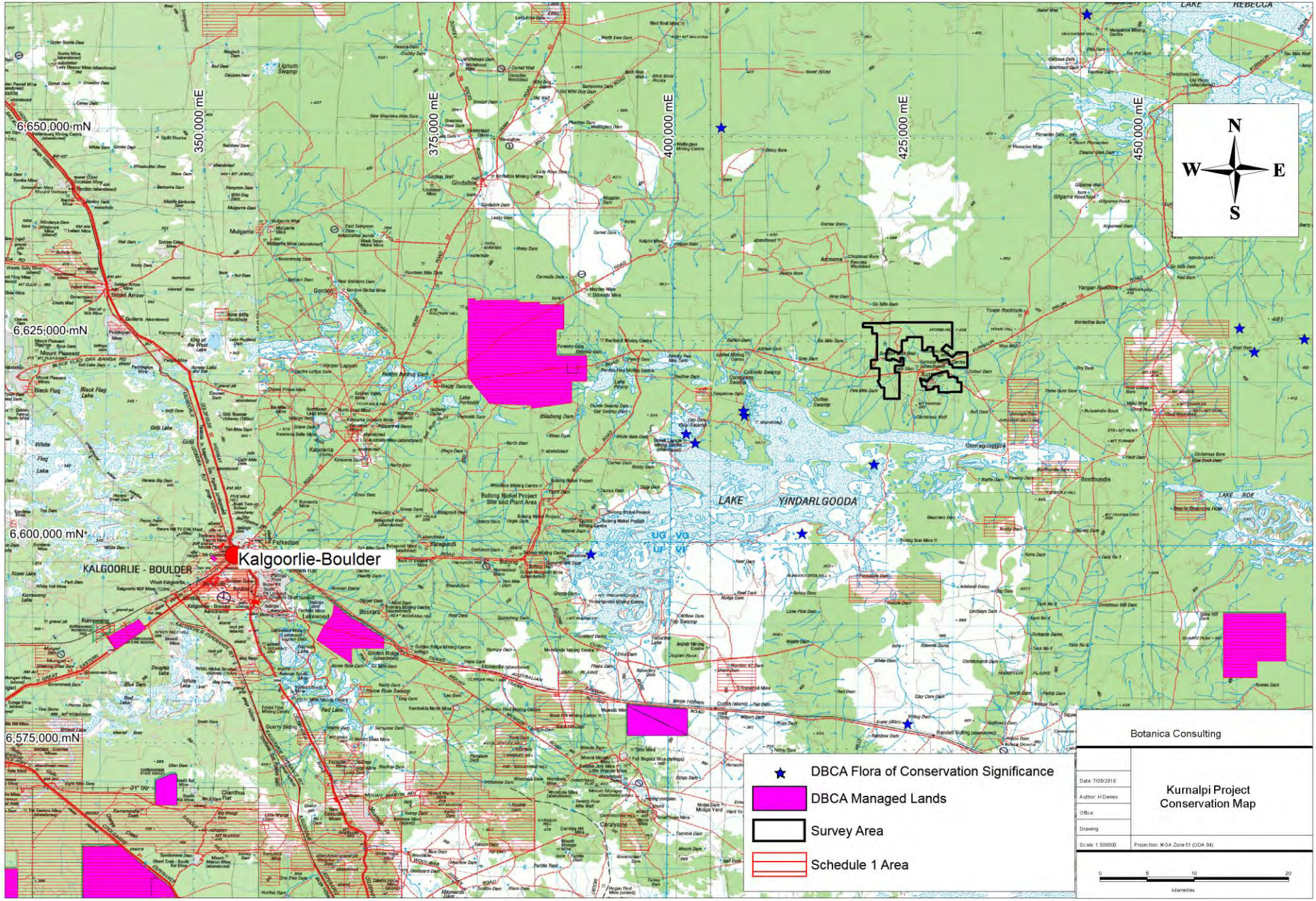
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Appendix 1: Regional map of the survey area including DBCA Flora of Conservation Significance and areas of Conservation Significance



Appendix 2: List of species identified within each vegetation type

Blue text-annual species; Green text-Introduced species (WAHERB, 2018)

Family	Genus	Taxon	CLP-AFW1	CLP-MWS1	CLP-CS1	CLP-EW1	OD-MWS1	RH-AFW1	RH-CFW1	RH-EW1	RH-MWS1
Amaranthaceae	*Ptilotus*	*aervoides (A)*						*			
Amaranthaceae	*Ptilotus*	*nobilis (A)*				*					
Amaranthaceae	*Ptilotus*	*obovatus*	*	*	*	*	*	*	*	*	*
Asteraceae	*Chrysocephalum*	*puteale*						*			
Asteraceae	*Cratystylis*	*microphylla*								*	
Asteraceae	*Cratystylis*	*subspinescens*		*	*				*		
Asteraceae	*Olearia*	*muelleri*	*	*				*	*	*	*
Asteraceae	*Olearia*	*pimeleoides*							*		
Casuarinaceae	*Casuarina*	*pauper*	*	*	*		*	*	*		*
Chenopodiaceae	*Atriplex*	*nummularia* subsp. *spathulata*		*		*	*		*	*	
Chenopodiaceae	*Atriplex*	*bunburyana*		*		*	*				
Chenopodiaceae	*Atriplex*	*codonocarpa* (A)			*						
Chenopodiaceae	*Atriplex*	*nummularia*	*		*						
Chenopodiaceae	*Atriplex*	sp. (sterile)		*			*				
Chenopodiaceae	*Atriplex*	*vesicaria*	*			*				*	
Chenopodiaceae	*Enchylaena*	*tomentosa*				*				*	
Chenopodiaceae	*Maireana*	*georgei*		*	*		*		*	*	*
Chenopodiaceae	*Maireana*	*oppositifolia*			*	*					
Chenopodiaceae	*Maireana*	*pentatropis*							*		
Chenopodiaceae	*Maireana*	*pyramidata*			*	*					
Chenopodiaceae	*Maireana*	*sedifolia*	*	*	*		*		*	*	
Chenopodiaceae	*Maireana*	*tomentosa*			*	*					
Chenopodiaceae	*Maireana*	*trichoptera*								*	
Chenopodiaceae	*Maireana*	*triptera*	*	*	*	*	*		*		
Chenopodiaceae	*Salsola*	*australis* (A)		*			*				
Chenopodiaceae	*Sclerolaena*	*cuneata*		*	*	*	*				
Chenopodiaceae	*Sclerolaena*	*diacantha*	*	*	*	*	*			*	
Chenopodiaceae	*Sclerolaena*	*eurotioides*	*	*		*	*				
Chenopodiaceae	*Sclerolaena*	*uniflora*				*					

Family	Genus	Taxon	CLP-AFW1	CLP-MWS1	CLP-CS1	CLP-EW1	OD-MWS1	RH-AFW1	RH-CFW1	RH-EW1	RH-MWS1
Chenopodiaceae	*Tecticornia*	*disarticulata*				*					
Chenopodiaceae	*Tecticornia*	*indica* subsp. *bidens*				*					
Cucurbitaceae	*Citrullus*	*lanatus (W)*							*		
Cucurbitaceae	*Cucumis*	*myriocarpus (W)*				*					
Fabaceae	*Acacia*	*aptaneura*									*
Fabaceae	*Acacia*	*caesaneura*	*	*			*	*	*		*
Fabaceae	*Acacia*	*hemiteles*		*		*	*				*
Fabaceae	*Acacia*	*incurvaneura*	*	*	*		*				
Fabaceae	*Acacia*	*mulganeura*	*	*			*	*			
Fabaceae	*Acacia*	*murrayana*							*		
Fabaceae	*Acacia*	*quadrimarginea*	*	*			*	*			
Fabaceae	*Acacia*	*ramulosa* var. *ramulosa*	*	*			*	*	*		*
Fabaceae	*Acacia*	*tetragonophylla*	*	*	*	*	*	*	*	*	*
Fabaceae	*Senna*	*artemisioides* subsp. *filifolia*		*	*	*	*	*	*	*	*
Fabaceae	*Senna*	*artemisioides* subsp. x *artemisioides*						*			
Frankeniaceae	*Frankenia*	*interioris*			*						
Goodeniaceae	*Scaevola*	*spinescens*	*	*		*	*	*	*	*	*
Lamiaceae	*Salvia*	*verbenaca* (W)				*					
Loranthaceae	*Amyema*	*preissii*		*			*				
Malvaceae	*Brachychiton*	*gregorii*						*	*		
Malvaceae	*Sida*	*calyxhymenia*	*	*	*	*	*	*			
Malvaceae	*Sida*	*intricata*	*	*			*				
Malvaceae	*Sida*	Golden calyces glabrous (H.N. Foote 32)	*	*		*	*	*	*		
Myrtaceae	*Eucalyptus*	*ewartiana*						*	*		
Myrtaceae	*Eucalyptus*	*celastroides*									*
Myrtaceae	*Eucalyptus*	*concinna*	*	*			*				
Myrtaceae	*Eucalyptus*	*lesouefii*				*			*	*	
Myrtaceae	*Eucalyptus*	*oleosa*		*			*				*
Myrtaceae	*Eucalyptus*	*salmonophloia*			*	*					
Myrtaceae	*Eucalyptus*	*salubris*				*					
Pittosporaceae	*Pittosporum*	*angustifolium*							*		
Poaceae	*Austrostipa*	*elegantissima*							*		*

Family	Genus	Taxon	CLP-AFW1	CLP-MWS1	CLP-CS1	CLP-EW1	OD-MWS1	RH-AFW1	RH-CFW1	RH-EW1	RH-MWS1
Poaceae	*Austrostipa*	*nitida (A)*	*	*			*	*			
Poaceae	*Enneapogon*	*caerulescens*		*	*		*	*	*		
Poaceae	*Triodia*	*scariosa*							*		*
Santalaceae	*Exocarpos*	*aphyllus*				*			*	*	*
Santalaceae	*Santalum*	*spicatum*							*		*
Sapindaceae	*Dodonaea*	*bursariifolia*							*		
Sapindaceae	*Dodonaea*	*lobulata*	*	*	*		*	*	*	*	*
Sapindaceae	*Dodonaea*	*viscosa* subsp. *angustissima*						*			
Scrophulariaceae	*Eremophila*	*alternifolia*	*	*	*		*		*	*	
Scrophulariaceae	*Eremophila*	*decipiens*		*			*		*	*	*
Scrophulariaceae	*Eremophila*	*glabra*		*			*				
Scrophulariaceae	*Eremophila*	*interstans*				*					
Scrophulariaceae	*Eremophila*	*longifolia*				*					
Scrophulariaceae	*Eremophila*	*oldfieldii* subsp. *angustifolia*	*	*		*	*	*	*		*
Scrophulariaceae	*Eremophila*	*oldfieldii subsp. oldfieldii*	*	*			*				
Scrophulariaceae	*Eremophila*	*parvifolia*		*			*		*	*	
Scrophulariaceae	*Eremophila*	*pustulata*								*	
Scrophulariaceae	*Eremophila*	*scoparia*		*		*	*		*	*	
Scrophulariaceae	*Eremophila*	sp. (sterile)	*							*	
Solanaceae	*Solanum*	*lasiophyllum*	*	*	*	*	*	*	*		
Solanaceae	*Solanum*	*orbiculatum*		*		*	*	*	*		

Appendix 3: Vegetation Condition Rating

Vegetation Condition Rating	South West and Interzone Botanical Provinces	Eremaean and Northern Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor		Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or ‘parkland cleared’ with their flora comprising weed or crop species with isolated native trees or shrubs.

Appendix 4: Potential Fauna Species List

Fauna Recorded or Potentially in Region of Study Area

Compiled by Greg Harewood - June 2018

Recorded (Captured/Sighted/Heard/Signs) = X

Kurnalpi, W.A.

Approximate centroid - 30.528240°S and 122.229920°E

Harewood G (2012). Terrestrial Fauna Survey (Level 1) Kurnalpi Project. Unpublished report for Carrick Gold Ltd. Feb 2012

WAM (1992). The Biological Survey of the Eastern Goldfields of Western Australia. Part 8. The Kurnalpi - Kalgoorlie Study Area. Rec. West. Aust. Mus. Supplement No. 41. (Kurnalpi Records)

DBCA (2018). NatureMap Database Search – "By Circle" Centre 122° 13' 48" E,30° 31' 42" S (plus 40km buffer). Accessed 06/06/2018.

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Amphibia					
Myobatrachidae Ground or Burrowing Frogs					
Neobatrachus kunapalari	Kunapalari Frog	LC			X
Neobatrachus sutor	Shoemaker Frog	LC			X
Neobatrachus wilsmorei	Plonking Frog	LC			
Pseudophryne occidentalis	Western Toadlet	LC			
Reptilia					
Carphodactylidae Knob-tailed Geckos					
Nephrurus laevissimus	Smooth Knob-tail				
Nephrurus milii	Barking Gecko			X	
Nephrurus vertebralis	Midline Knob-tailed Gecko				

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DBCA Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Diplodactylidae Geckoes					
Diplodactylus conspicillatus	Fat-tailed Gecko				
Diplodactylus granariensis	Western Stone Gecko				
Diplodactylus pulcher	Western Saddled Ground Gecko			X	X
Lucasium maini	Mains Ground Gecko			X	
Oedura reticulata	Reticulated Velvet Gecko				
Rhynchoedura ornata	Beaked Gecko			X	X
Strophurus assimilis	Goldfields Spiny-tailed Gecko				
Strophurus elderi	Jewelled Gecko				
Gekkonidae Geckoes					
Gehyra purpurascens	Purple Arid Dtella				X
Gehyra variegata	Variegated Dtella			X	X
Heteronotia binoei	Bynoe's Gecko			X	X
Pygopodidae Legless Lizards					
Delma butleri	Unbanded Delma				X
Lialis burtonis	Burton’s Legless Lizard			X	X
Pygopus nigriceps	Hooded Scaly Foot				

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Agamidae Dragon Lizards					
Caimanops amphiboluroides	Mulga Dragon				
Ctenophorus cristatus	Bicycle Dragon			X	X
Ctenophorus fordi	Mallee Sand Dragon			X	X
Ctenophorus reticulatus	Western Netted Dragon			X	X
Ctenophorus scutulatus	Lozenge-marked Bicycle Dragon			X	X
Moloch horridus	Thorny Devil			X	X
Pogona minor	Western Bearded Dragon			X	X
Tympanocryptis cephalus	Pebble Dragon				
Varanidae Monitor's or Goanna's					
Varanus caudolineatus	Stripe-tailed Pygmy Monitor			X	X
Varanus gouldii	Bungarra or Sand Monitor			X	X
Varanus tristis	Racehorse Monitor				X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Scincidae Skinks					
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink			X	
Ctenotus atlas	Southern Malle Ctenotus			X	X
Ctenotus leonhardii	Leonhardi's Skink				X
Ctenotus schomburgkii	Barred Wedge-snout Ctenotus			X	X
Ctenotus uber	Spotted Ctenotus			X	X
Cyclodomorphus melanops elongatus	Eastern Slender Blue-tongue			X	
Egernia depressa	Pygmy Spiny-tailed Skink			X	X
Egernia formosa	Goldfields Crevise Skink			X	X
Egernia inornata	Desert Skink				
Eremiascincus richardsonii	Broad-banded Sand Swimmer				
Lerista kingi	Common Mulch Skink			X	X
Lerista picturata	Goldfields Robust Lerista				
Menetia greyii	Dwarf Skink			X	X
Morethia butleri	Woodland Dark-flecked Morethia			X	X
Tiliqua occipitalis	Western Bluetongue			X	X
Tiliqua rugosa	Bobtail			X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Typhlopidae Blind Snakes					
Ramphotyphlops bicolor	Dark-spined Blind Snake				
Ramphotyphlops bituberculatus	Prong-snouted Blind Snake				
Ramphotyphlops hamatus	Northern Hook-snouted Blind Snake				
Ramphotyphlops waitii	Common Beaked Blind Snake				
Boidae Pythons, Boas					
Morelia spilota	Carpet Python				X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Elapidae Elapid Snakes					
Acanthophis pyrrhus	Desert Death Adder				X
Brachyurophis fasciolata	Narrow-banded Shovel-nosed Snake				
Demansia psammophis	Yellow-faced Whipsnake				
Furina ornata	Moon Snake				
Neelaps bimaculatus	Black-naped Snake				
Parasuta monachus	Monk Snake			X	X
Pseudechis australis	Mulga Snake				X
Pseudonaja modesta	Ringed Brown Snake			X	X
Pseudonaja nuchalis	Gwardar				
Simoselaps bertholdi	Jan's Banded Snake				
Suta fasciata	Rosen's Snake				
Aves					
Casuariidae Emus, Cassowarries					
Dromaius novaehollandiae	Emu	LC	X		X
Megapodiidae Moundbuilders					
Leipoa ocellata	Malleefowl	S3 VU VU A2bce+3ce		X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Accipitridae Kites, Goshawks, Eagles, Harriers					
Accipiter cirrocephalus	Collared Sparrowhawk	LC			
Accipiter fasciatus	Brown Goshawk	LC			X
Aquila audax	Wedge-tailed Eagle	LC			X
Aquila morphnoides	Little Eagle	LC			
Circus assimilis	Spotted Harrier	LC			
Elanus caeruleus	Black-shouldered Kite	LC			
Haliastur sphenurus	Whistling Kite	LC			
Hamirostra isura	Square-tailed Kite	LC			
Falconidae Falcons					
Falco berigora	Brown Falcon	LC		X	X
Falco cenchroides	Australian Kestrel	LC	X	X	X
Falco longipennis	Australian Hobby	LC			
Falco peregrinus	Peregrine Falcon	S7 LC			X
Otididae Bustards					
Ardeotis australis	Australian Bustard	LC			
Turnicidae Button-quails					
Turnix velox	Little Button-quail	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Columbidae Pigeons, Doves					
Ocyphaps lophotes	Crested Pigeon	LC	X		X
Phaps chalcoptera	Common Bronzewing	LC		X	X
Psittacidae Parrots					
Cacatua roseicapilla	Galah	LC	X	X	X
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	LC	X	X	
Melopsittacus undulatus	Budgerigar	LC		X	
Nymphicus hollandicus	Cockatiel	LC	X		
Platycercus varius	Mulga Parrot	LC		X	X
Platycercus zonarius	Australian Ringneck	LC	X	X	X
Cuculidae Parasitic Cuckoos					
Cacomantis flabelliformis	Fan-tailed Cuckoo	LC			
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	LC		X	X
Chrysococcyx osculans	Black-eared Cuckoo	LC		X	
Cuculus pallidus	Pallid Cuckoo	LC		X	
Strigidae Hawk Owls					
Ninox novaeseelandiae	Boobook Owl	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Tytonidae Barn Owls					
Tyto alba	Barn Owl	LC			
Podargidae Frogmouths					
Podargus strigoides	Tawny Frogmouth	LC	X		X
Caprimulgidae Nightjars					
Eurostopodus argus	Spotted Nightjar	LC			
Aegothelidae Owlet-nightjars					
Aegotheles cristatus	Australian Owlet-nightjar	LC		X	X
Halcyonidae Tree Kingfishers					
Todiramphus pyrrhopygia	Red-backed Kingfisher	LC	X		
Todiramphus sanctus	Sacred Kingfisher	LC			
Meropidae Bee-eaters					
Merops ornatus	Rainbow Bee-eater	JA LC		X	X
Climacteridae Treecreepers					
Climacteris affinis	White-browed Treecreeper	LC			
Climacteris rufa	Rufous Treecreeper	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Maluridae Fairy Wrens, GrassWrens					
Malurus lamberti	Variegated Fairy-wren	LC		X	X
Malurus leucopterus	White-winged Fairy-wren	LC	X		X
Malurus splendens	Splendid Fairy-wren	LC	X		X
Acanthizidae Thornbills, Geryones, Fieldwrens & Whitefaces					
Acanthiza apicalis	Broad-tailed Thornbill	LC	X	X	X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	LC	X	X	X
Acanthiza robustirostris	Slaty-backed Thornbill	LC	X	X	
Acanthiza uropygialis	Chestnut-rumped Thornbill	LC	X	X	X
Aphelocephala leucopsis	Southern Whiteface	LC		X	X
Gerygone fusca	Western Gerygone	LC			
Pyrrholaemus brunneus	Redthroat	LC	X	X	X
Smicrornis brevirostris	Weebill	LC	X	X	X
Pardalotidae Pardalotes					
Pardalotus striatus	Striated Pardalote	LC	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Meliphagidae Honeyeaters, Chats					
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	LC	X	X	X
Anthochaera carunculata	Red Wattlebird	LC	X		X
Certhionyx niger	Black Honeyeater	LC			
Certhionyx variegatus	Pied Honeyeater	LC			
Epthianura albifrons	White-fronted Chat	LC			X
Epthianura tricolor	Crimson Chat	LC			
Lichenostomus leucotis	White-eared Honeyeater	LC	X	X	X
Lichenostomus ornatus	Yellow-plumed Honeyeater	LC	X	X	
Lichenostomus plumulus	Grey-fronted Honeyeater	LC		X	
Lichenostomus virescens	Singing Honeyeater	LC	X	X	
Lichmera indistincta	Brown Honeyeater	LC	X	X	X
Manorina flavigula	Yellow-throated Miner	LC	X	X	X
Melithreptus brevirostris	Brown-headed Honeyeater	LC		X	X
Phylidonyris albifrons	White-fronted Honeyeater	LC	X	X	

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Petroicidae Australian Robins					
Drymodes brunneopygia	Southern Scrub-robin	LC			X
Microeca fascinans	Jacky Winter	LC	X	X	X
Petroica cucullata	Hooded Robin	LC			
Petroica goodenovii	Red-capped Robin	LC		X	X
Pomatostomidae Babblers					
Pomatostomus superciliosus	White-browed Babbler	LC	X	X	
Cinclosomatidae Whipbirds, Wedgebills, Quail Thrushes					
Cinclosoma castanotus	Chestnut Quail-thrush	LC			
Neosittidae Sitellas					
Daphoenositta chrysoptera	Varied Sittella	LC			X
Pachycephalidae Crested Shrike-tit, Crested Bellbird, Shrike Thrushes, Whistlers					
Colluricincla harmonica	Grey Shrike-thrush	LC	X	X	X
Oreoica gutturalis	Crested Bellbird	LC	X	X	
Pachycephala inornata	Gilbert's Whistler	LC			X
Pachycephala rufiventris	Rufous Whistler	LC	X	X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Dicruridae Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo					
Grallina cyanoleuca	Magpie-lark	LC			X
Rhipidura fuliginosa	Grey Fantail	LC			
Rhipidura leucophrys	Willie Wagtail	LC	X		X
Campephagidae Cuckoo-shrikes, Trillers					
Coracina maxima	Ground Cuckoo-shrike	LC	X		X
Coracina novaehollandiae	Black-faced Cuckoo-shrike	LC	X	X	X
Lalage tricolor	White-winged Triller	LC		X	X
Artamidae Woodswallows, Butcherbirds, Currawongs					
Artamus cinereus	Black-faced Woodswallow	LC			X
Artamus cyanopterus	Dusky Woodswallow	LC			
Artamus minor	Little Woodswallow	LC			
Artamus personatus	Masked Woodswallow	LC			X
Cracticidae Currawongs, Magpies & Butcherbirds					
Cracticus nigrogularis	Pied Butcherbird	LC	X	X	X
Cracticus tibicen	Australian Magpie	LC	X		X
Cracticus torquatus	Grey Butcherbird	LC	X	X	X
Strepera versicolor	Grey Currawong	LC	X	X	X

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, Mig = Migratory, DBCA Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, IUCN Red List Category Definitions - LC = Least Concern, for others see App. A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Corvidae Ravens, Crows					
Corvus bennetti	Little Crow	LC			X
Corvus coronoides	Australian Raven	LC	X		X
Corvus orru	Torresian Crow	LC			
Corvus sp	Corvid sp.			X	
Motacillidae Old World Pipits, Wagtails					
Anthus australis	Australian Pipit	LC			
Estrilidae Grass Finches & Mannikins					
Taeniopygia guttata	Zebra Finch	LC			
Dicaeidae Flowerpeckers					
Dicaeum hirundinaceum	Mistletoebird	LC		X	X
Hirundinidae Swallows, Martins					
Cheramoeca leucosternus	White-backed Swallow	LC			
Hirundo ariel	Fairy Martin	LC			
Hirundo neoxena	Welcome Swallow	LC			
Hirundo nigricans	Tree Martin	LC			

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Sylviidae Old World Warblers					
Cincloramphus cruralis	Brown Songlark	LC	X		
Cincloramphus mathewsi	Rufous Songlark	LC			
Mammalia					
Tachyglossidae Echidnas					
Tachyglossus aculeatus	Echidna	LC	X		X
Dasyuridae Carnivorous Marsupials					
Ningaui ridei	Wongai Ningaui	LC		X	X
Sminthopsis crassicaudata	Fat-tailed Dunnart	LC		X	X
Sminthopsis dolichura	Little long-tailed Dunnart	LC		X	X
Burramyidae Pygmy Possums					
Cercartetus concinnus	Western Pygmy-possum	LC			
Macropodidae Kangaroos, Wallabies					
Macropus fuliginosus	Western Grey Kangaroo	LC	X		X
Macropus robustus	Euro	LC			
Macropus rufus	Red Kangaroo	LC	X		X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Emballonuridae Sheath-tailed Bats					
Taphozous hilli	Hill's Sheathtail-bat	LC			X
Molossidae Freetail Bats					
Austronomus australis	White-striped Freetail-bat	LC		X	
Ozimops petersi	Inland Freetail-bat	LC			
Vespertilionidae Ordinary Bats					
Chalinolobus gouldii	Gould's Wattled Bat	LC		X	X
Chalinolobus morio	Chocolate Wattled Bat	LC		X	X
Nyctophilus geoffroyi	Lesser Long-eared Bat	LC			X
Nyctophilus major tor	Central Long-eared Bat	P4			
Scotorepens balstoni	Inland Broad-nosed Bat	LC		X	X
Vespadelus baverstocki	Inland Forest Bat	LC			X
Vespadelus regulus	Southern Forest Bat	LC		X	X

Class **Family** *Species*	Common Name	Conservation Status	Harewood 2012	WAM 1992	DEC 2012
Muridae Rats, Mice					
Mus musculus	House Mouse	Introduced		X	X
Notomys alexis	Spinifex Hopping-mouse	LC			
Notomys mitchellii	Mitchell's Hopping-mouse	LC		X	
Pseudomys bolami	Bolam's Mouse	LC			X
Pseudomys hermannsburgensis	Sandy Inland Mouse	LC		X	X
Canidae Dogs, Foxes					
Canis lupus dingo	Dingo	LC			
Felidae Cats					
Felis catus	Cat	Introduced			X
Bovidae Horned Ruminants					
Bos taurus	European Cattle	Introduced	X		X
Capra hircus	Goat	Introduced	X		X
Ovis aries	Sheep	Introduced			
Leporidae Rabbits, Hares					
Oryctolagus cuniculus	Rabbit	Introduced	X		X

Appendix G: Reconnaissance Flora and Basic Fauna Assessment (2022)

Kurnalpi North Project

Reconnaissance Flora and Basic Fauna Assessment

Prepared for Northern Star Ltd.



January 2022

Prepared by

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Cover Photo: Vegetation within Kurnalpi North Project survey area (30/11/2021)

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1 EXECUTIVE SUMMARY

Botanica Consulting Pty Ltd (Botanica) was commissioned by Northern Star Resources Ltd. to undertake a reconnaissance flora/ vegetation survey and basic fauna survey of Kurnalpi North Project area (referred to as the 'survey area'). This area consists of a polygon of approximately 1,096 ha, and a transport corridor of approximately 25 km length and 200 m width, resulting in an area of approximately 495 ha. The total extent of the survey area is approximately 1,591 ha. The survey area is located approximately 75 km north-east of Kalgoorlie, Western Australia. This assessment is intended to support a Native Vegetation Clearing Permit (NVCP) application and relevant mining approvals for the Kurnalpi North Project.

The survey area lies within the Eastern Goldfield (COO3) subregion of the Coolgardie Bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA).

The Eastern Goldfield subregion (5,102,428 ha) lies on the Yilgarn Craton's Eastern Goldfields Terrain, which is described as gently undulating plains with a subdued relief, interrupted in the west with low hills and ridges of Archaean greenstones and in the east by a horst of Proterozoic basic granulite. The underlying geology is of gneisses and granites eroded into a flat plane covered with tertiary soils and with scattered exposures of bedrock. Calcareous earths are the dominant soil group and cover much of the plains and greenstone areas. A series of large playa lakes in the western half are the remnants of an ancient major drainage line (Cowan 2001).

The vegetation consists of Mallees, Acacia thickets and shrub-heaths on sandplains, with diverse *Eucalyptus* woodlands occurring around salt lakes, on ranges, and in valleys. Salt lakes support dwarf shrublands of samphire. Woodlands and *Dodonaea* shrubland occur on basic granulite of the Fraser Range, and the area is rich in endemic Acacias.

In accordance with Beard (1990) the survey area is located in the Coolgardie Botanical District of the Southwestern Interzone Province. The landscape is described as gently undulating with occasional ranges of low hills, with sandplains in the western part and some large playa lakes. Soils are principally brown calcareous earths, which overlays the Proterozoic granite and gneiss of the Fraser Range block and Archaean granite, with infolded volcanics and meta-sediments, of the Yilgarn block. Vegetation is predominately *Eucalyptus* woodlands, with slopes and flats containing *E. longicornis* alongside *E. salubris* and *E. salmonophloia*. Woodland understories range from tall sclerophyll shrubland dominated by *Melaleuca pauperiflora* to soft-leaved saltbush shrubland of *Atriplex vesicaria* and *A. nummularia*. Some hill slopes contain mallees of *E. livida* or *E. loxophleba*, while ironstone ridges are covered in thickets of *Acacia quadrimarginea*, *Allocasuarina acutivalvis* and *A. campestris*. Other vegetation assemblages include species-rich scrub-heaths and *Allocasuarina* thickets on sandplains, merging into *Acacia* thickets and Kwongan vegetation to the north.

The dominant land uses of the Eastern Goldfield subregion includes Unallocated Crown Land (UCL) and Crown reserves and pastoral grazing, with conservation areas and mining leases also present (Cowan, 2001). The survey area is located within the Hampton Hill pastoral lease.

Prior to the field assessment a literature review was undertaken of previous flora and fauna assessments conducted within the local region. Documents reviewed included:

- Botanica Consulting Pty Ltd. (2018). *Reconnaissance Flora & Fauna Survey Kurnalpi Project.* Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., June 2018.
- Botanica Consulting Pty Ltd. (2013). *Level 2 Flora & Vegetation Survey for the Arcoona Haul Road*. Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., January 2013.
- Botanica Consulting Pty Ltd. (2012). *Kalpini Haul Road Level 1 Flora & Vegetation Survey*. Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., June 2018.
- Botanica Consulting Pty Ltd. (2011). *Level 2 Flora and Vegetation Survey of the Kurnalpi Project.* Unpublished report prepared on behalf of Carrick Gold Resources Ltd., 2011.

In addition to the literature review, searches of the following databases were undertaken to aid in the compilation of a list of significant flora within the survey area:

- DBCA Threatened/ Priority Flora spatial data (DBCA, 2019a);
- DBCA NatureMap database (DBCA, 2021b); and
- EPBC Protected Matters search tool (DAWE, 2021a).

The NatureMap species search and EPBC Protected Matters search were conducted with a 40 km buffer from the survey area.

The NatureMap desktop search identified 198 vascular flora species as occurring within 40 km of the survey area, representing 97 genera from 35 families. The most diverse families were Asteraceae (31 species), Myrtaceae (29 species) and Fabaceae (25 species). The most dominant genera were *Acacia* (16 species), *Eucalyptus* (15 species) and *Eremophila* (13 species). This total includes 19 introduced (weed) species (3.0%).

No potential Declared Pest species or Weeds of National Significance were identified.

The assessment of the DBCA Priority/ Threatened flora database records (DBCA, 2019), NatureMap (DBCA, 2020) and Protected Matters searches (DAWE, 2020a) and previous relevant literature identified 10 significant flora species recorded within a 40 km radius of the survey area. These consist of one Threatened, three Priority 1, four Priority 2 and two Priority 3 taxa.

These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment identified one Priority species, *Austrostipa blackii* (P3), as previously recorded within the survey area. In addition, three taxa were identified as possibly occurring in the survey area; consisting of one Priority 1, one Priority 2 and one Priority 3 taxa.

The Protected Matters search (DAWE, 2020a) did not identify any Threatened Ecological Communities recorded within 40 km of the survey area. Analysis of the Priority Ecological Communities within the Goldfields region (DBCA, 2017) did not identify any significant vegetation assemblages as likely or possibly occurring within the survey area.

The Barlee 20 vegetation association retains >99% of its pre-European extent.

According to the results of the NatureMap search (DBCA, 2021b), a total of 131 terrestrial vertebrate fauna taxa have been recorded within 40 km of the survey area, consisting of 69 bird, 20 mammal, 40 reptile and two amphibian taxa. This total includes five introduced (feral) species (3.8%).

The desktop review identified eight terrestrial vertebrate fauna species of conservation significance as previously being recorded in the regional area, consisting of four Threatened, one Priority 4 and three migratory or otherwise protected species. In addition, six migratory wading/shorebird species were assessed collectively due to their similar habitat requirements.

Habitat and distribution data was used to determine the likelihood of occurrence within the survey area. The assessment identified three significant fauna species as potentially occurring in the survey area, consisting of two Vulnerable and one Specially Protected taxa.

There are no proposed or gazetted conservation reserves, Environmentally Sensitive Areas or wetlands of international importance (Ramsar Wetlands) or national importance (Australian Nature Conservation Agency Wetlands) within the survey area.

The closest significant environmental feature is the Bullock Holes Timber Reserve, which is DBCA-managed land located approximately 35 km west of the survey area. Disturbances within the survey area are unlikely to impact this Reserve.

Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey on the 30th November 2021. The survey area was traversed on foot and with 4WD by Jim Williams (Director/Principal Botanist, Diploma of Horticulture) and Jennifer Jackson (Senior Botanist, BSc (Honours) Environmental Management).

The field survey identified 145 vascular flora taxa within the survey area. These taxa represented 71 genera across 29 families, with the most diverse families being Myrtaceae and Fabaceae (23 species each), followed Scrophulariaceae (16 species). Dominant genera include *Eucalyptus* (16 species) and *Eremophila* and *Acacia* (15 species each). No introduced (weed) species were recorded.

No Threatened, Priority or otherwise significant flora species were recorded within the survey area. One record of a Priority 3 flora species, *Austrostipa blackii* was previously recorded within the survey area by Botanica during a Level 2 survey conducted in 2011, however this taxon was not observed during the current survey, despite a focused search within areas of suitable habitat. The location of the previous record was observed as heavily grazed.

A total of ten broad-scale vegetation communities were identified within the survey area. Vegetation community descriptions and extents were determined from field survey results, aerial imagery interpretation and extrapolation of the communities.

The survey found CLP-MW1 was the most widespread community in the survey area, occupying 549 ha (34.5%), while OD-MW1 was the most restricted with 10 ha (0.6%). The most diverse vegetation community was SLP-MW1 with 60 species (41.4%), while the least diverse was CLP-EW1, with 25 species (17.2%).

No Threatened or Priority Ecological Communities or otherwise significant vegetation were identified within the survey area.

Based on vegetation and associated landforms identified during the flora and vegetation assessment, seven broad scale terrestrial fauna habitats were identified as occurring within the survey area.

One inactive Malleefowl mound was recorded within the survey area. The mound appears to be in good condition and is likely to have been used within the last five years. No other evidence of significant fauna species were observed during the survey.

Native vegetation condition within the survey area was categorised as ‘good’. Disturbances within the survey area include vegetation clearing, access roads and cumulative historical impacts.

The assessment found that the proposed vegetation clearing activities may be at variance with clearing principle (f).

2 INTRODUCTION

Botanica Consulting Pty Ltd (Botanica) was commissioned by Northern Star Resources Ltd. to undertake a reconnaissance flora/ vegetation survey and basic fauna survey of Kurnalpi North Project area (referred to as the 'survey area'). This area consists of a polygon of approximately 1,096 ha, and a transport corridor of approximately 25 km length and 200 m width, resulting in an area of approximately 495 ha. The total extent of the survey area is approximately 1,591 ha (Figure 2-1). The survey area is located approximately 75 km north-east of Kalgoorlie, Western Australia. This assessment is intended to support a Native Vegetation Clearing Permit (NVCP) application and relevant mining approvals for the Kurnalpi North Project.

2.1 Objectives

The flora assessment was conducted in accordance with the requirements of a reconnaissance flora survey as defined in *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment – December 2016* (EPA, 2016a). The objectives of the assessment were to:

- gather background information on flora and vegetation in the target area (literature review, database and map-based searches);
- identify significant flora, vegetation and ecological communities and assess the potential sensitivity to impact;
- conduct a field survey to verify / ground truth the desktop assessment findings;
- undertake floristic community mapping to a scale appropriate for the bioregion and described according to the National Vegetation Information System (NVIS) structure and floristics;
- undertake vegetation condition mapping;
- assess the project area's plant species diversity, density, composition, structure and weed cover, using NVIS classification system for vegetation description;
- assess Matters of National Environmental Significance (MNES) and indicate whether potential impacts on MNES as protected under the EPBC Act are likely to require referral of the project to the Commonwealth DAWE; and
- determine the State legislative context of environmental aspects required for the assessment.

The fauna assessment was conducted in accordance with the requirements of a basic terrestrial fauna survey as defined in *Technical Guidance - Terrestrial Fauna Surveys for Environmental Impact Assessment – June 2020* (EPA, 2020). The objectives of the assessment were to:

- Undertake a literature review, including map-based information searches of all current and relevant literature sources and databases relating to the survey area;
- Undertake a desktop investigation to identify any previously recorded occurrences of or potentially occurring Threatened and Priority listed fauna within the survey area;
- Undertake searches on available databases for details relating to any Threatened and Priority listed fauna previously identified as occurring or potentially occurring within the survey area;
- Conduct fauna habitat mapping and identify habitat types which are suitable for each significant fauna considered likely or possible to occur, or fauna recorded in the survey area;
- Compile an inventory of fauna species occurrences within the survey area;
- Undertake opportunistic, low intensity sampling of fauna; and
- Report on the conservation status of species present using the Western Australian Museum and *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) databases for presence of Threatened and Priority listed fauna species within the survey area.



Figure 2-1: Regional map of the desktop survey area/ survey area

3 BIOPHYSICAL ENVIRONMENT

3.1 Regional Environment

The study area lies within the Eastern Murchison (MUR1) subregion of the Murchison Bioregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA).

The Eastern Murchison comprises the northern parts of the craton's Southern Cross and Eastern Goldfields Terrains and is characterised by internal drainage and extensive areas of elevated red desert sandplains with minimal dune development. Salt Lake systems are associated with the occluded paleodrainage system. Broad plains of red-brown soils and breakaways complexes as well as red sandplains are widespread. Vegetation is dominated by Mulga woodlands and is often rich in ephemerals, hummock grasslands, saltbush shrublands and *Tecticornia* shrublands (Cowan, 2001).

In accordance with Beard (1990), the Murchison region is located in the Austin Botanical District within the Eremaean Province of WA. It is defined by the vegetational expression of geological boundaries of the Yilgarn Block, described as Archaean granite with infolded volcanics and meta-sediments (greenstones) of a like age. The topography is undulating, with occasional ranges of low hills and extensive sandplains in the eastern half. The principal soil type is shallow earthy loam overlying red-brown hardpan, with shallow stony loams on hills and red earthy sands on sandplains. The western half of the region more or less coincides with the basin of the Murchison River, the eastern half embraces the drainage of former rivers, now dry, draining towards the Eucla Basin. Vegetation is predominantly mulga low woodland *(Acacia aneura)* on plains, reduced to scrub on hills, with a tree steppe of *Eucalyptus* spp. and *Triodia basedowii* on sandplains. The climate is arid, with summer and winter rains and an average annual precipitation of 200 mm.

3.2 Land Use

The dominant land uses of the Eastern Murchison subregion include grazing native pastures (85.47%), unallocated crown reserves (11.34%), conservation (1.4%) and mining (1.79%) (Cowan, 2001). The survey area is located within the Hampton Hill pastoral lease.

3.3 Soil Landscape Systems

The survey area lies within the Kalgoorlie Province, located in the southern Goldfields between Paynes Find, Menzies, Southern Cross and Balladonia. The landscape consists of undulating plains (with some sandplains, hills and salt lakes) on the granitic rocks and greenstone of the Yilgarn Craton. Soils range from calcareous loamy earths and red loamy earths with some salt lake soils to red deep sands, yellow sandy earths, shallow loams and loamy duplexes. Vegetation communities are predominately Eucalypt woodlands with some acacia-casuarina thickets, mulga shrublands, halophytic shrublands and spinifex grasslands.

The Kalgoorlie Province is further divided into six soil-landscape zones, with the survey area located in the Kambalda (265) and Norseman (266) Zones.

The Kambalda Zone is located in the south-eastern Goldfields between Menzies, Norseman and the Fraser Range and contains flat to undulating plains (with hills, ranges and some salt lakes and stony plains) on greenstone and granitic rocks of the Yilgarn Craton. Soils consist of calcareous loamy earths and red loamy earths with salt lakes soils and some redbrown hardpan shallow loams and red sandy duplexes. Vegetation includes red mallee, blackbutt-salmon gum-gimlet woodlands with mulga and halophytic shrublands (and some spinifex grasslands).

The Norseman Zone is located in the southern Goldfields between Koolyanobbing, Menzies, Zanthus (Trans-Australian Railway), Norseman and Lake Hope and is characterised by undulating plains and uplands (with some sandplains and salt lakes) on granitic rocks of the Yilgarn Craton. Soil types include calcareous loamy earths, yellow sandy and loamy earths, red loamy earths, red deep sands and salt lake soils. Vegetation consists of salmon gum-redwood-merrit-red mallee-gimlet woodland with acacia/ casuarina thickets (and some mulga shrublands and spinifex grasslands).

The soil landscape zones are further divided into soil landscape systems, with the survey areas located within seven landscape systems, as described in Table 3-1 and shown in Figure 2-1, in accordance with soil landscape system mapping data (Government of Western Australia, 2019).

Table 3-1: Soil landscape systems within the survey area

Soil Landscape System	Description	Extent within Survey Area
Campsite System	Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.	448 ha (28.2%)
Gundockerta System	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.	224 ha (14.1%)
Kirgella System	Gently undulating sandplains, with scattered granite outcrop supporting spinifex hummock grasslands, mulga shrublands and mallees.	211 ha (13.3%)
Leonora System	Low greenstone hills and stony plains supporting mixed chenopod shrublands.	344 ha (21.6%)
Moriarty System	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.	47 ha (3.0%)
Waguin System	Sandplains and stripped granite or laterite surfaces with low fringing breakaways and lower plains; supports bowgada and mulga shrublands with wanderrie grasses and minor halophytic shrublands.	12 ha (0.8%)
Yowie System	Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.	305 ha (19.2%)

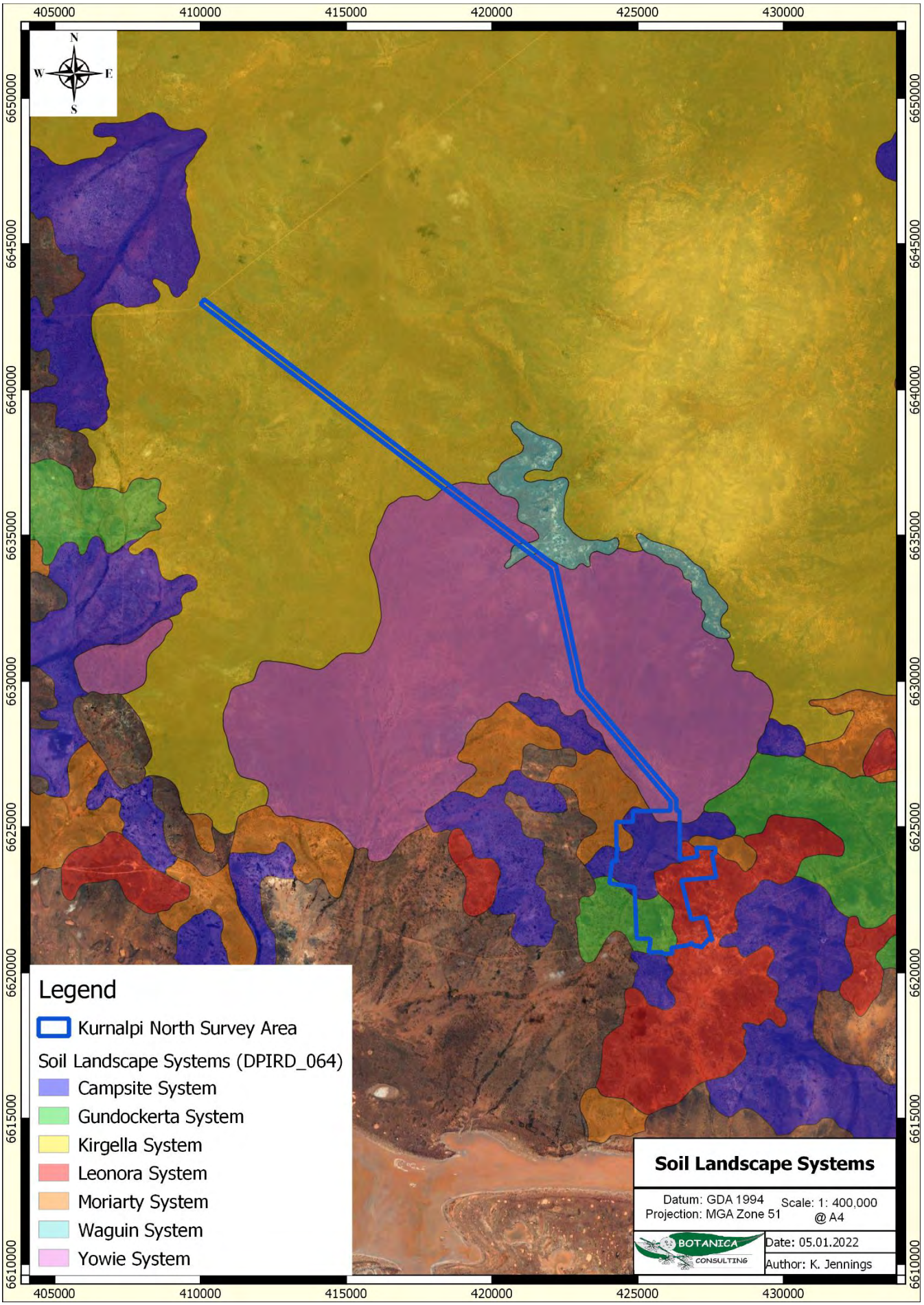


Figure 3-1: Map of soil landscape systems within the survey area

3.4 Regional Vegetation

In accordance with Tille (2006), the vegetation of the Kambalda Zone is typified by the preponderance of stony plains with acacia shrublands and halophytic shrublands, low hills with eucalypt or acacia woodlands with halophytic undershrubs, stony plains with acacia shrublands and alluvial plains with eucalypt woodlands and halophytic undershrubs rangeland. Vegetation in the Norseman Zone differentiates from the Kambalda Zone due to the 'preponderance of the *sandplains and occasional dunes with spinifex grasslands'* rangeland land type'.

More broadly, the vegetation of the Kalgoorlie Province is described by Tille (2006) as woodlands of redwood (*Eucalyptus transcontinentalis*), red mallee (*E. oleosa*), Dundas blackbutt (*E. dundasii*), merrit (*E. flocktoniae*) and salmon gum (*E. salmonophloia*), found on undulating plains over granite. There are also some hummock grasslands with red mallee over spinifex (*Triodia scariosa*) and thickets of Acacia, Casuarina and Melaleuca spp. Plains on greenstone have woodlands of York gum (*E. loxophleba*), salmon gum and gimlet (*E. salubris*). The valley plains have woodlands of salmon gum, red mallee, Goldfields blackbutt (*E. lesouefii*), gimlet, York gum and morrel (*E. longicornis*). These sometimes have an understorey of saltbush (Atriplex spp.), pearl bluebush (*Maireana sedifolia*), sago bluebush (*M. pyramidata*) and *Eremophila* spp. There are areas of spinifex grasslands with red mallee, mallees (e.g. *E. youngiana*) and marble gum (*E. gongylocarpa*). Low woodlands of mulga (Acacia aneura) and black sheoak (*Casuarina pauper*) over bluebush and saltbush are also present. Apart from the bare salt lake surfaces, saline valley floors have shrublands of samphire (*Tecticornia* spp.) and *Frankenia* spp. in lower areas, shrublands of saltbush and bluebush on red deep sandy duplexes, and woodlands of salmon gum, merrit, red mallee, gimlet and York gum. *Acacia neurophylla*, *A. beauverdiana* and *A. resinimarginea* thickets grow on gently sloping uplands on granite, with thickets of acacia, casuarina and melaleuca. There are also scrub-heaths and York gum-salmon gum-gimlet woodlands on these uplands. The hilly terrain on greenstone supports woodlands of salmon gum, Goldfields blackbutt, coral gum (*E. torquata*), York gum, gimlet, morrel, Dundas blackbutt and black sheoak. Thickets of granite wattle (*Acacia quadrimarginea*) are also present. The stony plains support scattered woodlands of Goldfields blackbutt, gimlet and salmon gum, along with shrublands of saltbush and bluebush. Sandplains in the west have acacia (*A. coolgardiensis*, *A. ramulosa*, *A. aneura*, *A. burkittii* and *A. tetragonophylla*) shrublands, commonly with patchy native pine (*Callitris glaucophylla, C. preissii*) and mallees (*E. leptopoda*, *E. longicornis* and *E. loxophleba*). Native box (*Bursaria occidentalis*), *Melaleuca uncinata* and *Hakea recurva* may also be present. Hard spinifex (*T. basedowii*) grasslands with mulga, marble gum and mallees (e.g. *E. kingsmillii*) are found on sandplains to the east. The sandy-surfaced plains support acacia, casuarina and melaleuca thickets; woodlands of York gum, cypress pine (*Callitris columellaris*), salmon gum, gimlet and mulga; and shrublands of bowgada (*A. ramulosa*).

3.5 Conservation Values

The Eastern Goldfield subregion contains 16 vegetation associations, predominately open *Eucalyptus* woodlands, that have at least 85 per cent of their total extent in the bioregion (Cowan 2001) The subregion is considered a centre of endemism for Eucalypts in the Goldfields Woodlands region, and is also noted for the diversity of *Acacia* spp. and ephemeral flora communities of the tertiary sandplain shrublands and the valley floors of woodland areas.

The subregion contains one wetland of national importance: Rowles Lagoon System, located approximately 130 km west of the survey area. In addition, there are seven wetlands of subregional importance (Cowan, 2001). Other significant assemblages in the region include plant assemblages of the Fraser Range and the Woodline Hills.

