PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

Iron Bridge Operations Pty Ltd

ecoscape

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Pippingarra and Wodgina Roads: Flora and Fauna Survey
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Iron Bridge are seeking to upgrade portions of Pippingarra and Wodgina Roads utilised as part of its North Star operations and Ecoscape were engaged by Iron Bridge to undertake a Reconnaissance Flora and Vegetation survey, as well as Basic Fauna survey, to extend upon existing biodiversity information.

The area proposed by Iron Bridge for road upgrade purposes, known as the 'survey area' in this report, is located approximately 90 km south of Port Hedland, and extends approximately 30km from the Great Northern Highway along Wodgina and Pippingarra Roads, forming a narrow corridor of road-adjacent vegetation with several slightly wider portions extended to one side of the roadway (proposed laydown areas). The survey area totals 129.8 hectares (ha).

The desktop assessment identified the following relevant aspects:

- there are four land systems mapped within the survey area
- there are no environmentally sensitive areas within or in close proximity to the survey area
- the survey area corresponds with a two pre-European vegetation associations (93 and 619), both of which have greater than 98% state-wide extent remaining
- the majority of the survey area have been subject to previous flora and vegetation assessments
- the DBCA communities database search identified one Priority Ecological Community (PEC), the Gregory Land System (P3), known from approximately 14 km west of the survey area
- the combined flora database searches identified 20 conservation listed flora taxa as previously recorded within 40 km of the survey area including one Threatened Flora (TF), one Priority 1 (P1), 15 P3 and three P4 species. A likelihood assessment identified that eight of these species have a Possible likelihood of occurring within the survey area.
- the combined fauna database searches identified 30 conservation listed fauna species within the search area. Two of these species have been previously recorded and six are considered to have a High likelihood of occurring within the survey area.

The field survey, conducted during July 2020 identified the following:

- 100 flora taxa recorded from 10 floristic quadrats and opportunistic observations including:
  - two Priority Flora taxa, *Heliotropium muticum* (P3) and *Triodia chichesterensis* (P3), were recorded both within and outside of the survey area boundary
  - two introduced weed species (**Aerva javanica* (Kapok) and **Cenchrus ciliaris* (Buffel Grass)), both of which are listed as 'Priority Weeds' according to a list maintained by Fortescue for management purposes. These were restricted to the **EcAtCc** vegetation type corresponding with the Turner River
- nine vegetation types were recorded from field survey including:
  - one vegetation type (**EcAtCc**) characterised with *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* is considered likely to represent groundwater dependent vegetation (GDV)
  - two vegetation types (**ChAbTc** and **ChAiTc**) characterised by *Triodia chichesterensis* (P3) in the ground stratum may be considered of significance as being characterised by a conservation listed flora species

- The majority of the survey area contained vegetation considered to be Excellent condition (63.9%), with a substantial proportion completely degraded with vegetation cleared for the existing roads and other infrastructure (29.1%)
- two fauna habitat types were recorded, Hummock Grassland and Creekline. Both habitat types are considered well represented outside the survey area
- 45 fauna species were recorded from the survey area including one conservation listed fauna species; Western Pebble-mound Mouse (*Pseudomys chapmani*) DBCA P4.

1 INTRODUCTION

1.1 BACKGROUND

Fortescue Metals Group Limited (Fortescue) is an iron ore producer based in Western Australia. It operates an integrated business comprising of mines and supporting rail and port operations in the Pilbara region of Western Australia, with its head office based in Perth. Currently, Fortescue operates three mine sites in the Chichester Range (the Chichester Hub), known as Cloudbreak, Christmas Creek and Nullagine. Fortescue also operates three mines in the northern Hamersley Range (the Solomon Hub), known as the Firetail, Kings and Trinity. Fortescue is also developing the Eliwana Mine and Rail Project and Iron Bridge Limited (Iron Bridge), a subsidiary of Fortescue, is developing the North Star Hematite and Magnetite Project.

Iron Bridge are seeking to upgrade portions of Pippingarra and Wodgina Roads utilised as part of its North Star operations. In order to support environmental approvals required for the road upgrade and associated laydown areas, Ecoscape were engaged by Iron Bridge to undertake a Reconnaissance Flora and Vegetation survey, as well as Basic Fauna survey, to extend upon existing biodiversity information and provide further understanding of key environmental factors relevant to the proposed clearance footprint.

1.2 SURVEY AREA

The area proposed by Iron Bridge for road upgrade purposes, known as the 'survey area' in this report, is located in the Pilbara region approximately 90 km south of Port Hedland, on the boundary between the Shire of East Pilbara and Town of Port Hedland (**Figure 1**). The survey area extends approximately 30km from the Great Northern Highway along Wodgina and Pippingarra Roads, forming a narrow corridor of road-adjacent vegetation with several slightly wider portions extended to one side of the roadway (proposed laydown areas). The southern end of the survey area incorporates a roadway crossing of the Turner River and merges with the Port Hedland – Wittenoom Road. The survey area totals 129.8 hectares (ha).

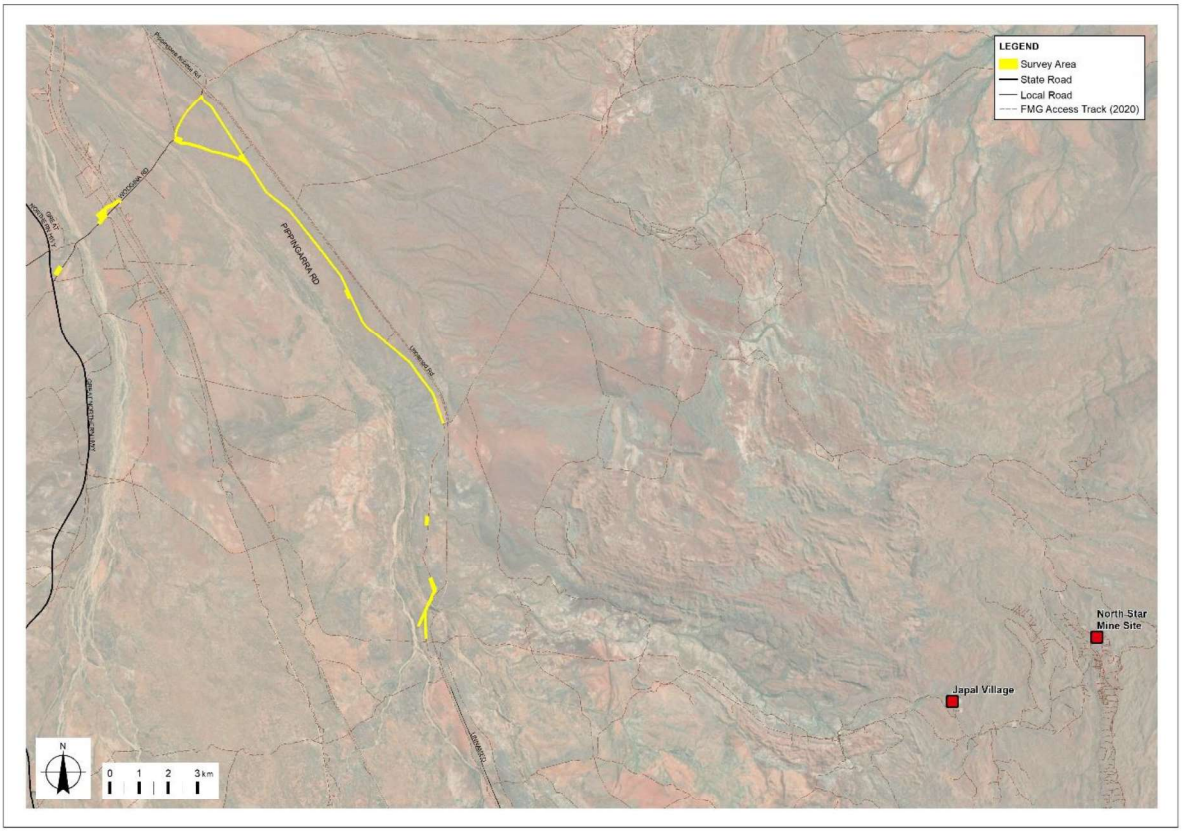


Figure 1: Survey area location

1.3 SURVEY REQUIREMENTS

The scope of works was to conduct a Reconnaissance Flora and Vegetation survey, as well as a Basic Fauna survey including:

- a desktop assessment including a literature review and demonstrating that the survey meets the relevant guidelines
- consolidation of existing information where available
- a field flora and vegetation survey including:
  - establishment and single-phase sampling of floristic quadrats ('quadrats') representative of each vegetation type within the survey area
  - description and mapping of vegetation types, particularly where they may represent a conservation significant ecological community
  - description and mapping vegetation condition, including identifying and recording the abundance of weeds
  - compilation of a flora species inventory for the survey area
  - targeted conservation significant flora searches in areas of preferred habitat
- a field fauna survey that includes:
  - active diurnal survey and assessment of representative habitat and microhabitat sites within the survey area
  - capture and analysis of motion sensitive camera images from areas where conservation significant fauna are considered likely to be present
  - capture and analysis of bat and additional fauna calls using acoustic and ultrasonic recording equipment

  - targeted conservation significant flora searches in areas of preferred habitat
- a comprehensive assessment report that includes:
  - desktop and field survey methodology
  - field survey results
  - discussion
- preparation of digital data to Iron Bridge's standards.

1.4 COMPLIANCE

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Western Australian *Animal Welfare Act 2002*
- Department of Environment Water Heritage and the Arts (DEWHA 2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*
- Department of Sustainability Environment Water Population and Communities (DSEWPaC 2011a) *Survey guidelines for Australia's threatened mammals*
- DSEWPaC (2011b) *Survey guidelines for Australia's threatened reptiles*
- DEWHA (2010a) *Survey guidelines for Australia's threatened bats*
- DEWHA (Department of the Environment Water Heritage and the Arts 2010b) *Survey guidelines for Australia's threatened birds*
- Threatened Species Scientific Committee (TSSC 2005) *Commonwealth Listing Advice on Northern Quoll (Dasyurus hallucatus)*
- Commonwealth of Australia (Commonwealth of Australia 2016) *EPBC Act referral guidelines for the endangered Northern Quoll Dasyurus hallucatus*
- Department of Parks and Wildlife (DPaW 2017) *Interim Guideline for Preliminary Surveys of Night Parrot (Pezoporus occidentalis) in Western Australia*
- TSSC (Threatened Species Scientific Committee 2016) *Conservation Advice Pezoporus occidentalis.*

As well as those listed above, the assessment complied with Environmental Protection Authority (EPA) requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA (2016a) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment*, known as the Flora and Vegetation Technical Guidance
- EPA (2020b) *Technical Guidance – Terrestrial Fauna Surveys for Environmental Impact Assessment*, known as the Fauna Technical Guidance
- EPA (2016b) *Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna*
- EPA (2020a) *Statement of Environmental Principles, Factors and Objectives*.

Fortescue's internal management Guidelines and Procedures were also complied with including:

- *Flora and Vegetation Assessment Guidelines* (100-GU-EN-0005) (Fortescue 2014)
- *Terrestrial Vertebrate Fauna Assessment Guidelines* (100-GU-EN-0005) (Fortescue 2011)
- *Environmental Datasets – Data Governance Guidelines* (100-GU-EN-0020)
- *Geographic Information Systems and Raw Data Guideline* (100-GU-EN-0009)
- *Environmental Document Standard Terminology* (100-GU-EN-002)

- *Environment Sample Point Naming Convention Guideline* (100-GU-EN-0041)
- *Proposal and Project Management Guidelines* (100-GU-EN-0010).

1.4.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, Threatened taxa (flora and fauna) are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild (detailed in **Table 13** in **Appendix One**).

1.4.2 WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian EP Act was created to provide for an Environmental Protection Authority (the EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

1.4.3 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. It commenced on 1 January 2019.

Threatened species (both flora and fauna) and ecological communities that meet the categories listed within the BC Act are protected under this legislation and require authorisation by the Minister to take or disturb. These are known as Threatened Flora, Threatened Fauna and Threatened Ecological Communities. The conservation categories of Critically Endangered, Endangered and Vulnerable are detailed in **Table 14** in **Appendix One**; these categories align with those of the EPBC Act.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the BC Act.

The most recent flora and fauna listings were published in the *Government Gazette* on 11 September 2018 (Government of Western Australia 2018b).

1.4.4 FLORA

1.4.4.1 Threatened and Priority Flora

Conservation significant flora species are those that are listed as TF (Threatened Flora) and (within Western Australia) as PF (Priority Flora). TF species are listed as Threatened by the Western Australian DBCA and protected under the provisions of the BC Act. Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and thereby have a greater level of protection than unlisted species.

There are seven categories covering State-listed TF and PF species (DBCA 2019) which are outlined in **Table 14** in **Appendix One**. PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in **Table 14**.

1.4.4.2 Other Significant Flora

According to the *Flora and Vegetation Technical Guidance* (EPA 2016a) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is considered to be:

- locally endemic or association with a restricted habitat type (e.g. Groundwater Dependent Ecosystems, Sheet Flow Dependent Vegetation)
- a new species or has anomalous features that indicate a potential new species
- at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range)
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

1.4.4.3 Introduced Flora

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as 'alien' on *FloraBase* (Western Australian Herbarium [WAH] 1998-2020) and are designated with an asterisk (*) in this document.

Weeds of National Significance

At a national level there are 32 weed species listed as Weeds of National Significance (WoNS) (Australian Government & Department of the Environment and Energy [DotEE] 2018; Weeds Australia 2012). The Commonwealth *National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance* (2012) describes broad goals and objectives to manage these species.

Declared Pest Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories, or exempt:

- C1 (exclusion), that applies to pests not established in Western Australia; control measures are to be taken to prevent their entry and establishment
- C2 (eradication), that applies to pests that are present in Western Australia but in low numbers or in limited areas where eradication is still a possibility
- C3 (management), that applies to established pests where it is not feasible or desirable to manage them in order to limit their damage
- exempt (no category).

1.4.5 ECOLOGICAL COMMUNITIES

1.4.5.1 EPBC-listed Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat (Government of Western Australia 2016). At Commonwealth level, Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. An ecological community may be categorised into one of the three sub-categories:

- Critically Endangered, if it is facing an extremely high risk of extinction in the wild in the immediate future
- Endangered, if it is not critically endangered and is facing a very high risk of extinction in the wild in the near future
- Vulnerable, if it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

1.4.5.2 Western Australian Threatened Ecological Communities

Western Australian TECs are protected under the BC Act. TECs are categorised much like those of the EPBC Act, shown in **Table 15** in **Appendix One**.

Currently described TECs are listed on the DBCA website, with the most recent list endorsed by the Minister for Environment in June 2018 (DBCA 2018).

1.4.5.3 Western Australian Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined. They are not protected under legislation but are taken into consideration as part of the environmental approvals process.

Currently described PECs are listed on the DBCA website, with the most recent list dated 5 May 2020 (Species and Communities Program & DBCA 2020).

1.4.6 OTHER SIGNIFICANT VEGETATION

1.4.6.1 Groundwater Dependent Ecosystems

Groundwater Definition

Groundwater is water that is found in the saturated zone of the soil, where all soil pores are filled with water. The water table is the upper surface of the saturated zone in an unconfined aquifer. Groundwater may also occur as a perched aquifer located above unsaturated rock formations as a result of a discontinuous permeable layer or held under pressure in a confined aquifer (Goulburn-Murray Water 2010).

Groundwater Dependent Ecosystems Definition

Groundwater Dependent Ecosystems (GDEs) have been defined as ecosystems that are dependent on groundwater for their survival at some stage or stages of their lifecycle, however groundwater use cannot be equated with groundwater dependence (Eamus 2009b). In some contexts, GDEs are also known as Groundwater Dependent Vegetation (GDV).

Hatton and Evans (1998) identified four types of GDEs based on their geographic setting: terrestrial vegetation (vegetation communities and dependent fauna that have seasonal or episodic dependence on groundwater), river base flow systems (aquatic and riparian ecosystems that exist in or adjacent to streams that are fed by groundwater base flow), aquifer and cave ecosystems, and wetlands.

Eamus *et al.* (2006) identified three primary classes based on type of groundwater reliance:

1. Aquifer and cave ecosystems.
2. All ecosystems dependent on the surface expression of groundwater:
    a) river base flows
    b) wetlands, swamplands
    c) seagrass beds in estuaries
    d) floodplains
    e) mound springs
    f) riparian vegetation
    g) saline discharge to lakes
    h) low lying forests.
3. All ecosystems dependent on the subsurface presence of groundwater, often accessed via the capillary fringe (non-saturated zone above the water table) when roots penetrate this zone:
    a) River Red Gum (*Eucalyptus camaldulensis*) forests
    b) Banksia woodlands
    c) Riparian vegetation in the wet/dry tropics.

GDEs in the Pilbara are generally determined to be vegetation associated with riparian areas. GDEs dependent on the surface expression of groundwater (Eamus *et al.* 2006 class 2) includes vegetation associated with wetlands (permanent or semi-permanent pools) within riparian areas, and generally includes *Melaleuca argentea* in association with other species described below. GDEs associated with the subsurface presence of groundwater (Eamus *et al.* 2006 class 3) includes riparian vegetation characterised by the phreatophytic species described below.

Direct impacts on GDEs i.e. clearing, and indirect impacts, including from dewatering and reinjection, frequently feature as being a significant environmental impact in mining approvals documents e.g. (Office of the Appeals Convenor 2016a; 2016b; Rio Tinto 2016).

Phreatophytic Species

Phreatophytic species rely on groundwater sources for water intake (Maunsell Australia Pty Ltd 2006); essentially the water requirements of phreatophytes are greater than can be provided from the surface soil profile (e.g. riparian vegetation) or they are dependent on free water availability (e.g. wetland species). They frequently show low tolerance to extended water stress due to a lack of physiological and/or morphological adaptation to drought, and respond to significant water deficit by a decline in health and eventual death (*ibid.*).

Obligate phreatophytes are dependent on free access to water (i.e. they are wetland species) whereas facultative phreatophytes can switch their water source between the soil surface profile in times of rain, to groundwater in times of drought when the soil surface profile (vadosphere) is depleted (Grierson 2010).

Phreatophytic species likely to occur in the Pilbara include:

- *Eucalyptus camaldulensis* subsp. *refulgens*, which is regarded as a facultative phreatophyte that is dependent on groundwater for part of its lifecycle and/or in times of drought. This species has been reported to be tolerant of groundwater falls of up to 4 m per year (Maunsell Australia Pty Ltd 2006), has both lateral and sinker roots and is tolerant of waterlogging (Grierson 2010).
- *Eucalyptus victrix*, which may be regarded as a facultative phreatophyte. It is considered to be relatively drought tolerant and likely to be tolerant of gradual declines to the water table (to a degree) (Maunsell Australia Pty Ltd 2006). *Eucalyptus victrix* has lateral and sinker roots (i.e. a dimorphic root system) but is

not tolerant of waterlogging (Grierson 2010). There is some conjecture that this species is actually a vadophyte (i.e. relies on water from within the soil surface profile, and is independent of groundwater) or, at best, weakly phreatophytic (Resource and Environmental Management Pty Ltd 2007). Depth to groundwater is likely to be an important indicator of groundwater dependence (Equinox Environmental 2017).

- wetland species such as *Melaleuca argentea*
- *Melaleuca xerophila* may be groundwater dependent in some areas (Markey 2016).

Vegetation containing *Eucalyptus camaldulensis* subsp. *refulgens* and *Melaleuca argentea* is generally considered to represent a GDE. However, that there is supporting evidence that, in some circumstances, *Eucalyptus victrix* does not always depend on groundwater (Batini 2009; Eamus 2009a; EPA & Hamersley Iron Pty Ltd 2010; Resource and Environmental Management Pty Ltd 2007) and therefore vegetation characterised by this species is considered to be potentially representative of a GDE.

Atlas of Groundwater Dependent Ecosystems

The Groundwater Dependent Ecosystems Atlas (Australian Government & BoM 2020) indicates the presence of known GDEs and Inflow Dependent Ecosystems (IDEs) in Australia.

An Inflow Dependent Ecosystem is one in which the vegetation within the landscape is likely to be accessing water in addition to rainfall, from soil or surface water or groundwater, assessed using remotely sensed data. The likelihood of a landscape using additional water is rated from one to 10 (low to high), with a rating above six indicating that a landscape is likely to be inflow dependent (Australian Government & BoM 2020).

1.4.6.2 Other Significant Vegetation

According to the *Flora and Vegetation Technical Guidance* (EPA 2016a), other than being listed as a TEC or PEC, vegetation can be considered as significant if it is considered to have:

- restricted distribution
- a degree of historical impact from threatening processes
- a role as a refuge
- provides an important function required to maintain ecological integrity of a significant ecosystem.

1.4.7 FAUNA

1.4.7.1 EPBC-listed Threatened Fauna

At a Commonwealth level, Threatened Fauna are protected under the EPBC Act, which lists species and ecological communities that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild (detailed in **Table 13** in **Appendix One**).

Migratory species subject to international agreements are also protected under the EPBC Act. The definition of a migratory species under the Act follows that prescribed by the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention) (DotEE 2019):

> *Migratory species are the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries.*

Species listed by the following international agreements are currently protected under the EPBC Act:

- *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention)
- *China-Australia Migratory Bird Agreement* (CAMBA)

- *Japan-Australia Migratory Bird Agreement* (JAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement* (ROKAMBA).

1.4.7.2 Western Australian-listed Threatened Fauna

Threatened fauna that meet the categories listed within the BC Act are protected and require authorisation by the Minister to take or disturb. The conservation categories of Critically Endangered, Endangered and Vulnerable have been aligned with those detailed in the EPBC Act.

Fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. These are known as Specially Protected Species in the BC Act. The categories covering State-listed threatened fauna species are outlined in **Table 14** in **Appendix One**.

1.4.7.3 Western Australian Priority Fauna

Conservation significant fauna species are listed by the DBCA as Priority Fauna where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to threatened fauna categories. Whilst Priority Fauna are not specifically listed in the BC Act, these have a greater level of significance than other native species. The categories covering Priority Fauna species are outlined in **Table 14** in **Appendix One**.

1.4.8 ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas around Western Australia identified as being of environmental significance within which the exemptions to the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the Environmental Protection (Environmentally Sensitive Areas) Notice (Government of Western Australia 2005).

1.4.9 CONSERVATION ESTATE

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. The Conservation and Parks Commission is the vesting body for conservation lands, forest and marine reserves that are managed by DBCA (Government of Western Australia 2018a).

2 DESKTOP ASSESSMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 CLIMATE

The survey area is located within the Pilbara region, which includes two broad climatic zones. Coastal areas, as well as some higher rainfall inland areas, have a semi-desert tropical climate which experience 9-11 months of dry weather, with hot humid summers and warm winters. The remaining inland areas have a dry desert climate, typically with higher temperatures and lower rainfall, and often experience up to 12 months of dry weather, with hot dry summers and mild winters (Leighton 2004). The survey area is within the dry inland area.

According to the Köppen-Geiger climate classification, the survey areas have a hot arid desert climate (Class BWh) (Peel *et al*. 2007). This classification is considered to represent a desert climate where annual rainfall is generally less than 200 mm or the region loses more water via evapotranspiration than it receives as rain, generally a result of hot, sunny weather without significant cloud. The mean average temperature exceeds 18°C, and summer temperatures are frequently over 40°C.

Annual rainfall in the Pilbara has substantial yearly variation, but generally follows an inland to coastal and southern to northern increasing trend (Leighton 2004). Tropical cyclones, many of which originate in the Timor Sea, along with local thunderstorms, produce much of the summer and early autumn rainfall. The driest months are in spring (September to October) (McKenzie *et al*. 2009), and winter rainfall is highly variable, generally decreasing from the coast through to inland areas (Leighton 2004).

The closest Bureau of Meteorology (BoM) station with long term rainfall records is Indee (station number 4016, operating since 1909) located approximately 40 km north of the survey area. The mean annual rainfall is 337.6 mm with 65.91% falling during the summer period from January to March (Bureau of Meteorology 2020).

The closest BoM station with long term temperature records is Port Hedland Airport (station number 4032, operating since 1948) located approximately 80 km north of the survey area. March is the hottest month with a mean maximum temperature of 36.8° and minimum of 24.6°. July is the coldest month with a mean maximum of 27.3° and minimum of 12.4° (**Figure 2**).

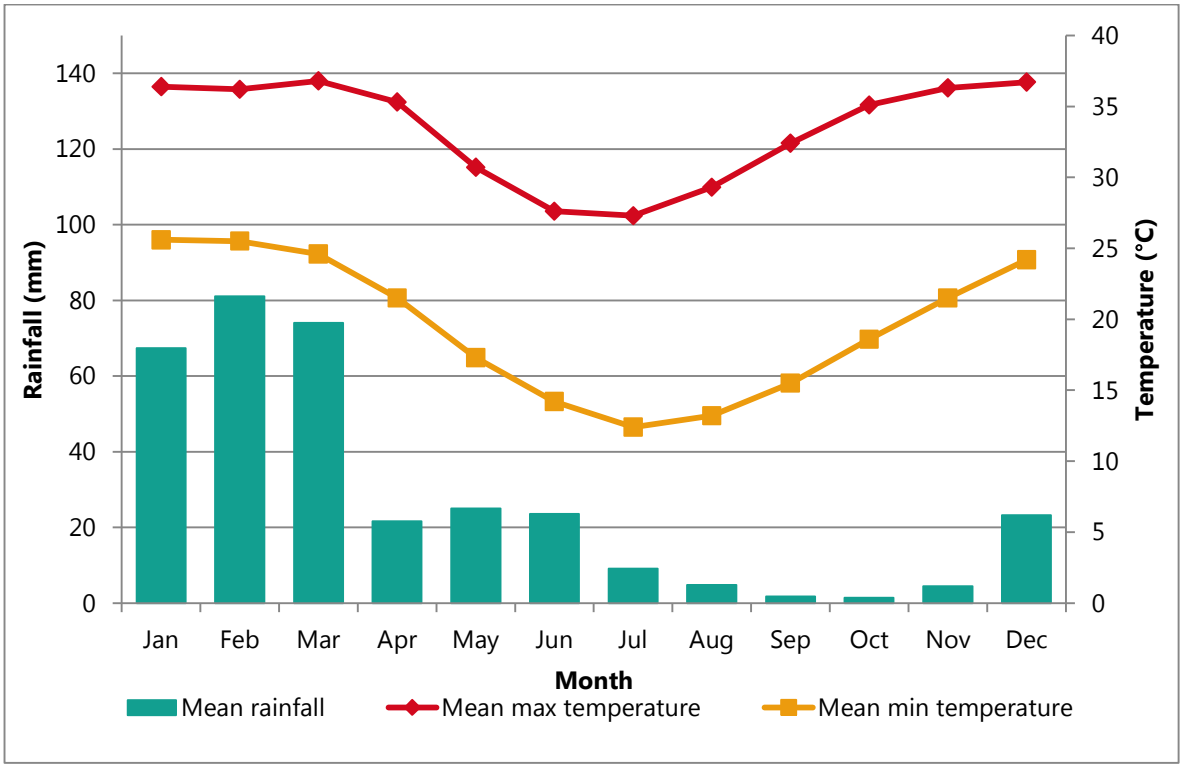


Figure 2: Long term average rainfall data (Indee) and temperature data (Port Hedland Airport) for the survey area (Bureau of Meteorology 2020)

2.1.2 LAND SYSTEMS

According to Department of Primary Industries and Rural Development (DPIRD 2018b) soil landscape mapping, the following land systems correspond with the survey area (**Table 1** and **Map 1**).

Table 1: Land systems (DPIRD 2018b)

Mapping unit	Land System	Description	Extent (ha)	%
280Bg	Boolgeeda	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.	0.67	0.52
283Mc	Macroy	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.	123.12	94.85
283Ri	River	Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.	3.68	2.84
283Ua	Uaroo	Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.	2.33	1.79

2.1.3 GEOLOGY

Geological mapping using the Surface Geology of Australia 1:1 000 000 scale dataset (Geoscience Australia 2017) shows that five geological units intersect the survey area (**Table 2**).

Table 2: Geological units that intersect the survey area (Geoscience Australia 2017)

Code	Description	Extent (ha)	%
Agi	Undifferentiated granitoid intrusions of the Sisters Supersuite; leucogranite (locally schlieric or pegmatitic), monzogranite, granodiorite, tonalite, diorite, tonalitic orthogneiss, rhyolite dykes, pegmatite; interleaved in places.	4.12	3.18
Agii	Moderately to strongly feldspar (-quartz)-porphyritic biotie (-hornblende) monzogranite; weakly to moderately foliated, typically with a strong phenocryst alignment.	5.37	4.14
Cza	Reworked or incised alluvium in older stream channels; alluvial terraces above younger alluvium; alluvial and colluvial outwash deposits not in defined channel systems; lateritised alluvium; sand, silt, gravel, clay, evaporites.	33.45	25.77
Qa	Channel and flood plain alluvium; gravel, sand, silt, clay; may be locally calcreted.	12.86	9.91
Qrc	Colluvium and/or residual deposits, sheetwash, talus, scree; boulder, gravel, sand; may include minor alluvial or sand plain deposits, local calcrete and reworked laterite.	73.99	57.00

2.1.4 WETLANDS AND DRAINAGE

The survey area is in the Turner River catchment (DBCA 2007-2020) and intersects the Turner River near the southern extent. The survey area includes areas of the River land system which is characterised by major river channels and seasonally active flood plains.

2.1.5 GROUNDWATER DEPENDENT ECOSYSTEMS

The *Groundwater Dependent Ecosystems Atlas* (Australian Government & BoM 2020) indicates that the survey area is considered as low potential for terrestrial GDEs to occur, with an IDE likelihood of 5.

2.1.6 ENVIRONMENTALLY SENSITIVE AREAS

The survey area does not correspond with any Environmentally Sensitive Areas listed under the *Environmental Protection (Clearing Native Vegetation) Regulations 2004*.

2.1.7 CONSERVATION LANDS

The survey area does not correspond with any conservation lands i.e. any Nature Reserves, National Parks or other areas vested for conservation. The nearest conservation estate is Mungaroona Range Nature Reserve which is approximately 60 km south west of the survey area.

2.1.8 LAND USE HISTORY

The majority of the survey area corresponds with existing roads and associated verges on either side. It overlies both Wallareenya and Kangan pastoral stations, including along a section of the boundary between these two stations.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 BIOGEOGRAPHIC REGION

Biogeographic regions are delineated on the basis of similar climate, geology, landforms, vegetation and fauna and are defined in the Interim Biogeographical Regionalisation for Australia (IBRA) (DotEE 2016).

The survey area is located in the Pilbara IBRA region in the Chichester subregion, described as:

> *Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by Acacia inaequilatera over Triodia wiseana (formerly Triodia pungens) hummock grasslands, while Eucalyptus leucophloia tree steppes occur on ranges. The climate is Semi-desert-tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock). Subregional area is 9,044,560 h* (DBCA 2020).

2.2.2 PRE-EUROPEAN VEGETATION

During the 1970s, John Beard and associates conducted a systematic survey of native vegetation, describing the vegetation systems in Western Australia at a scale of 1:250,000 in the south-west and at a scale of 1:1,000,000 in less developed areas.

