Appendix C

Balmoral South Environmental Impact Assessment – Flora and Fauna Survey

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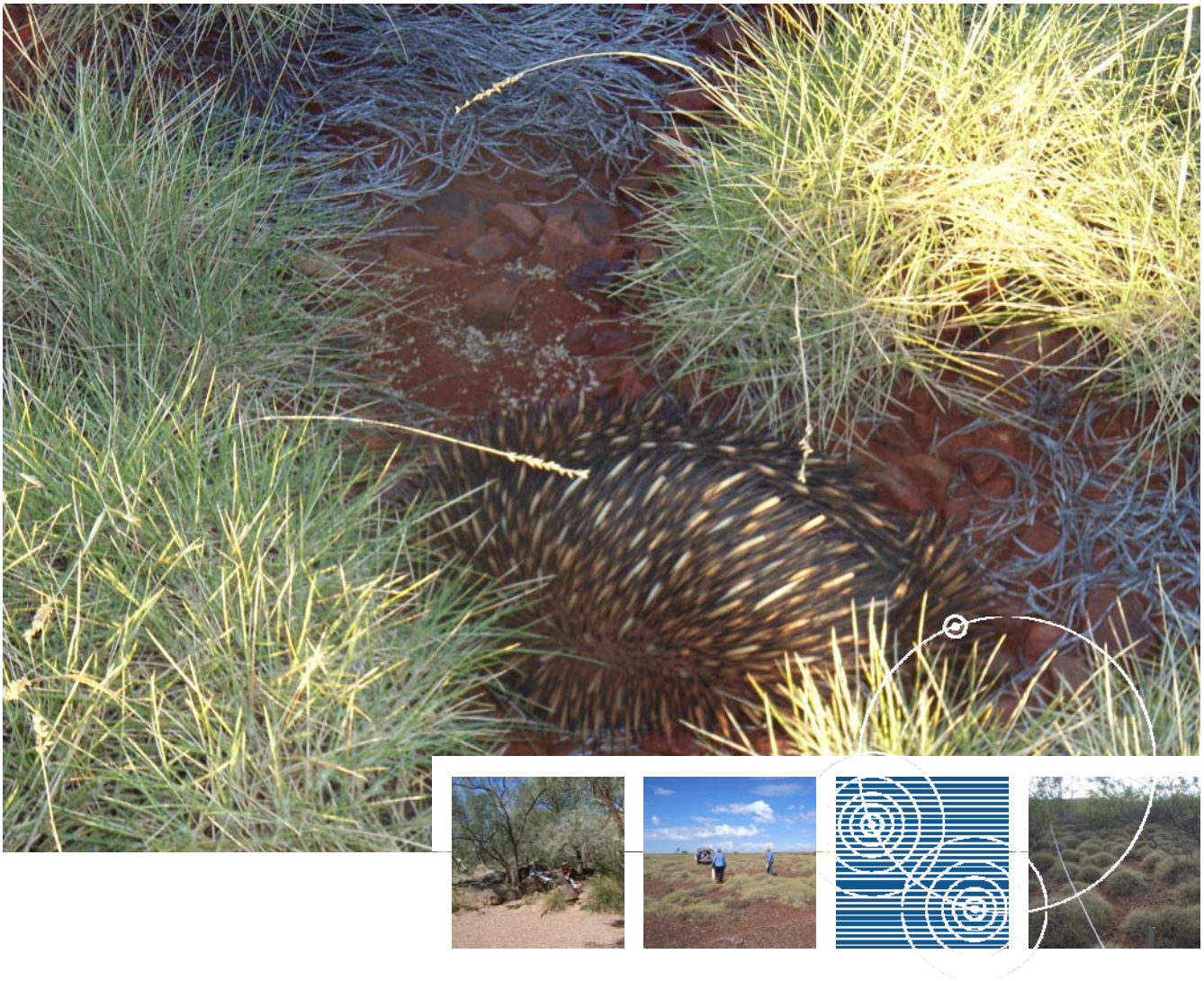

Cape Preston Mining Estate
Consolidated Vegetation, Flora and Fauna Assessment

International Minerals

25 September 2008

Consolidated Vegetation, Flora and Fauna Assessment

Prepared for

International Minerals

Prepared by

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2	09/09/2008	Report Finalisation	Jamie Shaw Principal Environmental Scientist	

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Executive Summary

In 2006, International Minerals (IM – formerley Australasian Resources) commissioned Maunsell AECOM Pty Ltd (Maunsell AECOM) to conduct Seasonal Flora and Fauna (Biological) Surveys of the project area. This commission included:

- A review of data previously collected in the project area; and
- Detailed studies in previously unsurveyed areas within the project area.

The biological surveys of the project area specifically dealt with:

- flora;
- vegetation communities;
- vegetation condition;
- observed fauna;
- evidence of fauna activity;
- trapped fauna records
- potentially present fauna; and
- inferred fauna habitats.

In 2000, Maunsell AECOM (then Halpern Glick Maunsell AECOM (HGM)) conducted a large scale Biological Survey of the area for the Austeel (Mineralogy) project. This survey assessed all of the mining leases (M08/118 to M08/130) covering the Balmoral Deposit held by Mineralogy, which encompassed some of the Balmoral South Project area.

The 2006 surveys involved detailed studies in the previously unsurveyed areas and a review of results gathered during the 2000 survey in the overlapping areas.

This report presents the findings of Maunsell AECOM's biological survey for the proposed mine and associated infrastructure locations, including survey results from 2006 and the previous study conducted in 2000. Reference is also made to a range of preliminary data from targeted fauna surveys carried out in 2008.

Flora

No species listed as Declared Rare Flora (DRF) by the Department of Environment and Conservation (DEC), under the *Wildlife Conservation Act, 1950*, or as Threatened under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act, 1999* were recorded within the project area. The 2000 survey recorded two Priority Flora species; *Phyllanthus aridus* (P3) and *Goodenia* sp. East Pilbara (P3). The 2006 survey recorded one Priority 3 species, *Goodenia pascua.*

None of the flora species recorded were found to be exhibiting a range extension from recorded occurrences, as documented by the WA State Herbarium (DEC, 2006).

A total of nine weed species were recorded in the 2000 and 2006 surveys. Two of these, **Prosopis pallida* (Mesquite) and **Datura leichhardtii* (Native Thornapple) are listed as Declared Plants by the Department of Agriculture, pursuant to the *Agriculture and Related Resources Protection Act, 1976.* Under the Act, landholders are obliged to carry out recommended control measures. Buffel Grass (**Cenchrus ciliaris*) was recorded across most of the project area and is also a significant weed within the region. Weed control measures are required within the project area as specified within the *Agriculture and Related Resources Protection Act, 1976.*

A number of vegetation communities recorded during the 2000 and 2006 surveys were determined to be of local or regional significance. The significance is due to either communities supporting significant flora, being limited to specific landforms, or both.

The condition of the vegetation within the project area ranges from Completely Degraded to Very Good. The majority of the vegetation is in Good condition, however weed invasion is relatively high throughout the project area.

Fauna

Fauna species of conservation significance that have been or may occur in the project area are outlined below. No Schedule species were identified but a number of Priority species were identified during field investigations.

Schedule 1

- *Pezoporus occidentalis* (Night Parrot). This species was not recorded during the 2006 and 2000 field surveys. Historically it has been recorded approximately 12km south of the project area, where it was known to inhabit areas dominated by *Triodia spp*.
- *Dasycercus cristicauda* (Mulgara). This species was not recorded during the 2006 and 2000 field surveys. It has been recorded to occur in the Pilbara region approximately 300km east of the project area throughout sandy arid regions.

Schedule 4

- *Falco peregrinus* (Peregrine Falcon). This species was not recorded during the 2006 and 2000 field surveys. The habitat of this species comprises cliffs along coasts, rivers and ranges and wooded water courses (Johnstone & Storr, 1998). Storr (1984) suggests that most Pilbara records have come from 'hilly country, especially the Hamersley Range'. It is likely that this species would occur within the creekline vegetation.

Priority 1

- *Mormopterus loriae cobourgiana* (Little North-Western Mastiff Bat). This species was recorded in 2000 in the mangrove vegetation community at Cape Preston, north of the project area. They are restricted to mangrove forests and adjacent areas (Churchill 1998). No targeted bat survey was undertaken during the 2006 field investigations but recommendations were made to undertake surveys. Subsequent bat surveys using bat call analysis (Phoenix Environmental Sciences 2008) failed to detect this species.

Priority 3

- *Lagorchestes conspicillatus leichardti* (Spectacled Hare-wallaby). This species was not recorded during the 2006 and 2000 field surveys. It is known to have declined from many parts of its previous distribution. This species is susceptible to predation by introduced carnivores.
- *Limnodromus semipalmatus* (Asian Dowitcher). The field survey was not conducted at an opportune time for recording migratory waders and may explain the failure to detect this and possibly other wader species. The preferred habitat of the Asian Dowitcher comprises mudflats and tidal creeks, which in this document are encompassed by the Beach and Mangrove habitats respectively. It is a seasonal visitor (between late August to early April) and is considered rare (Johnstone & Storr, 1998).

Priority 4

- *Leggadina lakedownensis* (Lakeland Downs Mouse, Kerakenga). This species was not recorded during the 2006 field trip, despite targeted efforts to locate it. It has been recorded on Mardie station, with three individuals captured or trapped in 2000. Prior surveys (2000) suggest that the preferred habitat of this species may be cracking clay. Extensive areas of cracking clay occur throughout the project area therefore it is expected that this species may occur in the project area, however the degraded condition of this habitat reduces this potential.
- *Pseudomys chapmani* (Western Pebble Mound Mouse). This species was not recorded during the 2006 field survey. It is known to inhabit low slopes and rocky hills. A single active mound was observed at Mardie in the 2000 survey; however, despite searching the small area of potentially suitable habitat (stony slopes and rises), no evidence of this species was encountered in the project area.
- *Ardeotis australis* (Bustard). This species was recorded during the 2006 field survey. It was also observed outside of the project area in the general location of the Balmoral shearing shed.
- *Burhinus grallarius* (Bush Stone Curlew). This species was not recorded during the 2006 field trip; it was recorded along the North West Coastal Highway in 2000. A single bird was seen on the access track whilst spotlighting. Two additional birds were recorded from the North West Coastal Highway adjacent to the Fortescue Roadhouse. This species prefers lightly wooded country near shelter (Johnstone & Storr, 1998) and is considered rare to uncommon in the region (Storr, 1984; Johnstone & Storr, 1998).
- *Numenius madagascariensis* (Eastern Curlew). This species was not recorded during the 2006 field survey. It was recorded in 2000 along the mud flats adjacent to mangroves west of the Project Area. It is regarded as a visitor between October and February, when it is considered moderately common along tidal mudflats, reef flats and sandy beaches of the Pilbara coast (Johnstone & Storr, 1998).
- *Hydromys chrysogaster* (Water Rat). This species inhabits marine waters along the Pilbara coast. It is known from Barrow Island and has been recorded from a tidal creek at Cape Lambert (Roy Teale, pers. obs.).
- *Falco hypoleucos* (Grey Falcon). Not recorded from the project area. Storr (1984) indicates that in the Pilbara, the Grey Falcon is mostly recorded from the coastal plain between the de Grey and Ashburton Rivers. Johnstone & Storr (1998) indicate that the preferred habitat of this species comprises lightly wooded coastal and riverine plains. In the project area this translates to the Creekline habitat.
- *Lophoictinia isura* (Square-tailed Kite). Not recorded from the project area. Johnstone & Storr (1998) suggest that this species would most likely only be transient in the Pilbara region. Storr (1984) does not mention this species in his account of birds of the Pilbara.
- *Esacus neglectus* (Beach Stonecurlew). Three birds were recorded from the beach on the western side of Cape Preston. The preferred habitat of this species comprises sandy or shingle beaches and tidal reef flats (Johnstone & Storr, 1998). It is considered to be rare on the Pilbara coast.
- *Sterna* (*albifrons*) *sinensis* (White-shafted Tern (Little Tern)). The preferred habitat of this species comprises sheltered seas, estuaries and mangrove creeks. It is mainly a non-breeding visitor (all months, although mostly September to June). Johnstone & Storr (1998) suggest that this species is generally uncommon but plentiful in the Pilbara and Kimberley during passage.

In addition to those already listed above, a further four Priority listed taxa were recorded during the survey:

Priority 1

- *Mormopterus loriae cobourgensis* (Little Western Freetail Bat). A total of 20 individuals (9 adult males, 11 adult females) were captured in mist nets set against Rhizophora and with a harp trap between Avicennia. This subspecies of bat is listed as a Priority 1 taxa as there is little data available and it has a distribution restricted to the mangroves of the North-west of Western Australia.

Priority 4

- *Leggadina lakedownensis* (Short-tailed Mouse). Three individuals of this Priority 4 rodent were recorded from the services corridor. Regional records to date strongly suggest that the main habitat for this species on the mainland comprises areas of cracking clay. Extensive areas of cracking clay occur throughout the project area and the sites from which the species was recorded included, or were adjacent to, this habitat type. Until recently, *L. lakedownensis* was only known from offshore islands and a restricted locality in the Central Pilbara. The species has been recorded more frequently in recent surveys and is apparently more widely distributed in the region than initial records indicated.
- *Chelonia mydas* (Green Turtle). Several Green Turtles, both adults and sub-adults, were observed in the tidal creek at the base of Cape Preston. Furthermore, body holes of marine turtles were observed on the beaches at the northern end of Cape Preston. While these may possibly belong to Green Turtles, other species of marine turtles cannot be excluded as Hawksbills, Loggerheads and Flatbacks are all known to nest in the region. Significantly, the Loggerhead turtle is listed as a Schedule 1 species whilst the Hawksbill is listed as a Priority 4 species. Clearly there is a need to identify the species using the beaches for nesting so that the species involved and the potential impacts can be clearly identified.

Fauna species of a national significance (EPBC listed) that may occur within or near the project area are listed below:

- *Dasycercus cristicauda* (Mulgara) – Schedule 1, Vulnerable. Occurs within drainage lines near sandy plains and dunes;
- *Rhinonicteris aurantius (Pilbara form)* (Pilbara Leaf-Nosed Bat) – Vulnerable. Occurs within caves and abandoned mines;
- *Morelia olivacea barroni* (Olive Python) – Vulnerable. Occurs within drainage lines of the Fortescue River System;
- *Caretta caretta* (Loggerhead Turtle) – Endangered;
- *Chelonia mydas* (Green Turtle) – Vulnerable;
- *Dermochelys coriacea* (Leatherback Turtle) – Vulnerable;
- *Eretmochelys imbricate* (Hawksbill Turtle) – Vulnerable;
- *Natator depressus* (Flatback Turtle) – Vulnerable.

The undescribed species of skink, *Ctenotus* aff. r*obustus* was also recorded during the 2006 survey and two species listed under the JAMBA/CAMBA International Agreements for the protection of Migratory bird species were recorded. The Rainbow Bee-eater (*Merops ornatus)* was recorded regularly throughout the project area and the White-bellied Sea Eagle (*Haliaeetus leucogaster)* was sighted once.

In general, it has been determined over the course of the 2000 and 2006 field surveys the fauna habitats within the project area are all regarded as well represented in the region and none are regraded as regionally significant or unique. Many years of livestock grazing has reduced the quality of available fauna habitat.

Factors of Significance
The factors of biological significance determined to be present within the project area are:

- Priority 3 Flora species *Phyllanthus aridus*, recorded during 2000;
- Priority 3 Flora species, *Goodenia pascua*, recorded during 2006;
- Declared Plants **Prosopis pallida* (Mesquite) and **Datura leichhardtii* (Native Thornapple) recorded throughout the area;
- a range of communities considered locally or regionally significant due to supporting significant flora or being limited to specific landforms;
- The Priority fauna species; the Little Western Freetail (Mastiff) Bat (*Mormopterus loriae cobourgensis)*, Western Pebble-mound Mouse (*Pseudomys chapmani)*, Lakeland Downs Mouse (*Leggadina lakedownensis)*, Bush Stonecurlew (*Burhinus grallarius)*, Beach Stonecurlew (*Esacus neglectus)*, Eastern Curlew (*Numenius madagascariensis)* and the Australian Bustard and the Green Turtle (*Chelonia mydas)*.;
- Two undescribed rodent species recorded during 2000 and one of these also during 2006;
- EPBC/JAMBA/CAMBA Migratory Bird species, the Rainbow-bee Eater and the White-bellied Sea Eagle were recorded during 2006;
- The project area may contain suitable habitat for several EPBC listed species, including the Pilbara Olive Python, the Mulgara, several marine turtles and two migratory terrestrial bird species.

The statutory obligations arising as a result of the flora and fauna surveys are:

- liaison with DEC regarding priority flora and fauna recorded;
- liaison with DEC regarding significant vegetation communities;
- control of Declared Plants as per recommended control measures of the Department of Agriculture and Food; and
- referral under the EPBC Act for EPBC listed species that could potentially occur within the project area.

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1.0 Introduction

1.1 Background

International Minerals Pty Ltd (IM) is currently seeking environmental approval for the proposed Balmoral South Iron Ore project (the Balmoral South Project) located approximately 80km south-west of Karratha.

The Balmoral South Project will include the development of an open pit, processing plant, waste disposal facilities, product stockpiles and additional infrastructure including access roads, haul roads, accommodation village, power station, power distribution network, desalination plant and rail corriodor (Figure 1). Full details of the development and environmental studies undertaken are provided in the Public Environmental Review (PER).

The project will take place within the Cape Preston Mining Precinct, and will be located adjacent to the approved Central Block Project.

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Figure 1: Cape Preston Iron Ore Project Area Central Block and Balmoral South Projects (Mineralogy Pty Ltd)

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In 2006, IM commissioned Maunsell AECOM (Maunsell Australia Pty Ltd) to conduct Seasonal Flora and Fauna (Biological) Surveys of the project area. This commission included:

- a review of data previously collected in the project area; and
- detailed studies in previously unsurveyed areas within the project area.

During 2000, Maunsell AECOM (then Halpern Glick Maunsell (HGM)) conducted a large scale Biological Survey of the area for the Austeel (Mineralogy) project. This survey assessed all of the mining leases (M08/118 to M08/130) covering the Balmoral Deposit held by Mineralogy, which encompassed some of the Balmoral South project area. Figure 2 highlights where flora and vegetation surveys have been conducted over the project area.

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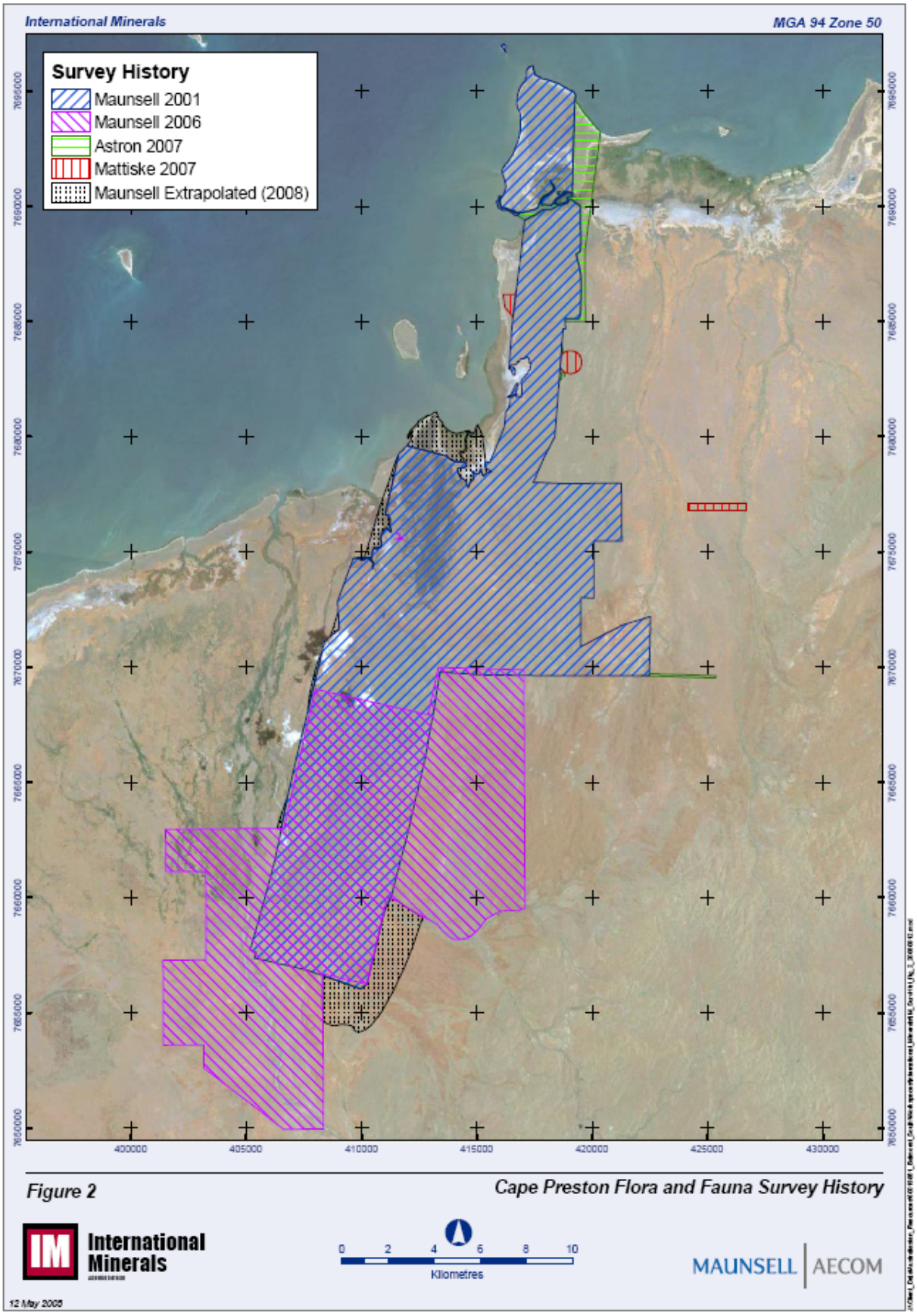
Figure 2: Cape Preston Iron Ore Project Area Survey History



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The 2006 surveys involved detailed studies in the previously unsurveyed areas and a review of results gathered during the 2000 survey in the overlapping areas.

Mattiske Consulting and Astron Environmental Services conducted additional surveys within the project area during 2007.

Collectively, five floristic assessments and two fauna assessments were conducted within the project area between 2000 and 2007. They are:

- Austeel. Biological Survey Phase 1 (Biota Environmental and MF Trudgen and Associates, 2001, also referred to as HGM 2001);
- Cape Preston Iron Ore Development, Seasonal Biological Survey – Threatened Flora (Maunsell AECOM Australia Pty Ltd, 2003);
- Balmoral South Environmental Impact Assessment, Flora and Fauna Survey, Balmoral South (Maunsell AECOM Australia Pty Ltd, 2006);
- Flora and Vegetation Survey of Cape Preston Potential Campsites and Airstrips (Mattiske Consulting, 2007); and
- General Purpose Leases G 08/52 and G08/53 Additional Vegetation Survey and Mapping (Astron Environmental Services, 2007).

The surveys specifically dealt with:

- flora;
- vegetation communities;
- vegetation condition;
- observed fauna;
- evidence of fauna activity;
- trapped fauna records;
- potentially present fauna; and
- inferred fauna habitats.

This report presents the collective findings of these surveys in the context of the Balmoral South Iron Ore project.

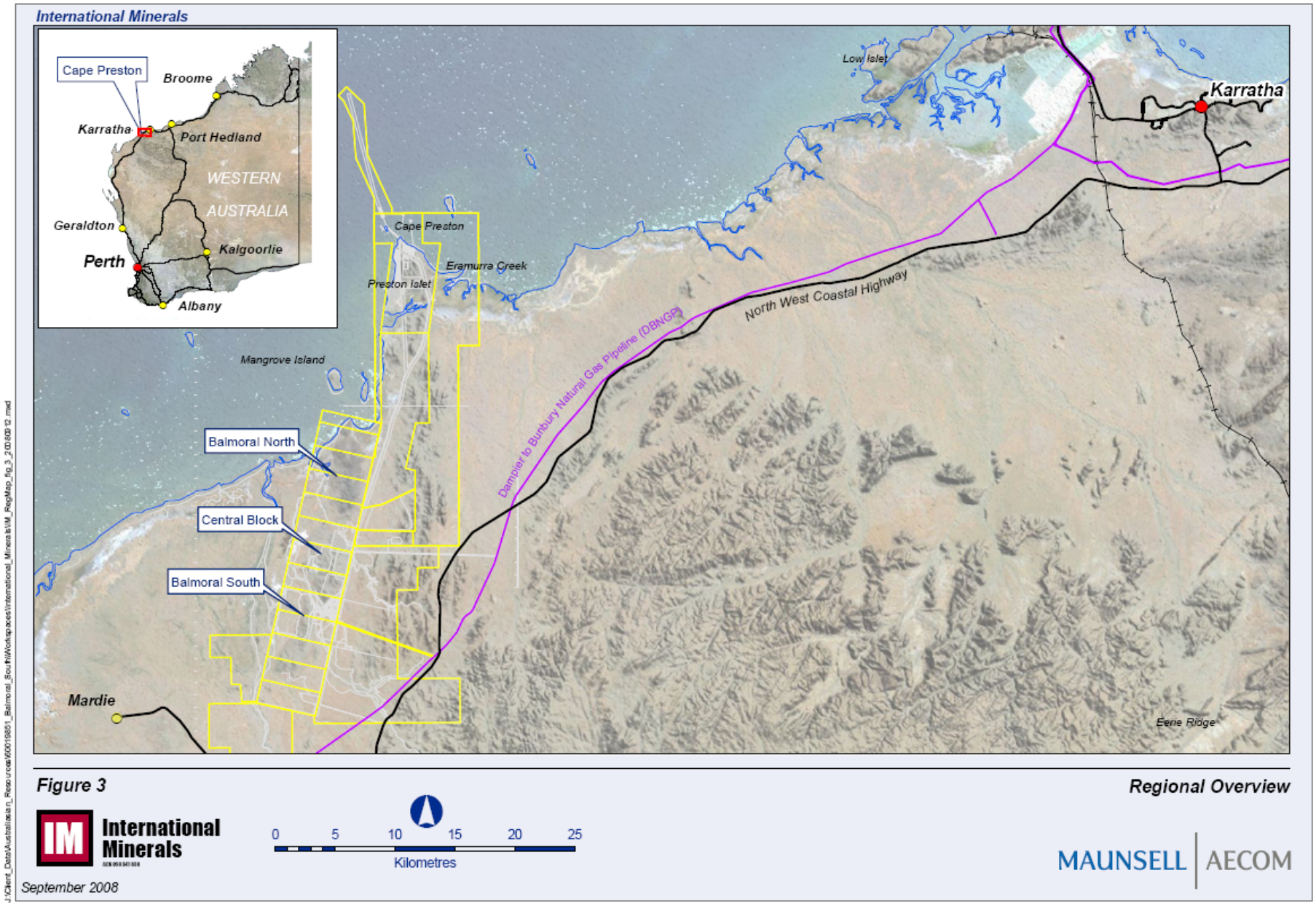
In addition to the above surveys, Maunsell AECOM is currently undertaking an additional flora and vegetation survey, focusing on the Balmoral North project area (M08/118 – M08/122) and southern parts of the Balmoral South stage 2 project area (M08/128 – M08/129) (Maunsell AECOM, 2008, in prep).

Furthermore, Phoenix Environmental Sciences has carried out a desktop and field assessment of key fauna habitats in relation to their potential to support populations of the listed species: Mulgara (*Dasycercus cristicauda*) and Pilbara Olive Python (*Liasis olivaceus barroni*) (Phoenix Environmental Sciences, 2008a). The project area has also been surveyed for bats using Bat Call Analysis (Phoenix Environmental Sciences 2008). Phoenix Environment has also surveyed the project area for the presence of Short Range Endemic species in August (Phoenix Environmental Sciences, 2008c – in prep) and has undertaken a single season Level 2 vertebrate fauna survey and targets species survey in September, 2008 (Phoenix Environmental Sciences 2008b – in prep).