No ecosystems are listed as threatened under WA State legislation occur within the subregion, but 18 communities and vegetation associations are thought to be at risk for a variety of reasons. Grazing from livestock, goats and rabbits and impacts from mining are the main threatening processes in the region, with changed fire regimes, erosion and sedimentation also causing significant impacts.

3.6 Climate

The climate of the Eastern Goldfield subregion is characterised as arid to semi-arid with 200-300 mm of rainfall, sometimes in summer but usually in winter (Cowan 2001). Rainfall data for the Kalgoorlie-Boulder Airport (#12038) weather station, located approximately 75 km south-west of the survey area, is shown in Figure 3-2. Mean monthly rainfall ranges from 31.6.5 mm in February to 13.5 mm in September, with a mean annual rainfall of 264.9 mm. The survey was conducted in November 2021, with the preceding month (October) being characterised by above-average rainfall, following below-average rainfall during August-September. Due to the significant October rainfall, flowering material and ephemeral species are expected to be present, and climate conditions are unlikely to represent a survey constraint.

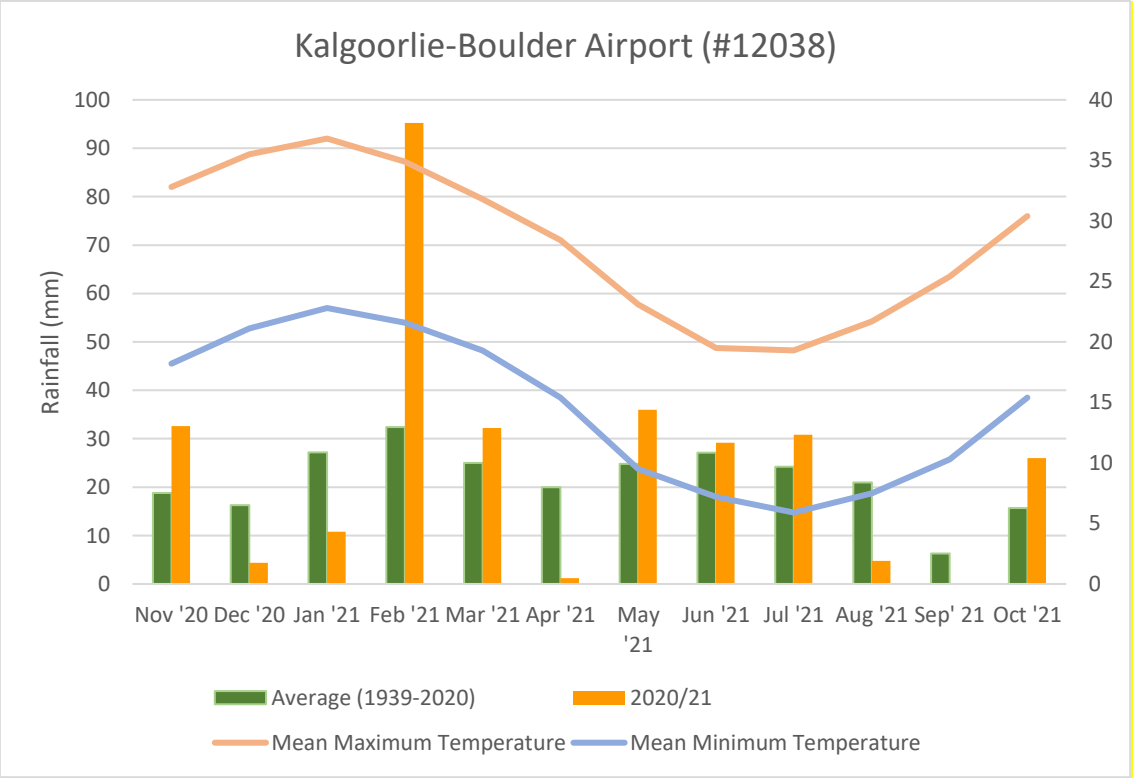


Figure 3-2: Climate data for Kalgoorlie-Boulder Airport (BoM, 2021a)

3.7 Hydrology

According to the Geoscience Australia database (2015), there are no permanent or ephemeral inland waters within the survey area. There are multiple minor ephemeral drainage lines that intersect the survey area (Figure 3-3).

Groundwater Dependent Ecosystems (GDE) includes biological assemblages of species such as wetlands or woodlands that use groundwater either opportunistically or as their primary water source. For the purposes of this report, a GDE is defined as any vegetation community that derives part of its water budget from groundwater and must be assumed to have some degree of groundwater dependency. In accordance with the BoM *Atlas of Groundwater Dependent Ecosystems* (BoM, 2020b) database, there are two moderate-potential and five low-potential terrestrial GDE's within the survey area. These are described in Table 3-2 and their extent shown in Figure 3-3.

There are no potential aquatic GDE's within the survey area.

Table 3-2: Potential GDE's within the survey area

Geomorphology	Potential	Vegetation Description	Area (ha)	Area (%)
Undulating plains with some sandplains, ferruginous breakaways; ridges of metamorphic rocks and granitic hills and rises; calcretes, large salt lakes and dunes along valleys.	Moderate	Alluvial plains, supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.	448	28.2
		Sandplains and stripped granite or laterite surfaces with low fringing breakaways and lower plains; supports bowgada and mulga shrublands with wanderrie grasses.	12	0.8
	Low	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.	47	3.0
		Extensive sandplain, with scattered granite outcrop supporting mainly spinifex hummock grasslands and mulga and mallee shrublands.	211	13.3
		Low greenstone hills and stony plains supporting mixed stony chenopod shrublands.	344	21.6
		Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.	224	14.1
		Sandy plains supporting shrublands of mulga and bowgada with patchy wanderrie grasses.	305	19.2

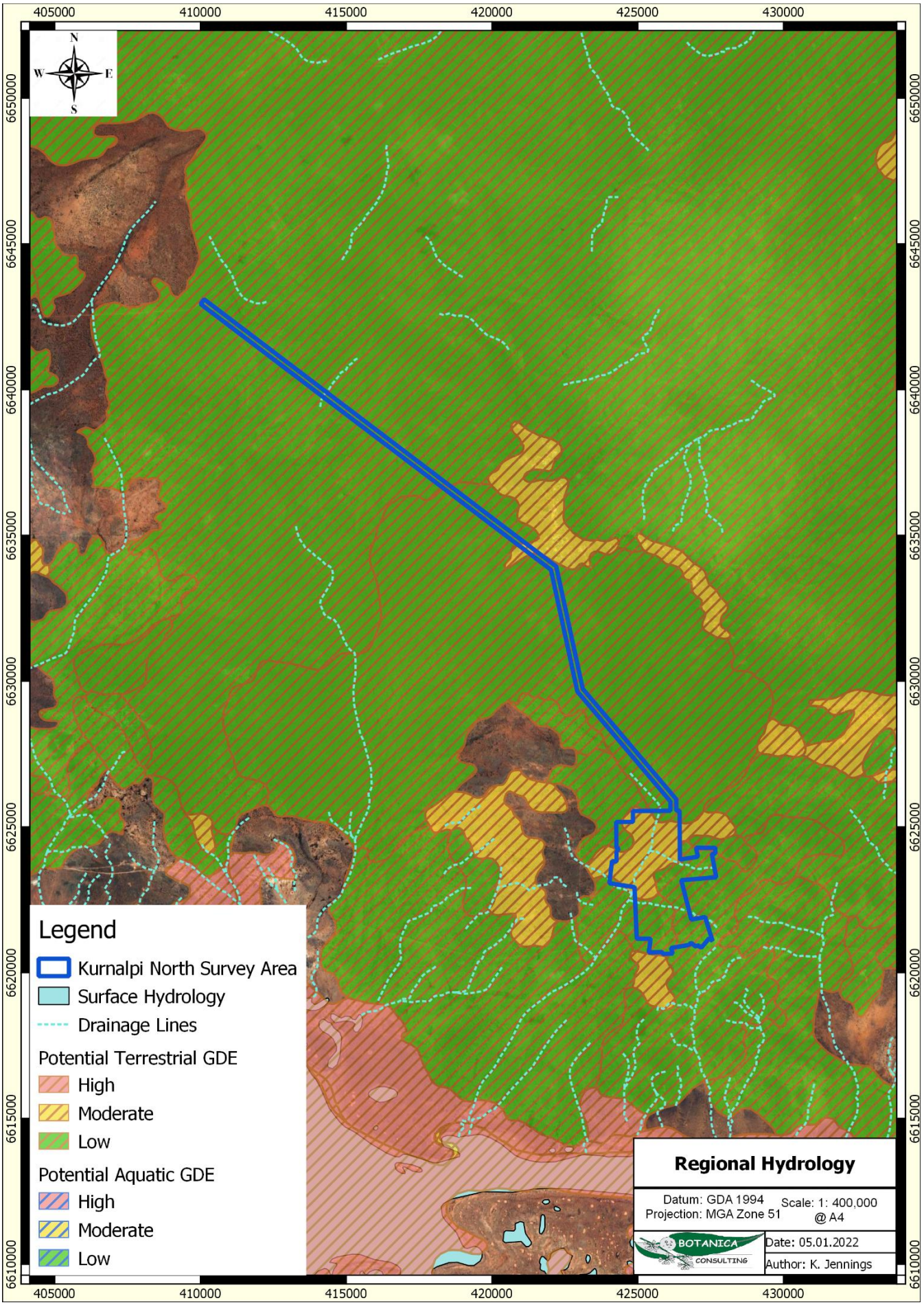


Figure 3-3: Regional hydrology of the survey area

4 SURVEY METHODOLOGY

4.1 Desktop Assessment

Prior to the field assessment a literature review was undertaken of previous flora and fauna assessments conducted within the local region. Documents reviewed included:

- Botanica Consulting Pty Ltd. (2018). *Reconnaissance Flora & Fauna Survey Kurnalpi Project.* Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., June 2018.
- Botanica Consulting Pty Ltd. (2013). *Level 2 Flora & Vegetation Survey for the Arcoona Haul Road*. Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., January 2013.
- Botanica Consulting Pty Ltd. (2012). *Kalpini Haul Road Level 1 Flora & Vegetation Survey*. Unpublished report prepared on behalf of KalNorth Gold Mines Ltd., June 2018.
- Botanica Consulting Pty Ltd. (2011). *Level 2 Flora and Vegetation Survey of the Kurnalpi Project.* Unpublished report prepared on behalf of Carrick Gold Resources Ltd., 2011.

In addition to the literature review, searches of the following databases were undertaken to aid in the compilation of a list of significant flora within the survey area:

- DBCA Threatened/ Priority Flora spatial data (DBCA, 2019a);
- DBCA NatureMap database (DBCA, 2021b); and
- EPBC Protected Matters search tool (DAWE, 2021a).

The NatureMap species search and EPBC Protected Matters search were conducted with a 40 km buffer from the survey area.

Significant flora species identified by the desktop review were assessed with regards to their population extent and distribution and preferred habitat to determine their likelihood of occurrence within the survey area.

The assessment categorised flora species as follows:

- Unlikely- Suitable habitat is not expected to occur and/or the survey area is outside the known range of the species.
- Possible- Suitable habitat may be present, and the area is within the known range of the species. This option is also used when there is insufficient information to determine the preferred habitat of a species.
- Likely- Suitable habitat is expected to occur and there are records within 10 km of the survey area.
- Previously Recorded- A record for this species is located within the survey area. Field survey will ground-truth currently occurring individuals and populations.

It should be noted that these lists are based on observations from a broader area than the assessment area (40 km radius) and therefore may include taxa not present. The databases also often include very old records that may be incorrect or in some cases the taxa in question have become locally or regionally extinct. Information from these sources should therefore be taken as indicative only and local knowledge and information also needs to be taken into consideration when determining what actual species may be present within the specific area being investigated.

The conservation significance of flora taxa was assessed using data from the following sources:

- *Environment Protection and Biodiversity and Conservation* (EPBC) *Act 1999*. Administered by the Australian Government (DAWE);
- *Biodiversity Conservation* (BC) *Act 2016*. Administered by the WA Government (DBCA);
- Red List produced by the Species Survival Commission (SSC) of the World Conservation Union (also known as the IUCN Red List – the acronym derived from its former name of the International Union for Conservation of Nature and Natural Resources). The Red List has no legislative power in Australia but is used as a framework for State and Commonwealth categories and criteria; and
- Priority Flora list. A non-legislative list maintained by DBCA for management purposes (released December 2018).

Descriptions of conservation significant species and communities are provided in Appendix A.

4.2 Flora and Vegetation Field Assessment

Botanica conducted a reconnaissance flora/ vegetation and basic fauna survey on the 30th November 2021. The survey area was traversed on foot and with 4WD by Jim Williams (Director/Principal Botanist, Diploma of Horticulture) and Jennifer Jackson (Senior Botanist, BSc (Honours) Environmental Management). A GPS track log of the survey effort is shown below in Figure 4-1.



Figure 4-1: GPS track log of the survey effort

4.2.1 Flora Assessment

Prior to the commencement of field work, aerial photography was inspected and obvious differences in the vegetation assemblages were identified. The different vegetation communities identified were then inspected during the field survey to assess their validity. A handheld GPS unit was used to record the coordinates of the boundaries between existing vegetation communities. At each sample point, the following information was recorded:

- GPS location;
- Photograph of vegetation;
- Dominant taxa for each stratum;
- All vascular taxa (including annual taxa);
- Landform classification;
- Vegetation condition rating;
- Collection and documentation of unknown plant specimens; and
- GPS location, photograph and collection of flora of conservation significance if encountered.

Unknown specimens collected during the survey were identified with the aid of samples housed at the Botanica Herbarium and Western Australian Herbarium. Vegetation was classified in accordance with NVIS classifications.

4.3 Data Analysis Tools

Following field assessments, vegetation types and condition were mapped using the GIS program QGIS, and the hectare area/ percentage area of each vegetation type and condition within the survey area was calculated. Spatial maps illustrating the location of vegetation types and any significant flora/ vegetation and fauna were generated using QGIS.

4.4 Terrestrial Fauna Field Assessment

Fauna habitat types were identified across the survey area based on broad major vegetation groups and associated landform. A handheld GPS unit was used to record the coordinates of the boundaries between fauna habitats and each habitat was photographed.

The main aim of the fauna habitat assessment was to determine the likelihood of a species of conservation significance utilising habitat within the survey area. The habitat information obtained was also used to aid in finalising the overall potential fauna list.

Available information on the habitat requirements of the species of conservation significance listed as possibly occurring in the area (determined from the desktop assessment) was researched. During the field survey, the habitats within the survey area were assessed and specific elements identified, if present, to determine the likelihood of listed Threatened and Priority species utilising habitat within the survey area.

Opportunistic observations of fauna species were made during all field survey work.

Fauna of conservation significance identified during the literature review and database searches as previously being recorded in the general area were assessed and ranked for their likelihood of occurrence within the survey area.

The rankings and criteria used were:

- Would Not Occur: There is no suitable habitat for the species in the survey area and/or there is no documented record of the species in the general area since records have been kept and/or the species is generally accepted as being locally/regionally extinct (supported by a lack of recent records).

- Locally Extinct: Populations no longer occur within a small part of the species natural range, in this case within 10 or 20 km of the survey area. Populations do however persist outside of this area.

- Regionally Extinct: Populations no longer occur in a large part of the species natural range, in this case within the Goldfields region. Populations do however persist outside of this area.

- Unlikely to Occur: The survey area is outside of the currently documented distribution for the species in question, or no suitable habitat (type, quality and extent) was identified as being present during the field assessment. Individuals of some species may occur occasionally as vagrants/transients especially if suitable habitat is located nearby but the site itself would not support a population or part population of the species.

- Possibly Occurs: Survey area is within the known distribution of the species in question and habitat of at least marginal quality was identified as likely to be present during the field survey and literature review, supported in some cases by recent records being documented in literature from within or near the survey area. In some cases, while a species may be classified as possibly being present at times, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

- Known to Occur: The species in question has been positively identified as being present (for sedentary species) or as using the survey area as habitat for some other purpose (for non-sedentary/mobile species) during field surveys within or near the survey area. This information may have been obtained by direct observation of individuals or by way of secondary evidence (e.g. tracks, foraging debris, scats). In some cases, while a species may be classified as known to occur, habitat may be marginal (e.g. poor quality, fragmented, limited in extent) and therefore the frequency of occurrence and/or population levels may be low.

4.5 Scientific Licences

Table 4-1: Scientific Licenses of Botanica Staff coordinating the survey

Licensed Staff	Permit Number	Date of Expiry
Jim Williams	FB62000108 (licence to take flora for scientific purposes)	27/05/2022
Jennifer Jackson	FB62000309 (Licence to take flora for scientific purposes)	11/01/2024

4.6 Survey Limitations and Constraints

It is important to note that flora surveys will entail limitations notwithstanding careful planning and design. Potential limitations are listed in Table 4-2.

The conclusions presented in this report are based upon field data and environmental assessments and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. Also, it should be recognised that site conditions can change with time. Information not available at the time of this assessment which may subsequently become available may alter the conclusions presented.

Some species are reported as potentially occurring based on there being suitable habitat (quality and extent) within the survey area or immediately adjacent. The habitat requirements and ecology of many of the species known to occur in the wider area are however often not well understood or documented. It can therefore be difficult to exclude species from the potential list based on a lack of a specific habitats or microhabitats within the survey area. As a consequence of this limitation, the potential species list produced is most likely an overestimation of those species that actually utilise the survey area for some purpose.

In recognition of survey limitations, a precautionary approach has been adopted for this assessment. Any flora species that would possibly occur within the survey area (or immediately adjacent), as identified through ecological databases, publications, discussions with local experts/residents and the habitat knowledge of the author, has been listed as having the potential to occur.

Table 4-2: Limitations and constraints associated with the flora/ vegetation and fauna survey

Variable	Potential Impact on Survey	Details
Access problems	Not a constraint	The survey was conducted via 4WD and on foot. Numerous access tracks were present within the survey area providing ease of access.
Competency/ Experience	Not a constraint	The Botanica personnel that conducted the survey were regarded as suitably qualified and experienced. **Coordinating Staff**: Jim Williams (Botanist) **Data Interpretation**: Jim Williams (Botanist), and Kelby Jennings (Senior Environmental Consultant).
Timing of survey, weather & season	Not a constraint	Fieldwork was undertaken within the EPA's recommended survey period (September - November) for the South-West and Interzone Province. Flowering material and ephemeral species were present within the survey area
Area disturbance	Not a constraint	Although some areas are impacted by mining, exploration activity and grazing, the majority of native vegetation was intact and in good condition.
Survey Effort/ Extent	Not a constraint	Survey intensity was appropriate for the size/significance of the area with a reconnaissance flora survey and basic fauna survey completed to identify vegetation types/ fauna habitats and significant flora, fauna and vegetation.
Availability of contextual information at a regional and local scale	Not a constraint	Conservation significant flora database searches provided by the DBCA were used to identify any potential locations of Threatened/Priority flora species. BoM, DWER, DPIRD, DBCA and DAWE databases were reviewed to obtain appropriate regional desktop information on the biophysical environment of the local region. Botanica has conducted a number of surveys within Coolgardie and Murchison Bioregions and was also able to obtain information about the area from previous research conducted within the area. Results of previous assessments in the local area were reviewed to provide context on the local environment.
Completeness	Not a constraint	In the opinion of Botanica, the survey area was covered sufficiently in order to identify vegetation assemblages. All observed flora individuals were able to be identified to species level. Fieldwork was undertaken within the EPA's recommended survey period (September - November) for the South-West and Interzone Province. The vegetation associations for this study were based on visual descriptions of locations in the field. The distribution of these vegetation associations outside the survey area is not known, however vegetation associations identified were categorised via comparison to vegetation distributions throughout WA given on NVIS (DotEE, 2017).

5 RESULTS

5.1 Desktop Assessment

5.1.1 Flora

The NatureMap desktop search identified 198 vascular flora species as occurring within 40 km of the survey area, representing 97 genera from 35 families. The most diverse families were Asteraceae (31 species), Myrtaceae (29 species) and Fabaceae (25 species). The most dominant genera were *Acacia* (16 species), *Eucalyptus* (15 species) and *Eremophila* (13 species). This total includes 19 introduced (weed) species (3.0%).

5.1.1.1 Introduced Flora

The desktop review identified eight introduced flora (weed) species, representing six families, as potentially occurring in the vicinity of the survey area. None of these are listed as a Declared Pest on the Western Australian Organism List (WAOL) under the *Biosecurity and Agriculture Management* (BAM) *Act 2007*, or as a Weed of National Significance. The full list of potential weed species is contained in Appendix B.

5.1.1.2 Significant Flora

The assessment of the DBCA Priority/ Threatened flora database records (DBCA, 2019), NatureMap (DBCA, 2020) and Protected Matters searches (DAWE, 2020a) and previous relevant literature identified 10 significant flora species recorded within a 40 km radius of the survey area. These consist of one Threatened, three Priority 1, four Priority 2 and two Priority 3 taxa (Appendix C).

These taxa were assessed for distribution and known habitat to determine their likelihood of occurrence within the survey area. The assessment did not identify and taxa as likely to occur within the survey area. The assessment identified one Priority species, *Austrostipa blackii* (P3), as previously recorded within the survey area. In addition, three taxa were identified as possibly occurring in the survey area; consisting of one Priority 1, one Priority 2 and one Priority 3 taxa. The full flora likelihood assessment is listed in Appendix C. The locations of the DBCA database records are illustrated spatially in Figure 5-1.

Table 5-1: Significant flora potentially occurring within the survey area

Status	Taxon	Habitat	Comments	Likelihood
P1	*Ptilotus procumbens*	Red clay.	At extreme of known range, habitat may be present	Possible
P2	*Thryptomene eremaea*	Red or yellow sand. Sandplains.	Within known range, habitat may be present	Possible
P3	*Micromyrtus serrulata*	Brownish sandy and clayey soils over granite.	Within known range, habitat may be present	Possible
P3	*Austrostipa blackii*	-	Previously recorded in survey area (Botanica, 2011)	Previously Recorded

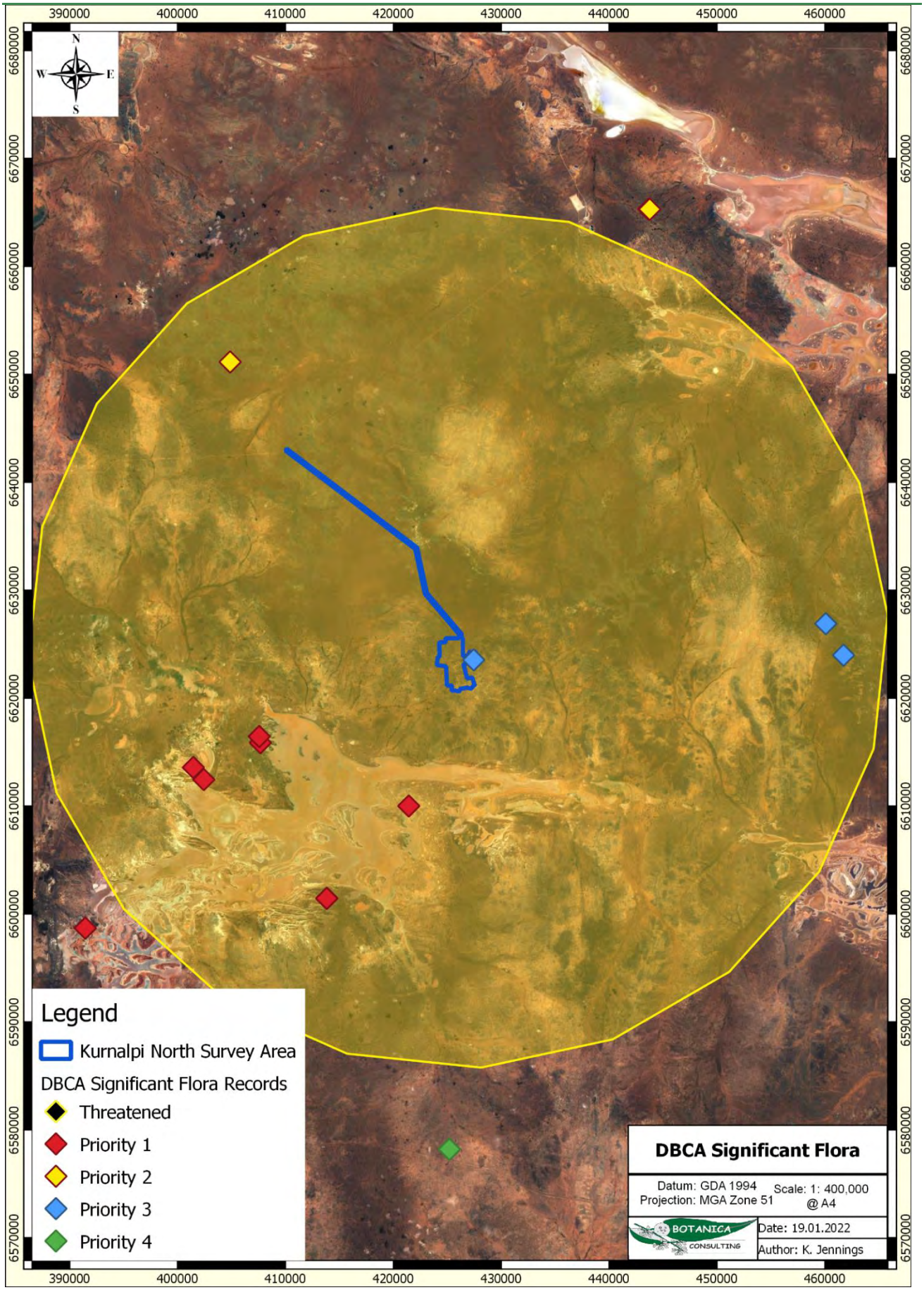


Figure 5-1: Significant flora within the desktop search area

5.1.2 Vegetation and Ecological Communities

5.1.2.1 Vegetation Associations

The Pre-European vegetation association spatial mapping dataset (DPIRD, 2018) identified the Barlee 20 vegetation association as occurring within the survey area (Figure 5-2). The association description and its remaining extent, as specified in the 2018 Statewide Vegetation Statistics (DBCA, 2019b) are provided in Table 5-2. Areas retaining less than 30% of their pre-European vegetation extent generally experience exponentially accelerated species loss, while areas with less than 10% are considered "endangered" (EPA, 2000). The Barlee 20 vegetation association retains >99% of its pre-European extent, and development within the survey area will not significantly reduce the current extent of this vegetation association.

Table 5-2: Pre-European vegetation associations within the survey area

Vegetation Association	Current Extent (ha)	% Pre-European extent remaining	% Protected for Conservation	Floristic Description	Extent within Survey Area
Barlee 20	1169909	99.78	8.9	Low woodland; mulga mixed with *Casuarina pauper* & *Eucalyptus* sp.	1,591 ha (100%)

5.1.2.2 Significant Ecological Communities

The Protected Matters search (DAWE, 2020a) did not identify any Threatened Ecological Communities recorded within 40 km of the survey area. Analysis of the Priority Ecological Communities within the Goldfields region (DBCA, 2017) did not identify any significant vegetation assemblages as likely or possibly occurring within the survey area.



Figure 5-2: Pre-European vegetation systems within the survey area

5.1.3 Fauna

According to the results of the NatureMap search (DBCA, 2021b), a total of 131 terrestrial vertebrate fauna taxa have been recorded within 40 km of the survey area, consisting of 69 bird, 20 mammal, 40 reptile and two amphibian taxa. This total includes five introduced (feral) species (3.8%).

5.1.3.1 Introduced (Feral) Fauna

The NatureMap and EPBC database searches identified 13 feral fauna species, representing eight families, as potentially occurring in the survey area (Table 5-3).

Table 5-3: Potentially occurring introduced fauna

Family	Species	Common Name
Bovidae	*Bos taurus*	European Cattle
	Capra hircus	Goat
Camelidae	*Camelus dromedarius*	Dromedary Camel
Canidae	*Canis lupus familiaris*	Domestic Dog
	Vulpes vulpes	Red Fox
Columbidae	*Columba livia*	Domestic Pigeon
	Streptopelia chinensis	Spotted Turtle-Dove
	Streptopelia senegalensis	Laughing Turtle-Dove
Equidae	*Equus asinus*	Donkey, Ass
	Equus caballus	Horse
Felidae	*Felis catus*	Cat
Leporidae	*Oryctolagus cuniculus*	Rabbit
Muridae	*Mus musculus*	House Mouse

5.1.3.2 Conservation Significant Fauna

The desktop review identified nine terrestrial vertebrate fauna species of conservation significance as previously being recorded in the regional area, consisting of five Threatened, one Priority 4 and three migratory or otherwise protected species. In addition, seven migratory wading/shorebird species were assessed collectively due to their similar habitat requirements. The full fauna likelihood assessment is listed in Appendix D.

Habitat and distribution data was used to determine the likelihood of occurrence within the survey area. The assessment identified three significant fauna species as potentially occurring in the survey area, consisting of two Vulnerable and one Specially Protected taxa (

Table 5-4).

Table 5-4: Potentially occurring significant fauna

Species	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Grey Falcon *Falco hypoleucos*	VU	VU	-	The Grey Falcon occurs at low densities across inland Australia. The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter. Prey species include small birds species including doves, pigeons, small parrots, cockatoos and finches. Nonavian prey include small mammals and lizards.	Survey area may form part of larger home range but unlikely to breed in area	Possible
Malleefowl *Leipoa ocellata*	VU	VU	-	Scrublands and woodlands dominated by mallee and wattle species (DAWE, 2020b).	Habitat likely marginal and unsuitable for breeding. Occasional transients only.	Possible
Peregrine Falcon *Falco peregrinus*	-	OS	-	The Peregrine Falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites and prefers coastal and inland cliffs or open woodlands near water, and may even be found nesting on high city buildings (Birdlife Australia, 2018).	Survey area may form part of larger home range but unlikely to breed in area	Possible

5.2 Field Assessment

5.2.1 Flora

The field survey identified 145 vascular flora taxa within the survey area. These taxa represented 71 genera across 29 families, with the most diverse families being Myrtaceae and Fabaceae (23 species each), followed Scrophulariaceae (16 species). Dominant genera include *Eucalyptus* (16 species) and *Eremophila* and *Acacia* (15 species each). No introduced (weed) species were recorded. The full field species inventory is listed in Appendix E.

5.2.1.1 Introduced Flora

No introduced (weed) species were recorded.

5.2.1.2 Significant Flora

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant flora includes:

- flora being identified as threatened or priority species;
- locally endemic flora or flora associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- new species or anomalous features that indicate a potential new species;
- flora representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- flora with relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

No Threatened, Priority or otherwise significant flora species were recorded within the survey area.

The previously recorded *Austrostipa blackii* (P3) was not observed within the survey area, despite a focused search at the location of the previous record () and within areas of suitable habitat. Vegetation in the vicinity of the previous record was observed to be heavily grazed.



Figure 5-3: Historical record of *Austrostipa blackii* (P3) within the survey area

5.2.2 Vegetation Communities

A total of ten broad-scale vegetation communities were identified within the survey area. Vegetation community descriptions and extent are listed below in Table 5-5 and illustrated spatially in Figure 5-4. Vegetation community descriptions and extents were determined from field survey results, aerial imagery interpretation and extrapolation of the communities. Areas cleared of vegetation, significantly degraded and/or rehabilitated were not included in the vegetation community calculations.

The survey found CLP-MW1 was the most widespread community in the survey area, occupying 549 ha (34.5%), while OD-MW1 was the most restricted with 10 ha (0.6%). The most diverse vegetation community was SLP-MW1 with 60 species (41.4%), while the least diverse was CLP-EW1, with 25 species (17.2%).

Table 5-5: Summary of vegetation communities within the survey area

Vegetation Code	NVIS Major Vegetation Group	Vegetation Type	Landform	Image
CLP-AFW1 196 ha (12.3%)	*Acacia* low forest/ woodland	*Acacia caesaneura* low forest/ woodland over mixed shrubland over *Ptilotus obovatus* low open shrubland	Clay-loam plain	
CLP-EW1 29 ha (1.8%)	*Eucalyptus* woodland	*Eucalyptus salubris* and *E. transcontinentalis* open woodland over *Eremophila scoparia* shrubland	Clay-loam plain	

Vegetation Code	NVIS Major Vegetation Group	Vegetation Type	Landform	Image
CLP-EW2 230 ha (14.5%)	*Eucalyptus* woodland	*Eucalyptus salmonophloia* low open woodland over *Atriplex nummularia* and *Maireana sedifolia* low open shrubland	Clay-loam plain	
CLP-EW3 549 ha (34.5%)	*Eucalyptus* woodland	*Eucalyptus salmonophloia and E. salubris* low woodland over *E. oleosa* open mallee shrubland over mixed low shrubland	Clay-loam plain	

Vegetation Code	NVIS Major Vegetation Group	Vegetation Type	Landform	Image
CLP-MW1 81 ha (5.1%)	*Eucalyptus* mallee woodland	*Eucalyptus oleosa* low open mallee woodland over *Acacia caesaneura* and *A.* sp. narrow phyllode	Clay-loam plain	
OD-MW1 10 ha (0.6%)	*Eucalyptus* low woodland	*E. loxophleba* subsp. *lissophloia* low woodland over *Ptilotus obovatus* low open shrubland	Open depression	

Vegetation Code	NVIS Major Vegetation Group	Vegetation Type	Landform	Image
RH-AW1 132 ha (8.3%)	*Acacia* low woodland	*Acacia caesaneura* low open woodland over *A.* sp. narrow phyllode, *A. quadrimarginea* and *A. colletioides* shrubland	Rocky hillslope	
RH-EW1 244 ha (15.3%)	*Eucalyptus* low woodland	*Eucalyptus lesouefii* low woodland over *Maireana sedifolia* low open shrubland	Rocky hillslope	

Vegetation Code	NVIS Major Vegetation Group	Vegetation Type	Landform	Image
SLP-MW1 77 ha (4.8%)	*Eucalyptus* mallee woodland	*Eucalyptus horistes* and *E. concinna* low mallee woodland over *Westringia cephalantha, Grevillea oncogyne* and *Triodia scariosa* low open shrubland/ hummock grassland	Sandy-loam plain	
SP-CW1 36 ha (2.3%)	*Casuarina* low open woodland	*Casuarina pauper* low open woodland over *Ptilotus obovatus* low open shrubland	Sandplain	

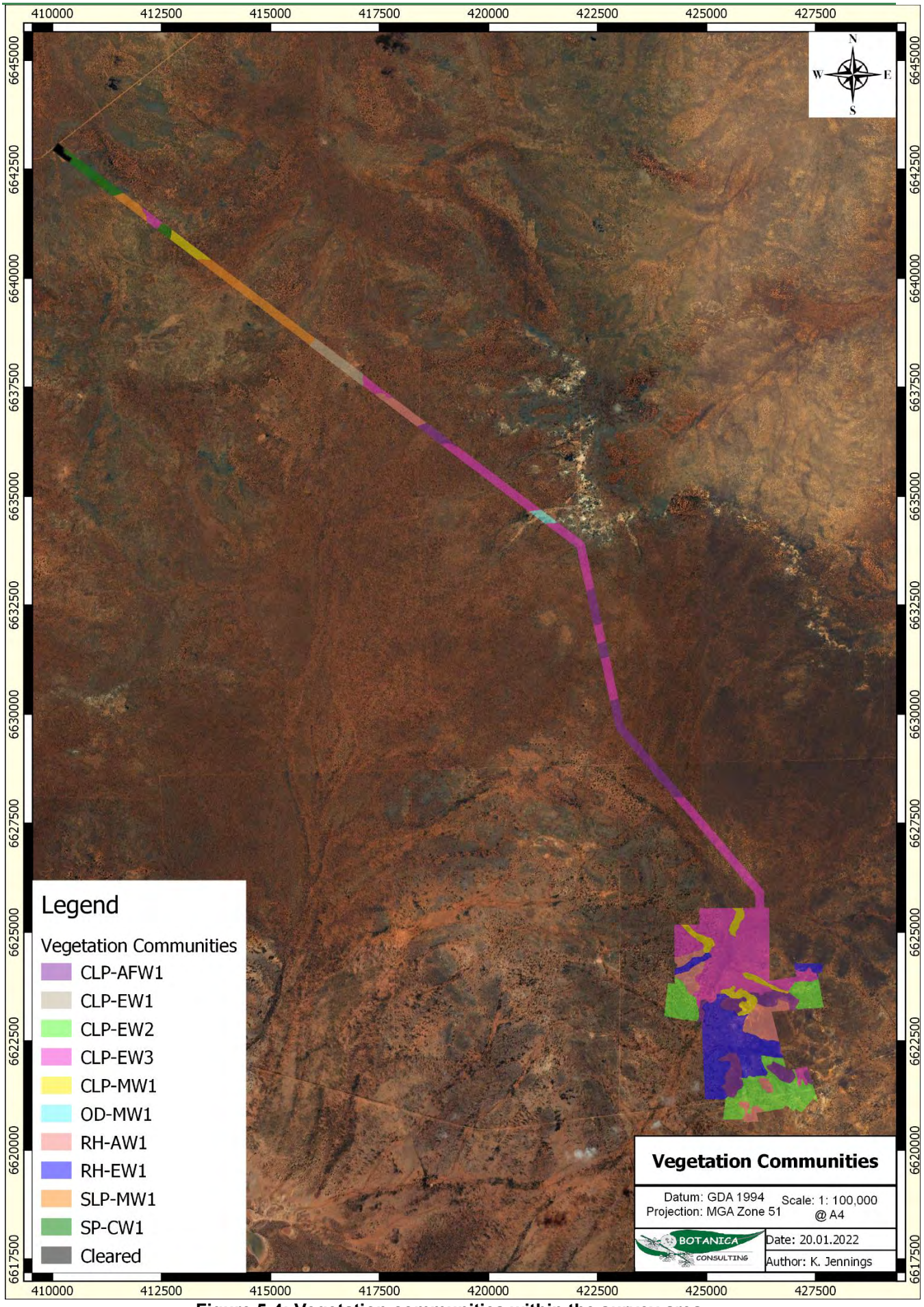


Figure 5-4: Vegetation communities within the survey area

5.2.3 Vegetation Condition

Based on the vegetation condition rating scale adapted from Keighery (1994) and Trudgen, (1988), native vegetation within the survey area was categorised as 'good'. (Table 5-6,Figure 5-5). Vegetation condition rating descriptions are listed in Appendix F. Disturbances within the survey area include vegetation clearing for mining and exploration, access roads and cumulative historical impacts such as grazing and fire events.

Table 5-6: Vegetation condition rating within the survey area

Condition rating	Description	Area (ha)	Area (%)
Good	Obvious signs of damage caused by human activity since European settlement, such as historical clearing, numerous vehicle tracks, changed fire regimes and low levels of grazing by feral animals	1,584	99.6
Completely Degraded	Mining operations and major roads	7	0.4
TOTAL		**1,591**	**100**

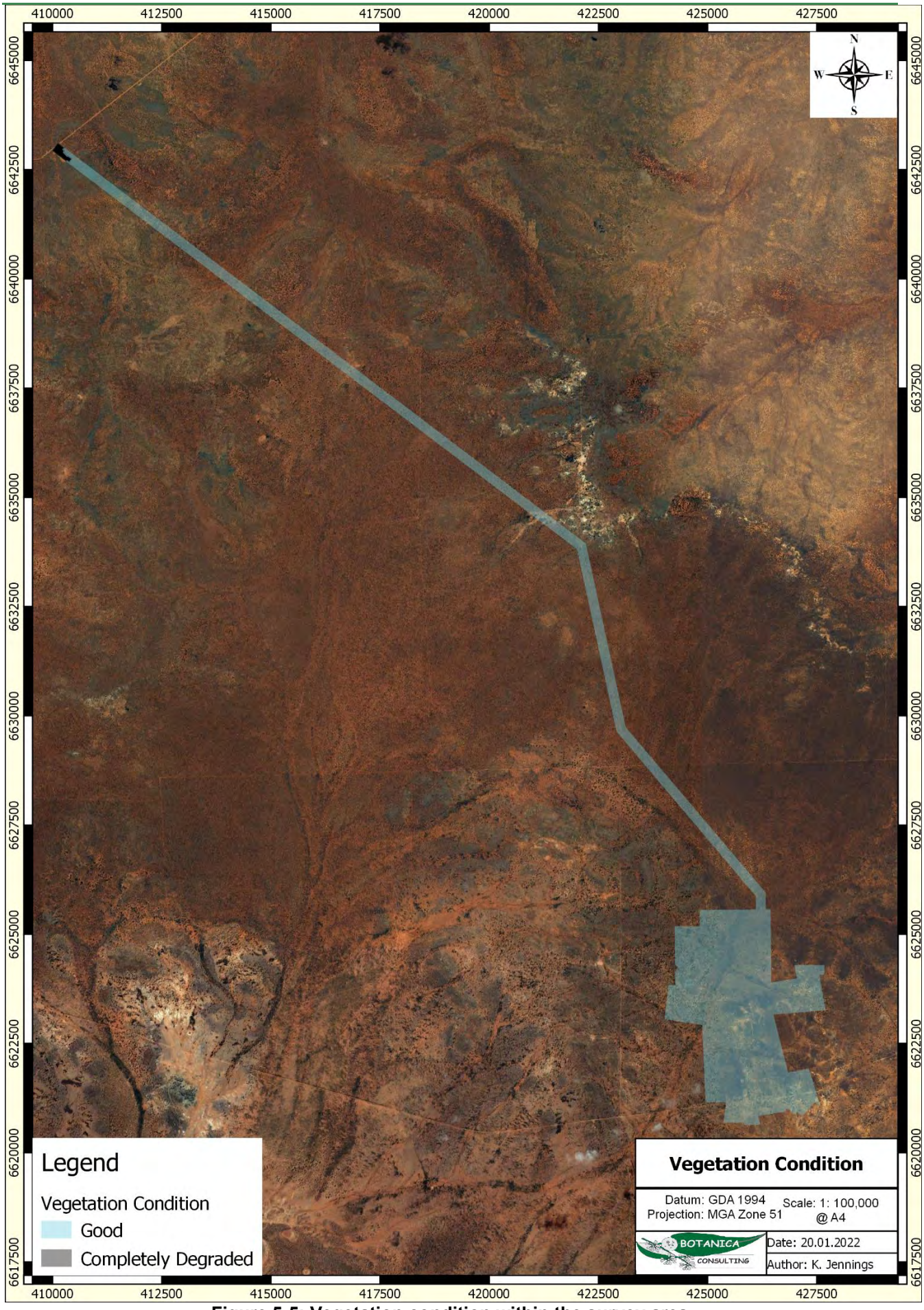


Figure 5-5: Vegetation condition within the survey area

5.2.4 Significant Vegetation

According to the EPA *Environmental Factor Guideline for Flora and Vegetation* (EPA, 2016b) significant vegetation includes:

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

No Threatened, Priority or otherwise significant ecological communities were identified within the survey area.

5.2.5 Fauna Habitat

Based on vegetation and associated landforms assessed during the flora and vegetation assessment, eight broad scale terrestrial fauna habitats were identified as occurring within the survey area. Table 4-7 provides the area and a visual representation of fauna habitat types, and the extent of fauna habitats is shown spatially in Figure 5-6.

Table 5-7: Main terrestrial fauna habitats within the survey area

Fauna Habitat	Description	Representative Fauna Attributes	Conservation Significant Species that possibly occur in habitat	Example Image
Acacia woodland on clay-loam plain Area= 196 ha (12.3%)	*Acacia caesaneura* woodland over *Ptilotus obovatus* mixed low shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Moderately dense vegetation and low to moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	
Eucalyptus woodland on clay-loam plain Area= 644 ha (40.5%)	*Eucalyptus* open woodland over *Atriplex, Eremophila* and *Maireana* mixed shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	

Fauna Habitat	Description	Representative Fauna Attributes	Conservation Significant Species that possibly occur in habitat	Example Image
Eucalyptus mallee woodland on clay-loam plain Area= 245 ha (15.4%)	*Eucalyptus* open mallee woodland over over mixed low shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	
Eucalyptus mallee woodland in open depression Area= 9 ha (0.6%)	*Eucalyptus* open mallee woodland over mixed low shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	

Fauna Habitat	Description	Representative Fauna Attributes	Conservation Significant Species that possibly occur in habitat	Example Image
Acacia low woodland on rocky hillslope Area= 132 ha (8.3%)	*Acacia* woodland and shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata*	
Eucalyptus woodland on rocky hillslope Area= 244 ha (15.3%)	*Eucalyptus* woodland over *Maireana* low shrubland	• Ground not especially suited to burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	

Fauna Habitat	Description	Representative Fauna Attributes	Conservation Significant Species that possibly occur in habitat	Example Image
Eucalyptus mallee woodland on sandy-loam plain Area= 78 ha (4.9%)	*Eucalyptus* open mallee woodland over mixed low shrubland	• Ground suitable for burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	
Casuarina woodland on sandplain Area= 36 ha (2.3%)	*Eucalyptus* open mallee woodland over *Ptilotus obovatus* low shrubland	• Ground suitable for burrowing species. • Moderately diverse vegetation strata supporting diverse avifauna assemblage. • Low to moderately dense vegetation and moderate leaf litter.	Malleefowl *Leipoa ocellata* Grey Falcon *Falco hypoleucos* Peregrine Falcon *Falco peregrinus*	
Cleared Area= 7 ha (0.4%)	-	-	-	-

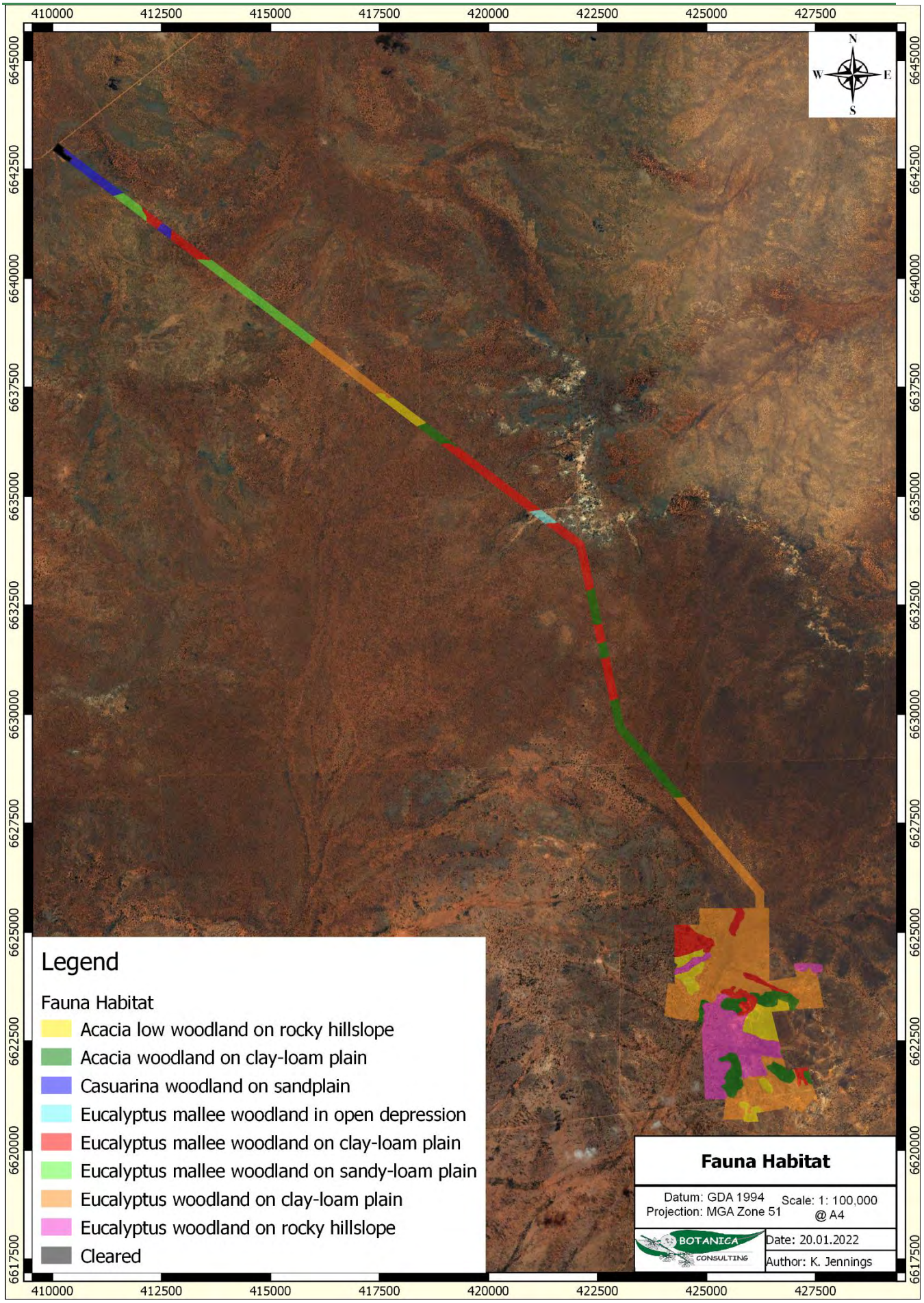


Figure 5-6: Fauna habitats within the survey area

5.2.6 Significant Fauna

According to the EPA *Environmental Factor Guideline for Terrestrial Fauna* (EPA, 2016c) significant fauna includes:

- Fauna being identified as a Threatened or Priority species;
- Fauna species with restricted distribution;
- Fauna subject to a high degree of historical impact from threatening processes; and
- Fauna providing an important function required to maintain the ecological integrity of a significant ecosystem.

One inactive Malleefowl mound was recorded within the survey area (Figure 5-8). The mound appears to be in good condition and is likely to have been used within the last five years.

No other evidence of significant fauna species were observed during the field survey.

The current status of some species on site and/or in the general area is difficult to determine, however, based on the habitats present and, in some cases, direct observations or recent nearby records, the following species of conservation significance can be regarded as possibly utilising the survey area for some purpose at times, these being:

- **Malleefowl (*Leipoa ocellata)* - Vulnerable (EPBC Act and BC Act)**

This species is occasionally recorded in the Eastern Goldfields subregion. The majority of habitat within the survey area appears marginal/or unsuitable for breeding due to the open nature of the vegetation. However, the presence of activity within an inactive mound indicates that the species persists within the local area. Significant local impacts may occur.

Table 5-8: Malleefowl mound details

Mound #	Status	Location (GDA 94, Zone 51)	
		Easting	Northing
1	Inactive (Profile 1)	413327	6640517



Figure 5-7: Malleefowl mound (inactive) within the survey area

- **Grey Falcon (*Falco hypoleucos)* - Vulnerable (EPBC Act and BC Act)**

This species is sparsely recorded throughout inland Australia. Suitable habitat may be present but in unlikely to represent critical habitat. Significant impact unlikely.

- **Peregrine Falcon (*Falco peregrinus)* – Specially Protected (EPBC Act)**

This species potentially utilises some sections of the survey area as part of a much larger home range, though records in this area are uncommon. It is considered unlikely to breed within the survey area. Significant impact unlikely.

It should be noted that while habitats onsite for one or more of the species listed above are considered possibly suitable, some or all may be marginal in extent/quality and therefore the fauna species considered as possibly occurring may in fact only visit the area for short periods as infrequent vagrants.