Beard's vegetation maps attempted to depict the native vegetation as it was presumed to be at the time of settlement, and is known as the pre-European vegetation type and extent and has since been developed in digital form by Shepherd *et al.* (2002) and updated by DPIRD (2018a). Extents are updated annually by DBCA (Government of Western Australia 2019). This mapping indicates that the survey areas correspond with two pre-European vegetation units:

- Association 93: Hummock grasslands, shrub steppe; kanji over soft spinifex
- Association 619: Medium woodland; river gum (*Eucalyptus camaldulensis*).

The pre-European vegetation associations identified from the survey area (DPIRD 2018a) and their pre-European and current extents are listed in **Table 3** (Government of Western Australia 2019) and shown on **Map 2**.

Table 3: Pre-European vegetation association representation (Government of Western Australia 2019)

Region	Vegetation association	Original extent (ha)	Current extent (ha)	% Remaining
Western Australia	93	3,044,309.52	3,040,640.98	99.88
	619	74,186.11	72,765.18	98.08
IBRA biographic region (Pilbara)	93	3,042,114.27	3,038,471.67	99.88
	619	118,920.31	118,116.78	99.32
IBRA biographic sub-region (Chichester)	93	2,940,348.04	2,936,731.54	99.88
	619	85,543.15	85,520.95	99.97
LGA (Town of Port Hedland)	93	1,015,339.22	1,014,599.99	99.93
	619	63,650.59	62,598.14	98.35
LGA (Shire of East Pilbara)	93	1,709,522.24	1,706,780.57	99.84
	619	52,765.30	52,763.69	100.00

2.2.3 PREVIOUS VEGETATION MAPPING

Additional vegetation mapping has been undertaken for much of the survey area and adjacent land by various consultants prior to the 2020 field survey by Ecoscape. Mapping provided by Iron Bridge based on previous

surveys (**Section 2.3**) indicate the following vegetation type descriptions have been previously documented from the survey area (**Map 3**), several of which are overlapping and therefore likely to represent duplication:

- AaTb - *Petalostylis labicheoides* and *Acacia acradenia* sparse mid shrubland over *Corchorus laniflorus* sparse low shrubland over *Chrysopogon fallax* sparse tussock grassland and *Triodia basedowii* sparse hummock grassland
- Ac13 - *Corymbia hamersleyana* scattered low trees over *Acacia tumida* closed scrub over *Triodia lanigera* mid-dense hummock grassland
- Ac22 - *Corymbia* spp. low open woodland over *Acacia acradenia, A. ancistrocarpa* open scrub over *Triodia epactia* open hummock grassland and *Chrysopogon fallax*, *Themeda triandra* tussock grassland
- Apt13 - *Acacia ancistrocarpa* open shrubland to open heath over *Triodia lanigera* hummock grassland
- CzAaTl - *Corymbia zygophylla* sparse low woodland over *Acacia ancistrocarpa* mid sparse shrubland over *Triodia* aff. *lanigera* mid hummock grassland
- EvCc* - *Eucalyptus victrix, Eucalyptus camaldulensis* open mid woodland, over **Cenchrus ciliaris* tussock grassland
- PfTe - *Pluchea ferdinandi-muelleri* low sparse shrubland over *Triodia epactia* and *Triodia secunda* mid open hummock grassland
- PfTp - *Pluchea ferdinandi-muelleri* open low shrubland over *Triodia pungens* sparse hummock grassland and **Cenchrus ciliaris, Eriachne lanata* and *Chrysopogon fallax* open tussock grassland
- TlaHG1 - *Triodia lanigera* Mid Dense Hummock Grassland
- Tw3 - *Triodia wiseana* and *Triodia basedowii* hummock grassland
- Tw4 - *Triodia wiseana* hummock grassland.

2.2.4 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

The *Protected Matters Search Tool* (PMST) search (Australian Government and DotEE 2020, search reference PMST_78XZ7J) using a 50 km buffer around a point approximating the centre of the survey area, identified no EPBC-listed TECs.

The DBCA database search (search reference 25-0620EC using a 50 km buffer) identified one known PEC within the search area, Gregory Land System (Priority 3). This PEC is characterised by 'linear dunes and restricted sandplains supporting shrubby hard spinifex (and occasionally soft spinifex) grasslands'. The nearest occurrence of this PEC is approximately 14 km west of the survey area.

2.2.5 THREATENED AND PRIORITY FLORA

The PMST search (as above) identified one EPBC-listed TF that is known to occur within the 50 km search buffer area. The PMST search identified *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) as 'species or habitat known to occur within area'.

A search of DBCA's databases was conducted (search reference 12-0620FL) using a 40 km buffer around the supplied shapefiles (TPFL List, taken from Threatened and Priority Flora Report Forms and DBCA surveys, and WA Herb, taken from vouchered specimens held in the Western Australian Herbarium). The DBCA database searches identified 20 conservation listed flora taxa including one TF, one P1, 15 P3 and three P4. The results of the DBCA database searches are presented in **Table 19** in **Appendix Two** with results displayed on **Map 3**.

Fortescue/Iron Bridge maintains a database of conservation listed flora and other flora of conservation interest associated with its operational and exploration tenements. This database consists of DBCA database search results requested for flora and vegetation assessments and the results of field surveys it has commissioned. The resultant list, and associated location data, provides a comprehensive understanding of the conservation

significant flora and other flora of conservation interest (e.g. significant range extensions, unusual forms) within and close to Fortescue's areas of interest. Fortescue's significant flora database identified no additional TF or PF taxa, though additional locations of those taxa identified by the DBCA database searches are presented in on **Map 3**.

2.2.5.1 Threatened and Priority Flora Likelihood Assessment

Ecoscape conducted a likelihood assessment to identify TF and PF species that have potential to occur within the survey area. The likelihood of a species occurring is based on attributes, as listed on *FloraBase* (WAH 1998-2020) or in more detailed documents e.g. information from recent nearby surveys, incorporating an assessment of habitats likely to be present in the survey area. The attributes taken into consideration were:

- broad soil type usually associated with the species
- broad landform usually associated with the species
- usual vegetation (characteristic species) with which the species is usually associated
- species having previously been recorded from within approximately 20 km of the survey area (considered as 'nearby') taking age of record and locational accuracy into account
- nearby recent records (i.e. records within the previous 25 years).

The likelihood rating is assigned using the categories listed in **Table 4**.

Table 4: Categories for likelihood of occurrence of TF and PF

	Categories
Recorded	Species recorded within the survey area
Possible	May occur within the survey area (but has not been recorded); broadly, 2-4 of the required attributes (but always including records from nearby) are present in the survey area
Unlikely	Could occur but is not expected; 1-3 of the required attributes are present in the survey area but: • it is not known from nearby, or • it is known from nearby but has no other required attributes, or • it is known from nearby but has at least one well-defined attribute that does not occur in the survey area (e.g. it is associated with a specific landform or soil type that does not occur in the survey area) • it is known from nearby but the record is old (>25 years) or the locational data is potentially inaccurate or the area has been significantly cleared at and around the location of the record and survey area and as such the habitat almost certainly no longer occurs within the survey area.
Highly unlikely	The species characteristics include only one or none of the required attributes of soil, landform, associated vegetation and having previously been recorded nearby, or a critical element (often landform) is not within the survey area and as such it almost certainly does not occur.

The likelihood assessment is available in **Table 19** in **Appendix Two.** None of the TF or PF have been previously recorded within the survey area. Seven P3 and one P4 were identified as having a Possible likelihood of occurring based on the information available from the desktop assessment. These were considered the most likely to occur and were prioritised for field survey.

2.2.6 THREATENED AND PRIORITY FAUNA

Exclusively marine species (e.g. whales, sea turtles etc.) are not included in the Threatened and Priority Fauna lists as their habitat does not correspond with the survey area.

Naming nomenclature for all fauna species follows that of the Western Australian Museum.

2.2.6.1 Protected Matters Search

The PMST search (Australian Government and DotEE 2020, search reference PMST_78XZ7J) using a 50 km buffer was used to identify conservation significant fauna and/or fauna habitat suitable for such species within the search area buffer. The PMST search identified:

- four mammals: three 'species or species habitat known to occur within area', one 'breeding likely to occur within area'
- four birds: four 'species or species habitat may occur within area'
- one reptile: one 'species or species habitat likely to occur within area'.

The PMST results are incorporated in **Table 20** in **Appendix Two**. Not all species identified by the PMST search have DBCA/Western Australian Museum (WAM) records (*NatureMap*, see below). The following were identified by the PMST search but not by the *NatureMap* search:

- Australian Painted Snipe (*Rostratula australis*) – EN
- Barn Swallow (*Hirundo rustica)* – MI
- Curlew Sandpiper (*Calidris ferruginea*) – CR
- Eastern Curlew, Far Eastern Curlew *(Numenius madagascariensis)* – CR
- Greater Bilby (*Macrotis lagotis*) – VU
- Grey Wagtail *(Motacilla cinerea)* – MI
- Night Parrot (*Pezoporus occidentalis*) – EN
- Oriental Pratincole (*Glareola maldivarum)* – MI
- Pectoral Sandpiper (*Calidris melanthos*) – MI
- Sharp-tailed Sandpiper (*Calidris acuminata*) – MI
- Yellow Wagtail *(Motacilla flava)* – MI

2.2.6.2 NatureMap

NatureMap (DBCA 2007-2020) is maintained collaboratively by the DBCA and the WAM. These records represent a combination of vouchered museum specimens and records obtained via the Fauna Survey Returns Database maintained by the DBCA.

The *NatureMap* search identified 530 fauna species previously recorded within the applied 40 km buffer area:

- 50 mammals (42 native; 8 introduced)
- 149 birds
- 119 reptiles
- 10 amphibians
- 2 fish
- 200 invertebrates.

Twenty conservation significant fauna species were identified:

- Greater Bilby (*Macrotis lagotis*) - VU
- Brush-tailed Mulgara (*Dasycercus blythi*) – P4
- Common Sandpiper (*Actitis hypoleucos*) – MI
- Fork-tailed Swift, Pacific Swift (*Apus pacificus*) - MI
- Gane's Blind Snake (*Anilios ganei*) – P1
- Ghost Bat (*Macroderma gigas*) - VU
- Grey Falcon (*Falco hypoleucos*) - VU
- Long-tailed Dunnart (*Sminthopsis longicaudata*) – P4

- Northern Quoll (*Dasyurus hallucatus*) - EN
- Northern Short-tailed Mouse (*Leggadina lakedownensis*) – P4
- Orange Leaf-nosed Bat (*Rhinonicteris aurantia*) – P4
- Oriental Plover (*Charadrius veredus*) - MI
- Peregrine Falcon (*Falco peregrinus*) - OS
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara)) - VU
- Pilbara Olive Python (*Liasis olivaceus* subsp. *barroni*) - VU
- Pin-striped Fine-snout Skink (*Ctenotus nigrilineatus*) – P1
- Spectacled Hair-wallaby (*Lagorchestes conspicillatus* subsp. *leichardti*) – P4
- Striated Grasswren (inland) (*Amytornis striatus* subsp. *striatus*) – P4
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – P4
- Wood Sandpiper (*Tringa glareola*) – MI.

The conservation significant species identified by the *NatureMap* search are incorporated into **Table 20** in **Appendix Two**.

2.2.6.3 DBCA Database Searches

The DBCA database search (search reference 2020/000669 #6361, using a 15 km buffer) returned the following:

- eight mammals
- four birds
- one reptile.

Thirteen conservation significant fauna were identified:

- Common Sandpiper (*Actitis hypoleucos*) – MI
- Fork-tailed Swift, Pacific Swift (*Apus pacificus*) - MI
- Brush-tailed Mulgara (*Dasycercus blythi*) – P4
- Northern Quoll (*Dasyurus hallucatus*) - EN
- Grey Falcon (*Falco hypoleucos*) - VU
- Peregrine Falcon (*Falco peregrinus*) - OS
- Spectacled Hair-wallaby (*Lagorchestes conspicillatus* subsp. *leichardti*) – P4
- Pilbara Olive Python (*Liasis olivaceus* subsp. *barroni*) - VU
- Ghost Bat (*Macroderma gigas*) - VU
- Greater Bilby (*Macrotis lagotis*) - VU
- Western Pebble-mound Mouse (*Pseudomys chapmani*) – P4
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara)) - VU
- Long-tailed Dunnart (*Sminthopsis longicaudata*) – P4.

The conservation significant species identified by the DBCA database search are shown on **Map 4** and incorporated in **Table 20** in **Appendix Two**.

2.2.6.4 FMG Database Search

No additional taxa were identified from FMG's database search results (**Map 4**). The full list of Threatened and Priority fauna is incorporated in **Table 20** in **Appendix Two**.

2.2.6.5 Threatened and Priority Fauna Likelihood Assessment

The likelihood of occurrence of significant fauna species identified by the database and literature searches was assessed using the following criteria:

- suitability of habitats present within the survey area
- distance between previous record of significant species and the survey area
- frequency and number of records in the region
- date of record of significant species (recent or historical).

The sufficiency of information and behavioural and ecological characteristics, such as cryptic behaviours were also taken into account. Using the above criteria, the categories of likelihood of occurrence are shown in **Table 5**.

Table 5: Categories for likelihood of occurrence of significant vertebrate fauna

Likelihood	Categories
Recorded	Species recorded within the survey area within a reasonable timeframe (0-25 years)
High	Species recorded in close proximity to the survey area (<5 km) within the past 25 years; and suitable habitat occurs within the survey area
Medium	Species historically recorded in close proximity (<5 km) to the survey area, more than 25 years ago; and suitable habitat may exist within the survey area
Low	Species not recorded in the proximity of the survey area or rarely recorded within 10 km of the survey area; and suitable habitat unlikely to occur within the survey area
Very Low	Species not recorded by multiple surveys/databases within 20 km of the survey area and suitable habitat does not occur within the survey area, however species or suitable habitat is listed as potentially occurring in the wider region

Based on the above criteria, two species have previously been recorded from within the survey area (Greater Bilby (*Macrotis lagotis*) and Forked-tailed Swift (*Apus pacificus*)) and six species are considered to have a High likelihood of occurring including:

- Brush-tailed Mulgara (*Dasycercus blythi*)
- Grey Falcon (*Falco hypoleucos*)
- Northern Quoll (*Dasyurus hallucatus*)
- Peregrine Falcon (*Falco peregrinus*)
- Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia* (Pilbara))
- Western Pebble-mound Mouse (*Pseudomys chapmani*).

The likelihood of species occurring within the survey area are indicated in **Table 21** in **Appendix Two**.

2.2.7 FAUNA HABITAT

The majority of the survey area has been subject to previous fauna assessments and habitat mapping. The Ecologia (2011a) previous level 2 terrestrial vertebrate fauna assessment reported two fauna habitat types that correspond to the survey area. The habitats were described as; Sandy plains with spinifex and scattered granites and Creeklines. These were used as the basis for ground truthing during the field survey.

2.3 LITERATURE REVIEW

The following documents were reviewed for relevance to the survey area:

- Ecoscape (2016); *Conservation Significant Fauna Monitoring 2015/2016 – North Star.* Monitoring of EPBC Act listed threatened fauna species (Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python) conducted approximately 20 km east of the survey area.
- Ecologia (2016); *Iron Bridge North Star Stage 2 Pityrodia sp. Marble Bar Regional Survey.* Targeted survey for Priority 1 (now Threatened) *Pityrodia* sp. Marble Bar within a search area that partially corresponds with the survey area in the south.
- Ecoscape (2015); *North Star Pilbara Olive Python Monitoring 2015.* Monitoring of the EPBC Act listed Pilbara Olive Python as part of the North Star Project, conducted approximately 20 km east of the survey area.
- Ecologia Environment (2015); *North Star Slurry and Infrastructure Corridors Conservation Significant Flora and Vegetation Assessment*. Targeted CS flora and vegetation survey conducted within the infrastructure corridor connecting Port Hedland and the North Star Hematite project, which in part overlies the survey area.
- Coffey Environments (2014); *North Star Alternate Access Road Flora and Vegetation Assessment.* The North Star Alternate Access Road survey area was a Level 2 assessment that partially corresponds with the northern section of the current survey area.
- Ecologia (2014); *EPBC Listed Threatened Fauna Monitoring Report.* Fauna monitoring for the North Star Project in accordance with legislative requirements, conducted approximately 20 km east of the survey area.
- Ecologia {Ecologia Envionment;, 2013 55105 /id /d}; *North Star Magnetite Project – Environmental Scoping Document. Response to requested terrestrial items.* Provides an assessment on the key ecological attributes of the EPBC listed Northern Quoll, Pilbara Leaf-nosed Bat and Pilbara Olive Python. Discussions on Mulgara, Greater Bilby and Grey Falcon are also provided.
- Ecologia (2012a); *North Star Access Corridor Flora, Vegetation, Vertebrate Fauna and Fauna Habitat Assessment.* A baseline flora and vegetation assessment as part of the environmental approvals processes for the North Star mine access corridor, which lies within the local vicinity to the west of the survey area.
- Ecologia (2012b); *North Star Vegetation and Flora Assessment.* A baseline flora and vegetation assessment as part of the environmental approvals processes for the North Star mine. The assessment partially corresponds with the southern section of the survey area.
- Ecologia (2012c); *Pityrodia sp. Marble Bar Targeted Flora Survey.* A targeted survey to identify *Pityrodia* sp. Marble Bar outside areas covered by the North Star flora and vegetation surveys. Provides regional context on the distribution of the Priority 1 (now listed as Threatened) species.
- Ecologia (2011a); *Level 2 Terrestrial Vertebrate Fauna Assessment.* A baseline Level 2 vertebrate fauna survey as part of the environmental approvals processes for the North Star mine which partially corresponds with the southern section of the survey area.
- Ecologia (2011b); *Targeted Conservation Significant Fauna Survey.* A targeted conservation significant fauna survey of the North Star Project which partially corresponds with the southern section of the survey area.
- Coffey Environments (2007); *Supplementary Vegetation and Flora Surveys of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure – Volume 1: Main Report and Figures.* A flora and vegetation survey of Fortescue's rail corridor, including a section of rail corridor in close proximity to the survey area.

- Biota (2004a); *Fauna Habitat and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor.* A Fortescue rail corridor fauna assessment, including a section of rail corridor in close proximity to the survey area.
- Biota (2004b); *Vegetation and Flora Survey of the Proposed FMG Stage A Rail Corridor.* A baseline botanical survey of the Fortescue rail corridor, including a section of rail corridor in close proximity to the survey area.

3 METHODS

3.1 GUIDING PRINCIPLES

3.1.1 FLORA AND VEGETATION

The flora and vegetation survey was conducted as a Reconnaissance survey according to the Flora and Vegetation Technical Guidance (EPA 2016a). The EPA recommends a Reconnaissance survey should:

- provide context and gather broad information
- verify the findings of the desktop assessment
- include low intensity sampling of the flora and vegetation to describe the general vegetation characteristics and condition
- clarify if the area may support any significant flora and vegetation
- identify if a detailed survey is required.

Targeted searches were also conducted in areas of habitat suitable for TF and PF identified during the desktop assessment and previous surveys as having potential to occur.

3.1.2 FAUNA

The following were considered when developing the survey methodology:

- EPA (2020b) *Technical Guidance – Terrestrial Vertebrate Fauna Survey for Environmental Impact Assessment* known as Fauna Technical Guidance
- background information on the survey area, fauna species and habitat likely to occur (i.e. desktop assessment, aerial imagery, and other data).

The Fauna Technical Guidance defines a Basic fauna survey as a low-intensity survey, conducted at the local scale to gather broad fauna and habitat information. A Basic survey can also be used to identify future survey site locations and determine site logistics and access. The results from the Basic survey are used to determine whether a detailed and/or targeted survey is required.

A Basic survey includes habitat assessment, photography, and mapping. During a basic survey, opportunistic fauna observations are made, and low-intensity sampling is used to gather data on the general faunal assemblage's present.

3.2 RECONNAISSANCE FLORA AND VEGETATION FIELD SURVEY

The methods utilised during the field survey followed those outlined in the Flora and Vegetation Technical Guidance (EPA 2016a), conducted as a single phase Reconnaissance survey. The flora and vegetation field survey was undertaken by Terri Jones (Senior Ecologist, Flora Taking (Biological Assessment) Licence FB62000191) during 2-6 July 2020.

Conservation criteria used in this assessment are included in **Table 13** and **Table 14** in **Appendix One**. Survey method details are outlined below.

3.2.1 FLORISTIC QUADRATS

Floristic quadrat ('quadrat') locations were selected using aerial photography, environmental values and field observations to best represent the vegetation values existing at the site. The unmarked quadrats were 50 m x

50 m in dimension, as required according to the Flora and Vegetation Technical Guidance 2016. Where the vegetation consisted of a narrow linear corridor, quadrats were linear but of the same overall size i.e. 2,500 m^2.

The following information was collected from within each quadrat:

- observer
- date
- quadrat/site number
- GPS location (GDA94) of the northwest corner
- digital photograph (spatially referenced with a reference number), taken from the northwest corner, looking diagonally across the quadrat
- soil type and colour
- topography
- list of flora species recorded with the average height and total cover within the quadrat for each species
- vegetation description (as per below)
- vegetation condition.

At least one quadrat was recorded per vegetation type for the Reconnaissance survey. All quadrat locations are displayed in the **Map 5** series.

3.2.2 TARGETED SEARCHES

Threatened and Priority Flora identified during the desktop analysis and previous surveys as having potential to occur were targeted for searches in areas of potential habitat.

The locations of all targeted taxa collected were recorded using a handheld GPS with the following data recorded:

- observer, date and time
- reproductive status and other features such as health of plants, percentage flowering and fruiting
- local abundance/population size and/or population boundary, including outside the development envelopes where possible
- landform
- brief vegetation community description
- representative photos of each species and habitat
- collection of representative specimens.

3.2.3 INTRODUCED SPECIES

Introduced species (weeds) were recorded during the collection of the overall flora inventory.

The field survey included searches for WONS, Declared Pest plants (DPP) and 'Priority Weeds' as outlined on a list maintained by Fortescue/ Iron Bridge for its management purposes. Their locations and numbers/extents were recorded where noted during the field survey, and each such introduced plant species photographed.

3.2.4 VEGETATION DESCRIPTION AND CLASSIFICATION

Vegetation was described from each of the quadrats using the height and estimated cover of dominant and characteristic species of each stratum based on the National Vegetation Information System, recorded at Level V (NVIS Technical Working Group 2017) (**Table 16** and **Table 17** in **Appendix One**). Up to three species per stratum from each stratum (upper, mid and ground) were used to formulate vegetation descriptions for each quadrat and each vegetation type.

Vegetation type descriptions were created as per Fortescue standards by combining quadrat descriptions and modifying, where necessary, based on the wider vegetation. Vegetation codes were formulated using the first letter of genus and species names of the dominant species of each stratum e.g. **ChAtTe** refers to ***C****orymbia* ***h****amersleyana* low open woodland over ***A****cacia* ***t****umida* var. *pilbarensis* mid sparse shrubland over ***T****riodia* ***e****pactia* and *Triodia wiseana* low hummock grassland.

3.2.5 VEGETATION CONDITION ASSESSMENT

Vegetation condition was assessed broadly and continuously throughout the survey area and at each quadrat using the Vegetation Condition Scale for the Eremaean Botanical Provinces (EPA 2016a) (**Table 18** in **Appendix One**). As quadrats are located in the best condition parts of a vegetation type, the condition rating of the quadrat may not match that of the broader vegetation type due to the scale of mapping.

3.3 BASIC FAUNA FIELD SURVEY

A Basic fauna survey, as defined by the recently released (July 2020) *Technical Guidance – Terrestrial Vertebrate Fauna Survey for Environmental Impact Assessment* (EPA 2020b), consists of a desktop study and ground truthing.

The fauna survey was conducted by Bruce Turner (Senior Zoologist) during 2-6 July 2020, under DBCA Fauna Taking (Biological Assessment) Licence BA27000270.

The survey focused on mapping major fauna habitat types within the survey areas, particularly those habitat types likely to be utilised by conservation significant species identified as part of the desktop survey. The Basic field surveys also comprised of the following opportunistic surveys:

- **Active searches:** 30 minute active searches of 1 ha areas within the survey area were conducted by an experienced zoologist. Microhabitats favoured by reptiles and amphibians were searched with particular emphasis placed on cryptic species not typically recorded in trapping grids. Survey techniques include raking of leaf litter and soil under shrubs, searching in rock piles and searching under and inside fallen timber.
- **Scats, tracks and other traces surveys:** Tracks, scats and other traces of terrestrial fauna were recorded and identified where possible.
- **Camera surveys:** trail cameras (Reconyx HC500) capable of taking images using both visible and infrared light were deployed across the survey areas at points of ecological interest (water holes, rocky outcrops, burrow entrances). This method is particularly effective in the detection of cryptic species.
- **Acoustic and Ultrasonic recorders:** acoustic recording devices (Wildlife Acoustics SongMeter SM2 fitted with acoustic microphone SMXII) were deployed in potential Night Parrot habitat. Ultrasonic recording devices (Wildlife Acoustics SongMeter SM4 fitted with ultrasonic microphone SMX-U1) were deployed within each survey area to detect bat species. Both recorder types were deployed for a minimum of four nights.
- **Bird surveys:** an opportunistic bird list was maintained for the survey area combining the bird species lists collected during opportunistic searches as well as those species observed when travelling between sites.

Fauna species were identified opportunistically based on sightings, calls, remains, diggings, and other signs. Potential habitats for conservation significant species were identified and evaluated and their likelihood of occurrence assessed.

3.3.1 FAUNA HABITAT MAPPING

Fauna habitat types were assessed continuously throughout the survey and at each observation of fauna, in particular when conservation significant species were recorded. Fauna habitats were described as an area which is distinguishable from its surrounding area by its landform, vegetation structure and composition, soil characteristics and fauna assemblage that occur in the area. In addition, the likelihood to harbour specialised fauna species which are not found in adjacent areas was taken into consideration. The spatial extent of each habitat type was mapped using GIS software.

The following information was used to identify and map all fauna habitats within the survey area:

- previous fauna habitat mapping
- land systems
- vegetation type and condition mapping
- aerial imagery
- landforms
- soil characteristic
- fauna assemblage information.

3.3.2 SPECIMEN SORTING AND IDENTIFICATION

Recorded data from ultrasonic and audio recording units for fauna calls were supplied to subcontracted experts for analysis.

4 RESULTS

4.1 FIELD SURVEY TIMING

The field survey was conducted during 2-6 July 2020. The rainfall in the 6 month period preceding the survey in July 2020 was slightly above average, with 105.4% of the mean rainfall in the six months prior to the field survey as indicated in the monthly rainfall graph (**Figure 3**) and rainfall deciles map (**Figure 4**). A large proportion of this rainfall was during February 2020 following Tropical Cyclone Damien (BoM 2020).

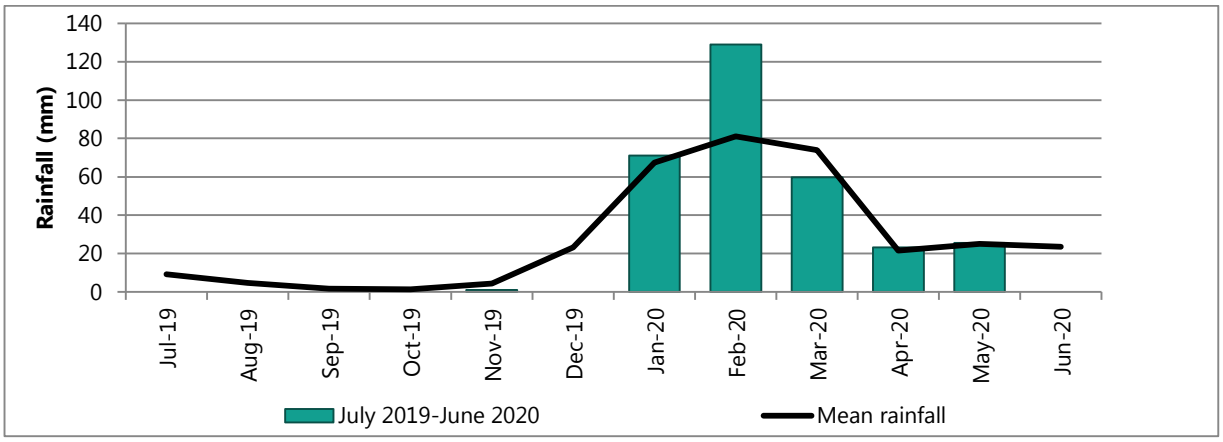


Figure 3: Mean rainfall and rainfall prior to the field survey (Indee, 1909-2020) (BoM 2020)

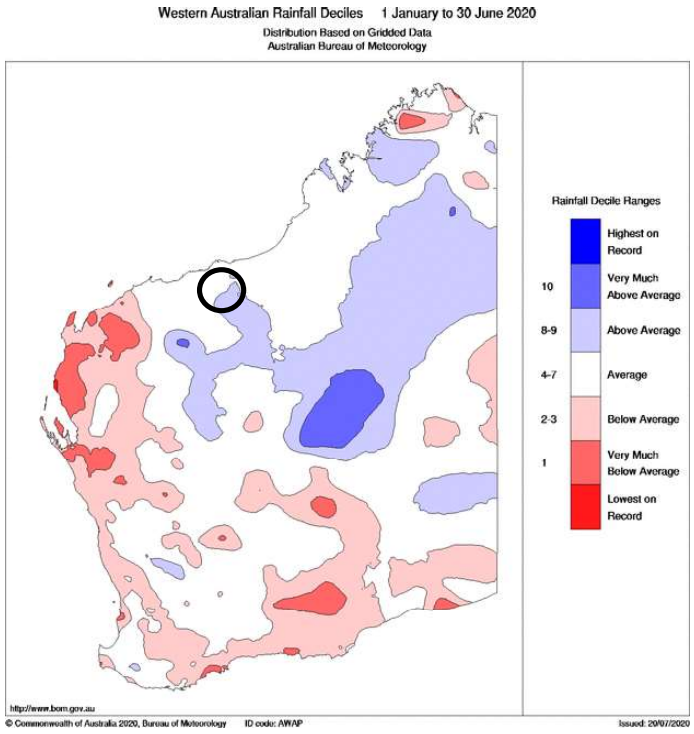


Figure 4: Rainfall percentages for the six months prior to the field survey (BoM 2020). The survey area lies to the south of Port Hedland approximately as circled.

4.2 FLORA AND VEGETATION SURVEY

4.2.1 FLORA

A total of ten quadrats were established during the field survey. Where possible these were placed within (or partially within) the defined survey area, however where this was not possible (e.g. due to narrow dimensions along the road alignment) the quadrats were established in representative adjacent vegetation.

4.2.1.1 Flora inventory

There were 100 vascular flora recorded from 24 families and 54 genera from the 10 floristic quadrats, opportunistic observations and during conservation significant flora searches. Of these, two (2%) were introduced and two (2%) could not be identified to species level due to lack of diagnostic material.

The most commonly represented families were *Fabaceae* with 21 taxa, *Poaceae* (15 taxa) and *Malvaceae* (11 taxa). The most commonly represented genera were *Acacia* with 11 taxa, *Triodia* (seven taxa) and *Ptilotus* (six taxa).

The number of species per quadrat ranged from nine (quadrat PW2008) to 36 (quadrat PW2003). The average species diversity per quadrat was 21.4 taxa. The most frequently recorded taxa were *Petalostylis labicheoides* (from seven quadrats), *Ptilotus calostachyus*, *Indigofera monophylla* and *Triodia lanigera* (six each).