1.2 Location

The Balmoral South Iron Ore project area is located approximately 90km WSW of Karratha and occurs within the Shire of Roebourne (Figure 3). The project area lies within the Cape Preston Mining Precinct, commencing at Cape Preston and terminating approximately 48 km to the south.

Figure 3: Balmoral South Project Location



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1.3 Climate

Rainfall is relatively low throughout the general region of the project area. Except in the far south, almost all rain comes from scattered summer thunderstorms and the occasional tropical cyclone.

The coast from Port Hedland to Exmouth Gulf is one of the most cyclone prone areas in Australia with several severe tropical cyclones crossing this section of coastline this century. The general rainfall range is 250 - 450mm per annum. In many cases several years may pass without significant rainfall followed by sudden and substantial downpours from tropical cyclone activity. In the south where tropical activity is lower, Bureau of Meteorology data (2006) shows lower rainfall totals.

This Pilbara region supports a number of Australia's consistently hottest townships. The normal inland summer range is 37 - 42˚C and the coast such as Port Hedland is 2 - 3 ˚C cooler, but often with higher humidity. Winter temperatures are warm, lasting 6 - 8 weeks with temperatures in the 23 - 27˚C range.

1.4 IBRA Bioregion

There are 85 recognised IBRA Biogeographic regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (Environment Australia, 2000). The project area lies within the Pilbara Biogeographic Region of Interim Biogeographic Regionalisation for Australia (IBRA).

The Pilbara Biogeographic Region is comprised of four Biogeographical subregions; the Chichester, Fortescue Plains, Hamersley and Roebourne Subregions. On a finer scale, the project area lies within the Roebourne Subregions.

Kendrick and Stanley (2001) have broadly described the Roebourne subregion as: Quaternary alluvial and older colluvial coastal and sub-coastal plains with a grass savannah of mixed bunch and hummock grasses and a dwarf shrub steppe of *Acacia stellaticeps* or *Acacia pyrifolia* and *Acacia inaequilatera*.

In 2003, the Pilbara – Hamersley region was identified as one of 15 biodiversity hotspots of Australia. The Hamersley – Pilbara hotspot provides habitat for a number of threatened, endemic and fire sensitive species and communities (DEWR, 2007) and provides protected habitats for species such as the Ghost Bat (*Macroderma gigas*), Mulgara (*Dasycercus cristicauda*) and Spectacled Hare – Wallaby (*Lagorchestes conspicillatus leichardti)*.

1.5 Existing Environment

1.5.1 Soils

The project area falls within the Pilbara Region which lies on a complex mixture of soils. The Balmoral South Iron Ore project area includes the weakly gilgaied cracking clay plains of the Horseflats, rugged basalt or jaspilite plateaus and ridges shifting to stony plains and active floodplains of deltaic deposits flanking major rivers and creeks (HGM, 2001).

1.5.2 Land Systems

The project area lies within a region for which the Land Systems have been mapped as part of the rangeland assessment programme (Department of Agriculture, 2004). Digital data was obtained from the current custodian, the Department of Land Information (DLI).

The project area includes portions of ten land systems (Figure 4), described as follows:

Boolgeeda Stony lower slopes and plains found below hill systems, supporting hard and soft spinifex grasslands and mulga shrublands. Predominantly deposition surfaces of very gently inclined stony slopes and plains becoming almost level further downslope.

Cheerawarra Sandy coastal plains and saline clay plains supporting soft and hard spinifex grasslands and minor tussock grasslands. Depositional surfaces of gently undulating sandy surfaced coastal plains.

Horseflats Extensive, gilgaied clay plains supporting tussock grasslands and minor grassy snakewood shrublands. Depositional surfaces consisting of gilgaied and non – gilgaied clay plains, stony plains, narrow linear drainage depressions and dissected slopes marginal to the River Land Systems.

Littoral Coastal fringe consisting of areas of mangal on the seaward fringe, samphire shrublands on mudflats, *Acacia coriacea* shrublands over spinifex or tussock grasses on coastal dunes and *Triodia angusta* hummock grasslands on broad sandy plains.

Macroy Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands.

Newman Rugged jaspilite plateaux and ridges with hard Spinifex grassland; prominent in the Northern, central and western sections of the study area.

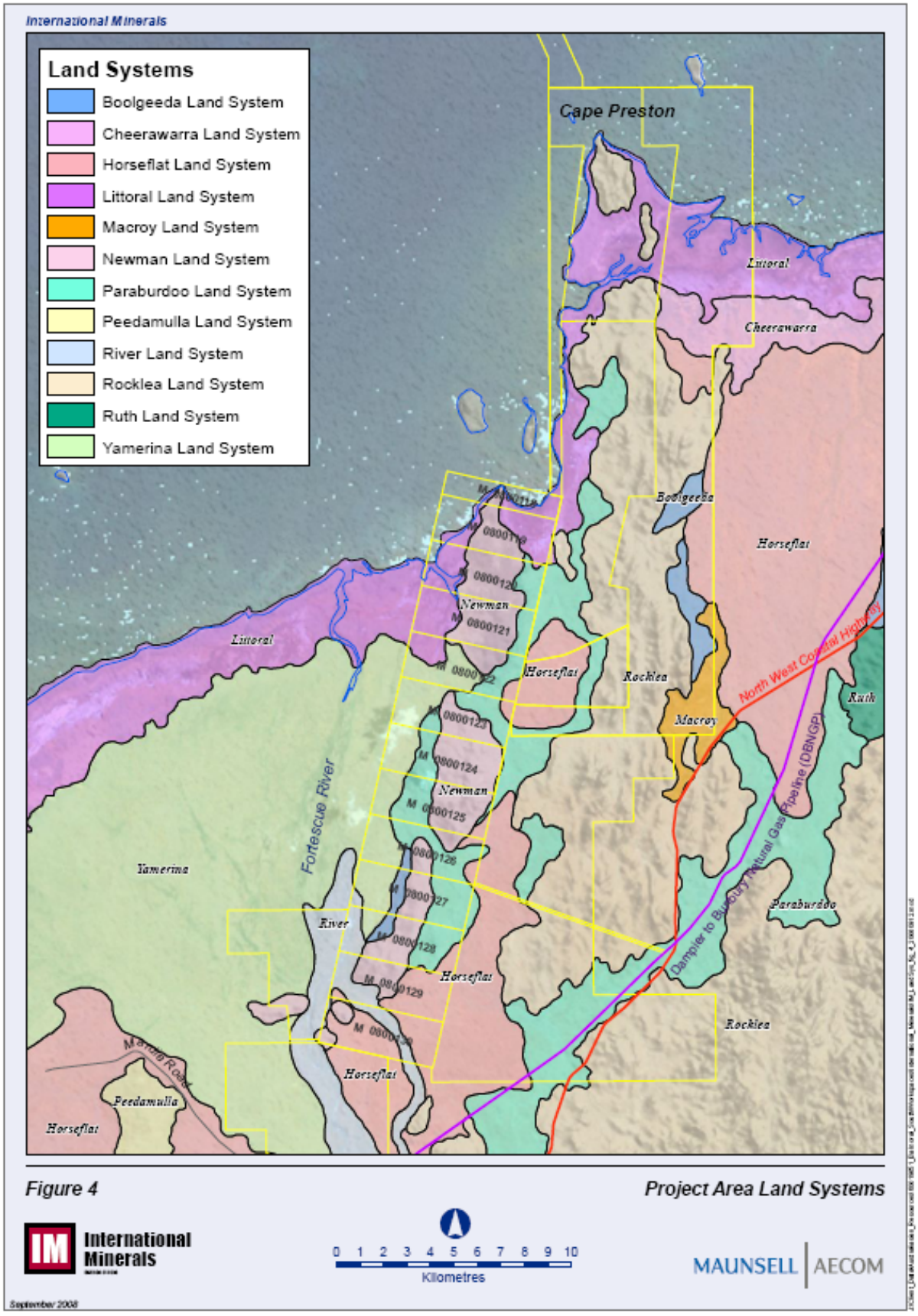
Paraburdoo Stony gilgai plains derived from basalt, supporting snakewood shrublands and mulga shrublands with spinifex and tussock grasses. Consists of depositional surfaces such as isolated low basalt hills and stony upper interfluves and plains with small groves.

River Active floodplains and terraces flanking major rivers and creeks, supporting riverine woodlands and tussock and hummock grasslands; associated with the Fortescue River system. Flood plains and river terraces are subject to fairly regular overbank flooding from major channels and watercourses, sandbanks and poorly defined levees and cobble plains.

Rocklea Rugged Basalt hills and plateau remnants with hard Spinifex grasslands; prominent in the northern portion of the project area.

Yamerina Floodplains and deltaic deposits supporting tussock grasslands with chenopod low shrubs and soft Spinifex grasslands; occurred in the western portions of the study area.

Figure 4: Project Area Land Systems.



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1.5.3 Flora and Vegetation

The project area is situated within the Fortescue Botanical District of the Pilbara region and broadly consists of:

- various *Acacia* Shrublands over *Triodia* Hummock Grasslands on the more rugged, shallow soiled habitats; and
- *Eragrostis xerophila* Tussock Grasslands dominating the heavy clay soils.

Drainage lines are dominated by *Eucalyptus* species over *Melaleuca* and *Acacia* Shrublands. These areas also tend to be heavily infested with **Cenchrus ciliaris* (Buffel Grass), a highly invasive weed introduced by pastoralists for its high grazing value.

Beard's (1975) 1:1,000,000 scale mapping of the Pilbara region identified the following broad terrestrial vegetation types occurring in the project area:

T_1Hi	*Triodia pungens* steppe (hummock grassland);
A_2Sr,t_1Hi	Shrub-steppe of *Acacia pyrifolia* over *Triodia pungens;*
xGc/t_1Hi	Mosaics of grass savannah with Spinifex *Triodia pungens;*
e_{40}Lr.xGc	*Eucalyptus* sp. *aff. aspersa* sparse tree savannah over short grassland;
a_{11}Sb.xGc/a_2Sr.t_1Hi	Shrub savannah of *Acacia xiphophylla* over short grassland and shrub-steppe of *Acacia pyrifolia.*

It is important to note that Beard's mapping is at a broad scale which requires amalgamation of minor vegetation types and is biased towards large and commonly distributed units. In addition, due to limited sampling, Beard's units often contain inaccuracies.

The Department of Agriculture WA has mapped the Land Systems (and sub-units of these) of the region from 1:50 000 aerial photography. This mapping provides the largest scale interpretation of vegetation units available for the project area (Van Vreeswyk *et al.*, 2004). The Land System Mapping describes eighty four terrestrial vegetation units, comprising ten land systems for the project area.

1.5.4 Fauna

As for most of the Pilbara region, the general area of the proposed mining development is relatively poorly surveyed for both flora and especially fauna (HGM, 2001). Recent mining booms in the Pilbara have resulted in the need for a rapid increase in the number of biological surveys.

Typically, adequate fauna trapping and sampling in climates such as the Pilbara is difficult, due to weather extremes. During higher temperature, there are significant timing limitations as traps must be cleared well before the onset of the heat of the day. Conversely, low levels of reptile and small mammal activity are encountered during cooler months. It is therefore considered that at any given time of the year, fauna surveys are unrepresentative of faunal composition of the region.

Based on the results of previous surveys, the fauna of the project area is dominated by avifauna (birds) and reptiles (HGM, 2001; Maunsell AECOM 2006). Several species of mammal are also common, predominantly consisting of small species such as native mice. Several species of conservation significance are known to occur in the region.

1.6 Biological Factors of Environmental Significance

1.6.1 Flora

Species of flora are defined as Declared Rare or Priority conservation status where their populations are restricted geographically or threatened by local processes. The DEC recognises these threats of extinction and consequently applies regulations towards population and species protection.

Rare Flora species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act, 1950.* It is an offence to "*take*" or damage Rare Flora without Ministerial approval. Section 23F of the *Wildlife Conservation Act, 1950* defines "*to take*" *as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means."*

Species designated as Priority Flora are under consideration for declaration as 'Rare Flora' and are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the *Wildlife Conservation Act, 1950* as extracted from the Department of Conservation and Land Management (2005) (CALM, now DEC).

Table 1: Definition of Declared Rare and Priority Flora Species (Department of Conservation and Land Management, 2005)

Conservation Code	Category
DRF	Declared Rare Flora – Extant Taxa *"Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such."*
P1	Priority One – Poorly Known Taxa *"Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."*
P2	Priority Two – Poorly Known Taxa *"Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."*
P3	Priority Three – Poorly Known Taxa *"Taxa which are known from several populations and the taxa are not believed to be under immediate threat (ie. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey."*
P4	Priority Four – Rare Taxa *"Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."*

Threats of extinction of species are also recognised at a Commonwealth level and are categorised according to the *Environment Protection and Biodiversity Conservation* (EPBC) *Act, 1999.* Categories of Commonwealth listed threatened species are summarised in Table 2.

Table 2: Categories of Threatened Flora Species (*Environment Protection and Biodiversity Conservation Act, 1999*)

Conservation Code	Category
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which 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.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of five years.

1.6.2 Vegetation

1.6.2.1 Threatened Ecological Communities

Communities are described as 'Threatened Ecological Communities' (TEC's) if they have been defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (DEC) and found to be Presumed Destroyed (PD), Critically Endangered (CR), Endangered (EN) or Vulnerable (VU). For definitions of TEC categories and criteria refer to English and Blyth (1997). CALM maintains a database of State listed TECs which is available for online searches at their website: www.calm.wa.gov.au.

Selected plant communities are also listed as TEC's under the Commonwealth EPBC Act. The TEC's on the Commonwealth register are also available online at the Department of Environment, Water, Heritage and The Arts (DEWHA) website: www.environment.gov.au

1.6.2.2 Locally and Regionally Significant Communities

Vegetation communities are referred to as Locally Significant where they:

- support populations of Priority Flora species;
- extend the geographic range of particular taxa from previously recorded locations;
- are restricted to only one or a few locations;
- occur as small isolated communities; or
- exhibit unusually high structural and species diversity.

Vegetation communities are referred to as Regionally Significant where they:

- are limited to specific landform types;
- are uncommon or restricted plant community types within the regional context; or
- support populations of Declared Rare Flora (Dr. E. Mattiske, *pers. comm*.).

1.6.3 Fauna

Species of fauna are defined as threatened where their populations are under threat, require protection or are protected under an international agreement. DEC recognises these threats of extinction and consequently applies regulations towards population and species protection.

Threatened fauna species are protected under Section 16 of the *Wildlife Conservation Act, 1950*. It is an offence to "take, destroy or possess" threatened fauna without Ministerial approval. Species of fauna listed under Schedule 1 to 4 of the *Wildlife Conservation Act, 1950* are summarised in Table 3.

Table 3: Western Australian *Wildlife Conservation Act, 1950* Codes for Threatened Fauna

Conservation Code	Category
Schedule 1	Fauna that is rare or likely to become extinct are declared to be fauna that is in need of special protection.
Schedule 2	Fauna that is presumed to be extinct are declared to be fauna that is in need of special protection.
Schedule 3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that is in need of special protection.
Schedule 4	Fauna that is in need of special protection, otherwise than for the reasons mentioned [in Schedule 1 – 3].

Priority fauna not listed as Threatened (Scheduled) under the *Wildlife Conservation Act, 1950*, but are poorly known or poorly represented in the conservation estate are regarded as Priority and attention is given to their conservation, primarily through improving available information, by DEC.

The five classifications of priority fauna are listed in Table 4.

Table 4: Explanation of Priority Codes Observed by DEC

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring – considered to have been adequately surveyed
Priority 5	P5	Taxa that are conservation dependent (i.e. their conservation status is dependent on ongoing active management)

Threats of extinction of fauna species are also recognised at a Commonwealth level and are categorised according to the EPBC Act. Categories of threatened species are summarised in Table 5.

Table 5: Categories of Threatened Fauna Species (*Environment Protection and Biodiversity Conservation Act, 1999*)

Conservation Code	Category
Ex	Extinct Taxa not definitely located in the wild during the past 50 years
ExW	Extinct in the Wild Taxa known to survive only in captivity
CE	Critically Endangered Taxa facing an extremely high risk of extinction in the wild in the immediate future
E	Endangered Taxa facing a very high risk of extinction in the wild in the near future
V	Vulnerable Taxa facing a high risk of extinction in the wild in the medium-term
NT	Near Threatened Taxa that risk becoming Vulnerable in the wild
CD	Conservation Dependent Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
DD	Data Deficient (Insufficiently Know) Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

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2.0 Objectives

The overall objectives for the flora and fauna biological assessments of the project area were to identify biological issues that may trigger formal assessment requirements, and to provide advice regarding ecological constraints on the development of the project area.

The specific objectives for the assessment of flora and vegetation values were to:

- review available information on terrestrial flora and vegetation of the project area and surrounds;
- review the conservation status of potential threatened flora and vegetation occurring within the project area;
- conduct a 'Level 2' detailed vegetation and flora survey (EPA 2004a);
- map and delineate vegetation communities within the project area;
- interpret and report on survey results, including a summary of the consequences of these results on environmental approvals;
- identify the potential impacts of the project; and
- provide management recommendations to reduce or eliminate any potential impacts on flora and vegetation.

The specific objectives for the assessment of fauna values are to:

- review available information on terrestrial vertebrate fauna of the project area and surrounds;
- review the conservation status of potential threatened vertebrate fauna occurring within the project area;
- conduct a 'Level 2' detailed fauna survey (EPA 2004a);
- interpret and report on survey results, including a summary of the consequences of these results on environmental approvals;
- identify the potential impacts of the project; and
- provide management recommendations to reduce or eliminate any potential impacts on flora and vegetation.

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3.0 Methodology

The seasonal surveys of the project area assessed a range of factors during the field investigations, including:

- *Flora*, with the focus on significant flora and threatened species;
- *Vegetation communities*, with the focus on threatened ecological communities and local and regional significance;
- *Vegetation condition;*
- *Fauna,* with the focus on threatened fauna; and
- *Fauna habitats*, based on vegetation

3.1 Terrestrial Flora and Vegetation Survey

The flora and vegetation field assessment of the project area was conducted in accordance with the EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004) for Level 2 Surveys. This included:

- a desktop review of available literature and DEC/EPBC databases; and
- field surveys, including:
  - a review field survey of areas surveyed in 2000; and
  - detailed field surveys of previously unsurveyed areas within the project area (including establishment of permanent study plots).

3.1.1 Desktop Studies

A literature review of available information documenting the flora and vegetation of the project area and the Pilbara region was conducted prior to the commencement of each field investigation. This review concentrated primarily on the original Biological Survey of the Austeel project area (HGM, 2001).

A search of the DEC Declared Rare and Priority Flora database was undertaken to identify significant flora that could potentially occur in the project area. The search co-ordinates used were 20^0 45' - 21^0 20' S and 116^0 00' - 116^0 15' E during 2000 and 21^0 00' - 21^0 19' S and 115^0 56' - 116^0 17' E during 2006. DEC's 'Declared Rare and Priority Flora List' was also interrogated. The results of both searches are presented in the results section of this report.

A search of the DEC's Threatened Ecological Communities (TEC) database was also conducted for the project area prior to undertaking the field survey. This search identified that there are no known occurrences of threatened ecological communities within the project area.

3.1.2 Field Survey

The field survey within the project area was conducted immediately after the peak rainfall season (July). This is considered to be the optimal time for flowering and for detecting the presence of annual and ephemeral species within the Pilbara.

The field survey included a reconnaissance review to confirm the results from the 2000 survey as well as detailed studies within previously unsurveyed sections of the project area.

Assessment of flora and vegetation included:

- broad scale vegetation mapping; and
- detailed permanent plot studies.

Aerial photography was utilised in the field to delineate vegetation community boundaries within the project area. The broad scale mapping involved defining vegetation community types by recording accurate information at various locations, based on changes in floristic structure and species composition. Where marked changes in species composition occurred, all flora species encountered were identified and recorded. These proportions were then used to describe the vegetation communities, which could then be delineated on aerial photography for extrapolation of distribution.

The broad scale vegetation mapping described was carried out over the entire project area in order to ground truth and review existing results.

The previously unmapped areas were mapped in 2008 by extrapolating and inferring the vegetation communities from adjacent communities within the lease that have been mapped on the ground via site verification. Using high resolution aerial photography, the boundary of each vegetation community was delineated. Areas that were of the same visual appearance and within similar positions in the landscape were deemed to be the same community.

The extent of newly mapped vegetation communities were manually delineated onto electronic aerial photography of the project area, using a Geographic Information System (Arc GIS).

Detailed assessment of the flora and vegetation was carried out within permanent vegetation quadrats established in a range of locations and within a range of vegetation communities, representative of the floral composition of the project area. Quadrats of 50m x 50m were established, which is in line with the recommended dimensions for Pilbara vegetation which has relatively low diversity and the 2000 assessment (HGM).

Creekline vegetation was sampled using 2m wide transects, rather than quadrats, to capture only the targeted vegetation type. Transect lengths varied based on the width of the riparian vegetation and the entire width was usually captured. In the event that transects encountered more than one distinct vegetation type, data was separated to permit accurate analysis without misleading results.

Collectively, a total of 155 quadrats were established and recorded across the project area. The locations of the detailed recording sites were chosen to represent the major vegetation types occurring within the project area. The majority of sites were concentrated in areas proposed for development, whilst still sampling a representative suite of vegetation types. Additionally, the DEC had previously identified cracking clay communities of the Horseflat Land System as a likely habitat for threatened flora species. Accordingly, particular attention was paid to sampling in this habitat via quadrats and numerous foot traverses.

Each of the quadrats was permanently pegged with one wooden peg in the north-west corner. Temporary pegs were placed in the remaining three corners during sampling and measuring tapes used to construct the quadrats were kept in place to clearly indicate quadrat boundaries.

Information was collected systematically using standardised data sheets, ensuring accurate and consistent data records. The following records were made at each location:

- quadrat number;
- vegetation community or quadrat location, based on broad scale mapping;
- GPS co-ordinates of the north-west corner peg;
- all flora species,
- dominance of each species;
- average height of each species;
- soil type and colour;
- outcropping rocks and their type;
- topography;
- percentage litter cover;
- percentage bare ground;
- degree of disturbance/weed invasion; and
- type of disturbance, if other than weed invasion (e.g. cattle, erosion, etc.).

Species unidentifiable in the field were systematically collected, pressed, dried and fumigated in accordance with the requirements of the West Australian Herbarium. The plant species were identified and then compared with pressed specimens housed at the West Australian Herbarium. Where appropriate, plant taxonomists with specialist skills were consulted. Nomenclature of the species recorded follows protocols of the West Australian Herbarium (CALM, 2005).

Vegetation condition was determined within each quadrat and at a range of additional locations, based primarily on the ratio of introduced (weed) species to native species. Where marked changes in vegetation condition were noted, detailed recordings were made and the level and nature of disturbance such as grazing or erosion were also considered. The categories used to determine vegetation condition consisted of a combination of methods developed by Keighery (1994) and the Braun-Blanquet Scale (Mueller-Dombois and Ellenberg, 1974) for cover abundance, as summarised in Table 6.

Table 6: Bushland Condition Ratings (adapted from Keighery, 1994 and the Braun-Blanquet Scale of Cover Abundance (from Mueller-Dombois and Ellenberg, 1974)).

Description	Explanation
Pristine	Pristine or nearly so, no obvious signs of disturbance. *0 % weed cover*
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. *1 – 5 % weed cover*
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing. *5 – 25 % weed cover*
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing. *25 – 50 % weed cover*
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing. *50 – 75 % weed cover*
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs. *75 – 100 % weed cover*

3.1.3 Data Processing

All raw site data from the 2006 flora assessment was submitted for analysis to Mr Ted Griffin, a local PATN expert. Data was entered into an Access database containing the entire suite of the Western Australian Flora. The database permits corrections to spelling mistakes and other nomenclature and then accurate data is statistically analysed using PATN (Belbein, 1987) Analysis. The PATN Analysis was used to determine which quadrats (and therefore vegetation communities) are floristically similar. The comparisons were run twice, using presence / absence data and percentage cover / dominance data. The presence/absence data was found to be most appropriate for assessing the regional nature of the variation in site composition of quadrat data in earlier analysis of the Pilbara bioregion (Ted Griffin *pers. comm*.).

Several modules of the numerical classification package PATN (Belbein, 1987) were used for the analysis. The Griffin (2006) report explains these methods and discusses some of the results of the analysis (Appendix A). The quadrat data used for the PATN analysis is included as Appendix B. The qualitative results of PATN analysis were used to refine the classification and distribution of vegetation communities identified in the field.

3.2 Vertebrate Fauna Survey

The fauna field assessments (2000 and 2006) of the project area were conducted in accordance with the EPA Guidance Statement No. 56, *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2003) for Level 2 Surveys, encompassing:

- Desktop studies;
- Field survey, encompassing:
  - opportunistic sightings and sampling; and
  - a targeted trapping program.

3.2.1 Desktop Studies

Maunsell AECOM conducted a literature review of available information documenting the fauna of the project area and the Pilbara region prior to the commencement of field investigations. This review concentrated primarily on the original Biological Survey of the Austeel project area (HGM, 2001).

As part of the desktop studies, a search of the DEC's Rare Fauna and EPBC databases was carried out to identify significant fauna that could potentially occur in the study area. The search co-ordinates used were 4707°S 115.882° E / 20.8749°S 116.415°E (Mardie Station plus 15 km buffer).

The results of the database searches are presented in the results section of this report.

Vegetation mapping and aerial photography of the project area were reviewed prior to the field survey in an effort to locate potential fauna trapping sites. Nominated areas were inspected on site and assessed for suitability and accessibility. Four transect sites were identified, representing a large proportion of the unsurveyed project area, as being required to complement those undertaken in 2000 (HGM 2001) of which nine sites were sampled. These areas were defined based on the habitat requirements of a range of vertebrate species, including reptiles, mammals and birds and were partially dependant on the level of livestock activity in the immediate area.

A subsequent desktop assessment of the likelihood of key habitats to support populations of Mulgara and the Pilbara Olive Python was undertaken in 2008 (Phoenix Environmental Sciences, 2008) and is provided in in Appendix J.

3.2.2 Field Survey

The 2006 fauna field survey was conducted during October in accordance with advice from the DEC that this timing would record optimum fauna records due to the onset of warmer weather and presence of flowering annuals. In addition, temperatures in the Pilbara region begin to increase at this time of year, resulting in increased activity by reptiles and other cold blooded animals. Field surveys took place between 21 - 29 October 2006 and previously between 14 – 28 April 2000 by Roy Teale (principal zoologist) and Kyle Armstrong (bat survey). An additional day (8 May 2000) was spent investigating potential sightings of Black and White Fairy-wrens on Cape Preston in conjunction with staff of the Western Australian Museum and CALM Karratha.

Sampling for the 2006 survey was conducted under the DEC's Regulation 17 "Licence to Take for Scientific Purposes" No SF005496.

The field survey within the project area specifically included;

- habitat definition, based on vegetation mapping;
- targeted searches along defined transects recording detailed field observations including;
  - evidence of fauna activity such as scats, tracks and fur; and
  - turning over rocks and searching micro-habitats;
- targeted trapping for frogs, reptiles and mammals over a series of consecutive nights, in a range of representative habitats;
- visual avifauna (bird) surveys; and
- night-time spotlighting for nocturnal species.

Some of the abovementioned sampling activities are described in more detail in the following sections.

3.2.2.1 Trapping

Methods employed for the sampling of vertebrate species via trapping included the use of pitfall, funnel and small box (Elliot) traps within the project area. Traps were deployed along four transects with the aim of sampling differing vegetation communities and soil types.

Table 7 summarises the trapping effort made during the 2006 survey.

Table 7: Summary of Trapping Effort during the 2006 Fauna Survey.

Site	Date Set-up	Date Closed	Nights Open	Pit Traps	Elliott Traps	Funnel Traps	Pit Trap Effort	Elliott Trap Effort	Funnel Trap Effort	Total Trap Effort
1	21/10/06	27/10/06	5	10	10	10	50	50	50	150
2	22/10/06	27/10/06	5	10	10	10	50	50	50	150
3	23/10/06	28/10/06	5	10	10	10	50	50	50	150
4	24/10/06	29/10/06	5	10	10	10	50	50	50	150
	Total		20	40	40	40	200	200	200	600

Each transect line comprised 10 pitfall traps, each placed at an interval of approximately of 25 - 30m, with Elliott traps placed adjacent to every pitfall, (10 Elliott traps per transect). Pitfall traps were made up of 20L PVC buckets with a 25 cm high flywire drift fence extending perpendicular to the transect, for approximately 2.5m either side of the pitfall.