Figure 5-8: Malleefowl mound locations within the survey area

5.3 Matters of National Environmental Significance

5.3.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act protects matters of national environmental significance and is used by the Commonwealth DAWE to list threatened taxa and ecological communities into categories based on the criteria set out in the Act (www.environment.gov.au/epbc/index.html). The Act provides a national environmental assessment and approval system for proposed developments and enforces strict penalties for unauthorised actions that may affect matters of national environmental significance. Matters of national environmental significance as defined by the Commonwealth EPBC Act include:

- Nationally threatened flora and fauna species;
- World heritage properties;
- National heritage places;
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed);
- Nationally threatened ecological communities;
- Commonwealth marine area;
- The Great Barrier Reef Marine Park; and
- Nuclear actions (including uranium mining) a water resource, in relation to coal seam gas development and large coal mining development.

No matters of national environmental significance as defined by the Commonwealth EPBC Act were identified within the survey area.

5.4 Matters of State Environmental Significance

5.4.1 *Environmental Protection Act WA 1986*

The EP Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment. The Act is administered by The Department of Water and Environment Regulation (DWER), which is the State Government's environmental regulatory agency.

Under Section 51C of the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations (Regulations) WA 2004* any clearing of native vegetation in Western Australia that is not eligible for exemption under Schedule 6 of the *EP Act 1986* or under the Regulations 2004 requires a clearing permit from the DWER or DMIRS. Under Section 51A of the *EP Act 1986* native vegetation includes aquatic and terrestrial vegetation indigenous to Western Australia, and intentionally planted vegetation declared by regulation to be native vegetation, but not vegetation planted in a plantation or planted with commercial intent. Section 51A of the *EP Act 1986* defines clearing as "the killing or destruction of; the removal of; the severing or ringbarking of trunks or stems of; or the doing of substantial damage to some or all of the native vegetation in an area, including the flooding of land, the burning of vegetation, the grazing of stock or an act or activity that results in the above". Exemptions under Schedule 6 of the EP Act and the EP Regulations do not apply in ESAs as declared under Section 51B of the EP Act or TEC listed under State and Commonwealth legislation.

No evidence of the survey area containing any TEC or Threatened flora or fauna was found during the survey period. The survey area is not located within an ESA.

5.4.2 *Biodiversity Conservation Act 2016*

This Act is used by the Western Australian DBCA for the conservation and protection of biodiversity and biodiversity components in Western Australia and to promote the ecologically sustainable use of biodiversity components in the State. Taxa are classified as 'Threatened" when their populations are geographically restricted or are threatened by local processes (see following sections for Threatened definitions). Under this Act all native flora and fauna are protected throughout the State. Financial penalties are enforced under this Act if threatened species are collected without an appropriate license.

Under Section 54(1) of the BC Act, habitat is eligible for listing as critical habitat if:

a) it is critical to the survival of a threatened species or a threatened ecological community; and
b) its listing is otherwise in accordance with the ministerial guidelines.

No threatened species or critical habitat listed under the BC Act were recorded within the survey area.

5.5 Other areas of Conservation Significance

The DBCA lists 'Priority' species and communities which are under consideration for declaration as 'Threatened' under the BC Act. These Priority species/ communities have no formal legal protection until they are endorsed by the Minister as being Threatened.

No Priority species or PEC as listed DBCA were identified within the survey area.

There are no wetlands of international importance (Ramsar Wetlands) or national importance (Australian Nature Conservation Agency Wetlands) within the survey area.

There are no proposed or gazetted conservation reserves within the survey area. Both proposed and gazetted conservation reserves are managed by DBCA with gazetted conservation reserves vested with the Conservation and Parks Commission of Western Australia. The Conservation and Parks Commission is an independent statutory authority that was established under the Conservation and Land Management (CALM) Act 1984 in November 2000 and is the controlling body in which the State's conservation estate, including national parks, conservation parks, nature reserves, state forests and timber reserves, are vested. The Conservation and Parks Commission develops policies and provides independent advice to the Minister for Environment with respect to conservation, the management of ecological biodiversity and the application of ecologically sustainable forest management. The DBCA manages land on behalf of the Conservation and Parks Commission.

The closest significant environmental feature is the Bullock Holes Timber Reserve, which is DBCA-managed land located approximately 35 km west of the survey area. Disturbances within the survey area are unlikely to impact this area. The location of proposed and vested Conservation Reserves, ESA's and Nationally Important Wetlands in relation to the survey area is provided in Figure 4 3.

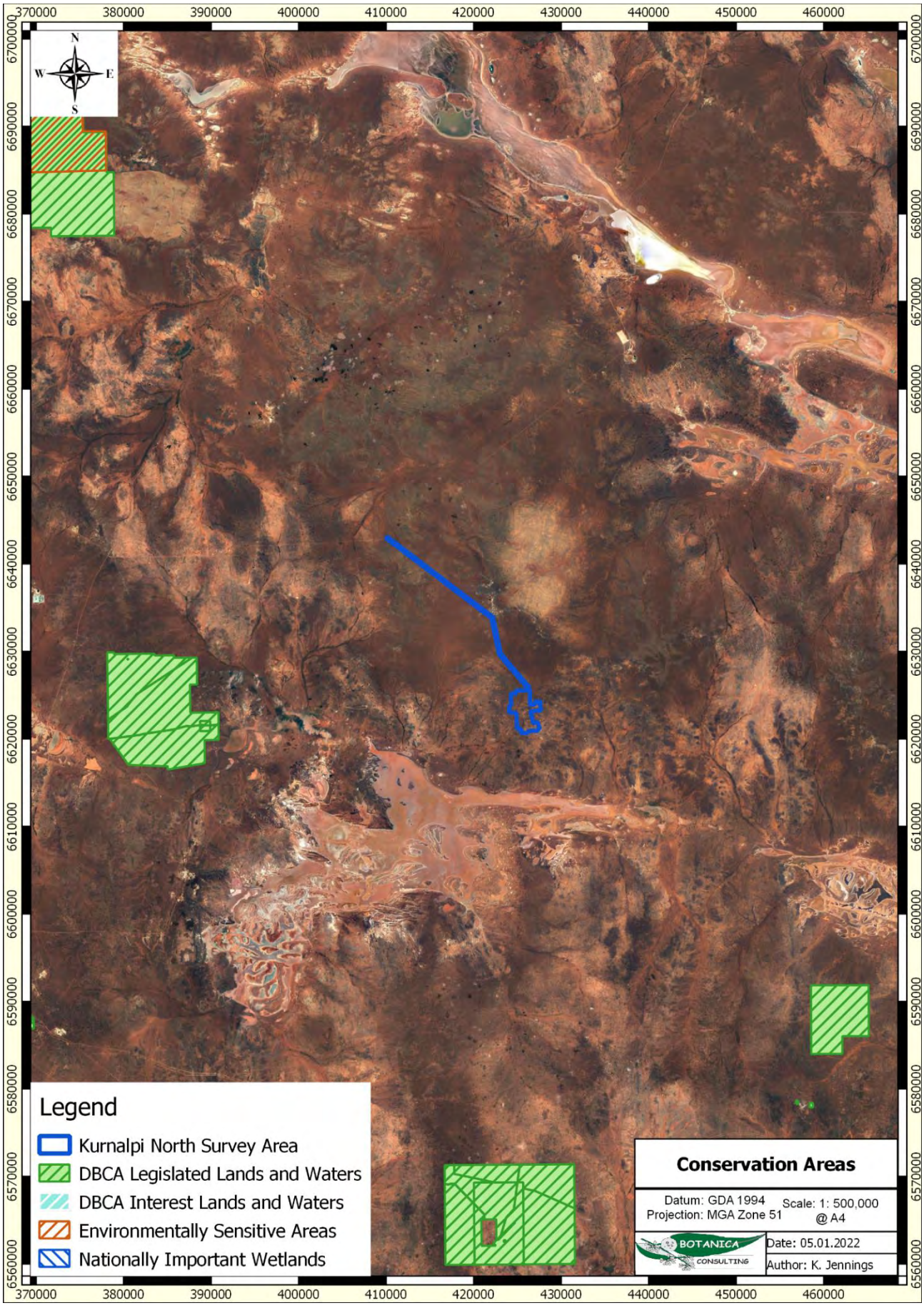


Figure 5-9: Areas of conservation significance

5.6 Native Vegetation Clearing Principles

Based on the outcomes from the survey undertaken, Botanica assessed the results of the desktop and field survey with regards to the native vegetation clearing principles listed under Schedule 5 of the EP Act (Table 5-9). The assessment found that the proposed vegetation clearing activities may be at variance with clearing principle (f).

Table 5-9: Assessment against native vegetation clearing principles

Letter	Principle	Assessment	Outcome
Native vegetation should not be cleared if it:			
(a)	comprises a high level of biological diversity.	Vegetation within the survey area is considered to be of low biological diversity and is well represented outside of the survey area. There are no Threatened or Priority Ecological Communities within the survey area.	Clearing is unlikely to be at variance with this principle
(b)	comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to WA.	An inactive malleefowl mound was recorded within the survey area. No recent activity was observed, and habitat appears marginal due to the open nature of the vegetation and lack of surface litter.	Clearing is unlikely to be at variance with this principle
(c)	includes, or is necessary for the continued existence of rare flora.	No Threatened Flora taxa, pursuant to the BC Act and the EPBC Act were identified within the survey area.	Clearing is unlikely to be at variance with this principle
(d)	comprises the whole or part of or is necessary for the maintenance of a threatened ecological community (TEC).	No TEC listed under the EPBC Act or by the BC Act occur within the survey area or the Eastern Goldfields subregion.	Clearing is not at variance with this principle
(e)	is significant as a remnant of native vegetation in an area that has been extensively cleared	The Barlee 20 vegetation association retains >99% of its original pre-European vegetation extent.	Clearing is unlikely to be at variance with this principle
(f)	is growing, in, or in association with, an environment associated with a watercourse or wetland	According to the Geoscience Australia database (2015), there are no permanent or ephemeral inland waters within the survey area. There are multiple minor ephemeral drainage lines that intersect the survey area. One vegetation community was associated with ephemeral drainage; OD-MW1 which represents 0.6% of the total survey area.	Clearing may be at variance with this principle
(g)	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The survey area and surrounding region has not been extensively cleared. Clearing within the survey area is not considered likely to lead to land degradation issues such as salinity, water logging or acidic soils.	Clearing is unlikely to be at variance with this principle
(h)	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The survey area is not located within or adjacent to conservation areas, Environmentally Sensitive Areas or Nationally Important Wetlands.	Clearing is unlikely to be at variance with this principle

Letter	Principle	Assessment	Outcome
Native vegetation should not be cleared if it:			
(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.	According to the Geoscience Australia database (2015), there are no permanent or ephemeral inland waters within the survey area. There are multiple minor ephemeral drainage lines that intersect the survey area. One vegetation community was associated with ephemeral drainage; OD-MW1 which represents 0.6% of the total survey area. The survey area is located in an arid to semi-arid environment with most rainfall lost by evaporation or surface runoff. Only a small portion infiltrates the soil and recharges the groundwater.	Clearing is unlikely to be at variance with this principle
(j)	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding	Rainfall in the Eastern Goldfields subregion has an average rainfall of 200-300mm and an evaporation rate of 2400 mm. Rainfall data for Kalgoorlie-Boulder indicates that rainfall is spread throughout the year and rainfall events are unlikely to result in localised flooding. Clearing within the survey area is not likely to increase the incidence or intensity of flooding within the survey area or surrounds.	Clearing is unlikely to be at variance with this principle

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APPENDIX A: CONSERVATION RATINGS BC ACT AND EPBC ACT

Definitions of Conservation Significant Species

Code	Category
State categories of Threatened and Priority species	
Threatened Species (T) 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).	
CR	**Critically Endangered** 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** 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** 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 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 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.	
IA	**International Agreement/ Migratory** 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.

Code	Category
	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** 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*.
Priority species Possibly Threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of Priority for survey and evaluation of conservation status so that consideration can be given to their declaration as Threatened Fauna or Flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.	
P1	**Priority 1: Poorly-known species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2	**Priority 2: Poorly-known species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3	**Priority 3: Poorly-known species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
P4	**Priority 4: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
Commonwealth categories of Threatened species	
EX	**Extinct** Taxa where there is no reasonable doubt that the last member of the species has died.
EW	**Extinct in the Wild** Taxa where it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CR	**Critically Endangered**

Code	Category
	Taxa that are facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
EN	**Endangered** Taxa which are not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
VU	**Vulnerable** Taxa which are not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Definitions of conservation significant communities

Category Code	Category
State categories of Threatened Ecological Communities (TEC)	
PD	**Presumed Totally Destroyed**
	An ecological community will be listed as Presumed Totally Destroyed if there are no recent records of the community being extant and either of the following applies:
	• records within the last 50 years have not been confirmed despite thorough searches or known likely habitats or;
	• all occurrences recorded within the last 50 years have since been destroyed.
CR	**Critically Endangered**
	An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future, meeting any one of the following criteria:
	The estimated geographic range and distribution has been reduced by at least 90% and is either continuing to decline with total destruction imminent, or is unlikely to be substantially rehabilitated in the immediate future due to modification;
	The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area;
	The ecological community is highly modified with potential of being rehabilitated in the immediate future.
EN	**Endangered**
	An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. The ecological community must meet any one of the following criteria:
	The estimated geographic range and distribution has been reduced by at least 70% and is either continuing to decline with total destruction imminent in the short-term future, or is unlikely to be substantially rehabilitated in the short-term future due to modification;
	The current distribution is limited i.e. highly restricted, having very few small or isolated occurrences, or covering a small area;
	The ecological community is highly modified with potential of being rehabilitated in the short-term future.
VU	**Vulnerable**
	An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing high risk of total destruction in the medium to long term future. The ecological community must meet any one of the following criteria:

Category Code	Category
	The ecological community exists largely as modified occurrences that are likely to be able to be substantially restored or rehabilitated;
	The ecological community may already be modified and would be vulnerable to threatening process, and restricted in range or distribution;
	The ecological community may be widespread but has potential to move to a higher threat category due to existing or impending threatening processes.
Commonwealth categories of Threatened Ecological Communities (TEC)	
CE	**Critically Endangered** If, at that time, an ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).
EN	**Endangered** If, at that time, an ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).
VU	**Vulnerable** If, at that time, an ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).
Priority Ecological Communities	
P1	**Poorly-known ecological communities**
	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist.
P2	**Poorly-known ecological communities**
	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, un-allocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.
P3	**Poorly known ecological communities**
	Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
	Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
	Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing and inappropriate fire regimes.
P4	**Ecological communities that are adequately known, rare but not threatened** or meet criteria for near threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
P5	**Conservation Dependent ecological communities**
	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX B: POTENTIALLY OCCURRING INTRODUCED (WEED) FLORA SPECIES

Family	Taxon	Common Name	WAOL Status	Control Category	WONS
Asteraceae	*Centaurea melitensis*	Maltese Cockspur	Permitted - s11	No Control Category	No
	Oligocarpus calendulaceus	-	Permitted - s11	No Control Category	No
Brassicaceae	*Carrichtera annua*	Ward's Weed	Permitted - s11	No Control Category	No
Caryophyllaceae	*Silene gallica* var. *gallica*	-	Permitted - s11	No Control Category	No
Fabaceae	*Medicago laciniata*	Cut leaf Medic	Permitted - s11	No Control Category	No
Geraniaceae	*Erodium aureum*	-	Permitted - s11	No Control Category	No
Poaceae	*Cenchrus ciliaris*	Buffel Grass	Permitted - s11	No Control Category	No
	Schismus arabicus	Araby Grass	Permitted - s11	No Control Category	No

APPENDIX C: SIGNIFICANT FLORA LIKELIHOOD ASSESSMENT

Status			Taxon	Habitat	Comments	Likelihood
EPBC Act	BC Act	DBCA				
VU	-	P1	*Tecticornia flabelliformis*	Clay. Saline flats.	Habitat unlikely to be present	Unlikely
-	-	P1	*Darwinia* sp. Gibson (R.D. Royce 3569)	Grey-brown sandy clay, white sand. Margins salt lakes, road verges.	Habitat unlikely to be present	Unlikely
-	-	P1	*Ptilotus procumbens*	Red clay.	At extreme of known range, habitat may be present	Possible
-	-	P1	*Ptilotus rigidus*	-	Outside known range of species	Unlikely
-	-	P2	*Eremophila praecox*	ed/brown sandy loam. Undulating plains.	Outside known range of species	Unlikely
-	-	P2	*Styphelia deserticola*	-	Outside known range of species	Unlikely
-	-	P2	*Thryptomene eremaea*	Red or yellow sand. Sandplains.	Within known range, habitat may be present	Possible
-	-	P2	*Trachymene pyrophila*	Yellow or orange sand. Sandplains; germinating after fire or other disturbances such as mining	At extreme of known range, habitat unlikely to be present	Unlikely
-	-	P3	*Micromyrtus serrulata*	Brownish sandy and clayey soils over granite.	Within known range, habitat may be present	Possible
-	-	P3	*Austrostipa blackii*	-	Previously recorded in survey area (Botanica, 2011)	Previously Recorded

APPENDIX D: SIGNIFICANT FAUNA LIKELIHOOD ASSESSMENT

Species	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Night Parrot *Pezoporus occidentalis*	EN	CR	-	Most habitat records are of Triodia (Spinifex) grasslands and/or chenopod shrublands in the arid and semi-arid zones, or *Astrebla* spp. (Mitchell grass), shrubby samphire and chenopod associations, scattered trees and shrubs, *Acacia aneura* (Mulga) woodland, treeless areas and bare gibber are associated with sightings of the species. Roosting and nesting sites are consistently reported as within clumps of dense vegetation, primarily old and large Spinifex (*Triodia*) clumps, but sometimes other vegetation types (DAWE, 2020b).	Outside known range, no suitable habitat expected to occur.	Would Not Occur
Grey Falcon *Falco hypoleucos*	VU	VU	-	The Grey Falcon occurs at low densities across inland Australia. The species frequents timbered lowland plains, particularly acacia shrublands that are crossed by tree-lined water courses. The species has been observed hunting in treeless areas and frequents tussock grassland and open woodland, especially in winter. Prey species include small birds species including doves, pigeons, small parrots, cockatoos and finches. Nonavian prey include small mammals and lizards.	Survey area may form part of larger home range but unlikely to breed in area	Possible
Malleefowl *Leipoa ocellata*	VU	VU	-	Scrublands and woodlands dominated by mallee and wattle species (DAWE, 2020b).	Habitat likely marginal and unsuitable for breeding. Occasional transients only.	Possible
Peregrine Falcon *Falco peregrinus*	-	OS	-	The Peregrine Falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites and prefers coastal and inland cliffs or open woodlands near water, and may even be found nesting on high city buildings (Birdlife Australia, 2018).	Survey area may form part of larger home range but unlikely to breed in area	Possible
Fork-tailed Swift *Apus pacificus*	MI	MI	-	Low to very high airspace over varied habitat from rainforest to semi desert (Birdlife Australia, 2019).	Very occasional transients only.	Unlikely
Migratory Shorebirds (Various species)	IA/MI	IA/MI	P3-P4	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. This includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline salt lakes inland (DAWE, 2020b).	No suitable habitat.	Would Not Occur
Grey Wagtail *Motacilla cinerea*	MI	MI	-	Running water in disused quarries, sandy, rocky streams in escarpments and rainforest, sewerage ponds, ploughed fields and airfields (Morecombe 2004).	No suitable habitat.	Would Not Occur

Species	Conservation Status			Habitat Description	Assessment	Likelihood
	EPBC Act	BC Act	DBCA Priority			
Thick-billed Grasswren (Western) *Amytornis textilis* subsp. *textilis*	-	-	P4	The western subspecies of the Thick-billed Grasswren occurs in semi-arid shrubland on coastal dunes, plains and drainage lines. In non-coastal areas, it occurs in fire-affected shrublands dominated by Ptilotus obovatus and Solanum orbiculatum following uncontrolled fires, low shrublands on calcareous sandplains, dominated by Acacia spp., Exocarpus spp., and other shrubs such as Thryptomene spp., and Ptilotus spp., mixed with hummocks of spinifex Triodia spp., and sometimes with Atriplex spp., and in dense thickets of Muehlenbeckia cunninghamii, Atriplex spp. and Eremophila spp. growing in drainage lines.	Potential habitat unlikely to occur or, if present, to represent critical habitat.	Unlikely
Chuditch *Dasyurus geoffroii*	VU	VU	-	Previously occurred throughout arid and semi-arid Australia but is now restricted to south-west Western Australia. (DAWE, 2020b).	Considered to be locally and regionally extinct.	Unlikely
Sandhill Dunnart *Sminthopsis psammophila*	EN	EN	-	Sandhill dunnarts occupy sandy, semi-arid and arid areas of southern central Australia, especially where sand dunes occur and when the vegetation is dominated by spinifex hummock grassland (Triodia spp.) (Woinarski et al., 2014). Overstorey vegetation is variable, with groves of desert oak (Allocasuarina decaisneana), or low, open Eucalyptus and Callitris woodlands. Recently recorded from five, widely-separated localities in the Great Victoria Desert (South Australia and Western Australia), and on the Eyre Peninsula	Outside known range.	Unlikely

APPENDIX E: LIST OF SPECIES IDENTIFIED WITHIN THE SURVEY AREA

(A) denotes ephemeral (annual) species

Family	Taxon	CLP-AFW1	CLP-EW1	CLP-EW2	CLP-EW3	CLP-MW1	OD-MW1	RH-AW1	RH-EW1	SLP-MW1	SP-CW1
Amaranthaceae	*Ptilotus exaltatus (A)*			*	*	*	*				
	Ptilotus gaudichaudii (A)	*		*					*		
	Ptilotus helipteroides (A)	*									*
	Ptilotus holosericeus				*	*		*			
	Ptilotus obovatus	*	*	*		*	*	*	*		*
Apocynaceae	*Marsdenia australis*			*	*	*				*	
Asteraceae	*Cephalipterum drummondii (A)*	*		*	*	*	*				
	Chrysocephalum puteale			*		*	*				
	Cratystylis subspinescens			*			*				
	Leucochrysum fitzgibbonii (A)						*	*			*
	Olearia muelleri				*	*	*	*			*
	Olearia pimeleoides									*	
	Olearia stuartii					*				*	
	Olearia subspicata	*		*						*	
	Rhodanthe floribunda (A)		*			*	*		*		
Boraginaceae	*Halgania integerrima*			*							
Casuarinaceae	*Allocasuarina helmsii*							*		*	
	Casuarina pauper		*	*		*	*	*	*		*
Chenopodiaceae	*Atriplex nummularia* var. *spathulata*	*	*	*	*		*		*		*
	Atriplex vesicaria				*		*	*			*
	Enchylaena tomentosa	*					*		*		
	Eriochiton sclerolaenoides	*		*	*	*	*	*	*		*
	Maireana georgei	*		*	*		*				*
	Maireana oppositifolia	*		*							
	Maireana pentatropis		*	*	*	*	*	*	*		
	Maireana sedifolia	*	*	*	*		*	*			*
	Maireana triptera	*	*		*	*	*		*		
	Salsola australis (A)					*					
	Sclerolaena diacantha	*						*	*		
	Sclerolaena uniflora				*		*				
Cupressaceae	*Callitris columellaris*								*	*	
Euphorbiaceae	*Euphorbia drummondii (A)*	*	*	*			*	*	*		
Fabaceae	*Acacia burkittii*	*		*			*	*			

Family	Taxon	CLP-AFW1	CLP-EW1	CLP-EW2	CLP-EW3	CLP-MW1	OD-MW1	RH-AW1	RH-EW1	SLP-MW1	SP-CW1
	Acacia caesaneura	*		*	*	*		*			*
	Acacia colletioides			*		*	*			*	
	Acacia eremophila var. *variabilis*		*	*					*	*	
	Acacia erinacea		*				*		*		
	Acacia hemiteles	*								*	
	Acacia jennerae							*		*	
	Acacia kempeana	*		*			*				*
	Acacia ligulata		*						*	*	
	Acacia oswaldii			*		*					*
	Acacia ramulosa	*						*			*
	Acacia sp. narrow phyllode (B.R. Maslin 7831)	*				*		*		*	*
	Acacia tetragonophylla	*		*	*	*		*		*	*
	Acacia collegialis	*									
	Acacia heteroneura var. *jutsonii*			*		*				*	
	Acacia quadrimarginea	*									
	Acacia effusifolia	*		*						*	
	Daviesia grahamii			*						*	
	Jacksonia arida										
	Kennedia prorepens									*	
	Senna artemisioides subsp. *filifolia*	*		*	*	*	*	*			*
	Senna artemisioides subsp. *artemisioides*	*		*					*	*	
	Swainsona canescens	*			*						
Frankeniaceae	*Frankenia setosa*				*		*			*	
Goodeniaceae	*Coopernookia strophiolata*							*		*	
	Goodenia mimuloides (A)	*		*				*	*		
	Goodenia pinifolia	*						*		*	
	Scaevola spinescens	*			*	*	*	*		*	*
	Velleia rosea (A)							*			
Haloragaceae	*Haloragis trigonocarpa (A)*	*		*							*
Lamiaceae	*Prostanthera althoferi*		*						*	*	*
	Prostanthera campbellii					*					
	Westringia cephalantha									*	
	Westringia rigida			*			*	*		*	
Loranthaceae	*Amyema preissii*	*		*							
Malvaceae	*Abutilon cryptopetalum*	*		*							

Family	Taxon	CLP-AFW1	CLP-EW1	CLP-EW2	CLP-EW3	CLP-MW1	OD-MW1	RH-AW1	RH-EW1	SLP-MW1	SP-CW1
	Brachychiton gregorii							*		*	
	Lawrencia squamata						*				
	Seringia velutina					*				*	
	Sida calyxhymenia	*		*							*
	Sida intricata	*	*			*			*		
Myrtaceae	*Aluta aspera subsp. aspera*	*	*						*	*	
	Enekbatus cryptandroides							*		*	
	Eucalyptus comitae-vallis			*						*	
	Eucalyptus concinna			*		*				*	
	Eucalyptus griffithsii		*	*			*	*	*		
	Eucalyptus horistes		*	*					*	*	
	Eucalyptus hypolaena		*	*					*	*	
	Eucalyptus leptopoda subsp. *subluta*	*								*	
	Eucalyptus lesouefii						*	*			*
	Eucalyptus loxophleba subsp. *lissophloia*										
	Eucalyptus oleosa				*			*			
	Eucalyptus rigidula					*		*		*	
	Eucalyptus salmonophloia		*		*		*				
	Eucalyptus salubris		*		*		*	*	*		
	Eucalyptus transcontinentalis		*						*		
	Eucalyptus yilgarnensis						*		*	*	
	Eucalyptus longissima	*		*		*					
	Homalocalyx thryptomenoides							*		*	
	Leptospermum fastigiatum									*	
	Melaleuca eleuterostachya									*	
	Melaleuca hamata									*	
	Thryptomene urceolaris									*	
Nyctaginaceae	*Boerhavia coccinea*	*							*		
Pittosporaceae	*Bursaria occidentalis*	*	*	*		*			*	*	
	Pittosporum angustifolium			*	*		*	*			
Poaceae	*Aristida contorta (A)*										*
	Aristida holathera (A)	*						*		*	
	Austrostipa elegantissima (A)			*	*			*			*
	Austrostipa nitida	*		*	*	*	*				
	Triodia rigidissima			*		*			*	*	

Family	Taxon	CLP-AFW1	CLP-EW1	CLP-EW2	CLP-EW3	CLP-MW1	OD-MW1	RH-AW1	RH-EW1	SLP-MW1	SP-CW1
	Triodia scariosa	*				*		*		*	
Proteaceae	*Grevillea acacioides*			*						*	
	Grevillea juncifolia subsp. *temulenta*	*		*					*	*	
	Grevillea nematophylla		*	*			*		*		
	Grevillea oncogyne								*	*	
	Grevillea sarissa subsp. *sarissa*		*						*	*	
	Hakea francisiana			*						*	
	Hakea recurva subsp. *recurva*	*		*		*			*		
Pteridaceae	*Cheilanthes sieberi* subsp. *sieberi*	*		*		*					
Rhamnaceae	*Cryptandra connata*	*									
Rutaceae	*Cyanothamnus coerulescens* subsp. *spinescens*							*		*	
	Phebalium filifolium	*									
	Phebalium canaliculatum		*	*				*	*	*	
	Philotheca brucei										*
	Philotheca tomentella									*	
Santalaceae	*Exocarpos aphyllus*						*				
	Santalum spicatum	*				*	*			*	*
Sapindaceae	*Alectryon oleifolius*				*		*				*
	Dodonaea lobulata	*				*				*	*
Scrophulariaceae	*Eremophila platythamnos* subsp. *platythamnos*									*	
	Eremophila caperata									*	
	Eremophila clarkei	*				*					
	Eremophila decipiens				*	*				*	*
	Eremophila forrestii	*									
	Eremophila georgei										*
	Eremophila gibbosa										*
	Eremophila glabra					*					*
	Eremophila interstans						*				
	Eremophila latrobei subsp. *gilesii*	*									
	Eremophila longifolia	*									
	Eremophila oldfieldii subsp. *angustifolia*	*					*				*
	Eremophila oldfieldii subsp. *oldfieldii*						*				

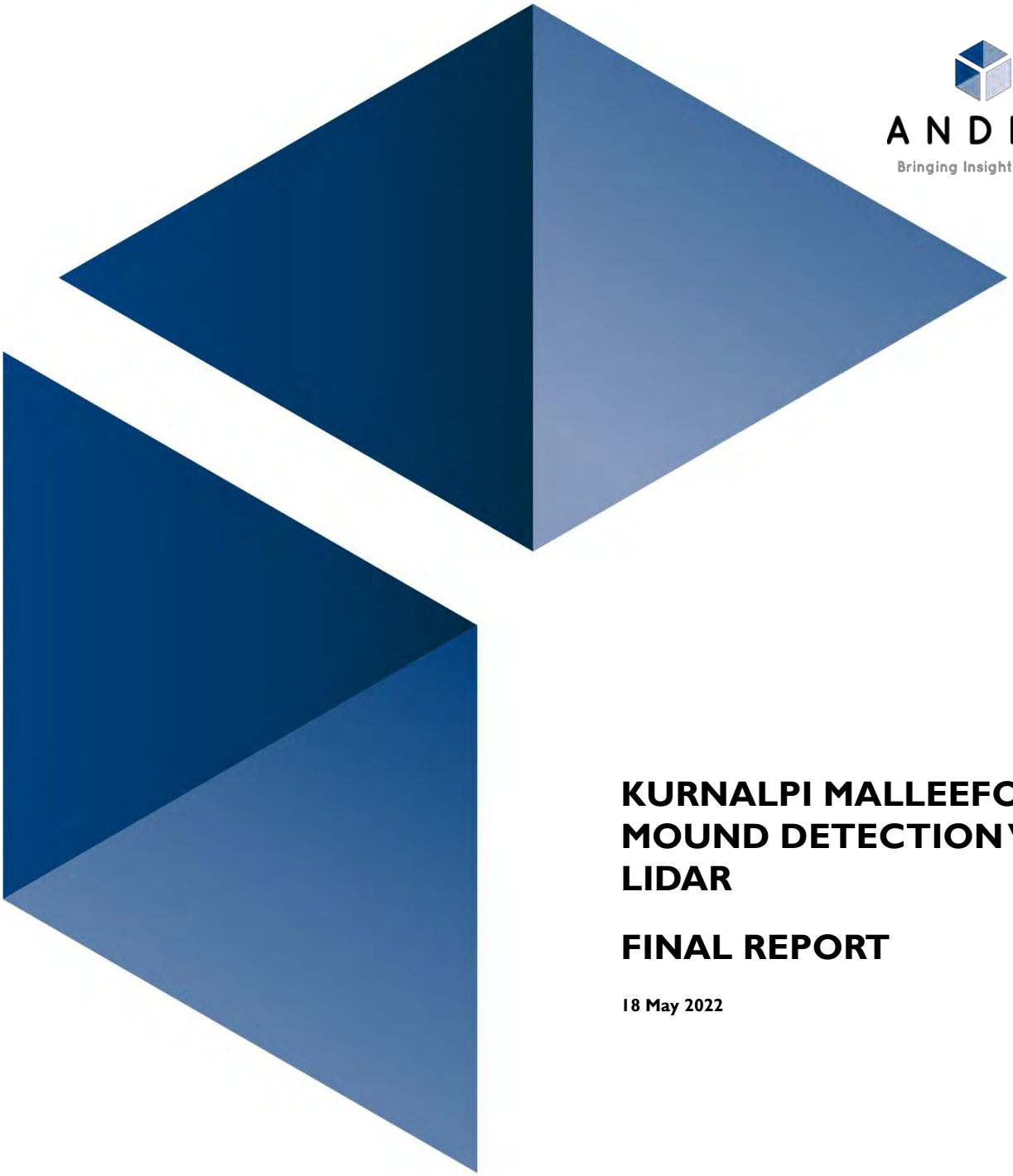
Family	Taxon	CLP-AFW1	CLP-EW1	CLP-EW2	CLP-EW3	CLP-MW1	OD-MW1	RH-AW1	RH-EW1	SLP-MW1	SP-CW1
	Eremophila parvifolia subsp. *auricampa*				*	*	*				*
	Eremophila pustulata						*				
	Eremophila scoparia		*		*		*				
Solanaceae	*Duboisia hopwoodii*					*					
	Solanum lasiophyllum	*				*					
	Solanum nummularium	*									
Thymelaeaceae	*Pimelea spiculigera* var. *thesioides*									*	
Zygophyllaceae	*Roepera aurantiaca* subsp. *aurantiaca (A)*	*					*				
	Roepera eremaeum (A)	*			*	*	*				*

APPENDIX F: VEGETATION CONDITION RATING

Vegetation Condition Rating	South West and Interzone Botanical Provinces	Eremaean and Northern Botanical Provinces
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.	
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor		Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees and shrubs.	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e., areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

APPENDIX G: NATUREMAP SPECIES LIST (40KM BUFFER)

Appendix H: Kurnalpi Malleefowl Mound Detection via LIDAR



ANDITI

Bringing Insight to Data

KURNALPI MALLEEFOWL MOUND DETECTION VIA LIDAR

FINAL REPORT

18 May 2022

KURNALPI MALLEEFOWL MOUND DETECTION VIA LIDAR

FINAL REPORT

Prepared by
Anditi Pty Ltd
on behalf of
Northern Star Resources Limited

Project Manager: Gareth Evans
Report No. Kurnalpi Malleefowl Mound Detection FINAL
Date: 18 May 2022



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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
1	Gareth Evans	18/05/2022		
2				

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2.0	**Project outline**	**3**
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1.0 Introducing Anditi Pty Ltd

Anditi Pty Ltd (Anditi) is a spatial analytics company that is focussed on providing high quality geospatial services to clients across the globe. Anditi provides Geographic Information Systems and Services including basic mapping. With our efficient proprietary spatial engine software we are able to tackle complex queries and problems through deep analysis of data in a way that no other GIS solutions can match.

Anditi combines more than 18 years' experience in advanced spatial analytics with the latest high-performance computing technologies. Our ingenious solutions unlock the potential of LiDAR, imagery and other spatial big data where precision, flexibility and scale make the difference.

Using cutting-edge data processing algorithms, machine learning and advanced cloud computing, Anditi provides businesses, organisations and the community with complete solutions for spatial empowerment.

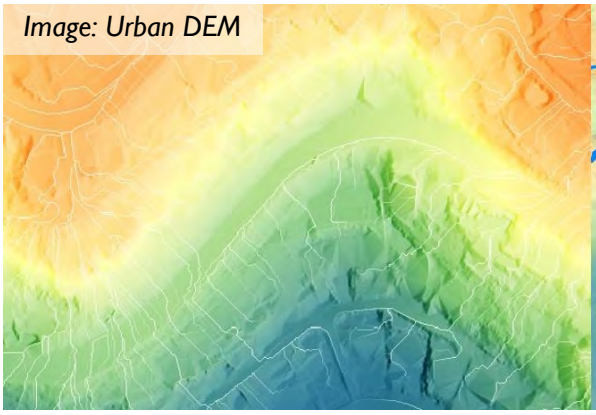


Image: Urban DEM

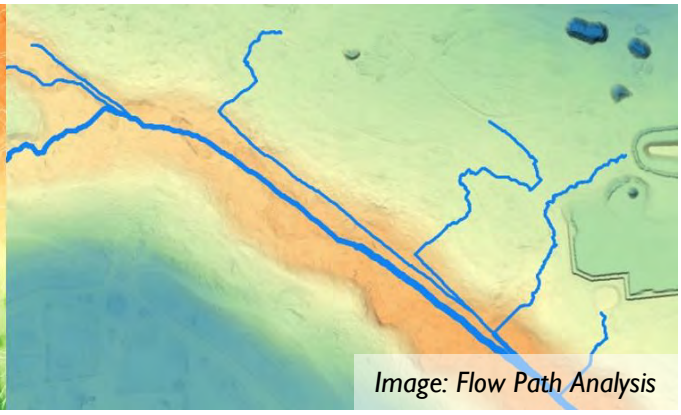


Image: Flow Path Analysis

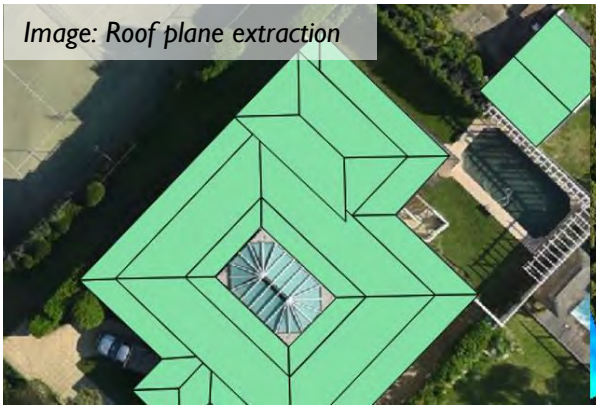


Image: Roof plane extraction

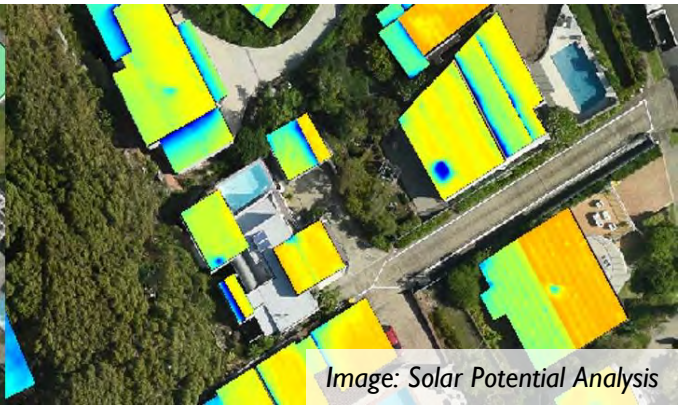


Image: Solar Potential Analysis

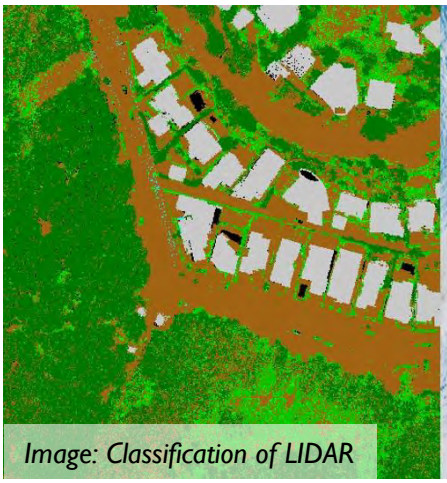


Image: Classification of LIDAR

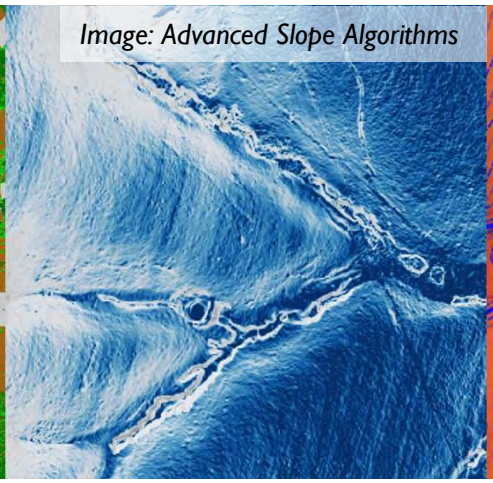


Image: Advanced Slope Algorithms

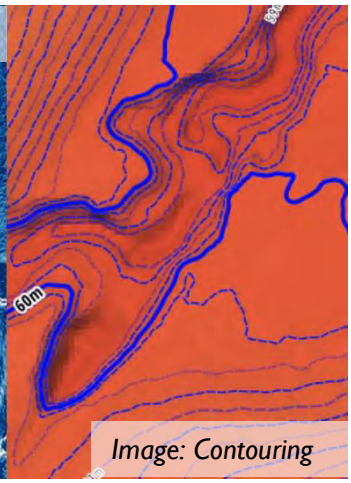


Image: Contouring

2.0 Project outline

This project covered point cloud analysis of the Kurnalpi site. This site is located in Western Australia, 73km North East of Kalgoorlie-Boulder.



Survey site



Survey site

3.0 Data analysis

Data Analysis

Utilising the LiDAR data and the Anditi data processing engine, Anditi classified the data into ground, vegetation and other non-ground classifications creating an accurate DEM that includes potential mound-like features. The data was then further analysed to identify Malleefowl mounds. These were found using Anditi's patented near-ground feature detection algorithms to identify potential sites, which are then ranked depending on the degree of certainty. Certainty is affected by the intactness of the mound, any overly dense obscuring vegetation and other factors, including the data gaps and general data variability.

While Anditi performed much of this automatically, some time was allowed for manual checks to ensure a high level of accuracy. An orthophoto was provided so manual checks compared ratings 1-3 against the orthophoto to check for false positives.

Rating mounds

The Anditi Malleefowl mound analysis algorithms look for ground features in the point cloud that best approximate a typical Malleefowl mound shape. Based on the algorithm match to shape and manual checks, a mound is classed from 1 to 4.

1 = Very closely matches a typical Malleefowl mound shape and is highly likely to be a Malleefowl mound

2 = Is similar to a Malleefowl mound shape and could be a Malleefowl mound

3 = Is a mound shape that is approximately within the parameters of size for a Malleefowl mound. This could be an old Malleefowl mound, a mound of earth around living or dead tree/vegetation, natural hummocks around waterways, etc.

4 = Is a mound shape that is approximately within the parameters of size for a Malleefowl mound but isn't very similar to a typical Malleefowl mounds. This could be a broken Malleefowl mound, a mound of earth around living or dead tree/vegetation, natural hummocks around waterways, tussock vegetation etc.

Attributes

Anditi extracted and supplied a range of attributes from Rating and location to height above sea level for each mound, mound radius, mound height and more.

Data is supplied as a shapefile with attributes – as per the example below.

client_final_mound_locations — Features Total: 1024, Filtered: 1024, Selected: 0

	id	rating	position x	position y	elevation	radius	height	surface area	circle std dev
1	2937	1	739945.6542	6487684.093	423.097097	3	0.674072	4.44	0.052252
2	2297	1	740329.6223	6485048.377	390.8028	2.4	0.657867	2.04	0.039238
3	166	1	736573.009	6480473.553	382.371182	2.2	0.640519	1.68	0.047274
4	2737	1	739142.7096	6486762.808	418.715197	3	0.497738	3.04	0.037957
5	821	1	738237.7376	6481998.821	372.154521	1.6	0.715078	1.72	0.033498
6	2943	1	740234.8896	6487689.63	420.244149	2.2	0.558879	1.64	0.032394
7	691	1	737300.9748	6481171.012	375.737914	1.8	0.434271	1.6	0.025737
8	814	1	737743.7436	6481510.974	376.580985	2	0.53598	1.68	0.021096
9	1578	1	739632.8132	6483498.206	388.770638	2	0.581617	1.84	0.044551
10	2609	1	739846.3222	6486332.567	409.600524	1.8	0.430974	1.04	0.046686
11	797	1	735258.5314	6481847.65	381.440052	2.2	0.420737	0.96	0.064682
12	683	1	736908.003	6481310.763	377.882123	1.6	0.301716	0.84	0.019385
13	1727	1	739572.7767	6483767.218	395.109681	2	0.33621	1.28	0.055014
14	1133	1	739947.8617	6482199.264	374.573285	1.4	0.289901	0.76	0.027842
15	1707	2	737198.0594	6483823.177	376.945786	2	0.330955	2.08	0.047334
16	2722	2	734924.0413	6486506.921	415.859759	2.2	0.537023	1.92	0.047415
17	2608	2	740454.2218	6486218.091	410.99816	2.4	0.567698	2.08	0.053743
18	2087	2	740690.4348	6484633.569	386.648115	2.6	0.482136	1.88	0.053248
19	1867	2	739065.5899	6484136.371	384.246193	2.6	0.487752	2.48	0.066046
20	1677	2	736938.008	6483857.63	379.414119	1.8	0.217015	1	0.037117

Show All Features

Image: example shapefile attributes

3.1 Data Load and Process

Once the data has been checked, the point cloud is loaded into the Anditi Engine, the proprietary software developed by Anditi data scientists for smart point cloud and image processing. The ground is defined through classification algorithms and then the Anditi Malleefowl mound detection algorithms are applied to the ground surface.

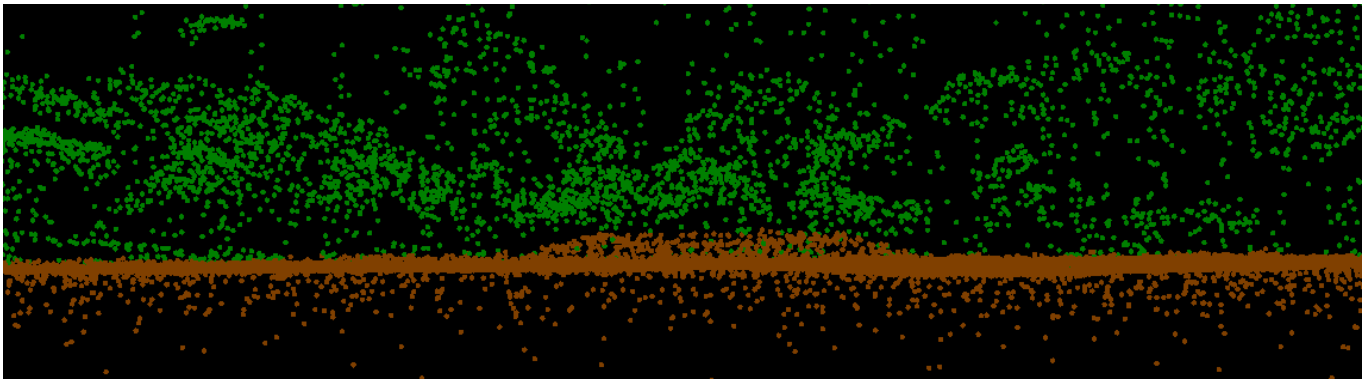


Image: example Ground / non-Ground with mound in ground

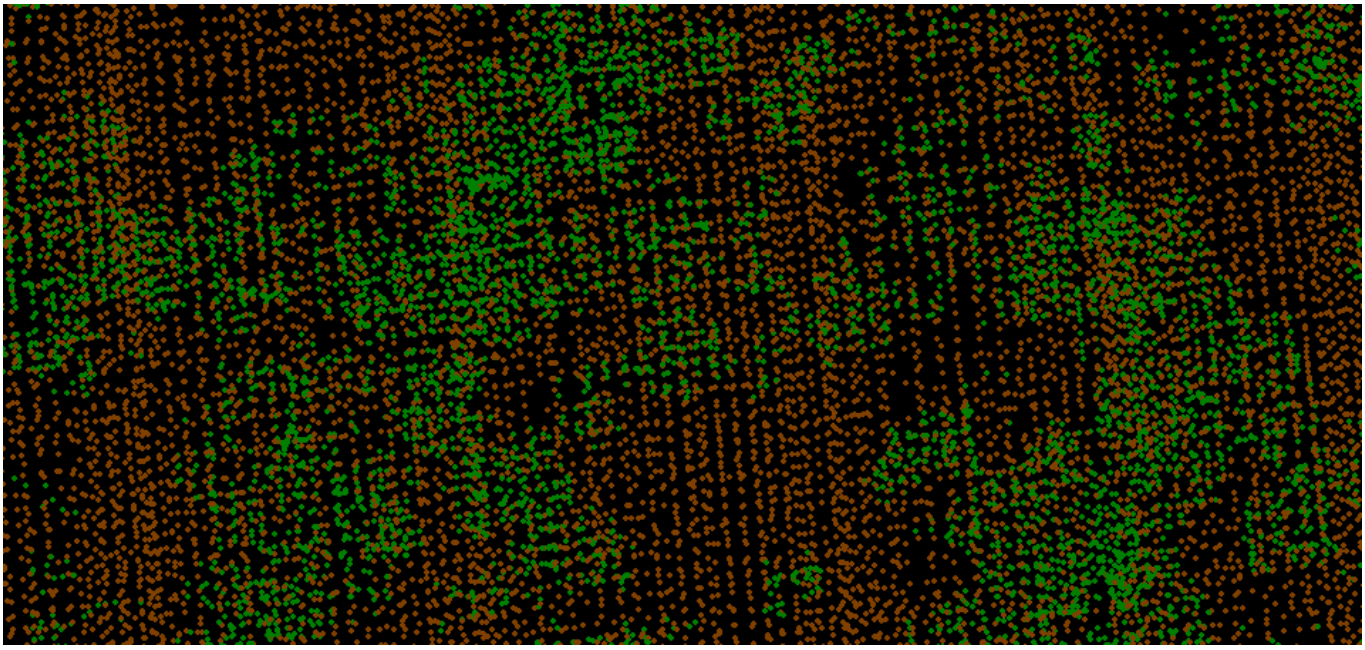


Image: example Ground / non-Ground

3.2 Automated analysis

All mound shapes that fall within certain parameters are ranked automatically from highest potential to lowest potential by the software. A database is created, and the mounds then undergo a manual rating procedure.

A digital elevation model (DEM) is created and contoured to highlight ground features

This is overlaid with the 3D LIDAR point cloud in the Anditi Editor so that manual editors can review the data from all angles. In some cases, the point cloud is coloured from the RGB colour orthophoto. All of these options enhance the quality of the resulting rated mounds, removing vegetation and other false positives.

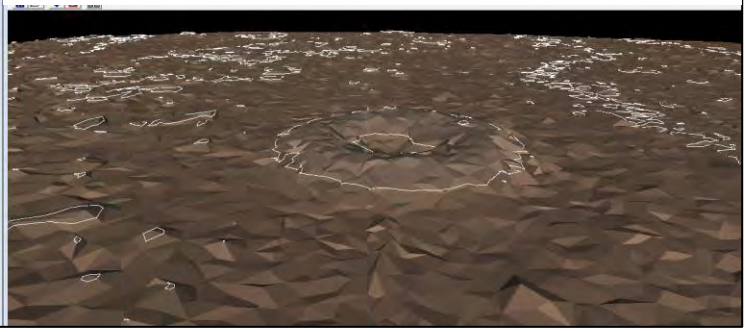
Image: DEM + Contours



Image: Mound cross-section



Image: Mound 3D



3.3 Data checking procedures

3.3.1 Manual checking

Manual checking is usually completed using the Anditi point cloud reviewing tools.