The combined flora inventory is presented in **Table 22** in **Appendix Three**. Complete quadrat data is presented in **Appendix Four**.

4.2.1.2 Conservation Significant Flora

No Commonwealth EPBC Act or Western Australian BC Act-listed Threatened Flora were recorded during the field survey, nor were any considered likely to occur based on desktop assessment.

Two Priority-listed flora were recorded (*Heliotropium muticum* and *Triodia chichesterensis*), as summarised in **Table 6**. Locations are presented in the **Map 5** series. The spinifex *T. chichesterensis* is known from a restricted distribution of approximately 30 km x 100 km, with records (as registered with DBCA) loosely associated with the Pippingarra Access Road.

Significant flora details, including locations and Threatened and Priority Flora Report Forms, are presented in **Appendix Five**.

Table 6: Priority Flora species recorded from the survey

Species				
	Description (WAH 1998-2020)	**Habitat (WAH 1998-2020)**	**Survey results**	**Photograph**
Priority 3	A grey-green, scabrous, perennial herb; ascending or spreading; to c. 30 cm tall. Leaves are small and ovate, flowers white with very short but stiff, spiny hairs.	Has been recorded from red to brown sandy and loamy soils, on sandy plains or flats. Distribution: Known from 73 records in the East Pilbara, Karratha and Port Hedland areas (Pilbara region).	**Records**: Approximately 444 individuals from 16 locations. **Populations**: Recorded locations may potentially represent 2-4 discrete populations. Populations are not confined to the survey area and extend into adjacent areas **Habitat**: Occurs in three vegetation types: • **AaTl** • **AiTw** • **CzAaTl**	
Species				
	Description (WAH 1998-2020)	**Habitat (WAH 1998-2020)**	**Survey results**	**Photograph**
Priority 3	Domed hummock grass to 35 cm tall, inflorescences 50 - 70 cm tall. Short, dull grey-green leaves with woolly orifice hairs and shiny speckling on fresh glumes.	Has been recorded from *Corymbia hamersleyana* open woodland or *Acacia* shrubland on sandy clay to clay-loam soils. At times associated with stony quartz soils and calcrete. Distribution: Known from 18 records (DBCA 2007-2020) in the East Pilbara and Port Hedland areas (Pilbara region).	**Records**: This species was recorded from six locations within the survey area. **Populations**: Estimated up to three separate populations. Populations are not confined to the survey area and extend into adjacent areas **Habitat**: Occurs in three vegetation types: • **AiTw** • **ChAbTc** • **ChAiTc**	

4.2.1.3 Post-survey Likelihood Assessment

Following field survey, when additional information is available regarding actual habitat availability and searches have been conducted, the likelihood of conservation significant flora occurring in the survey area was revised. This revised likelihood, that took into account vegetation condition, grazing and other disturbances, actual habitat availability and search effort, is included in **Table 19** in **Appendix Two**.

The post-survey likelihood assessment identified that three conservation significant taxa remain a possibility of occurring within the survey area including:

- *Eragrostis crateriformis* (P3)
- *Euphorbia clementii* (P3)
- *Goodenia nuda* (P4).

4.2.1.4 Other Significant Flora

According to the criteria outlined in the Flora and Vegetation Technical Guidance (EPA 2016a), with the exception of the PF listed above, none of the taxa recorded are considered significant (e.g. range extensions or species of taxonomic interest).

4.2.1.5 Introduced Flora

Two introduced flora species (weeds), representing 2% of the total flora species, were recorded during the field survey. Both species were recorded only in the vicinity of quadrat PW2010, in vegetation type **EcAtCc**. Approximately 20 individuals of **Aerva javanica* (Kapok) were observed as a small infestation at the quadrat, whilst moderate cover (30%) of **Cenchrus ciliaris* (Buffel Grass) was also recorded at that location and was a major contributor to vegetation condition assessment.

Neither of these taxa constitutes a DPP or WONS species, however, both species are identified as 'Priority' weeds according to a list maintained by Fortescue/Iron Bridge for management purposes, although **Cenchrus ciliaris* (Buffel Grass) is subject to pastoral exclusion zones. Occurrence of both species were associated with the Turner River and locations are shown on **Map 6**.

Image 1: *Aerva javanica (Kapok) form

Image 2: *Aerva javanica and grazed *Cenchrus ciliaris at quadrat PW2010

4.2.2 VEGETATION

A total of nine distinct vegetation types were recorded from within the survey area, based on a combination of structural vegetation type as identified in the field and subsequent review. Vegetation types are described in **Table 7** with the extents and representative quadrat locations are shown on the **Map 5** series.

4.2.2.1 Significant Vegetation

Threatened and Priority Ecological Communities

None of the existing vegetation has any formal conservation significance i.e. none is considered representative of any currently described TEC or PEC. The PEC identified by the DBCA database search, the Gregory Land System is characterised by linear dunes, a landform not present within the survey area.

Groundwater Dependent Vegetation

Eucalyptus camaldulensis sens. lat. is considered to be an obligate phreatophyte, and therefore vegetation with this species included is representative of a GDE (Eamus *et al.* 2006; Grierson 2010). *Eucalyptus victrix* may be regarded as a facultative phreatophyte although there is some evidence that it is not dependent on groundwater in all circumstances (Batini 2009; Eamus 2009a; EPA & Hamersley Iron Pty Ltd 2010; Equinox Environmental 2017; Resource and Environmental Management Pty Ltd 2007). Both *Eucalyptus camaldulensis* and *Eucalyptus victrix* were recorded as dominant species of the **EcAtCc** vegetation type and is therefore considered likely representative of GDV. This vegetation type occupied 3.4 ha or 2.6 % of the survey area.

Mulga

There were no species of Mulga recorded within the survey area and therefore sheetflow dependant mulga vegetation is not present within the survey area.

Table 7: Vegetation types

Landform	Mapping Unit	Vegetation Type	Floristic Quadrats	Representative Photograph	Other Characteristic Species	Area (ha) and Extent (%) of Survey Area
Sandplain	**AaTl**	*Acacia ancistrocarpa* tall sparse shrubland over *Triodia lanigera* low hummock grassland. M ^*Acacia ancistrocarpa*\^shrub\4\r;G+ ^*Triodia lanigera*\^hummock grass\1\c	PW2001		*Acacia inaequilatera* *Bonamia alatisemina* *Corymbia hamersleyana* *Indigofera monophylla* *Isotropis atropurpurea* *Ptilotus astrolasius*	51.6 ha 39.7 %
Sandplain	**AaTw**	*Acacia acradenia* and *Grevillea wickhamii* mid open shrubland over *Triodia wiseana* and *T. lanigera* low hummock grassland. M+ ^*Acacia acradenia,*^*Grevillea wickhamii*\^shrub\3\i;G ^*Triodia wiseana,*^*Triodia lanigera*\^hummock grass\1\c	PW2006		*Eriachne helmsii* *Eriachne pulchella* subsp. *dominii* *Fimbristylis simulans* *Goodenia stobbsiana* *Petalostylis labicheoides* *Scaevola browniana*	6.6 ha 5.1 %

Landform	Mapping Unit	Vegetation Type	Floristic Quadrats	Representative Photograph	Other Characteristic Species	Area (ha) and Extent (%) of Survey Area
Sandplain	**AiTw**	*Acacia inaequilatera* tall sparse shrubland over *Triodia wiseana* and *Acacia stellaticeps* low closed hummock grassland/shrubland. M ^*Acacia* inaequilatera\^shrub\4\r;G+ ^*Triodia wiseana*,^*Acacia stellaticeps*\^hummock grass,shrub\2\d	**PW2003** PW2009		*Acacia ancistrocarpa* *Bonamia pilbarensis* *Codonocarpus cotinifolius* *Corchorus tectus* *Corymbia hamersleyana* *Eriachne pulchella* subsp. *dominii* *Hakea lorea* subsp. *lorea* *Triodia lanigera* *Triodia longiceps*	15.6 ha 12.0 %
Sandplain	**AoTw**	*Acacia orthocarpa* and *A. inaequilatera* tall sparse shrubland over *Triodia wiseana* and *T. lanigera* low closed hummock grassland. M ^*Acacia orthocarpa*,^*Acacia inaequilatera*\^shrub\4\r;G+ ^*Triodia wiseana*,^*Triodia lanigera*\^\1\d	PW2002		*Acacia stellaticeps* *Bulbostylis barbata* *Corchorus parviflorus* *Corymbia hamersleyana* *Fimbristylis simulans* *Polycarpaea holtzei* *Senna symonii*	3.8 ha 2.9 %

Landform	Mapping Unit	Vegetation Type	Floristic Quadrats	Representative Photograph	Other Characteristic Species	Area (ha) and Extent (%) of Survey Area
Sandplain	**ChAbTc**	*Corymbia hamersleyana* low open woodland over *Acacia bivenosa* and *Petalostylis labicheoides* mid sparse shrubland over *Triodia chichesterensis* low closed hummock grassland. U+ ^*Corymbia hamersleyana*\^tree\6\r;M ^*Acacia bivenosa*,^*Petalostylis labicheoides*\^shrub\3\r;G ^*Triodia chichesterensis*\^hummock grass\1\d	PW2007		*Heliotropium ovalifolium* *Heliotropium tenuifolium* *Scaevola amblyanthera* var. *centralis* *Stackhousia muricata*	3.2 ha 2.4 %
Sandplain	**ChAiTc**	*Corymbia hamersleyana l*ow open woodland over *Triodia chichesterensis* low closed hummock grassland with *Acacia inaequilatera* tall isolated shrubs. U ^*Corymbia hamersleyana*\^tree\6\bi;M ^,*Acacia inaequilatera*\^,shrub\4\bi;G+ ^*Triodia chichesterensis*\^hummock grass\1\d	PW2008		*Acacia bivenosa* *Goodenia stobbsiana* *Grevillea wickhamii* *Hakea lorea subsp. lorea* *Scaevola amblyanthera* var. *centralis* *Tephrosia* sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	2.9 ha 2.2 %

Landform	Mapping Unit	Vegetation Type	Floristic Quadrats	Representative Photograph	Other Characteristic Species	Area (ha) and Extent (%) of Survey Area
Minor Drainage Line	**ChAtTe**	*Corymbia hamersleyana* low open woodland over *Acacia tumida* var. *pilbarensis* mid sparse shrubland over *Triodia epactia* and *T. wiseana* low hummock grassland. U+ ^*Corymbia hamersleyana*\^tree\6\r;M ^*Acacia tumida* var. *pilbarensis*\^shrub\3\r;G ^*Triodia epactia*,^ *Triodia wiseana*\^hummock grass\1\c	PW2005		*Acacia acradenia* *Bonamia erecta* *Chrysopogon fallax* *Heliotropium ovalifolium* *Hybanthus aurantiacus* *Indigofera monophylla* *Isotropis atropurpurea* *Paraneurachne muelleri* *Solanum diversiflorum* *Solanum phlomoides* *Triumfetta chaetocarpa*	0.8 ha 0.6 %
Sandplain	**CzAaTl**	*Corymbia zygophylla* low open woodland over *Acacia ancistrocarpa* mid sparse shrubland over *Triodia lanigera, Isotropis atropurpurea* and *Ptilotus astrolasius* low hummock grassland/shrubland. U+ ^*Corymbia zygophylla*\^tree\6\r;M ^*Acacia ancistrocarpa*\^shrub\3\r;G ^^*Triodia lanigera,Isotropis atropurpurea,Ptilotus astrolasius*\^hummock grass,shrub\1\c	PW2004		*Acacia tumida* var. *pilbarensis* *Bonamia erecta* *Codonocarpus cotinifolius* *Corchorus tectus* *Ptilotus axillaris* *Ptilotus fusiformis* *Sida* sp. Pilbara (A.A. Mitchell PRP 1543) *Triodia lanigera*	4.3 ha 3.3 %

Landform	Mapping Unit	Vegetation Type	Floristic Quadrats	Representative Photograph	Other Characteristic Species	Area (ha) and Extent (%) of Survey Area
Major Drainage Line	EcAtCc	*Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* mid woodland over *Acacia trachycarpa* and *Atalaya hemiglauca* tall open shrubland over *Cenchrus ciliaris* and *Triodia longiceps* mid tussock/hummock grassland. U+ ^*Eucalyptus camaldulensis* subsp. *refulgens*,^*Eucalyptus victrix*\^tree\7\i;M ^*Acacia trachycarpa*,^*Atalaya hemiglauca*\^shrub\4\i;G ^*Cenchrus ciliaris*,^*Triodia longiceps*\^tussock grass,hummock grass\2\c	PW2010		*Acacia ampliceps* *Acacia coriacea* subsp. *pendens* *Crotalaria cunninghamii* *Cyperus vaginatus* *Euphorbia australis* var. *hispidula* *Hibiscus austrinus* var. *austrinus* *Melaleuca glomerata* *Melaleuca linophylla* *Rhynchosia minima* *Solanum diversiflorum* *Solanum phlomoides*	3.4 ha 2.6 %
	Not vegetated (cleared)		n/a		n/a	37.7 ha 29.1 %
	TOTAL					129.8 ha

4.2.2.2 Vegetation Condition

The vegetation of the survey area ranged from Good to Excellent condition, with the majority in Excellent condition (**Table 8**, **Map 6**). A substantial proportion of the survey area (29.1%) was cleared of native vegetation. The main factors noted as influencing vegetation condition were dust accumulation and small amounts of rubbish/debris in areas proximal to the roadway, as well as livestock disturbance, invasive weeds and rubbish/debris in the Turner River.

Table 8: Vegetation condition extents

Vegetation condition	Extent (ha)	Extent (%)
Excellent	82.9	63.9
Very Good	5.1	4.0
Good	3.3	2.5
Poor	0.7	0.6
Degraded	0	0
Completely Degraded (Cleared/Not Vegetated)	37.7	29.1

4.2.3 ADEQUACY OF SURVEY

It should not be expected that a reconnaissance flora and vegetation survey would record a complete flora inventory, particularly with each vegetation type represented by a single floristic quadrat. A species accumulation curve generated from the 10 floristic quadrats suggests that additional survey would have recorded additional species as the curve has not reached an asymptote (**Figure 5**). However, a Bootstrap estimate of species richness is 110.3 which, when taking opportunistic observations into account, is only slightly more than the number of species recorded (100). This indicates that the majority of species present at the time of survey were recorded.

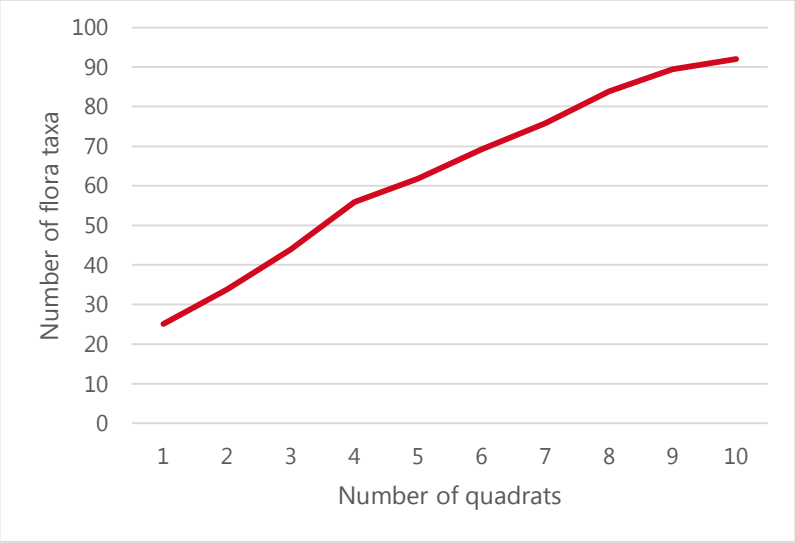


Figure 5: Species accumulation curve

4.2.4 BOTANICAL LIMITATIONS

Survey design: Single phase, quadrat-based flora and vegetation survey with additional traverses searching for conservation significant flora. Results from previous surveys were considered as part of survey design and the desktop assessment.

Survey type: Reconnaissance flora and vegetation survey with additional searches for significant flora conducted over a single phase. All areas were adequately surveyed for a reconnaissance level survey through the use of floristic quadrats to sample vegetation types, and targeted searches for conservation-listed flora.

Type of vegetation classification system: Vegetation classified at NVIS Level V (NVIS Technical Working Group 2017) using largely structural vegetation types defined using dominant and characteristic species and vegetation structure as recorded during the field surveys.

There only botanical limitation encountered was that recent fire had impacted a substantial proportion of the survey area, estimated less than six months prior. A full summary of botanical limitations is presented in **Table 9**.

Table 9: Botanical limitations

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Availability of contextual information at a regional and local scale	No	Significant parts of the survey area had been previously surveyed. There are also numerous flora and vegetation survey reports available from nearby surrounding areas.
Competency/experience of the team conducting the survey, including experience in the bioregion surveyed	No	The lead botanist conducting the field survey has 10 years' experience conducting flora and vegetation surveys in Western Australia, including the Pilbara region.
Proportion of the flora recorded and/or collected, and any identification issues	Negligible	A total of 100 flora taxa were recorded during the field survey of which two (2% of the total) were not identifiable to species level, most likely due to lack or diagnostic reproductive material. None of these unidentified specimens are considered None of the unidentified taxa are considered potential to represent any currently listed TF or PF.
Was the appropriate area fully surveyed (effort and extent)	No	The survey area was surveyed adequately to describe the flora, vegetation types and vegetation for the purpose of a reconnaissance survey.
Access restrictions within the survey area	No	The survey area was fully accessible.

Possible limitations	Constraints (yes/no): Significant, moderate or negligible	Comment
Survey timing, rainfall, season of survey	No	Despite the survey being conducted just outside of the optimal March-June timing recommended for the Eremaean bioregion, the majority (98%) of flora observed during survey was readily identifiable to species level or greater, with many specimens bearing characteristic flowering or fruiting material. The rainfall during the six months prior to the field survey was slightly above average at 105.4%, thus rainfall and moisture availability to vegetation was not considered a limitation to survey.
Disturbance that may have affected the results of the survey e.g. fire, flood, clearing	Moderate	There was evidence of recent (<6 months) fire occurring across much of the survey area, particularly along Pippingarra Road. Although vegetation structure and key dominant species could still be determined with confidence for much of the burnt area, fire history may have affected the results of the survey.

4.3 FAUNA

Ten trail cameras were deployed in representative habitat and on significant fauna species features such as the recorded Pebble-mounds (**Map 7**).

Two audio recording units (SM2 17715; SM2 17745, **Map 7**) were deployed in marginal habitat for the Night Parrot. Three ultrasonic recording units (SM4 1247; SM4 1233; SM4 1147, **Map 7**) were deployed in each habitat type for the detection of Bat species.

4.3.1 SURVEY AREA

The survey area (**Figure 1**) is comprised of a corridor of approximately 50 m width and six larger blocks (the largest is approximately 400 m x 300 m) the extent of the survey area is 129.8 ha. The 50 m corridor contains cleared road surfaces of approximately 20 m width leaving 15 m on either side of the road containing native vegetation. This constrained amount of available habitat restricts the likelihood of presence for both the Greater Bilby and Brush-tailed Mulgara, along with the presence of traffic, constructed drains, and road maintenance activity. The cleared extents of the survey area are not considered as fauna habitat and totalled 37.72 ha or 29.1% of the survey area

4.3.2 FAUNA HABITAT

Two fauna habitat types were recorded within the survey area (**Table 10**, **Map 7**). Hummock Grasslands and Creeklines. The Hummock Grasslands are associated with either *Acacia* shrubs or *Corymbia* Woodlands and were impacted by recent fires within the previous three to 12 months. Both habitats are also subject to degradation by Cattle trampling, road clearing, drainage construction, and maintenance activity.

Fauna habitats were assessed from 24 habitat assessment points across the survey area (**Table 24**, **Map 7**). Habitat quality varied from degraded to moderate dependent on the level of disturbance from clearing, fire history, and trampling by Cattle.

Habitat quality is based on the field surveyors experience, the level of disturbance due to weeds, road/tracks, clearing or other human disturbances, and the context of the habitat with the surrounding landscape.

4.3.2.1 Hummock Grassland (88.83 ha)

Scattered Acacia shrubs and Corymbia woodlands over hummock grasses and other herbs on stony clay and stony sandplain soils. Habitat quality was assessed as moderate overall and provides the most diverse environment within the survey area occupying 88.83 ha (64.43%). This habitat provides limited food and shelter for small mammals, birds (particularly granivorous species) and small reptiles.

4.3.2.2 Creekline (3.25 ha)

Seasonally wet drainage lines with bare sandy soil with scattered Eucalypt woodlands along edges and in sand bars. When water is absent this habitat creates avenues for the movement of feral species such as Cattle, Feral Cats, and Wild Dogs through the survey area. This habitat occupies 3.25 ha (2.5%) providing water resources for most fauna groups when inundated but has little habitat value when dry. The woodlands provide important food and shelter resources for arboreal reptiles and mammals and most bird species.

Table 10: Fauna habitat types

Habitat type	Description	Photo
Hummock Grasslands	Hummock Grasslands associated with either emergent *Acacia* shrubs or *Corymbia* woodlands on stony clay or, to a lesser extent sandy and stony sandplain soils. Habitat type is suitable for common suite of bird species, small reptiles, and mammals e.g. White-breasted Woodswallow, Military Dragon, Spinifex Hopping Mouse, and Western Pebble-mound Mouse **Extent:** 88.83 ha **Percentage of survey area:** 68.43%	
Creeklines	Eucalypt Woodlands over Hummock Grasses and shrubs on sandy soils. Habitat type is suitable for common creekline and woodland species e.g. Magpie Lark, Yellow-throated Miner, and Sand Goanna **Extent:** 3.25 ha **Percentage of survey area:** 2.5%	

4.3.3 FAUNA ASSEMBLAGE

Forty five vertebrate fauna species were recorded during the field survey, 11 mammals (including two introduced); 29 birds; and four reptiles (**Table 11**). Of the fauna species recorded, one is conservation listed, *Pseudomys chapmani* (Western Pebble-mound Mouse, P4); recorded by trail camera at site PMM3. All survey sites are shown in **Map 7** and listed in **Table 24** in **Appendix Six**.

Table 11: Recorded fauna species (* denotes introduced species)

Species	Common name	EPBC Act ranking	BC Act /DBCA ranking
Mammals			
Austronomus australis	White-striped Free-tailed Bat		
Chaerephon jobensis	Greater Northern Free-tailed Bat		
Chalinolobus gouldii	Gould's Wattled Bat		
**Canis familiaris*	Wild Dog		
**Equus asinus*	Donkey		
Macropus robustus	Euro		
Pseudomys chapmani	**Western Pebble-mound Mouse**	**-**	**P4**
Saccolaimus flaviventris	Yellow-bellied Sheath-tailed Bat		
Scotorepens greyii	Little Broad-nosed Bat		
Taphozous georgianus	Common Sheath-tailed Bat		
Vespadelus finlaysoni	Finlayson's Cave Bat		
Birds			
Ardea modesta	Great Egret		
Ardea novaehollandiae	White-faced Heron		
Ardea pacifica	White-necked Heron		
Ardeotis australis	Australian Bustard		
Artamus leucorynchus	White-breasted Woodswallow		
Cacatua sanguinea	Little Corella		
Certhionyx variegatus	Pied Honeyeater		
Circus approximans	Swamp Harrier		
Corvus bennetti	Little Crow		
Cracticus tibicen	Australian Magpie		
Cracticus torquatus	Grey Butcherbird		
Eremiornis carteri	Spinifexbird		
Falco berigora	Brown Falcon		
Falco longipennis	Australian Hobby		
Gavicalis virescens	Singing Honeyeater		
Geopelia cuneata	Diamond Dove		
Geophaps plumifera	Spinifex Pigeon		
Grallina cyanoleuca	Magpie-lark		
Haliastur sphenurus	Whistling Kite		
Malurus leucopterus	White-winged Fairy-wren		
Manorina flavigula	Yellow-throated Miner		
Merops ornatus	Rainbow Bee-eater		
Nymphicus hollandicus	Cockatiel		
Ocyphaps lophotes	Crested Pigeon		
Pelecanus conspicillatus	Australian Pelican		
Phalacrocorax sulcirostris	Little Black Cormorant		
Phaps chalcoptera	Common Bronzewing		
Rhipidura leucophrys	Willie Wagtail		
Taeniopygia guttata	Zebra Finch		
Reptiles			

Species	Common name	EPBC Act ranking	BC Act /DBCA ranking
Ctenophorus caudicinctus	Western Ring-tailed Dragon		
Ctenophorus isolepis	Central Military Dragon		
Ctenotus saxatilis	Rock Ctenotus		
Pseudechis australis	Mulga Snake		

4.3.4 CONSERVATION SIGNIFICANT FAUNA AND ASSOCIATED HABITAT

The Western Pebble-mound Mouse was recorded with five active mounds being located (**Map 7**). One of these mounds (PMM5) was within the survey area and one individual mouse image was captured by trail camera at mound PMM3 (**Image 1**). All five mounds were in the Hummock Grassland habitat type in areas regenerating from a recent fire.

Image 1: Western Pebble-mound Mouse at mound PMM3, lower right foreground

4.4 FAUNA SURVEY LIMITATIONS

Rainfall in the six months preceding the field survey are shown in **Figure 4** which indicates that the region recorded slightly above average rainfall.

The fauna survey was conducted during July which does not fall within the optimal prescribed season as per the Fauna Technical Guidance (EPA 2020b). The Guidance states that fauna surveys for reptiles within the Eremaean Province are optimally conducted between September and April to ensure sampling during peak activity. Survey timing for amphibians and birds is dependent on rainfall events which can occur during summer and autumn. Mammal activity is not dependent on weather and is therefore not constrained.

Recent fire across a substantial proportion of the survey area represents a possible constraint. A full summary of fauna limitations is presented in **Table 12**.

Table 12: Summary of fauna survey limitations

Possible limitations	Constraints (yes/possible/no)	Comment
Competency/experience of the consultant conducting the survey	No	35+ years' experience in assessing environmental impact and conducting fauna surveys across Western Australia
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	No	All fauna groups were sampled with the exception of amphibians due to the timing of the survey. Survey was conducted as a Basic survey, with the emphasis on describing habitat and assessing its suitability for conservation-listed species
Proportion of fauna identified, recorded and/or collected.	No	Fauna assemblage identified is representative of a Basic level survey with species that are identified in the field by observation, trail camera images, audio recordings, and evidence of presence e.g. scats and tracks
Sources of information (previously available information as distinct from new data).	No	Both State and Commonwealth sources readily available as was previous survey information
The proportion of the task achieved and further work which might be needed.	No	All tasks achieved
Timing/weather/season/cycle.	No (minor for reptiles and amphibians)	The survey was conducted as a Basic survey, with the emphasis on describing habitat and assessing its suitability for conservation-listed species. Survey timing, season and weather are not significant aspects of the survey
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	Possible	Large areas of the survey area were recently burnt (<6 months) with some smaller patches recovering from fire <1 year ago.
Intensity (in retrospect was the intensity adequate).	No	The size of the survey area and the expected level of disturbance warranted a basic survey as appropriate
Completeness (e.g. was relevant area fully surveyed), remoteness and/or access problems	No	Multiple representative sites within the survey area were traversed on foot
Resources (e.g. degree of expertise available in animal identification to taxon level).	No	35+ years in fauna survey and fauna species identification

5 DISCUSSION

5.1 FLORA SIGNIFICANCE

A total of 100 vascular flora species were recorded from 10 floristic quadrats and opportunistic searches. Two taxa identified (2%) represent introduced (weed) species. Two specimens could not be identified with certainty due to lack of diagnostic reproductive material; however, neither of these were similar to any currently described conservation listed species. The average species diversity recorded per quadrat (21.4 taxa) is comparable with that of other surveys conducted in the area, with Coffey (2014) and Ecologia (2012b) surveys in the vicinity reporting average quadrat richness of 18.4 and 25.7 taxa respectively.

The species accumulation curve indicates that further quadrats would yield additional taxa on the flora species inventory as the curve has not reached an asymptote (**Figure 5**). A Reconnaissance survey requires only low intensity sampling of the flora and as such a complete flora inventory is not expected. However, the Bootstrap estimate of species richness indicates that approximately 90% of flora species in the survey area at the time have been recorded during field assessment when opportunistic collections are considered. For a Reconnaissance flora survey this is considered adequate.

5.1.1 RECORDED CONSERVATION SIGNIFICANT FLORA

No TF species listed for protection under the Commonwealth EPBC Act or Western Australian BC Act were recorded during field survey. One TF species (*Pityrodia* sp. Marble Bar [G. Woodman & D. Coultas GWDC Opp 4]) is known to occur within 40 km of the survey area, however suitable habitat for this taxon was not observed during field assessment therefore no TF species are considered likely to occur within the survey area.

Two PF species, *Heliotropium muticum* (P3) and *Triodia chichesterensis* (P3), were recorded from field survey, both within and outside of the survey corridor. P3 species are considered poorly known and in need of further survey but are not currently under threat (DBCA 2019).

5.1.1.1 *Heliotropium muticum*

Heliotropium muticum was recorded from 16 point locations in and around the northern portion of the survey area, with at least 444 plants recorded. Whilst the majority of these observed locations lie within the survey corridor, six are located slightly outside of the footprint, and some of the sub-populations that were recorded inside the boundary extend beyond the survey area boundary. This species was observed in open, sandy areas predominantly within **AaTl** vegetation, and appeared to be more abundant in areas which had been burnt within approximately six months, suggesting an opportunistic increase in abundance due to reduced cover and competition. Based on Ecoscape's previous experience with survey of *H. muticum*, the taxon is known to proliferate in suitable burnt habitat. As other species within the burnt vegetation patches regenerate and restore foliage cover, numbers of individual *H. muticum* plants in these locations typically decline naturally as part of the community recovery process. Given that abundance of this species will fluctuate in response to fire, and a substantial portion of the local area was observed to have been recently burnt it is anticipated that there are additional areas that may support this species.

This species has a restricted distribution in the area south of Port Hedland within a 150 km radius. However, within this area it has been extensively recorded with 73 records listed on *NatureMap* (DBCA 2007-2020). The impact of road widening and associated activities is considered negligible based on the known distribution of the species, low number of plants and populations that extend outside the boundary of the survey area.

5.1.1.2 *Triodia chichesterensis*

Triodia chichesterensis occurrence was recorded at six locations during survey, primarily from stony soils incorporating quartz and calcrete, on flats and low rises as well as several lower-lying minor drainage features. This species was characteristic of the **ChAbTc** and **ChAiTc** vegetation types. Five of the six locations fall within the survey corridor and one outside of the survey boundary. However, at all locations the sub-populations are not defined though were observed to extend into adjacent vegetation beyond the survey area. In patches of recently burnt vegetation it was not always possible to identify *Triodia* species present to species level due to the lack of diagnostic material on small, regenerating hummocks, therefore additional locations may occur for this taxon in the survey area and adjacent land.

Triodia chichesterensis is known from a restricted distribution with a north-south extent of 100 km based on 18 records currently lodged with the Western Australian Herbarium, hence it is relatively poorly known and could be considered locally endemic. However, the potential impact of the road widening and associated activities is likely negligible, considering the populations are known to extend beyond the survey boundary.

5.1.2 REVISED THREATENED AND PRIORITY FLORA LIKELIHOOD ASSESSMENT

The TF and PF likelihood of occurrence was reviewed with consideration of the field survey results. There are three conservation listed flora species that were identified by the database searches from nearby are considered to have a Possible likelihood of occurring within the survey area based on their known distribution, habitat as described on *FloraBase* and in specimen records (WAH 1998-2020), and having potentially suitable habitat available within the survey area (**Table 19**), described below.