Each pitfall fence was linked to a 15 cm wide and 60 cm long funnel trap. Funnel traps were set up at the end of each drift fence with the funnel's 5cm entrance bisected by the fence. Each funnel trap was covered with shade cloth and where possible positioned under the cover of vegetation to provide shade and cooler conditions for trapped fauna. Elliott traps were baited with a mixture of rolled oats, peanut butter and sardines.

Due to the hot conditions during the survey, trap clearing commenced at first light and completed by 8am each day. Elliot traps were closed each morning and then re-opened during the late afternoon. Funnel traps were left unzipped during the heat of the day and then re-set in the late afternoon. The procedure for closing and opening traps, whilst time consuming, was necessary to help reduce the chances of fauna mortality under the hot conditions.

Each transect was operated for a total of five consecutive nights, equating to a total of 200 pitfall, 200 Elliott and 200 funnel trap nights.

The placement of traps and site selection was hampered by two key factors.

1) the number of livestock traversing the project areas; and
2) reduced vegetation (fauna habitat) due to grazing pressure.

The rationale behind spacing the pitfall traps at 25 – 30 m intervals was to help reduce damage to the trap sites caused by grazing livestock. The utilisation of a 100m transect with all pitfall traps linked continuously was abandoned as interference by cattle may have reduced effectiveness of all traps. By spacing the traps, it was considered that interference by cattle may have been reduced, as all the trap effort was not confined to a single location.

Further to trap interference, the project area was heavily grazed and locating suitable trapping sites that represented all vegetation communities was difficult. Spacing the pitfalls allowed a degree of flexibility in placement and helped capture varying soil types over short distances.

The location of trap transects were determined based on a range of factors, but largely governed by the need to capture a range of vegetation and soil types. The sample sites and information regarding their soil types is presented below.

(1) Site 1 – North - Western section of the proposed borefield

Location: E 402683.63, N 7655308.79 to E 402937.18, N 7654982.24 (GDA 95 Zone 50).

Soil association generally heavy clay with occasional sandy rises. Encompassing transitions between vegetation systems SG, LAGS and RF2.

(2) Transect 2 – Southern section of proposed bore field

Location: E 404900.30, N7654171.64 to E 404508.44, N 7654513.55 (GDA 94 Zone 50)

Soil association generally heavy clay with occasional stony and sandy rises. Encompassing vegetation system Rf1.

(3) Transect 3 – North western end of proposed tailings dam

Location: E 413651.26, N 7666543.71 to E 413271.74, N 7666696.26 (GDA 94 Zone 50)

Soil associations clay and cracking clays, encompassing vegetation systems Hp and Px2.

(4) Transect 4 –Proposed eastern tailings dam at Du Boulay Creek

Location: E 411368, N 7661768 to E 411274.75 N, 7662132.55 (GDA 94, Zone 50).

Vegetation system Pc, creek lines open to sparse dominated by tree species.

The fauna sampling for the 2000 survey was conducted under the "Licence To Take Fauna For Scientific Purposes" No. SF003099 and “Permit for Research/Educational Excursion in CALM Estate” No. NE002410, both issued to RJ Teale.

Fauna survey sites were selected so they:

- sampled a representative set of the fauna habitats/community types identified within the project area;
- sampled across the geographic extent of the project area, with some emphasis on proposed impact areas; and
- investigated areas of particular conservation significance.

Preston Island was not trapped during the survey for a number of reasons including its small size, inclement ocean conditions and the DEC’s advice that it was unlikely to support any regionally significant fauna.

For each of the 10 fauna survey sites, spatial coordinates were obtained using a hand-held GPS (Australian Geod ’84 datum), typically to an accuracy of less than 10 m. A number of parameters were recorded including the broad soil type, dominant vegetation type, landform and level of disturbance.

The fauna survey comprised both systematic and non-systematic approaches. The majority of the systematic trapping grids were established over the first three days of the survey period. Grids were either shut down after nine nights (Sites 1, 2 and 3), eight nights (Sites 4, 5, 6 and 7), seven nights (Site 8) or five nights (Sites 9 and 10). Non-systematic information was recorded throughout the period.

Systematic Censusing
The central component of the systematic censusing consisted of a number of intensive trapping grids, each located within a defined habitat. Each trapping grid consisted of a row of 10 pitfall traps, spaced at 10m intervals and connected with a single length of flywire, and 20 Elliott box traps arranged in two lines of 10 traps.

Elliott traps were generally spaced 10m apart, however, the spacing at each site varied according to the distribution of microhabitats. Traps were baited with a mixture of rolled oats and peanut butter, and each site and trap was assigned a unique reference number.

Traps were checked daily with vertebrates identified at the point of capture and released. Voucher specimens of each species were lodged with the Museum of Western Australia for confirmation of field identifications.

An account of each of the habitat units in the 2000 survey area is listed below. Where possible the habitats have been related to the Land System classification developed by AgWest, thereby providing an appreciation of their wider distribution in the region.

- Beach

  This habitat encompassed the tidal flats left by the receding tide and extended to the first set of vegetated dunes. It also included rocky headlands. The beach, coastal dunes, mangrove and samphire habitats were all part of the Littoral Land System (LS). Vegetation type Lb encompassed this habitat. No trapping was conducted within this habitat type, however numerous avifauna transects were carried out.

- Coastal Dunes

  The coastal dunes habitat occurred predominantly along the western side of Cape Preston. It comprised vegetation types Ld1, Ld2 and Ld3. One trapping grid (Site 9) was established in this habitat. Pale brown, deep sands predominated. The pit-line was positioned such that it crossed both a swale and a crest of a low dune.

- Mangroves (Mangals)

  This habitat occurred on the margins of the tidal creeks and along some of the coastline. It was most intensively surveyed on the tidal creek at the southern boundary of Cape Preston. This unnamed creek is referred to as Preston Creek in this document. Although no trapping occurred in this habitat, systematic avifauna censusing and opportunistic searching were carried out. In addition, the mangroves were targeted for bat sampling through trapping and the recording of ultrasonic calls.

- Samphire

  This habitat encompassed vegetation types Ls1 and Ls2. It typically occurred on the margins of mudflats, tidal creeks and low-lying saline areas. It was found largely in the northern portion of the project area, particularly on Cape Preston. A single trapping grid (Site 8) was established in this habitat type.

- Creeklines

  This habitat consisted of various vegetation types, principally Rc1, Rc2, Rc3, Rc4 and Rf1, but also a number of minor creeklines including Hc1, Nc1-4, ROc1-5 and Pc1-4. It occurred primarily in the River Land System (LS) and also within the Paraburdoo LS. Two grids were established in this habitat (Sites 6 and 10). The grids were located on the banks of Edward Creek close to the ecotone. The vegetation typically comprised scattered trees and tall shrubs over grasslands of Buffel grass **Cenchrus ciliaris.* Soil was typically a thin layer of loam over compact gravels or deep red loams.

- Cracking Clays

  Two trapping grids (Sites 1 and 2) were established in this habitat type. Although the two sites were somewhat similar, Site 1 was lower in the landscape than Site 2. Pit traps at Site 2 were positioned in the small raised stony islands that occur as a mosaic throughout much of the cracking clays. This habitat encompassed vegetation types Px1-3, Hpg1-3, Hps1 and Hc1. It was generally associated with the Paraburdoo and Horseflats Land Systems.

- Stony Plains

  A single trapping grid was located in this habitat type at Site 5. The area was extremely uniform and correlated with vegetation type Pp2. It was most strongly associated with the Paraburdoo Land System.

- Low Stony Hills

  Two trapping grids were established in this habitat type at Sites 3 and 7. At Site 3 the pit-line was positioned on the face of the hill perpendicular to the contour lines. At Site 7 the pits followed a minor drainage feature. This habitat was associated with vegetation associations Nh1-5 and ROh1a-2b and occurred generally over the Newman and Rocklea Land Systems.

- Rocky Hills and Outcrops

  Occurred as outcroppings on the proposed ore bodies and as rock piles and rock faces at the northern end of the project area. A single trapping grid (Site 4) was established in this habitat. This habitat would encompass vegetation types Nr1-4 and ROr1-3, and occurred principally in the Newman and Rocklea Land Systems, with small occurrences in the Macroy LS.

- Sandplain

  Identified towards the latter stages of the field survey, this habitat was not surveyed. It occupied a relatively small area of Littoral LS on Cape Preston, corresponding to vegetation type Ld4.

3.2.2.2 Avifauna Surveys

During the 2006 survey, Avifauna censusing was carried out in conjunction with checking traps and whilst the trap transects were approximately 300m in length, bird surveying was extended to approximately 500 m past the last trap. Birds seen or heard at these locations were recorded. Targeted surveys were also conducted along the Fortescue River, De Boulay Creek and areas proposed for tailings dams and the borefield. Opportunistic observations were also recorded whilst driving around site and when spotlighting.

Similarlly during the 2000 survey Avifauna censusing was undertaken during the field survey in conjunction with clearing of traps and opportunistic searches for ground vertebrates. A total of 40 censuses were conducted across 25 sites.

3.2.2.3 Spotlighting

Spotlighting was conducted on five nights commencing at approximately 1900 hrs and concluding at approximately 2200 hrs. Spotlighting was conducted from a vehicle over all access tracks within the project area, and portions of the creek lines within the proposed tailings dam area were traversed on foot.

3.2.2.4 Bat Sampling

Three general bat habitats were surveyed (HGM 2001) in the study area: mangal; over the open water of large rivers; and within wooded watercourses. Specific locations sampled within these habitats included areas of mangal south of Mt. Preston, the ford of Du Boulay Creek, Fauna Site 6 and Fauna Site 10.

Bat fauna were surveyed by trapping with mist nets and a harp trap (Austbat, Lower Plenty, Victoria). Within the mangal, a harp trap was placed in a narrow channel between two stands of *Avicennia* over two nights. A mist net arrangement was placed against a stand of *Rhizophora* in the main channel over two nights. A second mist net arrangement was placed within a stand of *Avicennia* for one night. These positions correspond to the foraging habitats of Kimberley mangrove bats (beside the stand but against the surfaces, beside the stand in the open, and within the stand; McKenzie & Rolfe, 1986). Trapping was conducted at low tide only. Harp trapping and mist netting were conducted over water within the wooded watercourses at Fauna Sites 6 and 10 for one night each.

In addition, bat species can be distinguished from each other using the characteristics of their echolocation calls. These calls are used by the bat primarily to locate prey and avoid obstacles. This method of identification relies on the comparison of the sample call sequence with a known reference call and in this survey was used as a supplement to trapping.

Phoenix Environmental Sciences completed Bat Call Analysis within the project area during 2008.

3.2.3 Data Processing

The taxonomy and nomenclature used for the fauna assessment are based on:

- **Reptiles**: Storr *et al.* (1999), Cogger (2000).
- **Birds**: Johnston (2000), Flegg (2002) and Simpson and Day (2000).
- **Frogs**: Tyler *et al.* (2000).
- **Mammals**: How *et al*. (2001), Menkhorst and Knight (2004).

The taxonomic orders presented in this report are generally based on the Western Australian Museum. Where a discrepancy exists between references, taxonomy follows that used by the Western Australian Museum.

4.0 Survey Limitations

4.1 Flora and Vegetation

Limitations experienced during the July 2006 flora and vegetation survey included:

- poor accessibility to some areas;
- time limitations to traverse such a large project area with few vehicular access tracks;
- relatively short days in terms of the hours of sunlight, limiting the effective duration of survey days; and
- difficulties in placing quadrat pegs in compacted clays or rocky soils.

It is important to note that none of the limitations highlighted within this section affected the quality of survey works conducted within the project area. All floristic assessments have been conducted in accordance with EPA Guidance Statement No. 51, *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004).

4.2 Fauna

Limitations experienced during the October 2006 fauna survey included:

- difficulty in selecting suitable trapping sites due to the extent of cattle grazing resulting in an absence of ground cover in many areas;
- continual interference with trap lines by grazing live stock, particularly at sites 1 and 2; and
- hot conditions placing pressure on opening/closing traps before temperatures became dangerous for trapped fauna.

It is important to note that none of the limitations highlighted within this section affect the quality of survey works conducted. All survey work has been conducted in accordance with EPA Guidance Statement No. 56, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2003.

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5.0 Peer Review

In December 2007, Mattiske Consulting Pty Ltd conducted a peer review of floristic works that had been conducted to date. It was noted from the peer review that the survey effort and timing of flora surveys carried out in the project area has been extensive and comprehensive and the flora work conducted for the project exceeds many others with similar impacts (Mattiske, 2007b). A copy of the Mattiske's correspondence is located in Appendix C.

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6.0 Results

6.1 Flora

6.1.1 General

Within the entire project area a total of 500 vascular flora species, from 64 families and 196 genera were recorded. This total includes 482 (96.4%) native species and 18 (3.6%) introduced (weed) or non-endemic species. The full list of the vascular plant species recorded in this section of the project area between 2000 and 2007 is presented in Appendix D. Species represented in individual quadrats for each survey can be located in the respective flora report and is not presented as an appendix.

Families with the highest representation were Poaceae (Grass family – 73 native taxa; 4 introduced taxa); Papilionaceae (Pea family – 44 native taxa); and the Malvaceae (Mallow Family – 49 native taxa, 2 introduced taxa).

None of the species recorded during either the flora surveys conducted between 2000 and 2007 surveys were found to be exhibiting a range extension from recorded occurrences, as documented by the WA State Herbarium (DEC, 2006).

6.1.2 Declared Rare and Priority Flora

The results of DEC database enquiry for Threatened Flora with the potential to occur within the project area are presented in Table 8.

Table 8: DEC Database Threatened Flora Species Reported as Potentially Occurring Within the Project Area

Species	Cons. Status	*Preferred Habitat*	*Flowering Period*	Likelihood of occurance
Acacia glaucocaesia	P3	*Hard red loam on plains*	*Fl. Jul-Sep. Red loam, sandy loam, clay flood plains*	Likely to occur
Goodenia nuda	P3	*Plain. Dry, red sand. Mesquite scrub*	*Fl. Apr-Aug.*	May occur
Goodenia pallida	P1	*Red soils.*	*Fl. purple, Aug*	May occur
Goodenia pascua	P3	*In red soil. Annual grassland*	*Fl. May-Aug. Red sandy soils, basaltic plains*	Likely to occur
***Gunniopsis* sp. Fortescue (M.E. Trudgen 11019)**	P1	*N/A*	*N/A*	Likely to occur
Ischaemum albovillosum	P2	*Dark red clay, basalt. Plateaus, crabholes*	*Fl. Apr*	Unlikely to occur
Owenia acidula	P3	Near creeks. Shrub steppe	N/A	May occur
***Tephrosia* sp. Catherdral Gorge (FH Mollemans 2420)**	P3	Clay-sand & pebbles	Fl. orange, red, Feb	Unlikely to occur

Species	Cons. Status	*Preferred Habitat*	*Flowering Period*	Likelihood of occurance
***Themeda* sp. Hamersley Station (ME Trudgen 11431)**	P3	Red clay. Clay pan, grass plain	Fl. Aug.	Unlikely to occur

No species listed as DRF by the Department of Environment and Conservation (DEC), under the *Wildlife Conservation Act, 1950*, or as Threatened under the EPBC Act were recorded within the project area.

Four Priority Flora species were recorded in the project area during the two field surveys (refer Table 9). None of these species is listed under the EPBC Act.

Table 9: Summary of Priority Flora Recorded Within the Cape Preston Mining Precinct.

Species	Conservation Status	Species Description	Year recorded
***Goodenia* sp. East Pilbara (aA Mitchell PRP 727)**	P1	This small herb was collected only once within the project area, from tussock grassland on clay soils at Site M027. This species is more typical of calcareous soils and is known from relatively few populations in the Weeli Wolli Springs – Marillana Creek area in the eastern Pilbara	2000
Phyllanthus aridus	P3	This small perennial shrub occurred as scattered individuals at a single site within creekline habitat in the Paraburdoo LS. While known from several Kimberley populations, this species had apparently not been recorded from the Fortescue District prior to the survey of the West Angelas rail corridors (Trudgen & Casson, 1998).	2000
Goodenia pascua	P3	This low herb was collected only once from the Hp community. *Goodenia pascua* is more typical of Basaltic plains and is known from relatively few populations in Port Headland and the Roebourne area (DEC, 2006).	2006

6.1.3 Introduced Weed Species

Two weed species that were recorded within the project area are listed as Declared Plants by the Department of Agriculture, pursuant to the *Agriculture and Related Resources Protection Act, 1976.* These species are **Prosopis pallida* (Mesquite) and **Datura leichhardtii* (Native Thornapple) (Department of Agriculture, 2006). These two declared weed species are discussed in further detail below.

***Prosopis pallida* (Mesquite)**

Several species of **Prosopis*, collectively known as Mesquite, were introduced to parts of the State as ornamental plants. The original stock lacked thorns; however this quickly reverted to the heavily spined and highly invasive wild type. All species of **Prosopis* are listed as Declared Plants (noxious weeds) in Western Australia. Mesquite was recorded within 19 of the total 75 quadrats sampled during 2000 and 2006 plus within other areas throughout the study area.

Mature plants were largely associated with tributaries and floodplains of the Fortescue River system and were also commonly growing along vehicle access tracks. The Mesquite hybrid high shrubland (Rf2) and the Mr5 Community represent the most significant stands of this species within the project area.

***Datura leichhardtii* (Native Thornapple)**
Native Thornapple (**Datura leichhardtii*) was mistakenly thought to be a native plant for many years, although it is actually of Mexican origin. This species is naturalised in the Australian tropics and was recorded from a single location within the project area in community Rf1.

In addition to the two declared weed species, ten environmental weed species for the Pilbara region were also recorded to occur. These weed species are largely common and are widespread species within the Pilbara Region. They are as follows:

- **Aerva javanica* - Kapok;
- **Argemone ochroleuca* - Mexican poppy;
- **Bidens bipinnata*- Beggar's Ticks;
- **Cenchrus ciliaris* - Buffel grass;
- **Cenchrus setigerus*- Birdwood grass;
- **Citrullus lanatus* - Pie Melon;
- **Malvastrum americanum* - Spiked Malvastrum;
- **Melochia pyramidata*;
- **Setaria verticillata* - Whorled Pigeon Grass; and
- **Vachellia farnesiana* – Mimosa bush.

6.2 Vegetation Communities

The DEC's database search for TEC's within the project area did not return any results. No threatened or Priority Ecological Communities were recorded to occur within the project area (Appendix F). Similarly, no EPBC listed vegetation communities were recorded within the project area.

A collective total of 80 distinct vegetation communities were described and mapped within the project area. These communities included but are not limited to; hummock and tussock grasslands, annual herblands on cracking clays, *Acacia* shrublands over hummock grasslands, tall Acacia shrublands and low Corymbia woodlands over Acacia shrublands.

The spatial distribution of vegetation communities mapped by various surveys throughout the project area, with the footprints of the approved Central Block Project and proposed Balmoral South Project overlaid is displayed in Figures 5.1 – 5.14, in Appendix E. A description of each of the vegetation communities recorded during the five floristic surveys is provided below, grouped under the Land System in which they occur.

6.2.1 Boolgeeda Land System

Bx1 ***Acacia xiphophylla* open shrubland over *Triodia epactia* hummock grassland**
The single site located on the area of Boolgeeda Land System west of the Southern Ore Body comprised an open shrubland of *Acacia xiphophylla* over moderately dense *Triodia epactia* hummock grassland. *Triodia wiseana* was present only as very occasional hummocks. Other species noted were relatively similar to those recorded for the more broadly distributed Snakewood shrublands over *Triodia wiseana* (see Px1).

Scattered low shrubs included *Enchylaena tomentosa, Indigastrum parviflorum, Solanum horridum, S. lasiophyllum* and *Triumfetta clementii.* Occasional grasses again included **Cenchrus ciliaris, Enneapogon caerulescens, Eriachne pulchella* subsp. *dominii, Paspalidium clementii* and *Sporobolus australasicus.* The very sparse herb stratum was not particularly diverse but included *Evolvulus alsinoides* var. *villosicalyx* and the Priority 3 species *Leptopus decaisnei.* This vegetation type was in very good condition, with only scattered weeds.

6.2.2 Horseflats Land System

The following vegetation types occurred on clayey plains within the Horseflats Land System. The grasslands and low Shrublands typically occurred as a mosaic (Hp); hence some sites contained portions of more than one sub-unit of the vegetation type. However, these sub-units are not distinct enough to be mapped separately ie, all mapped as HP.

Hpg1 ***Eragrostis xerophila* open tussock grassland**

Broad areas of red-brown cracking clay plain supported *Eragrostis xerophila* tussock grassland. These were characterised by open grassland which was strongly dominated by *E. xerophila,* with occasional other grasses such as *Dichanthium sericeum* subsp. *humilius* and *Xerochloa imberbis.* Scattered herbs included *Corchorus tridens, Lotus australis, Phyllanthus maderaspatensis* var. *angustifolius, Rhynchosia* aff. *minima* and *Stemodia kingii.* The cracking clays largely preclude growth of larger shrub species, however occasional small shrubs were recorded including *Indigofera trita, Neptunia dimorphantha* and forms of *Sida* aff. *fibulifera*. This vegetation type was generally in very good condition, despite being subject to grazing. The cracking clay substrate prevents substantial invasion by Buffel grass **Cenchrus ciliaris,* which is a pervasive weed on sandier soils within the project area.

Hpg2 ***Eriachne benthamii* tussock grassland**

Localised wetter areas within the clay plains supported *Eriachne benthamii* tussock grasslands. The *Eriachne benthamii* grasslands were typically denser than the *Eragrostis xerophila* grasslands. Apart from the obvious difference in the dominant grass species, the two grasslands supported quite similar species mixes. However, a number of species which are typical of wet areas were only recorded from the *E. benthamii* grasslands, including *Cyperus iria, C. squarrosus* and *Marsilea hirsuta.* Like the previous vegetation type, the *E. benthamii* grasslands were generally in very good condition, with little invasion by Buffel grass (**Cenchrus ciliaris*) and no obvious grazing effects.

Hpg3 ***Xerochloa imberbis* grassland**

Small patches of grassland dominated by *Xerochloa imberbis* were recorded on clay plains within the project area. These occurred principally within the Horseflats and Paraburdoo Land System. The vegetation at this site was characterised by a moderately dense, very low (~10cm tall) grassland of *X. imberbis,* with very occasional individuals of **Cenchrus ciliaris.* The very sparse cover of herbs was dominated by *Ptilotus murrayi* var. *murrayi*; other species present included *Portulaca oleracea, P. pilosa, Rhynchosia* cf. *minima* and *Trianthema triquetra.* Very occasional low shrubs were recorded, including species typical of clay plains (eg. *Neptunia dimorphantha* and *Sida* aff. *fibulifera* 'var. L') and species characteristic of saline soils (*Atriplex bunburyana* and *Trianthema turgidifolia*). This vegetation type was in very good condition, with occasional weeds representing the primary disturbance.

Hps1 ***Sida aff. fibulifera*** **low shrubland over very open herbland**

Patches of low shrubland were observed within the clayey plains in the project area. These were dominated by *Sida* aff. *fibulifera*, with occasional individuals of *Neptunia dimorphantha.* Scattered grasses included *Aristida contorta, *Cenchrus ciliaris, Dichanthium sericeum* subsp. *humilius, Enneapogon caerulescens* and *Sporobolus australasicus. Streptoglossa liatroides* were the most abundant herb species; others present were *Phyllanthus maderaspatensis* var. *angustifolius, Rhynchosia* cf. *minima* and *Sclerolaena costata.* This vegetation type was in very good condition, with occasional weeds representing the primary disturbance.

Hc1 ***Acacia sclerosperma*** **high shrubland over** ***Chrysopogon fallax*** **tussock grassland**

This vegetation was recorded within a single flowline in the Horseflats LS. It had a high shrubland layer dominated by *Acacia sclerosperma,* with lesser amounts of *Acacia coriacea* subsp. *pendens,* over a dense grassland dominated by *Chrysopogon fallax* with small amounts of **Cenchrus ciliaris, *C. setigerus, Eriachne benthamii, Themeda triandra* and the spinifex *Triodia epactia.* Other tall shrubs recorded included *Acacia farnesiana, A. inaequilatera, A. xiphophylla, Capparis spinosa* var. *nummularia* and *Eremophila longifolia.* Scattered low shrubs were dominated by *Indigastrum parviflorum,* and included *Solanum diversiflorum, S. horridum, S. lasiophyllum* and *Triumfetta clementii.* A variety of herbs was recorded, including *Alysicarpus rugosus, Crotalaria medicaginea, Euphorbia* species, *Ipomoea muelleri, *Malvastrum americanum, Phyllanthus maderaspatensis* var. *angustifolius, Pterocaulon sphacelatum, Rhynchosia* cf. *minima, Rostellularia adscendens* var. *clementii* and *Vigna lanceolata* var. *lanceolata.*

6.2.3 Littoral Land System

Lb **Beaches**

Narrow beaches occurred primarily along the western margin of Cape Preston. These consisted principally of bare sand, with very occasional individuals of *Spinifex longifolius* and herbs. The beaches were in excellent condition, with no obvious signs of disturbance.

Lm **Mangals**

Belts of mangroves occurred in the intertidal zone, particularly around tidal creeks such as Preston Creek. See section 6.2.1

Ls1 **Halosarcia spp. scattered low shrubs**

Broad areas of tidal mudflat with only scattered low samphires occurred in the northern section of the project area. Species present included the samphires *Halosarcia halocnemoides* subsp. *tenuis* and *H. indica* subsp. *leiostachya*. It typically adjoined mangal communities, slightly elevated samphire and tussock grass cheniers, tidal fringing hummock grasslands in areas devoid of depositional sands and areas of bare mudflats. This vegetation was in excellent condition, with no obvious signs of disturbance

Ls2 ***Halosarcia halocnemoides*** **subsp.** ***tenuis*** **low open shrubland to low open heath**

Areas of samphire occurred in the northern section of the study area on mudflats fringing the coast and tidal inlets. These consisted of an open to moderately dense low shrubland (typically ~30 cm tall) dominated by salt tolerant plants, principally samphires. The dominant species was *Halosarcia halocnemoides* subsp. *tenuis,* which occurred with lesser amounts of *Frankenia ambita*, *Halosarcia indica* subsp. *leiostachya, Hemichroa diandra, Muellerolimon salicorniaceum, Neobassia astrocarpa* and *Trianthema turgidifolia.* Occasional seedlings of the mangrove species *Avicennia marina* were also recorded. A small number of grasses was noted, with species of *Eragrostis* and *Sporobolus virginicus* providing a very sparse cover towards the landward edge of this vegetation type. Herbs were occasional only but included *Dysphania plantaginella.* This vegetation was generally in very good to excellent condition, with few obvious signs of disturbance.

Ls3a **Mixed *Lawrencia viridigrisea, Halosarcia* spp., and *Trianthema turgidifolia* low shrubland to low heath over mixed tussock grassland**

This community occupies supra – tidal low undulating plains and is found between open patches of samphire vegetation on mudflats and the adjacent, more elevated sandy plains. It contains a mixed samphire and saline tolerant shrubland with mixed tussock grassland over a coarse sandy and shell grit substrate. This community is restricted to the north eastern and southern sides of the main tidal mudflat complex.

Ls3b ***Acacia saligna* shrubland over mixed *Lawrencia viridigrisea, Halosarcia* spp., and *Trianthema turgidifolia* low shrubland to low heath over mixed tussock grassland**

This vegetation association is structurally the same as Ls3a except that it contains an Acacia saligna shrubland of sometime up to 30 – 40 % cover. This community is restricted to the north eastern side of the main tidal mudflat complex.