We use the following criteria for category 1 mounds:

- The mound should be fairly circular in shape and look like a classic Malleefowl mound shape.
- Contours displayed on the mound should be concentric.
- There must not be any obvious human activity; like digging, water dams, road clearing; close to the mound.
- There must not be a tree originating from the mound.
- The mound should not be on a very steep surface. Normally mounds are found on flat surfaces or on ground with a gentle slope.
- An orthophoto provides an excellent final check and can often clearly show Malleefowl mounds or check for and exclude false positives such as mound-like vegetation.

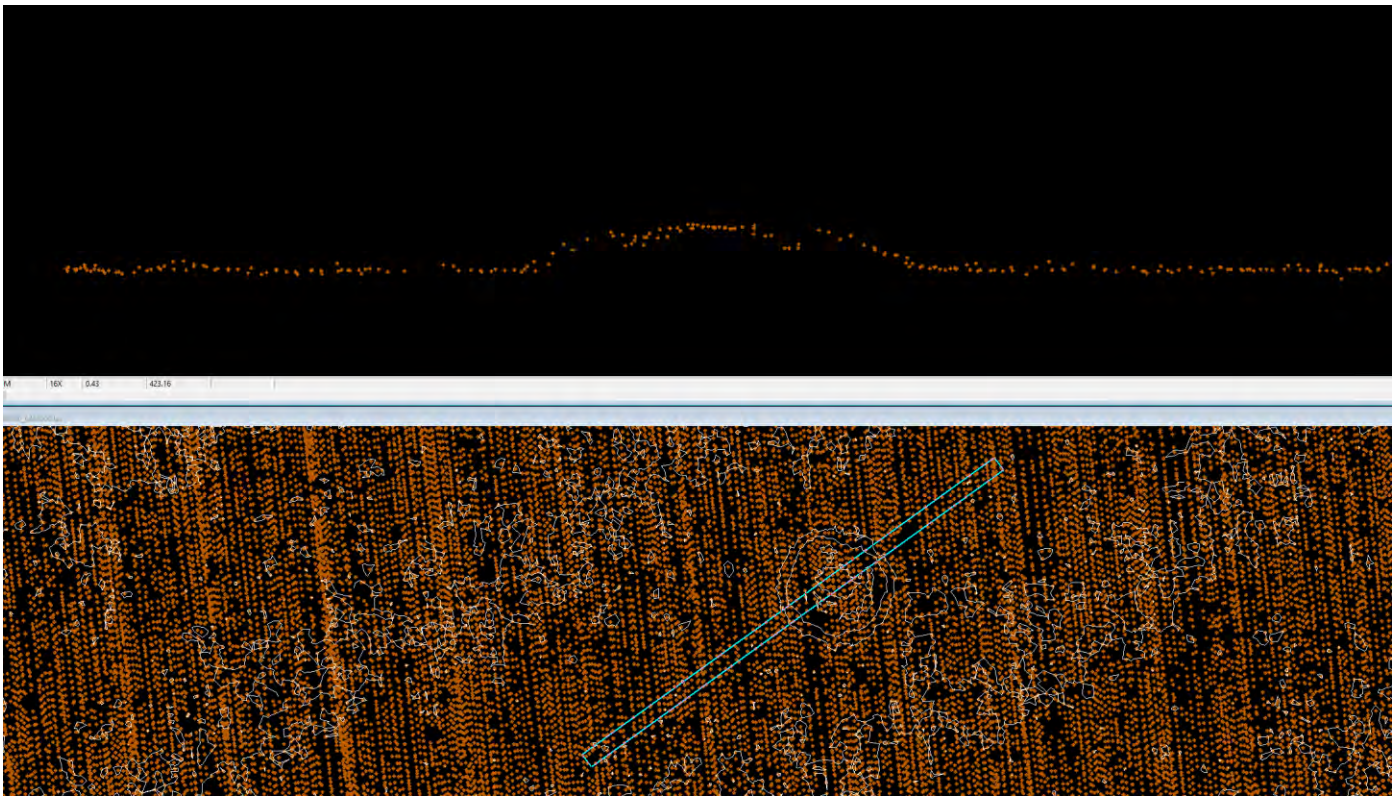


Image: example Rating 1 mound cross-section

3.4 Data delivery

The following data was delivered to Northern Star Resources Limited for this project.

- Shapefile of mound candidates rated 1 – 4 with attributes
- CSV of mound candidates rated 1 – 4 with attributes
- This report

4.0 Data Analysis Results

Rating 1	Rating 2	Rating 3
20	16	23

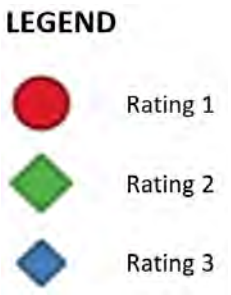
Comments

Two (2) sites were detected visually during checking and so do not have the full range of metrics associated. These are ID 10000 and 10001

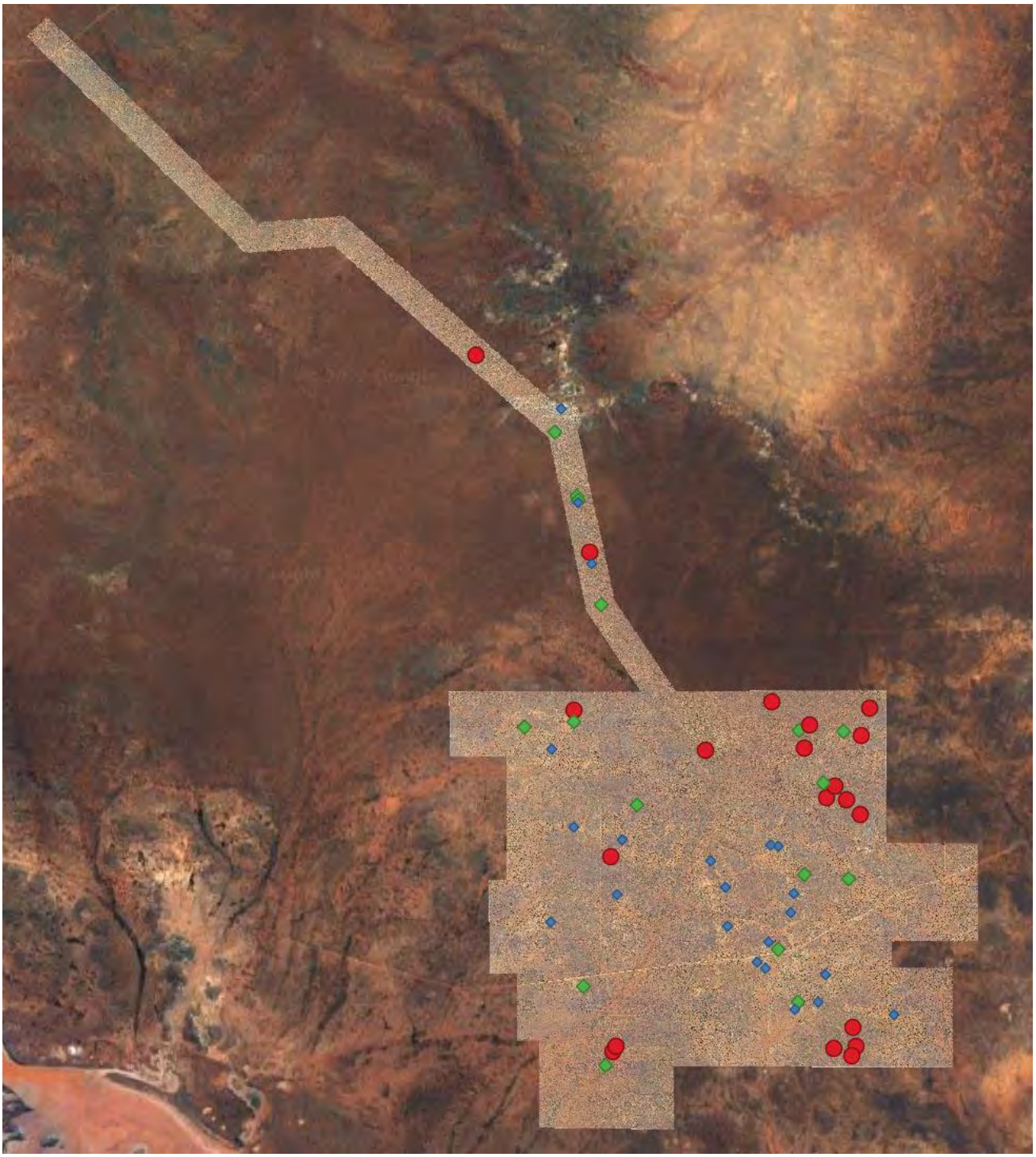
Classes reviewed

All Class 1, 2 and some 3 mounds were checked manually through review of the point cloud and where false positives were detected using the supplied imagery, these were moved to Class 4. Mounds rated 1-3 should be manually verified.

Distribution of the mound candidates and ratings are shown below using the symbols as shown. North is up in the images.

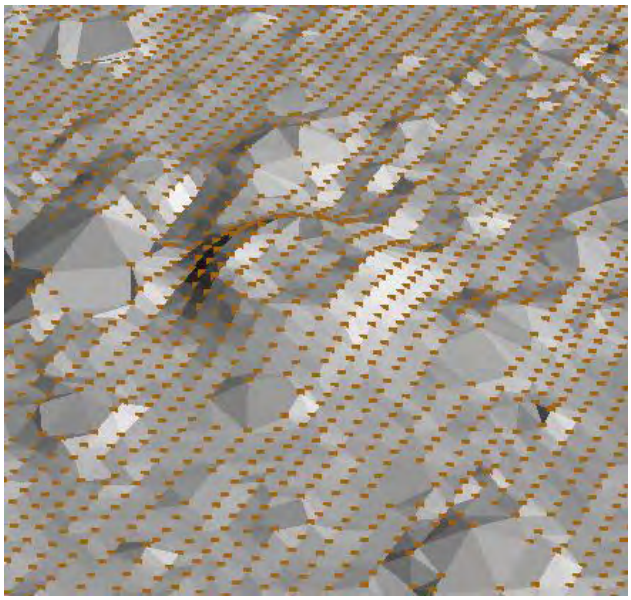


Kurnalpi Rating 1-3 Malleefowl Mounds



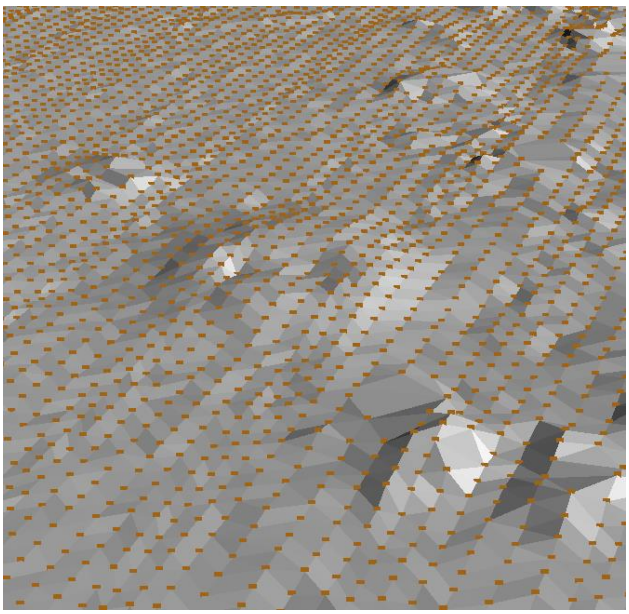
Example Kurnalpi LIDAR Rated Mounds

Rating 1 mounds



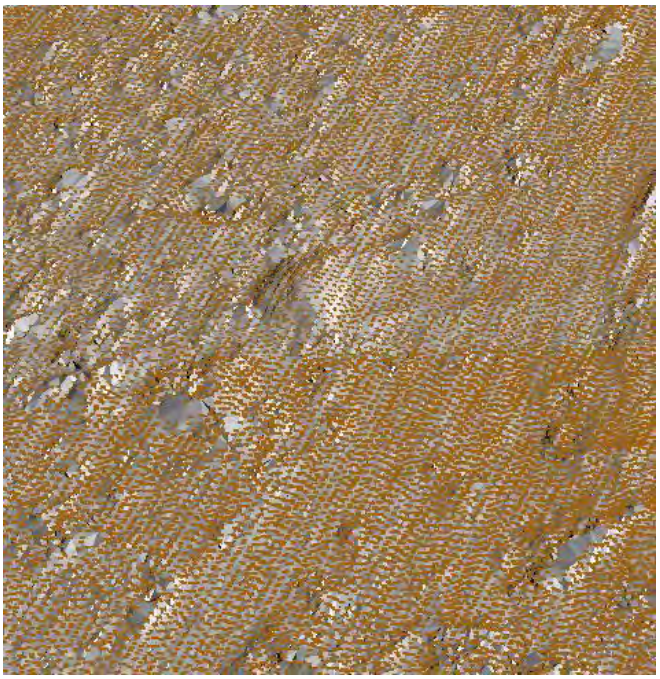


Rating 2 mounds





Rating 3 mounds





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APPENDIX H: EPBC PROTECTED MATTERS SEARCH (40KM BUFFER)

Appendix I: Malleefowl habitat assessment and targeted survey for Miscellaneous Licence L28/072

PHOENIX
ENVIRONMENTAL SCIENCES

Malleefowl habitat assessment and targeted survey for Miscellaneous Licence L28/072

Prepared for Northern Star Resources Ltd

April 2023

Final



Malleefowl habitat assessment and targeted survey for Miscellaneous Licence L28/072

Prepared for Northern Star Resources Ltd

Version history

Author/s	Reviewer/s	Version	Version number	Date submitted	Submitted to
P. Strickland	A. Jacks	Draft for client comments	0.1	10-Jan-23	B. McGillivray
P. Strickland	A. Jacks	Final, client comments addressed	1.0	24-Apr-23	C. Reeves

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Project code: 1525-KGP-NSR-VER

EXECUTIVE SUMMARY

To inform planning and approvals for future operations, Northern Star Resource Ltd (Northern Star) commissioned Phoenix Environmental Sciences Pty Ltd (Phoenix) to undertake a targeted Malleefowl survey for Miscellaneous Licence L 28/072, located 75 km north-east of Kalgoorlie, Western Australia.

The scope of work for the survey was to:

- conduct a desktop assessment and field survey of the study area in accordance with relevant guidelines
- prepare a targeted Malleefowl survey report
- provide an Index of Biodiversity Surveys for Assessments (IBSA) data package and GIS spatial files obtained during survey, including mound locations and habitat mapping.

A desktop review of Phoenix's biological database, previous fauna surveys in the study area and a recent LiDAR survey identified 83 Malleefowl records within 40 km of the study area, eight of which were within the study area.

A field survey was conducted from 14 – 18 November 2022. Field methods for the survey included habitat assessment, Malleefowl habitat assessment and targeted Malleefowl surveys. A total of 21 sites were assessed and four high intensity searches were conducted.

Three broad fauna types were identified and mapped: *Acacia* shrubland, Open *Eucalyptus* woodland and Open *Acacia* shrubland along with small Cleared areas. The habitat of the study area was found to be suitable for Malleefowl at all sites assessed. High suitability habitat (critical habitat with nesting potential as well as primary foraging) comprised 78.6% of the study area and Medium suitability (foraging and dispersal) comprised 20.7%. The field survey recorded one Extinct Malleefowl mound and several Malleefowl tracks throughout the study area. A Malleefowl was also opportunistically observed approximately 2.5 km from the study area.

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Appendix 2 Terrestrial fauna survey site descriptions
Appendix 3 Malleefowl habitat assessment scores

ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
BoM	Bureau of Meteorology
DAWE	Department of Agriculture, Water and Environment (now the Department of Climate Changes, Energy, Environment and Water)
DBCA	Department of Biodiversity, Conservation and Attractions
DPIRD	Department of Primary Industries and Regional Development
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation Act 1999
ESA	Environmentally sensitive area
IBRA	Interim Biogeographic Regionalisation of Australia
IBSA	Index of Biodiversity Surveys for Assessments
LiDAR	Light Detection and Ranging
NMMM	National Malleefowl Monitoring Manual
WA	Western Australia

1 INTRODUCTION

To inform planning and approvals for future operations, Northern Star Resources Ltd (Northern Star) requires a targeted Malleefowl survey of Miscellaneous Licence L28/072, located 75 km northeast of Kalgoorlie, Western Australia (WA; Figure 1-1).

In March 2022, Phoenix Environmental Sciences Pty Ltd (Phoenix) was commissioned by Northern Star to undertake Malleefowl habitat assessments and targeted searches for the Project.

The purpose of the survey was to determine the extent, type, and quality of Malleefowl habitat within the Project area. The key aims are to:

1. Provide a description of the proposed site, including location, size, current condition and relevant ecological/species habitat features, landscape context and cadastre boundaries of the sites, supported by mapping in accordance with DAWE (2021)
2. Baseline survey information to determine the extent, type and quality of Malleefowl habitat within the study area that was conducted in accordance with the National Malleefowl Monitoring Manual (NMMM) (NMRT 2022) and EPA guidelines for fauna surveys (EPA 2016a, 2020)

The study area is located in the City of Kalgoorlie-Boulder and the Eremaean Climatic Region as defined by EPA (2020).

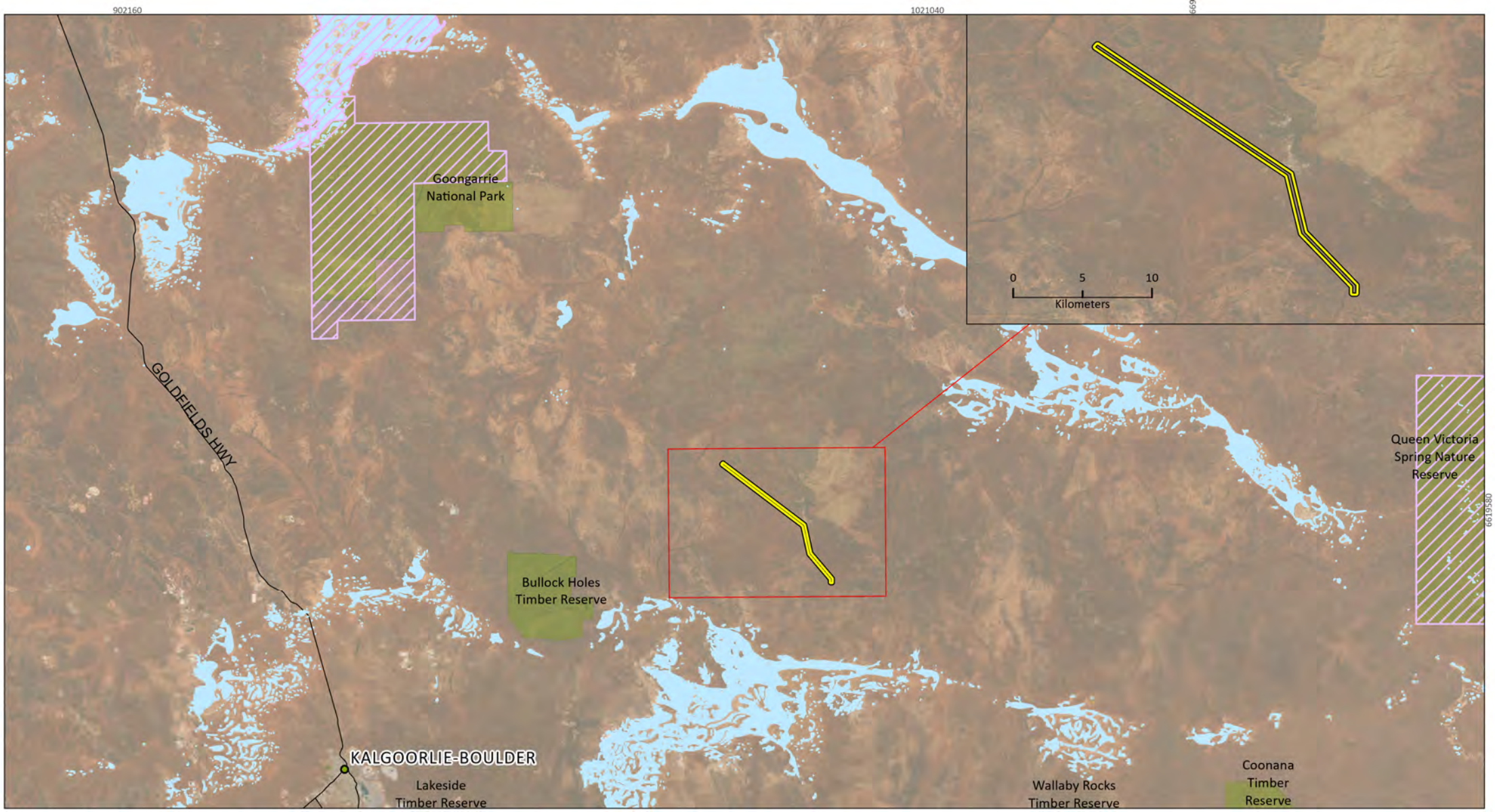
1.1 SCOPE OF WORK

The scope of work for the Malleefowl habitat assessments and targeted searches was as follows:

- conduct a desktop assessment and field survey of the study area in accordance with the NMMM (NMRT 2020) and other relevant guidelines
- prepare a targeted Malleefowl survey report outlining components listed in the aims above
- provide an Index of Biodiversity Surveys for Assessments (IBSA) data package and GIS spatial files obtained during survey, including mound locations and habitat mapping.
- prepare a separate memo which outlines an assessment of the Project against EPBC Significant Impact Guidelines.

1.2 STUDY AREA

The study area includes the miscellaneous licence area and a 100 m buffer (Figure 1-1). It is approximately 1,002 ha in size.





Northern Star Resources Ltd
Kurnalpi Gold Project

Project No	1525
Date	24/04/2023
Drawn by	BK
Map author	PS

0 12.5 25
Kilometers

1:760,800(at A4) GDA 1994 MGA Zone 51

All information within this map is current as of 24/04/2023. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.

- Study area
- Environmentally sensitive areas
- Lake
- DBCA managed land

Figure 1-1

Project location and study area

PHOENIX
ENVIRONMENTAL SCIENCES

2 EXISTING ENVIRONMENT

2.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is located in the Eastern Murchison subregion (MUR1) of the Murchison bioregion (Figure 2-1) which is characterised by (Cowan 2001) as:

> "The northern parts of the 'Southern Cross' and 'Eastern Goldfields' Terrains of the Yilgarn Craton. Characterised by its internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development. Salt lake systems associated with the occluded Paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and Halosarcia (now *Tecticornia*) shrublands."

2.2 LAND SYSTEMS AND SURFACE GEOLOGY

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

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

Table 2-1 Land systems and extent in study area

Land system	Description	Area (ha)	% of study area
Waguin System	Sandplains and stripped granite or laterite surfaces with low fringing breakaways and lower plains; supports bowgada and mulga shrublands with wanderrie grasses and minor halophytic shrublands.	26.5	2.64
Kirgella System	Gently undulating sandplains, with scattered granite outcrop supporting spinifex hummock grasslands, mulga shrublands and mallees.	424.8	42.37
Yowie System	Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.	551.3	54.99
	Total	**1,002.5**	**100**

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

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

Surface geology	Abbreviation	Description	Area (ha)	% of study area
colluvium 38491	Qrc	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked laterite	415.6	41.46
sand plain 38499	Czs	Sand or gravel plains; quartz sand sheets commonly with ferruginous pisoliths or pebbles, minor clay; local calcrete, laterite, silcrete, silt, clay, alluvium, colluvium, aeolian sand	586.9	58.54
		Total	**1,002.5**	**100**





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Study area

Region, subregion

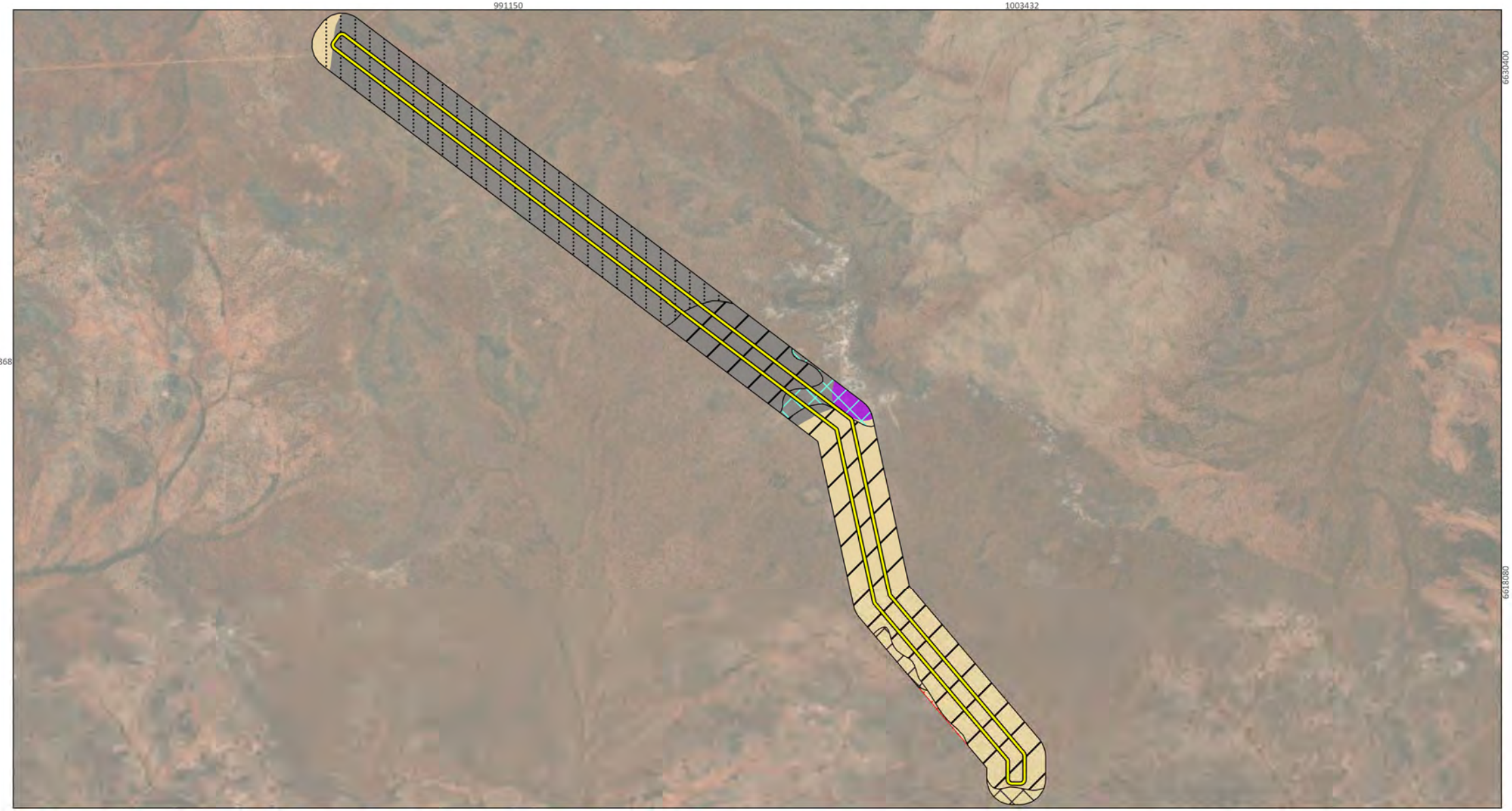
Coolgardie,Eastern Goldfield

Murchison,Eastern Murchison

Figure 2-1

Study area in relation to IBRA bioregions and subregions

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Study area

Land systems
- Campsite System
- Kirgella System
- Moriarty System
- Waguin System
- Yowie System

Surface geology
- Agh
- Czs
- Qrc

Figure 2-2
Land systems and surface geology in the study area

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2.3 CLIMATE AND WEATHER

The climate of the Eastern Murchison subregion is described as arid, with 200 mm of mainly winter rainfall (Cowan 2001). The nearest Bureau of Meteorology (BoM) weather station with comprehensive data collection and recent historic climate data is Kalgoorlie-Boulder Airport (no. 012038, Latitude: 30.78°S Longitude 121.45°E), located 90 km southwest of the study area.

Kalgoorlie-Boulder Airport records the highest mean maximum monthly temperature (33.7°C) in January (lowest in July, 16.9°C) and the lowest minimum mean monthly temperature (5.1°C) in July (highest in January, 18.3°C) (BoM 2022) (Figure 2-3). Median annual rainfall is 254 mm with May, June and July recording the highest monthly median (18.6, 18.6 and 20 mm respectively; Figure 2-3).

Daily mean temperatures at Kalgoorlie-Boulder Airport in the year preceding the survey were relatively consistent with long-term averages. Temperatures were slightly hotter than average for summer 2021/2022 and cooler than average in the spring, particularly October and November (2.1 and 2.0 °C respectively) (Figure 2-3).

Records from Kalgoorlie-Boulder Airport show that rainfall in the 12 months preceding the survey (188.2 mm) was less than the median annual rainfall (254 mm) but rainfall in the months preceding the survey was higher than usual with August and September (41.2 and 26.2 mm respectively) receiving a combined 41 mm more than average. Rainfall during the month of the survey was only slightly higher than average and 7 mm fell during the field survey (Figure 2-3).

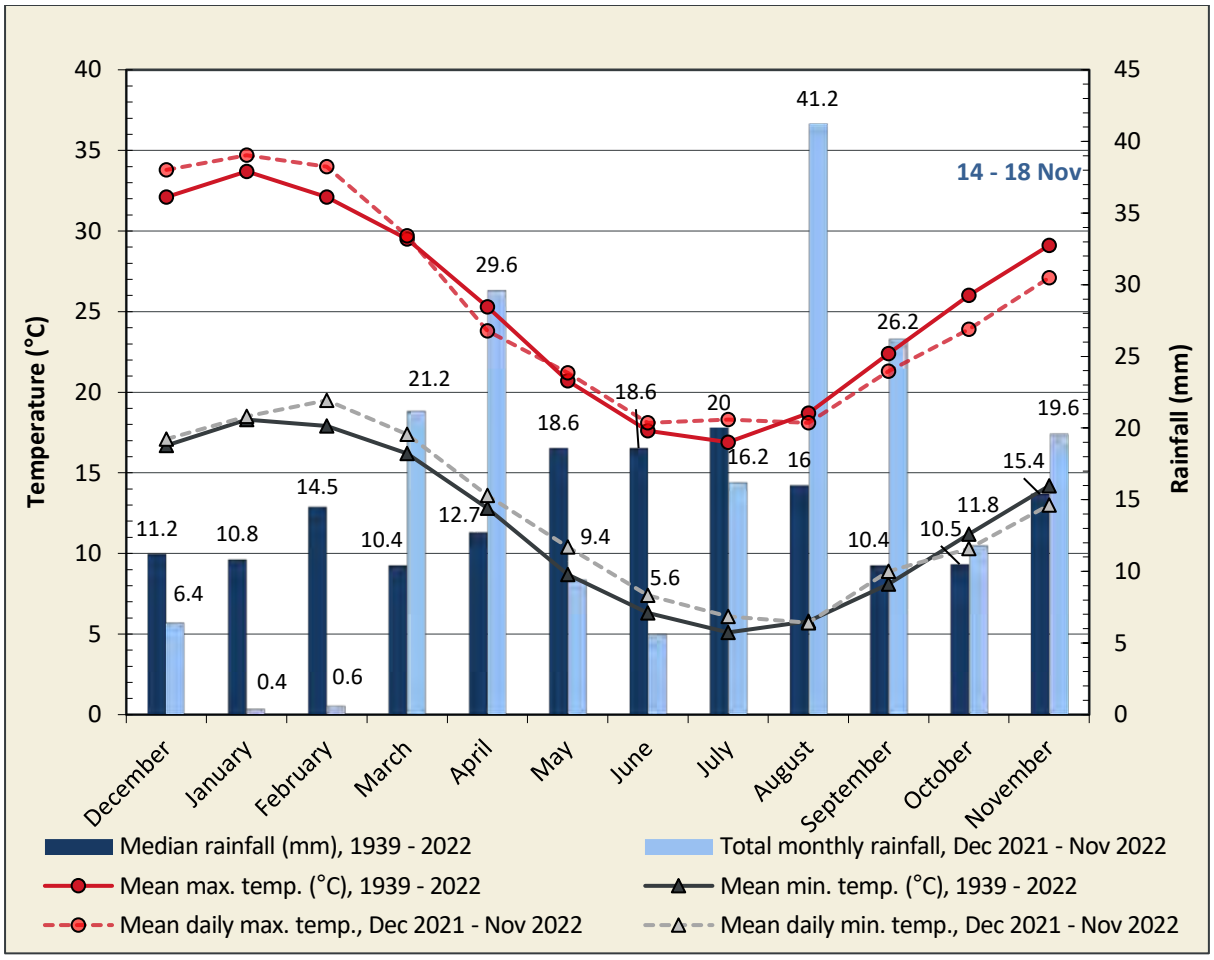


Figure 2-3 **Annual climate and weather data for Kalgoorlie-Boulder Airport (no. 012038) and mean monthly data for the 12 months preceding the survey (BoM 2022)**

2.4 LAND USE

The dominant land use within the East Murchison subregion is grazing on native pastures. This accounts for the vast majority of land use in the subregion with Unallocated Crown Land and Crown Reserves, mining and conservation making up the remainder (Cowan 2001).

2.5 CONSERVATION RESERVES AND ESAS

No conservation reserves or environmentally sensitive areas (ESAs) intersect with the study area. The nearest reserve is Bullock Holes Timber Reserve which is approximately 35 km west of the study area. Goongarrie National Park is approximately 50 km northwest of the study area and overlaps an unnamed ESA (Figure 1-1).

3 METHODS

The habitat assessment and targeted Malleefowl survey was conducted in accordance with relevant survey guidelines and guidance, including:

- *EPA Environmental Factor Guideline: Terrestrial fauna* (EPA 2016a)
- *EPA Technical Guidance: Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020)
- *National Malleefowl Monitoring Manual* (NMRT 2022).

3.1 DESKTOP REVIEW

A review of background environmental information for the study area was undertaken prior to the survey. It included assessments of aerial imagery to identify areas of potentially suitable habitat based on vegetation density and searches of Phoenix's biological database for historical records of Malleefowl within a 40 km buffer of the study area. This database is composed of both Phoenix field survey records and previous desktop review data, primarily from the Department of Biodiversity, Conservation and Attractions (DBCA) Threatened and Priority Fauna database.

Previous survey reports and LiDAR data provided by Northern Star were also reviewed for Malleefowl records. In November 2021 Botanica (2022) completed a Basic fauna survey of Miscellaneous Licence L28/072. In March 2022 Northern Star commissioned a LiDAR survey of the proposed haul road study area and associated mining area (Anditi Pty Ltd 2022). The LiDAR data was ground-truthed by Northern Star environmental staff but mound activity assessments have not yet taken place at the time of writing.

3.2 FIELD SURVEY

3.2.1 Survey timing and personnel

The field survey was conducted by Paula Strickland and Brooke Quick from the 14 – 18th November in Spring 2022. The field survey and reporting was managed by staff with a minimum of 3 years' experience conducting Malleefowl surveys. No license was required for the survey as no fauna was taken or disturbed.

The personnel involved in the survey are listed in Table 3-1.

Table 3-1 Survey personnel

Name	License	Qualifications	Experience	Role/s
Caitlin Nagle	NA	MSc (Cons. Biol.)	5 years	Project management
Paula Strickland		MSc (Trop. Biol. and Cons.)	3 years	Field supervisor, reporting
Brooke Quick		BSc (Env. Sci.)	2 years	Field survey
Brigitte Kovar		BSc (GIS)	N/A	GIS, mapping

3.2.2 Malleefowl survey

Field methods for the Malleefowl survey included:

- habitat assessment (see 3.2.2.1)
- Malleefowl habitat assessment (3.2.2.2)
- targeted Malleefowl searches (3.2.2.3)

A total of 21 sites were assessed and four high intensity ground searches were conducted (Figure 3-1; Figure 3-2; Appendix 1).

3.2.2.1 Habitat assessment

Initial habitat characterisation was undertaken using various remote geographical tools, including aerial photography (Google Earth®), land system maps and topographic maps. Habitats with the potential to support Malleefowl were identified based on known habitats within the Murchison bioregion. Sites were primarily chosen to represent the best example of distinct habitats within the broader habitat associations of the study area, to allow delineation of habitat types. Habitat descriptions and characteristics were recorded at all survey sites (Figure 3-1; Appendix 2). This information was used to inform the habitat mapping of the study area which was completed at a scale of 1:10,000.

The condition of vegetation was mapped across the study area based on the appropriate condition scale for the Eremaean Botanical Province (Trudgen 1988 in EPA 2016b) (Table 3-2). The vegetation condition ratings relate to vegetation structure, the level of disturbance and weed cover at each structural layer and the ability of the vegetation unit to regenerate. Vegetation condition ranges from Excellent being the highest rating to Completely Degraded as the lowest.

Table 3-2 Vegetation condition rating scale (EPA 2016b)

Condition rating	Description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

3.2.2.2 Malleefowl habitat assessment

Malleefowl habitat was assessed in the field using a set of environmental variables based on features of Malleefowl critical for survival of the species in Western and Central Australia, as described in the National Recovery Plan (Benshemesh 2007). Individual sites were assessed with a numerical score as a basis for mapping areas of suitable habitat in the study area. The score used is an unweighted sum of binary values (zero absent, one present) for the following attributes:

- sandy substrate (sand/sandy loam/sandy clay)
- litter (leaf litter forming distinct patches under trees/shrubs or - rarely in this area - continuous blanket over soil)
- canopy (tall shrubs or trees forming more or less continuous canopy, contributing to suitable ground microclimates and screen from aerial predators)
- level (ground approximately level, tending to prevent disturbance of soil and litter by rainfall runoff)
- mallee (presence of any mallee-form *Eucalyptus* sp.)
- *Melaleuca* (presence of any *Melaleuca* sp.)
- mulga s.l. (presence of any *Acacia* sp. of subgenus *Juliflorae*)
- *Triodia* (presence of any *Triodia* sp.).

Scores of four or greater (meaning a site contained at least 50% of features that comprise critical Malleefowl habitat) were considered to represent potential Malleefowl habitat. Scores of four and five were classified as Medium suitability habitat (foraging and dispersal habitat), while scores of six or more were classified as High suitability habitat (Critical breeding habitat and primary foraging). Sites scoring three or less were classified as Unsuitable/Low suitability habitat but may still be used for dispersal and occasional foraging. If habitat features that excluded breeding potential were present, such as drainage channels, the habitat type was deemed suitable foraging and dispersal only.

Sites that attained a value of four or greater were applied to vegetation type polygons and the entire polygon assigned as potential Malleefowl habitat. Where two or more sites were assessed within a single polygon, the higher score was applied unless features of the lower-scored site(s) were more representative. Where no site occurred within a polygon, polygons were classified based on scores for similar vegetation nearby and inspection of relative vegetation density. Cleared habitat was not assessed.

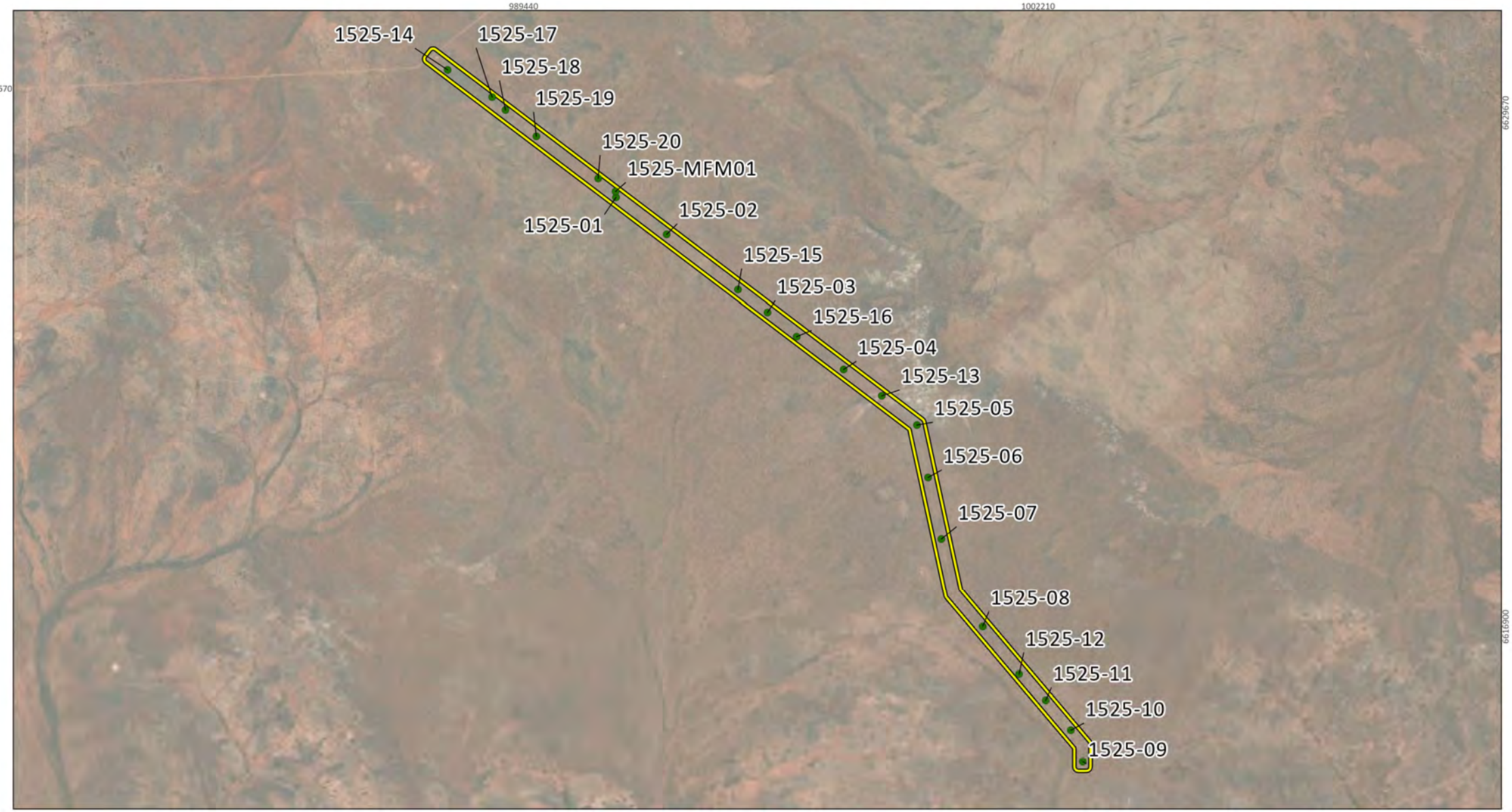
3.2.2.3 Targeted Malleefowl searches

High intensity ground searches were conducted over portions of the study area focusing on habitat considered suitable for Malleefowl. As much suitable habitat as feasible was covered by transects over the duration of the survey. Areas that were too sparse to provide adequate canopy cover for a mound, and areas of major drainage were excluded from the ground searches. Large sections of the study area that had already been thoroughly explored by LiDAR were also excluded. The team searched for signs of Malleefowl presence including tracks, scats, scraping and mounds. Systematic transects were traversed on foot by two personnel spaced 20 m apart.

Any new Malleefowl mounds found during fieldwork were GPS recorded, photographed and classified as either Active, Inactive or Long unused based on evidence of Malleefowl activity (Table 3-3). The Inactive classification was broken down into two sub-classes (sub-class 1 and sub-class 2) to provide a greater resolution on level of Malleefowl activity. Severely degraded mounds that are barely detectable in the landscape were considered to be Extinct and should not be included in future monitoring surveys.

Table 3-3 Mound status classification

Mound status	Definition
Active	Currently being used by Malleefowl as an incubator for their eggs and are likely to contain eggs.
Inactive (sub-class 1)	Mound shows signs of recent Malleefowl activity, such as fresh scats, tracks or scrapings.
Inactive (sub-class 2)	No evidence of recent activity but mound remains well formed and in good condition for future use.
Long unused / Extinct	Evidence of an extended period of inactivity such as dense shrubs or trees growing from hollow or mound very degraded/poorly formed. Highly unlikely to become Active in the future.





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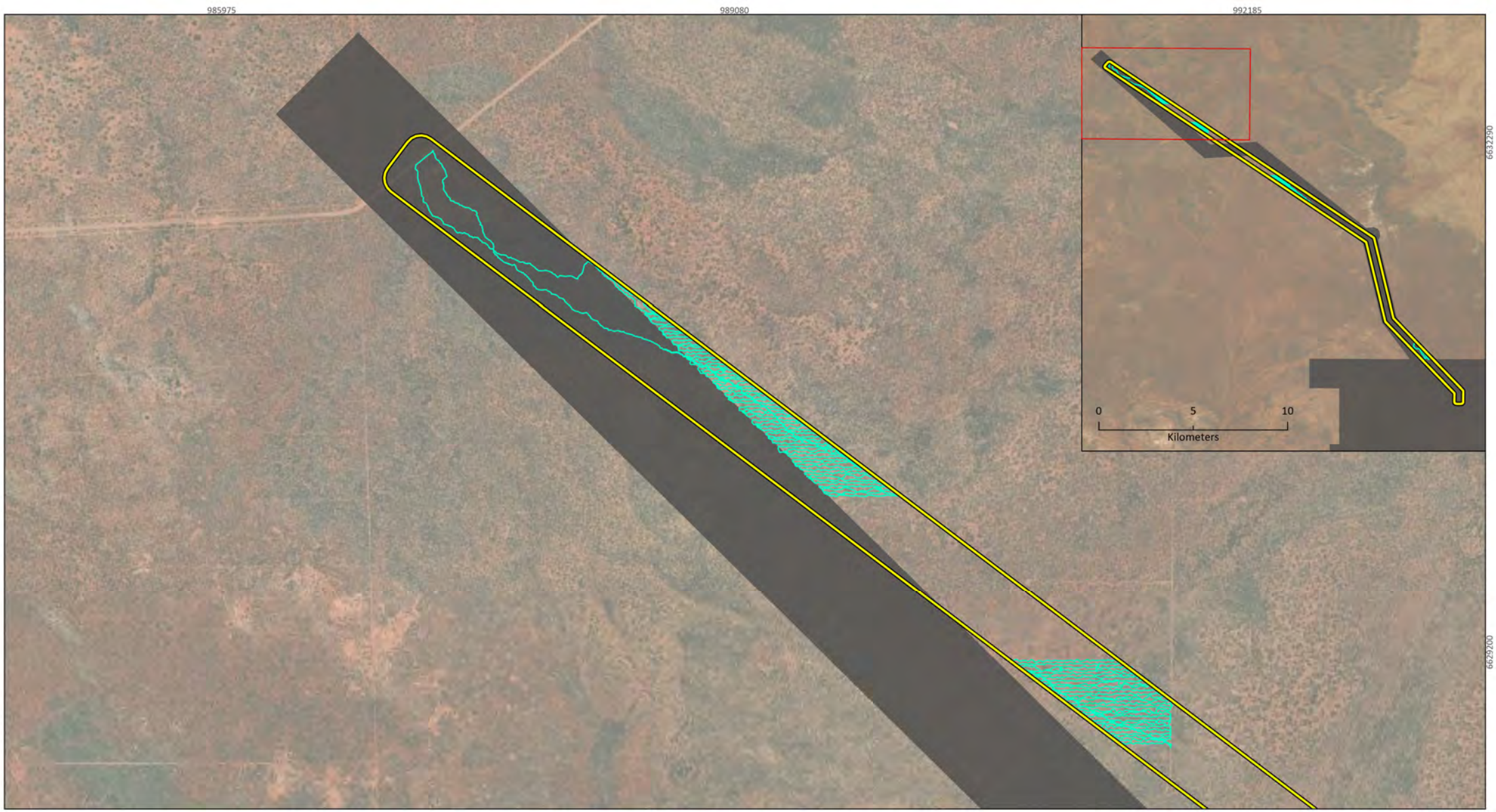
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- Study area
- Sites

Figure 3-1

Habitat assessment sites

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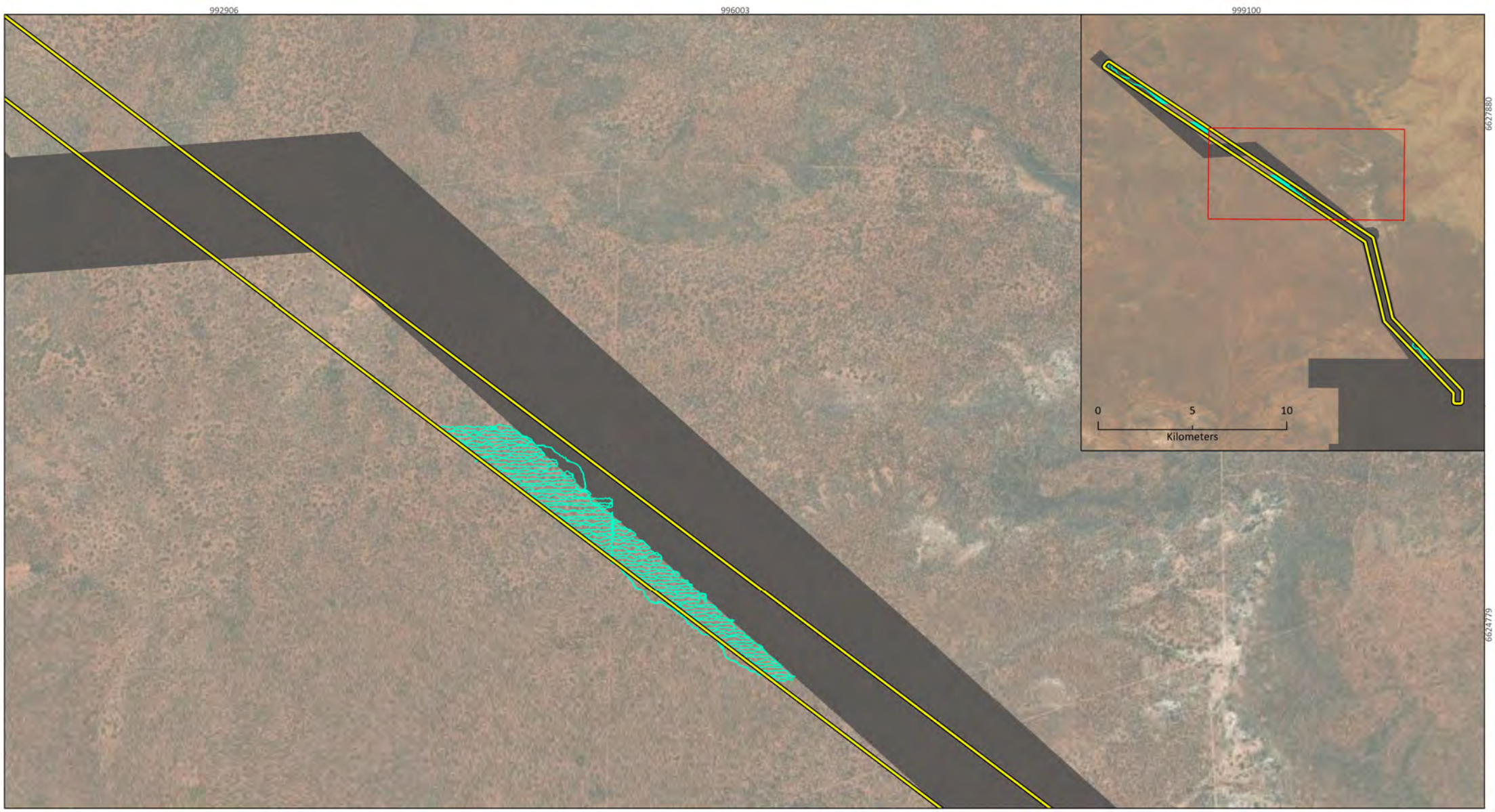
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- Study area
- LiDAR search extent
- Malleefowl transects

Figure 3-2a

Targeted Malleefowl search transects and LiDAR extent

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- Study area
- LiDAR search extent
- Malleefowl transects

Figure 3-2b

Targeted Malleefowl search transects and LiDAR extent

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- Study area
- LiDAR search extent
- Malleefowl transects

Figure 3-2c

Targeted Malleefowl search transects and LiDAR extent

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4 RESULTS

4.1 DESKTOP REVIEW

The assessment of aerial imagery for areas of dense vegetation that could potentially be suitable habitat for Malleefowl showed the densest vegetation in the north of the study area. The majority of the habitat through the middle and south of the study area is likely also dense enough to be suitable. The more open habitat at the south end may still provide suitable foraging and dispersal habitat as it is well connected with denser vegetation to the east and west outside the study area.