Eragrostis crateriformis (P3) is an annual, grass-like herb known primarily from the Pilbara bioregion, particularly the Port Hedland and East Pilbara areas. It can be found in low-lying areas, depressions and along drainage lines, often in clayey soils (WAH 1998-2020). The species has previously been recorded within 10 km of the survey area, and potentially suitable habitat was observed during field survey in proximity to minor and major drainage features. As this species is an annual relying on sufficient soil moisture for populations to thrive, its occurrence and identification is dependent upon environmental conditions, and presence within the survey area cannot be excluded based on current survey findings. Given proximal records and availability of habitat the post-survey likelihood of *E. crateriformis* occurring in the survey area is maintained as Possible.

Euphorbia clementii (P3) is a small, yellow-green herb with milky sap that occurs on a range of habitats in the East Pilbara and Port Hedland areas (WAH 1998-2020). It has previously been recorded from within 1 km of the survey corridor, and potential habitat was observed during the 2020 field survey. As this taxon is small in size (typically less than 30 cm in height) and can co-occur with visually similar species, there is potential for individuals to pass undetected at this level of survey, although larger populations would likely have been identified. The availability of habitat, low detectability of individuals, and proximity of recent records give grounds for likelihood of its occurrence in the survey area to be maintained as Possible.

Goodenia nuda (P4) is a small, erect or ascending herb with yellow flowers occurring from April to August. It is known from records across the Pilbara region, with isolated occurrences in the Gascoyne and Little Sandy Desert (WAH 1998-2020). Previous field studies in the North Star vicinity have returned multiple records within 1 km of the survey area. Typical habitat for the species, including seasonally inundated clay soils and drainage lines, is present along sections of the survey corridor. Although the survey was undertaken during the flowering period for *G. nuda* which increases the probability of identification in the field, the small habit of this species

coupled with co-occurrence of visually similar species can lower detectability at reconnaissance level of survey. It is therefore considered that a Possible likelihood of occurrence for this species within the survey area remains.

The potential impacts (if any) to the species listed above are considered negligible based on known distribution and the relatively small disturbance footprint.

5.1.3 OTHER SIGNIFICANT FLORA

None of the flora taxa recorded from field survey area are considered to represent range extensions of any significance.

5.1.4 INTRODUCED FLORA

Two introduced flora species (representing 2% of the total flora species) were recorded during the field survey. These were recorded only in the vicinity of quadrat PW2010, in vegetation type **EcAtCc** as indicated on **Map 6**. Individuals of **Aerva javanica* (Kapok) observed represent a small localised infestation, whilst moderate cover (30%) of **Cenchrus ciliaris* (Buffel Grass) was recorded and is anticipated to be contiguous throughout much of the associated vegetation type along the Turner River watercourse. Although not a DPP or WONS species, Kapok is recognised as a 'Priority' weed by Fortescue/Iron Bridge. Similarly, Buffel Grass is neither a DPP nor WONS taxon but is a recognised 'Priority' weed by Fortescue/Iron Bridge, however it is subject to pastoral exclusion zones. **Cenchrus ciliaris* was also recorded at the PW2010 location and was a major contributor to vegetation condition assessment.

5.2 VEGETATION SIGNIFICANCE

Nine vegetation types were recorded within the survey area, corresponding broadly with undulating sandplain and minor and major drainage line landforms. The significance of the identified vegetation types (where relevant) is examined below.

5.2.1 SIGNIFICANT ECOLOGICAL COMMUNITIES

No vegetation observed in the survey area was considered to represent any current Western Australian-listed or Commonwealth EPBC Act-listed TEC or PEC. No TEC in proximity to the survey area was returned from DBCA database search and desktop assessment, and the nearest known PEC is that of the Gregory System (*Linear dunes and restricted sandplains supporting shrubby hard spinifex (and occasionally soft spinifex) grasslands)* which lies approximately 15 km to the west of the survey area. No landforms or vegetation consistent with this community was observed in the survey area.

5.2.2 OTHER SIGNIFICANT VEGETATION

GDV is vegetation characterised by phreatophytic species that require access to groundwater for at least part of their life cycle. GDV mapping (Australian Government & Bureau of Meteorology 2020) (**Figure 6**) indicates that broad areas of the survey corridor and surrounds correspond with areas considered 'low' potential for GDV. Vegetation type **EcAtCc** occurred within the survey area in proximity to the Turner River and was characterised by *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix*. Both of these species are considered to be facultative phreatophytes, although there is some evidence that in some circumstances *E. victrix* is not dependent on groundwater (see **Section 1.4.6.1**). Therefore any changes to groundwater may have the potential to affect the **EcAtCc** vegetation type.

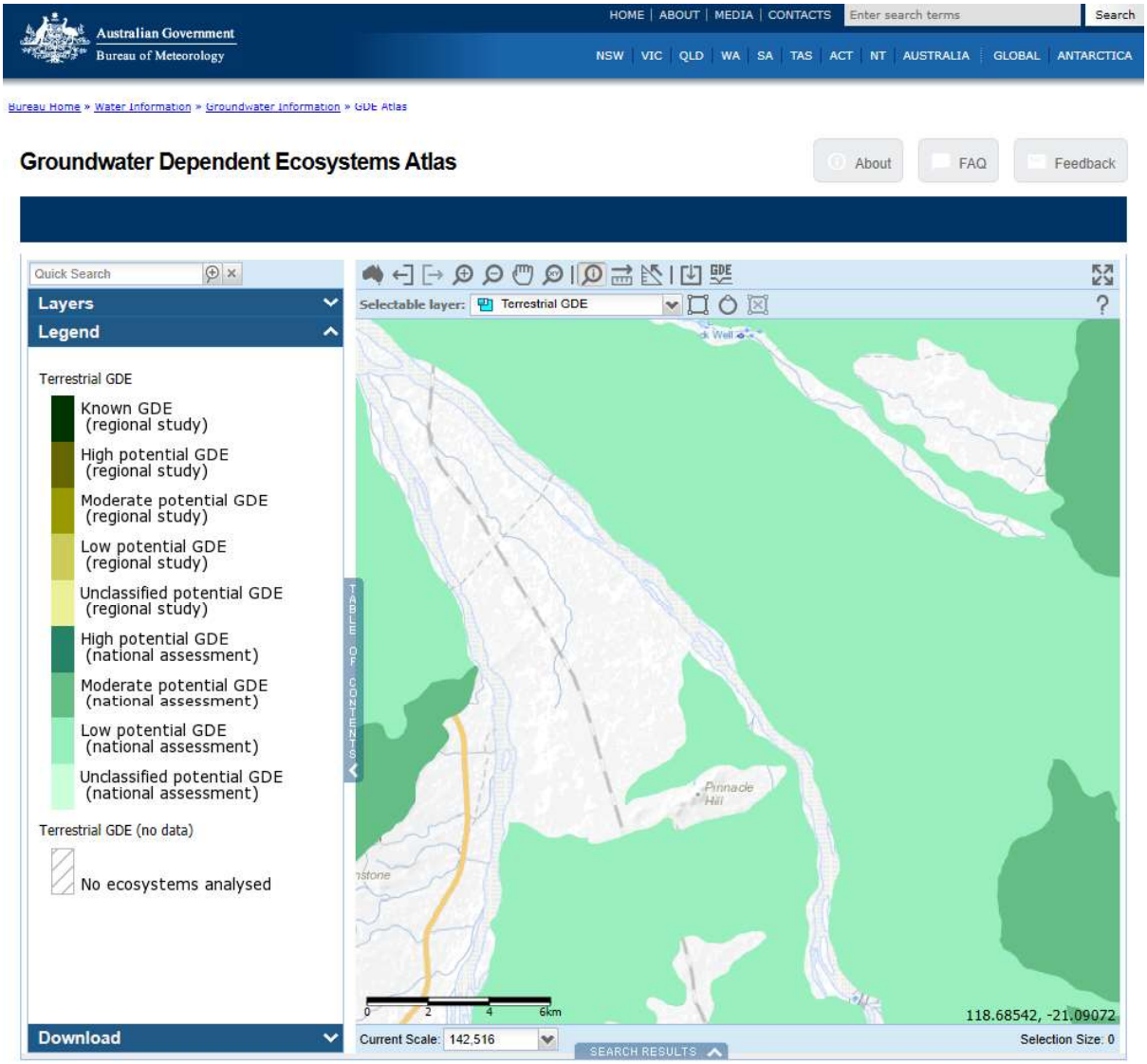


Figure 6: Groundwater Dependent Ecosystem Atlas (Australian Government & Bureau of Meteorology 2020)

Two vegetation types (**ChAbTc** and **ChAiTc**) as described from this survey incorporate the P3 species *Triodia chichesterensis* as a dominant species within the ground stratum. These vegetation types are potentially of local and/or regional significance due to being characterised by a conservation listed species and potentially locally and/or regionally restricted. However, potential impact to these vegetation types is considered negligible as they extend beyond the boundary of the survey area.

5.2.3 LOCAL AND REGIONAL SIGNIFICANCE

Local and regional significance of species and vegetation has not been formally assessed as part of the current Reconnaissance survey, however vegetation observed in the survey area corridor is overall consistent with that of the locally surrounding landscape. As outlined above, two vegetation types (**ChAbTc** and **ChAiTc**) characterised by *Triodia chichesterensis* (P3) have potential to be of local and/or regional significance.

A review of the available literature identified that vegetation with a ground stratum dominated by *T. chichesterensis* was previously described for the vicinity of the survey area (<15 km proximity) in 2018 (Woodman Environmental Consulting 2018 in Mineral Resources 2019). This vegetation type was described

from similar soils and habitat to that of **ChAbTc** and **ChAiTc**, and is mapped within the species' distribution, however further insight into local significance of this vegetation could not be gleaned from the information available.

5.3 VEGETATION CONDITION

Vegetation condition recorded within the survey area was generally categorised as 'Excellent' with the exception of several zones adjacent to existing laydown areas, and vegetation in 'Good' condition associated with the Turner River watercourse in **EcAtCc** vegetation type. The condition of this vegetation type was impacted primarily by the presence of weeds (Kapok and Buffel Grass) and evidence of livestock activity. Weed species have the potential to flourish within watercourses due to movement of seed and increased availability of soil moisture and nutrients. Buffel Grass in particular was locally widespread in this vegetation type and competitive with native groundcover species. The occurrence of Kapok represented a relatively isolated and discrete infestation, however this species has potential to spread rapidly via aeolian and alluvial deposition of seed material. Effects of livestock contributing to reduced vegetation condition included grazing and trampling of native vegetation, which has the potential to impact species richness, ground and foliage cover, and vegetation structure in the longer term.

Multiple small areas of vegetation adjacent to existing laydown areas and road features ranged in condition assessment from 'Very Good' to 'Poor' based predominantly on disruption to vegetation structure, bare ground cover and species assemblage. These portions were mainly distributed along (or near to) the Wodgina Road, where vehicle activity appeared to be greatest and several road-adjacent areas were apparently being used as material or vehicle depots.

Road corridors and previously cleared areas are devoid of vegetation and thus evaluated as 'Completely Degraded' for the purposes of condition assessment.

5.4 FAUNA SIGNIFICANCE

5.4.1 FAUNA HABITAT TYPES

Two habitat types were recorded within the survey area: Hummock Grasslands and Creeklines. The majority of the survey area is comprised of Hummock Grasslands associated with either emergent *Acacia* shrubs or *Corymbia* woodlands and was in a varying range of regeneration stages due to recent fires. The Creekline habitat was restricted to one location at the Turner River crossing in the southern portion of the survey area. Each of these habitat types supports a suite of birds, mammals, and reptiles some of which have specific requirements unique to a particular habitat. Both habitats were degraded by Cattle trampling, road clearing, and areas of recent clearing activity and are frequented by introduced predators (Wild Dog and Feral Cat). Neither of the habitat types recorded are considered of regional or local significance.

The habitat types present within the survey area may be suitable for conservation listed fauna species including Greater Bilby (which has been previously recorded from the survey area), Northern Quoll, and Brush-tailed Mulgara. These species were not detected within the survey area and the habitats have been impacted by recent fires and disturbance from Cattle. The potentially suitable Hummock Grassland habitat was in various stages of regeneration from fire which has reduced available shelter and food resources and is most likely the reason these species were not detected.

The remaining species considered to have a high likelihood of occurrence from the desktop assessment results are all birds (Grey Falcon, Peregrine Falcon, Fork-tailed Swift), these species are rarely sighted and have a

nomadic and widely dispersed distribution pattern, however the small extent of native vegetation and recent fires within the survey area have also reduced the available food resources.

The Creekline habitat was significantly impacted by Cattle activity and road clearing/construction however the common suite of woodland birds remain present e.g. Yellow-throated Miner, Cockatiel, and various Honeyeater species.

5.4.2 FAUNA ASSEMBLAGE

Forty five vertebrate fauna species were recorded during the field survey. All species recorded, with the exception of the Western Pebble-mound Mouse, are common to the region and were expected based on results from previous surveys adjacent to and overlapping the survey area. Seasonal conditions were average and have had no appreciable significance in relation to the species expected or recorded.

The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. seven species of bat were positively identified as being present (**Table 11**). The conservation listed species Ghost Bat (*Macroderma gigas*) and Pilbara Leaf-nosed Bat (*Rhinonicteris aurantia*) were not detected. Two species were unable to be positively identified, *Nyctophilus* sp. and Northern Free-tailed Bat (*Ozimops lumsdenae*) returned ambiguous results and are not included on the species list (Specialised Zoological 2020) (**Appendix Eight**).

5.4.2.1 Conservation Listed Fauna

The Western Pebble-mound Mouse (*Pseudomys chapmani*) was recorded with five active mounds being located (**Map 7**). One mound (PMM5) was within the survey area and one individual mouse image was captured by trail camera at mound PMM3 (**Image 1**). All five mounds were in the Hummock Grassland habitat type in areas regenerating from a recent fire.

This species is native and endemic to Western Australia, where it lives in pebbly soils in arid tussock grassland and acacia woodland (Kitchener 1983). Like other pebble-mound mice, the Western Pebble-mound Mouse creates its own microhabitat by scattering a mound of pebbles around its burrows (Dunlop & Pound 1981). Preferred habitat is hummock grasslands of *Triodia basedowii*, *Cassia*, *Acacia* and *Ptilotus*, and is associated with eroding sands at natural features which expose small stones (pebbles). The species occurs as disjunct populations within its range. The range is subject to changes in land use resulting in loss of habitat, and noted as contracting (Kitchener 1983).

The potential impact of road widening and associated activities to the Western Pebble-mound Mouse is considered negligible based on the single mound recorded within the survey area and numerous that were recorded outside of the survey area nearby.

REFERENCES

Australian Government. *Environment Protection and Biodiversity Conservation Act 1999.*

Australian Government & Bureau of Meteorology. 2020. *Groundwater Dependent Ecosystems Atlas*. Available from: http://www.bom.gov.au/water/groundwater/gde/map.shtml.

Australian Government & Department of Agriculture Water and the Environment. 2020. *EPBC Act Protected Matters Report (Protected Matters Search Tool)*. Available from:

Australian Government & Department of the Environment and Energy. 2018. *Weeds of National Significance*. Available from: http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html.

Batini, F. 2009, *Eucalyptus victrix, Karijini National Park.*, Report to EPA.

Biota Environmental Sciences Pty Ltd 2004a, *Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor*, Unpublished Report for Fortescue Metals Group.

Biota Environmental Sciences Pty Ltd 2004b, *Vegetation and Flora Survey of the Proposed FMG Stage B Rail Corridor and Mines Areas*, Unpublished Report for Fortescue Metals Group Ltd, December 2004.

Bureau of Meteorology. 2020. *Climate Data Online*. Available from: http://www.bom.gov.au/climate/data/.

Coffey Environments 2007, *Supplementary Vegetation and Flora Survey of the Port Hedland to Cloudbreak Rail Corridor and Associated Borrow Pits and Infrastructure*, Prepared for Fortescue Metals Group Ltd, August 2007, Report No. 2007/186: Version 1.

Coffey Environments 2014, *North Star Alternate Access Road Flora and Vegetation Assessment*, unpublished report prepared for Fortescue Metals Group Limited.

Commonwealth of Australia. 2016. *EPBC Act referral guidelines for the endangered Northern Quoll Dasyurus hallucatus*. Available from: http://www.environment.gov.au/system/files/resources/d7e011a7-bf59-40ed-9387-9afcb8d590f8/files/referral-guideline-northern-quoll.pdf.

Department of Biodiversity Conservation and Attractions. 2007. *NatureMap: Mapping Western Australia's Biodiversity*. Available from: https://naturemap.dbca.wa.gov.au/.

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

Department of Biodiversity Conservation and Attractions. 2019. *Conservation codes for Western Australian Flora and Fauna (3 January 2019)*. Available from: https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Conservation%20code%20definitions.pdf.

Department of Biodiversity Conservation and Attractions. 2020. *A Biodiversity Audit of Western Australia's 53 Biogeographic Subregions in 2002*. Available from: https://www.dpaw.wa.gov.au/about-us/science-and-research/ecoinformatics-research/117-a-biodiversity-audit-of-wa.

Department of Environment and Conservation. 2013. *Definitions, categories and criteria for Threatened and Priority Ecological Communities*. Available from: https://www.dpaw.wa.gov.au/images/plants-animals/threatened-species/definitions_categories_and_criteria_for_threatened_and_priority_ecological_communities.pdf.

Department of Environment Water Heritage and the Arts 2009, *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*, Australian Government.

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

Department of Primary Industries and Regional Development. 2018a. *Pre-European Vegetation (DPIRD-006) Spatial Dataset*. Available from: https://catalogue.data.wa.gov.au/dataset/pre-european-dpird-006.

Department of Primary Industries and Regional Development. 2018b. *Soil Landscape Mapping - Rangelands (DPIRD-063)*. Available from: https://catalogue.data.wa.gov.au/dataset/soil-landscape-mapping-rangelands.

Department of Sustainability Environment Water Population and Communities. 2011a. *Survey guidelines for Australia's threatened mammals: Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Available from: http://www.environment.gov.au/epbc/publications/pubs/survey-guidelines-mammals.pdf.

Department of Sustainability Environment Water Population and Communities. 2011b. *Survey guidelines for Australia's threatened reptiles: Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*. Available from: https://www.environment.gov.au/system/files/resources/eba674a5-b220-4ef1-9f3a-b9ff3f08a959/files/survey-guidelines-reptiles.pdf.

Department of Sustainability Environment Water Population and Communities. 2012. *Species Profile and Threats Database*. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl. [May 2012].

Department of the Environment and Energy. 2016. *Australia's bioregions (IBRA)*. Available from: https://www.environment.gov.au/land/nrs/science/ibra. [July 2016].

Department of the Environment and Energy. 2019. *SPRAT EPBC Migratory Species Lists in Species Profiles and Threats Database*. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowmigratory.pl.

Department of the Environment Water Heritage and the Arts. 2010a. *Survey guidelines for Australia's threatened bats*. Available from: http://www.environment.gov.au/system/files/resources/2f420bf1-d9e4-44ec-a69c-07316cb81086/files/survey-guidelines-bats.pdf.

Department of the Environment Water Heritage and the Arts. 2010b. *Survey guidelines for Australia's threatened birds*. Available from: https://www.environment.gov.au/system/files/resources/107052eb-2041-45b9-9296-b5f514493ae0/files/survey-guidelines-birds-april-2017.pdf.

Dunlop, J.N. & Pound, I.R. 1981. Observations on the Pebble-mound Mouse *Pseudomys chapmani* Kitchener, 1980. *Records of the Western Australian Museum*, vol. 9, no. 1, pp. 1-5

Eamus, D. 2009a, *A review of the report written by Frank Batini entitled "Eucalyptus victrix, Karijini National Park"*, Unpublished report for Rio Tinto Iron Ore.

Eamus, D. 2009b. *Identifying groundwater dependent ecosystems: a guide for land and water managers*. Available from: http://lwa.gov.au/files/products/innovation/pn30129/pn30129_1.pdf.

Eamus, D., Froend, R., Loomes, R., Hose, G., & Murray, B. 2006. A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany*, vol. 54, pp. 97-114

Ecologia. 2013. North Star Magnetite Project – Environmental Scoping Document .

Ecologia Environment 2011a, *North Star. Level 2 Vertebrate Fauna Assessment*, Unpublished report for Fortescue Metals Group.

Ecologia Environment 2011b, *North Star. Targeted Conservation Significant Fauna Survey*, Unpublished report for Fortescue Metals Group.

Ecologia Environment 2012a, *North Star Access Corridor Flora, Vegetation, Vertebrate Fauna and Fauna Habitat Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2012b, *North Star Vegetation and Flora Assessment*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2012c, *Pityrodia sp. Marble Bar Targeted Flora Survey*, Unpublished report for Fortescue Metals Group Ltd.

Ecologia Environment 2014, *North Star Hematite Project. EPBC listed Threatened Fauna Monitoring Report. Unpublished report for Fortescue Metals Group*.

Ecologia Environment 2015, *North Star Slurry and Infrastructure Corridors Conservation Significant Flora and Vegetation Assessment*, Unpublished report for Iron Bridge and Fortescue Metals Group.

Ecologia Environment 2016, *Iron Bridge North Star Stage 2 Pityrodia sp. Marble Bar Regional Survey 2015*, Unpublished report for FMG Iron Bridge (Aust) Pty Ltd.

Ecoscape (Australia) Pty Ltd 2015, *North Star Pilbara Olive Python Monitoring. Unpublished report for Fortescue Metals Group*.

Ecoscape (Australia) Pty Ltd 2016, *Conservation Significant Fauna Monitoring 2015/2016 - Operations*, Unpublished report for Fortescue Metals Group.

Environmental Protection Authority. 2016a. *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment*. Available from: http://www.epa.wa.gov.au/policies-guidance/technical-guidance-flora-and-vegetation-surveys-environmental-impact-assessment.

Environmental Protection Authority. 2016b. *Technical Guidance - Sampling Methods for Terrestrial Vertebrate Fauna*. Available from: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Sampling-TV-fauna-Dec2016.pdf.

Environmental Protection Authority. 2020a. *Statement of Environmental Principles, Factors and Objectives*. Available from:

https://epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Statement%20of%20Environmental%20Principles%20-%2003.04.2020_0.pdf.

Environmental Protection Authority. 2020b. *Technical Guidance - Terrestrial vertebrate fauna surveys for environmental impact assessment*. Available from: https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/EPA-Technical-Guidance-Vertebrate-Fauna-Surveys.pdf.

Environmental Protection Authority & Hamersley Iron Pty Ltd 2010, *Marandoo Mine Phase 2: Report and recommendations of the Environmental Protection Authority*, Environmental Protection Authority, Perth, Western Australia.

Equinox Environmental 2017, *Christmas Creek vegetation health investigation*, Unpublished report for Fortescue Metals Group Limited, CC-EN-0319.

Fortescue Metals Group Limited 2014, *Flora and Vegetation Assessment Guidelines 100 GU-EN-0005, 5 February 2014*, Fortescue Metals Group Limited.

Fortescue Metals Group Ltd 2011, *Terrestrial Vertebrate Fauna Assessment Guidelines. Environment* 100-GU-EN-0006.

Geoscience Australia. 2017. *Surface Geology of Australia 1:1 million scale dataset 2012 edition*. Available from: https://data.gov.au/data/dataset/surface-geology-of-australia-1-1-million-scale-dataset-2012-edition.

Goulburn-Murray Water. 2010. *Groundwater. Terms and definitions*. Available from: http://www.g-mwater.com.au/downloads/Groundwater/2977263-v5-GROUNDWATER_TERMS_AND_DEFINITIONS_GLOSS-1.pdf.

Government of Western Australia. *Environmental Protection Act 1986.*

Government of Western Australia. *Animal Welfare Act 2002.*

Government of Western Australia. *Environmental Protection (Environmentally Sensitive Areas) Notice 2005.*

Government of Western Australia. *Biosecurity and Agriculture Management Act 2007.*

Government of Western Australia. *Biodiversity Conservation Act 2016.*

Government of Western Australia. 2018a. *About the Conservation and Parks Commission*. Available from: https://www.conservation.wa.gov.au/.

Government of Western Australia. 2018b. *Government Gazette No. 135, 11 September 2018*. Available from: https://www.slp.wa.gov.au/gazette/gazette.nsf/searchgazette/EF556EEFA23C70FA482583040013E0FC/$file/Gg135.pdf.

Government of Western Australia. 2019. *2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Full Report). Current as of March 2019*. Available from: https://catalogue.data.wa.gov.au/dataset/dbca-statewide-vegetation-statistics.

Grierson, P. 2010, Ecological water requirements of riparian vegetation, *In Kwongan Workshop 2010: On the ecology of WA's arid zone*, University of Western Australia.

Hatton, T. & Evans, R. 1998, *Dependence of ecosystems on groundwater and its significance to Australia*, Land and Water Research and Development Corporation (Australia), Occasional Paper No. 12/98, Canberra, ACT.

Kitchener, D. J. 1983, "Pebble-mound Mouse *Pseudomys chapmani*," in *Complete book of Australian mammals*, R. Strahan ed., Angus and Robertson.

Leighton, K. A. 2004, "Climate," in *Technical Bulletin 92 - An inventory and condition survey of the Pilbara region, Western Australia*, Western Australian Department of Agriculture, Perth, pp. 19-38.

Markey, A. 2016, *Floristic Survey and Mapping of the Riparian and Halophyte Dominated Communities on the Fortescue Marsh (Martuyitha), Western Australia - DRAFT*, Department of Parks & Wildlife Science and Conservation Division.

Maunsell Australia Pty Ltd 2006, *Pit Dewatering and Vegetation Monitoring Plan - Iron Ore Mine and Downstream Processing, Cape Preston, Western Australia*, Unpublished report prepared for Mineralogy Pty Ltd.

McKenzie, N.L., van Leeuwen, S., & Pinder, A.M. 2009. Introduction to the Pilbara Biodiversity Survey, 2002–2007. *Records of the Western Australian Museum, Supplement*, vol. 78, pp. 3-89

Mineral Resources 2019, *Wodgina Lithium Project: Construction Environment Plan - Public Disclosure Document*.

NVIS Technical Working Group 2017, *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 7.0*, Department of the Environment and Energy, Canberra.

Office of the Appeals Convenor. 2016a. *Ministerial Statement No. 1038. Statement that a proposal may be implemented (Environmental Protection Act 1986) Yandicoogina Iron Ore Project - revised proposal*. Available from: http://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%20No.%201038.pdf.

Office of the Appeals Convenor. 2016b. *Ministerial Statement No. 1044. Statement that a proposal may be implemented (Environmental Protection Act 1986) Revised Iron Valley Iron Ore Project*. Available from: http://www.epa.wa.gov.au/sites/default/files/1MINSTAT/Statement%20No.1044.pdf.

Peel, M.C., Finlayson, B.L., & McMahon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, vol. 11, pp. 1633-1644

Resource and Environmental Management Pty Ltd 2007, *Pirraburdoo Creek Groundwater Dependent Ecosystems study*, Unpublished report for Pilbara Iron.

Rio Tinto 2016, *Yandicoogina Pocket and Billiard South: detailed responses to public submissions in relation to flora and vegetation*.

Shepherd, D.P., Beeston, G.R., & Hopkins, A.J.M. 2002. Native Vegetation in Western Australia: Extent, Type and Status. *Resource Management Technical Report 249*

Specialised Zoological 2020, *Acoustic analysis and bat call identification from Pippingarra, Western Australia Acoustic analysis and bat call identification from Pippingarra, Western Australia*, Unpublished report prepared for Ecoscape (Australia) Pty Ltd.

Species and Communities Program & Department of Biodiversity Conservation and Attactions. 2020. *Priority Ecological Communties for Western Australia Version 29. 5 May 2020*. Available from:

https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/Priority%20Ecological%20Communities%20list.pdf.

Threatened Species Scientific Committee. 2005. *Commonwealth Listing Advice on Northern Quoll (Dasyurus hallucatus)*. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=331.

Threatened Species Scientific Committee. 2016. *Conservation Advice Pezoporus occidentalis night parrot*. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/59350-conservation-advice-15072016.pdf.

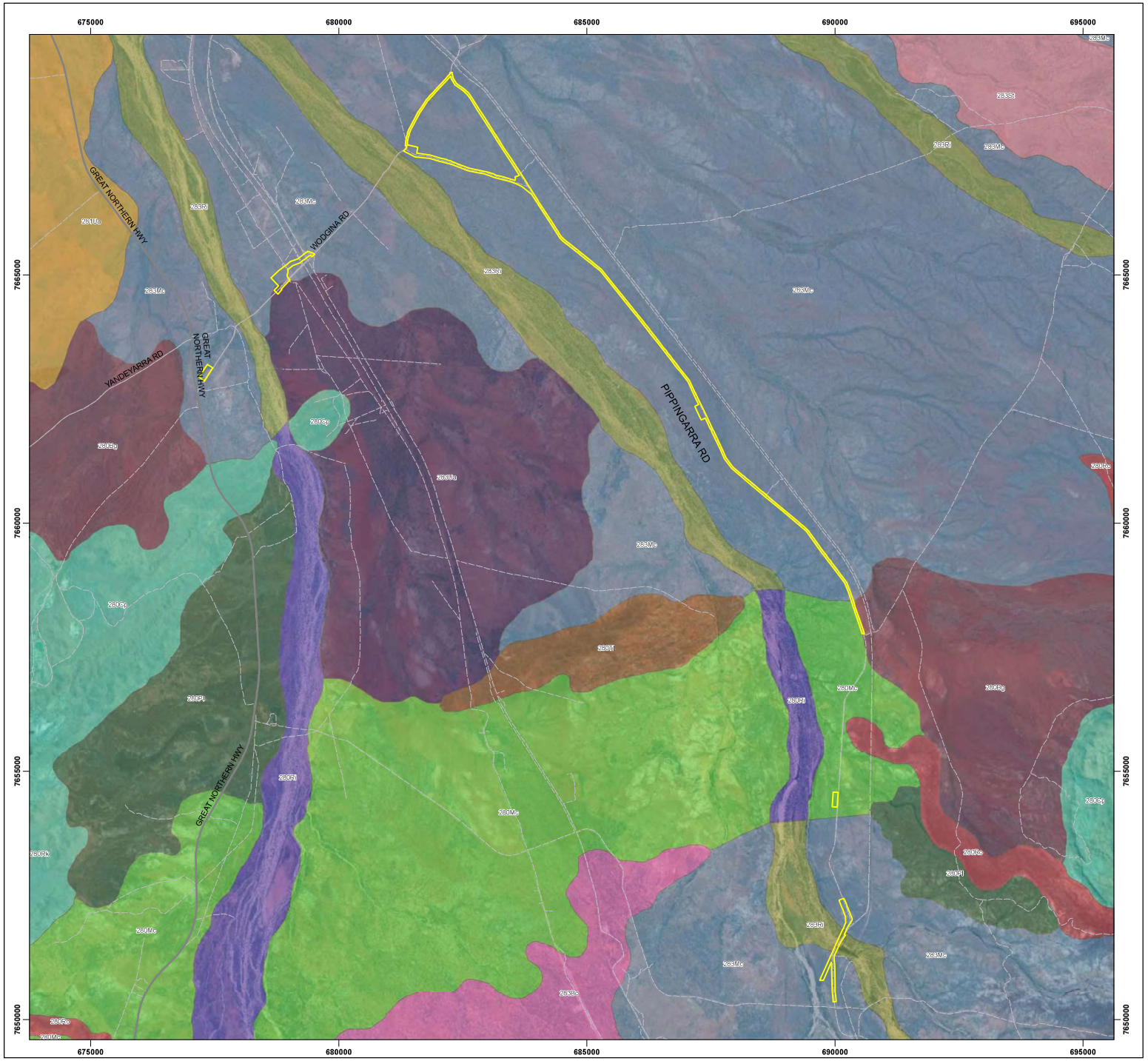
Walker, J. & Hopkins, M. 1990, "Vegetation," in *Australian Soil and Land Survey. Field Handbook.*, 2nd edn, R. McDonald et al. eds., Inkata Press, Melbourne.