Ld1 ***Acacia bivenosa* low open shrubland over *Spinifex longifolius* grassland**

This vegetation type occurred in a narrow band (~20m wide) along the seaward margin of the frontal dunes on Cape Preston. It was sampled only at Site M068, which comprised very undulating (2-3 m tall) dunes of coarse brown sand. This vegetation was characterised by a moderate height (to 1 m) shrubland dominated by a scattered to open cover of *Acacia bivenosa,* with occasional *Acacia coriacea* subsp. *coriacea, *Aerva javanica* and *Rhagodia preissii* subsp. *obovata,* over a moderately dense grassland of Beach spinifex *Spinifex longifolius,* with occasional **Cenchrus ciliaris.* Scattered herbs included *Euphorbia tannensis* subsp. *eremophila, Salsola tragus* and *Tribulus occidentalis.* This vegetation was in very good condition, with only occasional weeds recorded. (Site M068).

Ld2 ***Acacia coriacea, A. bivenosa* open shrubland to shrubland over scattered grasses**

This vegetation type occurred on the coarse brown sands of the gently undulating dunes which border Cape Preston. It consisted of an open to sparse tall shrubland that was dominated by *Acacia coriacea* subsp. *coriacea,* with lesser amounts of *A. bivenosa.* Occasional other shrubs included *Rhagodia preissii* subsp. *obovata, Scaevola spinescens* and *Threlkeldia diffusa.* The grass cover ranged from a scattered to sometimes open cover of **Cenchrus ciliaris,* with occasional other species such as *Enneapogon caerulescens* and *Triraphis mollis.* Very sparse herbs included *Amaranthus pallidiflorus, Cleome viscosa, Euphorbia schultzii, E. tannensis* subsp. *eremophila, Ptilotus exaltatus, Salsola tragus* and *Tribulus occidentalis.* This vegetation type ranged from very good to good condition, with invasion by Buffel grass the major factor reducing condition

Ld3 **Acacia coriacea, A. bivenosa open shrubland over Triodia epactia curly spinifex grassland**

Areas of backing dunes supported an open tall shrubland of Acacia coriacea subsp. coriacea, with lesser amounts of Acacia bivenosa and Rhagodia preissii subsp. obovata, over a curly spinifex (ie. not hummock forming) grassland of Triodia epactia. Other tall shrubs recorded *included Adriana tomentosa* and *Santalum lanceolatum*, while occasional low shrubs included **Aerva javanica*, *Corchorus walcottii, Melhania oblongifolia, Sida* aff. *fibulifera* and *Threlkeldia diffusa.* Grasses other than spinifex were dominated by scattered patches of *Eragrostis eriopoda*, with occasional **Cenchrus ciliaris* and *Triraphis mollis*. The very sparse herb stratum included *Amaranthus pallidiflorus, Cleome viscosa, Cuscuta victoriana, Euphorbia species, Salsola tragus* and *Swainsona formosa*. This vegetation was in very good condition, with only scattered weeds recorded

Ld4 ***Acacia coriacea* scattered shrubs over mixed low shrubland and *Triodia pungens, *Cenchrus ciliaris* curly spinifex / tussock grassland**

This vegetation occurred on a low, narrow dune and on a broad sandbank in the southwestern portion of Cape Preston. The sandbank supports a broader range of species given its location between more intact and more variable vegetation. The vegetation consisted of very scattered tall shrubs of *Acacia coriacea* subsp. *Coriacea* over sparse to occasional low shrubs of species such as *Adriana tomentosa, Atriplex bunburyana, Corchorus walcottii, Indigofera trita, Melhania oblongifolia, Solanum lasiophyllum, Trianthema turgidifolia* and *Waltheria indica.* The open to moderately dense curly spinifex grassland of *Triodia pungens* showed some invasion by **Cenchrus ciliaris.* Scattered other grasses included *Aristida holathera, Eragrostis cumingii, E. eriopoda, Eriachne mucronata* and *Panicum decompositum,* while very occasional sedges included *Bulbostylis barbata* and *Cyperus bulbosus.* Very sparse herbs included *Cleome viscosa, Indigofera colutea, Portulaca pilosa, Pterocaulon sphacelatum* and *Rhynchosia* cf. *minima*. This vegetation type was rated as being in very good (Site M069) to good condition (M063) depending on the extent of invasion by Buffel grass

Ld5 **Saline low shrubland**

This vegetation type was recorded within a single saline swale located between dunes on Cape Preston. The substrate consisted of pale brown, fine silty sand, with a blue-green algal surface crust in places. The vegetation consisted of a low shrubland (to ~30 cm tall) dominated by salt tolerant species, principally *Dissocarpus paradoxus* and *Frankenia pauciflora*, with lesser amounts of *Halosarcia indica* subsp. *leiostachya, Hemichroa diandra, Lawrencia viridigrisea* and *Neobassia astrocarpa.* Grasses contributed a very sparse cover. The dominant species was *Eragrostis falcata,* while very small amounts of **Cenchrus ciliaris, Dactyloctenium radulans, Xerochloa imberbis* and the spinifex *Triodia angusta* were also recorded. Occasional herbs present included *Dysphania rhadinostachya, Euphorbia coghlanii, Portulaca pilosa* and *Swainsona kingii.* This vegetation was in very good condition. (Site M061).

Lp1 ***Triodia angusta* hummock grassland on sandy plain**

This vegetation type occurred over a plain of pale brown silty loam on the lower section of Cape Preston. It consisted of a moderately dense hummock grassland of *Triodia angusta,* with considerable invasion by Buffel grass **Cenchrus ciliaris.* Occasional other grasses included *Eragrostis falcata* and *Panicum decompositum.* Scattered low shrubs included *Indigofera trita, Melhania oblongifolia, Neobassia astrocarpa* and *Trianthema turgidifolia.* Occasional herbs included *Portulaca oleracea* and *Trianthema triquetra*. This vegetation was considered to only be in moderate condition, given the extent of invasion by Buffel grass.

Lp2 ****Cenchrus ciliaris* (Buffel grass) tussock grassland on sandy loam plain**

This vegetation association was restricted to a low depression adjoining the leeward side of the coastal dune complex in the northern extent of the project area. It contained a dense tussock grassland (70 – 80 % cover) of **Cenchrus ciliaris* (Buffel grass) on depositional silty loams intermixed with coarser beach sands. Other species recorded in this area were typically moderately saline tolerant, including the scattered low shrub species *Indigofera trita, Trianthema turgidifolia* and *Melhania oblongifolia* and the tussock grass species *Sporobolus virginicus*.

Lp3 ***Triodia epactia* curly spinifex grassland on sandy loam plain**

This vegetation association was found in areas immediately adjoining the coastal depression of Lp2 in the northern extent of the project area. It contained a moderately dense (60 – 70% cover) hummock grassland of *Triodia epactia* that became intermixed with the tussock grass *Sporobolus virginicus* at the south end of its extent. Other species recorded included *Indigofera trita, Trianthema turgidifolia, Rhynchosia minima* and *Melhania oblongifolia*, plus the two weed species **Cenchrus ciliaris* (Buffel grass) and **Aerva javanica* (Kapok). This vegetation association was generally found on plains of tan coloured loams and sandy loams.

Lp4a ***Acacia bivenosa, Scaevola spinescens A. coriacea*** **shrubland to open heath over mixed** ***Triodia angusta, T. epactia*** **hummock grassland on red sandy loam undulating plains**

This vegetation association was located between the lower littoral plain associations and the adjoining rocky hinterland areas and coastal hills and dunes in the northern extent of the project area, as well as in similar areas on the southern side of the main tidal mudflat complex. It contained a mixed mainly *Acacia bivenosa* (30 – 40 *%* cover) and *Scaevola spinescens* (20 *%* cover) shrubland over a dense (70 *%*) predominantly *Triodia angusta* hummock grassland. This vegetation association was generally found on plains of reddy brown loams and sandy loams.

Lp4b ***Acacia bivenosa, A. coriacea, A. pyrifolia*** **shrubland to open heath over mixed** ***Triodia angusta, T. epactia*** **hummock grassland on red sandy loam undulating plains**

This vegetation association was located on reddy brown sandy loam plains in the mid-southern portion of the project area. It contained a mixed *Acacia* shrubland (most notably including *A. inaequilatera* and *A. pyrifolia*), sometimes mixed with *Hakea lorea*, over a mixed moderately dense (60 – 70 *%*) *Triodia* hummock grassland.

Lp5 ***Acacia bivenosa, Santalum lanceolatum*** **shrubland to high shrubland over** ***Triodia epactia*** **hummock grassland on red sandy loam undulating plains**

This vegetation association was located in the north-western corner of the project area on an area of reddy brown sandy loam undulating plain, situated between areas of coastal hills and the nearby rocky hinterland. It contained a shrubland of *Acacia bivenosa* mixed with the tall coastal sandalwood species *Santalum lanceolatum* over moderately dense (60- 70 *%* cover) *Triodia epactia* hummock grassland. Other significant species included the low herbaceous shrubs *Diplopeltis eriocarpa* (2 – 15 *%* cover)*, Scaevola cunninghamii* (2 – 10 *%* cover) and *Scaevola spinescens* (2 – 5 *%* cover).

Lh1 ***Acacia coriacea, Santalum lanceolatum, Eremophila longifolia*** **mixed shrubland over** ***Triodia wiseana*** **hummock grassland on near coastal rocky hill**

This vegetation association was restricted to two rocky hill areas within the Littoral land system in the northern portion of the project area. It contained a mixed shrubland of *Eremophila longifolia* (10 – 20 *% Acacia coriacea* (10 *%* and *Santalum lanceolatum* (2 – 10 *%*) with some *Scaevola spinescens* (2 – 5 *%* and scattered *Grevillea pyramidalis* (2 *%* over moderately dense (60 - 70%) hummock grassland of *Triodia wiseana*. This vegetation association was also found to contain the two weed species **Cenchrus ciliaris* (Buffel grass) and **Aerva javanica* (Kapok)

Lh2 ***Acacia gregorii*** **low open shrubland with** ***Scaevola cunninghamii*** **very open herbland to herbland with** ***Triodia wiseana*** **hummock grassland on undulating limestone ridge and/or mixed** ***Triodia*** **hummock grassland on red sands over limestone**

This vegetation association was restricted to calcareous rocky areas that surrounded the Lh1 vegetation association within the Littoral land system in the northern portion of the project area. It contained an herbaceous shrubland of *Scaevola cunninghamii* (30 – 50%) with a low open shrubland of *Acacia gregorii* (2 - 10%) over moderately dense (50 – 70%) hummock grassland of *Triodia wiseana* on exposed limestone rocky areas. The *T. wiseana* grassland within the vegetation association was noted as becoming mixed with *T. epactia* and *T. angusta* in those areas where red sands and sandy loams formed a veneer over the calcareous rocks. Other species included scattered *Trichodesma zeylanicum* (2 – 5 *%* and *Diplopeltis eriocarpa* (2 *%*

6.2.4 Macroy Land System

Mp1 ***Acacia bivenosa, A. ancistrocarpa* shrubland over *Triodia wiseana* hummock grassland**

This vegetation occurred generally on the calcareous loamy soils of plains along the eastern portion of the Access Road. It consisted of a shrubland dominated by *Acacia bivenosa,* with lesser amounts of *A. ancistrocarpa,* over moderately dense hummock grassland of *Triodia wiseana.* Other tall shrubs recorded included *Acacia pyrifolia* and *Senna glutinosa* subsp. *glutinosa.* Scattered low shrubs were dominated by *Corchorus walcottii,* and also included *Heliotropium ovalifolium, Ptilotus astrolasius, Sida clementii* and *Triumfetta clementii.* Very sparse grasses included *Cymbopogon ambiguus, Dichanthium sericeum* subsp. *humilius, Enneapogon caerulescens* and *Sporobolus australasicus.* Scattered herbs included *Boerhavia* species, *Bonamia media* var. *villosa, Evolvulus alsinoides* var. *villosicalyx, Hybanthus aurantiacus, Phyllanthus maderaspatensis* var. *angustifolius, Pterocaulon sphacelatum* and *Trachymene oleracea*. This vegetation was in very good to excellent condition, with low weed invasion.

Mr1 ***Fimbristylis dichotoma* low sedgeland**

This vegetation type was recorded only on shallow soil fringing a sheet outcrop along the proposed Access Corridor. It was characterised by a very open to moderately dense, low (~10 cm tall) sedgeland dominated by *Fimbristylis dichotoma,* which occurred with a variety of annual grasses and herbs. The sparse grass cover was dominated by *Aristida contorta,* with lesser amounts of *Tripogon loliiformis* and scattered other species such as **Cenchrus ciliaris, *C. setigerus, Dactyloctenium radulans, Dichanthium sericeum* subsp. *humilius, Digitaria ctenantha* and *Enneapogon caerulescens.* The very sparse herb cover supported a variety of species including *Crotalaria medicaginea, Euphorbia australis, E. coghlanii, Gomphrena cunninghamii, Heliotropium tenuifolium, Indigofera colutea, Portulaca oleracea, P. pilosa, Ptilotus helipteroides* and *Streptoglossa decurrens.* Very occasional low shrubs were recorded, including *Indigastrum parviflorum* and *Triumfetta clementii.* This vegetation type was in very good condition, with only occasional weeds.

Mr2 ***Acacia ancistrocarpa* high open shrubland over *Indigofera monophylla* low shrubland over *Triodia epactia* curly spinifex grassland and open herbland**

This vegetation type occurred on a small outcrop of large boulders, with pockets of calcareous soil in between. I t consisted of an open tall shrubland of *Acacia ancistrocarpa,* with very occasional *A. bivenosa,* over a low shrubland of *Indigofera monophylla.* Other low shrubs recorded included *Corchorus laniflorus, Isotropis atropurpurea, Solanum horridum* and *Triumfetta clementii.* The cover of spinifex was dominated by *Triodia epactia* with small amounts of *T. wiseana.* Sparse other grasses were dominated by **Cenchrus ciliaris*, and also included *Aristida contorta* and *Paspalidium clementii.* The open cover of herbs was dominated by *Rhynchosia* cf. *minima*, and included *Gomphrena cunninghamii, Hybanthus aurantiacus, Phyllanthus maderaspatensis* var. *angustifolius, Portulaca oleracea, P. pilosa, Streptoglossa decurrens, Trachymene oleracea* and *Trichodesma zeylanicum.* This vegetation type was in very good condition, with scattered weeds being the main disturbance noted.

Mr3 **Low Shrubland of *Acacia* spp. over a **Cenchrus ciliaris* and *Brachyachne convergens* Grassland**

This vegetation type consists of a Low Shrubland of *Acacia spp*. including *Acacia inaequilatera*, *Acacia sclerosperma* subsp. *sclerosperma*, *Acacia coriacea* var. *coriacea* and *Acacia victoriae* over a mid-dense Grassland of **Cenchrus ciliaris* and *Brachyachne convergens*. Occasional other grasses include *Eriachne aff. helmsii* and *Themeda triandra*.

Mr4 **Low Shrubland dominated by *Ptilotus aervoides* and *Sida rohlenae* over a Mid Dense Hummock Grassland of *Triodia wiseana* and *Enneapogon caerulescens***
This Low Shrubland is dominated by low shrubs including *Ptilotus aervoides* and *Sida rohlenae* with scattered *Triumfetta clementii* and typically occurred over a mid-dense Hummock Grassland usually consisting of little more than *Triodia wiseana* and *Enneapogon caerulescens*. Occasional other grasses include *Aristida contorta* and **Cenchrus ciliaris.* This vegetation community was found to have low disturbance.

Mr5 **Very Open Mixed Herbland with infestation of Mesquite (**Prosopis pallida*)**
This highly disturbed association was dominated by large quantities of the Declared Weed, Mesquite (also known as Mesquite). A range of other herbaceous species were recorded as seasonally occurring, including *Ptilotus aervoides, *Malvastrum americanum* and *Ptilotus exaltatus* var*. exaltatus* occurring over perennial grasses including **Cenchrus ciliaris, Sporobolus australasicus* and *Enneapogon caerulescens.*

Mr6 **Closed Tussock Grassland dominated by *Enneapogon caerulescens, Aristida contorta* and *Eriachne benthamii***
A Closed Tussock Grassland of *Enneapogon caerulescens, Aristida contorta* and *Eriachne benthamii* with very little overstorey characterised the Mr6 community type. This classification of vegetation was generally in Good condition with scattered Mesquite (**Prosopis pallida,* Mesquite). Other species of grass are sometimes present, including *Eragrostis tenellula* and *Eraichne* aff*. Helmsii,* whilst *Eremophila maculata* was also recorded consistently.

6.2.5 Newman Land System

The hills were dominated by hummock grasslands of the Newman Land System. These were separated on the basis of differing overstorey layers, which ranged from virtually absent to an open shrubland dominated by some combination of *Acacia* and/or *Senna* species. These grasslands were difficult to map separately as they tended to occur as a mosaic, and also because the different units had a similar photo pattern.

Low Hills and Slopes

Nh **Triodia wiseana hummock grassland with scattered emergent *Acacia* or *Senna* shrubs**
Mosaic community of Nh1, Nh2, Nh3, Nh4 ,Nh5

Nh1 ***Triodia wiseana* hummock grassland**
Areas of hillslopes with very shallow soil in both the Newman and Rocklea Land System supported moderately dense hummock grassland of *Triodia wiseana* with negligible overstorey. Very occasional low shrubs included *Solanum horridum, S. lasiophyllum, Tephrosia supina* and *Triumfetta clementii. Paspalidium clementii* was the only regularly recorded grass species (other than spinifex), while very scattered sedges included *Bulbostylis barbata* and *Fimbristylis dichotoma.* The very sparse herb stratum included *Crotalaria medicaginea, Evolvulus alsinoides* var. *villosicalyx, Gomphrena cunninghamii, Trachymene oleracea* and *Trichodesma zeylanicum.* This vegetation ranged from very good to excellent condition, with very few weeds recorded. Buffel grass **Cenchrus ciliaris* was conspicuously absent.

Nh2 ***Acacia bivenosa*, *A ancistrocarpa* open shrubland over *Triodia wiseana* hummock grassland**

Hillslopes within the Newman Land System supported an open shrubland dominated by *Acacia bivenosa,* with lesser amounts of *Acacia ancistrocarpa,* over moderately dense hummock grassland of *Triodia wiseana.* Other tall shrubs frequently recorded included *Acacia coriacea* subsp. *coriacea, A. pyrifolia* and *Senna glutinosa* subsp. *pruinosa.* Scattered low shrubs included *Corchorus laniflorus, Indigofera monophylla, Solanum lasiophyllum* and *Triumfetta clementii.* Grasses such as *Cymbopogon ambiguus, Digitaria brownii* and *Paspalidium clementii* provided a very sparse cover, while scattered herbs included **Bidens bipinnata, Bonamia media* var. *villosa, Cassytha capillaris, Evolvulus alsinoides* var. *villosicalyx, Hybanthus aurantiacus, Polygala* aff. *isingii, Ptilotus aervoides, Trachymene oleracea* and *Trichodesma zeylanicum.* This vegetation type was generally in very good to excellent condition, with few obvious signs of disturbance.

Nh3 ***Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland**

This vegetation type was similar to the previous, differing primarily in the general lack of *Acacia ancistrocarpa* and *A. pyrifolia* in the tall shrub stratum. Other notable differences included the absence of *Hybanthus aurantiacus* and *Ptilotus aervoides* and the presence of *Tephrosia supina* within this vegetation. The differences in species composition would appear to indicate a lower water availability in this (Nh3) vegetation type. This vegetation was mostly in very good condition, with few signs of disturbance apart from occasional weeds. Mesquite **Prosopis pallida* hybrid seedlings were recorded at some of the sites within this vegetation type, but did not appear to survive to maturity.

Nh4 ***Senna glutinosa* subsp. *pruinosa* scattered shrubs over *Triodia wiseana* hummock grassland**

Some areas of stony hills supported very sparse moderate height shrublands of *Senna glutinosa* subsp. *pruinosa* over hummock grasslands of *Triodia wiseana.* Few other tall shrubs were noted, and *Acacia inaequilatera* was the only species recorded as mature plants from more than one site (seedlings of Mesquite **Prosopis pallida* hybrid occurred at three sites). Scattered low shrubs included *Corchorus laniflorus, Indigastrum parviflorum, Indigofera monophylla, Tephrosia supina* and *Triumfetta clementii.* Scattered individuals of the herbs *Bonamia media* var. *villosa, Polygala* aff. *isingii, Trachymene oleracea* and *Trichodesma zeylanicum* were recorded. Apart from spinifex, no grass species occurred at more than one site.

Nh5 ***Acacia arida* low open shrubland over *Triodia wiseana* hummock grassland**

Ridge crests on the Central OB supported a low shrubland (to ~1m tall) dominated by *Acacia arida* over a hummock grassland of *Triodia wiseana.* Other low shrubs recorded included *Corchorus laniflorus* and *Sida cardiophylla* (juvenile), while scattered taller shrubs included *Acacia bivenosa, A. pyrifolia, Senna glutinosa* subsp. *glutinosa* and subsp. *pruinosa*, and *Sida clementii.* The very sparse cover of grasses typically included *Cymbopogon ambiguus*, while the very sparse herb stratum included *Bonamia media* var. *villosa*, *Cassytha capillaris, Euphorbia boophthona, Gomphrena cunninghamii, Trachymene oleracea* and *Trichodesma zeylanicum.*

Minor Flowlines

Nc **Variable low open woodlands and/or high shrublands over spinifex and/or tussock grasslands.**

Mosaic of Nca, Nc2, Nc3, Nc4

Nc1 ***Corymbia hamersleyana* scattered low trees over *Acacia ancistrocarpa, A. tumida, Petalostylis labicheoides* open scrub over *Triodia pungens* hummock grassland**

Narrow flowlines within the rocky hills of the Newman Land System often supported scattered low trees of *Corymbia hamersleyana* over a tall shrubland which was dominated by a mixture of *Acacia ancistrocarpa, A. tumida* and *Petalostylis labicheoides,* usually with lesser amounts of *Acacia bivenosa.* Low shrubs generally provided a sparse cover and were dominated by *Indigofera monophylla.* Other species recorded included *Abutilon lepidum, Corchorus laniflorus, Isotropis atropurpurea, Solanum gabrielae, S. lasiophyllum, Triumfetta clementii* and *Waltheria indica.* Soft spinifex *Triodia pungens* provided an open cover, usually with some *Triodia wiseana* from the surrounding hummock grasslands. Other grasses recorded included *Digitaria brownii, Eriachne mucronata* and *Paspalidium clementii.* A large variety of herbs were recorded, including **Bidens bipinnata, Goodenia stobbsiana, Hybanthus aurantiacus, *Malvastrum americanum, Pterocaulon sphacelatum* and *Trichodesma zeylanicum.* The lianes *Cassytha capillaris* and *Porana commixta* were also often present.

Nc2 ***Acacia monticola* dominated open scrub over *Triodia wiseana* hummock grassland**

Other sections of narrow flowlines supported a tall shrubland dominated by *Acacia monticola*, usually with lesser amounts of *Acacia ancistrocarpa*, *A. bivenosa*, A. coriacea subsp. pendens, A. pyrifolia, and sometimes with significant amounts of *Petalostylis labicheoides*. The cover of low trees of *Corymbia hamersleyana* ranged from negligible to open. The sparse cover of low shrubs was again dominated by *Indigofera monophylla*, and also included *Corchorus laniflorus*, *Solanum horridum* and *Triumfetta clementii*. The moderately dense spinifex layer was dominated by *Triodia wiseana*, with small amounts of *T. epactia*. Other grasses noted included *Cymbopogon ambiguus* and *Digitaria brownii*. A variety of herbs were recorded, including **Bidens bipinnata*, *Bonamia media* var. *villosa*, *Hybanthus aurantiacus*, *Evolvulus alsinoides*, *Trachymene oleracea* and *Trichodesma zeylanicum*. The taxa *Cassytha capillaris* and *Porana commixta* were also recorded. This vegetation type was generally in very good condition, with minor weed invasion.

Nc3 ***Acacia coriacea* high shrubland over *Triodia wiseana* hummock grassland**

Some minor flowlines on Cape Preston supported sparse to open tall shrublands dominated by *Acacia coriacea* subsp. *pendens,* frequently over *A. bivenosa.* Other tall shrubs recorded included *Acacia elachantha, A. pyrifolia, A. tumida* and *Scaevola spinescens.* The sparse cover of low shrubs included *Achyranthes aspera, Indigofera monophylla, Melhania oblongifolia, Solanum lasiophyllum* and *Triumfetta clementii.* The cover of spinifex *Triodia wiseana* ranged from sparse to moderately dense. The sparse cover of other grasses included **Cenchrus ciliaris, Cymbopogon ambiguus, C. obtectus* and *Paspalidium clementii.* The very sparse cover of herbs included *Alternanthera nana, Bonamia media, Evolvulus* species*, Hybanthus aurantiacus, *Malvastrum americanum, Phyllanthus maderaspatensis* var. *angustifolius, Portulaca pilosa, Trachymene oleracea* and *Trichodesma zeylanicum.* This vegetation type was generally in very good condition, with only minor invasion by weeds.

Nc4 ***Acacia coriacea* high shrubland over *Eriachne benthamii, *Cenchrus ciliaris* tussock grassland**

Located between a ridge of Newman Land System and a plain of Yamerina Land System, this flowline supported a tall shrubland of *Acacia coriacea* subsp. *pendens,* with occasional individuals of *Acacia bivenosa, A. elachantha, A. farnesiana* and *Ehretia saligna.* Scattered low shrubs included *Achyranthes aspera, Indigofera* species*, *Melochia pyramidata, Sida* aff. *fibulifera* (MET Site 1346), *Sida rohlenae, Solanum lasiophyllum* and *Triumfetta clementii.* The moderately dense cover of tussock grasses was dominated by *Eriachne benthamii,* with lesser amounts of **Cenchrus ciliaris.*

Rockpiles

Nr **Scattered tall shrubs dominated by *Acacia coriaceae* over lianes, spinifex and/or bunch grass.**
Mosaic of Nr1,Nr2,Nr3,Nr4.

Nr1 ***Acacia coriacea, Ficus platypoda* high open shrubland over *Cymbopogon ambiguus* open tussock grassland and *Operculina aequisepala, Trichosanthes cucumerina* lianes**
This vegetation was similar to ROr1, but occurred on rockpiles composed of smaller boulders, with more soil present in between. This substrate supported a number of species that were not common within ROr1, while other species (eg. *Canavalia rosea*) which were prominent on the larger boulder piles were absent. This vegetation consisted of a sparse tall shrubland dominated by *Acacia coriacea* subsp. *coriacea,* with lesser amounts of *Ficus platypoda,* over sparse lianes dominated by *Operculina aequisepala* and *Trichosanthes cucumerina.*

Nr2 ***Ficus platypoda, Acacia coriacea, Ehretia saligna* high open shrubland over *Triodia wiseana* open hummock grassland and scattered lianes**
This vegetation type was recorded from boulder outcrops on the Southern Ore Body. It featured a sparse tall shrubland dominated by *Ficus platypoda* var. *minor,* with lesser amounts of *Acacia coriacea* subsp. *coriacea* and *Ehretia saligna.* Other species recorded included *Acacia tumida, Alectryon oleifolius, Capparis spinosa* var. *nummularia, Eremophila longifolia* and very occasional Mesquite **Prosopis pallida* hybrid. Low shrubs were uncommon but included *Enchylaena tomentosa, Senna notabilis* and *Solanum gabrielae.* Grasses were typically sparse and dominated by small amounts of *Triodia wiseana,* although there was a variable degree of invasion by **Cenchrus ciliaris.* The very sparse herb stratum included *Amaranthus mitchellii, *Bidens bipinnata, Boerhavia* species, *Cleome viscosa, Gomphrena cunninghamii, Leptopus decaisnei, Nicotiana benthamiana, Polycarpaea longiflora* (pale form) and *Trachymene oleracea.* Lianes were scattered across the outcrops and included *Operculina aequisepala, Tinospora smilacina* and *Trichosanthes cucumerina.*

Nr3 ***Acacia coriacea* scattered tall shrubs over **Cenchrus ciliaris*, *Cymbopogon ambiguus* open tussock grassland**
This area supported very scattered shrubs of *Acacia coriacea* subsp. *coriacea, A. monticola, *Prosopis pallida* hybrid (one individual only), *Rhagodia eremaea* and *Wrightia saligna* over a sparse cover of grasses dominated by **Cenchrus ciliaris* with small amounts of *Triodia pungens* and *Cymbopogon ambiguus.* Low shrubs were uncommon but included *Enchylaena tomentosa, Solanum gabrielae* and *Triumfetta clementii.* The sparse cover of herbs included **Bidens bipinnata, Euphorbia* species, *Gomphrena cunninghamii, *Malvastrum americanum, Polycarpaea longiflora* (pale form), *Trichodesma zeylanicum* and *Zaleya galericulata.* The liane *Tinospora smilacina,* which often occurs in rocky situations, was also recorded.