The habitat within the study area is continuous outside the study area and well connected to surrounding suitable habitat with little anthropogenic or natural barriers to Malleefowl dispersal. Roads in the area are mostly narrow dirt tracks that are rarely travelled and there are only a few areas that Malleefowl may avoid due to sparse vegetation cover.

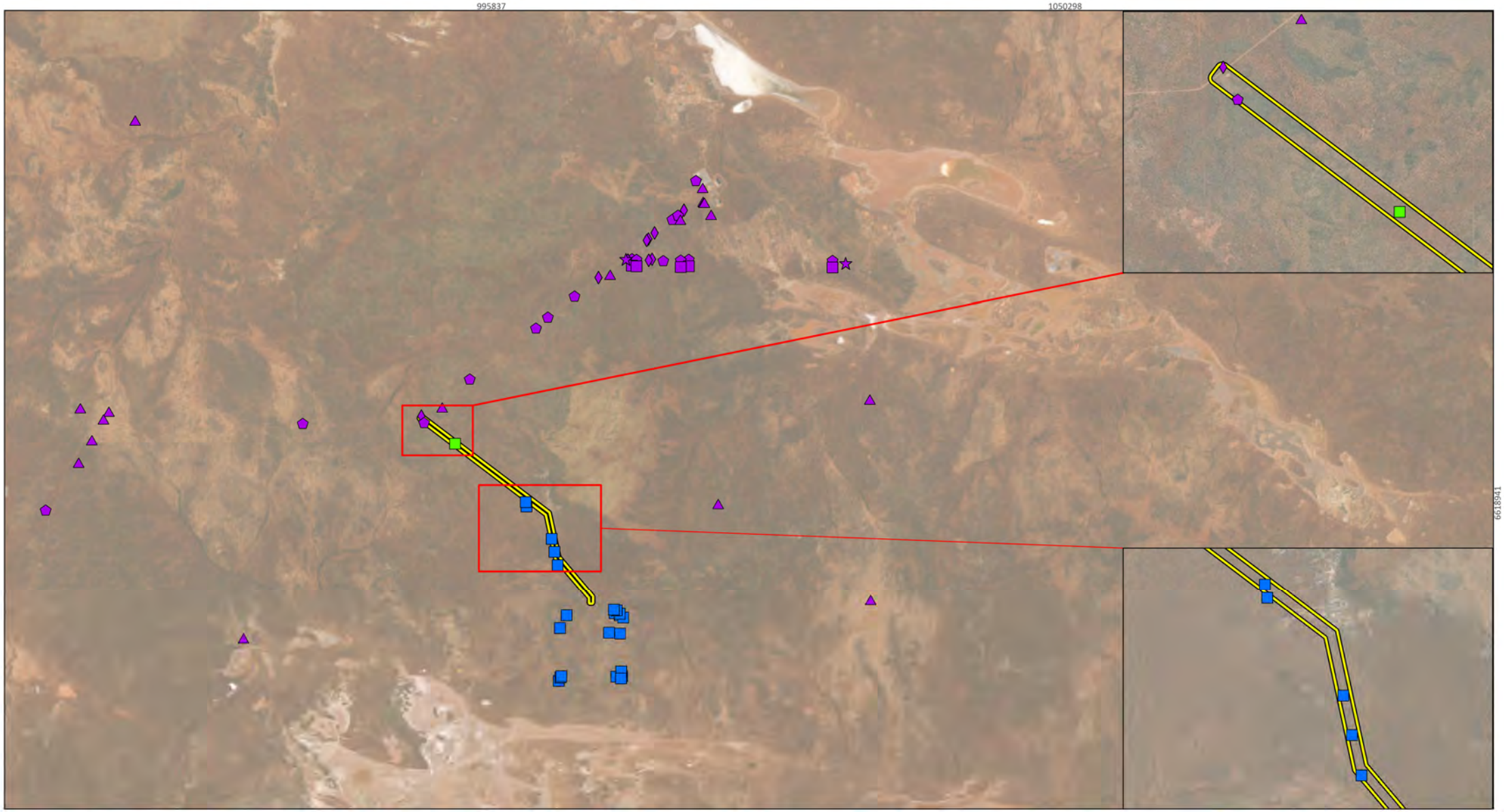
The desktop review of Phoenix's biological database identified a total of 60 Malleefowl records within a 40 km radius of the study area (Table 4-1; Figure 4-1). The majority of records were along roads or nearby the Carosue Dam mine site and village. Two records were within the study area, tracks 40 m north of the Carosue Dam Haul Road and unknown secondary evidence approximately 700 m south of the haul road (Figure 4-1).

The Botanica (2022) Basic fauna survey recorded an Inactive but well-shaped mound in the north of the study area (Table 4-1; Figure 4-1).

The LiDAR survey (Anditi Pty Ltd 2022) detected five Malleefowl mounds of unknown activity status within the southern half of the study area and 17 mounds of unknown activity status in the proposed mining area south of the study area (Table 4-1; Figure 4-1). The LiDAR mounds have been verified as mounds by Northern Star environment staff and some were noted to be Active during verification (NSR Environment staff 2022, pers. comm., 14 November) but the activity status of the mounds has not been formally assessed at the time of writing.

Table 4-1 Desktop records of Malleefowl within 40 km of study area

Source	Sightings	Secondary evidence			Unknown	Total
		Mounds	Tracks	Unknown		
Phoenix's biological database	20	5	13	20	2	60
Botanica (2022) fauna survey		1				1
Anditi Pty Ltd (2022) LiDAR		22				22
Total	**20**	**28**	**13**	**20**	**2**	**83**





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Study area

Source

- Botanica 2022
- Northern Star (Anditi 2022) LiDAR
- Phoenix biological databse

Evidence

- △ Direct sighting
- □ Mound
- ⬠ Secondary sign
- ◊ Tracks
- ☆ Unknown

Figure 4-1

Desktop records of Malleefowl within 40 km of study area

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4.2 FIELD SURVEY

4.2.1 Habitats

Three broad fauna habitat types were identified in the study area, comprising of *Acacia* shrubland, Open *Eucalyptus* woodland and Open *Acacia* shrubland (Table 4-2; Figure 4-2). *Acacia* shrubland and Open *Eucalyptus* woodland occupy the majority of the study area at 62.9 and 31.6% respectively with the remainder comprised of Open *Acacia* shrubland (4.7%). The remaining 0.8% is Cleared. All three habitats represent suitable Malleefowl habitat (Table 4-2). These habitats are visibly continuous outside the study area on aerial imagery and extensive in the region (Cowan 2001). Based on the aerial imagery, much of the surrounding habitat is also likely to be suitable for Malleefowl, excepting salt lakes and large, recent burn scars which lack the native vegetation necessary for Malleefowl to forage, construct mounds and shelter from predators.

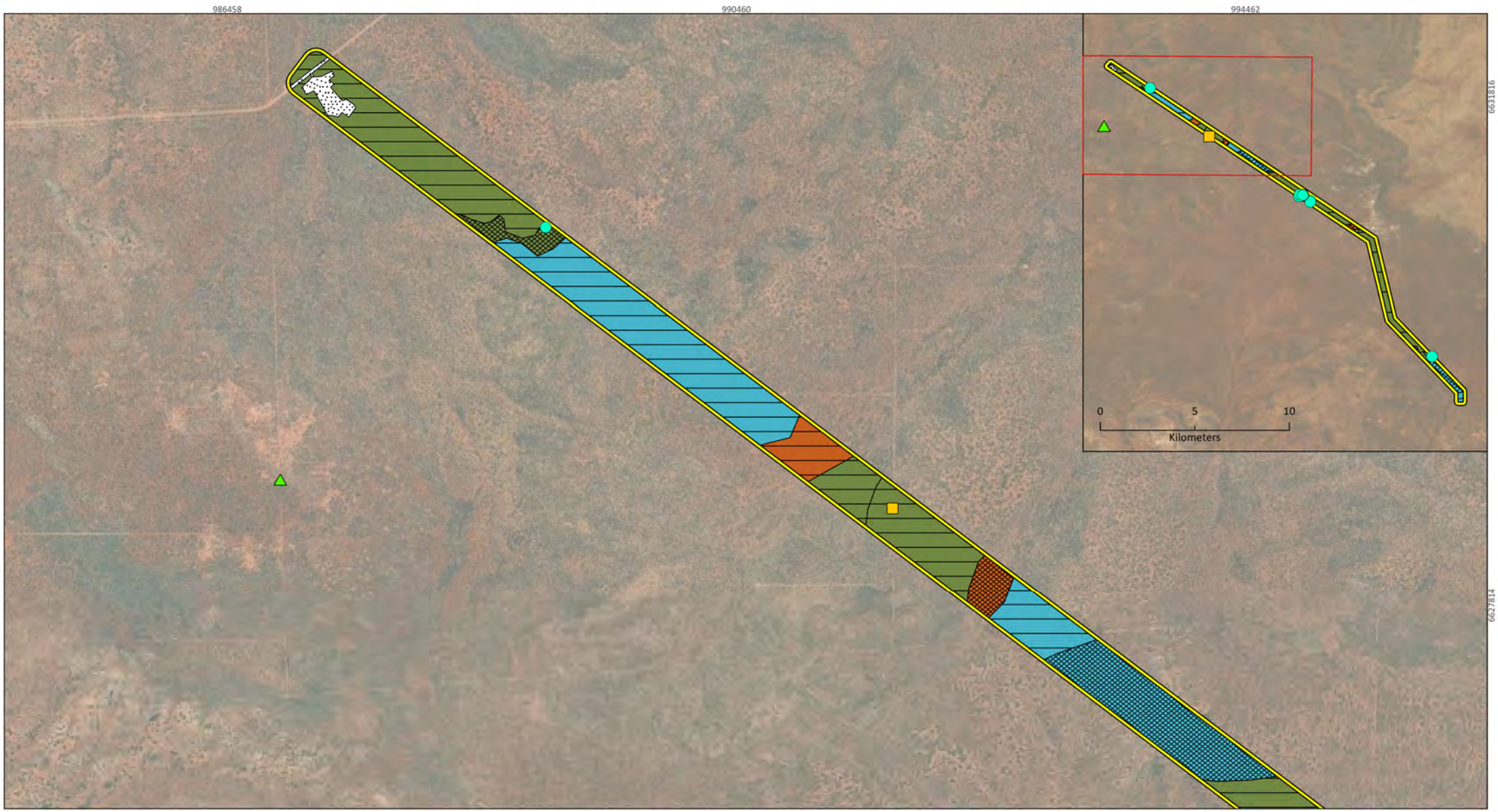
The vegetation condition within the study area was generally Very Good with areas of Excellent condition exhibiting intact vegetation structure and few disturbances. The most frequent disturbances were old vehicle tracks, light livestock presence and evidence of feral herbivores such as camels and rabbits.

Small areas of minor disturbance such as unsealed access tracks are not distinguished from adjacent natural vegetation due to the coarse scale of mapping and the fact that they may be used by fauna for dispersal and foraging.

Table 4-2 Extent and description of each fauna habitat in the study area

Habitat type	Site/s	Description	Extent in study area (ha) and % of study area	Representative photograph
1. Acacia shrubland	1525-01, 1525-03, 1525-04, 1525-05, 1525-06, 1525-07, 1525-08, 1525-12, 1525-14, 1525-15, 1525-16, 1525-17, 1525-18, 1525-MFM01	Medium to tall *Acacia* shrubland with scattered mallee eucalypts over variable mixed shrubs of *Eremophila*, *Maireana*, *Allocasuarina* and *Grevillea* over low Myrtaceae shrubs and occasionally spinifex on a sandy clay plain. Malleefowl: High suitability	630.9 (62.9%)	
2. Open eucalyptus woodland	1525-02, 1525-09, 1525-10, 1525-11, 1525-19	Open mallee *Eucalyptus* woodland over variable density mixed shrubs of *Eremophila*, *Acacia*, *Allocasuarina*, *Maireana*, *Atriplex* and *Santalum* over mixed low shrubs and occasionally spinifex on a sand or clay plain. Malleefowl: Medium to High suitability depending on understory density	317.1 (31.6%)	

Habitat type	Site/s	Description	Extent in study area (ha) and % of study area	Representative photograph
3. Open acacia shrubland	1525-13, 1525-20	Open low to medium tall *Acacia* shrubland with scattered mallee eucalypts over variable mixed shrubs of *Eremophila* and *Atriplex* over mixed low shrubs and spinifex on a sandy clay plain. Malleefowl: Medium to High suitability depending on understory density	46.8 (4.7%)	
Cleared	-	Cleared for infrastructure eg. roads	7.7 (0.8%)	-
		Total	**1,002.5**	





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- Study area

Habitat
- Acacia shrubland
- Cleared
- Open Acacia shrubland
- Open Eucalyptus woodland

Malleefowl records
- Direct sighting
- Mound extinct
- Tracks

Malleefowl habitat suitability
- High
- Medium
- NA

Figure 4-2a

Malleefowl habitat type and suitability, and records from the field survey

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- Study area

Habitat
- Acacia shrubland
- Cleared
- Open Acacia shrubland
- Open Eucalyptus woodland

Malleefowl records
- Direct sighting
- Mound extinct
- Tracks

Malleefowl habitat suitability
- High
- Medium
- NA

Figure 4-2b

Malleefowl habitat type and suitability, and records from the field survey

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- Study area

Habitat
- Acacia shrubland
- Cleared
- Open Acacia shrubland
- Open Eucalyptus woodland

Malleefowl records
- Direct sighting
- Mound extinct
- Tracks

Malleefowl habitat suitability
- High
- Medium
- NA

Figure 4-2c

Malleefowl habitat type and suitability, and records from the field survey

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4.2.2 Malleefowl habitat assessment

The habitat was found to be suitable to support Malleefowl at all 21 assessed sites. Seventeen of the sites (81%) were classified as High habitat suitability (critical habitat with potential for nesting as well as primary foraging; score of six or more) with the remaining four sites classified as Medium suitability (foraging and dispersal habitat; 17%). High suitability sites were mostly located in the *Acacia* shrubland habitat but were also present in Open *Eucalyptus* woodland and Open *Acacia* shrubland (Table 4-3).

Malleefowl habitat suitability scores from assessed sites were used to extrapolate suitability for the entirety of the study area (Figure 4-2). Based on the assessed sites, 787.5 ha (78.6%) of the habitat in the study area was classified as High suitability habitat and 207.3 ha (20.7%), was classified as Medium suitability habitat (Table 4-3).

Table 4-3 Malleefowl habitat assessment scores

Malleefowl habitat suitability	Score	Survey sites	Habitat type	Extent (ha) and % of study area	Total sites and %
Unsuitable/Low	0				
	1				
	2				
	3				
Medium	4	1525-10, 1525-11, 1525-13	Open *Eucalyptus* woodland, Open *Acacia* shrubland	207.3 (20.7%)	3 (14.3%)
	5	1525-18	*Acacia* shrubland		1 (4.8%)
High	6	1525-02, 1525-03, 1525-04, 1525-05, 1525-06, 1525-07, 1525-08, 1525-09, 1525-12, 1525-14, 1525-15, 1525-16, 1525-17, 1525-20	*Acacia* shrubland, Open *Eucalyptus* woodland, Open *Acacia* shrubland	787.5 (78.6%)	14 (66.7%)
	7	1525-01, 1525-19, 1525-MFM01	*Acacia* shrubland, Open *Eucalyptus* woodland		3 (14.3%)
	8				
			Total	**994.8 (99.2%)***	**21 (100%)**

*excludes Cleared habitat (7.7 ha, 0.8%)

4.2.3 Targeted searches

One old, degraded Malleefowl mound that was classified as Extinct was recorded in *Acacia* shrubland habitat approximately 6 km from the north of the study area (1525-MFM01; Table 4-4; Figure 4-2). Malleefowl tracks were recorded throughout the study area in three of the four transect searches and a Malleefowl was seen on an unsealed access track approximately 2.5 km southwest of the border of the study area (Table 4-4; Figure 4-2). As searches did not cover the entirety of the study area, it is probable that additional signs of use by Malleefowl were not detected during the field survey, particularly in areas of densely vegetated suitable habitat.

Table 4-4 Malleefowl records from the study area

Site	Latitude	Longitude	Record	Photo
1525-MFM01,	-30.3720	122.1117	Mound – Extinct	
1525-MFtracks01	-30.4800	122.2176	Tracks	
1525-MFtracks02	-30.4031, -30.4033, -30.4035, -30.4034	122.1546, 122.1563, 122.1563, 122.1561	Tracks	
1525-MFtracks03	-30.4061, -30.4066	122.1598, 122.1597	Tracks	
1525-MFtracks04	-30.4041	122.1543	Tracks	
1525-MFtracks05	-30.3524	122.0836	Tracks	
1525-MFSighting	-30.3701	122.0617	Direct sighting	

4.2.4 Introduced fauna

Five species of introduced fauna were recorded in the study area (Table 4-5). The majority of feral predator evidence was recorded on or near vehicle access tracks.

Table 4-5 Introduced fauna recorded in the study area

Species	Record evidence	Number of records	Survey sites
Rabbit (*Oryctolagus cuniculus*)	Scats	4	1525-05, 1525-12, 1525-13, 1525-16
Cattle (*Bos taurus*)	Scats/tracks	3	1525-08, 1525-11, 1525-13
Camel (*Camelus dromedarius*)	Scats/tracks	5	1525-03, 1525-04, 1525-13, 1525-14, 1525-16
Cat (*Felis catus*)	Scats/tracks	2	1525-06, 1525-Cat
Dog/dingo (*Canis familaris*)	Tracks	3	1525-03, 1525-06, 1525-08

4.3 SURVEY LIMITATIONS

The limitations of the survey have been considered in accordance with EPA (2020) (Table 4-6).

Table 4-6 Consideration of potential survey limitations

Limitations	Constraint	Comments
Availability of contextual information at a regional and local scale	Partial	Malleefowl distribution in the Goldfields region is well known in general, but there is limited information available at the local scale for this area.
Competency/experience of the team carrying out the survey	No	The field team and report authors have sufficient experience in terrestrial biological surveys within the Goldfields region to satisfy EPA criteria and were competent in sampling the target fauna species.
Scope and completeness	No	All items in the scope were achieved.
Access within the study area	No	Where vehicle access within the study area was limited sites were visited on foot.
Timing, rainfall, season	No	The survey was conducted during the Malleefowl breeding season (October to January). Conditions during the survey were warm and mostly dry.
Disturbance that may have affected the results of the survey	No	No substantial disturbances were present within the study area which could have significantly affected the results of the survey.

5 DISCUSSION

The desktop review identified a total of 83 Malleefowl records within 40 km of the study area, 60 from Phoenix's biological database, one from the Botanica (2022) survey, and 22 from the Anditi Pty Ltd (2022) LiDAR survey. Of the records from Phoenix's biological database, two records from secondary evidence were within the study area near the intersection with the Carosue Dam Haul Road. Most of the records were along roads and in the vicinity of Carosue Dam infrastructure. The lack of records away from infrastructure suggests that much of the area is under surveyed for Malleefowl. The Botanica (2022) survey recorded one Inactive mound within the study area and the Anditi Pty Ltd (2022) LiDAR survey recorded another five mounds of unknown status within the study area and 17 in the proposed mine area to the south. While the LiDAR mounds have not been formally assessed for activity at the time of writing, some of the mounds were observed to be Active by the Northern Star environment staff who ground-truthed the mounds.

All three habitat types recorded; *Acacia* shrubland, Open *Eucalyptus* woodland and Open *Acacia* shrubland, were found to be suitable for Malleefowl with the level of suitability dependant on their structure. Based on the sites assessed, 787.5 ha (78.6%) of the habitat in the study area was classified as High suitability habitat (critical habitat with potential for nesting as well as primary foraging; score of six or more) and 207.3 ha (20.7%), was classified as Medium suitability habitat (foraging and dispersal habitat; score of 4 or 5). Cleared areas, 7.7 ha (0.8%) such as roads were not assessed for Malleefowl suitability as they lacked the necessary native vegetation for Malleefowl use. Most of the High suitability habitat was in *Acacia* shrubland, the most widespread habitat covering over 60% of the study area. Open *Eucalyptus* woodland, covering over 30% of the study area, and Open *Acacia* shrubland, just under 5%, also contained areas of High suitability habitat. Based on the aerial imagery, all broad fauna habitats occurring within the study area extend outside and are widespread in the region.

During the transect searches, one Extinct mound and several sets of tracks were recorded throughout the study area. A Malleefowl was also seen approximately 2.5 km from the study area while travelling. As searches did not cover the entirety of the study area, it is probable that additional signs of use by Malleefowl were not detected during the field survey, particularly in areas of densely vegetated suitable habitat. Based on the desktop and field survey results it is evident there is a resident breeding population of Malleefowl that utilise almost the entirety of the study area.

Introduced predators are a critical threat to Malleefowl. Secondary evidence of cats and dingos or dogs was recorded at multiple sites on or nearby vehicle access tracks. While no signs of foxes were recorded during the field survey they are likely in the area but can be difficult to detect.

6 CONCLUSION

All habitat in the study area is suitable for Malleefowl with the highest rated habitat primarily in *Acacia* shrubland habitat. Almost 80% of the habitat within the study area was classified as High suitability which is considered to be critical habitat with the potential for nesting. All habitat types extend outside the study area and are widespread in the region. Malleefowl were recorded by secondary evidence throughout the study area, and it is evident there is a breeding population resident in the area.

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Appendix 1 Survey site locations

Site name	Sample type	Latitude	Longitude
1525-01	Habitat assessment	-30.3733	122.1118
1525-02	Habitat assessment	-30.3817	122.1248
1525-03	Habitat assessment	-30.3993	122.1507
1525-04	Habitat assessment	-30.4121	122.1702
1525-05	Habitat assessment	-30.4247	122.1890
1525-06	Habitat assessment	-30.4364	122.1918
1525-07	Habitat assessment	-30.4502	122.1951
1525-08	Habitat assessment	-30.4700	122.2056
1525-09	Habitat assessment	-30.5004	122.2312
1525-10	Habitat assessment	-30.4934	122.2282
1525-11	Habitat assessment	-30.4867	122.2217
1525-12	Habitat assessment	-30.4807	122.2149
1525-13	Habitat assessment	-30.4181	122.1800
1525-14	Habitat assessment	-30.3445	122.0687
1525-15	Habitat assessment	-30.3942	122.1431
1525-16	Habitat assessment	-30.4047	122.1582
1525-17	Habitat assessment	-30.3507	122.0800
1525-18	Habitat assessment	-30.3536	122.0835
1525-19	Habitat assessment	-30.3595	122.0914
1525-20	Habitat assessment	-30.3691	122.1073
1525-MFM01	Habitat assessment/ Transect	-30.3720	122.1117
1525-Cat	Transect	-30.4017	122.1510
1525-MFtracks01	Transect	-30.4799	122.2176
1525-MFtracks02	Transect	-30.4031	122.1546
1525-MFtracks03	Transect	-30.4061	122.1598
1525-MFtracks04	Transect	-30.4041	122.1543
1525-MFtracks05	Transect	-30.3525	122.0836
1525-MFSighting	Opportunistic sighting	-30.3701	122.0617

Site details			
Site	**1525-01**	**Position (WGS84)**	-30.373349285, 122.111806646
Topography	plain	**Soil texture**	sand
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Shrubland with mallee eucalypts over mulga, calitris and eremophila over low myrtaceae shrubs over scattered spinifex on orange sand.			
Habitat	shrubland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	105	**Litter distribution**	under vegetation
Tree cover (%)	30	**Litter depth(cm)**	2
Shrub cover (%)	70	**Litter cover (%)**	40
Grass cover (%)	5		
Herb cover (%)	0		



Site details			
Site	**1525-02**	**Position (WGS84)**	-30.3816973958, 122.124778469
Topography	plain	**Soil texture**	sand
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Mallee eucalypts over eremophila and scattered acacia over low grevillea and myrtaceae shrubs over patchy spinifex on orange sand.			
Habitat	open woodland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	90	**Litter distribution**	under vegetation
Tree cover (%)	25	**Litter depth(cm)**	2
Shrub cover (%)	60	**Litter cover (%)**	25
Grass cover (%)	5		
Herb cover (%)	0		



Site details			
Site	**1525-03**	**Position (WGS84)**	-30.3992997253, 122.150652019
Topography	plain	**Soil texture**	sand,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Shrubland with mallee eucalypts and tall allocasuarina trees over mulga and eremophila over low myrtaceae shrubs over scattered herbs on orange clay sand.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	96	**Litter distribution**	under vegetation
Tree cover (%)	30	**Litter depth(cm)**	2
Shrub cover (%)	65	**Litter cover (%)**	30
Grass cover (%)	0		
Herb cover (%)	1		



Site details			
Site	**1525-04**	**Position (WGS84)**	-30.4121436479, 122.170189594
Topography	plain	**Soil texture**	sand,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Shrubland with mallee eucalypts over scattered brachychiton over mulga, eremophila and sida shrubs over sparse herbs on orange clay sand.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	101	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	2
Shrub cover (%)	60	**Litter cover (%)**	35
Grass cover (%)	0		
Herb cover (%)	1		



Site details			
Site	**1525-05**	**Position (WGS84)**	-30.4247031981, 122.189019527
Topography	plain	**Soil texture**	sand,sandy clay,gravel
Slope	negligible	**Rock type**	quartz
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Mulga shrubland with scattered mallee trees over eremophila and acacia over ptilotus and mixed herbs on orange sandy clay.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	102	**Litter distribution**	under vegetation
Tree cover (%)	35	**Litter depth(cm)**	2
Shrub cover (%)	65	**Litter cover (%)**	25
Grass cover (%)	0		
Herb cover (%)	2		



Site details			
Site	**1525-06**	**Position (WGS84)**	-30.4364335793, 122.191766272
Topography	plain	**Soil texture**	sand,sandy clay
Slope	negligible	**Rock type**	calcrete
Soil colour	orange	**Rock cover (%)**	1

Site description - visit 1 (14 Nov 2022)			
Tall mulga shrubland (5m) with scattered mallee over eremophila and pearl blue bush on orange clay sand.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	93	**Litter distribution**	under vegetation
Tree cover (%)	75	**Litter depth(cm)**	2
Shrub cover (%)	15	**Litter cover (%)**	30
Grass cover (%)	2		
Herb cover (%)	1		



Site details			
Site	**1525-07**	**Position (WGS84)**	-30.4502209905, 122.195098555
Topography	plain	**Soil texture**	sand,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Tall mulga shrubland (5m) with scattered mallee over eremophila, acacia and pearl blue bush on orange clay sand.			
Habitat	shrubland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	76	**Litter distribution**	under vegetation
Tree cover (%)	60	**Litter depth(cm)**	1
Shrub cover (%)	15	**Litter cover (%)**	30
Grass cover (%)	1		
Herb cover (%)	0		



Site details			
Site	**1525-08**	**Position (WGS84)**	-30.4699858822, 122.205621996
Topography	plain	**Soil texture**	sand,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (14 Nov 2022)			
Tall mulga shrubland with mallee eucalypts over acacia, eremophila and allocasuarina over sparse herbs and clumps of grass on orange clay sand.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	88	**Litter distribution**	under vegetation
Tree cover (%)	55	**Litter depth(cm)**	2
Shrub cover (%)	30	**Litter cover (%)**	40
Grass cover (%)	2		
Herb cover (%)	1		



Site details			
Site	**1525-09**	**Position (WGS84)**	-30.5003875095, 122.231208238
Topography	plain	**Soil texture**	sandy clay,clay,gravel
Slope	negligible	**Rock type**	quartz,chert
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (15 Nov 2022)			
Open mallee eucalypt woodland over mid to tall allocasuarina over mulga, eremophila and pearl blue bush over scattered ptilotus herbs on orange brown sandy clay with quartz and chert gravel.			
Habitat	open woodland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	82	**Litter distribution**	under vegetation
Tree cover (%)	30	**Litter depth(cm)**	1
Shrub cover (%)	50	**Litter cover (%)**	15
Grass cover (%)	1		
Herb cover (%)	1		



Site details			
Site	**1525-10**	**Position (WGS84)**	-30.4933683696, 122.228165834
Topography	plain	**Soil texture**	sandy clay,clay,gravel
Slope	negligible	**Rock type**	quartz,calcrete
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (15 Nov 2022)			
Stands of mallee eucalypts over santalum over eremophila, acacia and scattered mulga over grey bush and pearl blue bush on orange brown sandy clay with calcrete gravel.			
Habitat	open woodland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	60	**Litter distribution**	under vegetation
Tree cover (%)	20	**Litter depth(cm)**	2
Shrub cover (%)	40	**Litter cover (%)**	15
Grass cover (%)	0		
Herb cover (%)	0		



Site details			
Site	**1525-11**	**Position (WGS84)**	-30.4866655394, 122.22174379
Topography	plain	**Soil texture**	clay,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (15 Nov 2022)			
Stands of mallee eucalypts over eremophila, mulga and scattered santalum over greybush and pearl bluebush on orange brown sandy clay.			
Habitat	open woodland		
Disturbance	vehicle tracks,livestock tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	75	**Litter distribution**	under vegetation
Tree cover (%)	25	**Litter depth(cm)**	2
Shrub cover (%)	50	**Litter cover (%)**	20
Grass cover (%)	0		
Herb cover (%)	0		



Site details			
Site	**1525-12**	**Position (WGS84)**	-30.4806944071, 122.214929709
Topography	plain	**Soil texture**	clay,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (15 Nov 2022)			
Mulga shrubland with open mallee eucalypts over mulga, acacia, eremophila and santalum over scattered ptilotus on orange brown sandy clay.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	96	**Litter distribution**	under vegetation
Tree cover (%)	25	**Litter depth(cm)**	2
Shrub cover (%)	70	**Litter cover (%)**	35
Grass cover (%)	0		
Herb cover (%)	1		



Site details			
Site	**1525-13**	**Position (WGS84)**	-30.4181233567, 122.17997225
Topography	floodplain	**Soil texture**	clay,sandy clay
Slope	gentle	**Rock type**	none
Soil colour	light-brown,orange	**Rock cover (%)**	0

Site description - visit 1 (15 Nov 2022)			
Low patchy shrubland with scattered mallee over mulga, eremophila and acacia over greybush and other low chenopod shrubs with scattered ptilotus on light brown orange sandy clay.			
Habitat	shrubland		
Disturbance	evidence of feral animals,livestock tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	42	**Litter distribution**	sparse
Tree cover (%)	5	**Litter depth(cm)**	1
Shrub cover (%)	35	**Litter cover (%)**	5
Grass cover (%)	1		
Herb cover (%)	1		



Site details			
Site	**1525-14**	**Position (WGS84)**	-30.3445334358, 122.068669339
Topography	plain	**Soil texture**	sandy clay,clay
Slope	negligible	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (16 Nov 2022)			
Tall mulga shrubs (6m) over mid mulga shrubland, eremophila and acacia with sparse low mallee over myrtaceae on orange clay with scattered patches of sand.			
Habitat	shrubland		
Disturbance	evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	101	**Litter distribution**	under vegetation
Tree cover (%)	35	**Litter depth(cm)**	1
Shrub cover (%)	65	**Litter cover (%)**	25
Grass cover (%)	0		
Herb cover (%)	1		



Site details			
Site	**1525-15**	**Position (WGS84)**	-30.3941817969, 122.14309934
Topography	plain	**Soil texture**	clay,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (16 Nov 2022)			
Groves of tall mulga shrubland with scattered mallee eucalypts over tall shrubs of mulga, allocasuarina and grevillea over eremophila, acacia and smaller grevillea on orange brown sandy clay.			
Habitat	shrubland		
Disturbance	vehicle tracks,litter		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	75	**Litter distribution**	under vegetation
Tree cover (%)	35	**Litter depth(cm)**	1
Shrub cover (%)	40	**Litter cover (%)**	50
Grass cover (%)	0		
Herb cover (%)	0		



Site details			
Site	**1525-16**	**Position (WGS84)**	-30.4047263084, 122.158151485
Topography	plain	**Soil texture**	clay,sandy clay
Slope	negligible	**Rock type**	none
Soil colour	orange,brown	**Rock cover (%)**	0

Site description - visit 1 (16 Nov 2022)			
Mulga shrubland with scattered mallee eucalypts and tall allocasuarina shrubs over mulga, acacia and eremophila over sparse grasses and herbs on orange brown sandy clay.			
Habitat	shrubland		
Disturbance	vehicle tracks,evidence of feral animals		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	97	**Litter distribution**	under vegetation
Tree cover (%)	35	**Litter depth(cm)**	1
Shrub cover (%)	60	**Litter cover (%)**	35
Grass cover (%)	1		
Herb cover (%)	1		



Site details			
Site	**1525-17**	**Position (WGS84)**	-30.3506900706, 122.080036252
Topography	plain	**Soil texture**	clay,sandy clay,gravel
Slope	negligible	**Rock type**	chert
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (17 Nov 2022)			
Thick mulga shrubland with medium tall mixed mulga and acacia over mixed low shrubs of myrtaceae and eremophila on orange sandy clay with sparse gravel.			
Habitat	shrubland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	moderate (>5 years)
Total veg. cover (%)	121	**Litter distribution**	even/continuous
Tree cover (%)	80	**Litter depth(cm)**	1
Shrub cover (%)	40	**Litter cover (%)**	80
Grass cover (%)	1		
Herb cover (%)	0		



Site details			
Site	**1525-18**	**Position (WGS84)**	-30.3536046172, 122.083515796
Topography	dune	**Soil texture**	sand
Slope	gentle	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (17 Nov 2022)			
Medium high acacia shrubland on sandy hill with fringing mallee over acacia and calitris over mixed low shrubs over ring forming spinifex on orange sand.			
Habitat	shrubland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	moderate (>5 years)
Total veg. cover (%)	75	**Litter distribution**	sparse
Tree cover (%)	15	**Litter depth(cm)**	1
Shrub cover (%)	40	**Litter cover (%)**	5
Grass cover (%)	20		
Herb cover (%)	0		



Site details			
Site	**1525-19**	**Position (WGS84)**	-30.3595492524, 122.09137519
Topography	undulating plain	**Soil texture**	sand
Slope	gentle	**Rock type**	none
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (17 Nov 2022)			
Mallee woodland over mid mulga shrubs, acacia and eremophila over low mixed shrubs over sparse spinifex grasses on orange sand.			
Habitat	woodland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	moderate (>5 years)
Total veg. cover (%)	96	**Litter distribution**	under vegetation
Tree cover (%)	40	**Litter depth(cm)**	1
Shrub cover (%)	50	**Litter cover (%)**	35
Grass cover (%)	5		
Herb cover (%)	1		



Site details			
Site	**1525-20**	**Position (WGS84)**	-30.3690674204, 122.107284099
Topography	plain	**Soil texture**	sandy clay,gravel
Slope	negligible	**Rock type**	chert
Soil colour	orange	**Rock cover (%)**	0

Site description - visit 1 (18 Nov 2022)			
Scattered mallee over acacia and mulga shrubs over mixed low shrubs over spinifex grass on orange sandy clay.			
Habitat	shrubland		
Disturbance	none evident		
Vegetation condition	Excellent	**Fire age**	moderate (>5 years)
Total veg. cover (%)	60	**Litter distribution**	under vegetation
Tree cover (%)	20	**Litter depth(cm)**	1
Shrub cover (%)	35	**Litter cover (%)**	15
Grass cover (%)	5		
Herb cover (%)	0		



Site details			
Site	**1525-MFM01**	**Position (WGS84)**	-30.3720285586, 122.111704355
Topography	plain	**Soil texture**	sand
Slope	negligible	**Rock type**	none
Soil colour	yellow	**Rock cover (%)**	0

Sample and effort summary

Visit	Sample method	Sample quant. (hrs)	Repli-cation	Date start	Date stop
1	Transect	0	1	18 Nov 2022	18 Nov 2022

Site description - visit 1 (18 Nov 2022)

Acacia shrubland with scattered mallee eucalypts over medium high acacia over melaleuca and myrtaceae shrubs on yellow sand.

Habitat	shrubland		
Disturbance	vehicle tracks		
Vegetation condition	Very Good	**Fire age**	moderate (>5 years)
Total veg. cover (%)	97	**Litter distribution**	under vegetation
Tree cover (%)	70	**Litter depth(cm)**	1
Shrub cover (%)	25	**Litter cover (%)**	60
Grass cover (%)	1		
Herb cover (%)	1		



Appendix 3 Malleefowl habitat assessment scores

Site name	Sand	Leaf litter	Canopy cover	Level ground	Mallee	Melaleuca	Mulga	Triodia	Score	Malleefowl habitat	Habitat suitability
1525-01	1	1	1	1	1	0	1	1	7	Yes	High
1525-02	1	1	1	1	1	0	0	1	6	Yes	High
1525-03	1	1	1	1	1	0	1	0	6	Yes	High
1525-04	1	1	1	1	1	0	1	0	6	Yes	High
1525-05	1	1	1	1	1	0	1	0	6	Yes	High
1525-06	1	1	1	1	1	0	1	0	6	Yes	High
1525-07	1	1	1	1	1	0	1	0	6	Yes	High
1525-08	1	1	1	1	1	0	1	0	6	Yes	High
1525-09	1	1	1	1	1	0	1	0	6	Yes	High
1525-10	1	0	0	1	1	0	1	0	4	Yes	Medium
1525-11	1	0	0	1	1	0	1	0	4	Yes	Medium
1525-12	1	1	1	1	1	0	1	0	6	Yes	High
1525-13	1	0	0	1	1	0	1	0	4	Yes	Medium
1525-14	1	1	1	1	1	0	1	0	6	Yes	High
1525-15	1	1	1	1	1	0	1	0	6	Yes	High
1525-16	1	1	1	1	1	0	1	0	6	Yes	High
1525-17	1	1	1	1	1	0	1	0	6	Yes	High
1525-18	1	0	0	1	1	0	1	1	5	Yes	Medium
1525-19	1	1	1	1	1	0	1	1	7	Yes	High
1525-20	1	1	0	1	1	0	1	1	6	Yes	High
1525-MFM01	1	1	1	1	1	1	1	0	7	Yes	High



Appendix J: Malleefowl Impact Assessment (2024)

Technical memorandum

To: Cliff Bennison <CBennison@nsrltd.com>

From: Caitlin Nagle <caitlin.nagle@phoenixenv.com.au>

Date: 09 October 2024

Subject: Kurnalpi Haul Road Project – Significant Fauna Impact Assessment

1 INTRODUCTION

Phoenix Environmental Sciences Pty Ltd (Phoenix) performed a targeted Malleefowl survey for the Kurnalpi Haul Road Project on Miscellaneous Licence (ML) L28/72, located 75 km north-east of Kalgoorlie, Western Australia in November 2022 (Figure 1), and provided a full report which was finalised in April 2023 (Phoenix 2023c). The purpose of the Malleefowl survey was to inform planning and approvals for construction of a potential haul road connecting the existing Carosue Dam access road to the proposed Kurnalpi gold mine (the Proposed Action).

The ML area is 497.75 ha, 26.86 km long by ~230 m wide. A portion of the proposed alignment (4.33 km) follows an existing single-lane track. The targeted Malleefowl assessment comprised a survey of the L28/72 survey area and a 100 m buffer (Figure 1).

This Memo documents an assessment of the Proposed Action against the *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act) Significant Impact Guidelines and determine whether referral under EPBC Act would be required.

For the purposes of this assessment, ML L28/72 is considered the Development Envelope (DE) for the Proposed Action. Within the DE, a corridor up to 30 m wide will be cleared. This will result in clearing up to 80.6 ha (approx. 30 m x 26 km) within the 498 ha DE. There will be flexibility during design of the haul road to align this corridor to avoid Malleefowl nesting mounds.

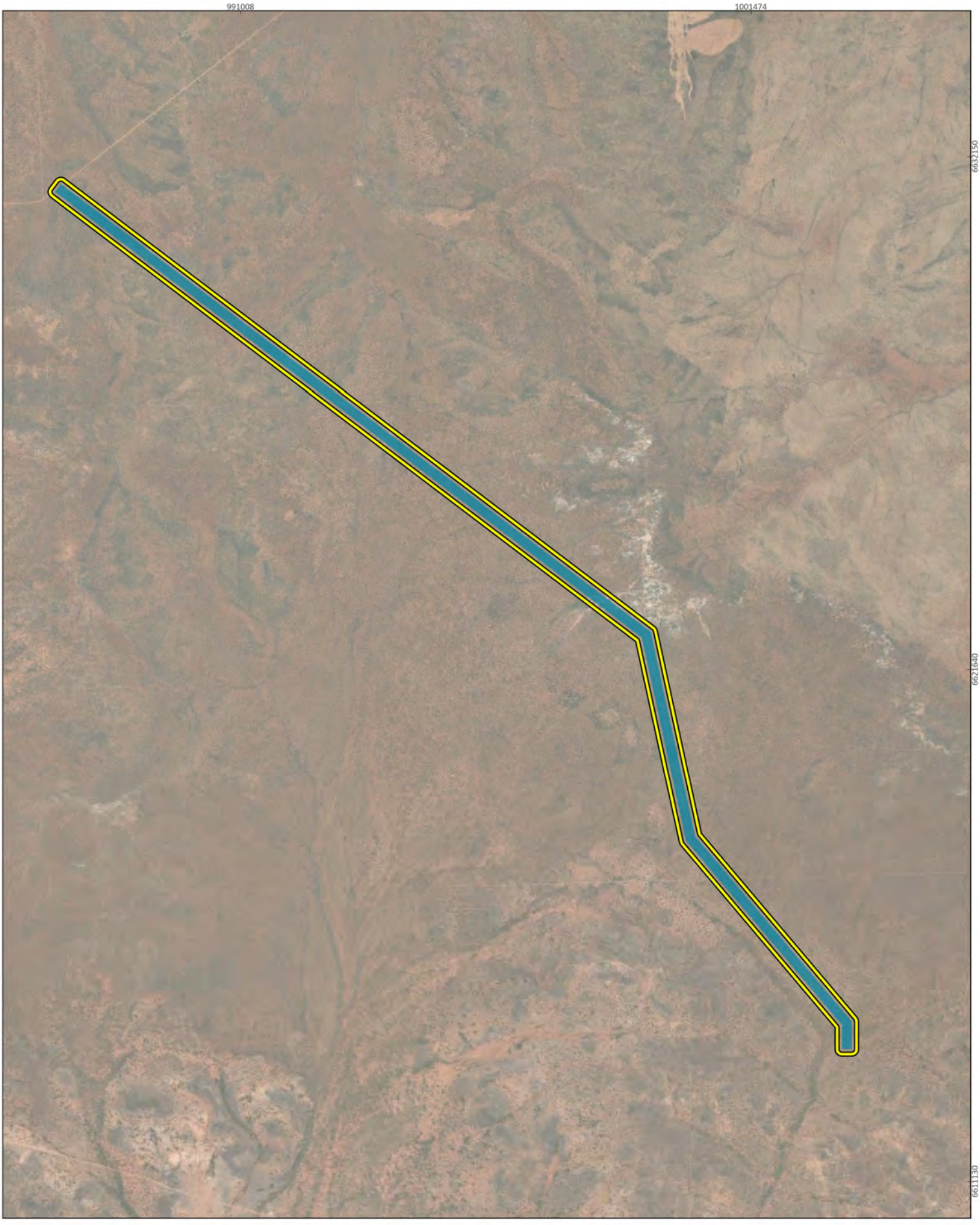
The Targeted Malleefowl survey results indicate the survey area consists mainly of high quality Malleefowl habitat, which is widespread and continuous in the vicinity. There is a resident population of Malleefowl utilising the habitat in the area, evidenced by mounds and tracks within the survey area, as well as direct sightings of Malleefowl in the vicinity (Phoenix 2023c).

The assessment contained in this memo relates only to the Proposed Action and does not consider potential impacts relating to separate actions outside the survey area (such as the construction or operation of a mine).

2 METHODS

2.1 ASSESSMENT AGAINST EPBC SIGNIFICANT IMPACT GUIDELINES

The EPBC Act Matters of National Environmental Significance - Significant Impact Guidelines 1.1 (DoE 2013) (the Guidelines) outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether it is necessary to submit a referral to the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. This process is followed here.





Northern Star Resources Ltd
Kurnalpi Gold Project

Project No	1525
Date	9/10/2024
Drawn by	BK
Map author	JS

0 1.5 3
Kilometers

1:100,105 (at A4) GDA 1994 MGA Zone 51

All information within this map is current as of 9/10/2024. This product is subject to COPYRIGHT and is property of Phoenix Environmental Sciences (Phoenix). While Phoenix has taken care to ensure the accuracy of this product, Phoenix make no representations or warranties about its accuracy, completeness or suitability for any particular purpose.

Targeted Malleefowl survey study area

Tenement

L 28/72

Figure 1

ML L28/72 area and Malleefowl survey study area

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3 REFERRAL CONSIDERATIONS

The guidelines provide the following considerations to determine if an action requires referral (DoE 2013):

1. Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?
2. Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities, and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?
3. Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?
4. Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?

3.1 SIGNIFICANT IMPACT CRITERIA: TERMINOLOGY

An action is likely to have a **significant impact** on a vulnerable species if there is a real chance or possibility that it will (DoE 2013):

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

A '**significant impact**' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DoE 2013).

An '**important population**' is a population that is necessary for a species' long-term survival and recovery. This may include populations that are (DoE 2013):

- identified as such in recovery plans

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

'**Habitat critical to the survival of a species**' refers to areas that are necessary (DoE 2013):

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species (including the maintenance of species essential to the survival of the species, such as pollinators)
- to maintain genetic diversity and long-term evolutionary development, or
- for the reintroduction of populations or recovery of the species.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species as habitat critical for that species; and/or habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act (DoE 2013).

3.2 RELATIVE EXTENT OF POTENTIAL IMPACT

The following spatial datasets were considered in order to extrapolate habitat attributes and estimate the extent of suitable Malleefowl habitat and maximum area that may be directly impacted by the Project, in the context of a desktop search area comprising the survey area plus a 40 km buffer:

- ESRI World Imagery (ESRI *et al.* 2023) and Google Satellite imagery (Google 2023); both are composites of images taken at different dates, so that some parts of each are more recent than the other and show unique areas of recent clearing
- Water features (Geoscience Australia 2020)
- Pre-European Vegetation types (DPIRD 2018)
- Native Vegetation Extent (DPIRD 2020)
- DBCA Fire history (DBCA 2023) – shapefile of polygons showing approximate extent of burnt vegetation extending back to the 1970s. Benshemesh *et al.* (2020) "…found strong evidence for a positive effect of time since fire (0.298; 95% CI 0.179, 0.399), and an interaction between time since fire and the proportion of a site burnt (0.292; 95% CI 0.173, 0.410) on Malleefowl breeding activity. A standard deviation increase in the number of years since a fire (17 years) increased breeding activity on average by 33.1%. The proportion of a site burnt was negatively associated with breeding activity (−0.191; 95% CI −0.363, −0.030)." Due to variable intensity of fires and rate of recovery, recency of fire is not simply related to current vegetation cover; some fire scars dating from the 1980s remain sharply distinct in aerial imagery, while some more recent fires have had no obvious impact.

Based on the above spatial datasets and imagery, habitat classes relevant to Malleefowl breeding and foraging values were mapped and attributed for the area including a 40 km buffer around the survey area, using open-access GIS software (QGIS Development Team 2021). This mapping was undertaken on a broader scale and lower resolution than in the targeted survey (Phoenix 2023c) but with reference to site descriptions from previous work (Phoenix 2023d). Polygons were attributed to one of the following classes:

- **Cleared** – areas cleared for roads (other than single-lane unsealed access tracks), mines, and associated infrastructure, water storage dams etc., some partially regenerating as very low or open shrubland; negligible habitat value for Malleefowl
- **Open** – naturally bare or sparsely vegetated areas including lakes, salt lake playa, extensive rock outcrop, scars of recent or intense fires, and sparse shrubland dominated by chenopods or hummock grass; marginal habitat value, unsuitable for breeding, and of low value for foraging, may be used by Malleefowl infrequently for dispersal between other habitat types but associated with increased predation risk due to visual exposure (e.g. Phoenix 2022c)
- **Drainage** – drainage lines with distinct channels or relatively dense fringing vegetation, may be used by Malleefowl for foraging but unlikely to support nesting
- **Suitable** – shrublands and low woodlands not dissected by drainage and with adequate tree/shrub cover to provide leaf litter, thermal shelter and visual screening from predators; presumed to represent foraging and potential nesting habitat for any resident Malleefowl.

or combined categories:

- **Suitable (mosaic)** – areas of suitable shrubland/woodland habitat interspersed with scattered areas of clearing (e.g. exploration drill pads and tracks), naturally open patches, and/or drainage lines
- **Open/drainage** – open areas dissected by drainage lines with or without dense vegetation; potential foraging and dispersal habitat, not considered suitable for breeding.

The areas of each of these categories were calculated for the targeted survey area (L28/72 + 100 m buffer) and wider areas defined by buffers of 10, 20, and 40 km.