Weeds Australia. 2012. *Weeds of National Significance*. Available from: http://www.weeds.org.au/WoNS/.

Western Australian Herbarium. 1998. *FloraBase - the Western Australian Flora. Department of Biodiversity, Conservation and Attractions*. Available from: https://florabase.dpaw.wa.gov.au/.

Western Australian Herbarium. 2019. *FloraBase: Descriptions by the Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions. Text used with permission*. Available from: https://florabase.dpaw.wa.gov.au/help/copyright.

MAPS



LEGEND

Survey Area

Soil Land Systems (DPIRD 2018)

- 280Bg: Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands.
- 280Cp: Rugged sandstone hills, ridges, stony footslopes and interfluves supporting low acacia shrublands or hard spinifex grasslands with scattered shrubs.
- 280Mc: Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.
- 280Pl: Dissected slopes and raised plains supporting shrubby hard spinifex grasslands.
- 280Ri: Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.
- 280Rk: Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex and occasionally soft spinifex grasslands with scattered shrubs.
- 280Ro: Low plateaux, mesas and buttes of limonite supporting soft spinifex and occasionally hard spinifex grasslands.
- 280Tl: Hills and ridges of greenstone and chert and stony plains supporting hard and soft spinifex grasslands.
- 281Ua: Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.
- 283Bo: Granite hills, domes, tor fields and sandy plains supporting spinifex grasslands with scattered shrubs.
- 283Mc: Stony plains and occasional tor fields based on granite supporting hard and soft spinifex shrubby grasslands.
- 283Ri: Narrow, seasonally active flood plains and major river channels supporting moderately close, tall shrublands or woodlands of acacias and fringing communities of eucalypts sometimes with tussock grasses or spinifex.
- 283St: Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands.
- 283Ua: Broad sandy plains, pebbly plains and drainage tracts supporting hard and soft spinifex hummock grasslands with scattered acacia shrubs.

State Road

Local Road

FMG Access Track

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LAND SYSTEMS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

DATASOURCES
SOURCE DATA: SOIL LANDSCAPE DATA DPIRD 2018; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER

Fortescue The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

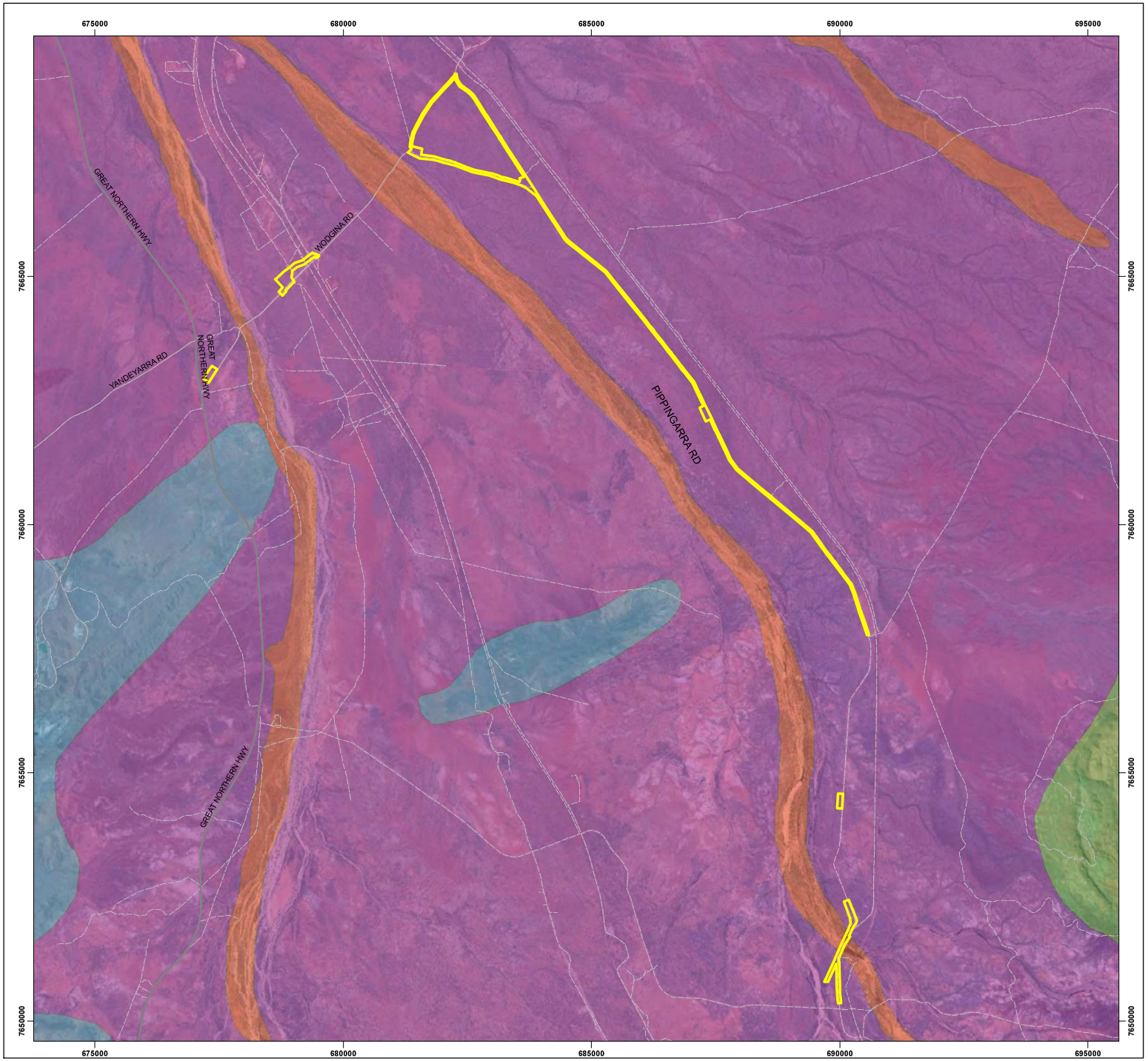
SCALE: 1:75,000 @ A3

0 1 2 km

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	27/07/2020

MAP 1



LEGEND

- Survey Area

Pre European Vegetation (DPIRD, 2018)

- 82: Hummock grassland with scattered bloodwoods & snappy gum Triodia spp., Corymbia dichromophloia, Eucalyptus leucophloia
- 93: Hummock grassland with scattered shrubs or mallee Triodia spp. Acacia spp., Grevillea spp. Eucalyptus spp
- 619: Wheatbelt; York gum, salmon gum etc. Eucalyptus loxophleba, E. salmonophloia. Goldfields; gimlet, redwood etc. E. salubris, E. oleosa. Riverine; rivergum E. camaldulensis. Tropical; messmate, woolyb
- 626: Hummock grassland with sparse shrubs Triodia spp. Acacia spp.
- State Road
- Local Road
- FMG Access Track

DATA SOURCES
SOURCE DATA: SOIL, LANDSCAPE DATA DPIRD 2018; STATE AND LOCAL ROADS DATA MRWA 2012; ACCESS TRACKS DATA FMG 2020.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, DIGITALGLOBE, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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PRE EUROPEAN VEGETATION

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

FMG Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

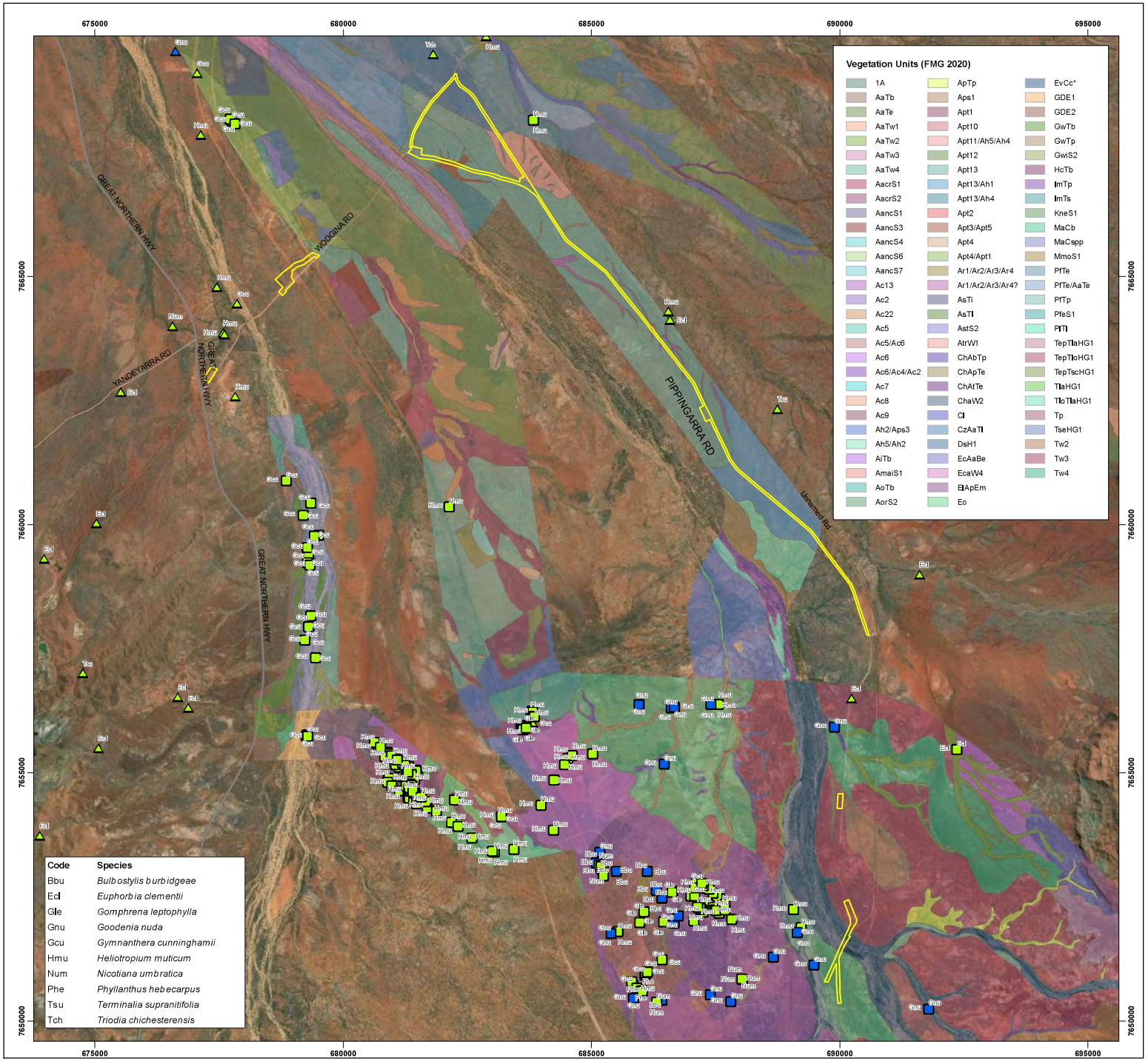
SCALE: 1:75,000 @ A3

0 1 2 km

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	27/07/2020

MAP
2



LEGEND

- Survey Area

Conservation Listed Flora (FMG 2020)

- Priority 3
- Priority 4

Conservation Listed Flora (DBCA 2020)

- Priority 3
- Priority 4
- State Road
- Local Road

DATA SOURCES

SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; VEGETATION UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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FLORA & VEGETATION DATABASE SEARCH RESULTS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

FMG Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

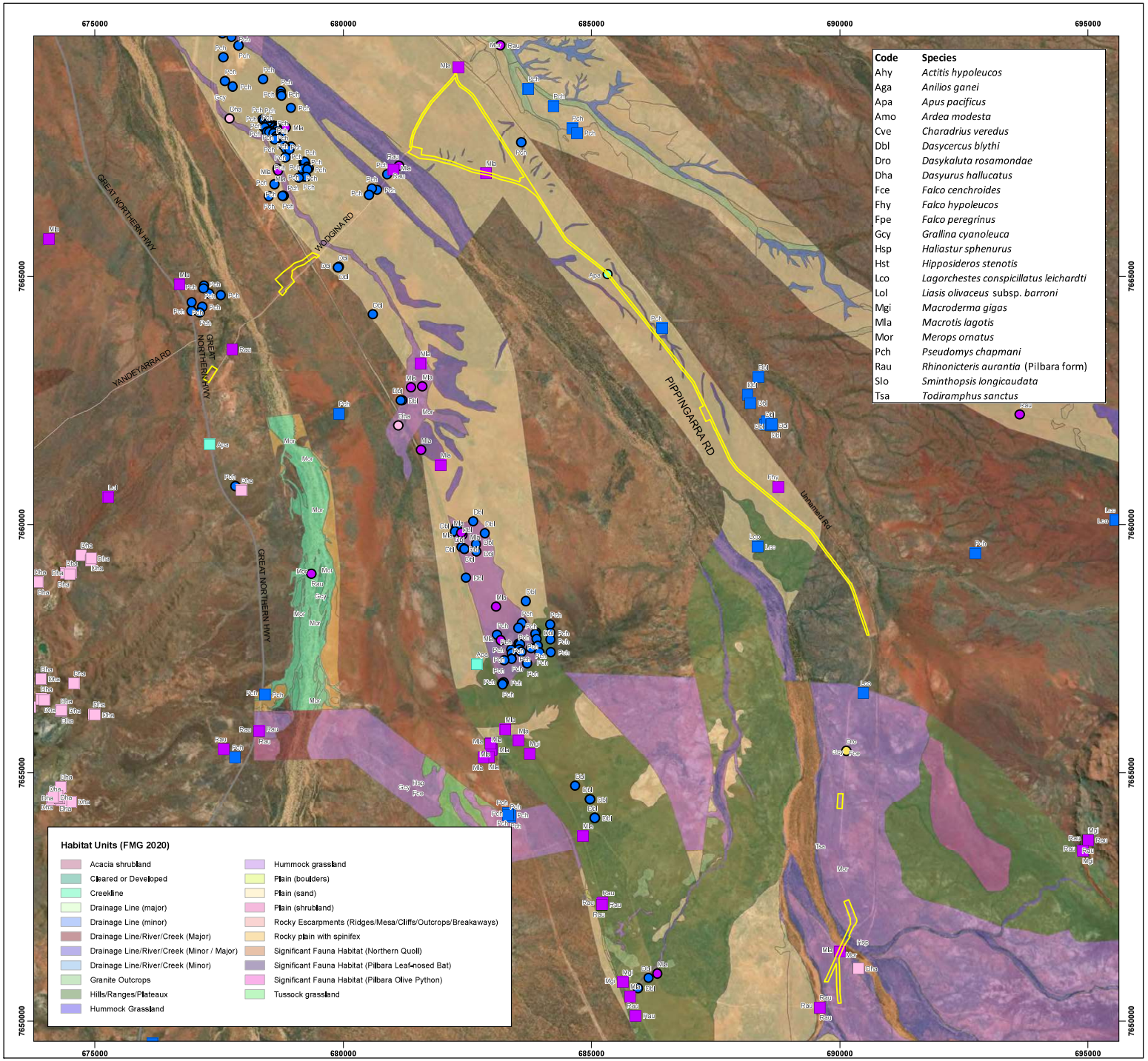
SCALE: 1:75,000 @ A3

0 1 2 km

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	27/07/2020

MAP 3



LEGEND

- Survey Area

Conservation Significant Fauna (DBCA 2020)

- Endangered
- Vulnerable
- Migratory Species
- Priority 4

Conservation Significant Fauna (FMG 2020)

- Endangered
- Vulnerable
- Migratory Species
- Priority 4
- Other (Local endemism/restricted distribution - GS56)
- State Road
- Local Road

DATA SOURCES

SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

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FAUNA & HABITAT DATABASE SEARCH RESULTS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

Fortescue
The New Force in Iron Ore

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:75,000 @ A3

0 1 2 km

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	27/07/2020

MAP 04

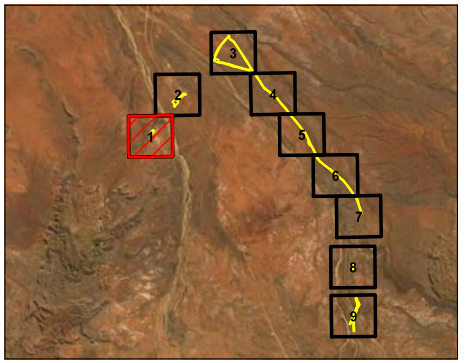
LEGEND

- Survey Area
- Quadrat Locations

Vegetation Types

- AoTw: *Acacia orthocarpa* and *A. inaequilatera* tall sparse shrubland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



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VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5A

LEGEND

- Survey Area
- Quadrat Locations

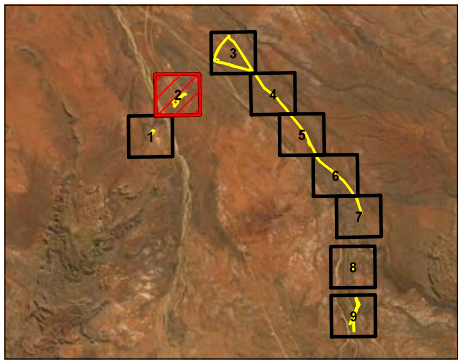
Conservation Listed Flora

- Priority 3

Vegetation Types

- AaTl: *Acacia ancistrocarpa* tall sparse shrubland.
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



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VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

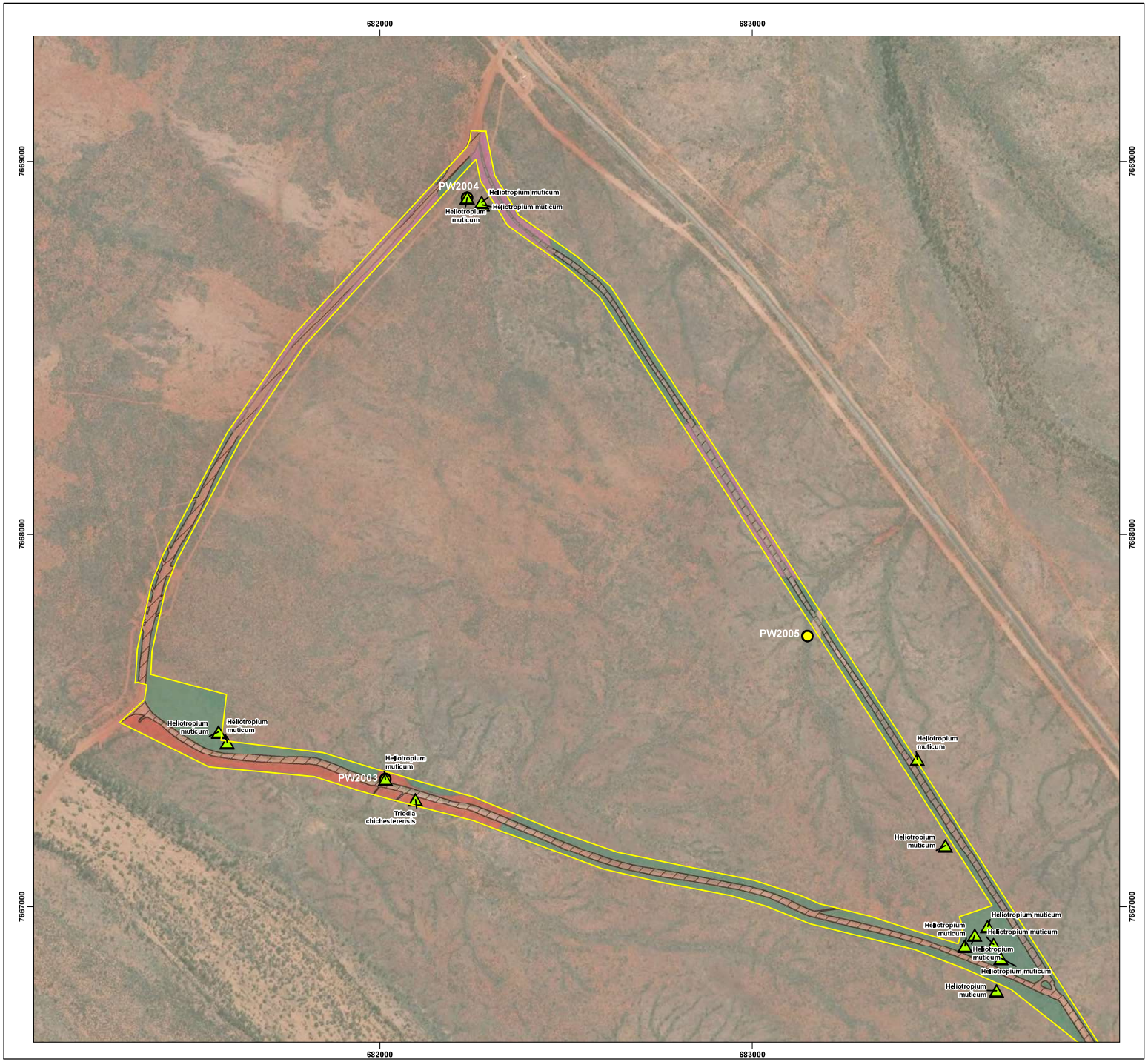
COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5B



LEGEND

- Survey Area
- Quadrat Locations

Conservation Listed Flora

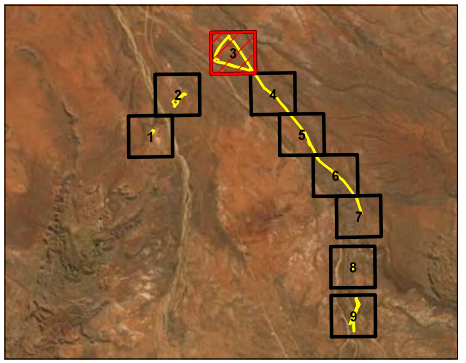
- Priority 3

Vegetation Types

- AaTl: *Acacia ancistrocarpa* tall sparse shrubland.
- AiTw: *Acacia inaequilatera* tall sparse shrubland
- ChAtTe: *Corymbia hamersleyana* low open woodland
- CzAaTl: *Corymbia zygophylla* low open woodland
- NV: Cleared/Not Vegetated

DATA SOURCES

SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 5C

LEGEND

Survey Area

Conservation Listed Flora

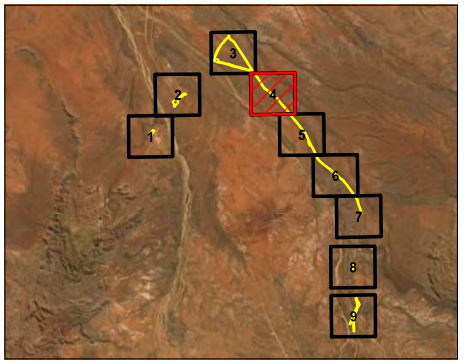
Priority 3

Vegetation Types

AaTl: *Acacia ancistrocarpa* tall sparse shrubland.

NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

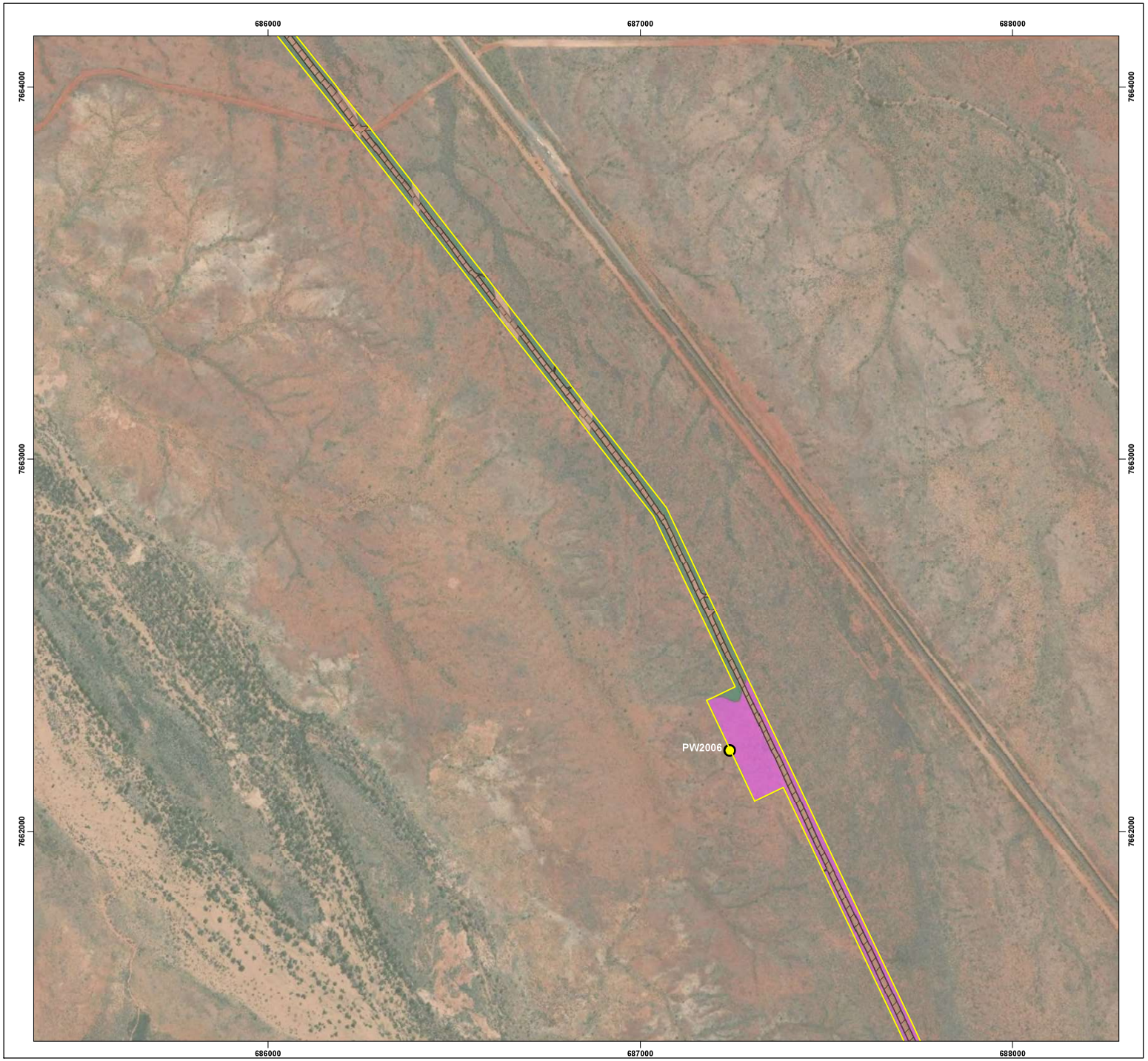
N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5D



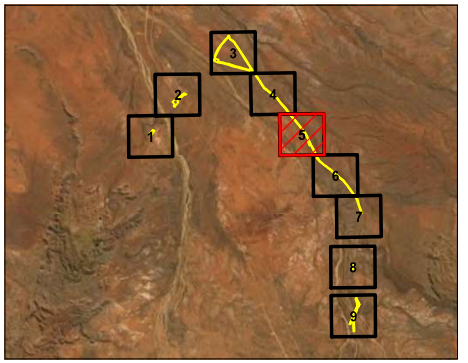
LEGEND

- Survey Area
- Quadrat Locations

Vegetation Types

- AaTl: *Acacia ancistrocarpa* tall sparse shrubland.
- AaTw: *Acacia acradenia* and *Grevillea wickhamii* mid open shrubland
- ChAtTe: *Corymbia hamersleyana* low open woodland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5E

LEGEND

- Survey Area
- Quadrat Locations

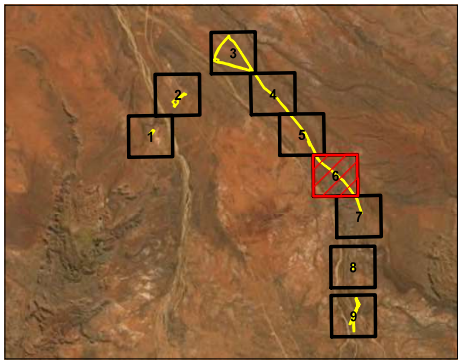
Conservation Listed Flora

- Priority 3

Vegetation Types

- AaTl: *Acacia ancistrocarpa* tall sparse shrubland.
- AaTw: *Acacia acradenia* and *Grevillea wickhamii* mid open shrubland
- ChAbTc: *Corymbia hamersleyana* low open woodland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 5F

LEGEND

- Survey Area
- Quadrat Locations

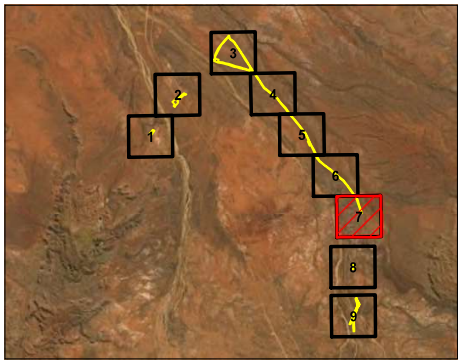
Conservation Listed Flora

- Priority 3

Vegetation Types

- AaTl: *Acacia ancistrocarpa* tall sparse shrubland.
- AoTw: *Acacia orthocarpa* and *A. inaequilatera* tall sparse shrubland
- ChAbTc: *Corymbia hamersleyana* low open woodland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