Nr4 **Regenerating low open shrubland over open herbland and open grassland**
The early seral stage of vegetation was thus dominated by an open cover of herbs, particularly *Gomphrena canescens* and *G. cunninghamii,* over an open cover of the grass *Paspalidium clementii.* A large number of other herbs and grasses was recorded. Scattered regenerating shrubs were noted, including *Abutilon lepidum, Acacia ancistrocarpa, A. monticola, A. pyrifolia, Petalostylis labicheoides, Scaevola spinescens, Tribulus platypterus* and *Triumfetta clementii.*

6.2.6 Paraburdoo Land System

Snakewood (*Acacia xiphophylla*) shrublands characterise the Paraburdoo Land System, and a number of distinct Snakewood types were recognised for it, based primarily on the composition of the understorey. These shrublands frequently occurred in a mosaic with annual herblands on cracking clay and with the grasslands described for the Horseflats Land System. Snakewood shrublands also dominated the section of Boolgeeda Land System within the study area and occurred occasionally within the Rocklea Land System.

Px1 ***Acacia xiphophylla* open shrubland over patches of *Triodia wiseana* hummock grassland**

This represented the most common of the Snakewood vegetation types, occurring generally on the stony plains of the Paraburdoo Land System. It consisted of a sparse to open (typically ~5-10 % cover) tall shrubland of *Acacia xiphophylla* over patches of moderately dense *Triodia wiseana* hummock grassland. Other shrubs were infrequent, however the low shrubs *Enchylaena tomentosa* and *Maireana planifolia* were commonly present. Grasses other than spinifex generally contributed a very sparse cover but included a variety of species (e.g. *Aristida contorta, *Cenchrus ciliaris, *C. setigerus, Enneapogon caerulescens, Eragrostis xerophila, Eriachne pulchella* subsp. *dominii, Iseilema dolichotrichum, Paspalidium clementii, Sporobolus australasicus* and *Tragus australianus*). Very sparse herbs included *Evolvulus alsinoides* var. *villosicalyx, Leptopus decaisnei, Portulaca oleracea* and *Sclerolaena eriacantha.* This vegetation was generally in very good condition, with only scattered weeds at most sites.

Px2 ***Acacia xiphophylla* open shrubland over patches of *Eragrostis xerophila* tussock grassland**

Areas of clayey plain within the Paraburdoo Land System, particularly near boundaries with the Horseflats Land System, supported open shrublands of *Acacia xiphophylla* over occasional low shrubs such as *Enchylaena tomentosa* and *Neptunia dimorphantha.* The patches of moderately dense tussock grasses were typically dominated by *Eragrostis xerophila,* sometimes with significant amounts of **Cenchrus ciliaris* and/or *Eriachne benthamii.* Other species recorded included *Enneapogon caerulescens, Enteropogon acicularis, Sporobolus australasicus* and *Xerochloa imberbis.* Herbs were very sparse but included *Cleome viscosa, Heliotropium heteranthum, Hibiscus brachysiphonius*, **Malvastrum americanum, Portulaca oleracea* and *Streptoglossa liatroides.* This vegetation type was generally in very good condition, with only minor invasion by weed species.

Px3 **Mixed chenopod very open herbland**

Patches of more gravelly soil within the Snakewood shrublands supported herblands. These were dominated by chenopods, particularly *Sclerolaena eriacantha* with lesser amounts of *Atriplex codonocarpa*, and also typically supported *Streptoglossa liatroides.* Other herbaceous species recorded included *Hibiscus brachysiphonius, Portulaca pilosa, Ptilotus aervoides, P. murrayi* var. *murrayi* and *Sclerolaena glabra*. Occasional grasses included *Brachyachne prostrata, Dactyloctenium radulans, Tragus australianus* and *Xerochloa imberbis,* while the sedge *Fimbristylis depauperata* was also recorded. Very occasional low shrubs included *Sida* aff. *fibulifera* 'var. L'. These vegetation types were generally in very good condition, with few signs of disturbance. (Site M028B).

Pp1 ***Acacia bivenosa*** **open shrubland over** ***Indigofera trita*** **low open shrubland over** ***Triodia wiseana*** **hummock grassland**

This vegetation type dominated stony plains of the Paraburdoo LS. It consisted of a sparse to open shrubland of *Acacia bivenosa*, over a low open shrubland dominated by *Indigofera trita,* usually with *Triumfetta clementii.* Other low shrubs recorded included *Hibiscus* aff. *Platychlamys* (M39.14)*, Indigofera monophylla, Solanum horridum* and *S. lasiophyllum.* The moderately dense to dense hummock grassland of *Triodia wiseana* included scattered individuals of **Cenchrus ciliaris.* Very sparse herbs included *Euphorbia coghlanii, Evolvulus alsinoides* var. *villosicalyx, Pterocaulon sphacelatum, Ptilotus exaltatus* and *Rhynchosia* cf. *minima.*

Pp2 ***Triodia angusta*** **hummock grassland with patches of open herbland**

This vegetation occurred broadly on stony plains in the northern section of the project area. It consisted of a moderately dense to dense hummock grassland of *Triodia angusta,* with a very sparse to sparse overstorey of low shrubs, principally *Atriplex bunburyana, Indigofera trita* and *Sclerolaena hostilis.* Very occasional grasses included **Cenchrus ciliaris, Dactyloctenium radulans* and *Dichanthium sericeum* subsp. *humilius*, while occasional sedges (*Fimbristylis dichotoma*) were also present. Herbs were very sparse within the general hummock grassland and included *Cassytha capillaris, Corchorus tridens, Crotalaria medicaginea, Evolvulus alsinoides* var. *villosicalyx, Phyllanthus maderaspatensis* var. *angustifolius, Polycarpaea corymbosa* and *Portulaca pilosa.* Small patches of open herblands in the area supported greater densities of these species, together with others such as *Trianthema turgidifolia* and *Sclerolaena eriacantha.*

The Paraburdoo System was also found to support *Eucalypt* communities that dominate the creeklines. The Pc vegetation type typically occurred as a mosaic and some areas mapped as PC may therefore contain more than one sub-unit, however, these sub-units are not distinct enough to be mapped separately.

Pc **Open to sparse tall woodlands of Eucalyptus camaldulensis and/or Eucalyptus victrix over tall shrubs dominated by Acacia coriacea over herbs, grasses or Spinifex.**

Pc1 ***Eucalyptus victrix, E. camaldulensis*** **woodland over** ***Acacia coriacea,*** **Mesquite high shrubland over open herbland**

This vegetation type was recorded within the bed of a major creekline. It consisted of a woodland of *Eucalyptus victrix* and *E. camaldulensis* over a high shrubland dominated by *Acacia coriacea* subsp. *pendens,* with significant invasion by Mesquite (**Prosopis pallida* hybrid). Other tall shrubs recorded included *Acacia pyrifolia, A. trachycarpa, Ehretia saligna, Eremophila longifolia, Melaleuca glomerata* and *Santalum lanceolatum.* Scattered low shrubs included *Achyranthes aspera, Plumbago zeylanicum, Sesbania cannabina* and *Triumfetta clementii.* Grasses such as **Cenchrus ciliaris, *C. setigerus, Eragrostis tenellula* and *Eriachne benthamii* provided a very sparse to sparse cover. The sparse to open herb stratum was dominated by *Alternanthera nana,* with lesser amounts of *Vigna lanceolata* var. *lanceolata.* A variety of other species was recorded including *Cleome viscosa, Hybanthus aurantiacus, Ipomoea muelleri, *Malvastrum americanum, *Melochia pyramidata*, the Priority 3 species *Phyllanthus aridus, Phyllanthus maderaspatensis* var. *angustifolius, Pterocaulon sphacelatum, Rostellularia adscendens* var. *clementii, Trichodesma zeylanicum* and the lianes **Cucumis melo* subsp. *agrestis, Ipomoea muelleri* and **Passiflora foetida.* Occasional sedges included *Cyperus bifax* and *C. vaginatus.* This vegetation type was in moderate condition with the invasion by Mesquite being the major disturbance. (Site 59).

Pc2 ***Eucalyptus victrix*** **open woodland over** ***Acacia coriacea*** **high shrubland over** ***Cenchrus*** **species tussock grassland**

This vegetation type occurred along minor creeklines within the Paraburdoo LS. It consisted of trees of *Eucalyptus victrix,* ranging in cover from scattered to an open

woodland, over a high shrubland dominated by *Acacia coriacea* subsp. *pendens.* Other tall shrub species recorded included *Acacia farnesiana* and *A. pyrifolia,* while scattered low shrubs included *Achyranthes aspera, Sesbania cannabina* and *Triumfetta clementii.* The moderately dense to dense grassland was dominated by **Cenchrus ciliaris* and **C. setigerus.* Other grasses recorded included *Dactyloctenium radulans, Eriachne tenuiculmis* (only at Site M006), and spinifex (*Triodia angusta* or *T. pungens*). While the spinifex usually occurred only as scattered individuals, the cover of *T. angusta* at Site M043 was as high as 10%. A variety of herbs contributed a very sparse cover, including *Alternanthera nana, Amaranthus pallidiflorus, *Bidens bipinnata, Cleome viscosa, Hybanthus aurantiacus, Leptopus decaisnei, *Malvastrum americanum, Operculina aequisepala, Phyllanthus maderaspatensis* var. *angustifolius* and *Rostellularia adscendens* var. *clementii.* This vegetation was generally in good to moderate condition, with invasion by Buffel Grass being the major disturbance factor noted. (Sites M006, M025, M043 & M066).

Pc3 ***Eucalyptus victrix* open woodland over *Acacia coriacea* high open shrubland over *Triodia epactia* open curly spinifex grassland and **Cenchrus ciliaris* open tussock grassland**

This vegetation type was recorded within a single small creekline. It had an open woodland of *Eucalyptus victrix* over a high open shrubland of *Acacia coriacea* subsp. *pendens,* with occasional other species such as *Acacia bivenosa, A. pyrifolia* and *Eremophila longifolia.* Scattered low shrubs included *Achyranthes aspera, Isotropis atropurpurea, Solanum horridum, S. lasiophyllum, Triumfetta clementii* and *Waltheria indica. Triodia epactia* contributed ~12 % cover, while the moderate cover of other grasses was dominated by **Cenchrus ciliaris,* and also included small amounts of *Cymbopogon ambiguus, Digitaria brownii*, *D. ctenantha* and *Themeda triandra.* A variety of herbs was recorded, including *Alternanthera nana, Amaranthus pallidiflorus, Cassytha capillaris, Glycine canescens, Ipomoea muelleri, *Malvastrum americanum,* various species with affinities to *Mukia maderaspatana*, *Polymeria ambigua* and *Vigna lanceolata* var. *lanceolata*. This vegetation type was in very good condition, with minor invasion by weeds being the major disturbance. (Site M029).

Pc4 ***Eucalyptus victrix* scattered trees over *Acacia ancistrocarpa* high open shrubland over *Sorghum* open annual tussock grassland and *Triodia wiseana* very open hummock grassland**

This vegetation type consisted of scattered low trees of *Eucalyptus victrix* over a sparse tall shrubland dominated by *Acacia ancistrocarpa.* Other tall shrubs included *Acacia bivenosa, A. coriacea* subsp. *pendens* and *A. pyrifolia.* Scattered low shrubs included *Indigofera monophylla, I. trita, Solanum diversiflorum, S. horridum, S. lasiophyllum* and *Triumfetta clementii.* The open grassland was dominated by annual *Sorghum plumosum*, with lesser amounts of **Cenchrus ciliaris, Eulalia aurea, Themeda triandra* and the spinifex *Triodia wiseana*. Other species recorded included *Bothriochloa ewartiana* and *Chrysopogon fallax.* The very sparse herb stratum was dominated by *Ipomoea muelleri,* and also included *Alternanthera nana, Cleome viscosa, Hybanthus aurantiacus, *Malvastrum americanum, Polymeria ambigua, Trichodesma zeylanicum* and *Vigna lanceolata* var. *lanceolata*. This vegetation type was in very good condition, with minor invasion by weeds. (Site M083).

Pf1 **Scattered patches of *Corymbia hamersleyana* low open woodland over patches of *Acacia trachycarpa* high shrubland over **Cenchrus ciliaris* closed tussock grassland**

This vegetation type comprised of scattered patches of *Corymbia hamersleyana* low trees over patches of tall shrubs of *Acacia trachycarpa,* with occasional *A. coriacea* and *A. pyrifolia.* Scattered low shrubs included *Abutilon* species, *Indigastrum parviflorum, Indigofera* species, *Solanum diversiflorum, S. lasiophyllum* and *Triumfetta clementii.* The dense grassland was dominated by **Cenchrus ciliaris,* which occurred with scattered **Cenchrus setigerus* and *Chrysopogon fallax.* The spinifex *Triodia angusta* and *T. epactia* occurred only as occasional hummocks. A variety of herbs was recorded, including *Alysicarpus rugosus, Amaranthus pallidiflorus, Cleome viscosa, Euphorbia* species, **Malvastrum americanum, Phyllanthus maderaspatensis* var. *angustifolius,* and the lianes **Cucumis melo* subsp. *agrestis, Ipomoea muelleri* and *Vigna lanceolata* var. *lanceolata*. This vegetation was in moderate condition, with heavy invasion by Buffel grass. (Site M005).

6.2.7 Rocklea Land System

Similar to the Newman Land System, hummock grasslands of the low hills of the Rocklea Land System frequently occurred as a mosaic and hence could not be mapped separately. These were separated on the basis of differing overstoreys, which ranged from virtually absent, to low open shrublands of the pea *Indigofera monophylla*, to sparse or open shrublands of mixed *Acacia* species.

ROh1 ***Triodia wiseana* hummock grassland with scattered emergent low shrubs**

Mosaic of Roh1a/Roh1b

ROh1a ***Triodia wiseana* hummock grassland**

As mentioned previously, some stony hillslopes of the Rocklea LS supported *Triodia wiseana* hummock grasslands with very little overstorey. These were very similar to the Nh1 vegetation type of the Newman LS.

ROh1b ***Indigofera monophylla* low open shrubland over *Triodia wiseana* hummock grassland**

Stony hillslopes in the northern section of the project area, particularly on Cape Preston, typically supported a low shrubland dominated by *Indigofera monophylla*, often with *Corchorus walcottii*, over moderately dense hummock grassland of *Triodia wiseana.* Other low shrub species recorded included *Crotalaria novae-hollandiae, Hibiscus* aff. *Platychlamys* (M39.14)*, Melhania oblongifolia, Scaevola spinescens, Solanum diversiflorum, S. lasiophyllum, Tephrosia supina* and *Triumfetta clementii.* Tall shrubs were occasional only and included *Acacia bivenosa, A. coriacea* subsp. *coriacea* and *A. pyrifolia.* The very sparse cover of grasses other than spinifex included **Cenchrus ciliaris, Cymbopogon ambiguus* and *Paspalidium clementii.* The variety of herbs which contributed a very sparse cover was often dominated by *Euphorbia schultzii,* and also included *Boerhavia gardneri, Bonamia media* var. *villosa, Evolvulus alsinoides* var. *villosicalyx, Gomphrena cunninghamii, Hybanthus aurantiacus, Phyllanthus maderaspatensis* var. *angustifolius, Polycarpaea longiflora* (pale form), *Pterocaulon sphacelatum, Rhynchosia* cf. *minima, Trachymene oleracea* and *Trichodesma zeylanicum.*

ROh2 **Triodia wiseana hummock grassland with scattered Acacia tall shrubs**

Mosaic of Roh2a/Roh2b

ROh2a ***Acacia inaequilatera, A. bivenosa*** **scattered shrubs over** ***Triodia wiseana*** **hummock grassland**

This vegetation occurred on gentle footslopes of hills, particularly in the northern half of the project area. It consisted of a very sparse shrubland of *Acacia inaequilatera* and *A. bivenosa* over moderately dense hummock grassland of *Triodia wiseana.* Scattered low shrubs included *Hibiscus* aff. *platychlamys* (M39.14), *Indigofera monophylla, I. trita, Solanum lasiophyllum* and *Triumfetta clementii.* Scattered grasses included **Cenchrus ciliaris, Dichanthium sericeum* subsp. *humilius* and *Paspalidium clementii,* while the very sparse herb stratum included *Bonamia media* var. *villosa, Evolvulus alsinoides* var. *villosicalyx, Gomphrena cunninghamii* and species with affinities to *Mukia maderaspatana*.

ROh2b ***Acacia ancistrocarpa*****,** ***A. bivenosa*** **open shrubland over** ***Triodia wiseana*** **hummock grassland**

This vegetation type had a shrubland of *Acacia ancistrocarpa* or *A. bivenosa* over a moderately dense hummock grassland of *Triodia wiseana.* Scattered low shrubs typically included *Abutilon lepidum, Corchorus laniflorus, Hibiscus* aff. *coatesii* (Site 664)*, Sida* sp. 'rugose', *Tephrosia supina* and *Triumfetta clementii.* Very sparse grasses were dominated by **Cenchrus ciliaris* and also included *Cymbopogon ambiguus.* The sedge *Fimbristylis dichotoma* was also present. Scattered herbs included *Bonamia media* var. *villosa, Crotalaria medicaginea, Evolvulus alsinoides* var. *villosicalyx, Gomphrena cunninghamii, Rhynchosia* cf. *minima* and *Trachymene oleracea.*

ROp1 ***Triodia angusta*** **hummock grassland**

This vegetation type occurred as a narrow strip (frequently only 12-15m wide) on gentle stony slopes fringing coastal areas of the Rocklea LS. Its distribution reflected calcretisation caused by seepage (M. Trudgen, pers. obs.), and this vegetation type was localised at the bottom of slopes between the belt of samphire fringing the coast and the *Triodia wiseana* hummock grassland vegetation of the hills. It consisted of a moderately dense hummock grassland of *Triodia angusta,* with occasional patches of *Themeda triandra.* Other scattered grasses included *Cymbopogon ambiguus*, *Eriachne mucronata* and *Eulalia aurea.* Shrubs were rare but included very occasional *Acacia bivenosa, Achyranthes aspera, Indigofera monophylla, I. trita, Solanum horridum, S. lasiophyllum, Tephrosia clementii* and *Triumfetta clementii.* Sparse herbs were dominated by *Cassytha capillaris,* and also included *Cleome viscosa, Euphorbia coghlanii, Gomphrena cunninghamii, Phyllanthus maderaspatensis* var. *angustifolius* and *Polycarpaea longiflora* (pale form).

ROx1 ***Acacia xiphophylla*** **open shrubland over patches of** ***Triodia wiseana*** **hummock grassland**

Patches of Snakewood *Acacia xiphophylla* shrubland over *Triodia wiseana* hummock grassland occurred occasionally within the Rocklea LS, but were much more common within the Paraburdoo LS.

ROc1 ***Corymbia hamersleyana*** **low woodland over** ***Acacia bivenosa*** **high shrubland over** ***Triodia wiseana*** **hummock grassland**

This vegetation type occurred in minor flowlines. It consisted of an open cover of *Corymbia hamersleyana* low trees over an open tall shrubland dominated by *Acacia bivenosa.* Other tall shrubs recorded included *Acacia ancistrocarpa, A. coriacea* subsp. *pendens, A. pyrifolia* and *Senna glutinosa* subsp. x *luerssenii*. The sparse cover of low shrubs included various species such as *Corchorus laniflorus, Isotropis atropurpurea, Solanum lasiophyllum* and *Triumfetta clementii.* A moderately dense cover of the spinifex *Triodia wiseana* occurred with a sparse cover of other grasses, which was dominated by **Cenchrus ciliaris* and also included *Cymbopogon ambiguus, Digitaria ctenantha, Paraneurachne muelleri* and *Sporobolus australasicus.* A variety of herbs was recorded, including *Euphorbia* species, *Flaveria australasica, Hybanthus aurantiacus, *Malvastrum americanum, Trichodesma zeylanicum* and the lianes *Mukia* aff. *maderaspatana* sp. F and *Porana commixta.*

ROc2 ***Acacia coriacea* high shrubland over hummock / tussock grassland**

This flowline vegetation was common in the Rocklea LS. It consisted of a tall shrubland of *Acacia coriacea* subsp. *pendens,* sometimes with *A. inaequilatera,* over sparse spinifex (*Triodia wiseana* and/or *T. angusta*) and moderately dense tussock grasses. The latter was dominated by a variable amount of **Cenchrus ciliaris,* with small amounts of other species such as *Sorghum plumosum* and *Themeda triandra.* Other tall shrubs recorded included *Acacia bivenosa* and *A. farnesiana,* while scattered lower shrubs included *Indigofera monophylla, I. trita, Melhania oblongifolia, Solanum horridum* and *S. lasiophyllum.* Very sparse herbs included *Alternanthera nana, Cassytha capillaris, Euphorbia tannensis* subsp. *eremophila, Hybanthus aurantiacus, Portulaca oleracea, Pterocaulon sphacelatum* and *Trichodesma zeylanicum.*

ROc3 ***Acacia sclerosperma* high shrubland over **Cenchrus ciliaris*, *Themeda triandra* tussock grassland and *Triodia wiseana* open hummock grassland**

This vegetation was recorded from one group of flowlines in the northern section of the project area. The overstorey consisted of a tall shrubland dominated by *Acacia sclerosperma,* with small amounts of *A. bivenosa* and occasional *A. ancistrocarpa, A. farnesiana, A. victoriae* and *Eremophila longifolia.* Scattered low shrubs included *Abutilon trudgenii* ms, *Enchylaena tomentosa, Melhania oblongifolia, Solanum diversiflorum* and *S. lasiophyllum.* The moderately dense grassland was dominated by **Cenchrus ciliaris* with lesser amounts of *Themeda triandra.* Other grasses recorded included *Dichanthium sericeum* subsp. *Humilius* and *Digitaria ctenantha.* The sparse cover of spinifex was dominated by *Triodia wiseana* and occasional *T. angusta* hummocks were also present. Herbs included *Alternanthera nana, Cleome viscosa, Euphorbia* species, *Hybanthus aurantiacus, *Malvastrum americanum, Phyllanthus maderaspatensis* var. *angustifolius, Pterocaulon sphacelatum* and *Stemodia grossa.*

ROc4 ***Acacia coriacea, A. bivenosa* high shrubland over mixed shrubs and grasses**

A relatively well developed creekline on Cape Preston supported variable vegetation which was sampled at a single site. This consisted of a high shrubland dominated by *Acacia bivenosa* and *A. coriacea* subsp. *pendens*, with lesser amounts of several species including *Acacia ampliceps* and *Rhagodia eremaea.* The diverse array of low shrubs included *Abutilon cunninghamii, Capparis spinosa* var. *nummularia, Senna artemisioides* subsp. *oligophylla, Solanum gabrielae, S. lasiophyllum, Tephrosia rosea* var. *clementii* and *Triumfetta clementii.* At ground level there was a variable cover of the spinifex *Triodia wiseana* with other grasses dominated by **Cenchrus ciliaris.* Scattered herbs included *Corchorus tridens, Dysphania rhadinostachya* and *Pterocaulon sphacelatum,* and patches of the sedge *Cyperus vaginatus* were also recorded.

ROc5 ***Acacia ampliceps* high shrubland over *Triodia angusta* hummock grassland and tussock grasses**

This vegetation type consisted of an open tall shrubland of *Acacia ampliceps,* with occasional individuals of other species such as *Acacia coriacea* subsp. *pendens* and *Sesbania cannabina.* The sparse to open grass cover was dominated by a small amount of the spinifex *Triodia angusta,* and a variable cover of **Cenchrus ciliaris* or *Sporobolus virginicus.* Very sparse herbs included *Corchorus tridens, Ipomoea muelleri, *Malvastrum americanum, Phyllanthus maderaspatensis* var. *angustifolius* and *Trichodesma zeylanicum*

Rockpiles

ROr **Scattered tall shrubs dominated by Acacia coriacea over lianes, spinifex and/or bunch grasses (mosaic of ROr1/ ROr2/ ROr3)**

ROr1 ***Acacia coriacea, Ficus platypoda* high open shrubland over lianes dominated by *Canavalia rosea***

This vegetation type consisted of a sparse tall shrubland of *Acacia coriacea* subsp. *coriacea,* usually with similar amounts of *Ficus platypoda* var. *minor,* over a very sparse to open cover of lianes, principally *Canavalia rosea,* but also including *Operculina aequisepala* and *Trichosanthes cucumerina. *Passiflora foetida* was recorded from one site. Scattered low shrubs included *Abutilon* species, *Achyranthes aspera, Capparis spinosa* var. *nummularia, Rhagodia eremaea, Scaevola spinescens, Solanum lasiophyllum* and *Triumfetta clementii.* Scattered herbs included a variety of species such as **Bidens bipinnata, Cleome viscosa, Commicarpus australis, Gomphrena cunninghamii, Polycarpaea longiflora* (pale form), *Portulaca oleracea, Trachymene oleracea* and *Trichodesma zeylanicum.*

ROr2 ***Acacia coriacea* high shrubland over *Cymbopogon, *Cenchrus ciliaris, Triodia wiseana* tussock / hummock grassland**

The overstorey of this vegetation type comprised an open tall shrubland dominated by *Acacia coriacea* subsp. *coriacea,* with scattered individuals of other species including *Acacia bivenosa, A. pyrifolia, Ehretia saligna, Ficus opposita* var. *aculeata* and *Santalum lanceolatum.* Scattered low shrubs were dominated by *Achyranthes aspera,* and also included *Enchylaena tomentosa, Solanum gabrielae, S. horridum* and *Triumfetta clementii.* The open cover of grasses was typically dominated by **Cenchrus ciliaris* and *Cymbopogon ambiguus*, with the spinifex *Triodia wiseana* providing a sparse to open cover. *Themeda triandra* was common in places, and other scattered grasses included *Chrysopogon fallax, Digitaria ctenantha* and *Paspalidium clementii.* Scattered herbs included *Cleome viscosa, Crotalaria medicaginea, Gomphrena cunninghamii* and *Polycarpaea longiflora* (pale form). Scattered lianes included *Tinospora smilacina* and *Trichosanthes cucumerina.*

ROr3 ***Acacia coriacea, A. bivenosa* scattered tall shrubs over *Cymbopogon ambiguus* tussock grassland**

This vegetation consisted of scattered to sparse tall shrubs of *Acacia coriacea* subsp. *coriacea,* with less *A. bivenosa,* over a very sparse to sparse cover of grasses, particularly *Cymbopogon ambiguus* with occasional **Cenchrus ciliaris.* Scattered other shrub species included *Capparis spinosa* var. *nummularia, Enchylaena tomentosa, Eremophila longifolia, Sida* aff. *fibulifera* (M37.16)*, Sida* sp. 'rugose', *Tephrosia* aff. *densa* and *Triumfetta clementii.* Very occasional herbs included *Gomphrena cunninghamii, Hybanthus aurantiacus, Mukia maderaspatana, Phyllanthus maderaspatensis* var. *angustifolius* and *Rhynchosia* cf. *minima*.

6.2.8 River Land System

Rc1 **Scattered riverine trees and shrubs**

Areas of scoured creekbed occurred within major creeklines associated with the Fortescue River system. These consisted primarily of bare gravels, with occasional trees and tall shrubs of species occurring on the creek banks (eg. *Eucalyptus camaldulensis* and *Melaleuca glomerata*). Herbs and grasses were sometimes abundant on islands within the creek beds.