4 RESULTS

4.1 NATIONAL ENVIRONMENTAL SIGNIFICANCE

The first consideration is:

> "Are there any matters of national environmental significance located in the area of the proposed action (noting that 'the area of the proposed action' is broader than the immediate location where the action is undertaken; consider also whether there are any matters of national environmental significance adjacent to or downstream from the immediate location that may potentially be impacted)?"

The results of both the desktop review and field survey show that a population of a nationally threatened species, the Malleefowl (*Leipoa ocellata*; Vulnerable under the EPBC Act) is present within the survey area and its surrounds (Phoenix 2023c).

All Kurnalpi tenement areas shown in Figure 1 (except L28/72) were fully covered by LiDAR survey (Anditi Pty Ltd 2022), and all candidate ground features rated 1-3 by Anditi were ground-truthed by Northern Star Resources (2022), confirming a number of Malleefowl mounds outside those tenements, but no mounds of any age within them (Phoenix 2023c: Figure 4-1). However, LiDAR survey coverage of L28/72 was incomplete, and not all of the remaining areas were covered by walked transects (Phoenix 2023c: Figure 3-2), so that some mounds may remain unidentified in the survey area.

At least 7 Malleefowl nesting mounds are present in the survey area, 5 of them within L28/72 (Botanica Consulting 2022; Northern Star Resources 2022; Phoenix 2023c); one is classified as extinct, one inactive (likely to have been used in the last 5 years, based on fig 5-7 of Botanica Consulting 2022), but activity status of the others has not been assessed (Northern Star Resources 2022). Inactive mounds may be re-used in future years, so activity assessment applies only to the current season.

The targeted survey found that almost all of the survey area (L28/72 + 100 m buffer; 98.4%) represents suitable Malleefowl habitat, comprising (Phoenix 2023c):

- 787.5 ha (78.6% of the survey area) classified as high suitability habitat (critical habitat with potential for nesting as well as primary foraging)
- 207.3 ha (20.7%) classified as medium suitability habitat (foraging and dispersal habitat).

Within L28/72, Phoenix (2023c) identified 389.45 ha as high suitability habitat, 102.75 ha as medium suitability and 5.55 ha as low/not suitable. The extent of suitable habitat within the 30 m wide corridor proposed for clearing cannot be calculated until the layout is confirmed.

The broader scale mapping undertaken here (Figure 2) found that most habitat within a 10 km radius of the survey area (79%) was also suitable for Malleefowl, with 64,038 ha mapped as suitable or suitable (mosaic) at the 10 km scale (Table 1). The proportion of suitable (including mosaic) habitat reduces as the buffer distance is increased (Table 1) due to greater variability in landform and habitat types.

Suitable habitat for Malleefowl appears to be much more abundant in the northern half of the 40 km buffer area (Figure 2). Suitable habitat in the survey area is contiguous with that outside in most directions; there is particularly good connectivity to the north and northwest. Vegetation south of the survey area is typically sparser and more open.

The survey area intersects a large contiguous patch of suitable (non-mosaic) habitat, that covers approximately 3,1615 ha of the surrounding area and extends approximately 7 km SW and 11 km NE of the survey area. In contrast, most of the suitable habitat mapped outside the 10 km buffer (i.e. between 10 and 40 km) is mosaic habitat.

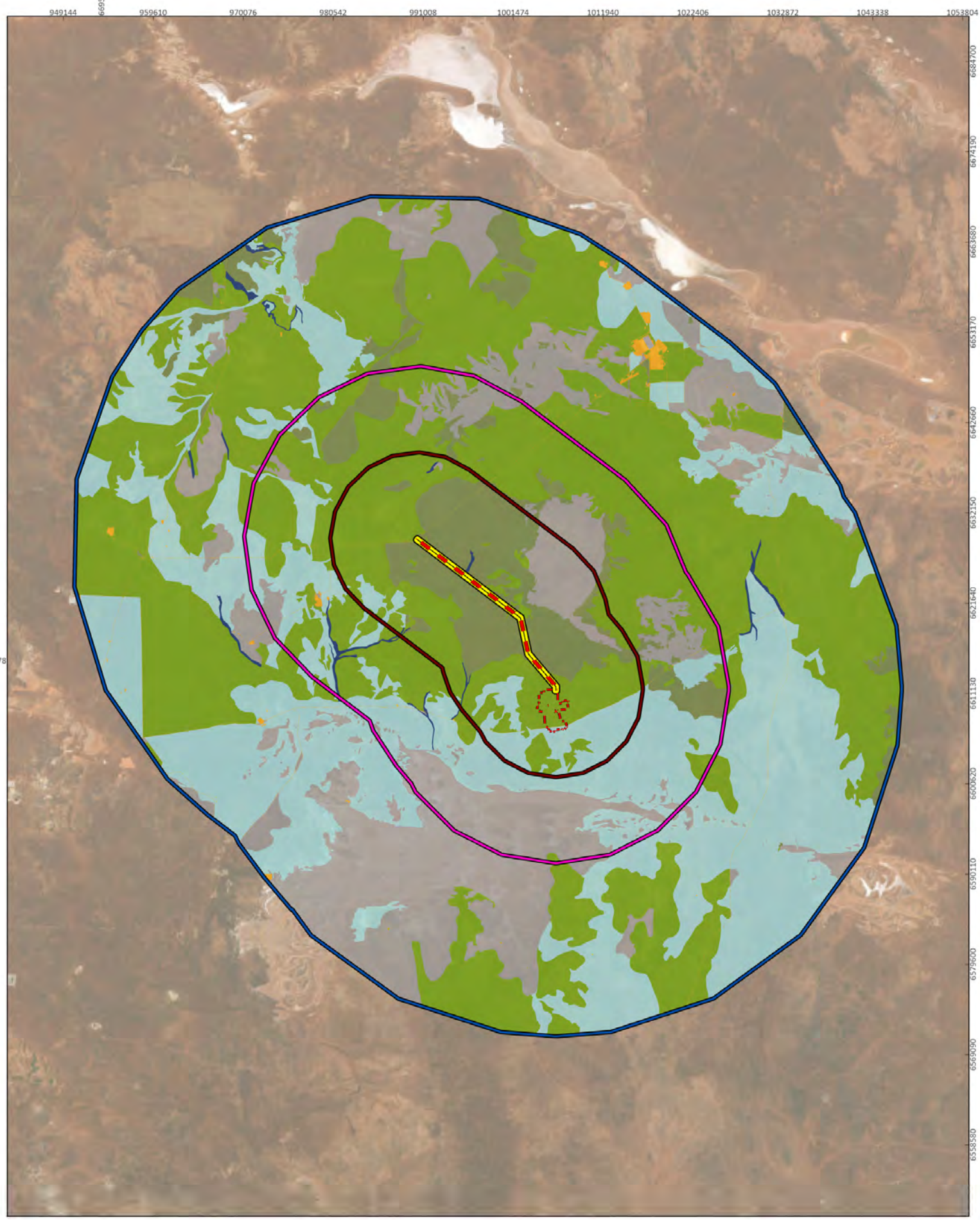


Figure 2

Kurnalpi survey tenements, and broad-scale habitat mapping of 40 km buffer around L28/72

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Table 1 Area of Malleefowl habitat categories in targeted survey area and adjacent region

Habitat	L28/72		Buffer extent on L28/72							
			100 m (survey area)		10 km		20 km		40 km	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Cleared	5.99	2.02	8.30	0.83	89.71	0.11	333.84	0.15	2,576.69	0.37
Drainage	2.14	0.43	7.78	0.78	266.04	0.33	1,051.78	0.47	2,697.90	0.39
Open	0.00	0.00	0.00	0.00	6,274.44	7.73	37,486.65	16.81	129,319.52	18.57
Open/drainage	0.00	0.00	0.00	0.00	10,501.03	12.94	49,847.53	22.35	213,774.53	30.70
Suitable	396.71	79.70	793.22	79.12	29,662.35	36.54	41,123.63	18.44	53,942.62	7.75
Suitable (mosaic)	92.91	18.66	193.23	19.27	34,375.34	42.35	93,212.42	41.79	294,027.65	42.22
Total	**497.74**	**100.00**	**1,002.54**	**100.00**	**81,168.90**	**100.00**	**223,055.85**	**100.00**	**696,338.91**	**100.00**

4.2 POTENTIAL IMPACTS AND MITIGATION

The second consideration is:

> "Considering the proposed action at its broadest scope (that is, considering all stages and components of the action, and all related activities, and infrastructure), is there potential for impacts, including indirect impacts, on matters of national environmental significance?"

The third consideration is:

> "Are there any proposed measures to avoid or reduce impacts on matters of national environmental significance (and if so, is the effectiveness of these measures certain enough to reduce the level of impact below the 'significant impact' threshold)?"

Potential for direct and indirect impacts on the Malleefowl population are considered in Table 2, along with a range of management actions to mitigate impacts. The effectiveness of these actions in reducing the level of impact varies and while it is often difficult to completely eliminate impacts, the aim is to reduce level of impact to below the threshold of a significant impact for the species.

Table 2 Potential impacts on Malleefowl

Stage	Potential impacts	Management Measures	Assessment
Construction	**Direct impacts**		
	Damage to and/or destruction of Malleefowl mounds from clearing/earthworks	No Malleefowl mounds will be disturbed for the Proposed Action. The DE provides sufficient flexibility to design the road to avoid Malleefowl nesting mounds present. Further LiDAR and ground-truthing to identify potential Malleefowl mounds, prior construction of the haul road. Fauna spotter present during vegetation clearing.	Five mounds have been recorded in the DE and 2 in the buffer area. Of the 7 mounds identified in the survey area (Botanica Consulting 2022; Northern Star Resources 2022; Phoenix 2023c), one was classified as extinct and one inactive. The activity status of the others has not been assessed. Activity assessment applies only to the assessed breeding season and may change from year to year. Malleefowl mounds will be avoided during construction, so no direct disturbance or destruction/damage is expected to occur.
	Loss of habitat from clearing	Habitat clearing will be limited to the area necessary to safely construct the haul road The haul road will be aligned within existing cleared land as far as practicable e.g. widening existing pastoral tracks.	Extent of habitat classes shown in Table 1. The total extent of habitat to be cleared will be up to 80.6 ha (approx. 30 m x 26 km). Assuming that all habitat cleared is suitable for Malleefowl, the clearing extent represents 16% of suitable (including 'mosaic') habitat within the DE, 8% of suitable habitat within the 100 m buffer survey area, 0.1% of suitable habitat within 10 km, and 0.02% of suitable habitat within 40 km.
	Indirect impacts		
	Reduced use of area due to human disturbance associated with construction (e.g. noise, dust), including potential abandonment of active nesting mounds	Where practicable, construction will take place outside Malleefowl breeding season. No Malleefowl mounds will be disturbed for Proposed Action. The DE provides sufficient flexibility to design the road to avoid Malleefowl nesting mounds present. There will be no unnecessary use of vehicles or machinery. Vehicles and machinery will remain within the authorised construction area.	Malleefowl can be resilient to noise and dust emissions. At the nearby Carosue Dam Operations, breeding and foraging activity has been observed to persist despite ongoing construction and mining operations. This has included Malleefowl breeding activity near an operational haul road, open pit mining, and ore and waste rock handling and processing. No active mounds have been identified within the DE, however the area has not been completely surveyed and the activity status has not been assessed for all mounds found to date. Usage of mounds may also vary from year to year.

Stage	Potential impacts	Management Measures	Assessment
		Noise emissions will be minimised through maintenance and operations of vehicles and machinery in accordance with Australian standards. Dust emissions will be managed through the implementation of dust suppression.	The likelihood of long-term abandonment of habitat due to construction and operation of the haul road is relatively low, particularly when considering the short duration of construction.
	Increased feral predation risk due to predators' use of roads (predator highways) through a largely intact area of habitat (Raiter *et al.* 2018)	Workforce to be accommodated offsite during construction and all food waste (wrappers/scraps) to be removed and disposed of offsite to reduce attraction of feral predators to the area.	The proposal is unlikely to introduce any new food sources that would attract predators. A study of predator (cat, fox and dingo) activity in WA demonstrated that predator activity is 12 – 261 times greater on-road compared with off-road (Raiter *et al.* 2018). The proposed haul road is likely to act as a predator highway through the otherwise largely intact area, which may expose Malleefowl to higher predation risk on and in the vicinity of the haul road. Sections of road passing through denser vegetation, which is associated with high quality Malleefowl habitat, may be utilised more frequently by predators, particularly foxes (Raiter *et al.* 2018). This may result in higher predator activity on the road as is passes through the otherwise large, contiguous patch of suitable habitat at the northern end of the proposed route.
Operation	**Direct impacts**		
	Mortality from vehicle strikes	Driver awareness through inductions and road signage. Includes Malleefowl Awareness training for relevant personnel. Speed limits. Drivers to report Malleefowl sightings (vehicle strike incidents, earlier roadkill, and live birds unless at previously reported location) to supervisors or site	In areas of low and highly variable rainfall such as the Goldfields, Malleefowl populations tend to occur in lower density, more widely distributed population (DCCEEW 2024) The proposed controls are well established at Carosue Dam Operations and have been effective at avoiding vehicle strikes with Malleefowl.

Stage	Potential impacts	Management Measures	Assessment
		environmental team to help identify areas of high Malleefowl activity. Vehicles strikes of Malleefowl reported as environmental incidents using Northern Star's compliance system (INX Incontrol)	The risk of vehicle strike associated with the Proposed Action is therefore low.
	Indirect impacts		
	Reduced use of area due to vehicle traffic (e.g. noise, dust)	Driver awareness through inductions Speed limits. Vehicles will comply with relevant Australian Standards for noise emissions. Restrict vehicle speeds along gravel/unsealed roads to limit dust generation. Dampen open cleared areas using water carts to minimise dust generation.	Dust generation increases exponentially with speed (Alsheyab *et al.* 2023) but varies with other factors so suitable limits depend on local conditions and materials. Dust suppression once applied is extremely effective due to the hypersaline nature of the water. The dust suppression forms a crust over the areas watered, therefore minimising dust generation to an acceptable standard. Annual monitoring of Malleefowl at Carosue Operations has shown that with the proposed controls in place, Malleefowl continue to forage and breed in areas subject to ongoing mining activity and vehicle use. Operation of the proposed haul road is therefore unlikely to reduce use of the area by Malleefowl.
	Reduction in foraging resources due to increased incidents of weed outbreaks from human activity	Implementation of the weed management procedure including: All vehicles entering site must be cleaned prior to arrival and checked before they commence work. Suspected occurrences of weeds will be reported. Weed control, particularly of Buffel grass, implemented where necessary. Weed free material used for construction (sand, gravel etc)	Most weeds are not a threat to Malleefowl, though infestation may result in degradation of habitat condition (DCCEEW 2024). Buffel grass has been identified as particularly threatening and may affect Malleefowl via loss of dietary resources, changes in vegetation structure and increased occurrence and intensity of fire (DCCEEW 2024). Proposed controls will likely be adequate to prevent the introduction or spread of weeds.

Stage	Potential impacts	Management Measures	Assessment
	Reduction in resources due to changes in fire regime	Staff training and awareness on fire prevention and management. Vehicles fitted with fire extinguishers. Water carts.	Fire regime could be altered by potential sources of ignition, and exposure, and drying of vegetation adjacent to clearing, but the Proposed Action will also have a firebreak effect in the landscape. Ignition of bushfires from haul traffic is unlikely given the clearance distance between trucks and road surface, and regular maintenance implemented for all vehicles and machinery. Regular traffic along the haul road will provide opportunity for prompt reporting and rapid response to any fires identified along the haul road.
	Presence of road acts as a behavioural barrier to dispersal, resulting in population fragmentation	Clear to minimum required width.	The proposed clearing area is expected to be no more than 30 m wide, which is unlikely to act as a barrier to what is a highly mobile species.

4.3 POTENTIAL FOR SIGNIFICANT IMPACTS

The fourth and last consideration is:

> "Are any impacts of the proposed action on matters of national environmental significance likely to be significant impacts (important, notable, or of consequence, having regard to their context or intensity)?"

In order to determine if the impacts of the Project are significant, it must first be established if the Malleefowl population is an "important population" and whether the habitat to be impacted is "habitat critical to the survival of a species". The Project can then be assessed against the significant impact criteria.

4.3.1 Important population

An important population is one that is necessary for a species' long-term survival and recovery, such as populations that meet one or more of the criteria presented in Table 3 (DoE 2013).

The National Recovery Plan (DCCEEW 2024) states that:

> "All populations and areas occupied by Malleefowl are considered of equal importance for the protection and recovery of the Malleefowl. This is despite any variability of Malleefowl density, population size, conservation challenges relevant to the area, or other factors that may be perceived as discounting the relative importance of an area or population.
>
> Malleefowl still occur over most of their range, and although populations tend to be sparser in areas with low or highly variable winter rainfall, this is compensated by these areas being extensive. Conversely, Malleefowl densities are highest in remnants of habitat within the wheatbelts, but these areas are usually small and fragmented and will require intensive management in the long term to retain the species."

Whereas population density and breeding activity have been declining over most of the species range in recent decades, only populations in small reserves have been specifically mentioned as important for conservation (Benshemesh *et al.* 2020).

Based on these criteria, it is concluded that the Malleefowl population in the vicinity of the survey area does not qualify as an important population in the relevant sense (Table 3).

Table 3 Important population criteria

Criteria	Assessment	Comments
Identified as important in recovery plans	No	The Malleefowl population in the vicinity of the survey area has not been identified in any recovery plans.
Key source populations either for breeding or dispersal	No	The Malleefowl population in the vicinity of the survey area is not known to be a key source population for breeding or dispersal.
Populations that are necessary for maintaining genetic diversity	No	The Malleefowl population in the vicinity of the survey area is not known to be necessary for maintaining genetic diversity of the species.
Populations that are near the limit of the species range	No	The Malleefowl population in the vicinity of the survey area is not near the limit of the species range (Benshemesh 2007; Benshemesh *et al.* 2020).

4.3.2 Habitat critical to the survival of a species

Habitat critical to the survival of a species refers to habitat that is necessary for one or more of the criteria presented below in Table 4 (DoE 2013). The habitat of the survey area meets at least two of the criteria and thus qualifies as habitat critical to the survival of Malleefowl (Table 4).

Table 4 Habitat critical to the survival of a species criteria

Criteria	Assessment	Comments
For activities such as foraging, breeding, roosting, or dispersal.	Yes	The survey area contains habitat suitable for and used by Malleefowl for foraging, breeding, roosting, and dispersal (Phoenix 2023c). The targeted survey found that almost all of the survey area (98%) represents suitable Malleefowl habitat (Phoenix 2023c). Most (787.5 ha, 78.6%) of the survey area was classified as high suitability habitat, (critical habitat with potential for nesting, as well as primary foraging). A further 207.3 ha (20.7%) of the survey area was classified as medium suitability habitat (foraging and dispersal habitat). Suitability as breeding habitat is supported by the confirmed presence of Malleefowl nesting mounds, 5 within the proposed DE, and an additional 2 in the 100 m buffer (Botanica Consulting 2022; Northern Star Resources 2022; Phoenix 2023c). However, no active breeding has yet been confirmed, with activity status assessments not yet assessed for all mounds. Other evidence of Malleefowl presence in the survey area was recorded by (Phoenix 2023c), with Malleefowl tracks observed at several locations. Several desktop records were also identified close to the survey area, with 2 additional records within it.
For the long-term maintenance of the species.	No	The survey area is not located in an area that is formally identified as being important for the long-term maintenance of the species. The survey area occurs within a much larger contiguous patch of suitable breeding habitat, which is mostly surrounded by suitable foraging and dispersal habitat (Figure 2). Phoenix (2023c) identified over 80 desktop records within 40 km of the survey area, including 22 mounds from a LiDAR survey. Desktop records of Malleefowl are largely limited to near roads and mining activity (likely due to concentrated survey effort around these areas), however they likely utilise the entirety of the larger contiguous habitat patch and surrounds. This expanse of habitat may be important for the long-term maintenance of the local population but given the widely dispersed, low density of Malleefowl populations in arid regions (DCCEEW 2024) like the survey area, it is

Criteria	Assessment	Comments
		not likely to be critical to the long-term maintenance of the species as a whole. The DE represents only a very small portion of contiguous, suitable habitat (1.6%) and is not of any higher value than the more extensive surrounding suitable breeding habitat patch (Figure 2). Therefore, on its own, the habitat within the proposed DE is not critical for the long-term maintenance of the species.
To maintain genetic diversity and long-term evolutionary development.	No	The National Recovery Plan for the Malleefowl (DCCEEW 2024) notes the importance of maintaining genetic integrity in isolated Malleefowl populations. As the survey area occurs within a largely intact landscape, with suitable habitat for Malleefowl extensive and contiguous within the 40 km buffer (Figure 2), the Malleefowl population in this area would not be considered an isolated population and therefore the habitat within the proposed DE is unlikely to be necessary for maintaining genetic diversity and long term evolutionary development of the population.
For the reintroduction of populations or recovery of the species.	No	The survey area is not located in an area that has been designated for Malleefowl reintroduction as the species persists in the region. No specific recovery strategies are underway in, or in the vicinity of, the survey area.
Habitat identified in a recovery plan for the species as habitat critical for that species.	Yes	The National Recovery Plan for the Malleefowl (DCCEEW 2024) identified that habitat critical for survival of the species in WA includes shrublands dominated by *Acacia*, and occasionally in woodlands dominated by eucalypts. Habitat within the proposed DE is broadly consistent with these habitat types, comprising *Acacia* shrubland, Open Eucalyptus woodland and Open *Acacia* shrubland.
Habitat listed on the Register of Critical Habitat maintained by the minister under the EPBC Act.	No	Not listed on the Register of Critical Habitat.

4.3.3 Significant impact criteria

An action is likely to have a significant impact on a vulnerable species if it meets one or more of the criteria presented below in Table 5 (DoE 2013).

Table 5 Significant impact criteria for vulnerable species

Significant Impact Criterion	Comments	Outcome
Lead to a long-term decrease in the size of an important population of a species.	The recovery plan states that 'All populations and areas occupied by Malleefowl are considered of equal importance' for their protection and recovery, despite variation in size and density (DCCEEW 2024).	Significant impact unlikely.
Reduce the area of occupancy of an important population.	Malleefowl populations in the Goldfields are generally sparsely distributed and of low density. The proposed DE lies within a large contiguous patch of suitable habitat. Based on the species recovery plan (DCCEEW 2024), the Malleefowl population in the vicinity of the survey area is not identified as any more important than any other Malleefowl population, and does not qualify as an important population in the relevant sense (Table 3).	Significant impact unlikely.
Fragment an existing important population into two or more populations.	The Proposed Action is unlikely to lead to fragmentation or a decline in size or area of occupancy of a Malleefowl population due to the small extent of the impact in relation to the large extent of contiguous suitable habitat within the wider area (Table 1). The total area of suitable habitat in the proposed DE (489.62 ha) represents only 0.8% of suitable habitat within the 10 km buffer, and 0.1% of suitable habitat within 40 km. Assuming that all habitat cleared (up to 80.6 ha) is suitable for Malleefowl, the clearing extent represents 16% of suitable (including 'mosaic') habitat within the DE, 8% of suitable habitat within the 100 m buffer survey area, 0.1% of suitable habitat within 10 km, and 0.02% of suitable habitat within 40 km.	Significant impact unlikely.
Adversely affect habitat critical to the survival of a species.	Habitat within the proposed DE includes habitat critical for survival of the species on the basis that it includes suitable breeding and foraging habitat. However, this habitat is common and widespread throughout the region and the proposed DE lies within a large, contiguous patch of similar habitat. Assuming that all habitat cleared (up to 80.6 ha) is suitable for Malleefowl, the clearing extent represents 16% of suitable (including 'mosaic') habitat within the DE, 8% of suitable habitat within the 100 m buffer survey area, 0.1% of suitable habitat within 10 km, and 0.02% of suitable habitat within 40 km.	Significant impact unlikely.
Disrupt the breeding cycle of an important population.	Five mounds have been recorded in the DE and 2 in the buffer area. The presence of Malleefowl mounds in the DE indicates that a breeding population was and may still be present. Impacts on breeding can be managed by avoiding disturbance to active mounds. Multiple Malleefowl monitoring programs have noted that Malleefowl have continued to breed in the vicinity of active operations (Mount Gibson Mining Ltd 2012; Phoenix 2020, 2021a, b, 2022a, b, 2023a, b). However, the Malleefowl population in the vicinity of the survey area is not identified as an important population (Table 3).	Significant impact unlikely.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	The Proposed Action is unlikely to damage or reduce the availability of habitat to the extent that Malleefowl would decline. The extent of suitable habitat affected will be negligible compared to the extent of habitat available regionally. Assuming that all habitat cleared (up to 80.6 ha) is suitable for Malleefowl, the clearing extent represents 16% of suitable (including 'mosaic') habitat within the DE, 8% of suitable habitat within the 100 m buffer survey area, 0.1% of suitable habitat within 10 km, and 0.02% of suitable habitat within 40 km. As such, the impact is not likely to be significant.	Significant impact unlikely.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.	The Proposed Action is unlikely to result in new invasive species becoming established. Feral cats occurs in the survey area, and Red Fox is widespread and likely to be present also (Phoenix 2023c). However, the Proposed Action may cause changes in the abundance and activity of predators that are already present, with higher predator activity documented on-road compared to off-road (Raiter *et al.* 2018). This could result in increased predator interaction with Malleefowl along the haul road. However, Northern Star have procedures in place to address and mitigate risks associated with invasive species, therefore it is unlikely that invasive species will significantly impact Malleefowl populations or habitat due to the proposed development.	Significant impact unlikely.
Introduce disease that may cause the species to decline.	The Proposed Action is unlikely to lead to the introduction of any disease that causes Malleefowl to decline. There is no information on disease in wild Malleefowl populations, although the species is susceptible to a range of common diseases in captive situations and may also be susceptible to exotic diseases (Benshemesh 2007).	Significant impact unlikely.

Interfere substantially with the recovery of the species.	The Project works are unlikely to interfere with the recovery of the species (any adverse effects are local and reversible). Comments are provided below in regard to key actions for the species recovery identified in the 2024 recovery plan:
	• retain Malleefowl habitat
	  o extent of habitat affected will be negligible in comparison to extent of habitat available regionally (Table 1)
	• maintain and increase connectivity of habitat fragments
	  o the narrow band of disturbance is unlikely to act as a significant movement barrier or significantly increase habitat fragmentation
	• reduce chance of large-scale fires that may burn most or all suitable habitat
	  o potential for human activities to increase fire frequency, however, haul road may also act as a firebreak and prevent burning of entire patch
	• reduce grazing pressure
		Significant impact unlikely.

Significant Impact Criterion	Comments	Outcome
	o project works unlikely to have any impact on grazing pressure • manage introduced predators o development unlikely to result in establishment on new feral predators o presence of predators can be monitored by Project and addressed if necessary • control Buffel grass and other weeds in and adjacent to Malleefowl habitat o proposed controls will be adequate to prevent the introduction or spread of Buffel grass and other weeds • reduce mortality on roads o road related mortalities can be controlled through warning signs and appropriate speed limits in high Malleefowl occurrence areas • integration of large-scale management programs o Malleefowl mounds identified can be reported to National Malleefowl Recovery Group for inclusion in national database to aid in ongoing monitoring efforts.	

5 CONCLUSION

The EPBC Significant Impact Guidelines provide a self-assessment framework to determine whether it is necessary to submit a referral to DCCEEW (DoE 2013) for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. As per DoE (2013), referral to the minister is required if the Proposed Action will have, or is likely to have, a significant impact on a matter of national environmental significance.

The survey area comprises mostly suitable breeding habitat for Malleefowl, which is listed as vulnerable under the EPBC Act. The survey area is part of a much larger contiguous patch of suitable habitat for the species, where a resident population is present.

Application of the self-assessment process to available data (Anditi Pty Ltd 2022; Northern Star Resources 2022; Phoenix 2023c) indicates that, without appropriate mitigation measures, there is potential for the Proposed Action to have direct and indirect impacts on Malleefowl habitat and the local population (which is not identifiable as an 'important population' (Table 3)). The high quality habitat intersected by the survey area meets 2 of the criteria for 'habitat critical to survival' (Table 4), however is common throughout the region and the extent of habitat to be cleared (up to 80.6 ha) is an insignificant proportion (0.1%) of habitat available within 10km.

Therefore, while any clearing, construction, and operations within habitat critical to survival can be expected to have some adverse effects on the habitat and population, these impacts would be local and temporary. Appropriate mitigation measures and post-closure remediation and/or natural regeneration will be effective at reducing residual impacts to a level that is not considered significant as per the definition provided by the DoE (2013) i.e. is important, notable, or of consequence, having regard to its context or intensity.

On the basis of this assessment, the Proposed Action is considered unlikely to have a significant impact on Malleefowl and therefore referral not considered necessary.

Yours Sincerely,

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Appendix K: Subterranean fauna desktop report for the Carosue Dam Operations

PHOENIX
ENVIRONMENTAL SCIENCES

Subterranean fauna desktop report for the Carosue Dam Operations - Kurnalpi Gold Project

Prepared for Northern Star Resources

February 2025

Final



Subterranean fauna desktop report for the Carosue Dam Operations Project – Kurnalpi Gold Project
Prepared for Northern Star Resources

Version history

Author	Version	Version number	Date submitted	Submitted to
A. Jacks	Draft for client comments	0.1	20-Dec-24	C. Bennison
A. Jacks	Final, client comments addressed	1.0	10-Feb-25	C. Bennison M. Erskine

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1 INTRODUCTION

Northern Star Resources (Northern Star) operates the Carosue Dam Operations (CDO), (the Project), located 100 km north-east of Kalgoorlie-Boulder, Western Australia (WA; Figure 1-1). Carosue Dam Operations comprises three mining hubs that all feed ore into the same mill at CDO: Carosue Dam, Porphyry, and Mt Celia.

Northern Star is planning to establish an additional mining hub at Kurnalpi, located about 40 km southwest of CDO and 70 km northeast of the Kalgoorlie-Boulder townsite in the Murchison bioregion.

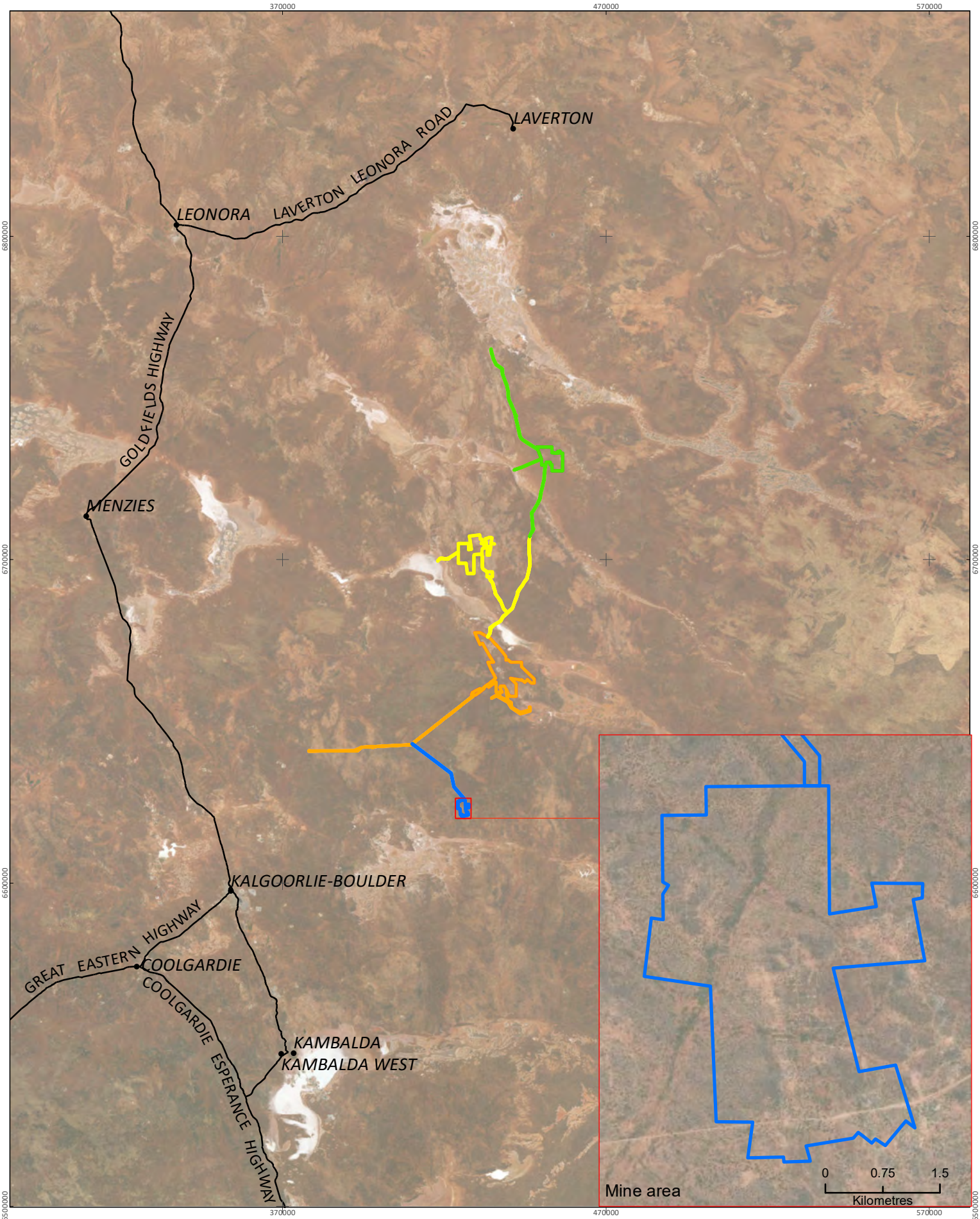
A new open pit gold mine is proposed at Kurnalpi. There has been a long history of minerals exploration in the Kurnalpi area, but there are currently no established mining operations in the locality. Similar to Porphyry and Mt Celia, ore from Kurnalpi will be hauled to the CDO mill for processing. Northern Star has started to develop the environmental approvals and permitting for the Kurnalpi gold mine.

1.1 SCOPE OF WORK

The scope of work is to undertake a desktop assessment for subterranean fauna within the Kurnalpi mine area.

1.2 STUDY AREA

The Development Envelope (DE) for the Project is 1,589.8 ha and comprises of both mine and infrastructure, including haul routes (Figure 1-1). As there is no risk to subterranean fauna from haul roads, the study area for this assessment is focussed on the mine area which is approximately 1,095.6 ha.





Northern Star Resources
Carosue Dam Operations - Kurnalpi

Project No	1699-CDO-NSR-SUB
Date	11/12/2024
Drawn by	AJ
Map author	AJ

0 30 60
Kilometers

1:1,500,000(at A4) GDA 1994 MGA Zone 51

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Study area

- Carosue Dam DE
- Kurnalpi DE
- Mt Celia (Safari Bore) DE
- Porphyry DE

Figure 1-1

Project lcoation and study area

PHOENIX ENVIRONMENTAL SCIENCES

2 OVERVIEW OF SUBTERRANEAN FAUNA

Subterranean fauna are fauna that live below the surface of the earth and are so-named to reflect their eco-physiological specialisation to subterranean habitats. Subterranean fauna can exist within a variety of void networks, including solution cavities within calcrete and karst; fractured rock and course sediments such as cobble or gravel strata (Howarth 1983; Humphreys 2008). They are typically divided into 2 groups:

- stygofauna, which are aquatic fauna that live within subterranean water bodies or aquifers
- troglofauna, which are air-breathing, and live in voids or caves above the water table.

Subterranean species can also be placed into one of three categories of specialisation to subterranean life (Barr 1968; Howarth 1983; Humphreys 2000; Humphreys 2008):

- stygobites and troglobites, that are restricted to subterranean habitats and usually perish on exposure to the surface environment
- stygophiles and troglophiles, which facultatively use subterranean habitats but are not reliant on them for survival
- stygoxenes, which inhabit surface water but can freely move between the surface and subterranean systems, and trogloxenes, which use subterranean systems for specific purposes only.

For the purposes of environmental impact assessment, the Environmental Protection Authority (EPA 2016) defines subterranean fauna as: *fauna which live their entire lives (obligate) below the surface of the earth*, therefore stygobitic and troglobitic species are of primary focus in subterranean fauna surveys.

Subterranean organisms can exist within a variety of subterranean void networks, including solution cavities within calcrete and karst; fractured rock and course sediments such as cobble or gravel strata (Howarth 1983; Humphreys 2008). The energy and nutrient resources for subterranean habitats are almost exclusively allochthonous, derived outside of the subterranean habitat (Poulson & Lavoie 2000). These usually enter the system in the form of dissolved or finely fragmented organic compounds. These are most usually carried into the subterranean system in rainwater that percolates through soil and rock strata from the surface. Tree roots and water form the most important transport routes that move energy and nutrients into subterranean networks (Howarth 1983; Humphreys 2000; Poulson & Lavoie 2000).

2.1 CONSERVATION SIGNIFICANCE

The EPA (2016) considers subterranean fauna species significant due to being identified as Threatened or Priority species, locally endemic, potentially new species, occupying restricted habitats and/or forming part of a Threatened or Priority Ecological Community (TEC or PEC). The obligate underground existence of subterranean fauna greatly increases the likelihood of short-range endemism and the possibility that a species' conservation status may be impacted as a result of the implementation of a proposal.

Very few subterranean fauna species or communities are listed as Threatened Fauna or TECs under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). At the State level however, several subterranean species and communities are listed as Threatened under the *Biodiversity Conservation Act 2016* (BC Act), or Priority by the Department of Biodiversity, Conservation and Attractions (DBCA). A total of 18 Threatened and 3 Priority stygofauna, and 21 Threatened and 5 Priority troglofauna are listed in WA (DBCA 2022), with the majority from the Pilbara and Carnarvon Interim Biogeographic Regionalisation of Australia (IBRA) regions (DBCA 2022).

Currently, there are 88 listed PECs associated with subterranean fauna, most of which are calcrete groundwater assemblages in the Midwest and Goldfields regions of the Yilgarn Craton (i.e. Cooper *et al.* 2008; Guzik *et al.* 2008; Humphreys *et al.* 2009). Several subterranean PECs also occur within the Pilbara region.

2.2 TROGLOFAUNA

Troglobitic fauna are adapted to exploit the special characteristics of air-filled subterranean networks. They are often characterised by specialised adaptations to subterranean life, such as lack or reduction of eyes, wings and body pigmentation, heightened chemosensory and mechano-sensory systems, loss of circadian rhythms and very low metabolic rate. These adaptations allow troglobites to exploit the dark, humid, nutrient-poor subterranean void networks (Howarth 1983, 1993; Humphreys 2000; Poulson & Lavoie 2000).

In WA, troglofauna invertebrates have been recorded from several taxonomic groups, in particular:

- arachnids, including spiders (Baehr *et al.* 2012; Burger *et al.* 2010; Harvey 2001b; Platnick 2008), short-tailed whipscorpions (Abrams & Harvey 2015; Harvey 2001a; Harvey *et al.* 2008), pseudoscorpions (Edward & Harvey 2008; Harms & Harvey 2013) and scorpions (Volschenk & Prendini 2008)
- palpigrades (Barranco & Harvey 2008)
- myriapods, including millipedes (Humphreys & Shear 1993; Shear & Humphreys 1996) and centipedes (Edgecombe 2005)
- crustaceans, specifically isopods (S. Judd, unpublished data)
- insects, including cockroaches (Roth 1991), beetles and true bugs (Hoch 1993).

2.3 STYGOFAUNA

Stygobitic fauna typically show similar traits to troglobites in their specialisation to subterranean life, including loss of body pigment, eyes, and heightened mechano-sensory systems. Range-restricted stygofauna are only represented by stygobitic species. In WA, stygofauna invertebrates have been recorded in:

- crustaceans, including ostracods (Karanovic 2007; Reeves *et al.* 2007), copepods (Karanovic 2006; Karanovic *et al.* 2013), amphipods (Bradbury & Williams 1997; Finston & Johnson 2004), syncarids (Abrams *et al.* 2013) and isopods (Finston *et al.* 2009; Keable & Wilson 2006)
- insects, in particular water beetles (Eberhard *et al*. 2016; Watts & McRae 2013)
- oligochaetes (Pinder 2001)
- nematodes (Halse & Pearson 2014).

2.4 IDENTIFYING TROGLOFAUNA AND STYGOFAUNA

The characterisation of subterranean fauna into troglobites or stygobites is largely based on an understanding of species habitat requirements. The recognition and identification of these species are usually limited to the presence of troglomorphies, such as reduction or loss of eyes or wings etc. Troglomorphies are used to infer a species that have become specialised to subterranean existence over many generations of confinement to subterranean habitats.

The use of troglomorphies may be justified when a species being identified belongs to a genus (or other higher taxonomic rank) in which epigean species do not exhibit troglomorphic characteristics. Some groups, such as diplurans, cryptopid centipedes and atelurine silverfish, are more difficult to assess since all members of these groups, whether subterranean or not, lack eyes and are generally pale.

An additional complication to identification of subterranean fauna arises from some clearly troglobitic species (such as some species of *Nocticola*) which have been found to have wide distributions. Widespread obligate subterranean fauna appear to be rare and their means of dispersal is not well understood.

Taxonomic resolution is also difficult to achieve in taxa for which there is no expertise to provide regional context. The apparently strong evolutionary pressure of subterranean habitats has resulted in highly convergent, morphologically similar species (Finston & Johnson 2004; Finston *et al.* 2007). Molecular techniques such as 'barcoding' (Hebert *et al.* 2003a; Hebert *et al.* 2003b) are routinely employed to overcome these identification problems. Barcoding methods can also resolve specimen identification where specimens represent taxonomically uninformative life stages or sexes.

3 EXISTING ENVIRONMENT

3.1 INTERIM BIOGEOGRAPHIC REGIONALISATION OF AUSTRALIA

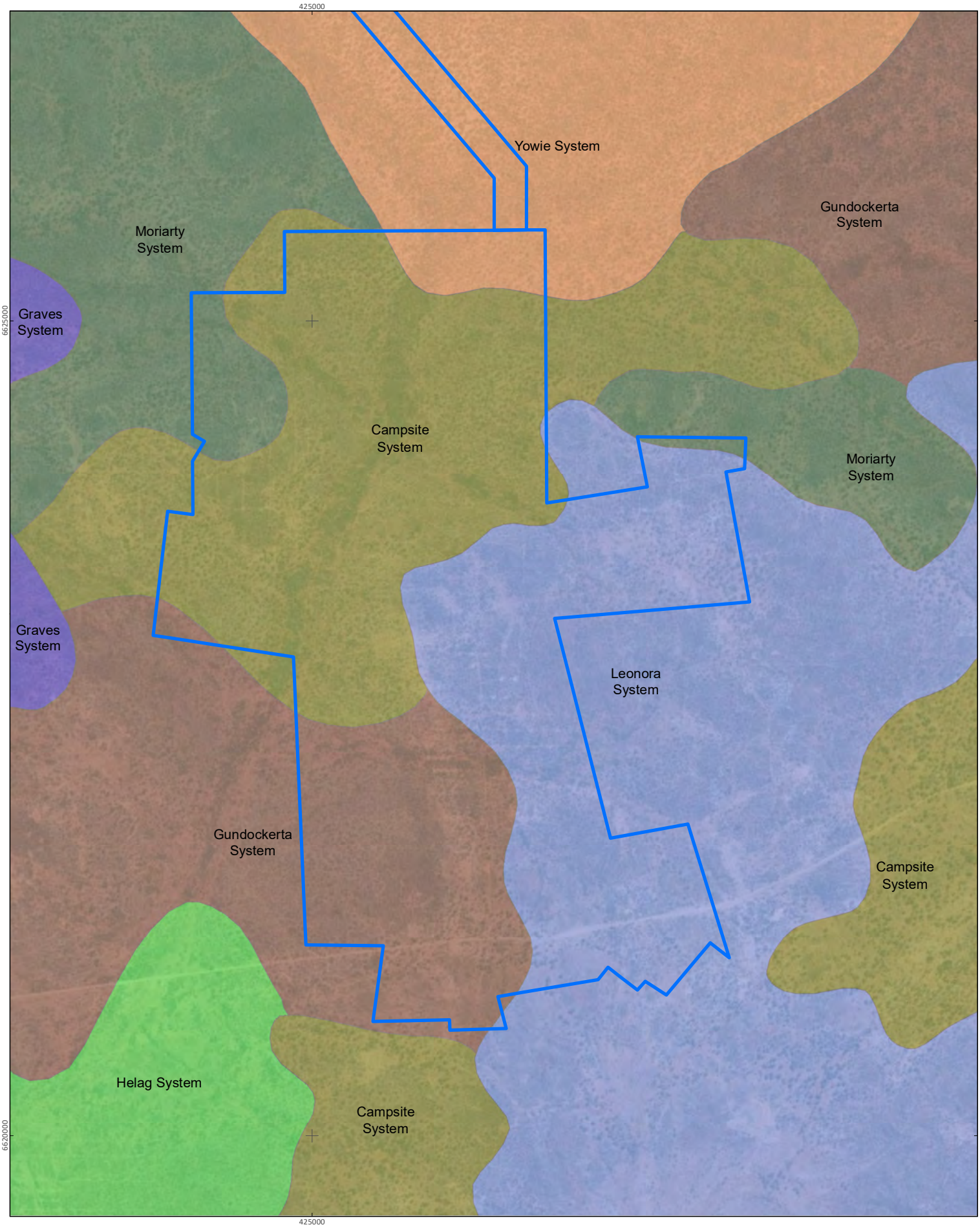
The Interim Biogeographic Regionalisation of Australia (IBRA) classifies Australia's landscapes into large 'bioregions' and 'subregions' based on climate, geology, landform, native vegetation and species information (DoEE 2016). The study area is located in the Eastern Murchison subregion (Mur1) of the Murchison bioregion which is characterised by its internal drainage, and extensive areas of elevated red desert sandplains with minimal dune development (Cowan 2001). Salt lake systems associated with the occluded paleodrainage system. Broad plains of red-brown soils and breakaway complexes as well as red sandplains. Vegetation is dominated by Mulga Woodlands often rich in ephemerals; hummock grasslands, saltbush shrublands and Halosarcia shrublands.

3.2 LAND SYSTEMS

DPIRD undertakes land system mapping for WA using a nesting soil-landscape mapping hierarchy (Schoknecht & Payne 2011). Land systems are defined as areas with recurring patterns of landforms, soils, vegetation and drainage (Payne & Leighton 2004). The study area intersects 5 land systems (Table 3-1; Figure 3-1).

Table 3-1 Land systems and extent in study area

Land system	Description	Area (ha)	% of study area
Campsite System	Alluvial plains supporting eucalypt woodlands with halophytic understoreys and acacia shrublands.	447.7	40.8
Gundockerta System	Extensive, gently undulating calcareous stony plains supporting bluebush shrublands.	223.5	20.4
Leonora System	Low greenstone hills and stony plains supporting mixed chenopod shrublands.	343.6	31.4
Moriarty System	Low greenstone rises and stony plains supporting chenopod shrublands with patchy eucalypt overstoreys.	47.1	4.3
Yowie System	Sandy plains supporting tall shrublands of mulga and bowgada with patchy wanderrie grasses.	33.7	3.1
	Total	**1,095.6**	**100**





Northern Star Resources
Carosue Dam Operations - Kurnalpi

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0 0.5 1
Kilometers

1:30,000 (at A4) GDA 1994 MGA Zone 51

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Study area
- Kurnalpi DE

Land system
- Campsite System
- Graves System
- Gundockerta System
- Helag System
- Leonora System
- Moriarty System
- Yowie System

Figure 3-1

Land systems in the study area

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4 METHODS

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

- *EPA Environmental Factor Guideline – Subterranean fauna* (EPA 2016)
- *EPA Technical Guidance – Subterranean fauna surveys for environmental impact assessment* (EPA 2021).

Searches of several biological databases were undertaken to identify and prepare lists of significant subterranean fauna that may occur within the study area (Table 4-1). A literature search was conducted for reports for assessments conducted within 200 km of the study area to build on the lists developed from the database searches (Table 4-2).

Table 4-1 Database searches conducted for the desktop review

Database	Target groups	Search extent
DBCA Threatened and Priority Ecological Communities Database (DBCA 2024)	TECs and PECs	Study area plus a 100 km buffer
WA Museum Arachnid and Myriapod Database, Mollusca Database, Crustacea Database, and Insecta Database	Arachnid, myriapod, crustacea, and insecta stygofauna/troglofauna	Study area plus a 100 km buffer
Index for Biodiversity Surveys for Assessment (IBSA)	stygofauna/troglofauna	Study area plus a 200 km buffer
Phoenix' internal database	stygofauna/troglofauna	Study area plus a 100 km buffer

Table 4-2 Survey reports included in the desktop review

Report author	Project	Survey type	Proximity to study area
Phoenix (2023a) Phoenix (2023b)	Butcher Well Project	Desktop	140 km north
Phoenix (2022)	Irwin Hills Nickel Project	Baseline survey	175 km northeast
Bennelongia (2021)	Mt Ida Gold Project	Baseline survey	245 km west
Phoenix (2017)	Binduli Expansion Project	Level 1 (Basic)	83 km west-southwest
Phoenix (2016)	St. Ives Gold Mine	Desktop	90 km southwest
Subterranean Ecology (2010)	Red October Gold Project	Desktop	170 km north
Biota (2003)	Deep South, Carosue Dam Operations	Stygofauna	45 km north
Humphreys (1998)	Murrin Murrin Nickel Cobalt Project - Roy-Valais and Korong North Borefields and Windarra Calcrete Quarry	Stygofauna	195 km north

5 RESULTS

5.1 ASSEMBLAGE

No stygofauna or troglofauna were recorded from within 100 km of the study area. Data from surveys and desktop assessments undertaken further afield (within 200 km of the study area) also indicate a low likelihood and risk to subterranean fauna. The surveys undertaken have confirmed subterranean fauna is absent or present in very low numbers at those sites. The nearest survey which has yielded high stygofauna assemblage is associated with large calcrete aquifers and is located 195 km north of the study area (Table 5-1).

Table 5-1 Survey reports included in the desktop review

Report author	Project	Survey type	Outcomes	Proximity to study area
Phoenix (2023a) Phoenix (2023b)	Butcher Well Project	Desktop	Concluded very low likelihood of troglofauna due to the high water table and low porosity of the unsaturated habitat.	140 km north
Phoenix (2022)	Irwin Hills Nickel Project	Baseline survey	Very low species richness and diversity of stygofauna (3 copepods and 3 oligochaetes) and troglofauna (one springtail and isopod).	175 km northeast
Bennelongia (2021)	Mt Ida Gold Project	Baseline survey	Project area was does not contain prospective habitat for subterranean fauna due to the fractured rock and hypersaline subterranean environment. Conservation significant species and high biodiversity subterranean communities are found regionally in paleodrainage channels or subterranean calcretes, which do not occur within the Project area.	245 km west
Phoenix (2017)	Binduli Expansion Project	Level 1 (Basic) troglofauna	No troglofauna recorded.	83 km west-southwest
Phoenix (2016)	St. Ives Gold Mine	Desktop	There is very limited opportunity for stygofauna to persist based on high salinities of the groundwater. Troglofauna may occur in alluvial deposits.	90 km southwest
Subterranean Ecology (2010)	Red October Gold Project	Desktop	Concluded very low likelihood of troglofauna due to the high water table and low porosity of the unsaturated habitat.	160 km north
Biota (2003)	Deep South, Carosue Dam Operations	Stygofauna	No stygofauna recorded.	45 km north
Humphreys (1998)	Murrin Murrin Nickel Cobalt Project -Roy-Valais and Korong North Borefields and Windarra Calcrete Quarry	Stygofauna	Stygofauna present at Windarra Calcrete Quarry. No stygofauna at the borefields.	195 km north

5.2 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

No TECs or PECs were recorded from the desktop review.