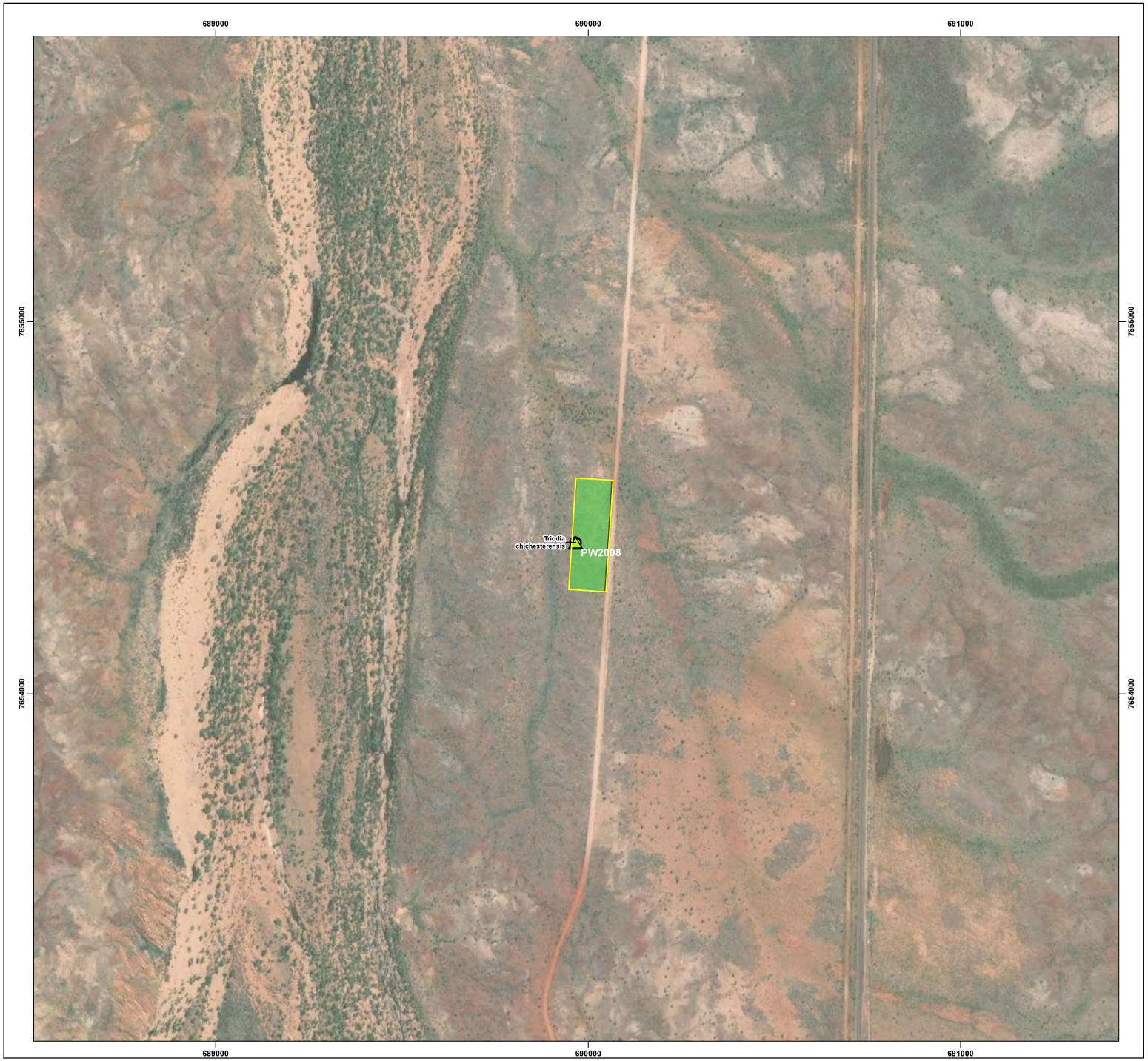
N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5G



LEGEND

- Survey Area
- Quadrat Locations

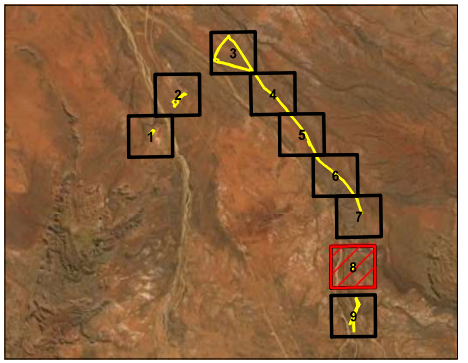
Conservation Listed Flora

- Priority 3

Vegetation Types

- ChAiTc: *Corymbia hamersleyana* low open woodland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
5H

LEGEND

- Survey Area
- Quadrat Locations

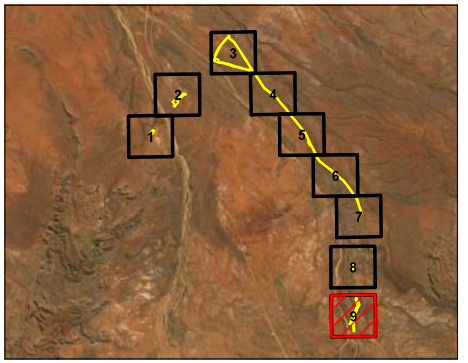
Conservation Listed Flora

- Priority 3

Vegetation Types

- AiTw: *Acacia inaequilatera* tall sparse shrubland
- ChAbTc: *Corymbia hamersleyana* low open woodland
- EcAtCc: *Eucalyptus camaldulensis* subsp. *refulgens* and *Eucalyptus victrix* mid woodland
- NV: Cleared/Not Vegetated

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION TYPES AND QUADRATS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

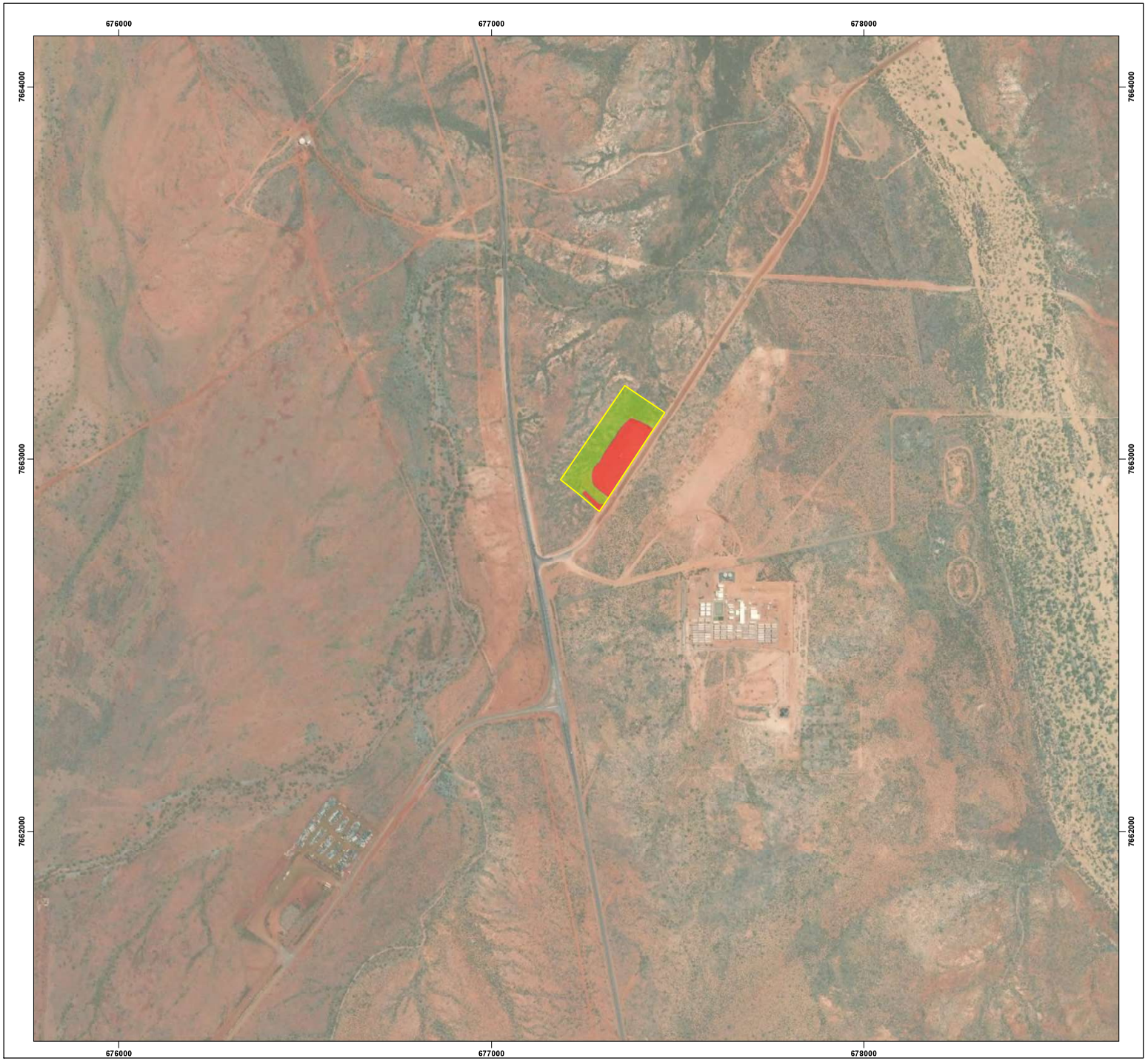
COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 5I



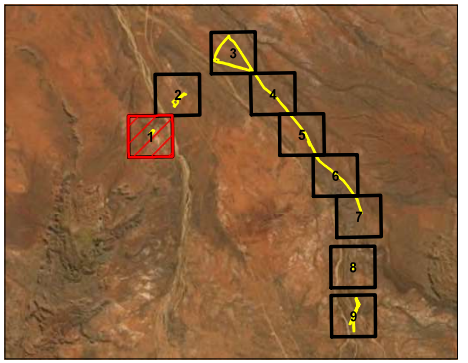
LEGEND

- Survey Area

Vegetation Condition

- Very Good
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6A

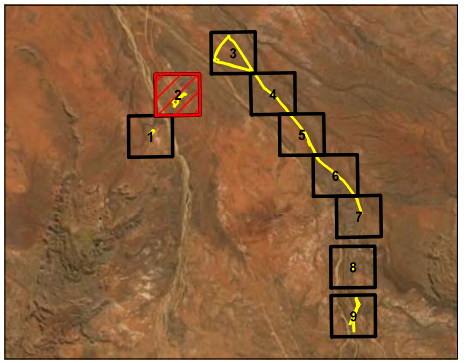
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Very Good
- Poor
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 6B

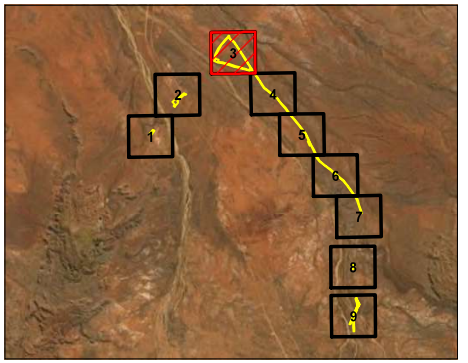
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Very Good
- Good
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

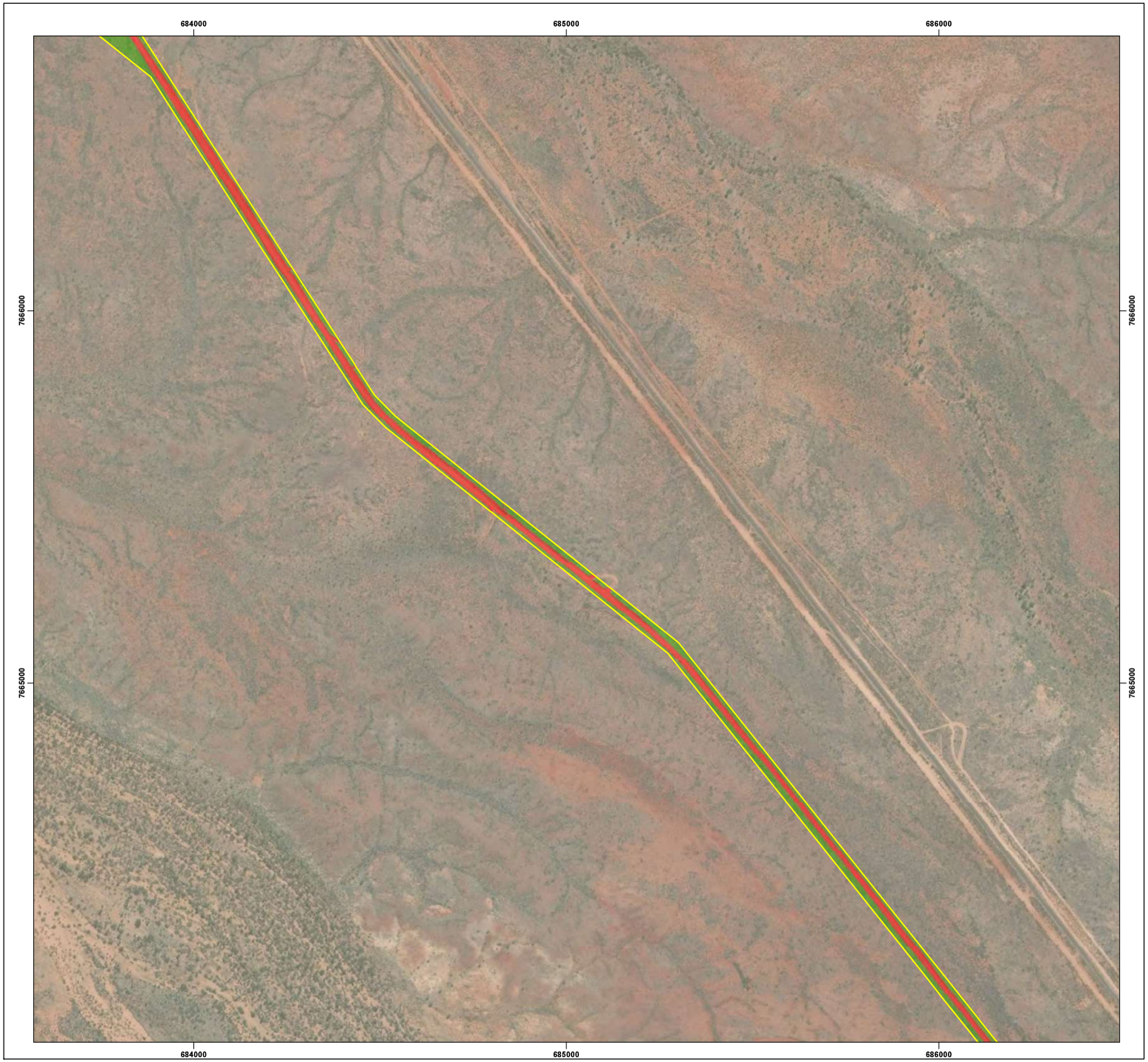
COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 6C



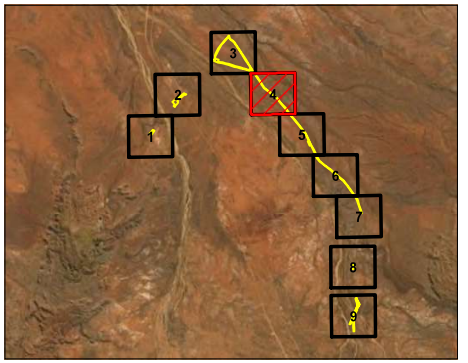
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6D

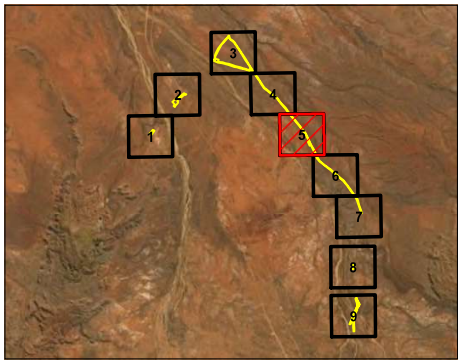
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6E

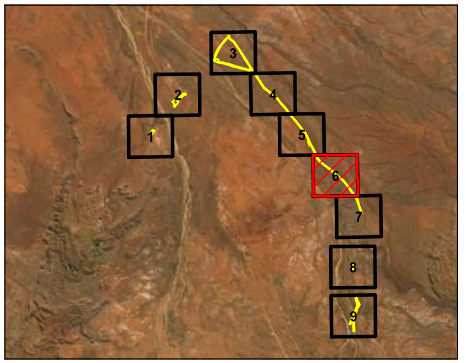
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6F

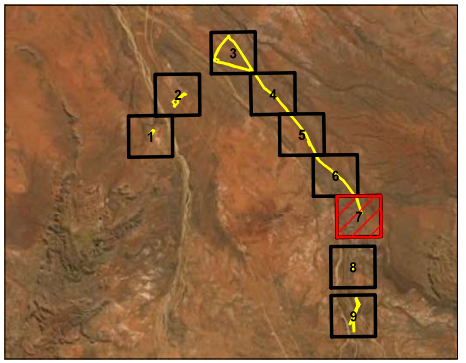
LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

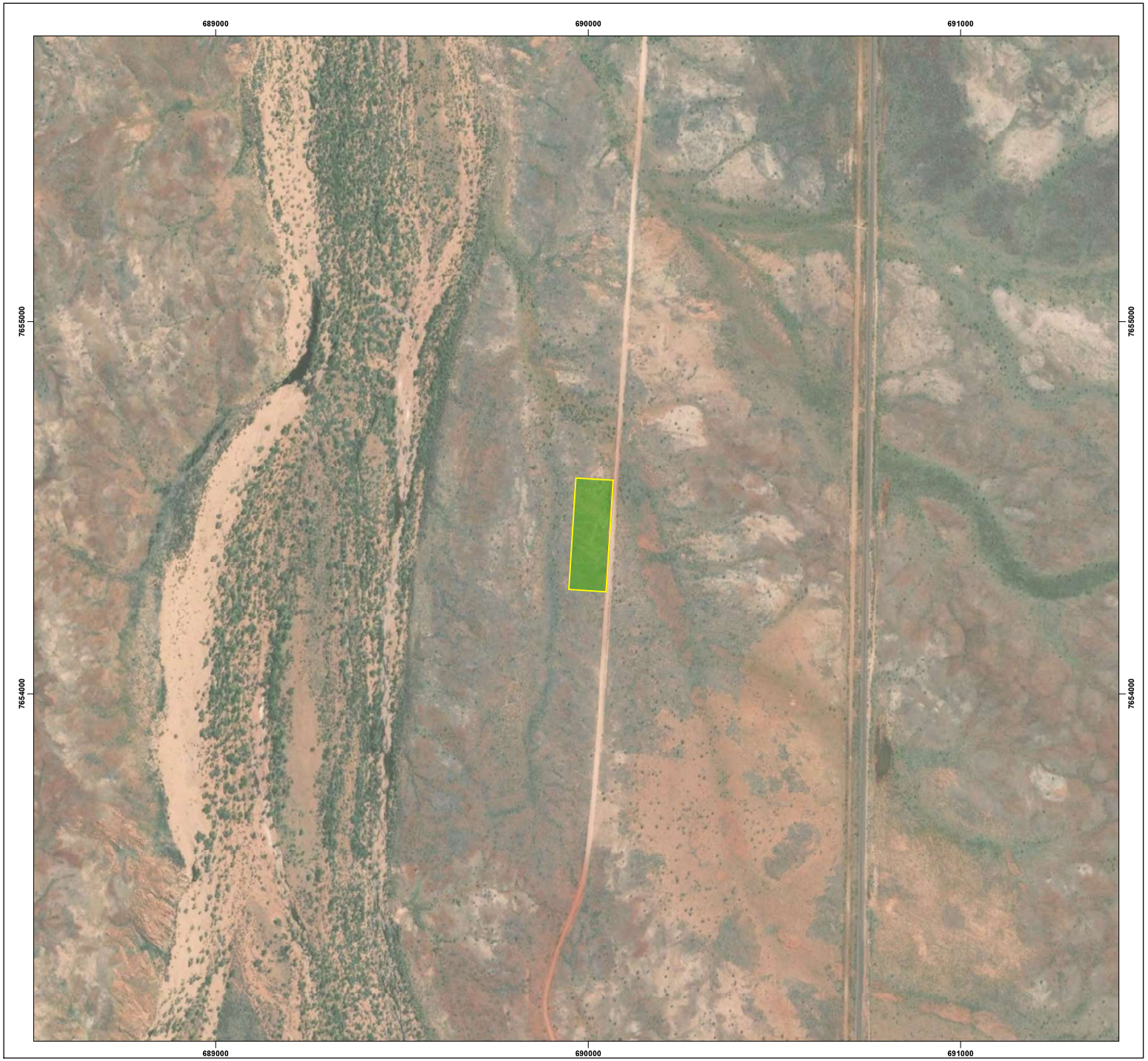
SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6G



LEGEND

- Survey Area

Vegetation Condition

- Excellent
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
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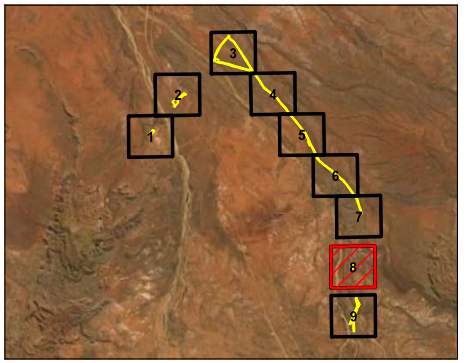


ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

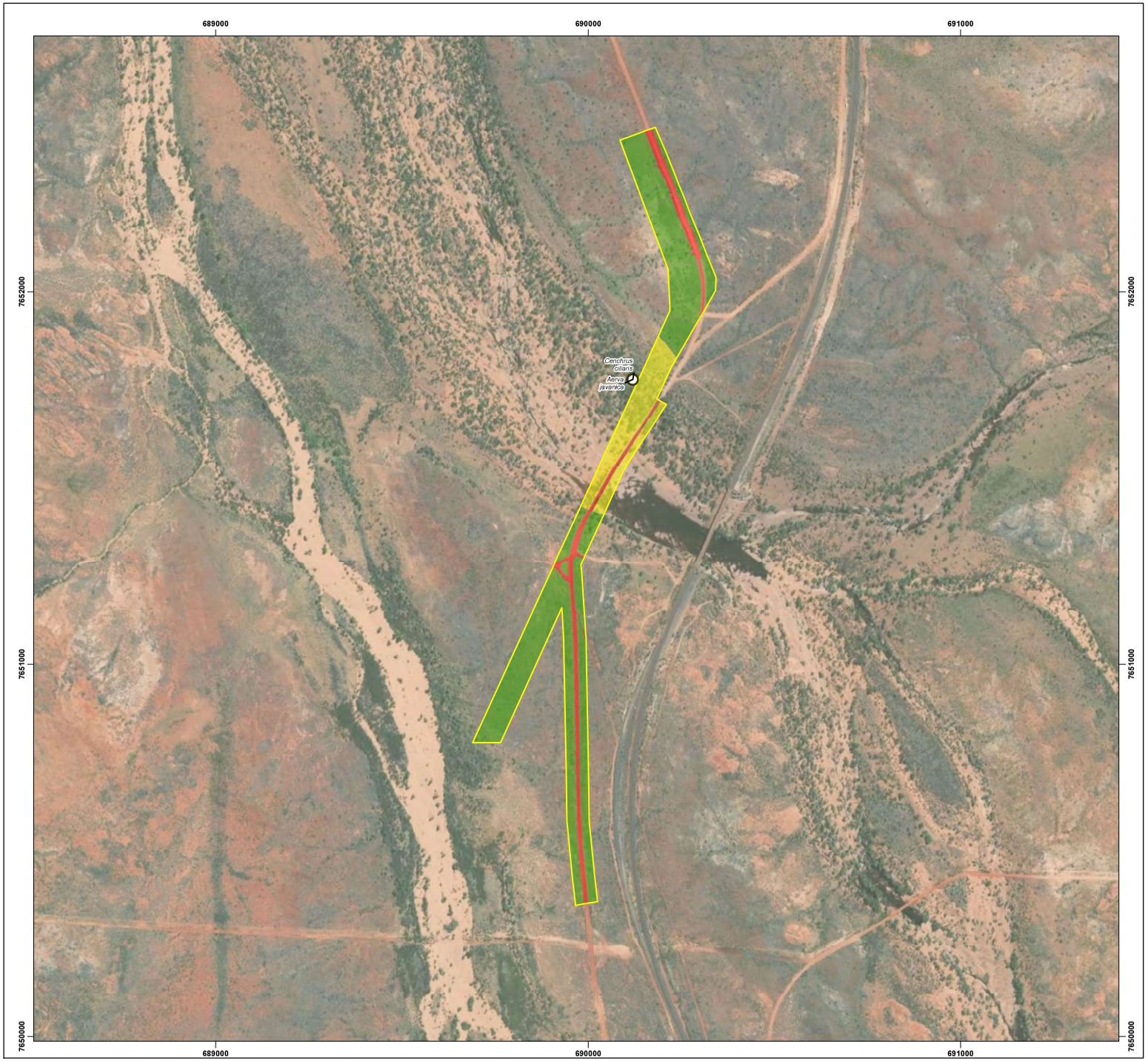
COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP
6H



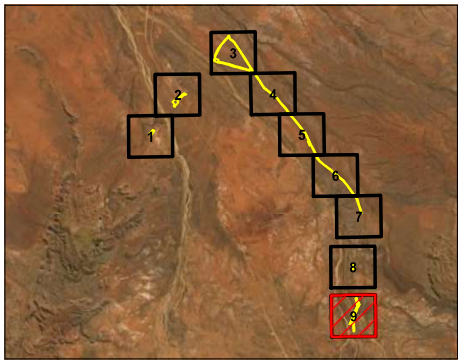
LEGEND

- Weeds
- Survey Area

Vegetation Condition

- Excellent
- Good
- Completely Degraded

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

VEGETATION CONDITION AND WEEDS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	TJ	SK	22/06/2020

MAP 6I

LEGEND

- Survey Area

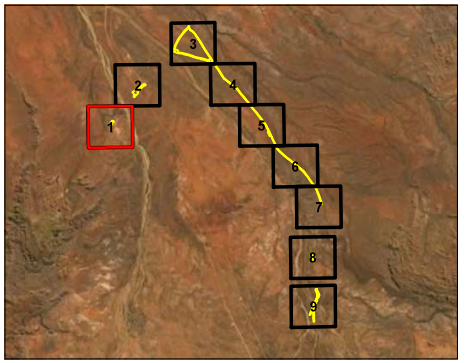
Habitat Survey Points

- Habitat Assessment

Habitat Types

- Cleared/Not Vegetated
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7A

LEGEND

- Survey Area

Habitat Survey Points

- Habitat Assessment
- Motion Camera
- Sound Recorded (Anabat / SM2)

Habitat Types

- Cleared/Not Vegetated
- Hummock Grasslands

DATA SOURCES

SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7B

LEGEND

- Survey Area

Habitat Survey Points

- Burrow / Mound
- Habitat Assessment
- Motion Camera
- Ornithological Survey
- Sound Recorded (Anabat / SM2)

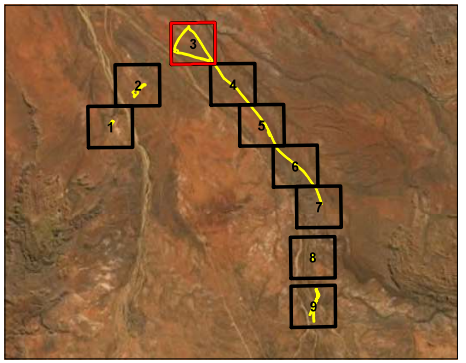
Conservation Listed Fauna

- Priority 4: Western Pebble-mound Mouse

Habitat Types

- Cleared/Not Vegetated
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7C

LEGEND

Survey Area

Habitat Types

Cleared/Not Vegetated

Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY

ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7D

LEGEND

- Survey Area

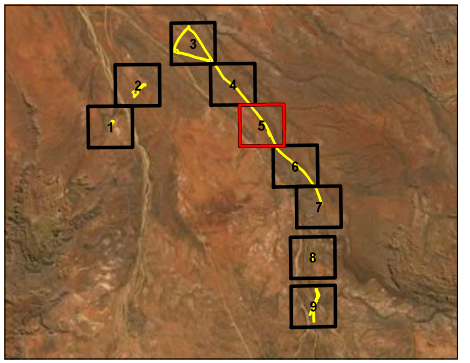
Habitat Survey Points

- Habitat Assessment

Habitat Types

- Cleared/Not Vegetated
- Creekline
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7E

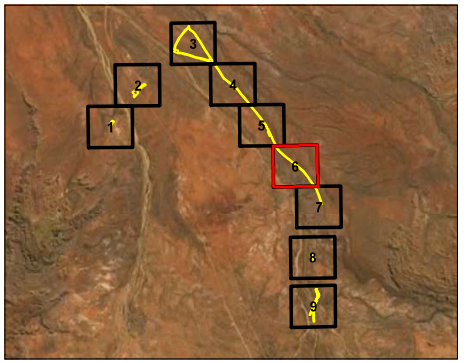
LEGEND

- Survey Area

Habitat Types

- Cleared/Not Vegetated
- Creekline
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