Rc2 **Cadjeput *Melaleuca argentea*, River Redgum *Eucalyptus camaldulensis* open forest over patches of *Acacia coriacea* high shrubland over **Cenchrus* species tussock grassland**

Only one location supporting Cadjeputs was observed during the field survey (although it should be noted that the entire river system was not traversed). Site M126 (from the 2000 assessment) was located on a permanent pool which supported an open forest (12-15 m tall) of *Melaleuca argentea* and *Eucalyptus camaldulensis.* Patches of tall shrubs were dominated by *Acacia coriacea* subsp. *pendens,* and also included scattered *Acacia trachycarpa, Erythrina vespertilio* and a single Mesquite (**Prosopis pallida* hybrid). **Cenchrus ciliaris* and **C. setigerus* dominated the moderately dense cover of grasses, while small patches of sedges included *Bulbostylis barbata, Cyperus bifax, C. squarrosus* and *C. vaginatus.* A variety of herbs was recorded, including *Alternanthera nodiflora, Ipomoea muelleri, *Malvastrum americanum, Marsilea hirsuta, *Melochia pyramidata* and *Rostellularia adscendens* var. *clementii.* This vegetation was in good condition, with invasion by introduced grasses being the only obvious disturbance.

Rc3 ***Eucalyptus camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over patches of *Cyperus vaginatus* sedgeland**

This riverine vegetation was recorded only within major tributaries of the Fortescue River system. It consisted of a woodland of *Eucalyptus camaldulensis,* with occasional individuals of *E. victrix,* over patches of tall shrubs dominated by *Melaleuca glomerata.* Other tall shrubs recorded included *Acacia coriacea* subsp. *pendens* and very occasional Mesquite **Prosopis pallida* hybrid. The sparse cover of low shrubs included *Achyranthes aspera* and *Sesbania cannabina.* Patches of sedges were dominated by *Cyperus vaginatus.* Other species noted included *Cyperus squarrosus* and *Typha domingensis.* Sparse grasses were typically dominated by **Cenchrus ciliaris.* The sparse herb stratum contained a variety of species including *Amaranthus pallidiflorus, *Argemone ochroleuca* (only at Site M124 from the 2000 assessment), *Basilicum polystachyon, Datura leichhardtii, *Melochia pyramidata, Mimulus gracilis, Rostellularia adscendens* var. *clementii,* and the lianes **Cucumis melo* subsp. *agrestis, Operculina aequisepala* and **Passiflora foetida.* This vegetation type was in good condition, with the major disturbance being invasion by weeds.

Rc4 ***Eucalyptus victrix, E. camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over **Cenchrus* species tussock grassland**

This vegetation type occurred in tributaries of the Fortescue River System and in Eramurra Creek. It consisted of a woodland of *Eucalyptus victrix* with lesser amounts of *E. camaldulensis* over patches of tall shrubs dominated by *Melaleuca glomerata,* frequently with small amounts of *Acacia ampliceps.* Other tall shrub species included *Acacia coriacea* subsp. *pendens* and scattered Mesquite **Prosopis pallida* hybrid, recorded from Site M101 only (from the 2000 assessment). Low shrubs such as *Sesbania cannabina* provided a very sparse cover. The moderately dense cover of grasses was dominated by **Cenchrus ciliaris* and **C. setigerus,* with occasional individuals of other species such as *Dactyloctenium radulans* and **Setaria verticillata.* Scattered patches of sedges included the species *Cyperus bifax, C. bulbosus, C. squarrosus, C. vaginatus* and *Schoenoplectus litoralis.* Herbs provided a very sparse to sparse cover and included *Amaranthus pallidiflorus, Corchorus tridens, Ipomoea muelleri, Nicotiana rosulata* subsp. *rosulata, Phyllanthus maderaspatensis* var. *angustifolius, Pluchea rubelliflora* and *Stemodia grossa.* This vegetation was considered to be in moderate condition, with the heavy infestations of introduced grasses being the major disturbance.

Rf1 ***Eucalyptus victrix* open woodland over *_Cenchrus_ species tussock grassland**

This vegetation type occurred on floodplains associated with the Fortescue River system. It consisted of scattered tall trees of *Eucalyptus victrix* with occasional low trees of *Erythrina vespertilio* over a moderately dense grassland dominated by **Cenchrus ciliaris* and **C. setigerus.* Very occasional tall shrubs included *Melaleuca glomerata,* which had been killed by a fire. A variety of herbs contributed a very sparse cover, including species such as *Alternanthera nodiflora, Amaranthus pallidiflorus, Ammannia baccifera,* Mexican poppy **Argemone ochroleuca, Basilicum polystachyon, Datura leichhardtii, Glinus lotoides, Rostellularia adscendens* var. *clementii, Stemodia grossa,* and the lianes *Ipomoea muelleri, Operculina aequisepala* and **Passiflora foetida.* This vegetation was in moderate condition, with heavy invasion by introduced grasses representing the major disturbance.

Rf2 **Mesquite *_Prosopis pallida_ hybrid high shrubland to open scrub**

Moderately dense, tall shrublands (>2m in height) of the Declared Weed Mesquite (a hybrid form of **Prosopis pallida*) occurred in the south of the project area on dense clayey plains associated with the Fortescue River system. These shrublands tended to occur over patches of Birdwood grass (**Cenchrus setigerus*) and Buffel grass (**C. ciliaris*). The few other species present included occasional low shrubs (eg. *Sida* aff. *fibulifera* 'var. L') and herbs such as *Euphorbia tannensis* subsp. *eremophila, Ptilotus aervoides, Salsola tragus* and *Trianthema triquetra.* These shrublands were completely degraded, being heavily infested by Mesquite.

6.2.9 Yamerina Land System

The Yamerina Land System occurred as broad plains in the western section of the study area.

Yp1 **Mosaic of patches of *Triodia angusta* hummock grassland with open herblands and Mesquite scattered tall shrubs**

The Yamerina LS occurred as broad plains close to the coast, west of the Northern OB. This LS appears to support extremely variable vegetation, dependent on small-scale variations in soil type and topography, but was only surveyed in a very cursory manner due to a lack of time. The primary vegetation identified consisted of a mosaic of moderately dense hummock grasslands of *Triodia angusta* with scattered patches of chenopod herbs, particularly *Sclerolaena eriacantha.* Scattered shrubs of Mesquite occurred throughout the plains. This vegetation was in good to moderate condition.

Yc1 ***Avicennia marina* high shrubland over patches of *Schoenoplectus litoralis* open sedgeland**

This vegetation was recorded within the tidal reaches of Edward Creek. It consisted of a high shrubland dominated by the mangrove *Avicennia marina,* with occasional individuals of *Melaleuca glomerata,* over patches of the sedge *Schoenoplectus litoralis.* Scattered Bulrushes *Typha domingensis* were also recorded. Occasional low shrubs included *Halosarcia halocnemoides* subsp. *tenuis* and *Samolus repens*. The grass *Sporobolus virginicus* provided a sparse cover on the banks, and occasional tall shrubs of *Acacia ampliceps* were also noted in this area. The alga *Chara* sp. was recorded from pools. The only herb species recorded was *Flaveria australasica.* This vegetation was in very good condition. (Site M113

6.3 Assessment of Vegetation Significance

A range of factors, including isolation, supporting significant flora or fauna and landform type, determines the significance of native vegetation communities. However, the most important factor in consideration of community significance is the degree of representation in the local and regional area. That is, vegetation communities are considered significant if they are poorly represented elsewhere. The following sections discuss representation of the vegetation of the project area at a range of scales and by a range of studies.

6.3.1 Assessment at the Level of Beard's (1975) Mapping of the Pilbara

The vegetation types mapped by Beard (1975) in the project area are:

- *Triodia pungens* steppe (hummock grassland);
- shrub-steppe of *Acacia pyrifolia* over *Triodia pungens;*
- mosaics of grass savannah with Spinifex *Triodia pungens;*
- *Eucalyptus* sp aff. *aspersa* sparse tree savannah over short Grassland; and
- shrub savannah of *Acacia xiphophylla* over short Grassland and Shrub-steppe of *Acacia pyrifolia*

Beard's mapping shows all of these vegetation units as being relatively widespread and of fairly extensive occurrence. However, inside the project area, each of these units contains substantial variation, as recorded during the surveys. For this reason it is not possible to realistically determine the extent of representation of the vegetation at this broad level.

6.3.2 Assessment at Land System Level

Of the ten Land Systems occurring within the project area, the Horseflats, Yamerina, Newman, Rocklea and Paraburdoo are widespread throughout the Pilbara, according to the Department of Agriculture Land System Mapping. The vegetation types occurring as part of these Land Systems in the project area are therefore also likely to be well represented and not regionally significant.

The River Land System is widely distributed in the region, but is not very abundant as it covers only a small proportion of the land surface, occurring in association with river systems. This vegetation type is significant due to this limited shape and particularly as it provides connectivity along a vast area of the landscape. In the event that such areas are severed for development clearing, this connectivity will be lost. The areas of this System in the project area (as for the land system as a whole) tend to be highly degraded by grazing and subsequent erosion and weed invasion. The degree of degradation is highly variable, with more stony areas resisting erosion and invasion by weeds and the more sandy and loamy areas being more degraded and often severely infested with **Cenchrus ciliaris* (Buffel grass). The areas of this Land System within the project area that are in good condition hold significant conservation value due to the degree of degradation of the System as a whole and the limited area of its occurrence of Good quality representation.

The Boolgeeda Land System occurs as a single thin swathe in the study area and is associated with the stony lower slopes and plains found below hill systems. There are significant areas of this Land System to the north-east and south-west of the study area and while the portion of it within the project area is considered locally significant due to being a locally limited type, these values are considered well represented outside of the project area.

A summary of vegetation community areas within each Land Systems of the project area is presented in Appendix G.

The total area of each land system to be cleared by the project is presented in Table 10. For the Balmoral South project, the land system to be most impacted by clearing within the Roebourne sub region is Newman, with 9.17 % of its extent to be cleared, followed by Paraburdoo Land System at 5.46 %. On a Pilbara wide scale, the Land System with the highest proportion of its extent cleared will be Paraburdoo at 1.52 %. When considered cumulatively with the Central Block project, the combined projects will result in the clearing of 25.93 % of the Newman Land System within the Roebourne sub region, but only 0.9 % of its extent throughout the Pilbara region.

Table 10: Total area of each Land System to be cleared for the Balmoral Project.

Land System	Total area to be cleared (ha) Balmoral South	Total area of Land System within Roebourne Subregion (ha)	% Cleared within Roebourne Subregion	Total area of Land System within the Pilbara Region (ha)	% Cleared within Pilbara Region
Boolgeeda	132.26	27,085.24	0.49	826,416.12	0.02
Cheerawara	6.05	48,424.73	0.01	49,210.84	0.01
Horseflat	1284.31	297,358.74	0.43	328,911.14	0.39
Littoral	375.37	212,125.90	0.18	248,221.78	0.15
Newman	447.08	4,872.65	9.17	1,458,027.91	0.03
Paraburdoo	973.77	17,850.10	5.46	64,135.89	1.52
River	33.87	125,519.60	0.03	463,955.92	0.01
Rocklea	1452.11	43,182.63	3.36	2,428,593.74	0.06
Yamerina	592.13	119,391.09	0.50	120,270.82	0.49

6.3.3 Assessment at Recorded Community Level

The extent of each of the vegetation communities within the project area is given in Table 11. There is no available mapping of the region at this scale and level of vegetation description, and there is no systematic listing of plant communities or vegetation associations for the Fortescue Botanical District giving areas of distributions. It is therefore not possible to provide an objective assessment of the degree of representation and therefore significance of each of the vegetation communities within the region.

However, it is possible to give an opinion of the conservation significance of the communities based on the extent of that community within the project area. Vegetation communities with moderate – high or high conservation values warrant priority conservation status in the project area.

Table 11 provides such an opinion for the vegetation communities recorded within the areas proposed for clearing for infrastructure development within the project area, including other comments for each community. Based on the areas presented in Table 11, the suite of Ls, Lh, Ror and Hc1 vegetation communities are considered to be locally significant. Each of these communities only comprises a small proportion of the entire project area. These small percentages are indicative of the presence of these communities at a local scale and the potential for these communities to be of local and regional significance.

Communities that occur within the Littoral Land System were also identified to occur within the Cheerawarra Land System. For this reason no distinct vegetation communities were described within the Cheerawarra Land System. Similarly, communities impacted by the project that occur within the Yamerina Land System were also identified to occur within the River and Paraburdoo Land Systems and, accordingly, no distinct vegetation communities were described within the Yamerina Land System.

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Table 11: Significance of Vegetation Communities within Cape Preston Project Area

Landform	Vegetation Community	Conservation Significance	Features	Total Area Mapped (ha)	Area to be Impacted (ha) Balmoral South project	Cumulative area to be impacted (ha)	Percentage of mapped Vegetation community to be impacted (Balmoral South)	Proportional Representation of community in project area
Stoney plains	Bx1	Moderate to High	Represented by a small proportion of the landscape. Floral composition is of common species.	197.50	127.66	127.66	64.6%	0.57%
Clayey plains	Hpg1, Hpg2, Hpg3, Hps1	Moderate to High	Red cracking clay habitat quite widespread and typical flora also relatively widespread and common. Vegetation in Good Condition and supports some Priority flora (*Goodenia pascua* P3). Cracking clays susceptible to weed invasion and erosion following physical disturbance.	3831.67	689.66	926.97	17.99 %	11.17%
Flowlines	Hc1	Moderate to High	Minor flowlines of dominated by *Acacia sclerosperma*, over a dense grasslands of *Chrysopogon fallax*.	20.06	Nil	19.02	Nil	0.06%
Beaches	Lb	Low to Moderate	Beaches of bare sand with scattered grasses and herbs	53.32	1.06	1.24	1.99%	0.16%
Intertidal zones	Lm	High	Mangrove communities provide a range of significant ecological functions, including physical stabilisation of shorelines and provision of terrestrial and marine fauna and inputs of nutrients to coastal ecosystems. Includes bare mudflats.	452.00	29.93	67.29	6.62%	1.32%
Tidal mudflats	Ls1, Ls2, Ls3a	Moderate	Saline flats are abundant along the coast. Communities likely to be relatively similar in floristic composition. Susceptible to physical disturbance such as vehicle trafficking.	872.42	142.78	298.73	16.36%	2.54%
Dunes	Ld1, Ld2, Ld3, Ld4, Ld5	High	Coastal dune habitat relatively widespread but has a limited area. Similar habitat and vegetation occurs to the east at Cape Lambert (M. Maier, pers. obs.) and Karratha (Dames & Moore, 1995). Dunes susceptible to invasion by Buffel grass and erosion following physical disturbance.	559.32	95.32	122.57	17.04%	1.63%

Landform	Vegetation Community	Conservation Significance	Features	Total Area Mapped (ha)	Area to be Impacted (ha) Balmoral South project	Cumulative area to be impacted (ha)	Percentage of mapped Vegetation community to be impacted (Balmoral South)	Proportional Representation of community in project area
Sandy plains	Lp1, Lp2, Lp3, Lp4a, Lp4b, Lp5	Moderate	Flora quite widespread and common. Sandy plain habitat likely to be poorly distributed along coast.	179.74	87.13	90.04	48.48%	0.52%
Hills	Lh1, Lh2	Moderate	Rocky hills within the Littoral Land System occurring in the northern portion of the project area. Contains a mixed shrubland *of Acacia coriaceae, Santalum laceolatum* and *Eremophila longifolia* over *Triodixa wiseana* hummock grasslands.	22.67	Nil	Nil	Nil	0.07%
Plains	Mp1	Moderate	Occupies a small area on the eastern boundary of the project area, and generally occurs on calcareous loamy soils.	504.10	Nil	23.91	Nil	1.47%
Outcrops	Mr1,Mr2, Mr3, Mr4, Mr5, Mr6	Moderate	Flora relatively common and widespread. Macroy LS relatively widely distributed in region, therefore vegetation type unlikely to be restricted. Vegetation in very good to excellent condition with little weed invasion.	1940.36	226.58	226.58	11.68%	5.66%
Low Hills and slopes	Nh, Nh1, Nh2, Nh3,Nh4, Nh5	Moderate	Flora widespread and common. Hummock grasslands dominate, however the HGM study in 2000 found that this vegetation communities could possibly be restricted in the region, given their occurrence on the most coastal part of the Newman land System.	3997.60	413.85	1154.06	10.35%	11.65%
Minor flowlines	Nc, Nc1, Nc2, Nc3, Nc4	Moderate to High	Minor creeklines and have a small representation in the landscape. Where influenced by underlying geology, vegetation communities of these creeklines are possibly restricted in the region.	578.32	74.68	191.40	12.91%	1.69%
Rockpiles	Nr, Nr1, Nr2, Nr3, Nr4	Low to Moderate	Rockpiles within the project area commonly occurring on the Newman LS and supports a combination of the tall shrubs *Acacia coriacea* and *Ficus* species over an understorey of grasses.	4.38	0.16	2.35	3.65%	0.01%

Landform	Vegetation Community	Conservation Significance	Features	Total Area Mapped (ha)	Area to be Impacted (ha) Balmoral South project	Cumulative area to be impacted (ha)	Percentage of mapped Vegetation community to be impacted (Balmoral South)	Proportional Representation of community in project area
Plains	Px1, Px2, Px3, Px4, Px5	Moderate	Typical flora is common and widespread and suitable habitat is broadly distributed in the region within the Paraburdoo Land System. Vegetation community is therefore unlikely to be restricted in the region. Habitat is susceptible to weed invasion (Buffel grass)	5821.78	1495.16	2024.39	25.68%	16.97%
Plains	Pp1, Pp2	Moderate	Flora generally common and widespread. Suitable habitat is likely to exist elsewhere in the Yamerina Land System.	936.30	104.47	152.86	11.16%	2.73%
Creeklines and Floodplains	Pc, Pc1, Pc2, Pc3, Pc4, Pf1	High	Creeklines have high species richness and support various habitat-specific flora, including Priority flora in some areas (*Phyllanthus aridus*). Make up small proportion of landscape. Vegetation very variable, but unlikely to be restricted in region given extensive occurrence of Paraburdoo LS. Susceptible to weed invasion (Buffel grass and Mesquite).	671.28	235.84	248.06	35.13%	1.96%
Creeklines	Rc1, Rc2, Rc3, Rc4	High	Riverine vegetation has high species richness and supports a range of habitat specific flora. Flora relatively widespread and typical of such habitats. The River Land is widely distributed in region and vegetation communities are therefore unlikely to be restricted. However river systems make up a small portion of the land surface, and riverine forests with Cadjeputs is likely to have a particular limited distribution in the region. Vegetation susceptible to weed invasion. Occurs in the Fortescue River and its tributaries, which represent the major drainage system for the area.	1082.13	41.97	42.20	3.88%	3.15%
Floodplains	Rf1, Rf2	Moderate	Flora largely common and widespread (HGM, 2001). Vegetation would occur elsewhere in region on floodplains of the River Land System. Floodplains are an important component of drainage systems. Susceptible to weed invasion.	4567.66	432.29	518.64	9.46%	13.32%

Landform	Vegetation Community	Conservation Significance	Features	Total Area Mapped (ha)	Area to be Impacted (ha) Balmoral South project	Cumulative area to be impacted (ha)	Percentage of mapped Vegetation community to be impacted (Balmoral South)	Proportional Representation of community in project area
Low hills and slopes	Roh1, Roh1a, ROh1b, Roh2, ROh2a, ROh2b, Roh3a	Low to Moderate	Flora largely common and widespread. Hummock grassland likely to be broadly distributed given its extensive occurrence in the Rocklea Land System.	6741.38	998.10	1559.96	14.81%	19.65%
Plains	ROpl, ROx1	Low to Moderate	Vegetation type associated with calcretisation caused by seepage; occurs elsewhere along the coast in similar habitat (eg. where rocky slopes abut beaches on the Burrup; M. Trudgen, pers. obs.). Some areas support restricted species.	258.69	33.60	42.70	12.99%	0.75%
Minor flowlines	ROc1, ROc2, ROc3, ROc4, ROc5	Moderate	Minor creeklines relatively species rich and have a small representation in the landscape. Vegetation types unlikely to be restricted in the region, given the broad distribution of the Rocklea LS. Some areas support Priority flora (*Abutilon trudgenii* ms.)	483.82	50.58	84.03	10.45%	1.41%
Rockpiles	Ror, Ror2, Ror1, Ror3	Low to Moderate	Rockpiles of the Rocklea Land System restricted to the northern portion of the project area. Supports scattered *Acacia coriaceae* shrublands over spinifex and or other bunch grasses.	23.99	1.61	5.29	6.71%	0.07%
Plains	Yp1	Low to Moderate	The Yamerina Land System supports extremely variable vegetation. Primary vegetation consisted of moderately dense hummock grasslands with scattered patches of chenopod herbs.	225.62	Nil	Nil	Nil	0.66%
Watercourse		Low to Moderate	Tidal watercourse at Cape Preston comprising of mudflats.	59.43	Nil	0.36	Nil	0.17%
Tidal creek	Yc1	Moderate	High shrublands dominated by mangroves over patches of *Schoenoplectus litoralis* open sedgeland	6.75	Nil	Nil	Nil	0.02%

6.3.3.1 Assessment at Recorded Species Level

Vegetation communities are considered regionally significant where they support populations of Priority Flora. For this reason, Vegetation Communities Bx1, Rf1 and Hp may be considered significant due to the species *Phyllanthus aridus* (P3) and *Goodenia pascua* (P3) being recorded within them, respectively.

6.4 Vegetation Condition

The condition of the vegetation within the project area ranges from Completely Degraded to Very Good. The majority of the vegetation is in Good condition with relatively high weed invasion, especially on the grassy flats, dominated by **Cenchrus ciliaris* (Buffel Grass). A high degree of erosion is also present throughout much of the project area as a result of cattle activity. This erosion is often particularly evident along streamlines and riverbanks, where cattle congregate to drink or obtain shelter.

Areas of better quality vegetation with significantly less weed invasion and higher species richness and native foliage cover were found to occur on the rocky hills and particularly in the area of the main orebody.

6.5 PATN Analysis

PATN is a statistical analysis software program that generates estimates of association (resemblance, affinity, distance) between any set of objects or data described by a suite of variables or attributes (such as species). PATN then classifies the data into groups (or vegetation communities), condenses the information into three dimensions and displays the patterns graphically (www.patn.com.au).

The data collected during the 2000 and 2006 field survey was submitted to local PATN expert Mr Ted Griffin for analysis on two separate occasions. The results of the PATN analysis from 2000 and 2006 are presented in Figures 5 and 6 respectively. The objective of the analysis was to provide a classification of sites that are a strong representation of the floristic composition of the sampled communities.

As mentioned previously, the data was analysed as two datasets; one with species being considered as either present or absent from each site and the other as a transformation cover. The analysis indicated that whilst there are differences in the classification using the cover compared to using presence or absence data, there was also significant concurrence. That is, it was possible to determine that all field classifications of vegetation communities were consistent with results from the PATN analysis.

From the results presented in Figures 5 and 6, it is possible to infer that a number of differing vegetation communities show similarities in species composition and Projected Foliage Cover (PFC). Branches within the dendogram link vegetation communities with similar appendages. Nine separate groups were identified to occur in the project area.

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Figure 5: Dendogram Arising From PATN Analysis, Showing Relationships between Quadrat Data, 2000 Data

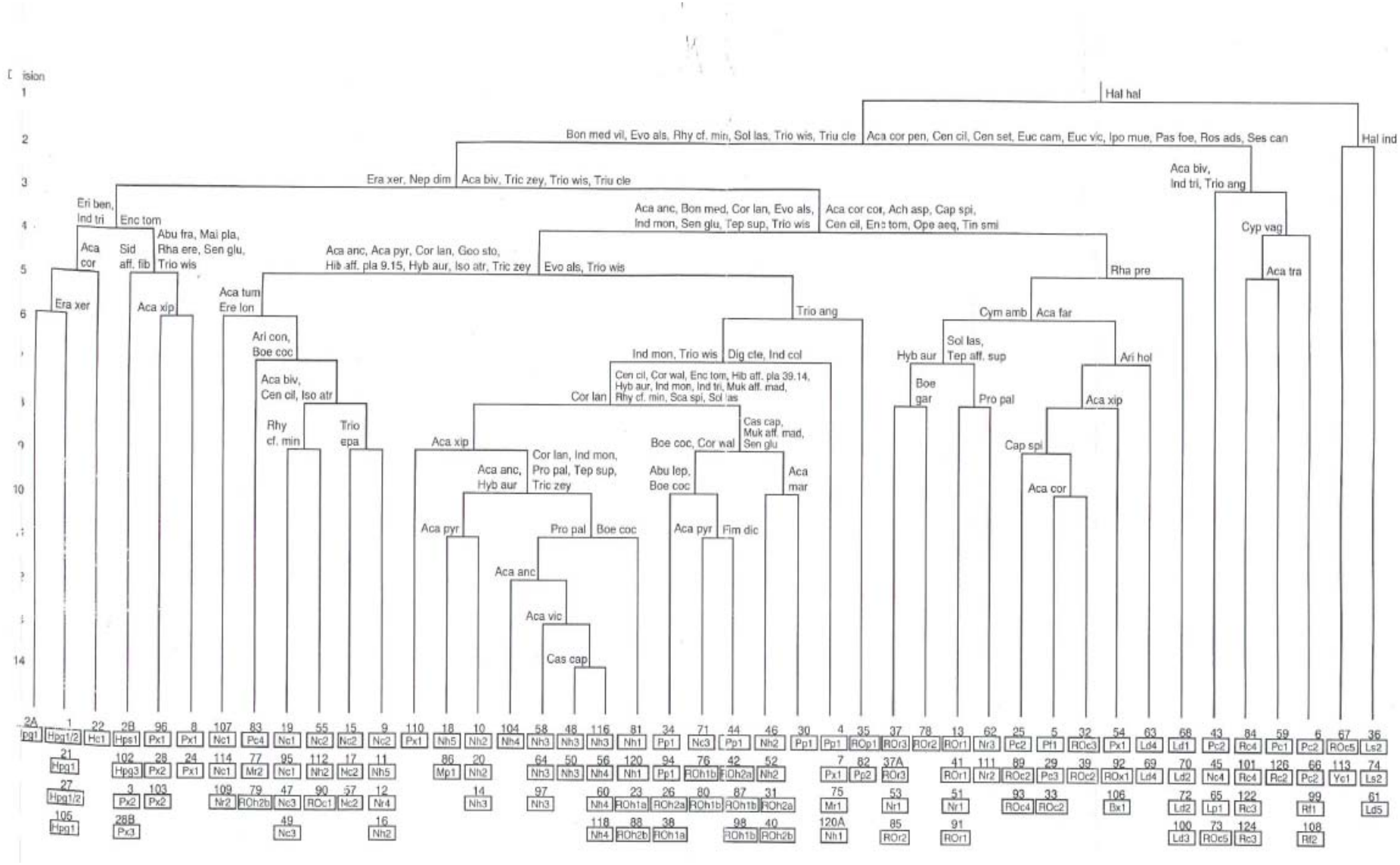

Figure 6: Dendogram Arising From PATN Analysis, Showing Relationships between Quadrat Data, 2006 Data

GP9	GP16	site	Community	data
				11/24/06 05:43:35.45 dend Maunsell AECOM cover Nov 2006
				0.3000 0.3944 0.4889 0.5833 0.6778 0.7722 0.8667 0.9611 1.0556 1.1500
				| | | | | | | | | |
1	1	1	Nh	_____
1	1	2	Px1	_____|_____
1	2	5	Roh1b	_____ |
1	2	8	Roh1b	_____ | |
1	2	25	Nh2	_____|_____|_____ |
1	2	11	Roh1b	_____|_____ |
1	3	32	Nh2	_____ | |
1	3	34	Roh1	_____|_____|_|_____
2	4	7	Bg	_____ |
2	5	13	PP2	_____ | |
2	5	19	Nh	_____|_____|_____ |
2	6	15	Sg	_____|_____ |
3	7	10	Tt	_____|____ |
4	8	16	LH	_____|__ |
5	9	33	Px1	_____|_____|_____
6	10	9	HP	_____ |
6	10	12	HP	_____|_____ |
6	11	30	HP	_____ | |
6	11	31	Px2	_____|_____|_____ |
7	12	14	Ag	_____ | |
7	12	26	Rf1	_____|_____ | |
7	13	20	AS1	_____ | | |
7	13	23	Px2	_____ | | | |
7	13	27	AS1	_____|_|_ | | |
7	13	29	AS1	_____|_____| | |
7	14	28	ASG	_____|_____ | |
8	15	17	Rf2	_ | | |
8	15	18	Rf2	|_____ | | |
8	15	21	Rf1	_____|_____ | | |
9	16	22	Rf1	_____|_____|_____|_____|_____|
				| | | | | | | | | |
				0.3000 0.3944 0.4889 0.5833 0.6778 0.7722 0.8667 0.9611 1.0556 1.1500

6.6 Fauna

6.6.1 DEC-listed Threatened Fauna

The DEC's database enquiry for Threatened Fauna previously recorded within the project area was conducted for the area 21.4707°S, 115.882° E to 20.8749°S, 116.415°E (Mardie Station plus 15 km buffer). The search identified the threatened species, Schedule 1, *Pezoporus occidentalis* (Night Parrot) and the Peregrine Falcon *Falco peregrinus* (Schedule 4) to occur in the area. Also 13 Priority species were noted to occur within the project area. Subsequent, independent advice also considered it possible that Mulgara, Olive Python and Pilbara Leaf Nosed Bat may be present in the project area (Appendix F). These species are discussed in more detail below.