5.2.1 Habitat assessment

5.2.1.1 Landforms

The study area is generally low lying and flat, with gently undulating stony, hardpan, sandy, calcareous or alluvial plain with occasional low hills and rises. Lake Yindarlgooda is located 8 km to the south of the study area.

5.2.1.2 Geology

According to the Surface Geology of Australia 1:1,000,000 scale, Western Australia database (Stewart et al. 2008), the study area intersects 3 geological formations (Table 5-2; Figure 5-1). Of these, 2 (Czl, and Qrc) contain geologies that may support subterranean fauna (ie. porous spaces), such as nodular or vuggy rocks, gravels, or calcrete. These are of higher suitability than substrates that are not porous such as silts, clay, sand, saprolite, and igneous or metamorphic rocks. Silt, clay and saprolite may also present in Czl and Qrc, therefore the composition of these surface geologies is locally variable.

Table 5-2 Surface geology of the study area, extent by deposit type

Surface geology	Code	Description	Suitability for subterranean fauna	Area (ha)	% of study area
Mafic extrusive rocks	Abe	Basalt, high-Mg basalt, minor mafic intrusive rocks; some andesite; agglomerate; mafic schist; amphibolite; dolerite; komatiitic basalt; carbonated basalt; basaltic andesite; mafic rock interleaved with minor granitic rock	Low to medium dependent on degree of fracturing	383.3	35.0%
Ferruginous duricrust	Czl	Pisolitic, nodular or vuggy ferruginous laterite; some lateritic soils; ferricrete; magnesite; ferruginous and siliceous duricrusts and reworked products, calcrete, kaolinised rock, gossan; residual ferruginous saprolite	Low to medium dependant on composition	<0.1	<0.1
Colluvium	Qrc	Colluvium, sheetwash, talus; gravel piedmonts and aprons over and around bedrock; clay-silt-sand with sheet and nodular kankar; alluvial and aeolian sand-silt-gravel in depressions and broad valleys in Canning Basin; local calcrete, reworked	Low to medium dependant on composition	712.3	65.0%
			Total	**1,095.6**	**100**

According to the Kurnalpi drill logs of 998 bores, geological composition data obtained from 1 to 2 m intervals were analysed, resulting in 70,000 data points (Soil Water Consultants 2022), no highly suitable subterranean fauna habitat such as highly porous or highly fractured rock, or calcrete occurs (Table 5-3). Only about 2% of the samples might be suitable for troglofauna, in particular troglophiles or soil fauna that are not restricted to subterranean environments (Quaternary sediment), but move between the upper substrate and surface. The underlying bedrock may be suitable for stygofauna, however the large amounts of clay-based geology overlying this habitat probably limits its suitability.

Table 5-3 Summary of lithology data across the Project Area (Soil Water Consultants 2022)

Lithology	No.	%	Lithology	No.	%
Soil	165	0.2	Sedimentary	88	0.1
Quaternary sediment	1,396	2.0	Felsic	200	0.3
Clay zone	5,999	8.6	Intermediate rock	1,051	1.5
Hardpan soil	1,157	1.7	Dolerite	7,942	11.4
Laterite	4,144	6.0	Basalt	11,948	17.2
Upper saprolite	4,905	7.1	Ultramafic	23,505	33.8
Lower saprolite	604	0.9	Vein	1,269	1.8
Saprock	526	0.8			

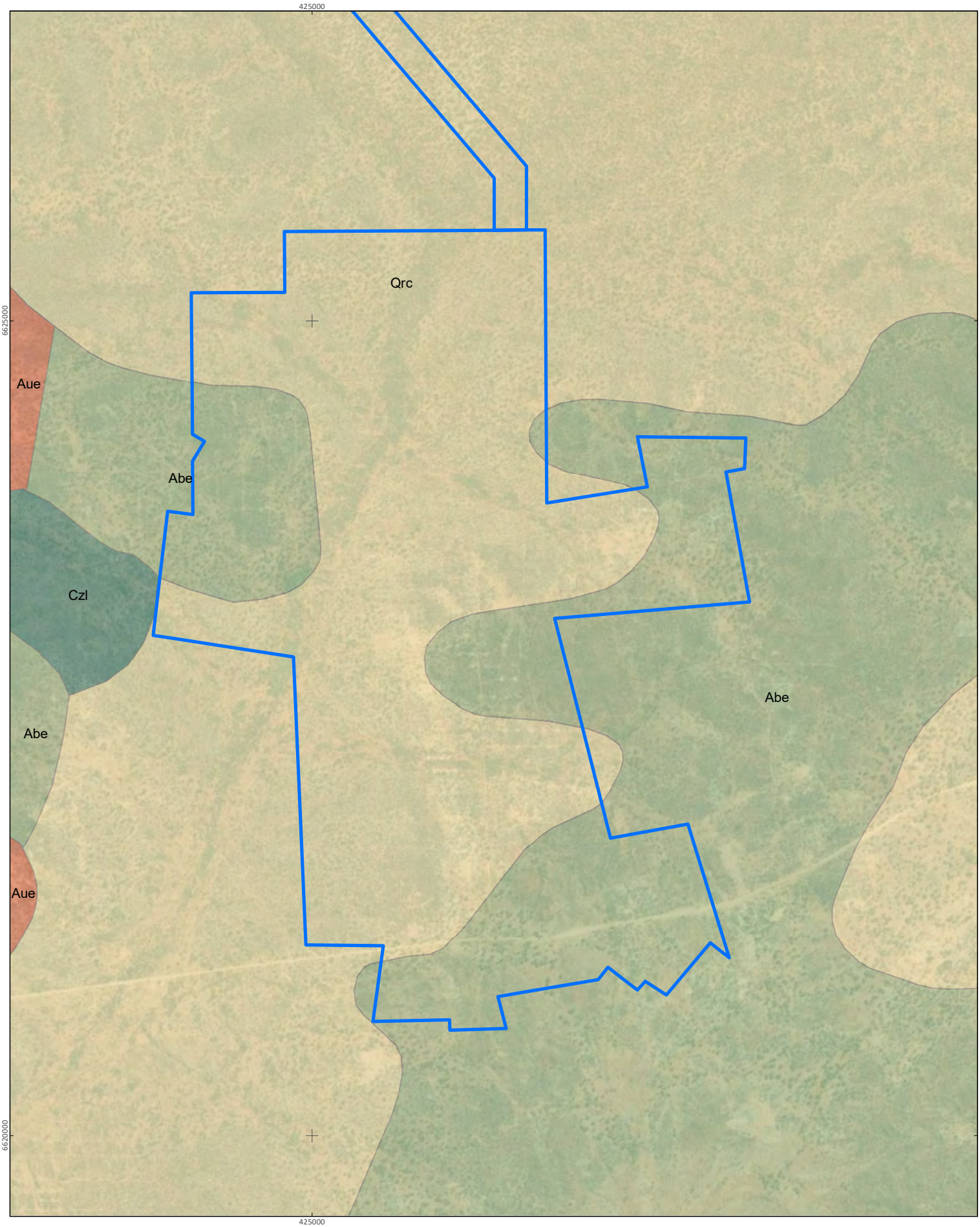
5.2.2 Hydrogeology

The water level within the study area is between 36 and 42 m (Rockwater 2021). According to Statewide Hydrology (DoW 2001), the study area intersects one aquifer type “Fractured and deeply weathered rocks - local aquifers, minor groundwater resources, locally large supplies from fracture zones and permeable horizons in weathering profile” with a geological description of “Mafic and ultramafic rocks, basalt, komatiite and minor metasediments; subsurface weathered to clay” (Figure 5-2). This aquifer type and lithology has a low to moderate suitability for stygofauna, dependant on composition, degree fracturing and porosity. However, given the low transmissivity (Rockwater 2021), and high clay content in the upper layers (Soil Water Consultants 2022), the local conditions indicate low suitability for stygofauna.

The groundwater within the study area is saline, with the salinity of sampled drillholes varying between 3,700 to 9,000 mg/L (Rockwater 2021).

5.2.3 Surface hydrology

The study area is situated in gently undulating landscape, with a few minor drainages occurring throughout, draining southwards into Lake Yindarlgooda, located 8 km south of the study area. Lake Yindarlgooda is a large salt lake stretching 50 km from east to west. It forms part of a paleochannel, where the groundwater in the alluvium may be used for water supply in the northern part of the area where the groundwater salinity is relatively low, however, the groundwater is saline in the south (DWER 2019; Humphreys 2001) where the study area lies.





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Carosue Dam Operations - Kurnalpi

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Kilometers

1:30,000 (at A4) GDA 1994 MGA Zone 51

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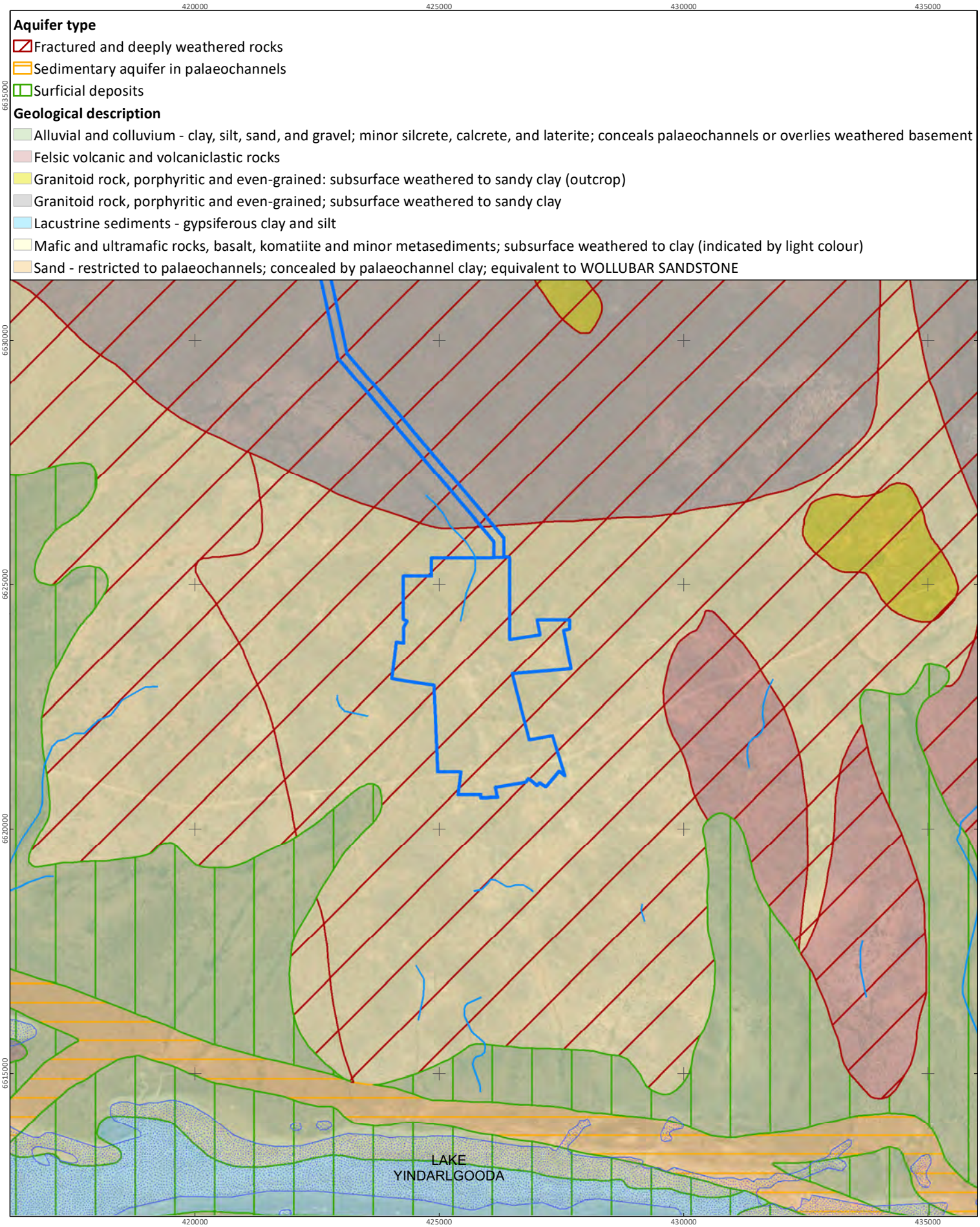
Study area
- Kurnalpi DE

Surface geology
- Abe
- Aue
- Czl
- Qrc

Figure 5-1

Surface geology in the study area

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Northern Star Resources
Carosue Dam Operations - Kurnalpi

Project No	1699-CDO-NSR-SUB
Date	23/12/2024
Drawn by	AJ
Map author	AJ

0 1.5 3
Kilometers

1:100,000 (at A4) GDA 1994 MGA Zone 51

Kurnalpi DE
Surface hydrology
Watercourse (minor)

Figure 5-2

Hydrology and hydrogeology of the study area

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6 DISCUSSION AND CONCLUSION

The EPA's objective for subterranean fauna is to protect subterranean fauna so that biological diversity and ecological integrity are maintained (EPA 2016, 2021). Subterranean communities are often restricted to very small areas and it is supposed this is based on the limited dispersal capabilities of the fauna, with short-range endemism interpreted at a much smaller scale than in terrestrial systems (Eberhard *et al.* 2009).

Direct impacts to subterranean fauna from mining projects include removal of habitat via pit creation and/or water abstraction. Indirect impacts may include contamination/pollution, vibration and nutrient starvation.

Given the lack of suitable geological and hydrogeological features within of the study area (ie. porous geologies such as calcrete, and the low proportion of alluvium and colluvium), the study area is unlikely to support a high diversity of troglofauna, if any.

The combination of saline water and very low porosity habitat within the study area limits the likelihood of stygofauna occurring. While stygofauna have been recorded in high salinities (Bennelongia 2020), this is uncommon and highly diverse and abundant communities are only likely to occur in combination with highly suitable geologies.

This is further supported by the lack of records from the desktop review search area. While few surveys have been undertaken, the ones that have suggest no subterranean fauna are present.

The research suggests stygofauna in the region are restricted to areas of suitable habitat above 29° south, with significant stygofauna communities appearing from 200 km north/ north-west/ north-east of the study area (Bennelongia 2020; Biologic 2021; Humphreys 1998).

Given the above, the risk to subterranean fauna from development of the Kurnalpi Gold mine is low.

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Appendix L: Baseline Surface Water Assessment

KURNALPI GOLD MINE

Surface Water Assessment



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1 INTRODUCTION

1.1 Background

Northern Star Resources Limited (NSR) has proposed a gold mine development at Kurnalpi, about 75 km north-east of Kalgoorlie, in the Goldfields region of Western Australia. The proposed access road to the project area from Kalgoorlie is via the Yarri road and the Kurnalpi-Pinjin road, as shown in Figure A.

The operational mine life is 2 years, and is expected to produce about 29.2 Mt of waste rock and 2.1 Mt of ore. The proposed development displayed on Figure B consists of two open pits, two waste rock dumps (WRD) adjacent to the pits and the associated mining infrastructures / facilities.

The pits will have a combined footprint of approximately 47.6 ha with bench heights of 10-20 m. A mining ore pad (MOP) will be located immediately east of each pit, where the ore will be temporarily stockpiled, and then transported via road trains to the Carosue Dam Mill for processing.

The objective of this study is to provide a surface water assessment supporting the approval process. Typically, environmental approvals for projects that involve land disturbance require maintaining surface water regimes and protecting the downstream sensitive receptors. This assessment will aid in understanding of surface water behaviour to the sensitive cultural and environmental receptors.

1.2 Scope of Works

The Scope of Works includes identification of key surface water / hydrological risks as a result of the proposed mining layouts, as follows:

- Review existing information (maps, aerial photos) and mine layout (pits, WRDs, etc)
- Characterise and describe the existing surface water environment
- Hydrological analysis including catchment delineation and peak flow estimation
- Estimation of flood depths and velocities impacting the mine, by 2D hydraulic modelling
- Report – summary to identify flood risks and mitigation measures required within the mine development areas, and to minimise the environmental impact of the project on the natural drainage systems

2 PROJECT AREA

2.1 Topographic data

The following spatial dataset with GDA94 horizontal datum, MGA Zone 51 projection was used to characterise the study and to undertake the hydrologic assessment:

- Kurnalpi 1 m LiDAR (211010_Kurnalpi_1m_DTM_MGA94.tif) provided by NSR
- Kurnalpi 0.5 m and 1 m interval contours provided by NSR
- Kurnalpi orthophoto (211010_Kurnapli_Ortho_10 cm_MGAz51_AHD.ecw) provided by NSR
- National one second (~30 m resolution) digital terrain model (DEM) derived from Shuttle Radar Topographic Mission (SRTM) surface, accessible from Geoscience Australia dataset
- ESRI World Imagery.

The key limitation in the available spatial data was the DEM accuracy in the upper part of the catchment (north of the explosive magazine) and downstream portion of the catchment not covered by 1 m LiDAR data. Thereby, a considerable elevation difference between SRTM data and high resolution LiDAR required modification in the hydraulic model.

On a regional basis, the Kurnalpi development is spread over low undulating plains within surface elevations of 374–357 mAHD that mostly slopes from north-east to south-west toward the main watercourse (west side of the development area) of the study catchment, refer to Figure B.

2.2 Land system

Based on the landscape mapping of Western Australia (DPIRD-063, 2018) published by Department of Primary Industries and Regional Development, soil characteristic covering the study area shown on Figure C were grouped into the land types as follows.

- Yowie and Waguin land systems cover from north-west to middle of the catchment; Mostly sandy plains with mesas and stony plains at high points supporting mulga shrublands.
- Kirgella, Gundockerta and Lonora land systems are spread east of the catchment; Gently undulating sandplains (and occasional dunes), calcareous stony plains and low greenstone hills supporting acacia and mulga shrublands.
- Graves and Moriarty land systems cover west of the catchment; Basalt and greenstone rises, low hills and stony plains supporting eucalypt woodlands with prominent saltbush.
- Campsite and Gundockerta land systems specify the land characteristic over majority of the development area; Gently undulating calcareous stony plains and alluvial plains toward south supporting eucalypt woodlands and acacia shrublands.

2.3 Catchment description

Kurnalpi lies within the Raeside-Ponton hydrographic catchment (Department of Water and Environmental Regulation dataset) approximately 8 km north of the Lake Yindarlgooda. Surface run-off from the project area consists of small local catchments that flows to the main watercourse discharging to the Lake Yindarlgooda, Figure D.

As a registered Aboriginal heritage place, Lake Yindarlgooda is a known cultural receptor downstream of the project area (Department of Planning, Lands and Heritage dataset). Therefore, run-off associated with construction and operational activities needs to be assessed and managed to avoid adverse environmental and cultural impacts (flow and water quality discharging to the lake).

The catchment area of Kurnalpi Creek (named for the purposes of this report, the main waterway which flows north to south down the western side of the proposed mine site) has a total size of 96.5 km^2, with the catchment characteristic outlined in Table 1.

Table 1: Study catchment details

Area (km²)	Centroid coordinate	Outlet coordinate	Mainstream length (km)	Equal area slope (m/km)
96.5	Lat: -30.4828 °S Lon: 122.2279 °E	Lat: -30.5464 °S Lon: 122.2029 °E	17.0	4.2

2.4 Climate

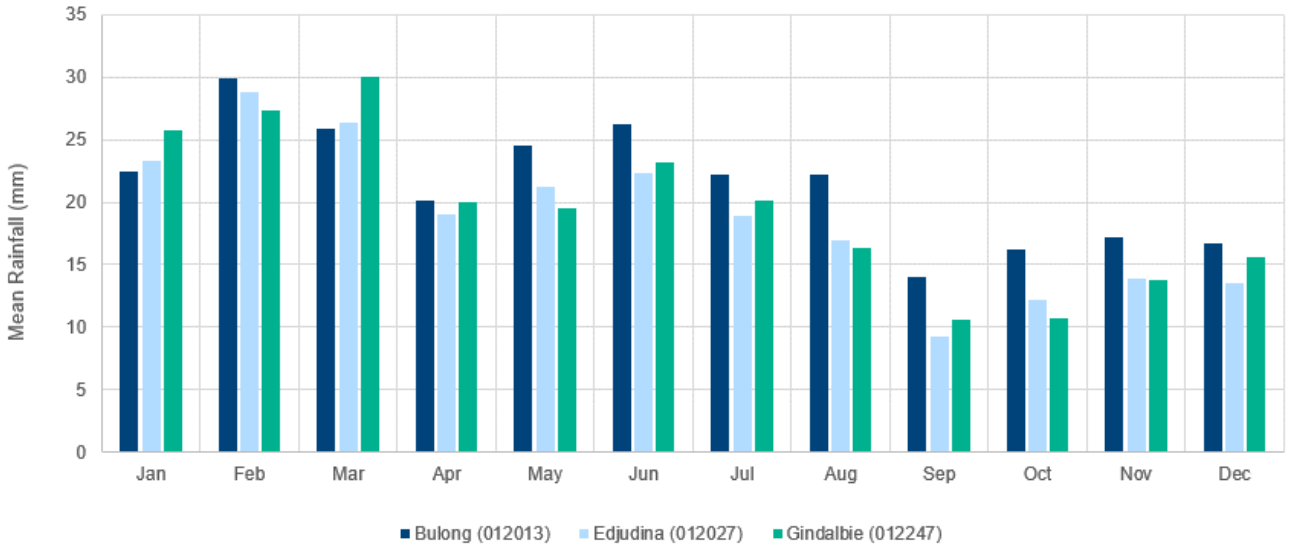
Kurnalpi is located in the Goldfields-Esperance region and is typically classified as an arid to semi-arid climate with hot, humid summers and warm dry winters. Details of three Bureau of Meteorology (BOM) rainfall stations nearby are listed in Table 2.

Table 2: BOM rainfall stations details

Number	Name	Coordinate	Elevation (m)	First record	Status	Years of record
012013	Bulong	Lat: 30.75° S Lon: 121.75° E	380	1897	Open	125
012027	Edjudina	Lat: 29.81° S Lon: 122.35° E	460	1900	Open	122
012247	Gindalbie	Lat: 30.28° S Lon: 121.76° E	380	1918	Open	104

Mean annual rainfall calculated over years of data are 257 mm, 221 mm and 231 mm for the Bulong, Edjudina and Gindalbie station, respectively. The highest and lowest annual rainfall depths at these stations are 674 mm and 48 mm, which were recorded at the Gindalbie rain station.

The highest monthly rainfall recorded are from the month of January to March, as shown in Graph 1.



Graph 1: Mean monthly rainfall over years of record (stations 012013, 012027, 012247)

The closest BOM station to Kurnalpi with a record of temperature is Kalgoorlie-Boulder Airport (station 012038), open from year 1939. Mean maximum and minimum temperatures calculated over years of data at this station are 25 °C and 12 °C, while monthly mean maximum temperatures vary from 38 °C in January to 17 °C in July.

3 REGIONAL FLOW ESTIMATION

There are no streamflow gauging data available for the study catchment from which peak floods may be estimated by performing a Flood Frequency Analysis (FFA).

Typically, most design flood estimates of small to medium sized catchments are on catchments that are ungauged or have little recorded streamflow data. In these cases, peak flow estimates can be obtained using available regional flood techniques. Regional flood estimation methods use basic catchment parameters and rainfall data to derive peak discharge at a particular location.

Regional Flood Frequency Estimation (RFFE) technique (Rahman et al. 2015) is a common flood estimation method for ungauged catchments, however, this method is currently unavailable for ARID region.

Therefore, the following regional flood estimation methods applicable to the project area (Goldfields region), were investigated with results presented in Table 3.

- Regional Flood Frequency Procedure (RFFP) for the Goldfields-Leinster area (Flavell, 2012). This procedure was developed using the very limited available streamflow data (13 years of record of one gauge) and on-site observation.
- Regional flood frequency curves for arid and semi-arid regions of Australia (Northfield et al. 2021). In this method, a regional curve was derived by combining the dimensionless frequency curves at a number of streamflow gauges. Normalised discharge along with the mean annual flow (MAF) and catchment area are used to estimate flows

Table 3: Peak discharge at catchment outlet by regional method

Method	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
RFFP	28	52	90	125	179
Arid RFFE 2021	63	105	151	214	263

The estimated peak flows by RFFP are considerably lower than the Arid RFFE method results. Due to the limited data in developing the Goldfields-Leinster RFFP, the estimates are likely to be underestimated, hence are not considered reasonable for the project assessment.

4 HYDROLOGICAL MODELLING

4.1 Model configuration

A hydrological model for the study catchment was developed using the RORB (v6.45) program to estimate peak flows. RORB is a rainfall run-off routing model that calculates flood hydrographs from input parameters such as rainfall and channel inputs. The specific parameters in RORB are the catchment non-linearity parameter and lag parameter (Kc) which relates to the reach length.

Spatial layout of the model outlining sub-areas, reach alignments and nodes is shown in Figure E. Considering the project extent and mostly flat topography with not well defined channels, simply three sub-areas were specified. The average flow distance from centroid of sub-areas to the model outlet (d_{av}) is 8.07, this is calculated and reported by RORB.

4.2 Design rainfall

Design rainfalls are a probabilistic or statistically based estimate of the likelihood of a specific rainfall depth being recorded at a particular location within a defined duration. Based on Australian Rainfall and Runoff (ARR 2019), there are five broad classes (with some overlap) of rainfall that are currently used for design purposes, generally categorised by frequency of occurrence.

Table 4: Classes of design rainfall

Class	Frequency of occurrence	Probability range
Very Frequent	Very Frequent	12 EY to 1 EY (exceedance per year)
Intensity Frequency Duration (IFD)	Frequent	1 EY to 10% AEP
	Infrequent	10% to 1% AEP
Rare Design Rainfalls	Rare	1% AEP to 1 in 2000 AEP
Probable Maximum Precipitation (PMP)	Extreme	< 1 in 2000 AEP

In order to assess the impact of future climates, an adjustment must be made to the design rainfalls. Climate change research undertaken for ARR 2019 has led to an interim recommendation to factor the design rainfalls based on temperature scaling using temperature projections. In this assessment, climate change has not been factored in rainfall depths.

At the centroid of the study catchment, point rainfall burst depths were obtained from BOM design rainfall data system (2016) and pre-burst depth from the ARR Datahub (2019), refer to Table 5 and Table 6.

Table 5: Design rainfall depth (mm) at -30.4828°S, 122.2279°E

Duration	63.2%	50%	20%	10%	5%	2%	1%
30 min	9.03	10.9	17.3	22.2	27.5	35.4	42.1
45 min	10.4	12.6	19.9	25.6	31.7	40.8	48.6
1 hour	11.5	13.9	21.9	28.2	34.9	44.9	53.4
1.5 hour	13.2	15.9	25	32	39.7	51	60.8
2 hours	14.6	17.4	27.4	35.1	43.4	55.8	66.4
3 hours	16.6	19.8	31	39.7	49.1	63.1	75.1
4.5 hour	18.9	22.5	35.2	44.9	55.5	71.3	84.9
6 hours	20.7	24.6	38.4	49	60.5	77.8	92.6
9 hours	23.2	27.7	43.2	55.2	68.3	87.8	105
12 hours	25.1	29.9	46.7	59.9	74.3	95.6	114
18 hours	27.6	32.9	51.8	66.8	83.3	107	128
24 hours	29.2	34.9	55.4	71.7	90	116	139
30 hours	30.4	36.4	58.1	75.6	95.2	123	148

Duration	63.2%	50%	20%	10%	5%	2%	1%
36 hours	31.3	37.5	60.2	78.7	99.5	129	155
48 hours	32.6	39.2	63.4	83.4	106	139	167
72 hours	34.3	41.4	67.8	90	116	152	183

Table 6: Median pre-burst depth (mm) at -30.4828°S, 122.2279°E

Duration	50%	20%	10%	5%	2%	1%
1 hour	2.6	1.9	1.4	1.0	1.1	1.3
1.5 hour	2.0	1.7	1.6	1.4	1.0	0.7
2 hours	2.4	2.0	1.8	1.6	1.3	1.1
3 hours	1.7	2.2	2.5	2.9	3.9	4.6
6 hours	0	1.3	2.2	3.1	3.1	3.1
12 hours	0	0.2	0.4	0.6	1.1	1.5
18 hours	0	0	0.1	0.1	0.7	1.1
24 hours	0	0	0	0	0.8	1.3
36 hours	0	0	0	0	0.3	0.5
48 hours	0	0	0	0	0.3	0.6
72 hours	0	0	0	0	0	0

4.2.1 Areal reduction factor

Areal reduction factor (ARF) is introduced to convert point rainfall to areal depth estimates, and to account for the variation of rainfall intensities over catchments. The ARF is a function of the total area of the catchment, the duration and AEP of the design rainfall event. ARR2019 recommends use of ARF for events more frequent than 1 in 2000 AEP.

The ARF coefficients of the Inland Arid region are applicable to the project area for durations longer than 24 hours. The ARFs were determined by the calculation procedure described in ARR 2019.

4.2.2 Distribution of rainfall

Rainfall exhibits both spatial and temporal variability at all spatial and temporal scales that are of interest in flood hydrology. While it is important to be aware of this variability, for design flood estimation based on catchment modelling, it is only necessary to reflect rainfall variability at space and time scales that are influential in the formation of flood events.

A temporal pattern describes how rainfall falls over time as a design input. The analysis of observed rainfall events from even a single pluviograph shows that a wide variety of temporal patterns is possible, hence, the importance of temporal patterns has increased as the practice of flood estimation has evolved from peak flow estimation to full hydrograph estimation (ARR2019).

ARR 2019 recommends adopting areal temporal patterns for catchments greater than 75 km^2 and storm durations greater than 12 hours. Areal temporal patterns of the Rangeland region downloaded from the ARR Datahub were adopted in the hydrological simulations.

As a minimum, ARR 2019 recommends a single non-uniform spatial pattern for catchments with an area greater than 20 km^2. For the 1% 12-hour duration storm, spatial distribution was calculated as a ratio of sub-area rainfall depth to the weighted average catchment rainfall. However, a uniform distribution was assumed in the hydrological model as the spatial variation was found insignificant across the sub-areas.

4.3 Routing parameters

Most studies have found that the non-linearity parameter lies in the range 0.6 to 1.0, and many studies adopt a constant value of 0.8 (ARR2019). The widely agreed non-linearity parameter of 0.8 was adopted in the RORB model.

The Kc parameter used to estimate the flow routing and attenuation characteristics within the catchment was determined through investigation of two equations applicable to the project area.

1. Equation developed by McMahon and Muller (1983):

$Kc = C_{0.8}\ d_{av}$.

Where:

- C0.8 is the catchment characteristic (for non-linearity parameter of 0.8)
- dav is the average flow distance from centroid of sub-areas to the catchment outlet (km).

Pearcey et al. (2014) suggest using a mean $C_{0.8}$ value of 0.59 for the Pilbara region by creating calibrated hydrological models across that region. As the study catchment is located in an arid area with similar to the Pilbara region, $C_{0.8}$ value of 0.59 was adopted, which resulted in Kc of 4.76.

1. Regional relationship developed for the Wheatbelt and Kimberly regions is recommended for the arid interior of Western Australia (ARR2019):

$Kc=1.06 \times L^{0.87} \times Se^{-0.46}$

Where:

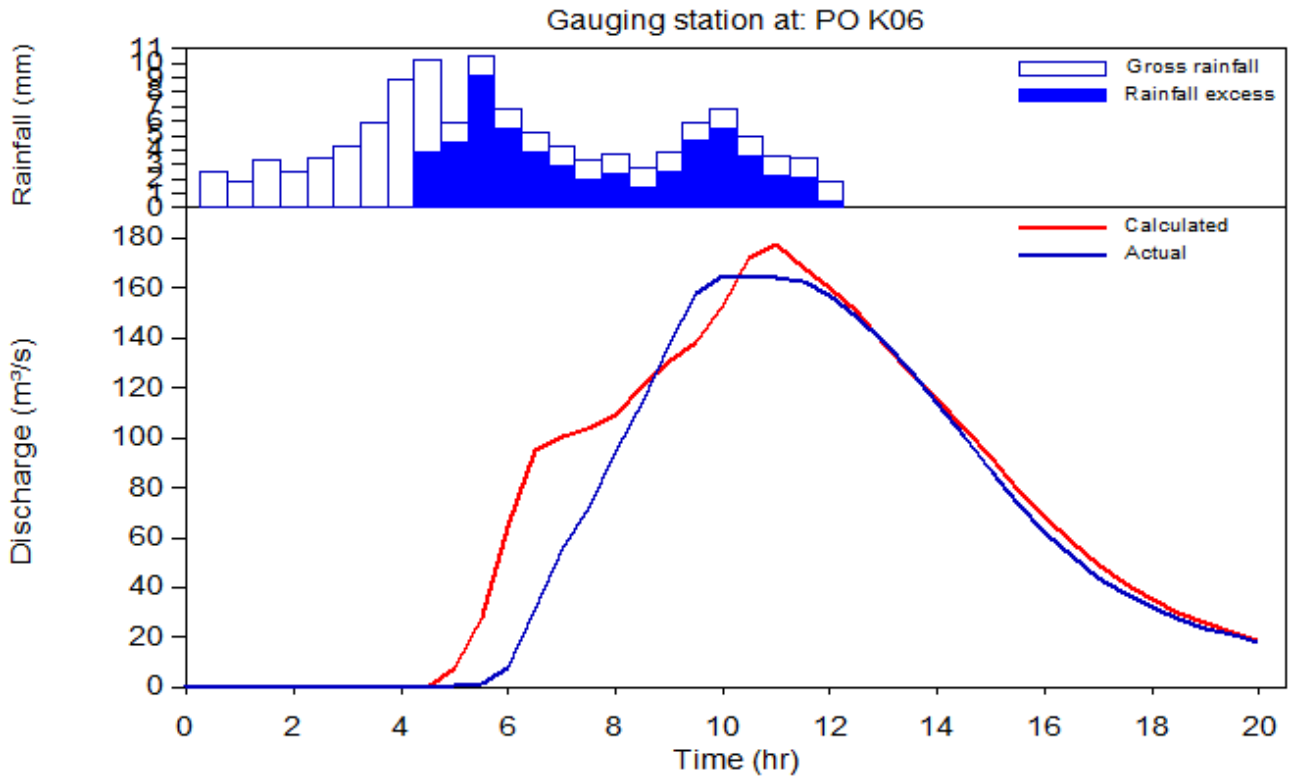
- L is the stream length (km)
- Se is the stream slope (m/km).

Therefore, the calculated Kc by this method is 6.49.

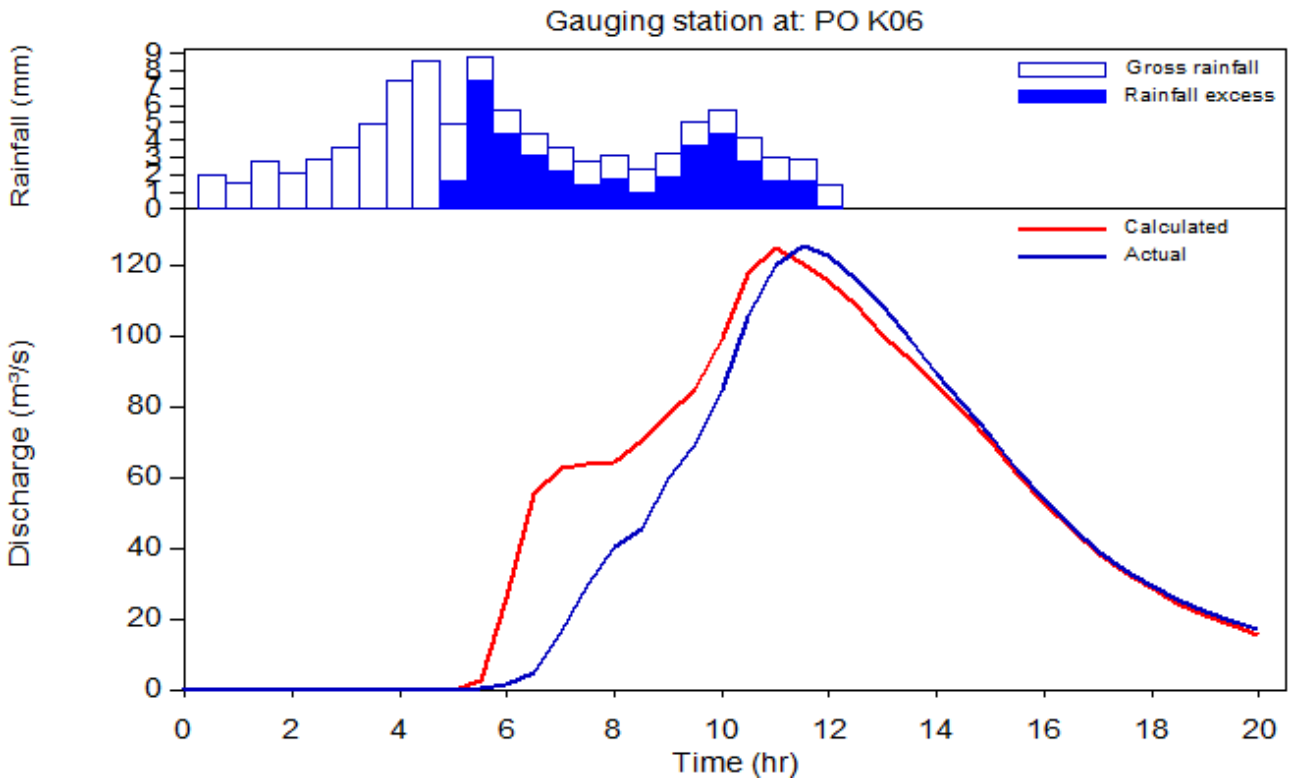
In addition to the above equations, fitting RORB model to the flow hydrographs generated by a 2D hydraulic model was tested to determine the routing parameter. Terrain and waterway characteristic can be reflected in a hydraulic model to examine the corresponding routing parameter in hydrological modelling.

A preliminary hydraulic model using TUFLOW software was developed for the study catchment. With available DEM data (SRTM and LiDAR), simulations of 10%, 5%, 2%, 1% AEP events, 12-hour duration and arbitrary temporal pattern were undertaken. The same loss model was used in the RORB and TUFLOW models.

Flow hydrographs estimated at the catchment outlet were defined as inputs in the RORB model. Peak flow, hydrograph shape (rising and falling limbs), time to peak and volume were examined to determine the agreement between RORB and TUFLOW hydrographs.



Graph 2: Tuflow (actual) vs RORB (calculated) hydrograph; 1% AEP 12-hour



Graph 3: Tuflow (actual) vs RORB (calculated) hydrograph; 2% AEP 12-hour

Results at the catchment outlet indicate a sensible agreement of hydrographs for rare events, Graph 2 and Graph 3, while the hydrographs of frequent events are poorly aligned. Thus, the Kc of 8.0 resulted from 1% AEP fit was considered in the further analysis.

4.4 Losses

Loss is defined as the precipitation that does not appear as direct run-off, and is attributed to the interception by vegetation, infiltration into the soil, retention on the surface (depression storage) and transmission loss through the stream bed and banks.

Given the lack of recorded data across the project area for derivation of loss parameters and no valid loss data from the ARR Datahub, using the different loss model approaches including the initial – continuing loss (IL-CL) and the Soil Conservation Service (SCS) run-off curve number were investigated.

The initial – continuing loss models are ARR 2019 Region two median losses (IL 37.5 mm – CL 2.7 mm/hr) and Region 2 median gridded losses (IL 51.3 mm – CL 4.3 mm/hr).

Assuming run-off curve number of 67 for arid rangelands with poor hydrologic condition, initial abstraction of 25 mm and run-off coefficient of 0.42 (1% AEP 12-hour duration event) were calculated.

4.5 Monte Carlo simulation

In the absence of calibration data, peak flows can be estimated by the Monte Carlo approach by random selection of variable parameters (design AEPs, temporal patterns and losses). This probabilistic approach provides a more robust understanding of uncertainty for analysis of a range of variables compared to a deterministic approach. Results of the Monte Carlo simulation with various Kc values and losses are presented in Table 7.

Table 7: Peak discharge at catchment outlet estimated by RORB Monte Carlo

Kc	Loss	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
4.76	IL 37.5 – CL 2.7	23.6	72.8	130.6	229.3	299.6
4.76	IL 51.3 – CL 4.3	0	24.7	73.9	152.1	230.3
4.76	IL 25 – run-off Coeff. 0.42	40.6	62.4	87.5	125.9	158.8
6.49	IL 37.5 – CL 2.7	18.2	56.7	106	182	255.8
6.49	IL 51.3 – CL 4.3	0	19	57.2	120.1	190.9
6.49	IL 25 – run-off Coeff. 0.42	36.1	54.0	74.5	106.7	134
8.0	IL 37.5 – CL 2.7	13.9	45	87.6	156.8	220.9
8.0	IL 51.3 – CL 4.3	0	12.1	40.7	99.7	160.3
8.0	IL 25 – run-off Coeff. 0.42	32	47.8	65.2	93.5	118.5

4.6 RAFTS model

XP RAFTS was also used for estimation of peak flows. Like RORB, RAFTS is a computerised hydrologic run-off routing model that develops a stormwater run-off hydrograph, from either a recorded rainfall event or a design storm using IFD data. Data inputs include catchment area (divided into sub-areas as required), catchment slope, rainfall loss rates, design rainfall IFDs and dimensionless storm temporal patterns. With increased rainfall intensity, the loss factors reduce.

With the catchment layout developed, same as RORB model, the 1% AEP peak flows were estimated as 59 m^3/s (12-hour duration) and 81 m^3/s (24-hour duration).

4.7 Results

The 1% AEP peak flow estimated by RAFTS program was lower than the peak flow estimates by RORB model and regional methods.

As the fitted Kc of 8.0 has been derived from rare event hydrographs, and Kc of 4.76 estimated from recommended parameters for Pilbara region, the Kc of 6.49 was considered more reasonable and was selected for estimation of flows.

All rainfall depth in a 20% AEP storm is consumed by the high initial loss of 51.3 mm (Region 2 gridded loss) with no run-off generated. Peak flows for the frequent events are very low, with assumption of this loss model. Thus, this loss model is considered more appropriate for flood assessment of rarer events.

It is noted that estimated peak flows by Arid RFFE method are fairly comparable with the RORB estimates by Region 2 median losses of IL 37.5 mm – CL 2.7 mm/hr. Hence, this loss parameters have been selected for the further hydraulic modelling. A 12-hour duration is predominantly the critical duration for all AEPs, which generates the peak flow at the catchment outlet.

Peak flows were estimated for a range of events from frequent to rare (20% to 1% AEP), while to generate flood maps using 2D flood modelling, two storm events of 10% and 1% AEPs were adopted.

5 HYDRAULIC MODEL

5.1 Roughness Coefficient

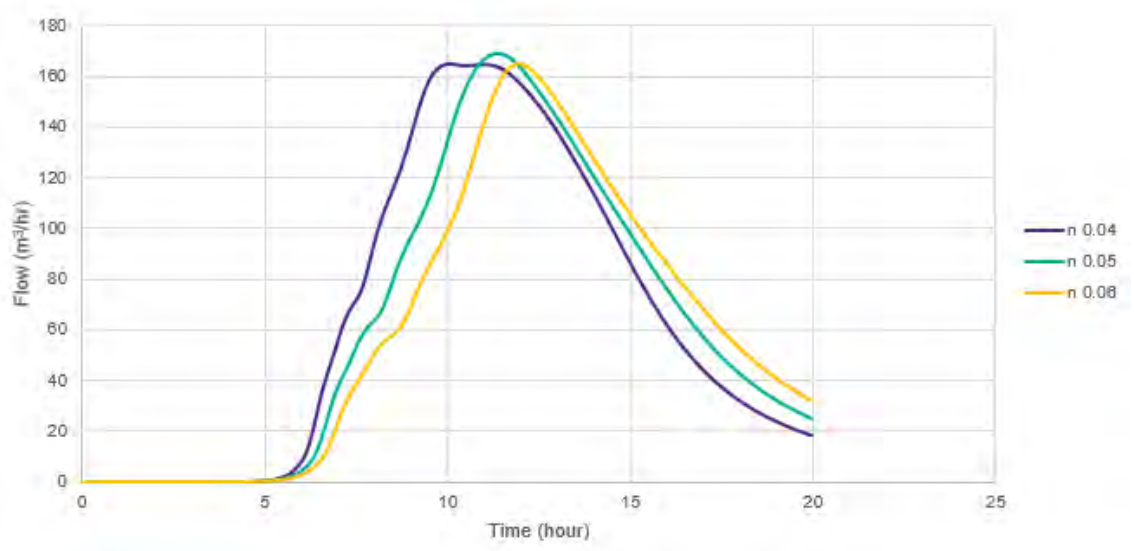
Free surface flows are driven by gravity and resisted by shear forces on the channel bed and drag forces on objects such as vegetation and obstructions. The increase in roughness on the floodplain due to vegetation means that the floodplain flows are typically shallower and slower than the flow in the main channel.

2D roughness parameter nominally represents friction loss due to the ground surface material in each grid element and is generally parameterised in terms of Manning 'n'. Typical ranges of 2D roughness parameters for various land-use types recommended in ARR2019 and relevant to this study are:

- Open pervious areas, minimal vegetation range from 0.03 to 0.05
- Open pervious areas, moderate vegetation range from 0.05 to 0.07
- Waterways with minimal vegetation range from 0.02 to 0.04
- Vegetated waterways range from 0.04 to 0.1

Different global constant Manning values were modelled (1% AEP 12-hour duration storm) for a sensitivity analysis of surface roughness. The values of 0.04, 0.05 and 0.06 were specified based on the understanding of vegetation and terrain from the aerial imagery and LiDAR survey data of the project area; this assumption is consistent with ARR2019 recommendation.

The comparison of water level profiles along the main creek of the catchment indicates that water level is not sensitive to change of the roughness. Additionally, flow hydrographs at the outlet of the catchment are comparable except for a delay in the time to peak with increase of the roughness coefficient as illustrated in the Graph 4. As such, roughness of 0.04 was selected to model the design storm events.



Graph 4: Comparison of Catchment Outlet Hydrograph for Various Roughness

5.2 Model Configuration

The primary aim of hydraulic modelling is to describe the water level and velocity characteristics of the hydrologically derived flood flows. Typical applications for hydraulic models may include prediction of the flood behaviour, evaluation of the effects of proposed changes that may affect flood flows, and assessment of a range of flood mitigation works.

In 2D hydraulic modelling, calculations are performed over a terrain with more complex catchment details to derive hydraulic results across a model domain. TUFLOW software was used to undertake 2D modelling on the existing topography and to produce baseline flood data.

By selected loss parameters and Kc value, peak flow estimated (for critical duration) by RORB model were introduced as steady-state inflow of the main creek. The adopted initial and continuing losses were applied directly to the rainfall hyetograph.

The downstream model boundary extended to south is approximately 5km away from the proposed development. Details of the model setup are listed in the Table 8.

Table 8: TUFLOW Model Setup Details

Item	Value
Topographic data	30m SRTM and 1m LiDAR DEM Due to a considerable elevation difference between DEM data, some elevation adjustments were undertaken.
Grid resolution	10m cell size Sub-Grid Sampling at 5m
Roughness (Manning's n)	0.04
Design storms	10% and 1% AEP Design rainfall depths at the centroid of catchment
Areal Reduction Factor	1 (point rainfall) As runoff impacting the development area is mainly driven by direct rainfall from the local small catchments, use of point rainfall is more applicable.
Losses	IL37.5 - CL2.7 selected from RORB model

5.3 Results

A rain-on-grid (direct rainfall) model utilising an ensemble of rainfall durations and temporal patterns was developed to identify the maximum flood depths and velocities for design events (1% and 10% AEP).

The critical duration, the duration that yields the maximum flood depth, is 12-hour for the 1% AEP event for Kurnalpi Creek, while mainly the 3-hour duration was found critical for local drainages that traverse development areas and proposed access roads. On the other hand, the 12-hour duration is primarily the critical duration of the 10% AEP event.

The flood results are shown in 6 no. Figures F-K covering results for the 10% and 1% AEP pre-development floods. Figure F and I show the flood extents; Figure G and J show the flood velocities, Figure H and K show the critical duration storm at any given location in hours.

6 SURFACE WATER MANAGEMENT

6.1 Flood Protection

The proposed mine area is located in flat to undulating terrain and impacted by catchments to the east with approximate size of 15 km^2. These eastern catchments mainly generate surface run-off in indistinct and shallow watercourses, which flow west through the site and into Kurnalpi Creek.

The north to south road accessing the site intersects several of these minor drainage paths. A larger northern catchment (~8 km²) crosses the road and impacts the area north of the office/workshop. Run-off from the central catchment (~3.5 km^2) crosses the road between the turkeys nest and office/workshop and southern catchment (~3.5 km²) drainage flows between the two MOPs.

The type of surface water infrastructure at the road / creek crossings is determined by the level of flood immunity required, and the time of closure acceptable during a flood. Floodways are commonly used for roads with relatively low traffic volume, alternatively, culverts can be used to improve flood immunity protection. Upstream flow can be directed towards the flood crossings by bunding on the upstream side.

The east to west road to the magazine building intersects Kurnalpi Creek, and a culvert or floodway is required at this creek crossing.

The southern watercourse crosses the north-south road and passes between the two MOPs and then the North and South pit. The northern WRD blocks the channel, and water will pond in this area after rain. A minor diversion (shallow bund / channel combination) is proposed to carry this water around the southern side of the WRD (and pass between the two WRDs, and back into Kurnalpi Creek).

Based on the flood extent maps, the northern WRD and western end of the topsoil stockpile encroach into the Kurnalpi Creek floodplain. It is estimated that the toe of the waste dumps would be inundated up to about 1.5m deep in a 1% AEP flood event, requiring a levee along the toe of the WRD. This levee will only marginally increase flood levels.

Associated mining facilities (such as the workshop/office, magazine, turkeys nests, magazine, topsoil stockpiles, MOPs) are only impacted by sheet flow and require minor surface water protection. This may take the form of slightly raising facilities off the ground, or minor drainage works to manage runoff locally and divert potential sheet flow around the facilities.

The proposed operational life of mine (LOM) is short at ~2 years, and the risk of a large rain event occurring over the LOM is low. The level of immunity provided to mine infrastructure is typically taken as the 1% AEP event, which would have a 2% chance of occurrence in the LOM. A 10% AEP storm would have a 20% chance of occurrence.