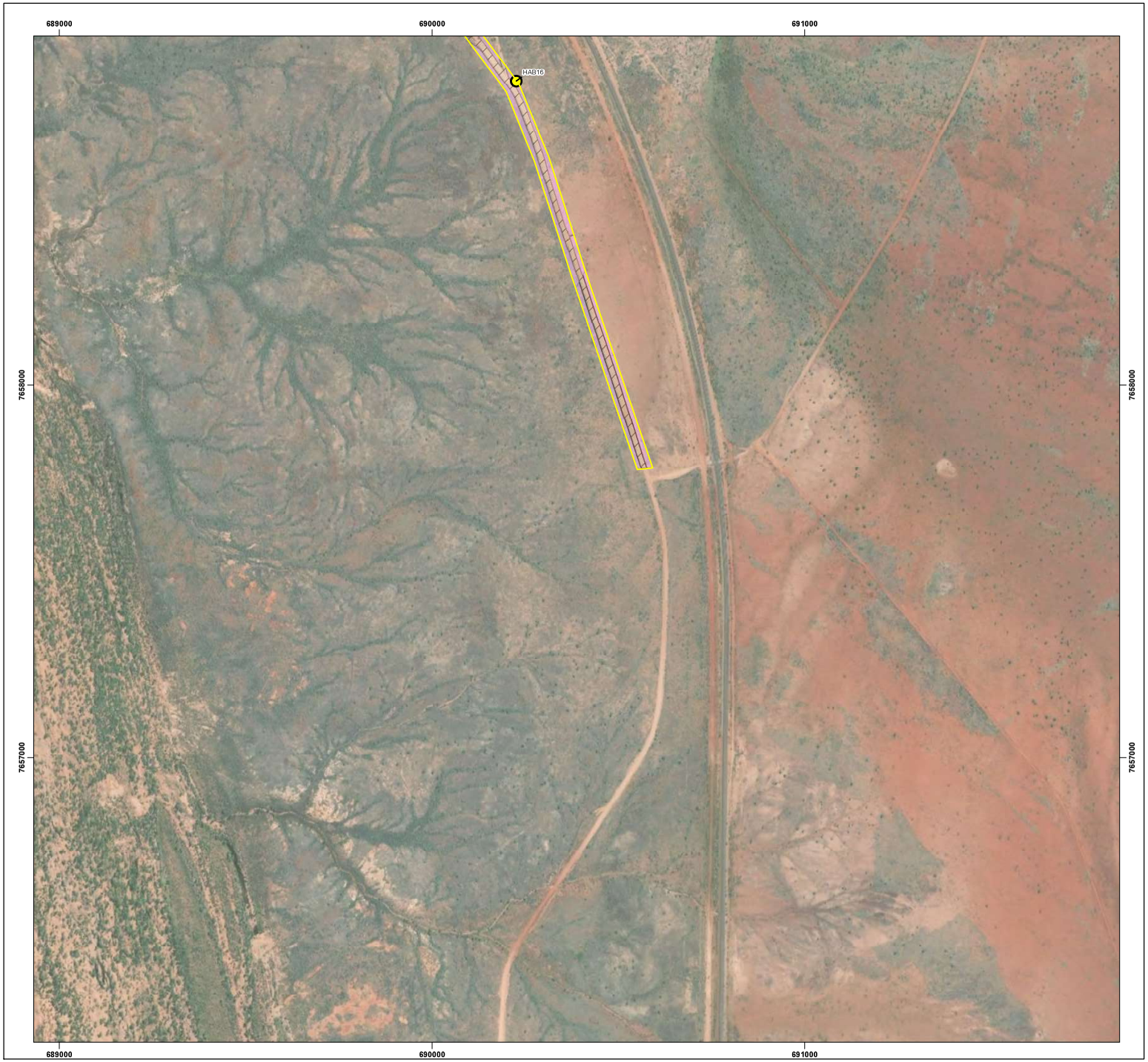
N

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7F



LEGEND

- Survey Area

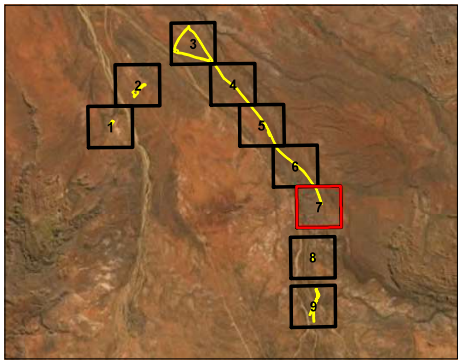
Habitat Survey Points

- Habitat Assessment

Habitat Types

- Cleared/Not Vegetated
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

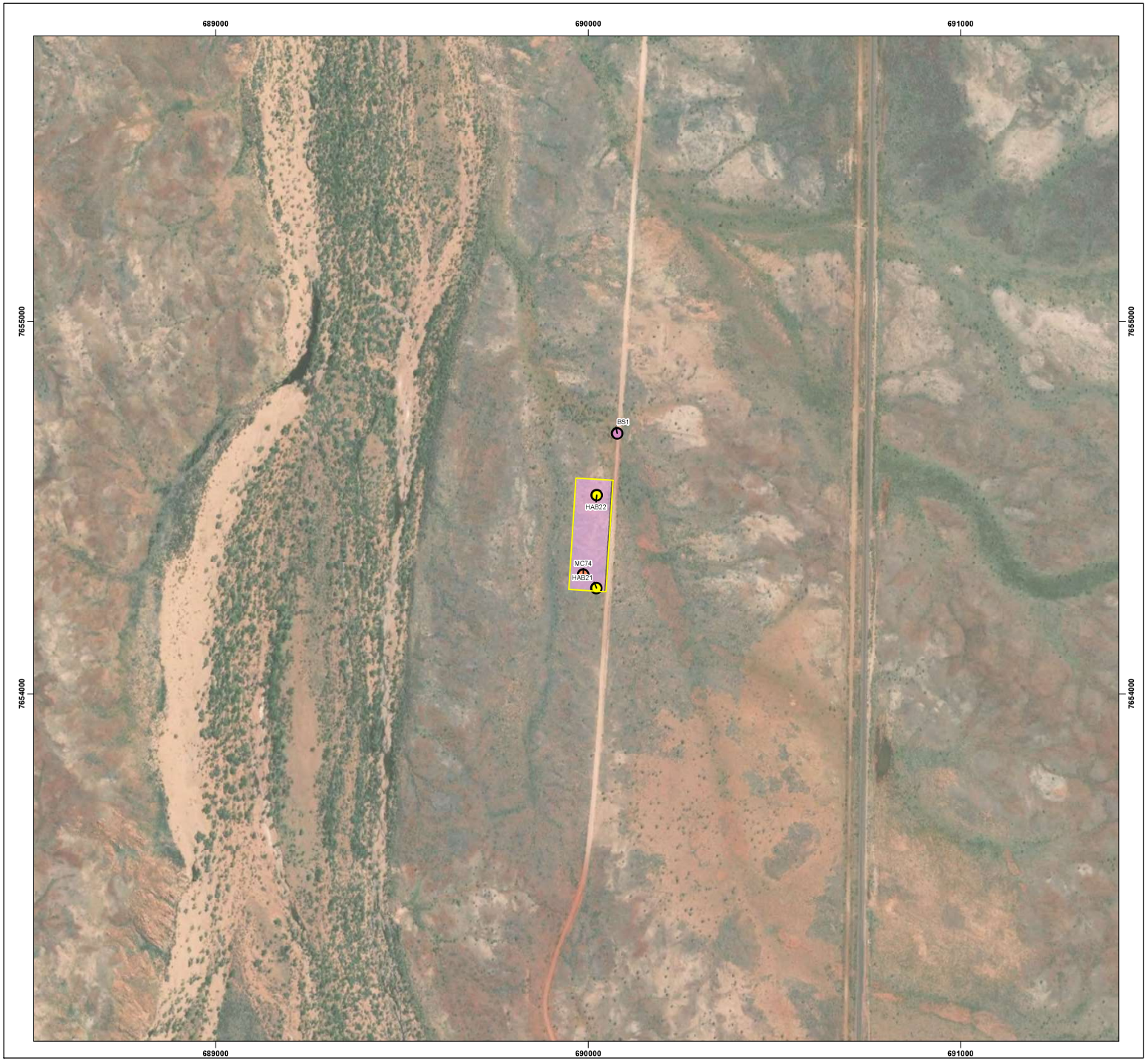
SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP
7G



LEGEND

- Survey Area

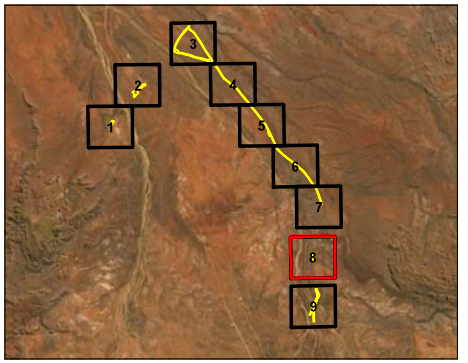
Habitat Survey Points

- Habitat Assessment
- Motion Camera
- Ornithological Survey

Habitat Types

- Cleared/Not Vegetated
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

N

PROJECT NO: 4537-20

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00	JT	SK	20/07/2020

MAP
7H

LEGEND

- Survey Area

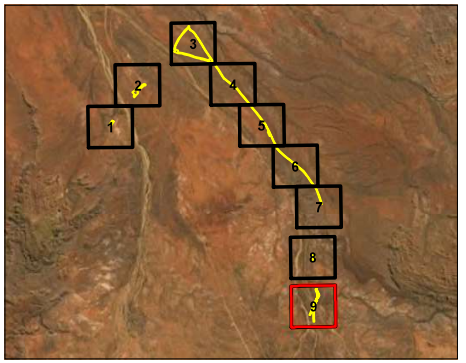
Habitat Survey Points

- Habitat Assessment
- Motion Camera
- Sound Recorded (Anabat / SM2)

Habitat Types

- Cleared/Not Vegetated
- Creekline
- Hummock Grasslands

DATA SOURCES
SOURCE DATA: CSF DATA FMG 2020 AND DBCA 2020; HABITAT UNIT DATA FMG 2020; STATE AND LOCAL ROADS DATA MRWA 2012.
AERIAL: ESRI BASEMAP 2018-2019
BASEMAP: GEOSCIENCE AUSTRALIA
SERVICE LAYERS: SOURCE: ESRI, MAXAR, GEOEYE, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEROGRID, IGN, AND THE GIS USER COMMUNITY



ecoscape

HABITAT TYPES AND SIGNIFICANT FAUNA LOCATIONS

PIPPINGARRA AND WODGINA ROADS: FLORA AND FAUNA SURVEY

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:10,000 @ A3

PROJECT NO: 4537-20

REV	AUTHOR	APPROVED	DATE
00	JT	SK	20/07/2020

MAP 7I

APPENDIX ONE DEFINITIONS AND CRITERIA

Table 13: EPBC Act categories for flora and fauna

EPBC Act category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) 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 (CE)	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (EN)	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (VU)	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it 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	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is 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 management 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 14: Conservation codes for Western Australian flora and fauna (DBCA 2019)

Conservation Codes for Western Australian Flora and Fauna	
Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such. **The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.** **Categories of Threatened, Extinct and Specially Protected fauna and flora are:**	
T	**Threatened species** Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.
CR	**Critically endangered species** Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as critically endangered undersection 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.
EN	**Endangered species** Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.
VU	**Vulnerable species** Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*". Listed as vulnerable undersection 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.
Extinct species **Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.**	
EX	**Extinct species** Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
EW	Extinct in the wild species Species that "*is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form*", and listing is otherwise in accordance with the ministerial guidelines (section 25of 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.**	

Conservation Codes for Western Australian Flora and Fauna	
MI	**Migratory species** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
CD	**Species of special conservation interest (conservation dependent fauna)** Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14of 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 18of the BC Act). Published as other specially protected fauna under schedule 7of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018.*
P	**Priority species** Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.
1	**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.
2	**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.
3	**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.
4	**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.
[1] The definition of flora includes algae, fungi and lichens. **[2] Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).**	

Table 15: DBCA definitions and criteria for TECs and PECs (DEC 2013)

Criteria	Definition
Threatened Ecological Communities	
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. 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 (A or B): A. Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B. All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. 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. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A. The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i. geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii. modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii. there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii. there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C. The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. 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. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A. The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i. the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii. modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B. Current distribution is limited, and one or more of the following apply (i, ii or iii): i. geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii. there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii. there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):

Criteria	Definition
	A. The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B. The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C. The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.
Priority ecological communities	
Priority One	*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. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	*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, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	*Poorly known ecological communities* i. 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; ii. 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; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	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. i. Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. ii. Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. iii. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*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.

Table 16: NVIS structural formation terminology, terrestrial vegetation (NVIS Technical Working Group 2017)

	Cover characteristics							
	Foliage cover *	70-100	30-70	10-30	<10	» 0 (scattered)	0-5 (clumped)	unknown
	Cover code	d	c	i	r	bi	bc	unknown
Growth Form	**Height Ranges (m)**	**Structural Formation Classes**						
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	tree, palm
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	tree mallee
shrub, cycad, grass-tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrub, cycad, grass-tree, tree-fern
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrub
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrub
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrub
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrub
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grass
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grass
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grass
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedge
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rush
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herb
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	fern
bryophyte	<0.5	closed bryophyte-land	bryophyte-land	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophyte
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichen
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vine

Table 17: NVIS height classes (NVIS Technical Working Group 2017)

Height		Growth form				
Height Class	**Height Range (m)**	**Tree, vine (M & U), palm (single-stemmed)**	**Shrub, heath shrub, chenopod shrub, ferns, samphire shrub, cycad, tree-fern, grass-tree, palm (multi-stemmed)**	**Tree mallee, mallee shrub**	**Tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)**	**Bryophyte, lichen, seagrass, aquatic**
8	>30	tall	NA	NA	NA	NA
7	10-30	mid	NA	tall	NA	NA
6	<10	low	NA	mid	NA	NA
5	<3	NA	NA	low	NA	NA
4	>2	NA	tall	NA	tall	NA
3	1-2	NA	mid	NA	tall	NA
2	0.5-1	NA	low	NA	mid	tall
1	<0.5	NA	low	NA	low	low
Source: (based on Walker & Hopkins 1990)						

Table 18: Vegetation Condition Scale for the Eremaean and Northern Botanical Provinces (EPA 2016a)

Condition rating	Description
Excellent	Pristine or nearly so, no obvious signs of disturbance or 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.

APPENDIX TWO DESKTOP ASSESSMENT RESULTS

Table 19: Combined flora database search results (blue shading indicates species recorded during survey)

WAH	TPFL	FMG	Species name	Habitat from *FloraBase* (WAH 1998-2019)	Flowers	Likelihood of occurrence	
						Desktop	Post-survey
			Threatened Flora				
X	X	X	*Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	Ironstone hill slopes, base of breakaways and gullies. Skeletal red-brown clay loam or sandy loam soil.	Jul-Oct	Highly Unlikely	Highly Unlikely
			DBCA Priority 1				
X	X		*Acacia leeuweniana*	Gritty, skeletal red-grey sandy loam, light orange-brown gravelly sand, granite. In rock fissures in outcrops, among boulders.	May	Unlikely	Highly Unlikely
			DBCA Priority 3				
X		X	*Abutilon* sp. Pritzelianum (S. van Leeuwen 5095)	Plains, floodplains, sand dunes. Red-brown or orange-brown sandy or loamy soil.	Apr-Sep	Possible	Unlikely
X	X		*Acacia levata*	Hillslopes. Sand or sandy loam over granite.	May	Unlikely	Unlikely
X			*Eragrostis crateriformis*	Creek banks, depressions. Clayey loam or clay.	Jan-Jul	Possible	Possible
X	X	X	*Euphorbia clementii*	Flats/plains, rocky slopes, drainage lines. Red-brown or orange clay loam with ironstone gravel.	May-Jul	Possible	Possible
X			*Fimbristylis sieberiana*	Pool edges, sandstone cliffs. Mud, skeletal soil pockets.	May-Jun	Unlikely	Highly Unlikely
X		X	*Gomphrena leptophylla*	Sand, sandy to clayey loam, granite, quartzite. Open flats, sandy creek beds, edges salt pans & marshes, stony hillsides.	Mar-Sep	Unlikely	Unlikely
X	X	X	*Gymnanthera cunninghamii*	Sandy soils.	Jan-Dec	Possible	Unlikely
X		X	*Heliotropium muticum*	Plains/sandplains. Brown to orange or red sand or sandy loam, sometimes with gravel.	May-Nov	Possible	Recorded
X			*Nicotiana umbratica*	Rocky outcrops with shallow soils.	Apr-Jun	Highly Unlikely	Highly Unlikely
X		X	*Phyllanthus hebecarpus*	Granite outcrops, drainage lines. Skeletal brown sand or red sandy loam.		Unlikely	Unlikely
X			*Rothia indica* subsp. *australis*	Sandhills and sandy flats. Sandy soils.	Apr-Aug	Possible	Unlikely
X		X	*Stylidium weeliwolli*	Edges of watercourses. Gritty red/brown sand or clay soil.	Aug-Sep	Unlikely	Highly unlikely
X		X	*Terminalia supranitifolia*	Drainage lines, cliffs, slopes, rocky outcrops. Red-brown clay loam or sandy soil.	May-Dec	Highly unlikely	Highly unlikely
X		X	*Triodia basitricha*	Hill tops, rocky plains and in gullies. Gravelly soils, red-brown clay loam over ironstone.	May-Jul	Highly unlikely	Highly unlikely
X			*Triodia chichesterensis*	Plains, low hills. Orange sandy soil or brown clay loam, sometimes gravelly.	Mar-May	Possible	Recorded
			DBCA Priority 4				
X	X	X	*Bulbostylis burbidgeae*	Granite outcrops, cliff bases, slopes. Brown skeletal clay-loam soils.	Mar-Aug	Highly Unlikely	Highly Unlikely
X		X	*Goodenia nuda*	Seasonally inundated clay soils and drainage lines.	Apr-Aug	Possible	Possible
X		X	*Ptilotus mollis*	Stony hills and screes.	May or Sep	Highly Unlikely	Highly Unlikely

WAH = herbarium record (vouchered specimen)
TPFL = Threatened and Priority Flora Report Form records; may not have vouchered specimen from indicated location thus not necessarily verified

Table 20: Combined vertebrate fauna database results

Species	Common name	Conservation status			Nature Map	DBCA	PMST	FMG
		BC Act	EPBC Act	DBCA				
Introduced Mammals								
Camelidae								
Camelus dromedarius	Dromedary, Camel	-	-	-			X	
Canidae								
Canis familiaris	Domestic dog	-	-	-			X	
Vulpes vulpes	Red Fox, Fox	-	-	-			X	
Equidae								
Equus asinus	Donkey, Ass	-	-	-			X	
Equus caballus	Horse	-	-	-			X	
Felidae								
Felis catus	Cat, House Cat, Domestic Cat	-	-	-			X	
Leporidae								
Oryctolagus cuniculus	Rabbit, European Rabbit	-	-	-			X	
Muridae								
Mus musculus	House Mouse	-	-	-			X	
Suidae								
Sus scrofa	Pig	-	-	-			X	
Native Mammals								
Dasyuridae								
Dasycercus blythi	Brush-tailed Mulgara	P4	-	P4	X	X		X
Dasyurus hallucatus	Northern Quoll	EN	EN	EN	X	X	X	X
Sminthopsis longicaudata	Long-tailed Dunnart	P4	-	P4	X	X		X
Hipposideridae								
Hipposideros stenotis	Northern Leaf-nosed Bat	P2	-	P2		X		
Megadermatidae								
Macroderma gigas	Ghost Bat	VU	VU	VU	X	X	X	X
Macropodidae								
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	P4	-	P4	X	X		X
Muridae								
Leggadina lakedownensis	Northern Short-tailed Mouse	P4	-	-	X			
Pseudomys chapmani	Western Pebble-mound Mouse	P4	-	P4	X	X		X
Thylacomyidae								
Macrotis lagotis	Greater Bilby	VU	VU	VU		X	X	X
Rhinonycteridae								
Rhinonicteris aurantia	Orange Leaf-nosed Bat	P4	-	P4	X	X		
Rhinonicteris aurantia (Pilbara form)	Pilbara Leaf-nosed Bat	VU	VU	VU	X	X	X	X
Birds								
Falconidae								

Species	Common name	Conservation status			Nature Map	DBCA	PMST	FMG
		BC Act	EPBC Act	DBCA				
Falco hypolaucos	Grey Falcon	VU	-	VU	X	X		X
Falco peregrinus	Peregrine Falcon	OS	-	OS	X	X		
Maluridae								
Amytornis striatus subsp. striatus	Striated Grasswren (inland)	P4	-	-	X			
Psittacidae								
Pezoporus occidentalis	Night Parrot	CR	EN	-			X	
Rostratulidae								
Rostratula australis	Australian Painted Snipe	EN	EN	-			X	
Reptiles								
Typhlopidae								
Anilios ganei	Gane's Blind Snake (Pilbara)	P1	-	P1	X	X		X
Pythonidae								
Liasis olivaceus barroni	Pilbara Olive Python	VU	VU	VU	X	X	X	X
Scincidae								
Ctenotus nigrilineatus	Pin-striped Fine-snout Skink	P1	-	-	X			
Migratory birds								
Apodidae								
Apus pacificus	Fork-tailed Swift	MI	MI	IA	X	X	X	X
Charadriidae								
Charadrius veredus	Oriental Plover, Oriental Dotterel	MI	MI	IA	X	X	X	
Glareolidae								
Glareola maldivarum	Oriental Pratincole	MI	MI	-			X	
Hirundinidae								
Hirundo rustica	Barn Swallow	MI	MI	-			X	
Motacillidae								
Motacilla cinerea	Grey Wagtail	MI	MI	-			X	
Motacilla flava	Yellow Wagtail	MI	MI	-			X	
Scolopacidae								
Actitis hyopleucos	Common Sandpiper	MI	MI	EN	X	X	X	X
Calidris acuminata	Sharp-tailed Sandpiper	MI	MI	-			X	
Calidris ferruginea	Curlew Sandpiper	CR	CR & MI	-			X	
Calidris melanotos	Pectoral Sandpiper	MI	MI	-			X	
Numenius madagascariensis	Eastern Curlew, Far Eastern Curlew	CR	CR & MI	-			X	
Tringa glareola	Wood Sandpiper	MI	MI	-	X			

Table 21: Combined conservation significant vertebrate fauna likelihood of occurrence (blue shading indicates high likelihood or was recorded by survey)

Species	Common name	EPBC Act ranking	BC Act ranking	Desktop likelihood	Post survey likelihood	Database
APODIDAE						
Apus pacificus	Fork-tailed Swift	MI	MI	Recorded	Low	FMG; NM; DBCA
CHARADRIIDAE						
Charadrius veredus	Oriental Plover	MI	MI	Very low	Low	NM
DASYURIDAE						
Dasycercus blythi	Brush-tailed Mulgara	-	P4	High	Low	NM; DBCA
Dasyurus hallucatus	Northern Quoll	EN	EN	High	Low	NM; DBCA
Sminthopsis longicaudata	Long-tailed Dunnart	-	P4	Low	Low	NM; DBCA
FALCONIDAE						
Falco hypoleucos	Grey Falcon	-	VU	High	Low	NM; DBCA
Falco peregrinus	Peregrine Falcon	-	OS	High	Low	NM; DBCA
GLAREOLIDAE						
Glareola maldivarum	Oriental Pratincole	MI	MI	Very low	Low	PMST
HIRUNDINIDAE						
Hirundo rustica	Barn Swallow	MI	MI	Very low	Very low	PMST
MACROPODIDAE						
Lagorchestes conspicillatus leichardti	Spectacled Hare-wallaby	-	P4	Low	Very low	NM; DBCA
MALURIDAE						
Amytornis striatus subsp. striatus	Striated Grasswren (inland)	-	P4	Low	Very low	NM
MEGADERMATIDAE						
Macroderma gigas	Ghost Bat	VU	VU	Medium	Low	DBCA
MOTACILLIDAE						
Motacilla cinerea	Grey Wagtail	MI	MI	Very low	Very low	PMST
Motacilla flava	Yellow Wagtail	MI	MI	Very low	Very low	PMST
MURIDAE						
Leggadina lakedownensis	Northern Short-tailed Mouse	-	P4	Very low	Very low	NM
Pseudomys chapmani	Western Pebble-mound Mouse	-	P4	High	Recorded	NM; DBCA
PSITTACIDAE						
Pezoporus occidentalis	Night Parrot	EN	CR	Very low	Very low	PMST
PYTHONIDAE						
Liasis olivaceus barroni	Pilbara Olive Python	VU	VU	Medium	Medium	NM; DBCA
RHINONYCTERIDAE						
Rhinonicteris aurantia	Orange Leaf-nosed Bat	P4		High	Low	DBCA
Rhinonicteris aurantia (Pilbara)	Pilbara Leaf-nosed Bat	VU	VU	High	Low	NM; DBCA
ROSTRATULIDAE						
Rostratula australis	Australian Painted Snipe	EN	EN	Very low	Very low	PMST
SCINCIDAE						
Ctenotus nigrilineatus	Pin-striped Fine-snout Skink	-	P1	Very low	Very low	NM
SCOLOPACIDAE						
Actitis hypoleucos	Common Sandpiper	MI	MI	Low	Low	NM; DBCA
Calidris acuminata	Sharp-tailed Sandpiper	MI	MI	Very low	Very low	PMST
Calidris ferruginea	Curlew Sandpiper	CR & MI	CR	Very low	Very low	PMST

Species	Common name	EPBC Act ranking	BC Act ranking	Desktop likelihood	Post survey likelihood	Database
SCOLOPACIDAE						
Calidris melanotos	Pectoral Sandpiper	MI	MI	Very low	Very low	PMST
Numenius madagascariensis	Eastern Curlew	CR & MI	CR	Very low	Very low	PMST
Tringa glareola	Wood Sandpiper	MI	MI	Very low	Very low	NM
THYLACOMYIDAE						
Macrotis lagotis	Greater Bilby	VU	VU	Recorded	Low	DBCA
TYPHLOPIDAE						
Anilios ganei	Gane's Blind Snake (Pilbara)	-	P1	Low	Low	NM

APPENDIX THREE FIELD SURVEY RESULTS

Table 22: Flora inventory (site x species)

Family	Species	Naturalised	Cons. code	PW2001	PW2002	PW2003	PW2004	PW2005	PW2006	PW2007	PW2008	PW2009	PW2010	Opportunistic
Amaranthaceae	**Aerva javanica*	Y											X	
	Ptilotus astrolasius			X		X	X		X					
	Ptilotus axillaris						X							X
	Ptilotus calostachyus			X	X	X	X	X	X					
	Ptilotus exaltatus													X
	Ptilotus fusiformis						X							
	Ptilotus helipteroides													X
Asteraceae	*Pterocaulon sphacelatum*												X	
	Streptoglossa sp.			X		X	X	X						
Boraginaceae	*Heliotropium crispatum*													X
	Heliotropium cunninghamii					X	X	X					X	
	Heliotropium muticum		P3			X	X							X
	Heliotropium ovalifolium				X	X	X	X		X				
	Heliotropium tenuifolium					X				X				
Caryophyllaceae	*Polycarpaea holtzei*				X									
Celastraceae	*Stackhousia muricata*									X				
Chenopodiaceae	*Sclerolaena densiflora*				X	X								
Cleomaceae	*Cleome uncifera*								X					
	Cleome viscosa			X		X								
Convolvulaceae	*Bonamia alatisemina*			X										
	Bonamia erecta			X			X	X	X					
	Bonamia media					X	X			X	X	X		
	Ipomoea muelleri												X	
	Polymeria ambigua					X			X					
Cucurbitaceae	*Cucumis variabilis*												X	
Cyperaceae	*Bulbostylis barbata*				X									
	Cyperus vaginatus												X	
	Fimbristylis simulans				X				X					
Euphorbiaceae	*Euphorbia australis* var. *hispidula*												X	
	Euphorbia coghlanii							X					X	
Fabaceae	*Acacia acradenia*					X		X	X					
	Acacia ampliceps												X	
	Acacia ancistrocarpa			X			X	X		X		X		
	Acacia bivenosa									X	X			X
	Acacia coriacea subsp. *pendens*												X	
	Acacia inaequilatera			X	X	X					X	X		
	Acacia orthocarpa				X									X
	Acacia sphaerostachya				X									
	Acacia stellaticeps				X	X						X		
	Acacia trachycarpa												X	

Family	Species	Naturalised	Cons. code	PW2001	PW2002	PW2003	PW2004	PW2005	PW2006	PW2007	PW2008	PW2009	PW2010	Opportunistic
	Acacia tumida var. *pilbarensis*						X	X	X					
	Crotalaria cunninghamii												X	
	Indigofera monophylla			X		X	X	X		X			X	
	Isotropis atropurpurea			X		X	X	X						
	Petalostylis labicheoides					X	X	X	X	X	X	X		
	Rhynchosia minima												X	
	Senna notabilis					X	X	X						
	Senna symonii			X	X	X	X							
	Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)										X			
	Tephrosia supina				X									
	Vigna lanceolata												X	
Goodeniaceae	*Dampiera candicans*					X		X						
	Goodenia armitiana					X								X
	Goodenia microptera			X		X	X	X						
	Goodenia stobbsiana							X	X		X	X		
	Scaevola amblyanthera var. *centralis*									X	X			
	Scaevola browniana								X					
Gyrostemonaceae	*Codonocarpus cotinifolius*					X	X							
Lauraceae	*Cassytha capillaris*				X	X								
Malvaceae	*Abutilon lepidum*													X
	Corchorus incanus												X	
	Corchorus parviflorus				X			X		X			X	
	Corchorus sp.												X	X
	Corchorus tectus			X		X	X	X						
	Hibiscus austrinus var. *austrinus*												X	
	Hibiscus burtonii							X						
	Hibiscus leptocladus				X									
	Sida clementii													X
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)						X							
	Triumfetta chaetocarpa							X						
Molluginaceae	*Trigastrotheca molluginea*			X	X	X								
Myrtaceae	*Corymbia hamersleyana*					X		X		X	X			
	Corymbia zygophylla						X							
	Eucalyptus camaldulensis subsp. *refulgens*												X	
	Eucalyptus victrix												X	
	Melaleuca glomerata												X	
	Melaleuca linophylla												X	
Poaceae	**Cenchrus ciliaris*	Y											X	
	Chrysopogon fallax							X						
	Enneapogon caerulescens													X
	Eragrostis eriopoda					X								

Family	Species	Naturalised	Cons. code	PW2001	PW2002	PW2003	PW2004	PW2005	PW2006	PW2007	PW2008	PW2009	PW2010	Opportunistic
	Eriachne helmsii								X					
	Eriachne pulchella subsp. *dominii*					X			X			X		
	Paraneurachne muelleri							X						
	Sporobolus australasicus					X		X						
	Triodia angusta													X
	Triodia brizoides											X		X
	Triodia chichesterensis		P3							X	X			
	Triodia epactia							X						
	Triodia lanigera			X	X	X	X		X			X		
	Triodia longiceps											X	X	X
	Triodia wiseana				X	X		X	X			X		X
Proteaceae	*Grevillea pyramidalis*													1
	Grevillea wickhamii					X	X	X	X					
	Hakea lorea subsp. *lorea*					X								
Sapindaceae	*Atalaya hemiglauca*												X	
Solanaceae	*Solanum diversiflorum*						X	X					X	
	Solanum phlomoides							X					X	
Violaceae	*Hybanthus aurantiacus*					X		X	X				X	
Zygophyllaceae	*Tribulus hirsutus*				X	X	X							

APPENDIX FOUR FLORISTIC QUADRAT DATA

PW2001

Staff TCJ **Date** 3/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Wodgina Road

MGA Zone 50 678837 **mE** 7664950 **mN** **Lat.** **Long.**

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Red sandy clay

Rock Type Quartz and ironstone

Loose Rock 10-20 % cover; 6-20 mm in size **Litter** 2 % cover ; <1 cm cm in depth

Bare ground 20 % cover **Weeds** 0 % cover

Vegetation M ^*Acacia ancistrocarpa*\^shrub\4\r;G+ ^*Triodia lanigera*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Nil obvious - near public road

Fire Age >10 years

Notes Large spinifex rings with good dry material, no charred material seen. Goodenia forrestii near quadrat.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia ancistrocarpa		2	6	
Acacia inaequilatera		2	1	
Bonamia alatisemina		0.1	<1	
Bonamia erecta		0.3	<1	
Bonamia erecta		0.5	<1	

Cleome viscosa	0.3	<1
Corchorus tectus	0.4	<1
Goodenia microptera	0.3	<1
Indigofera monophylla	0.5	<1
Isotropis atropurpurea	0.4	<1
Isotropis atropurpurea	0.5	1
Ptilotus astrolasius	0.5	1
Ptilotus calostachyus	0.7	<1
Senna symonii	0.6	<1
Streptoglossa sp.	0.1	<1
Trigastrotheca molluginea	0.1	<1
Triodia lanigera	0.4	60

PW2002

Staff TCJ **Date** 3/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Wodgina Rd

MGA Zone 50 677321 **mE** 7663191 **mN** **Lat.** -21.1239 **Long.** 118.7074

Habitat Low rise on gentle undulating plain

Aspect N **Slope** Gentle

Soil Type Orange brown sandy clay

Rock Type Quartz

Loose Rock 20-50 % cover; 20-60 mm in size **Litter** 10 % cover ; 2 cm cm in depth

Bare ground 25 % cover **Weeds** <1 % cover

Vegetation M ^*Acacia orthocarpa*,^*Acacia inaequilatera*\^shrub\4\r;G+ ^*Triodia wiseana*,^*Triodia lanigera*\^\1\d

Veg. Condition Very Good

Disturbance Nil seen, adjacent cleared lay down.

Fire Age >5 years

Notes Some large hummocks but much of veg small and or low.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia inaequilatera		2.5	1	
Acacia orthocarpa		3	2	
Acacia sphaerostachya		1.3	<1	
Acacia stellaticeps		0.6	8	
Bulbostylis barbata		0.1	<1	

Cassytha capillaris	0.5	<1	
Corchorus parviflorus	0.8	<1	
Fimbristylis simulans	0.2	<1	6
Heliotropium ovalifolium	0.2	<1	
Hibiscus leptocladus	0.3	<1	
Polycarpaea holtzei	0.1	<1	
Ptilotus calostachyus	0.8	<1	
Sclerolaena densiflora	0.1	<1	
Senna symonii	0.9	<1	
Tephrosia supina	0.2	<1	
Tribulus hirsutus	0.1	<1	
Trigastrotheca molluginea	0.1	<1	
Triodia lanigera	0.4	35	
Triodia wiseana	0.4	40	

PW2003

Staff TCJ **Date** 3/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Pippingarra Rd

MGA Zone 50 682015 **mE** 7667343 **mN** **Lat.** -21.0859 **Long.** 118.7521

Habitat Gently undulating plain

Aspect W **Slope** Very Gentle

Soil Type Orange brown clayey sand

Rock Type Quartz and ironstone

Loose Rock >90 % cover; 20-60 mm in size **Litter** <1 % cover ; <2 cm cm in depth

Bare ground 50 % cover **Weeds** <1 % cover

Vegetation M+ ^*Acacia inaequilatera*\^mallee shrub\4\r;G ^*Triodia wiseana*\^hummock grass\1\i

Veg. Condition Excellent

Disturbance Adjacent to road, no obvious signs.