Schedule 1

- *Pezoporus occidentalis* (Night Parrot). This species was not recorded during the 2006 and 2000 field surveys. Historically it has been recorded approximately 12km south of the project area, where it was known to inhabit areas dominated by *Triodia spp*.
- *Dasycercus cristicauda* (Mulgara). This species was not recorded during the 2006 and 2000 field surveys. It has been recorded to occur in the Pilbara region approximately 300km east of the project area throughout sandy arid regions.

Schedule 4

- *Falco peregrinus* (Peregrine Falcon). This species was not recorded during the 2006 and 2000 field surveys. The habitat of this species comprises cliffs along coasts, rivers and ranges and wooded water courses (Johnstone & Storr, 1998). Storr (1984) suggests that most Pilbara records have come from 'hilly country, especially the Hamersley Range'. It is likely that this species would occur within the creekline vegetation.

Priority 1

- *Mormopterus loriae cobourgiana* (Little North-Western Mastiff Bat). This species was recorded in 2000 in the mangrove vegetation community at Cape Preston, north of the project area. They are restricted to mangrove forests and adjacent areas (Churchill 1998). No targeted bat survey was undertaken during the 2006 field investigations but recommendations were made to undertake such surveys. Subsequent bat surveys using bat call analysis (Phoenix Environmental Sciences 2008) failed to detect this species.

Priority 3

- *Lagorchestes conspicillatus leichardti* (Spectacled Hare-wallaby). This species was not recorded during the 2006 and 2000 field surveys. It is known to have declined from many parts of its previous distribution. This species is susceptible to predation by introduced carnivores.
- *Limnodromus semipalmatus* (Asian Dowitcher). The field survey was not conducted at an opportune time for recording migratory waders and may explain the failure to detect this and possibly other wader species. The preferred habitat of the Asian Dowitcher comprises mudflats and tidal creeks, which in this document are encompassed by the Beach and Mangrove habitats respectively. It is a seasonal visitor (between late August and early April) and is considered rare (Johnstone & Storr, 1998).

Priority 4

- *Leggadina lakedownensis* (Lakeland Downs Mouse, Kerakenga). This species was not recorded during the 2006 field trip, despite targeted efforts to locate it. It has been recorded on Mardie station, with three individuals captured or trapped in 2000. Prior surveys (HGM 2001) suggest that the preferred habitat of this species may be cracking clay. Extensive areas of cracking clay occur throughout the project area therefore it is expected that this species may occur in the project area, however the degraded condition of this habitat reduces this potential. .
- *Pseudomys chapmani* (Western Pebble Mound Mouse). This species was not recorded during the 2006 field survey. It is known to inhabit low slopes and rocky hills. A single active mound was observed at Mardie in the 2000 survey; however, despite searching the small area of potentially suitable habitat (stony slopes and rises), no evidence of this species was encountered in the project area.
- *Ardeotis australis* (Bustard). This species was recorded during the 2006 field survey. It was also observed outside of the project area in the general location of the Balmoral shearing shed.
- *Burhinus grallarius* (Bush Stone Curlew). This species was not recorded during the 2006 field trip; it was recorded along the North West Coastal Highway in 2000. A single bird was seen on the access track whilst spotlighting. Two additional birds were recorded from the North West Coastal Highway adjacent to the Fortescue Roadhouse. This species prefers lightly wooded country near shelter (Johnstone & Storr, 1998) and is considered rare to uncommon in the region (Storr, 1984; Johnstone & Storr, 1998).
- *Numenius madagascariensis* (Eastern Curlew). This species was not recorded during the 2006 field survey. It was recorded in 2000 along the mud flats adjacent to mangroves west of the Project Area. It is regarded as a visitor between October and February, when it is considered moderately common along tidal mudflats, reef flats and sandy beaches of the Pilbara coast (Johnstone & Storr, 1998).
- *Hydromys chrysogaster* (Water Rat). This species inhabits marine waters along the Pilbara coast. It is known from Barrow Island and has been recorded from a tidal creek at Cape Lambert (Roy Teale, pers. obs.).
- *Falco hypoleucos* (Grey Falcon). Not recorded from the project area. Storr (1984) indicates that in the Pilbara, the Grey Falcon is mostly recorded from the coastal plain between the de Grey and Ashburton Rivers. Johnstone & Storr (1998) indicate that the preferred habitat of this species comprises lightly wooded coastal and riverine plains. In the project area this translates to the Creekline habitat.
- *Lophoictinia isura* (Square-tailed Kite). Not recorded from the project area. Johnstone & Storr (1998) suggest that this species would most likely only be transient in the Pilbara region. Storr (1984) does not mention this species in his account of birds of the Pilbara.
- *Esacus neglectus* (Beach Stonecurlew). Three birds were recorded from the beach on the western side of Cape Preston. The preferred habitat of this species comprises sandy or shingle beaches and tidal reef flats (Johnstone & Storr, 1998). It is considered to be rare on the Pilbara coast.
- *Sterna* (*albifrons*) *sinensis* (White-shafted Tern (Little Tern)). The preferred habitat of this species comprises sheltered seas, estuaries and mangrove creeks. It is mainly a non-breeding visitor (all months, although mostly September to June). Johnstone & Storr (1998) suggest that this species is generally uncommon but plentiful in the Pilbara and Kimberley during passage.

In addition to those already listed above, a further four Priority listed taxa were recorded during the survey:

Priority 1

- *Mormopterus loriae cobourgensis* (Little Western Freetail Bat). A total of 20 individuals (9 adult males, 11 adult females) were captured in mist nets set against Rhizophora and with a harp trap between Avicennia. This subspecies of bat is listed as Priority 1 taxa as there is little data available and it has a distribution restricted to the mangroves of the North-west of Western Australia.

Priority 4

- *Leggadina lakedownensis* (Short-tailed Mouse). Three individuals of this Priority 4 rodent were recorded from the services corridor. Regional records to date strongly suggest that the main habitat for this species on the mainland comprises areas of cracking clay. Extensive areas of cracking clay occur throughout the project area and the sites from which the species was recorded included, or were adjacent to, this habitat type. Until recently, L. lakedownensis was only known from offshore islands and a restricted locality in the Central Pilbara. The species has been recorded more frequently in recent surveys and is apparently more widely distributed in the region than initial records indicated.
- *Chelonia mydas* (Green Turtle). Several Green Turtles, both adults and sub-adults, were observed in the tidal creek at the base of Cape Preston. Furthermore, body holes of marine turtles were observed on the beaches at the northern end of Cape Preston. While these may possibly belong to Green Turtles, other species of marine turtles cannot be excluded as Hawksbills, Loggerheads and Flatbacks are all known to nest in the region. Significantly, the Loggerhead turtle is listed as a Schedule 1 species whilst the Hawksbill is listed as a Priority 4 species. Clearly there is a need to identify the species using the beaches for nesting so that the species involved and the potential impacts can be clearly identified.

Species of Interest

- *Pseudomys* sp. “hamersley”. The conservation status of this as yet undescribed taxon is unclear. It was first collected from Cape Lambert (Roy Teale, pers. obs.) and later at Nammuldi and Silvergrass (Stuart Anstee, Norah Cooper, pers. comm.; Roy Teale, pers. obs.). It may have been confused in previous collections with either *Pseudomys chapmani* or *P. hermannsburgensis,* with which it bears a close resemblance.
- *Ctenotus* aff. *robustus*. This undescribed species has been recorded from cracking clays near Tom Price and several individuals were recorded from the same habitat during the current survey. The conservation status of this undescribed species is unclear. It appears to be restricted to areas of cracking clay.
- *Ctenotus* sp. nov. A single specimen of what is believed to be a new species of *Ctenotus* was collected from the cracking clay

6.6.2 EPBC-listed Fauna

A search of the EPBC database (Appendix F) revealed that the following nationally significant threatened species may occur within or near the project area:

- *Dasycercus cristicauda* (Mulgara) – Schedule 1, Vulnerable. Occurs within drainage lines near sandy plains and dunes;
- *Rhinonicteris aurantius (Pilbara form)* (Pilbara Leaf-Nosed Bat) – Vulnerable. Occurs within caves and abandoned mines;
- *Morelia olivacea barroni* (Olive Python) – Vulnerable. Occurs within drainage lines of the Fortescue River System;
- *Caretta caretta* (Loggerhead Turtle) – Endangered;
- *Chelonia mydas* (Green Turtle) – Vulnerable;
- *Dermochelys coriacea* (Leatherback Turtle) – Vulnerable;
- *Eretmochelys imbricate* (Hawksbill Turtle) – Vulnerable; and
- *Natator depressus* (Flatback Turtle) – Vulnerable.

The beach habitat at Cape Preston is likely to provide nesting habitat for marine turtles, although the extent of these areas for this purpose is not fully known. Separate marine fauna surveys reports provide an assessment of the significance of the project area's beach habitat to listed marine turtles.

The Pilbara Leaf-Nosed Bat has specific habitat requirements, with roosting areas restricted to caves and abandoned mines. As there is no such habitat within the project area, it is considered highly unlikely that populations of this bat species reside and/or forage within the area.

A desktop comparison of on-site vegetation community types with habitat and vegetation that the Mulgara typically occurs within (Phoenix Environmental Sciences, 2008a), concluded that it was highly unlikely that Mulgara would exist in the project area. A subsequent fauna survey (Phoenix Environmental Sciences, 2008b – in prep), which included a targeted search for Mulgara, failed to locate any direct or indirect (eg diggings, scats, etc) evidence of Mulgara in the project area. The Mulgara is known to occur in areas dominated with hummock-forming Spinifex on sandy loam soil. Due to the lack of sandy loam soil within the project area, Mulgara occurrence in the project area is deemed unlikely.

A comparative review of on-site vegetation community types with the Olive Python's preferred habitat type suggests that the occurrence of Olive Python within some parts of the project area is considered low (Phoenix Environmental Sciences, 2008a). The Olive Python is known to occur within rocky outcrops and waterholes of the Fortescue River System. Both the Newman and Rocklea land systems may contain rocky outcrops, which, if in close association to waterholes and drainage lines, could form suitable habitat for this species. Specific habitats include:

- Rc2 which is a major drainage line;
- any other major drainage lines; and
- Nr and ROr (rockpiles) (Phoenix 2008).

These locations require further survey to identify whether they form significant habitat for the Olive Python. A targeted survey of suitable habitat for the Pilbara Olive Python was undertaken (Phoenix Environmental Sciences, 2008b – in prep) and concluded that the Pilbara Olive Python was unlikely to occur in the project area but stated that given the broad distribution of this species in the Pilbara it could not be excluded from the project area.

According to the EPBC database search enquiry results, a number of migratory wader species have the potential to exist within and adjacent to the project area. The beach and mudflat habitats of the project area however do not appear to provide significant habitat for waders. Future fauna surveys will clarify this position.

6.6.3 EPBC Listed Migratory Birds

Three EPBC-listed migratory terrestrial bird species have also been identified to potentially occur in the project area. These are:

- White-bellied Sea Eagle (*Haliaeetus leucogaster);*
- Barn Swallow *(Hirundo rustica); and*
- Rainbow Bee-eater *(Merops ornatus).*

Both the White-bellied Sea Eagle and Rainbow Bee-eater were sighted in the project area.

6.6.4 Field Survey

Field surveys were conducted with attention to the results of the DEC and EPBC database enquiries. Targeted surveys were conducted for the abovementioned species. Only one Priority 4 species was identified during the 2006 field survey (the Bustard).

Additional to these Priority species, one undescribed species of rodent (*Pseudomys* sp. "Hamersley") and two undescribed skinks (*Ctenotus* aff. *robustus* and *Ctenotus* sp. nov.) of possible conservation significance were recorded. The majority of these species have been recorded from other sites in the Pilbara, but their regional conservation status remains unclear.

The fauna habitats defined during the surveys are all regarded as well represented in the region and none are regraded as regionally significant or unique. Of some importance are the habitats of the cracking clays (Hp vegetation type), due to the presence of *Leggadina lakedownensis, Ctenotus* aff. *robustus* and *Ctenotus* sp. nov, and the major drainage lines, which represent the most fauna rich habitat in the area.

The full comprehensive report presenting the results of the fauna field survey conducted during 2006 is provided in Appendix H. The October 2006 field survey recorded 105 vertebrate species and 114 individuals were captured, identified at site and released. The faunal groups represented during the surveys are summarised in Table 12.

Table 12: Summary of fauna Species Recorded During the 2000 and the 2006 Field surveys

Faunal Group	No. of Individual Species Recorded in 2000	No. of Individual Species Recorded in 2006
Native Mammals	17	6
Introduced Mammals	5	3
Avifauna	96	57
Reptiles	58	38
Amphibians	3	1
Total	**179**	**105**

The groups represented in the project area in 2006 are discussed below.

6.6.4.1 Native Mammals

A total of nine mammal species were recorded during the 2006 field survey, including six native species and three introduced species. The most commonly recorded native species was *Macropus robustus erubescens* (Euro) and *Macropus rufus* (Red Kangaroo). Moderate numbers of both these species were recorded early in the mornings and during spotlighting events, often with young at foot.

Whilst searching the remains of the old shearer's quarters on Balmoral station, approximately ten bats were recorded roosting in old cupboards. Three individuals were captured and identified as belonging to the family Vespertilionidae. Positive identification of these individuals beyond the family group was not achieved. Although these bats were not located within the lease area, they would be expected to feed around water bodies, such as the Fortescue River and so were included in the results.

The species *Sminthopsis macroura* (Striped Faced Dunnart) and *Pseudomys hermannsburgensis* (Inland Sandy Mouse) were also recorded during the field survey. Scats of *Tachyglossus aculeatu*s (Echidna) were also observed. Each species is discussed in the following annotation.

TACHYGLOSSIDAE

- *Tachyglossus aculeatus* (Echidna). Scats of this species were observed on a rocky out-crop at the northern end of the tailings dam area. Prior to the October fauna field survey, one individual was recorded during the July botanical survey, to the west of the proposed tailings dam area.

DASYURIDAE

- *Sminthopsis macroura* (Stripe Faced Dunnart). Four individuals were captured: two from a sparse area of *Triodia* spp. at Traps 13 and 12 at Site 2 and two at Site 4, Trap 40, an area dominated by *Triodia* spp.

MACROPODIDAE

- Macropus robustus erubescens (Euro). Common. The Euro was commonly sighted during the day along creek lines at Sites 4, the River and BDT3. This particular species was recorded in abundance on spotlighting excursions through out the project area, particularly on grassy plains.
- *Macropus rufus* (Red Kangaroo). Common. This species was recorded at all sites with the exception of Site 2. It was commonly sighted early in the morning and on spotlighting excursions throughout the study areas and beyond.

MURIDAE

- *Pseudomys hermannsburgensis* (Inland Sandy Mouse). Two individuals were captured at Site 2 in Traps 11 and 12.

VESPERTILIONIDAE

- Vespertilionidae spp. Approximately ten individuals were observed in old cupboards in the Balmoral shearing quarters adjacent to the project area.

6.6.4.2 Introduced Mammals

A number of introduced mammals were observed at the project site.

MURIDAE

- *Mus musculus* (House Mouse). Four individuals were captured at Site 2, three of which were captured from Trap 19 on different days. This suggests that the same animal may have been captured repetitively.

CANIDAE

- *Canis lupus dingo* (Dingo). A single set of large dog tracks was observed on the track that bisects Site 4 at Du Boulay Creek.

FELIDAE

- *Felis catus* (Feral Cat). A single individual was recorded during a spotlighting excursion at the northern section of the bore field location.

6.6.4.3 Reptiles

A total of 38 reptile and one amphibian species were recorded during the October 2006 field survey. The 38 species were represented by 86 individual captures, 39.5% of which were attributed to the Scincidae (Skinks), 28% Gekkonidae (Geckoes) and 20.2% Agamidae (Dragons). The Boidae (Pythons), Elapidae (Front Fanged Snakes), Pygopodidae (Legless Lizards), Typhlopidae (Blind Snakes) and Varanidae (Monitors) all contributed < 10% of total captures. Each species is discussed in the following annotation.

AGAMIDAE

- *Ctenophorus caudicinctus caudicinctus*. Uncommon. One individual was captured at Site 3 (T23) on a stony rise over clay.
- *Ctenophorus isolepis isolepis*. Uncommon. It was recorded from Site 2 at Traps 11 and 13 and at Site 4, Traps 36 and 40. *Triodia* spp. was the dominant vegetation in all areas in which this species was found.
- *Ctenophorus nuchalis*. Uncommon. This species was recorded from Site 2 at Traps 14 and 15 and from Site 4 at Trap 40. All sites were dominated by *Triodia* spp.
- *Lophognathus longirostris*. Common. This species was regularly observed at Site 4 along the creek, and it was trapped at Site 4 in Traps 35 and 38. It was also recorded from vegetated areas along Fortescue River and associated feeder creeks.
- *Tympanocryptis cephalus*. This species is uncommon, with only four individuals trapped at Site 3. All four were captured at Trap 23 on a small rise of stony ground over heavy clay. Individuals ranged in size, indicating that the same individual was not re-captured.
- *Pogona mitchelli*. Individuals captured at Site 2 from Trap 18 where the vegetation was dominated by grasses and *Triodia* spp.; from Site 3, Traps 23 & 29 on unvegetated areas of stones over clay; and from Site 4 Trap 31, which consisted of course sand dominated by *Triodia* spp.

BOIDAE

- *Antaresia perthensis*. Only one individual was observed during a spotlighting transect of the northern end of the tailings dam area. This individual was recorded near a rocky ridge on the edge of the lease area.

ELAPIDAE

- *Pseudonaja nuchalis.* One individual was observed dead on a road adjacent to Site 3.
- *Pseudechis australis.* Only one individual was sighted near Trap 10 at Site 1. An individual was also recorded dead on the North west Highway; however, this individual was outside of the project area.
- *Acanthophis wellsi*. One individual was observed during a spotlighting excursion at the northern end of the tailings dam area. This individual was recorded near a rocky ridge on the edge of the lease area.

GEKKONIDAE

- *Diplodactylus conspicillatus*. This species is considered relatively common, with individuals captured over a variety of soil and vegetation types at Sites 1, 2, 3, and 4.
- *Diplodactylus savagei*. Only one individual was captured at Site 3 in an area of cracking clays at Trap 30. No other sightings of this species were recorded.
- *Gehyra pilbara.* Two individuals were captured at Sites 2 in cracking clay and at Site 4 along the creek bank in coarse sandy soil.
- *Gehyra variegate.* This is the most common gecko species captured. Individuals were recorded across a range of soil types at Sites 2, 3, and 4.

- *Nephrurus levis occidentalis.* Two individuals were captured: one at Site 4, Trap 40 and one at northern section of the bore field lease.
- *Heteronotia binoei.* Three individuals were captured at Site 4 at Traps 34 & 37 and one individual was captured whilst spotlighting the northern section of the bore field lease.

PYGOPODIDAE

- *Lialis burtonis.* One individual was captured on crackling clays at Site three, Trap 26.
- *Pygopus nigriceps.* Two individuals were captured: one at Site 2 on sandy loam dominated by *Triodia* spp. and one at Site 3 on an area of crackling clay with little ground cover.

SCINCIDAE

- *Ctenotus schomburgkii*. Individuals were captured over a range of soil types including coarse sand, gravel and cracking clays. Captures included: one at Site 1, three at Site 2, one at Site 3 and two at Site 4.
- *Ctenotus duricola.* Two individuals were captured, one at Site 1 in a well grassed area and one at Site three on cracking clays.
- *Ctenotus* aff. *helenae.* Individuals were captured at Sites 1, 2 and 4. With the exception of Site 1, this species was typically captured from areas of stone and gravel substrate dominated by *Triodia* spp. The majority of individuals were captured at Site 4 along Du Boulay Creek.
- *Ctenotus pantherinus ocellifer.* One individual was captured in Trap 32 at Site 4. The soil type at this location was gravel to coarse sand dominated by *Triodia* spp.
- *Ctenotus rufescens.* One individual was captured on a stony rise over clay at Trap 28, Site 3.
- *Ctenotus* aff. *robustus.* One individual was recorded at Site three. This species has not yet been classified by the Museum of Western Australia; however, its presence has previously been recorded in the Pilbara. Photographs of this individual were presented to the Museum, and its identity was confirmed.
- *Ctenotus saxatilis.* Two individuals were captured from Traps 35 & 38 at Site 4.
- *Glaphyromorphus isolepis.* There was only one record of this species from Trap 38 along Du Boulay Creek.
- *Lerista bipes.* This species was commonly trapped in the sandy substrates at Site 2, and it was also recorded from Site 1.
- *Lerista muelleri.* Three individuals were captured: one at Site 1 and two from Site 4.
- *Menetia greyii.* Four individuals were captured at Site 1, in areas of grass on clay; two individuals were captured at an area of grass on clay at Site 2; and one individual was captured from a sandy substrate at Site 4.
- *Morethia ruficauda exquisite.* Three individuals were captured among *Triodia* spp. in Trap 15 at Site 2.
- *Notoscincus ornatus ornatus.* One individual was captured at Site 4 in River bank vegetation.

TYPHLOPIDAE

- *Ramphotyphlops grypus.* One individual was captured in a grassed area over clay at Site 1.

VARANIDAE

- *Varanus acanthurus.* Two captured individuals were at Site 1: one in funnel Trap 9 and one in Elliott Trap 10.
- *Varanus brevicauda*. One individual was captured at Site 2 in Trap 12 and another was observed at Trap 14 Site 2.
- *Varanus gigantus.* One individual was recorded as road kill at the northern end of the tailings dam lease.
- *Varanus panoptes.* One individual was captured on the access track through the tailings dam lease.
- *Varanus gouldii.* One individual was observed at Site 2 basking at the base of an Acacia tree.

AMPHIBIANS

- Cyclorana maini (Mains Frog). One individual was recorded whilst spotlighting adjacent to the tailings dam lease area.

6.6.4.4 Birds

A total of 57 bird species were recorded during the survey of the project area, representing 31 families. The 57 species were represented by approximately 1845 records, 40% of which were attributed to one family group, Cacatuidae, with Galas, Little Corellas and Cockatiels observed in large groups. The family Passeridae was well represented by *Taeniopygia guttata (*Zebra Finch) accounting for 18% of total sightings and the family Columbidae, represented by *Geophaps plumifera* (Spinifex Pigeon) and *Ocyphaps lophotes (Crested Pigeon)* accounting for 11.3% of sightings. A total of 41 species were represented by less that 30 sightings, with 5 species represented by between 30 - 40 individuals, and they include: *Coturnix ypsilophora* (Brown Quail), *Phalacrocorax sulcirostris* (Little Black Cormorant), *Pelecanus conspicillatus* (Australian Pelican), *Vanellus tricolour (*Banded Lapwing*)* and *Merops ornatus* (Rainbow Bee-eater).

Of particular interest was the recording of two species listed as migratory species under the *EPBC Act 1999* and the JAMBA/CAMBA Agreements:

- *Merops ornatus* Rainbow Bee-eater (recorded regularly throughout the project area), and
- *Haliaeetus leucogaster* White-bellied Sea Eagle (one sighting recorded).

Records of breeding behaviour were made for only one species, *Dromaius novaehollandiae* (Emu). Two adult males were observed on different occasions, one with four chicks and the other with two chicks. Each species is discussed in the following annotation.

CASUARIIDAE

- *Dromaius novaehollandiae* (Emu). Common. This species was recorded on five occasions, from Sites 1, 4, the River, BDT2 and BDT3. Adult birds with chicks were observed on two occasions, at the River and at BDT2.

PHASIANIDAE

- *Coturnix ypsilophora* (Brown Quail). Common. This species was recorded on five occasions from Sites 1, 2, 4, River and BDT2 in small groups. Individuals were recorded from grasses on each occasion.

ANATIDAE

- *Anas superciliosa* (Black Duck). Uncommon. Individuals were recorded on three occasions from water holes along the River and Du Boulay Creek.
- *Anas gracilis* (Grey Teal). Uncommon. This species was recorded on one occasion at the River.

PHALACROCORACIDAE

- *Phalacrocorax sulcirostris* (Little Black Cormorant). Uncommon. Recorded on two occasions: one flock of 30 individuals was observed on the River and five individuals were observed at Du Boulay Creek.

PELECANIDAE

- *Pelecanus conspicillatus* (Australian Pelican). Uncommon. One flock of 33 individuals was observed on the River late in the afternoon.

ARDEIDAE

- *Ardea pacifica* (White-Necked Heron). Uncommon. This species was recorded at three locations: Site 4, at the River and at BDT3. Individuals were regularly observed at the same water bodies each day, indicating the same birds were regularly seen.
- *Egretta garzetta* (Little Egret). Uncommon. Individuals were recorded from three locations: Site 4, the River and BDT3. Individuals were sighted daily at the same locations.
- *Egretta novaehollandiae* (White-faced Heron). Uncommon. Individuals were recorded from three locations: Site 4, the River and BDT3. Individuals were sighted daily at the same locations.

THRESKIORNIDAE

- *Threskiornis spinicollis* (Straw Necked Ibis). Uncommon. Individuals were recorded on three occasions from Site 4, the River and BDT3; at each time they were observed foraging adjacent to remaining water bodies.

ACCIPITRIDAE

- *Accipiter fasciatus* (Brown Goshawk). Uncommon. This species was recorded on three occasions from Sites 3, 4 and the River. Two individuals were observed whilst flying and the third individual was observed while perched on a dead trees.
- *Aquila audax* (Wedge-tailed Eagle). Uncommon. This species was recorded on six occasions from Sites 1, 2, 3, 4, the River and BDT1. These same individuals may have been observed more than once.
- *Milvus migrans affinis* (Black Kite). Scarce. A single bird was observed on three occasions at Sites 3, the River and BDT2.
- *Hieraaetus morphnoides* (Little Eagle). Single individuals were observed on different days at three locations: Sites 2, 4 and the River. These sightings were possibly the same individuals.
- *Haliastur sphenurus* (Whistling Kite). A single bird was recorded on different days at Sites 3, 4, the River and BDT2. Three sightings at the River transect possibly reflect observation of the same individual.
- *Haliaeetus leucogaster* (White-bellied Sea Eagle). There was a single sighting of this species at the River. The individual was observed moving along the River between two large water bodies.

FALCONIDAE

- *Falco berigora* (Brown Falcon). This species was observed on only two occasions: once at Site 3 and once at the River.
- *Falco cenchroides cenchroides* (Nankeen Kestrel). Individuals were recorded at three locations: Sites 2, 4 and the River.

GRUIDAE

- *Grus rubicunda* (Brolga). Three individuals were recorded daily at the same large body of water along the River.

OTIDIDAE

- *Ardeotis australis* (Australian Bustard). This Priority 4 species was recorded once each at four locations: Sites 2, 3, 4 and the River. It was also observed on Balmoral adjacent to the shearing shed and on the road linking Northwest Highway. Both sites are outside of the Project Area.