The pits can be protected from flooding by the use of relatively minor earthworks and surface water management structures. Normal well-made pit bunds will be sufficient to protect the pits from surface water inflow.

Generally 1% AEP flood velocities are below 1.0 m/s, and no specific mitigation measures (such as rock armour) are proposed.

6.2 Sediment control

Heavy rainfall over disturbed or degraded land brings the risk of erosion, the largest impacts relate to sediment laden run-off from waste dumps and stockpiles. Adherence to surface water protection principles and implementation of environmental control measures is required. DWER provides “Water Quality Protection Guidelines” outline water quality objectives and management in mining and mineral processing, with the aim to minimise adverse impacts on downstream waterways (water quality, dependent vegetation communities and ecological systems).

This requires the identification, planning, and management of soil and water issues during the mine life and best management practices, such as limiting clearing, use of existing tracks, retaining adequate buffer zones, storing chemical and hydrocarbon away from flow paths, etc. Specific work procedures and control measures are required for clearing and grubbing, topsoil stripping and stockpiling, disturbance and excavation, waterway crossings, chemical storage and use, and refuelling operations.

Stormwater run-off from disturbed mining infrastructure can be captured behind demarcation bunds, collected in evaporation ponds, or captured in sedimentation basins. Waste dumps need to be shaped to drain internally with crest bunds to retain water on the top and reduce run-off and erosion down batter faces. Furthermore, perimeter bunds at the toe of the dump capture dirty water run-off.

Periodical site inspections / visual checks can be event-based, prior to or following significant predicted rainfall events, and prior to extended site shutdowns, to ensure appropriate mitigation measures and controls are in place; and are operational and effective. The outcomes of inspections, monitoring, and audits facilitate the identification of problems and any recurring issues or areas for improvement.

6.3 Rainfall over pit

The pits need to need to be protected from external surface water inflow, and will therefore only be impacted by rain falling directly over the pits. The volume of rainfall runoff that accumulates in the pit bottom increases as the pit staging unfolds, and the surface footprint becomes bigger. The pit shell will temporarily store any surface water inflows, but provisions need to be made for flood storage, to avoid flooded plant and equipment or production loss. The flood storage requirements for every stage of the development should be ascertained (such as stormwater sumps, or lower parts of the pit) to minimise disruption to operations.

The 72-hour rainfall is typically used in “volume” dependent storm events as a basis for operational flood impacts (flood response). Possible times to pump out accumulated water within a pit depend on available equipment on site. The approximate 72-hour rainfall volumes are shown in Table 9.

Table 9: Pit rainfall volumes (m³)

Pit	Max Pit surface outline (ha)	Flood Vol. (20%)	Flood Vol. (10%)	Flood Vol. (1%)
North Pit	32	15,000	22,000	49,000
South Pit	6.3	3,000	4,300	10,000

The flood volumes in the pit would continue to reduce over time due to evaporation and infiltration. For pumping rates of 20L/s to 70 L/s, the 1% AEP pump out times would vary from 8-28 days (North Pit) and 2-6 days (South Pit).

7 CLOSURE

Mining is a temporary land use and rehabilitation should be maintenance free over the long term, environmentally sustainable, and consistent with the projected future land (e.g. pastoralism, and heritage conservation).

Decommissioning of the mine site involves removal of infrastructure, and rehabilitation of disturbed areas (old roads, dumps, site compounds) to a safe and stable state, free draining, resistant to erosion gullying, vegetated with endemic plant communities that approximated those that existed prior to the disturbance, and visually compatible with its surrounds.

WRDs in particular can comprise unconsolidated, dispersive and erodible materials, combined with steep and / or long batter slopes with attendant erosion and water quality risks. Surface water management measures include compartmentalised cells to retain water on the top of dumps and reduce erosion on the batters, emulation of natural slope features / concave slopes, minimising the size of local catchments, contour ripping, etc and rockier outer materials.

The pits cut off minor sheet flow from the east and there will be minimal surface water impact at closure. A standard abandonment bund will be sufficient.

The open pits will hold water and the WRDs will trap run-off on top, and hence there will be a minor proportional reduction in contributing catchment area downstream. However in a landscape of broad catchments and creeks, with natural large seasonal and annual variations in catchment runoff, this reduction in catchment area and in effective run-off loss is not environmentally significant,

Post-closure performance monitoring continues after the landforms have been closed and then rehabilitated, until completion criteria to agreed standards have been achieved. Eventually, the landforms achieve equilibrium with the local environment with no adverse effects on surface and groundwater hydrological patterns / flows, water levels and water quality.

8 SUMMARY

Northern Star Resources has proposed a gold mine development at Kurnalpi, in the Goldfields-Esperance region of Western Australia. This region has an arid to semi-arid climate with hot, humid summers and warm dry winters.

Kurnalpi development area is spread over flat to undulating terrain with surface drainage from north-east to south-west direction joining the main watercourse that runs along the western side of the development area. Apart from the main watercourse channel, local drainage paths are not incised and are indicative of low velocity flows. As surface flows are not concentrated, flood impacts mainly result from the effects of sheet flow.

The Yindarlgooda lake, a registered Aboriginal heritage place, is a cultural receptor downstream of the Project area. Impacts on the flow and water quality due to the mining activities are to be assessed and managed throughout the project life.

Multiple flood estimation techniques have been investigated to perform hydrological and hydraulic assessment of the Kurnalpi development area. Catchment peak flows were estimated for a range of events from frequent to rare (20% to 1% AEP) by relevant regional methods and compared to the estimates by hydrological models. Based on the analysis results, loss parameters were selected and peak flows for Kurnalpi Creek (main watercourse in study catchment) were derived for hydraulic modelling.

A hydrological and a 2D hydraulic model were used to develop flood extent of 1% and 10% AEP events for the existing (pre-development) condition across the proposed Kurnalpi mining area.

Due to the DEM accuracy in part of the catchment not covered by 1 m LiDAR data extent, a considerable elevation difference between SRTM data and high resolution LiDAR was modified to generate a suitable terrain for the hydraulic modelling.

Based on the flood extent maps, a levee along the toe of the north WRD and a low flow channel diverting local run-off between pit footprints and around the WRD to Kurnalpi Creek are required. Minor drainage works are anticipated around other facilities to control run-off locally.

Proposed access roads around the site intersect several minor drainage paths and one crossing at the Kurnalpi creek. Depending on the level of flood immunity and road serviceability needed during flood events, floodways or culverts can be used at watercourse crossings to manage minor drainage paths and to maintain main creek flow as required.

Adherence to surface water protection principles and implementation of environmental control measures is required to mitigate risk of erosion and sedimentation derives from construction and mining activities. Site inspections of surface water infrastructures are required to monitor control measures put in place and to facilitate the identification of issues for improvement.

Mining is a temporary land use and at closure, the objective is to rehabilitate disturbed areas for alternative land use, with a focus on free draining, stable surfaces, revegetated and visually compatible with its surrounds.

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FIGURES

Figure A: Overview Map
Figure B: Proposed Site Layout
Figure C: Land System Mapping
Figure D: Study Catchment
Figure E: RORB Model Layout
Figure F: 1% AEP Pre-development Flood Extent
Figure G: 1% AEP Pre-development Flood Velocity
Figure H: 1% AEP Critical Duration
Figure I: 10% AEP Pre-development Flood Extent
Figure J: 10% AEP Pre-development Flood Velocity
Figure K: 10% AEP Critical Duration

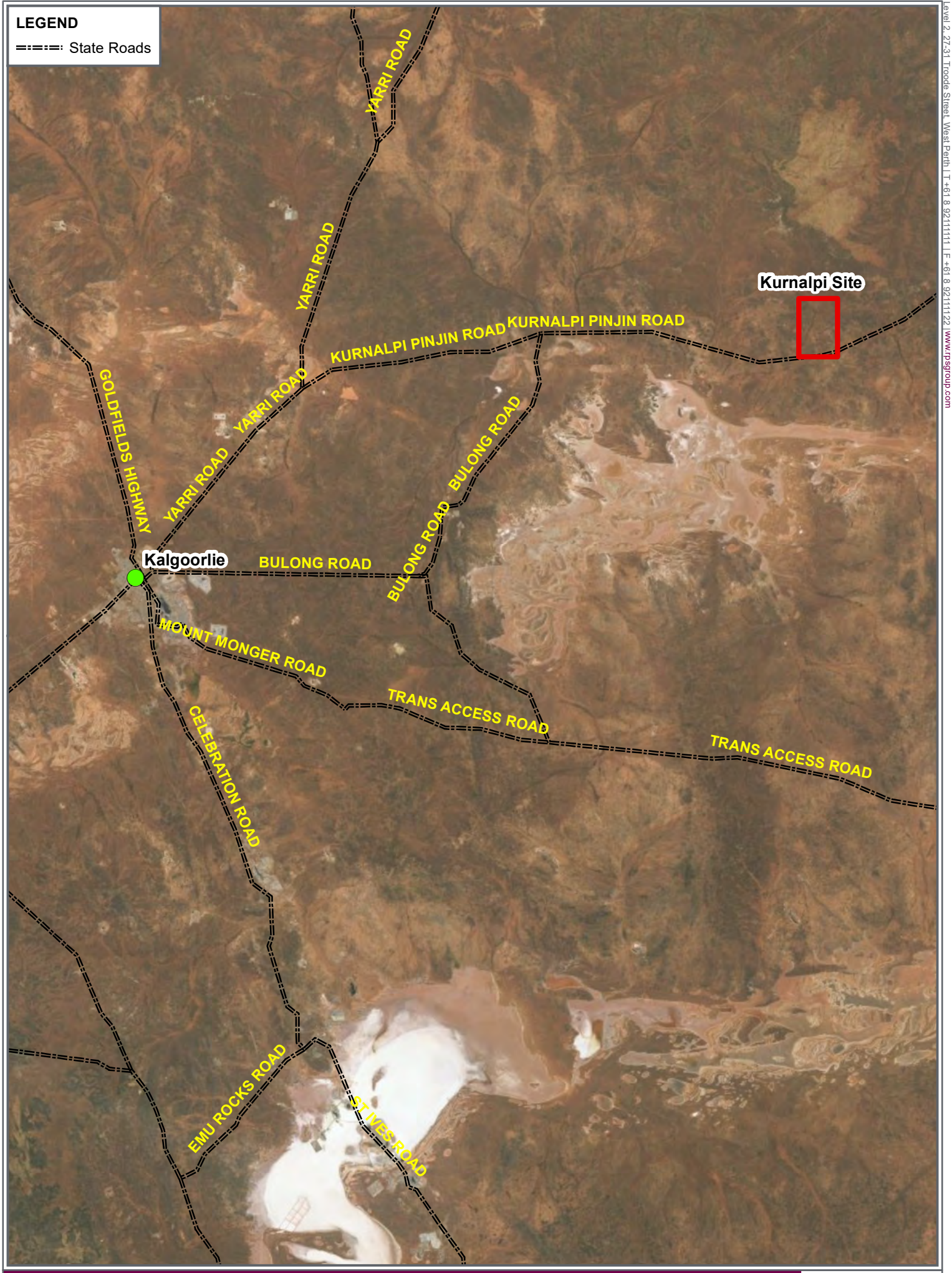


Figure A

Kurnalpi Gold Mine overview

GDA 1994 MGA Zone 51

0 5,000 10,000 20,000 m

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:500,000 @ A4
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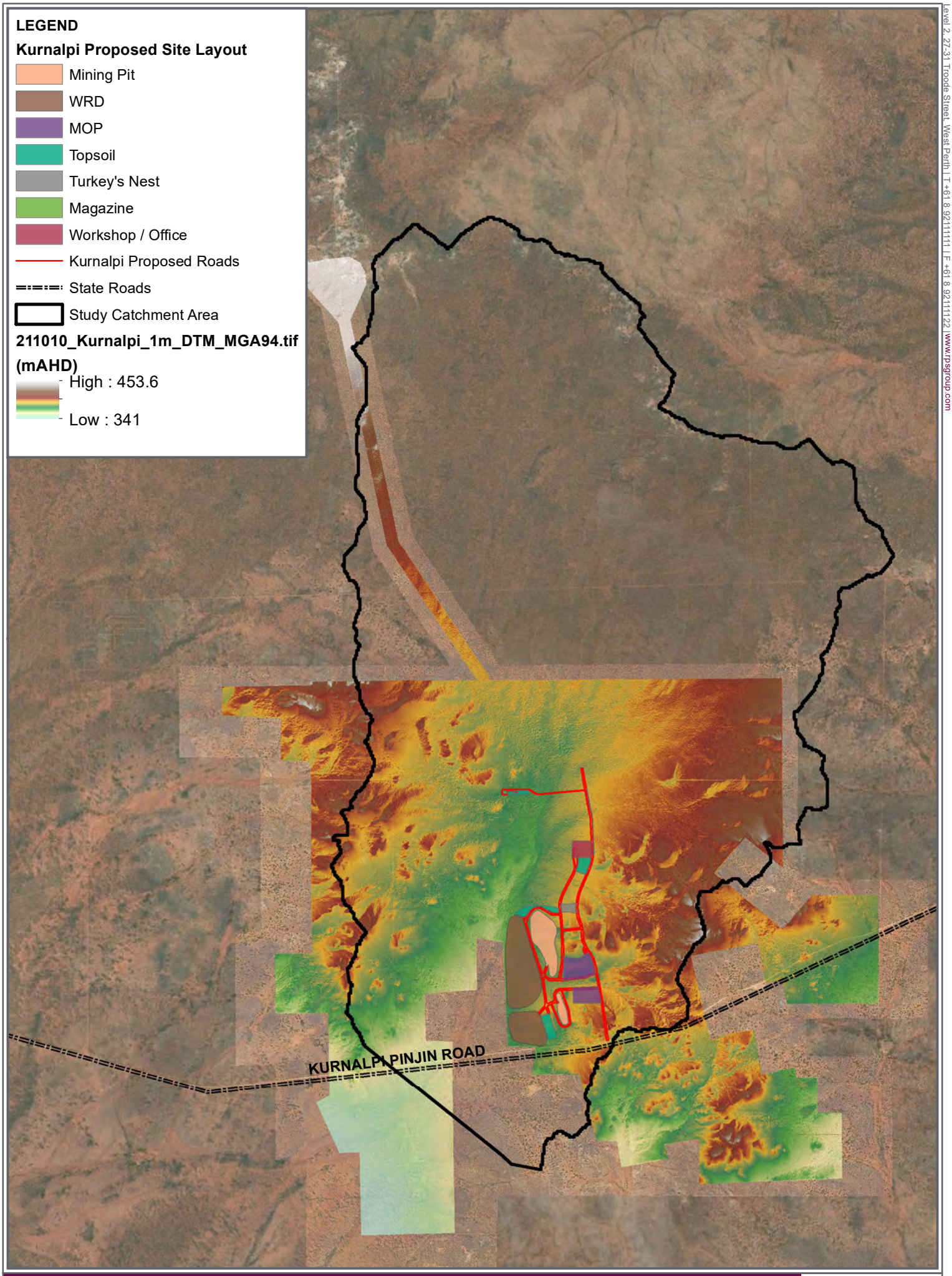


Figure B

Kurnalpi Gold Mine proposed site layout

GDA 1994 MGA Zone 51

0 800 1,600 3,200 m

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Date: 22.08.2022
Scale: 1:80,000 @ A4
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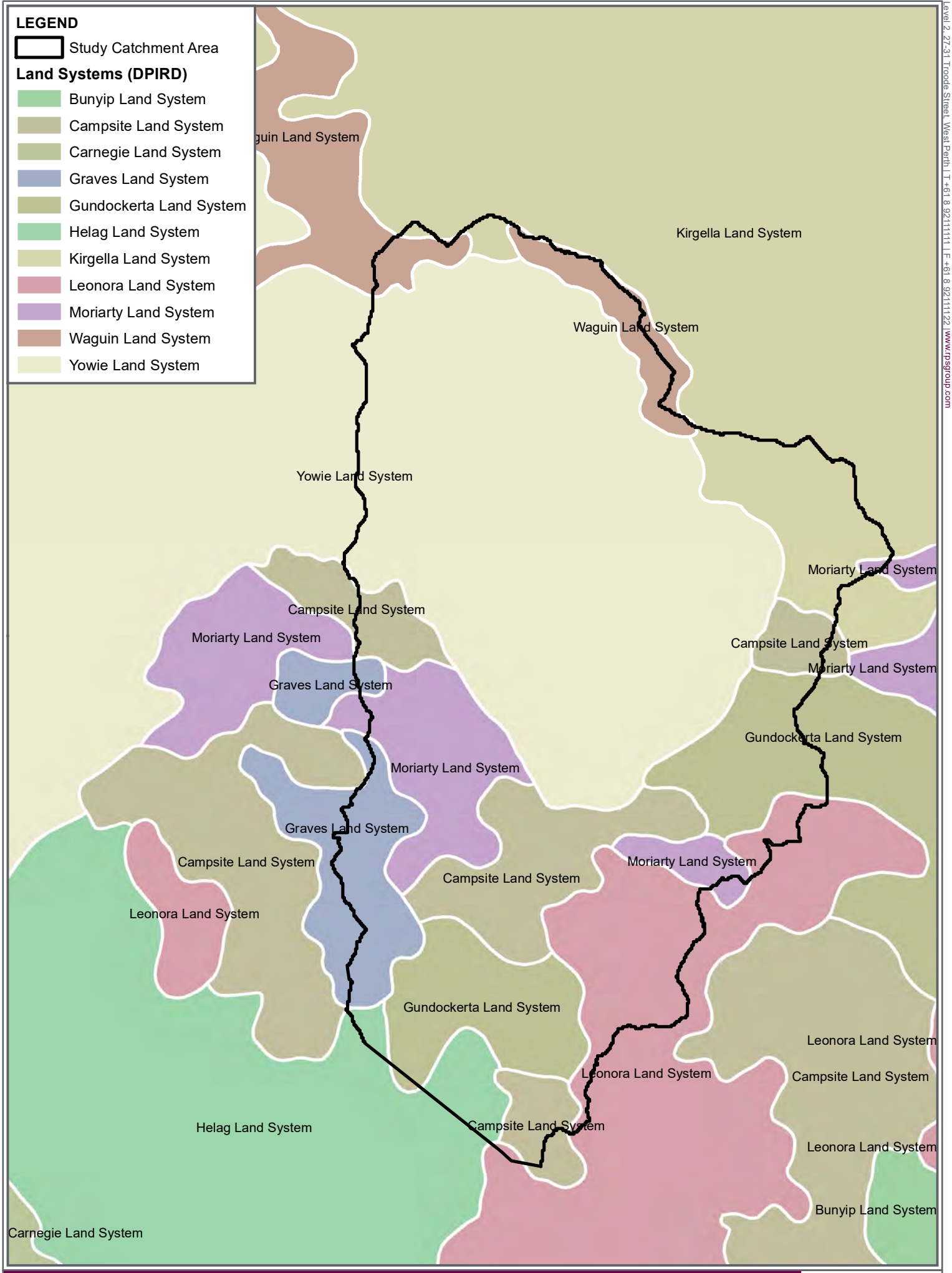


Figure C

Kurnalpi Gold Mine land system mapping

GDA 1994 MGA Zone 51

0 800 1,600 3,200 m

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:80,000 @ A4
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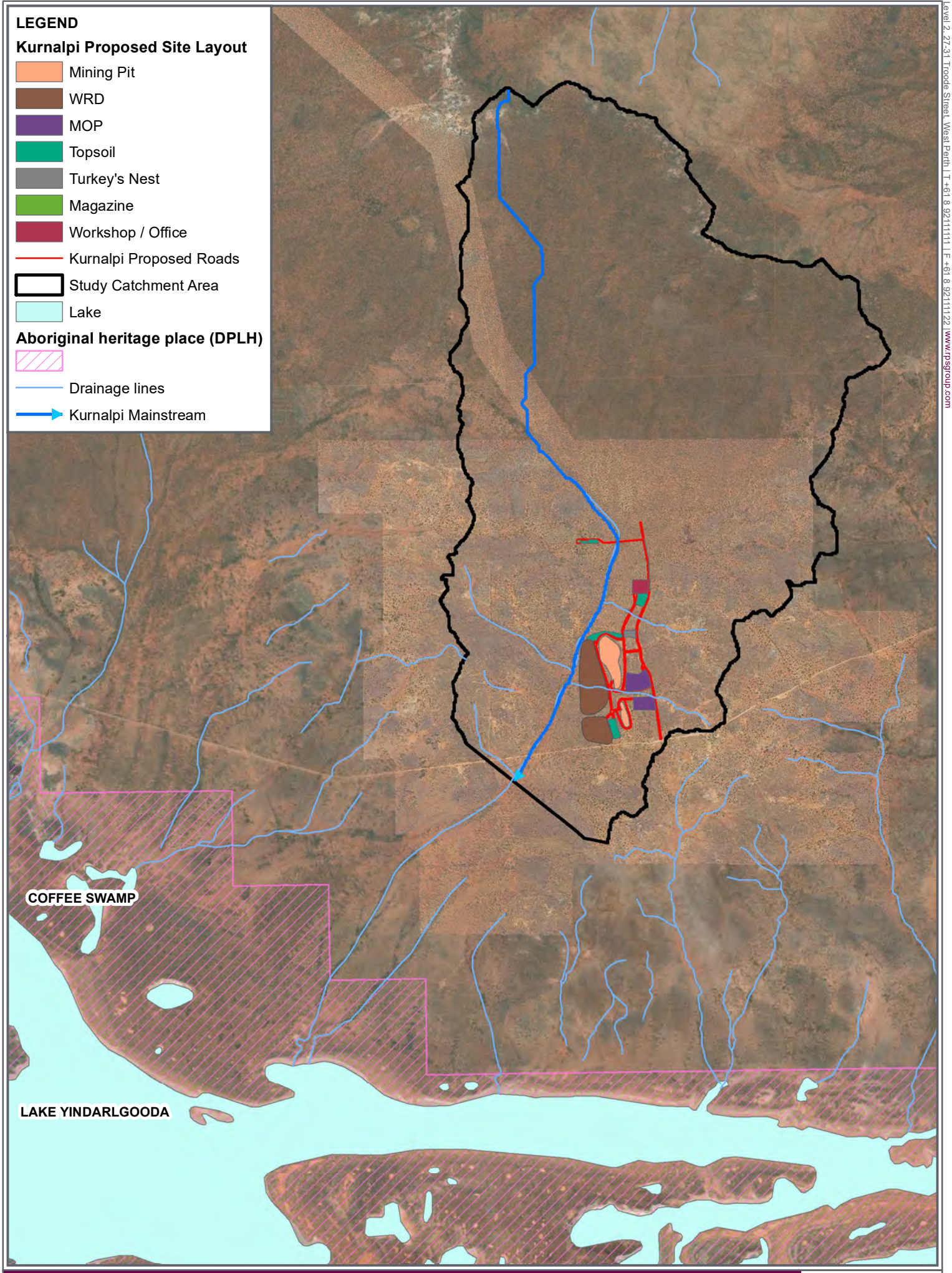


Figure D

Kurnalpi Gold Mine study catchment

GDA 1994 MGA Zone 51

0 1,000 2,000 4,000 m

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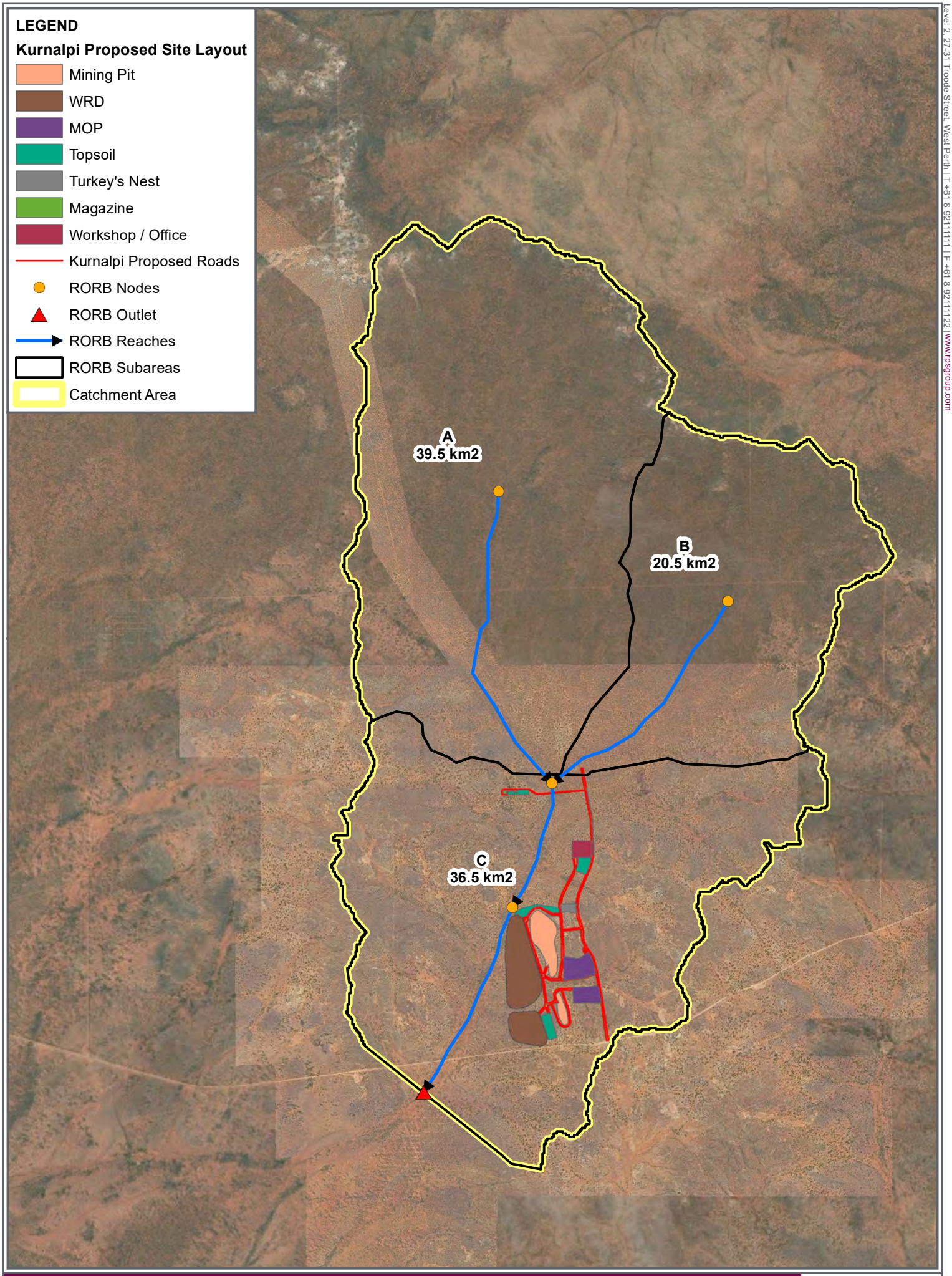


Figure E

Kurnalpi Gold Mine
RORB model layout

GDA 1994 MGA Zone 51

0 800 1,600 3,200 m

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:80,000 @ A4
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Source: Esri World Imagery

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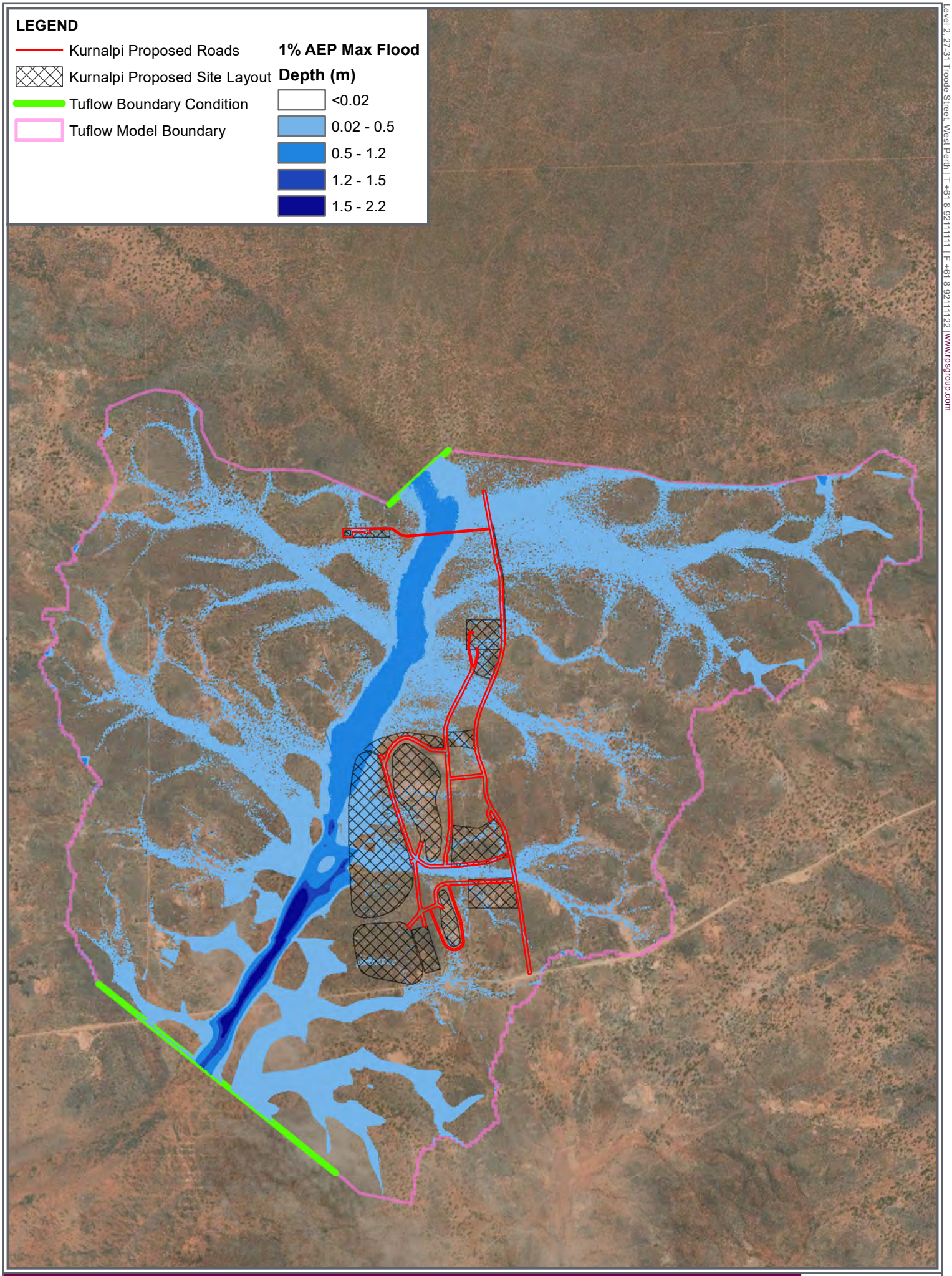


Figure F

Kurnalpi Gold Mine
1% AEP pre-development flood extetent

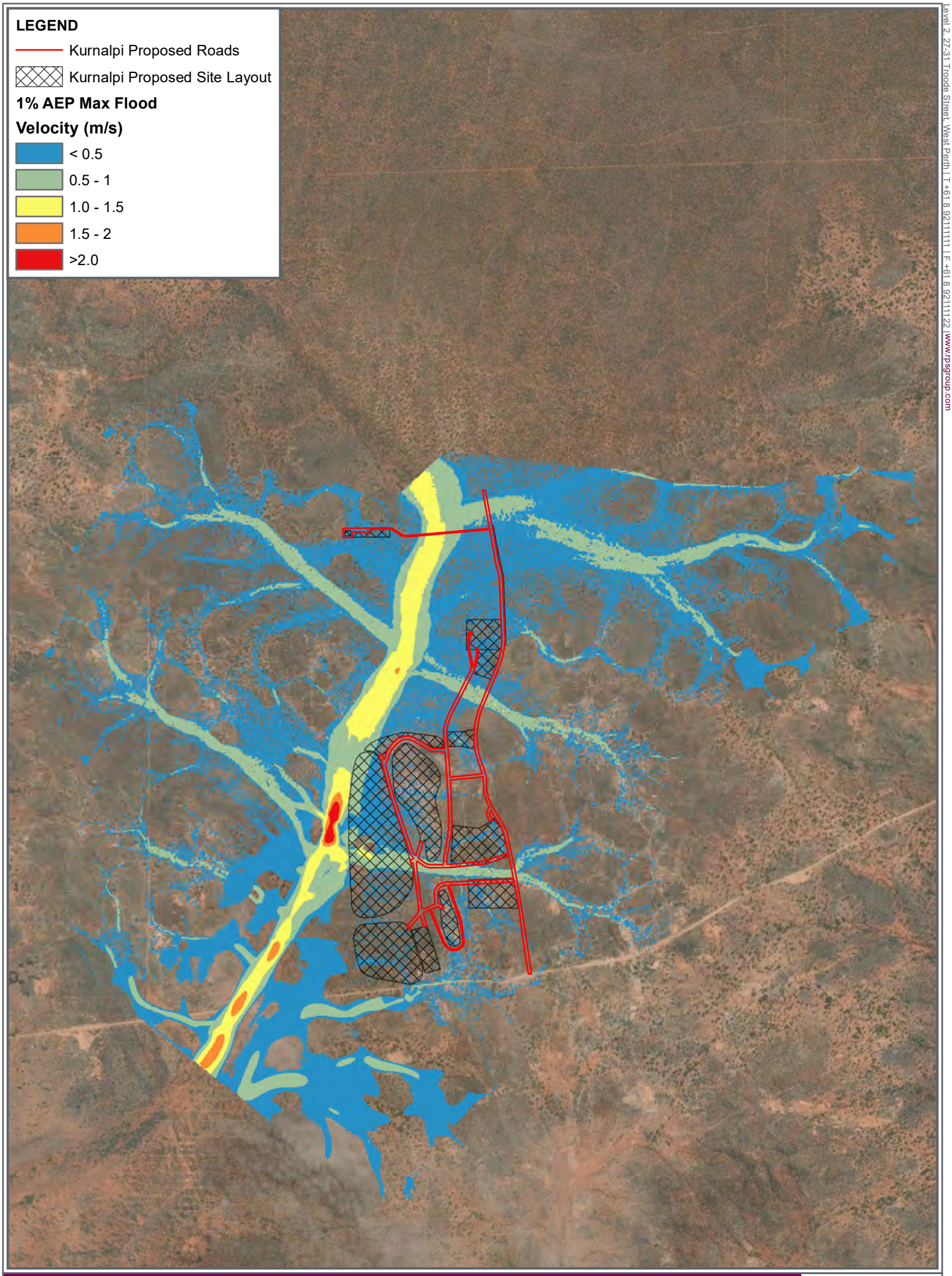
GDA 1994 MGA Zone 51

0 460 920 1,840 m

1%

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:45,000 @ A4
Created by: FK
Source: Esri World Imagery

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Figure G

Kurnalpi Gold Mine
1% AEP pre-development flood velocity

GDA 1994 MGA Zone 51

0 460 920 1,840 m

Project Number: WE3932.001
Date: 22.08.2022
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Source: Esri World Imagery

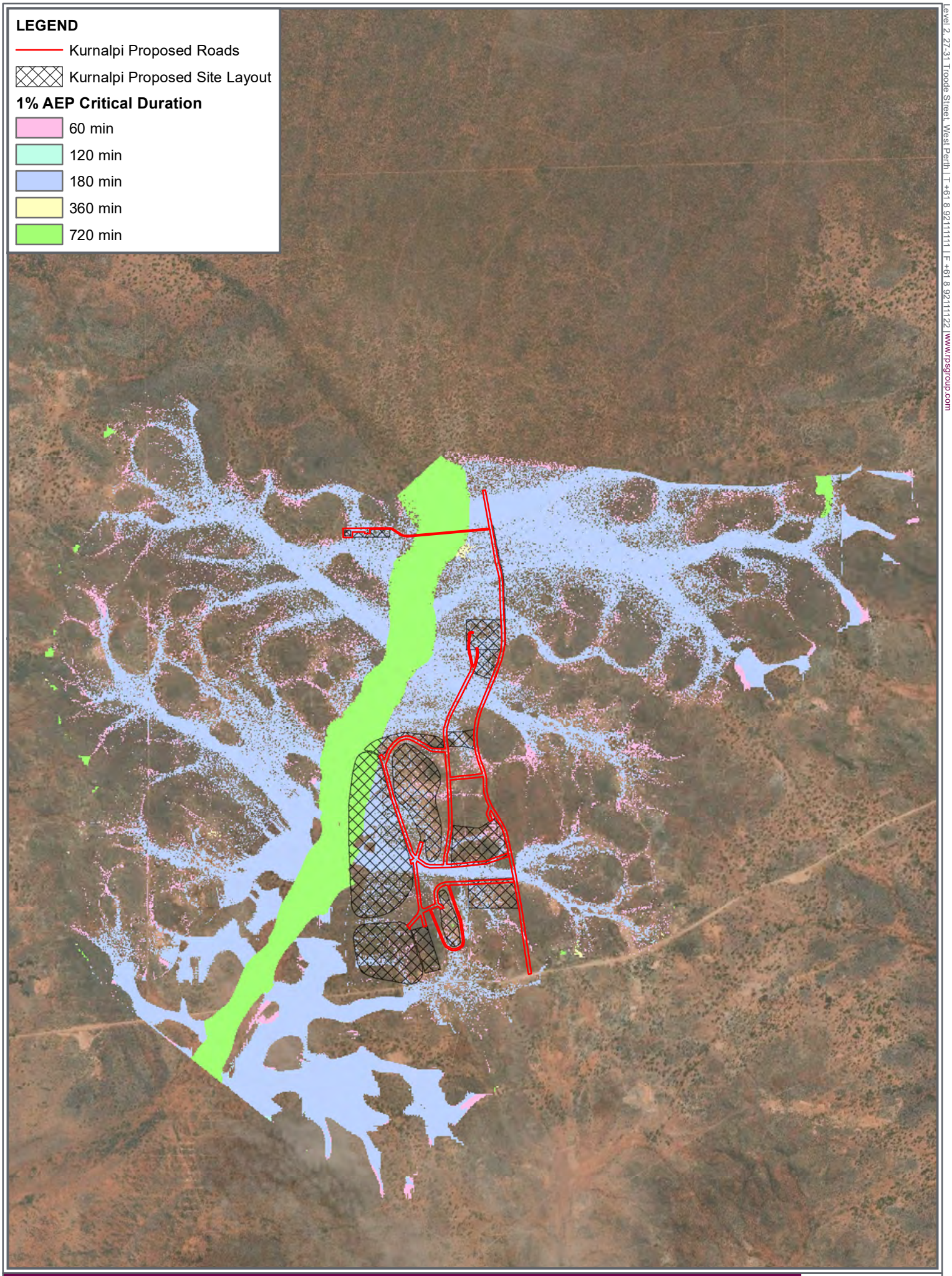


Figure H

Kurnalpi Gold Mine
1% AEP critical duration

GDA 1994 MGA Zone 51

0 460 920 1,840 m

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:45,000 @ A4
Created by: FK
Source: Esri World Imagery

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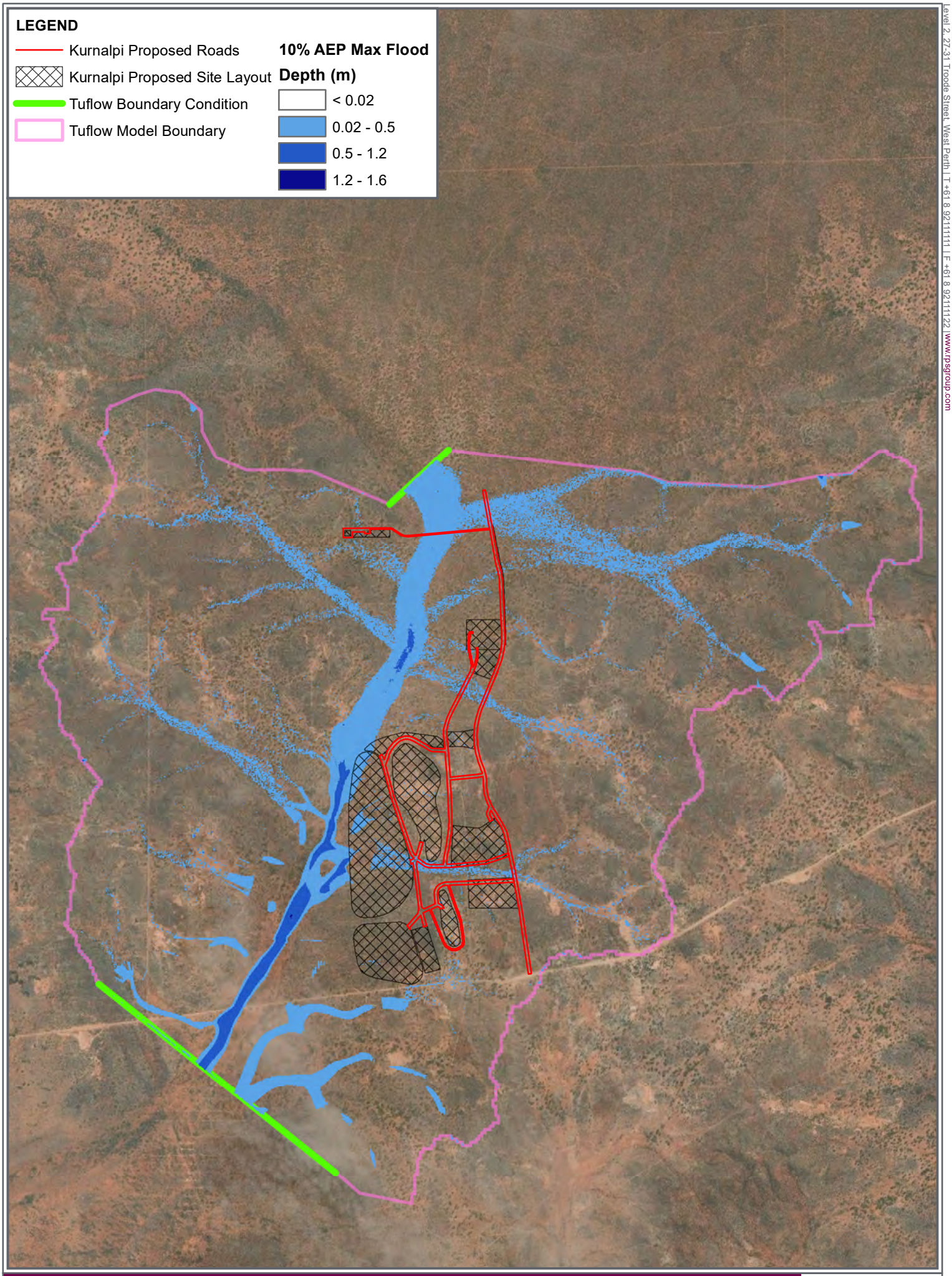


Figure I

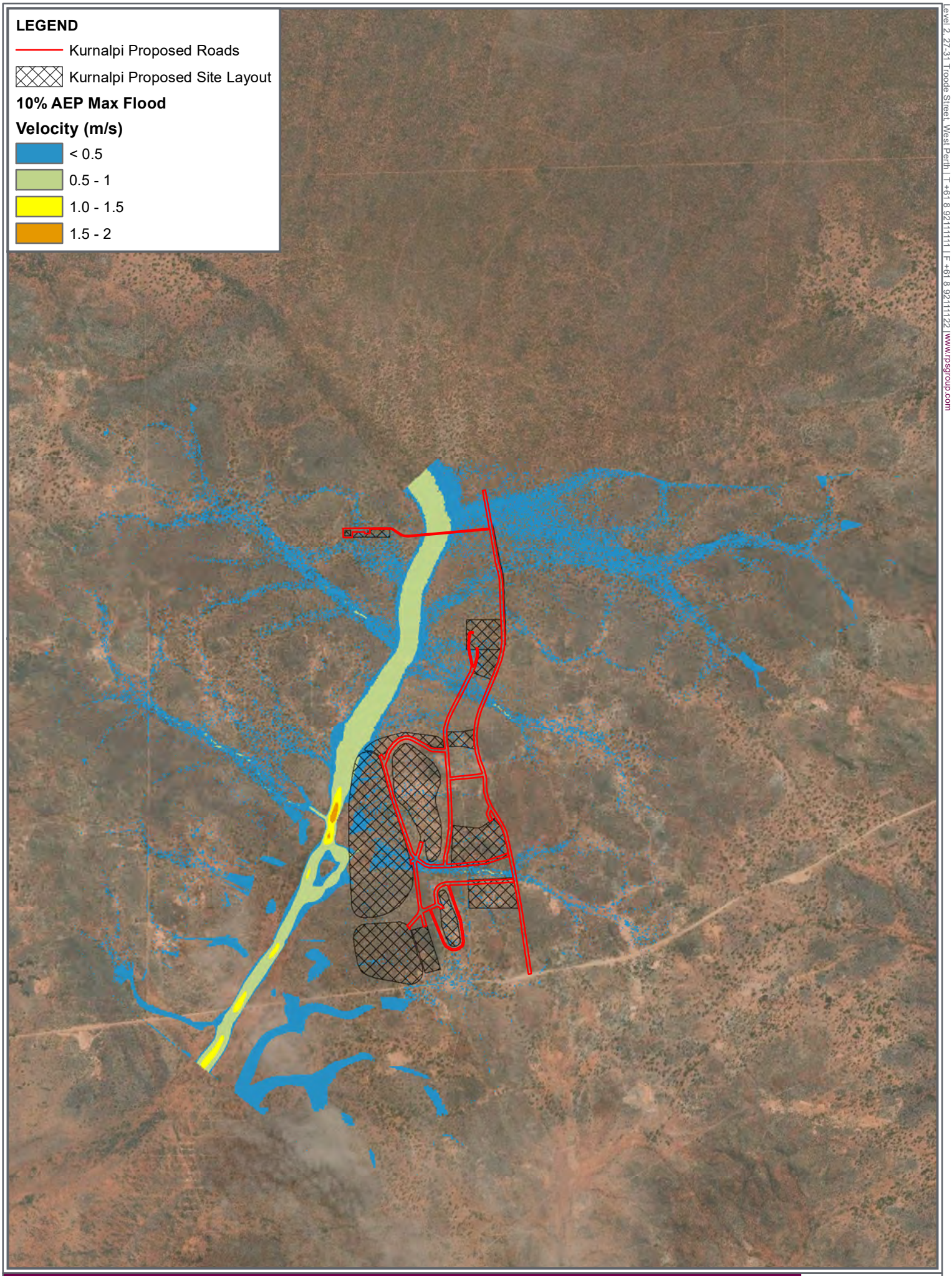
Kurnalpi Gold Mine
10% AEP pre-development flood extent

GDA 1994 MGA Zone 51

0 460 920 1,840 m

Project Number: WE3932.001
Date: 22.08.2022
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Figure J

Kurnalpi Gold Mine
10% AEP pre-development flood velocity

GDA 1994 MGA Zone 51

0 460 920 1,840 m

Project Number: WE3932.001
Date: 22.08.2022
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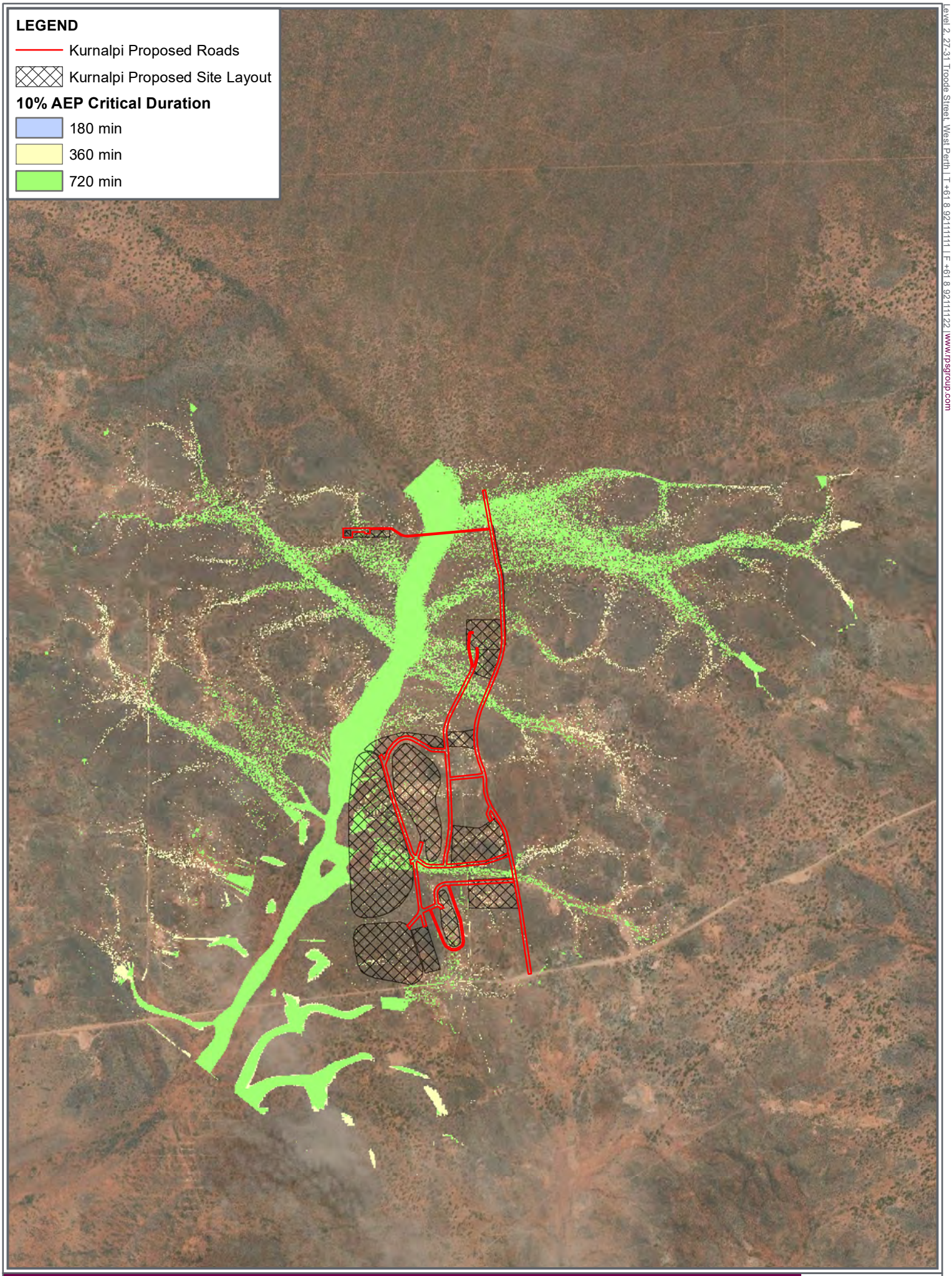


Figure K

Kurnalpi Gold Mine
10% AEP Critical Duration

GDA 1994 MGA Zone 51

0 460 920 1,840 m

Project Number: WE3932.001
Date: 22.08.2022
Scale: 1:45,000 @ A4
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