Fire Age <1 year

Notes Very small Triodia, although mid shrubs intact. Surrounding area also burnt, seems more intensely.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia acradenia		2	<1	
Acacia inaequilatera		2.5	3	
Acacia stellaticeps		0.4	<1	
Bonamia pilbarensis		0.1	<1	
Cassytha capillaris			<1	

Cleome viscosa		0.3	<1	
Codonocarpus cotinifolius		0.3	<1	
Corchorus tectus		0.5	1	
Corymbia hamersleyana		4	<1	
Dampiera candicans		0.1	<1	
Eragrostis eriopoda		0.2	<1	
Eriachne pulchella subsp. *dominii*		0.2	<1	
Goodenia armitiana		0.3	<1	<5
Goodenia microptera		0.3	<1	
Grevillea wickhamii		0.3	<1	
Hakea lorea subsp. *lorea*		0.8	<1	
Heliotropium cunninghamii		0.15	<1	
Heliotropium muticum	P 3	0.2	<1	510
Heliotropium ovalifolium		0.2	<1	
Heliotropium tenuifolium		0.25	<1	
Hybanthus aurantiacus		0.5	<1	
Indigofera monophylla		0.3	<1	
Isotropis atropurpurea		0.4	<1	
Petalostylis labicheoides		1.1	<1	
Polymeria ambigua		0.1	<1	
Ptilotus astrolasius		0.4	<1	
Ptilotus calostachyus		0.6	<1	
Sclerolaena densiflora		0.1	<1	
Senna notabilis		0.3	<1	
Senna symonii		0.6	<1	
Sporobolus australasicus		0.2	<1	
Streptoglossa sp.		0.2	<1	
Tribulus hirsutus		0.2	<1	
Trigastrotheca molluginea		0.1	<1	
Triodia lanigera		0.3	<1	
Triodia wiseana		0.1	12	

PW2004

Staff TCJ **Date** 4/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location NE corner of survey area.

MGA Zone 50 682235 **mE** 7668903 **mN** **Lat.** -21.0718 **Long.** 118.7541

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Red brown clayey sand

Rock Type Granite

Loose Rock 2-10 % cover; 2-6 mm in size **Litter** 2 % cover ; 1 cm cm in depth

Bare ground 18 % cover **Weeds** <1 % cover

Vegetation U+ ^*Corymbia zygophylla*\^tree\6\r;M ^*Acacia ancistrocarpa*\^shrub\3\r;G ^^*Triodia lanigera*, *Isotropis atropurpurea*,*Ptilotus astrolasius*\^hummock grass,shrub\1\c

Veg. Condition Excellent

Disturbance Fire <2yrs, track to east.

Fire Age 1-2 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia ancistrocarpa		1.3	3	
Acacia tumida var. *pilbarensis*		0.9	1.5	
Bonamia erecta		0.4	2	
Bonamia pilbarensis		0.1	<1	
Codonocarpus cotinifolius		0.5	<1	

Corchorus tectus		0.3	<1	
Corymbia zygophylla		3.5	<2	
Goodenia microptera		0.3	<1	
Grevillea wickhamii		0.4	<1	
Heliotropium cunninghamii		0.2	<1	
Heliotropium muticum	P 3	0.2	<1	5
Heliotropium ovalifolium		0.2	<1	
Indigofera monophylla		0.4	<1	
Isotropis atropurpurea		0.4	10	
Petalostylis labicheoides		0.9	<1	
Ptilotus astrolasius		0.4	5	
Ptilotus axillaris		0.1	<1	
Ptilotus calostachyus		0.7	<1	
Ptilotus fusiformis		0.4	<1	
Senna notabilis		0.3	<1	
Senna symonii		0.3	<1	
Sida sp. Pilbara (A.A. Mitchell PRP 1543)		0.3	1	
Solanum diversiflorum		0.4	<1	
Streptoglossa sp.		0.2	<1	
Tribulus hirsutus		0.1	<1	
Triodia lanigera		0.3	40	
Triodia lanigera		0.5	<1	

PW2005

Staff TCJ **Date** 4/07/2020 **Season** A

Revisit

Type Q 100 m x 25 m

Location Minor drainage NE area

MGA Zone 50 683147 **mE** 7667727 **mN** **Lat.** -21.0823 **Long.** 118.7630

Habitat Creek

Aspect SW **Slope** Very Gentle

Soil Type Red brown sand

Rock Type Quartz and granite

Loose Rock <2 % cover; 2-6 mm in size **Litter** <5 % cover ; <2 cm cm in depth

Bare ground 15 % cover **Weeds** <1 % cover

Vegetation U+ ^*Corymbia hamersleyana*\^tree\6\r;M ^*Acacia tumida* var. *pilbarensis*\^shrub\3\r;G ^*Triodia epactia*,^*Triodia wiseana*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Minor disused track runs through

Fire Age 1-2 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia acradenia		0.4	1	
Acacia ancistrocarpa		0.9	<1	
Acacia tumida var. *pilbarensis*		1.6	3	
Bonamia erecta			2	
Bonamia erecta			<1	

Chrysopogon fallax	0.9	<1
Corchorus parviflorus	0.5	<1
Corchorus tectus	0.4	1
Corymbia hamersleyana	8	3
Dampiera candicans	0.4	<1
Euphorbia coghlanii	0.3	<1
Goodenia microptera	0.3	<1
Goodenia stobbsiana	0.6	<1
Grevillea wickhamii	0.4	<1
Heliotropium cunninghamii	0.3	<1
Heliotropium ovalifolium	0.4	5
Hibiscus burtonii	0.8	<1
Hybanthus aurantiacus	0.4	0.5
Indigofera monophylla	0.5	0.5
Isotropis atropurpurea	0.4	5
Paraneurachne muelleri	0.5	<1
Petalostylis labicheoides	0.5	<1
Ptilotus calostachyus	0.6	<1
Senna notabilis	0.1	<1
Solanum diversiflorum	0.4	<1
Solanum diversiflorum		<1
Solanum phlomoides	0.6	<1
Sporobolus australasicus	0.2	<1
Streptoglossa sp.	0.3	<1
Triodia epactia	0.4	25
Triodia epactia	0.5	25
Triodia wiseana	0.3	5
Triumfetta chaetocarpa	0.5	<1

PW2006

Staff TCJ **Date** 4/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Laydown area west of central Pippingarra area.

MGA Zone 50 687241 **mE** 7662218 **mN** **Lat.** -21.1317 **Long.** 118.8030

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Red brown clayey sand

Rock Type Quartz and ironstone

Loose Rock 50-90 % cover; 20-60 mm in size **Litter** 3 % cover ; <2 cm cm in depth

Bare ground 20 % cover **Weeds** <1 % cover

Vegetation M+ ^*Acacia acradenia*,^*Grevillea wickhamii*\^shrub\3\i;G ^*Triodia wiseana*,^*Triodia lanigera*\^hummock grass\1\c

Veg. Condition Excellent

Disturbance Adjacent to road

Fire Age 2-5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia acradenia		1.9	22	
Acacia tumida var. *pilbarensis*		1.5	<1	
Bonamia erecta		0.4	<1	
Cleome uncifera		0.4	<1	
Eriachne helmsii		0.3	<1	

Eriachne pulchella subsp. *dominii*	0.1	<1	
Fimbristylis simulans	0.1	<1	30+
Goodenia stobbsiana	0.3	<1	
Grevillea wickhamii	2.2	2	
Hybanthus aurantiacus	0.4	<1	
Petalostylis labicheoides	1.6	1	
Polymeria ambigua	0.1	<1	
Ptilotus astrolasius	0.6	<1	
Ptilotus calostachyus	0.7	<1	
Scaevola browniana	0.2	<1	
Triodia lanigera	0.5	10	
Triodia wiseana	0.5	30	

PW2007

Staff TCJ **Date** 4/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Pippingarra Rd

MGA Zone 50 690219 **mE** 7658883 **mN** **Lat.** -21.1615 **Long.** 118.8320

Habitat Flat

Aspect N/A **Slope** N/A

Soil Type Pale brown sandy clay

Rock Type Quartz and calcrete

Loose Rock 20-50 % cover; 20-60 mm in size **Litter** <5 % cover ; <2 cm cm in depth

Bare ground 18 % cover **Weeds** <1 % cover

Vegetation U+ ^*Corymbia hamersleyana*\^tree\6\r;M ^*Acacia bivenosa*,^*Petalostylis labicheoides*\^shrub\3\r;G ^*Triodia chichesterensis*\^hummock grass\1\d

Veg. Condition Excellent

Disturbance Some rubbish, adjacent to road.

Fire Age >5 years

Notes

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia ancistrocarpa		1.5	<1	
Acacia bivenosa		2	6	
Bonamia pilbarensis		0.1	<1	
Corchorus parviflorus		0.5	<1	
Corymbia hamersleyana		8	3	

Corymbia hamersleyana		0.7	<1
Heliotropium ovalifolium		0.2	<1
Heliotropium tenuifolium		0.1	<1
Indigofera monophylla		0.5	<1
Indigofera monophylla		0.5	<1
Petalostylis labicheoides		1.6	3
Scaevola amblyanthera var. *centralis*		0.2	<1
Stackhousia muricata		0.25	<1
Triodia chichesterensis	P 3	0.3	75

PW2008

Staff TCJ **Date** 5/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Lay down area lower Pippingarra Rd.

MGA Zone 50 689967 **mE** 7654407 **mN** **Lat.** -21.2019 **Long.** 118.8301

Habitat Low rise

Aspect N **Slope** Gentle

Soil Type Brown sandy clay loam

Rock Type Ironstone, some quartz and calcrete

Loose Rock >90 % cover; 20-60 mm in size **Litter** <2 % cover ; <1 cm cm in depth

Bare ground 25 % cover **Weeds** <1 % cover

Vegetation U ^*Corymbia hamersleyana*\^tree\6\bi;M ^,*Acacia inaequilatera*\^,shrub\4\bi;G+ ^*Triodia chichesterensis*\^hummock grass\1\d

Veg. Condition Excellent

Disturbance Adjacent to road, no dist noted.

Fire Age >5 years

Notes Scattered grev wick and occasional hakea in surrounds, with isolated patches of A acradenia especially towards ne of laydown area and along road verge and drainage line at boundaries.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia bivenosa		2	<1	
Acacia inaequilatera		1.5	<1	
Bonamia pilbarensis		0.1	<1	
Corymbia hamersleyana		2	<1	

Goodenia stobbsiana		0.4	<1
Petalostylis labicheoides		1.6	<1
Scaevola amblyanthera var. *centralis*		0.4	<1
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)		0.1	<1
Triodia chichesterensis	P 3	0.3	75

PW2009

Staff TCJ **Date** 5/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location Southern end of survey area, sw of river.

MGA Zone 50 689815 **mE** 7651067 **mN** **Lat.** -21.2321 **Long.** 118.8290

Habitat Top of low rise

Aspect N/A **Slope** Very Gentle

Soil Type Red brown clay loam

Rock Type Ironstone, granite and quartz

Loose Rock >90 % cover; 20-60 mm in size **Litter** 3 % cover ; 1 cm cm in depth

Bare ground 6 % cover **Weeds** <1 % cover

Vegetation M ^*Acacia inaequilatera*\^shrub\4\r;G+ ^*Triodia wiseana*,^*Acacia stellaticeps*\^hummock grass, shrub\2\d

Veg. Condition Excellent

Disturbance Some old tins. Near road and laydown.

Fire Age >5 years

Notes Longiceps in lower lying areas and minor drainage lines nearby, along with acradenia and corymbia ham.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia ancistrocarpa		1.8	2	
Acacia inaequilatera		2.8	2	
Acacia stellaticeps		1	20	
Bonamia pilbarensis		0.1	<1	

Eriachne pulchella subsp. *dominii*	0.2	<1
Goodenia stobbsiana	0.2	<1
Petalostylis labicheoides	1.2	<1
Triodia brizoides	0.4	<1
Triodia lanigera	0.5	3
Triodia longiceps	0.5	1
Triodia wiseana	0.5	65

PW2010

Staff TCJ **Date** 5/07/2020 **Season** A

Revisit

Type Q 50 m x 50 m

Location River (riparian veg) at s end survey area.

MGA Zone 50 690120 **mE** 7651765 **mN** **Lat.** -21.2258 **Long.** 118.8319

Habitat River

Aspect NW **Slope** Very Gentle

Soil Type Pale brown sand

Rock Type Mixed

Loose Rock 2-10 % cover; 6-20 mm in size **Litter** 15 % cover ; <10 cm cm in depth

Bare ground 15 % cover **Weeds** <1 % cover

Vegetation U+ ^*Eucalyptus camaldulensis* subsp. *refulgens*,^*Eucalyptus victrix*\^tree\7\i;M ^*Acacia trachycarpa*,^*Atalaya hemiglauca*\^shrub\4\i;G ^*Cenchrus ciliaris*,^*Triodia longiceps*\^tussock grass,hummock grass\2\c

Veg. Condition Good

Disturbance Cattle tracks, some rubbish debris.

Fire Age >10 years

Notes Just north of road.

Species	WA Cons.	Height (m)	Cover (%)	Count
Acacia ampliceps		3	<1	
Acacia coriacea subsp. *pendens*		4	<1	
Acacia trachycarpa		3.5	5	
Acacia trachycarpa		2.5	1	

**Aerva javanica*	0.7	<1	20
Atalaya hemiglauca	3.5	4	
**Cenchrus ciliaris*	0.6	30	
Corchorus incanus	0.9	<1	
Corchorus parviflorus	0.5	<1	
Corchorus parviflorus	0.3	<1	
Crotalaria cunninghamii	0.6	<1	
Cucumis variabilis	0.1	<1	
Cyperus vaginatus	1.2	<1	
Eucalyptus camaldulensis subsp. *refulgens*	18	15	
Eucalyptus victrix	10	3	
Euphorbia australis var. *hispidula*	0.1	2	
Euphorbia coghlanii	0.2	<1	
Heliotropium cunninghamii	0.3	<1	
Hibiscus austrinus var. *austrinus*	0.2	<1	
Hibiscus austrinus var. *austrinus*	1.6	<1	4
Hybanthus aurantiacus	0.4	<1	
Indigofera monophylla	1.6	<1	
Ipomoea muelleri	0.1	<1	
Melaleuca glomerata	2.2	<1	
Melaleuca linophylla	2	<1	
Pterocaulon sphacelatum	0.3	<1	
Rhynchosia minima		1	
Solanum diversiflorum	1	<1	
Solanum phlomoides	1.1	<1	
Triodia longiceps	0.7	12	
Vigna lanceolata	0.1	<1	

APPENDIX SEVEN ANALYSIS OF BIRD AUDIO DATA

Nigel Jackett
[redacted]
ABN 28 786 512 608

21 July 2020

Bruce Turner
Senior Zoologist
Ecoscape Australia Pty Ltd

Ref: 4537-20 Pippingarra-Wodgina Access Roads

Dear Bruce,

Please find below the results of a targeted Night Parrot survey for Project 4537-20.

Survey summary

Ecoscape conducted sampling for the Night Parrot (*Pezoporus occidentalis*) in July 2020. Two Song Meter 2 (Wildlife Acoustics, MA, USA) bioacoustic recording units were deployed across two sites, and recorded a combined total of 8 nights of data (Table 1). The analysed dataset comprised 206 sound files (wav format) totalling 748 MB. Each unit was programmed to record from sunset until sunrise (approx. 12 hours), with the trigger function enabled.

Table 1. Bioacoustic recordings analysed from the July 2020 survey.

Song Meter prefix	Recording start date (PM)	Recording end date (AM)	Total recording nights
17715	02/07/2020	06/07/2020	4*
MKSNP747-02	02/07/2020	06/07/2020	4
* partial recording on final night		Total	8

Results

The analysis was undertaken using the software Kaleidoscope Pro v5.1.8, targeting the frequency range of 1000 – 4000 Hz for which all known calls of the Night Parrot are distributed within (Jackett *et al.* 2017; Murphy *et al.* 2017; Leseberg *et al.* 2019). Searching for calls over a large frequency range such as this is likely to produce a high number of false-positive results due to many other bird species, and often nocturnal insects, calling at similar frequencies. A total of 86 Kaleidoscope detections were manually assessed for Night Parrot vocalisations, and as expected, a high percentage (100% of all calls in this analysis) were false-positives.

No calls attributable to Night Parrots were detected during the analysis.

Four non-target bird species were detected during the analysis and are listed in Appendix 1.

Analysis remarks

The sound recordings were of average quality, with occasional noise interference from insects (typically > 4 kHz) and passing trains (typically < 2 kHz).

Non-target bird species were detected at both sites, although overall diversity was poor. The frequency range of the non-target bird species detected overlap with calls of the Night Parrot. It can therefore be expected that Night Parrot calls would have been detected had they occurred within a reasonable distance of a unit.

If you have any questions or comments relating to the analysis, don't hesitate to be in touch.

Sincerely,

Nigel Jackett

Selected references

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

Leseberg, N.P, Murphy, S.A., Jackett, N.A., Greatwich, B.R., Brown, J., Hamilton, N., Joseph, L. & Watson, J. (2019). Descriptions of known vocalisations of the Night Parrot *Pezoporus occidentalis*. *Australian Field Ornithology*, **36**, 79-88.

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

Appendix 1 – Species detected during the analysis

Species	Site	
	17715	MKSNP747-02
Galah		•
Yellow-throated Miner		•
Pied Butcherbird		•
Spinifexbird	•	
Total	1	3

APPENDIX EIGHT BAT ECHOLOCATION REPORT

Acoustic analysis and bat call identification from Pippingarra, Western Australia

Prepared for **Ecoscape Australia Pty Ltd**

Version **22 July 2020**

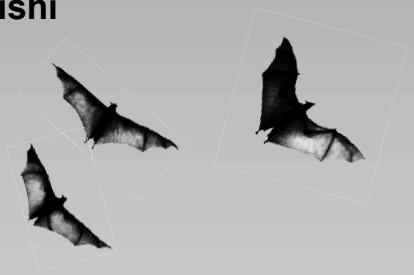
SZ project reference **SZ546**

Prepared by **Dr Kyle Armstrong and Yuki Konishi**

Specialised Zoological ABN 92 265 437 422

[redacted]

http://szool.com.au



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This report should be included as an appendix in any larger submission to Government, and cited as:

Specialised Zoological (2020). Acoustic analysis and bat call identification from Pippingarra, Western Australia. Unpublished report by Specialised Zoological for Ecoscape Australia Pty Ltd, 22 July 2020, project reference SZ546.

Summary

Bat identifications from acoustic recordings are provided from Pippingarra, in the Pilbara region of Western Australia. The identification of bat species from full spectrum WAV-format recordings of their echolocation calls was based on measurements of characteristic frequency, observation of pulse shape, and the pattern of harmonics. Up to nine species of bat were identified as being present (**Tables 1** and **2**). The Ghost Bat *Macroderma gigas* (Megadermatidae) and Pilbara Leaf-nosed Bat *Rhinonicteris aurantia* (Rhinonycteridae) were not detected. Representative echolocation calls for each identification are illustrated (**Figure 1**), as recommended by the Australasian Bat Society (ABS 2006). Further details are available should verification be required.

Methods

The data provided were recorded in full spectrum WAV format with Wildlife Acoustics Song Meter SM4BAT bat detectors (sampling rate 384 kHz, set to turn on automatically at sunset and off at sunrise).

A multi-step acoustic analysis procedure developed to process large full spectrum echolocation recording datasets from insectivorous bats (Armstrong and Aplin 2014; Armstrong et al. 2016) was applied to the recordings made on the survey. Firstly, the WAV files were scanned for bat echolocation calls using several parameter sets in the software SCAN'R version 1.8.3 (Binary Acoustic Technology), which also provides measurements (SCAN'R parameters) from each putative bat pulse. The outputs were then used to determine if putative bat pulses measured in SCAN'R could be identified to species. This was done using a custom [R] language script that performed three tasks: 1. undertook a Discriminant Function Analysis on training data from representative calls from the Pilbara region; 2. from the measurements of each putative bat pulse from SCAN'R, calculated values for the first two Discriminant Functions that could separate the echolocation call types derived from the analysis of training data, and plotted these resulting coordinates over confidence regions for the defined call types; and 3. facilitated an inspection in a spectrogram of multiple examples of each call type for each recording night by opening the original WAV files containing pulses of interest in Adobe Audition CS6 version 5.0.2.

The [R] language script also included a separate process that repeated the above steps using training data that included signals from cave-roosting bats in the Pilbara, including the Ghost Bat.

Species were identified based on information in McKenzie and Bullen (2009) and the author's own unpublished material; and nomenclature follows Jackson and Groves (2015).

Comments on ambiguous identifications

Most species were identified unambiguously, but some call types have more than one possibility for their source. It is often difficult to make an unambiguous identification of long-eared bats *Nyctophilus* spp., and here call sequences with minimum frequencies close to

45 kHz could have derived from either the Pallid Long-eared Bat *Nyctophilus daedalus*, or the Lesser Long-eared Bat *Nyctophilus geoffroyi*.

Calls were detected on two nights that might have derived from either the Northern Free-tailed Bat *Ozimops lumsdenae* or the Common Sheath-tailed Bat *Taphozous georgianus*. The harmonic patterning was not clear, and pulse shapes have been seen previously in both those species, so the source of the calls remains ambiguous.

Limitations

The identifications presented in this report have been made within the following context:

1. The identifications made herein were based on the ultrasonic acoustic data recorded and provided by a 'third party' (the client named on the front of this report).
2. The scope of this report extended to providing information on the identification of bat species in bulk ultrasonic recordings. Further comment on these species and the possible impacts of a planned project on bat species were not part of the scope.
3. In the case of the present report, the recording equipment was not set up and supplied by Specialised Zoological. The equipment was operated by the third party during the survey.
4. Other than the general location of the study area, Specialised Zoological has not been provided with detailed information of the survey area, has not made a visit to observe the habitats available for bats, nor have we visited the specific project areas on a previous occasion.
5. Specialised Zoological has had no input into the overall design and timing of this bat survey, recording site placement, nor the degree of recording site replication.
6. While Specialised Zoological has made identifications to the best of our ability given the available materials, and reserves the right to re-examine the data and revise any identification following a query, it is the client's and / or proponent's responsibility to provide supporting evidence for any identification, which might require follow-up trapping effort or non-invasive methods such as video recordings. Specialised Zoological bears no liability for any follow-up work that may be required to support an identification based initially on the analysis of acoustic recordings undertaken and reported on here.
7. There are a variety of factors that affect the 'detectability' of each bat species, given the frequency, power and shape characteristics of their calls. Further information on the analysis and the various factors that can impinge on the reliability of identifications can be provided upon request.
8. The analysis of ultrasonic recordings is one of several methods that can be used to survey for bats, and comprehensive surveys typically employ more than one method. If an identification in the present report is ambiguous or in question, a trapping programme would help to resolve the presence of the possibilities in the project area.

References

ABS (2006). Recommendations of the Australasian Bat Society Inc for reporting standards for insectivorous bat surveys using bat detectors. *The Australasian Bat Society Newsletter* 27: 6–9. [ISSN 1448-5877]

Armstrong, K.N. and Aplin, K.P. (2014). Identifying bats in an unknown acoustic realm using a semi-automated approach to the analysis of large full spectrum datasets. Oral presentation at the 16th Australasian Bat Society Conference 22–25 April 2014, Townsville, Queensland. *The Australasian Bat Society Newsletter* 42: 35–36.

Armstrong, K.N., Aplin, K.P. and Crotty, S. (2016). A pipeline and app for massive filtering, and assisted inspection of enormous acoustic datasets. Poster presentation at the 17th Australasian Bat Society Conference, 29 March-1 April 2016, Hobart, Tasmania, Australia. *The Australasian Bat Society Newsletter* 46: 51.

Jackson, S.M. and Groves, C.P. (2015). *Taxonomy of Australian mammals*. CSIRO Publishing, Victoria.

McKenzie, N.L. and Bullen, R.D. (2009). The echolocation calls, habitat relationships, foraging niches and communities of Pilbara microbats. Records of the Western Australian Museum Supplement 78: 123–155.

Table 1. Species identified in the present survey from all sites combined.

EMBALLONURIDAE	
Yellow-bellied Sheath-tailed Bat	*Saccolaimus flaviventris*
Common Sheath-tailed Bat	*Taphozous georgianus*
VESPERTILIONIDAE	
Gould's Wattled Bat	*Chalinolobus gouldii*
Little Broad-nosed Bat	*Scotorepens greyii*
Finlayson's Cave Bat	*Vespadelus finlaysoni*
Ambiguous identifications	
Unidentified long-eared bat	*Nyctophilus* sp.
MOLOSSIDAE	
White-striped Free-tailed Bat	*Austronomus australis*
Greater Northern Free-tailed Bat	*Chaerephon jobensis*
Ambiguous identifications	
Northern Free-tailed Bat	*Ozimops lumsdenae* (=*Mormopterus beccarii*)

Table 2. Species identifications, with the degree of confidence indicated by a code. Date and recording unit number correlates with site; see *Table 1* for full species names.

	A. australis	*C. gouldii*	*C. jobensis*	*Nyctophilus sp.*	*O. lumsdenae*	*S. flaviventris*	*S. greyii*	*T. georgianus*	*V. finlaysoni*
SM4BAT 1147									
2/07/2020	—	◆	◆	NC	—	—	◆	—	◆
3/07/2020	—	◆	—	—	—	—	◆	—	◆
4/07/2020	—	◆	◆	—	NC	◆	◆	—	◆
5/07/2020	—	◆	◆	—	NC	—	◆	◆	◆
SM4BAT 1233									
2/07/2020	—	◆	NC	—	—	—	◆	—	—
3/07/2020	—	—	◆	—	—	—	—	—	—
4/07/2020	—	—	◆	—	—	—	—	—	—
5/07/2020	—	—	◆	—	—	—	—	—	—
SM4BAT 1247									
2/07/2020	—	—	—	—	—	—	—	—	—
3/07/2020	◆	◆	◆	—	—	—	—	—	—
4/07/2020	—	—	◆	—	—	—	—	◆	◆
5/07/2020	—	—	—	—	—	—	◆	—	—

Definition of confidence level codes

— Not detected.

◆ Unambiguous identification of the species at the site based on measured call characteristics and comparison with available reference material. Greater confidence in this ID would come only after capture and supported by morphological measurements or a DNA sequence.

NC Needs Confirmation. Either call quality was poor, or the species cannot be distinguished reliably from another that makes similar calls. Alternative identifications are indicated in the *Comments on identifications* section of this report. If this is a species of conservation significance, further survey work might be required to confirm the record.

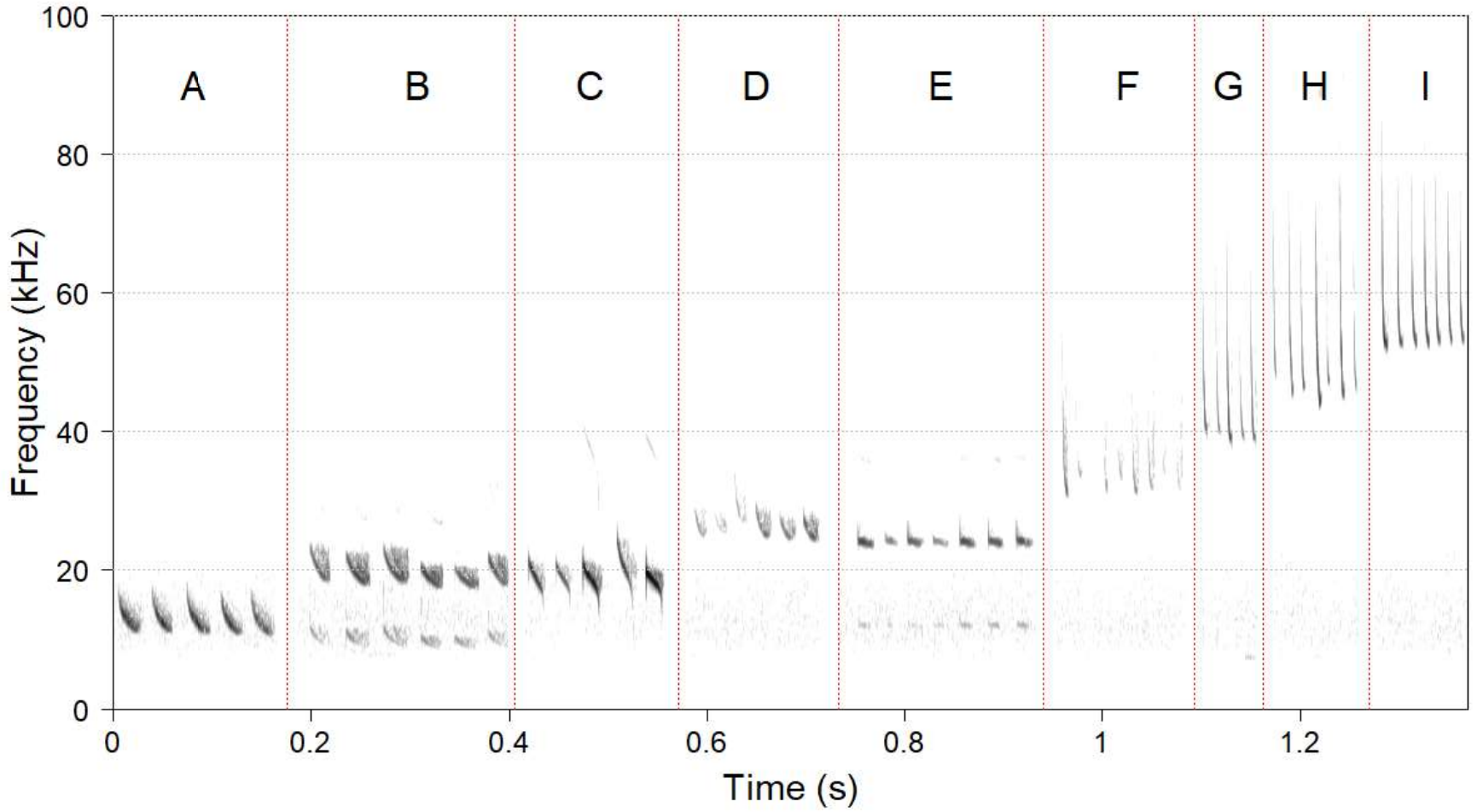

Figure 1. Representative echolocation call sequence portions of the species identified (**A**: *Austronomus australis*; **B**: *Saccolaimus flaviventris*; **C**: *Chaerephon jobensis*; **D**: *Ozimops lumsdenae?*; **E**: *Taphozous georgianus*; **F**: *Chalinolobus gouldii*; **G**: *Scotorepens greyii*; **H**: *Nyctophilus* sp.; **I**: *Vespadelus finlaysoni*; time between pulses has been compressed).