TURNICIDAE

- *Turnix velox* (Little Button Quail). Uncommon. This species was recorded at two locations: Site 1 and at the River. On both occasions it was observed in pairs.

CHARADRIIDAE

- *Elseyornis melanops* (Black Fronted Dotterel). Four pairs were recorded regularly at the same large body of water along the River.
- *Vanellus tricolour* (Banded Lapwing). Common. This species was recorded at seven locations: Sites 1, 2, 3, 4, the River, BDT1 and BDT3. As many as twelve individuals were observed at one time. This species was observed at livestock watering points throughout the greater area.

LARIDAE

- *Sterna caspia* (Caspian Tern). Uncommon. A single individual was recorded at two locations: Site 4 and the River. Individuals were observed flying low over water bodies, circling, and then landing at the water's edge.

COLUMBIDAE

- *Ocyphaps lophotes* (Crested Pigeon). Common. This species was recorded at seven sites in large groups. Large flocks were observed at water bodies and stock troughs. In addition, this species was observed as individuals or pairs throughout the greater area.
- *Geophaps plumifera* (Spinifex Pigeon). Common. This species was recorded at all locations. Large flocks were observed along the River and stony creek lines. It was often observed at stock watering points and along access tracks throughout the site.
- *Geopelia cuneata* (Diamond Dove). A single pair was recorded from Site 4 adjacent to a creek line, and a group of six individuals were recorded at the River.
- *Geopelia striata placida* (Peaceful Dove). This species was recorded at three locations, each time adjacent to the River or creek lines. The largest group recorded comprised of four individuals drinking at the River.

CACATUIDAE

- *Nymphicus hollandicus* (Cockatiel). Common. This species was observed in flocks of up to 30 at Sites 1, 2, 3, 4, the River and BDT3. It was regularly seen throughout project area, particularly during the early morning along the River.
- *Cacatua roseicapilla* (Galah). Common. This species was observed in large flocks at all sites except for Site BDT1. It was observed in large numbers around water holes and stock troughs.
- *Cacatua sanguinea* (Little Corella). Common. This species was observed in large flocks at Sites 1, 2, 4, the River and BDT2. It was observed in large numbers around water holes and stock troughs.

PSITTACIDAE

- *Melopsittacus undulatus* (Budgerigar). Uncommon. One flock of approximately 20 individuals was recorded from Site 1 late in the afternoon.

CUCULIDAE

- *Cuculus pallidus* (Pallid Cuckoo). Uncommon. Individuals were recorded form Sites 4 and the River. Both individuals were observed in Eucalyptus sp. adjacent to a water body.

PODARGIDAE

- *Podargus strigoides* (Tawny Frogmouth). Uncommon. A single individual was recorded whilst spotlighting along the River.

CAPRIMULGIDAE

- *Eurostopodus argus* (Spotted Nightjar). Uncommon. A single individual was observed whilst spotlighting on the main access track adjacent to the River.

HALCYONIDAE

- *Dacelo leachii leachii* (Blue Winged Kookaburra). Uncommon. A single individual was recorded on one occasion from the River. The individual was recorded drinking from a water body early in the morning.
- *Todiramphus sanctus* (Sacred Kingfisher). Uncommon. Individuals were recorded at Sites 4, the River and BDT3. Each individual was recorded adjacent to water bodies.

MEROPIDAE

- *Merops ornatus* (Rainbow Bee-bater). Common. Recorded from Sites, 2, 3, 4, river, BDT2 and BDT3. Often observed along the banks of water courses in small groups and feeding as singles or in pairs above project areas.

MALURIDAE

- *Malurus lamberti* (Variegated Fairy-wren). This species was recorded from five locations: Sites 1, 2, 4, the River and BDT1. This species was generally observed in association with small shrubs.
- *Malurus leucopterus* (White-winged Fairy-wren). Uncommon. This species was observed at Site 2 and one sighting at the River. It was often heard at Site 2 but only visually recorded twice, and both observations may have been the same individual.

PARDALOTIDAE

- *Gerygone tenebrosa* (Dusky Gerygone) Uncommon. Individuals were recorded at Sites 2, 4 and the River. Individuals were observed in the crowns of large eucalyptus trees.

MELIPHAGIDAE

- *Lichmera indistincta indistincta* (Brown Honeyeater). Uncommon. This species was recorded at Sites 4, the River, BDT2 and BDT3, and it was seen as individuals or pairs. It was only recorded once from each site.
- *Lichenostomus virescens* (Singing Honeyeater). This species was recorded at Sites 1, 2, 3, 4 and the River. However, only single birds or pairs were observed. It was also observed outside of the project area closer to the coast.
- *Manorina flavigula* (Yellow Throated Miner). Moderately common. This species was recorded at sites 1, 2, 4, the River, BDT2 and BDT3 with greater numbers observed along the River and creek line of Site 4.

DICRURIDAE

- *Grallina cyanoleuca* (Magpie Lark). Moderately common. This species was observed at Sites 3, 4, the River and BDT1, with larger numbers recorded from along the creek at Site 4 and the River.
- *Rhipidura leucophrys* (Wagtails). Moderately common. This species was recorded at all sites with the exception of Site BDT2. It was recorded as individuals at all sites.

CAMPEPHAGIDAE

- *Coracina novaehollandiae* (Black Faced Cuckoo Shrike). Common. This species was recorded from all sites as individuals or in pairs. Greater numbers were observed along the creek at Site 4 and the River.

ARTAMIDAE

- *Artamus cinereus* (Black Faced Woodswallow). Uncommon. This species was recorded from at sites, 1, 2, 3, 4, and river. Recorded as individuals or in pairs.
- *Artamus minor* (Little Woodswallow). Uncommon. One pair was recorded at Sites 1 and individuals were observed at Sites 3 and 4.
- *Cracticus nigrogularis* (Pied Butcherbird). Uncommon. This species was recorded along the creek at Site 4 and the River. Repeated sightings at Site 4 indicate that it may have been the same individual.

- *Artamus personatus* (Masked Woodswallow). Uncommon. Pairs were observed at Sites 3, the River and BDT2. Individuals were recorded at Site 4.
- *Gymnorhina tibicen* (Magpie). Uncommon. An individual was recorded from the creek line at Site 4 and one individual was observed drinking at the River.

CORVIDAE
- *Corvus orru* (Torresian Crow). Uncommon. This species was recorded on six occasions from Sites 1, 2, 3, 4, the River and BDT2, and they were mostly observed in pairs.

MOTACILLIDAE
- *Anthus novaeseelandiae* (Richards Pipit). Uncommon. Individuals were recorded at Sites 2, 4 and the River.

PASSERIDAE
- *Taeniopygia guttata* (Zebra Finch). Common. This species was observed in large numbers at all occasions, particularly from around water bodies and stock troughs.

HIRUNDINIDAE
- *Hirundo neoxena* (Welcome Swallow). Uncommon. Two individuals were recorded at the River. Another possible sighting was at the Fortescue River Bridge, outside of the project area.
- *Hirundo nigricans* Tree Martins). Uncommon. This species was seen in pairs or individuals along the River on numerous occasions.

The 2000 survey recorded a combined total of 179 vertebrate species. These species are discussed below.

6.6.4.5 Mammals

No systematic survey work has occurred in the project area prior to the current survey. Ongoing survey work of islands in the region and at Cane River is being undertaken by the DEC. As with the avifauna, the mammals of the Carnarvon Basin, the northern boundary of which lies approximately 100 km to the south of the project area, have been described.

Note that the identification of some specimens lodged with the Western Australian Museum is yet to be determined.

The survey recorded 22 species of mammals comprising the echidna, four dasyurids, two macropods, two molossid bats, three vespertilionid bats, five native and one introduced murid rodent, two canids, one felid and one bovid.

None of the mammal species were recorded in large numbers, with the exception of the Euro *Macropus robustus* which was particularly abundant. The most commonly trapped species was the bat *Mormopterus loriae cobourgiana* (20 records) followed by *Sminthopsis macroura* (16 records). The next most commonly recorded species was *Ningaui timealeyi* (13 records).

Bats comprise a significant component of the mammal assemblage in the Pilbara region of Western Australia. Approximately 18 chiropteran species have been recorded from the region, including two megachiropterans (flying foxes) and 16 microchiropterans (insect-eating bats). They utilise a range of habitats, some of which are found in the lease area.

Of the 73 total mammal records, the Dasyuridae accounted for the greatest proportion (49%), followed by the three species of molossid bats (29%). The murid rodents comprised 14% of all records. The total number of captures translates to an approximate trap success rate of 3.2%. This low trap success is attributed in part to the fact that much of the project area had been recently burnt prior to the survey.

TACHYGLOSSIDAE

Echidna - *Tachyglossus aculeatus.* Numerous scats of this species were recorded from amongst rock outcrops on the hill slopes in the immediate vicinity of Site 4.

DASYURIDAE

- Common Planigale - *Planigale maculate.* Trapped on four occasions. A female was recorded from an island of *Triodia wiseana* on heavy stony soils in a mosaic of *T. wiseana* and native grasses on cracking clay. Three individuals were recorded from the *T. angusta* hummock grassland at Site 5.
- Pilbara Ningaui - *Ningaui timealeyi.* Thirteen records of this species. It was most common in *Triodia* spp hummock grassland on stony substrates including Sites 3 (three records), 7 (five records) and 5 (single capture). Two records also from the cracking clay at Site 1 and the creekbank at Site 10.
- Stripe-faced Dunnart - *Sminthopsis macroura.* Recorded on 16 occasions from five sites. Most records came from *Triodia wiseana* hummock grassland on heavy soils. Absent from the rocky substrates of Site 4 and the pale coastal sands at Site 9. Seven records from the pit line at Site 2 that was centred on a raised island of *T. wiseana*. Five records from Site 5, an extensive hummock grassland of *T. angusta* on heavy stony soils. Single records from Sites 3, 6 and 8 on a low stony hill, creekline and samphire respectively.
- Little Red Kaluta - *Dasykaluta rosamondae.* Trapped on four occasions. A female was recorded from an island of *Triodia wiseana* on heavy stony soils in a mosaic of *T. wiseana* and native grasses on cracking clay at Site 2. Three individuals were recorded from the *T. angusta* hummock grassland on heavy stony soils at Site 5.

MACROPODIDAE

- Euro - *Macropus robustus erubescens.* Very common throughout the project area. Most females observed were with a young at heel and/or one in the pouch.
- Red Kangaroo - *Macropus rufus.* Although not as common as the Euro, this species was regularly observed on the grassy plains.

VESPERTILIONIDAE

- Arnhem Land Long-eared Bat - *Nyctophilus arnhemensis.* One adult male (M52375) was captured in a mist net set against a stand of *Rhizophora* in the main tidal river channel of Preston Creek on the 19/4/00 at 7.15pm.

MOLOSSIDAE

- Little North-western Mastiff Bat - *Mormopterus loriae cobourgiana.* Note that this taxa is currently undergoing revision and the nomenclature adopted here follows that currently being used by CALM (CALM, 2000). A total of 20 individuals was captured (9 adult males, 11 adult females) in mist nets set against *Rhizophora* and with a harp trap between *Avicennia* on the 19/4/00 – 20/4/00 between 7.00 - 9.00pm. Four specimens are lodged in the Western Australian Museum (M52376 – M52379).
- Northern Freetail-bat - *Chaerephon jobensis.* Calls were recorded at Site 10.
- Little Broad-nosed Bat - *Scotorepens greyi.* Calls recorded from the Bridge of the Fortescue River Roadhouse.
- Inland Cave Bat - *Vespadelus finlaysoni.* Calls recorded from the Bridge of the Fortescue River Roadhouse.

MURIDAE

- Short-tailed Mouse - *Leggadina lakedownensis.* Three animals recorded, one each from Sites 2, 3 and 7. Records to date suggest that the main habitat for this species on the mainland comprises areas of cracking clay (Mr. Stuart Anstee, pers. comm.), although they have also been recorded from rocky hills (Dr. P. Kendrick, pers comm.). Extensive areas of cracking clay occur throughout the project area and Site 2 was established within this habitat type. Site 3 was located on a low stony hill vegetated with *Triodia wiseana* adjacent to Site 2. Site 7 was located on a stony hill within the Central Ore Body and was therefore somewhat removed from areas of cracking clay.
- Undescribed species - *Pseudomys* sp. *"*hamersley*".* Several individuals of this as yet undescribed species were recorded from the survey area. Ms. Norah Cooper of the WA Museum has confirmed the identity of M52371 recorded from Site 10. In most cases live individuals are readily distinguishable from both *P. hermannsburgensis* and *P. chapmani,* based on pelage. The undercoat of this species is relatively uniform like *P. chapmani*, but unlike this species it has numerous guard hairs.
- Western Pebble-mound Mouse - *Pseudomys chapmani.* A small active mound of this species was observed at Site 7 on a low stony hill. The mound had a raised parapet around the entrance and was also observed by Mr K. Armstrong who scored it as a "7" on the scale developed by Anstee (1996). Many of the pebbles appeared to have been recently added to the parapet, as soil was noted adhering to the pebble surface despite heavy rainfall in the preceding week. Numerous old mounds were recorded throughout suitable habitat in the project area. Another active mound of this species is know from the area (Mr. Stephen van Leeuwen, pers. comm.).
- Delicate Mouse - *Pseudomys delicatulus.* Recorded on two occasions, including one from the pale coastal sands at Site 9 and one from Site 7 on a low stony hill within the Central Ore Body. Two specimens have been lodged with the WAM (M52364* and M52374*).
- Sandy Inland Mouse - *Pseudomys hermannsburgensis.* Four records of this species all from site 9 including M52372, M52365, M52382 and M52368*.

Bats

Positive identification was made of the two species captured (using the key in Churchill, 1998) and a number of calls are tentatively presented as identification of three other species. Two species have a reported strong preference for mangal habitats.

In the mangal, two species were captured and recorded: *Nyctophilus arnhemensis* and *Mormopterus loriae cobourgiana*. The genus *Mormopterus* is currently undergoing revision. The *Mormopterus* captured in this survey correspond with 'Population U' of Adams *et al*. (1988), which is currently known as *M. loriae cobourgensis* (Churchill, 1998) although the nomenclature used here follows CALM (2000) (ie. *M. loriae cobourgiana*).

Only one individual of *N. arnhemensis* was captured; an adult male in a mist net against a stand of *Rhizophora* in the main tidal river channel (19/4/00, 7:15 p.m.).

This bat species has a preference for mangal habitats (Churchill, 1998). The specimen is lodged in the Western Australian Museum (WAM number M52375). *M. loriae cobourgiana* was captured in mist nets against *Rhizophora* and with the harp trap between *Avicennia* (19/4/00 – 20/4/00, 7.00 - 9.00 p.m.). A total of 20 individuals was captured (9 adult males, 11 adult females, none in reproductive condition, mean ± SE forearm length = 33.94 ± 0.17 mm, mean ± SE weight = 6.8 ± 0.08 mm). Although the diet of this species has not been studied, it is possible that they were foraging on the numerous moths observed flying around the mangrove trees. All bat captures (including *N. arnhemensis*) had insect material in their mouth indicating that they were foraging in the mangal. *M. loriae cobourgensis* is recorded as being almost exclusively a mangrove species, although it does move to adjacent areas. They are recorded as roosting in hollows of *Avicennia* above the high tide mark and form congregations soon after emergence before dispersing to feed (Churchill, 1998). Four specimens are lodged in the WAM (M52376 – M52379).

Calls of three other bat species are tentatively included in this report, although positive identification could not be made without a capture. No captures were made at Site 6 or Site 10 both within Edward Creek. A bat call sequence was recorded at Site 6 (23/4/00) but was not of sufficient quality for identification. Calls of *Chaerephon jobensis* were recorded at Site 10 (24/4/00; Figure 5.1). A small group of three or more was observed foraging above and within the canopy of burnt Eucalypts in the confines of the riparian zone. One bat species was recorded foraging over Du Boulay Creek at the ford (**GPS**), however the call was not of sufficient quality for identification. Two species were recorded from the Fortescue River Bridge. Calls of *Scotorepens greyi* and *Vespadelus findlaysoni* were identified with some certainty. Other low frequency, narrow band calls were not of sufficient quality for identification. The bat species recorded at the bridge are also likely to occur within the project area, given the close proximity of the bridge and the fact that the Fortescue River runs through the lease area.

6.6.4.6 INTRODUCED MAMMALS

MURIDAE

- House Mouse - *Mus musculus.* A single *Mus* was captured in an Elliott trap from Buffel grass fringing Edward Creek at Site 6.

CANIDAE

- Dingo - *Canis lupus dingo.* A single animal was observed near the bank of Edward Creek at Site 6.
- Red Fox - *Vulpes vulpes.* Tracks of this species were common along the beach and coastal dunes on Cape Preston.

FELIDAE

- Cat - *Felis catus.* Tracks of this species were seen in the dunes at Site 9.

BOVIDAE

- Sheep - *Ovis aries.* Sheep are still run on the pastoral station and several large flocks were observed at a number of localities including Edward Creek at Site 10 and near Marda Well.

6.6.4.7 Birds

The regional (Pilbara) avifauna has been summarised by Storr (1984) who provides an annotated list of 284 species of birds. The only known survey in the locality was carried out by Johnstone (1990) who surveyed the mangals at the mouth of the Fortescue River. Johnstone (1990) recorded six species of mangrove birds including the Striated Heron *Butorides striatus*, Collared Kingfisher *Todiramphus chloris*, Dusky Gerygone *Gerygone tenebrosa*, White-breasted Whistler *Pachycephala lanioides*, White-breasted Woodswallow *Artamus leucorynchus* and the Yellow White-eye *Zosterops luteus*. Johnstone *et al.* (in press) have summarised the avifauna of the Carnarvon Basin, the northern boundary of which lies approximately 100 km to the south of the project area. These authors document 277 bird species including 159 breeding species. Whilst the range of many of these species does not extend into the project area, the paper summarises the distribution, abundance and habitat preferences of all but seven of the species recorded during the current survey.

A total of 96 species of birds was recorded during the survey of the project area. This total represented 40 families and included 59 non-passerines and 37 passerines. The 96 species were represented by 2458 records, 42% of which were contributed by just one species, the Little Corella. Sixty-four species were recorded from ten or fewer individuals, with 20 being recorded from just one individual.

The most abundant group of birds were the granivores. The 13 granivorous species comprised just 14% of the total number of species, but represented 60% of all records. Included as granivores are the Little Button-quail, Brown Quail, Crested Pigeon, Spinifex Pigeon, Diamond Dove, Peaceful Dove, Bar-shouldered Dove, Galah, Little Corella, Australian Ringneck, Cockatiel, Zebra Finch and Painted Finch. The majority of these records were of the Little Corella. The most abundant of the non-granivores were the small insectivorous species including the Yellow White-eye, Variegated Fairy-wren and Willie Wagtail. The Singing Bushlark, which feeds on small grasses, seeds and insects, was also relatively common.

CASUARIIDAE

- Emu - *Dromaius novaehollandiae.* Uncommon. Recorded on three occasions. Tracks were observed on the road adjacent to Site 7 (low stony hill), two adult birds were observed at Site 5 (stony plain vegetated with *Triodia angusta*), whilst a pair of adults with two younger birds were recorded adjacent to Site 4 (rocky hill).

PHASIANIDAE

- Brown Quail - *Coturnix ypsilophora.* Uncommon. Only recorded from amongst grasses on the pale coastal sands of Cape Preston. Recorded as single birds and groups of 2, 5 and twelve.

ANATIDAE

- Pacific Black Duck - *Anas superciliosa.* Uncommon. Recorded on just two occasions, both from small ephemeral pools in Creeklines. A single bird was recorded from Edward Creek at Site 10 and another from a large pool on Eramurra Creek at Site 84.

PODICIPEDIDAE

- Australasian Grebe - *Tachybaptus novaehollandiae.* Single bird seen in a large rock pool on Eramurra Creek at Site 84.

ARDEIDAE

- White-faced Heron - *Ardea novaehollandiae.* Two sightings of possibly the same individual at Site 10 in Edward Creek on consecutive days. First observed foraging in a small ephemeral pool populated with tadpoles (possibly of *Litoria rubella*) and subsequently perched in a tall dead Eucalypt above the same pool.
- Little Egret - *Ardea garzetta.* Single birds recorded on three occasions perched in the upper branches of mangrove trees on Preston Creek.
- Eastern Reef Egret - *Ardea sacra.* Both the grey and white forms of this species were seen perched in mangrove trees along Preston Creek. In one case thirteen Egrets were seen in a single tree at the mouth of Preston Creek.
- White-necked Heron - *Ardea pacifica.* A single bird seen flying over the mudflats adjacent to Site 5.
- Striated Heron - *Butorides striatus.* One individual recorded in the mangals of Preston Creek.
- Nankeen Night Heron - *Nycticorax caledonicus.* Single bird in the mangals on Preston Creek.

ACCIPITRIDAE

- Osprey - *Pandion haliaetus.* One bird recorded on a low dead shrub in the samphire flats at Site 8 adjacent to a muddy inlet. Another individual was observed feeding on a fish on the beach of ape Preston adjacent C to Site 9.
- Whistling Kite - *Haliastur sphenurus.* A single bird observed flying overhead at Edward Creek (Site 10).
- Brahminy Kite - *Haliastur Indus.* Single birds recorded on two occasions over Preston Creek.
- White-bellied Sea-eagle - *Haliaeetus leucogaster.* Recorded on two occasions above Preston Creek.
- Spotted Harrier - *Circus assimilis.* Single birds recorded on three occasions. Seen above Edward Creek at Sites 6 and 10 and also recorded from a creekline near Marda Pool at Site 122.
- Brown Goshawk - *Accipiter fasciatus.* Single bird observed perched in a Cadjeput *Melaleuca argentea* above an ephemeral pool at Site 10 on Edward Creek.
- Wedge-tailed Eagle - *Aquila audax.* A pair recorded circling above Edward Creek at Site 10, a single bird seen above the same locality the following day, and one bird recorded above grassy plain (cracking clay) near Site 1.

FALCONIDAE

- Brown Falcon - *Falco berigora.* Recorded on four occasions as single birds above Creeklines (Sites 6 and 10), rocky hills (Site 4), and opportunistically over cracking clay close to Site 1.
- Australian Hobby - *Falco longipennis.* Recorded perched in a tree adjacent to Edward Creek at Site 6.
- Nankeen Kestrel - *Falco cenchroides.* Recorded on 12 occasions, as single birds or in twos. Seven records came from Edward Creek at Sites 6 and 10. It is probable that the same birds were being noted at each of these sites. Also seen near Marda Pool (Site 122), an un-named drainage line (Site 84) and over coastal dunes on Cape Preston.

OTIDIDAE

- Australian Bustard - *Ardeotis australis.* As many as six individuals regularly seen on grassy plains near the intersection of the main access track to the mouth of the Fortescue River with the turn-off to Marda Well.

TURNICIDAE

- Little Button-quail - *Turnix velox.* Scarce. Five individuals recorded from three censuses. Two birds recorded from Site 1, two from Site 5 and a single from Site 201.

SCOLOPACIDAE

- Eastern Curlew – *Numenius madagascariensis.* Uncommon. Primarily recorded from the mudflats adjacent to the mangals. A total of 11 birds was recorded from seven censuses.
- Grey-tailed Tattler – *Tringa brevipes.* Uncommon. A single group of nine birds seen resting on the beach in a large mixed flock with several Greater Sand Plovers and Ruddy Turnstones.
- Ruddy Turnstone - *Arenaria interpres.* Uncommon to moderately common. Two flocks, one of nine and one of 11, were seen resting on the beach on the western side of Cape Preston. A single bird was observed at the mouth of a tidal creek and three birds were seen foraging on mudflats adjacent to Site 8.
- Red-necked Stint - *Calidris ruficollis.* Uncommon. Recorded twice. Sixteen birds seen resting on the beach in a mixed flock with Grey-tailed Tattler, Ruddy Turnstone and Greater Sand Plovers.

BURHINIDAE

- Bush Stone-curlew - *Burhinus grallarius.* Rare. Single bird seen on the access track whilst spotlighting. Two additional birds were recorded from the North West Coastal Highway adjacent to the Fortescue Roadhouse.
- Beach Stone-curlew - *Esacus neglectus.* Scarce. Three birds recorded from the beach on the western side of Cape Preston. The birds were species were spaced approximately 200m apart.

HAEMATOPODIDAE

- Pied Oystercatcher - *Haematopus longirostris.* Moderately common. A single group of 11 birds observed resting on a beach on the western side of Cape Preston. A single bird observed on the same stretch of beach and two birds observed flying Preston Creek.

CHARADRIIDAE

- Red-capped Plover - *Charadrius ruficapillus.* Scarce. Recorded on two censuses. One bird recorded from the beach on the western side of Cape Preston and one seen on a nest amongst rocks in a large mudflat near Site 5.
- Greater Sand Plover - *Charadrius leschenaultia.* Scarce. Two birds seen resting on a beach in a large mixed flock.
- Black-fronted Dotterel - *Charadrius melanops.* Moderately common. Recorded from small rock pools adjacent to a granite outcrop at Site 84 and numerous pairs seen along the pebbly shores of the Fortescue River.
- Banded Lapwing - *Vanellus tricolour.* Scarce. Single bird seen on an extensive plain of stony cracking clays adjacent to Site 6.

LARIDAE

- Silver Gull - *Larus novaehollandiae.* Uncommon. A total of 15 individuals recorded across six censuses, seen as singles, twos and fours. Most records from the beach on the western side of Cape Preston, but also seen over the mangals on Preston Creek and the samphire at Site 8.
- Caspian Tern - *Sterna caspia.* Scarce. Two birds seen flying along the beach on the western side of Cape Preston.
- Lesser Crested Tern - *Sterna bengalensis.* Scarce. Five resting on the beach in a mixed flock with Crested Terns and Silver Gulls.
- Crested Tern - *Sterna bergii.* Scarce. Eight resting on the beach in a mixed flock with Lesser Crested Terns and Silver Gulls.
- Bridled Tern - *Sterna anaethetus.* One seen flying over the mouth of the tidal creek at the southern boundary of Cape Preston.

COLUMBIDAE

- Crested Pigeon - *Ocyphaps lophotes.* Recorded on five occasions from three sites as either single birds or in pairs. Single birds were recorded on two occasions from Edward Creek at Site 10 whilst a pair was recorded from the same creek at Site 6. A single bird and one pair were also observed from emergent *Acacia coriacea* at Site 1.
- Spinifex Pigeon - *Geophaps plumifera.* Typically recorded from rocky and stony habitats. One pair and a single bird were recorded from Site 4, a single bird was seen on a rocky outcrop at Site 7, and two birds were recorded from rocky outcrops on the Southern Ore Body during transects. Three birds were recorded from amongst the *Triodia angusta* at Site 5.
- Diamond Dove - *Geopelia cuneata.* Seven individuals recorded from vegetation adjacent to a tidal creek at Site 113. Single birds recorded from Edward Creek at Site 10 and from a small drainage feature at Site 7. The latter bird was on a nest of loose sticks containing two eggs. The nest was approximately 1.2m above the ground and built in the branches of a dead *Acacia coriacea* shrub.
- Peaceful Dove - *Geopelia striata.* Recorded on four occasions from two sites. Restricted to creeklines. Recorded as single birds, pairs and small flocks of up to five individuals. Recorded from Edward Creek at Site 10, and from Jilan Jilan Pool.
- Bar-shouldered Dove - *Geopelia humeralis.* Uncommon. Two groups, one of three and one of four, seen behind the mangals on Cape Preston.

PSITTACIDAE

- Galah - *Cacatua roseicapilla.* Common to very common particularly along Edward Creek. Seen as single birds, pairs, small flocks and on a single occasion as a large flock of 150 birds. Often seen in the company of the Little Corella *Cacatua sanguinea*. Noted resting in *Acacia xiphophylla* along the margins of Edward Creek.
- Little Corella - *Cacatua sanguinea.* Very common, particularly at Site 6 on Edward Creek where several large flocks were recorded, including two of 50 birds, one of approximately 120, one of approximately 300 and one of about 500. Also seen as pairs perched in tall Eucalypts at Site 10 and Site 122 near Marda Pool.
- Cockatiel - *Nymphicus hollandicus.* A group of three birds was recorded flying along the edge of Edward Creek at Site 10.
- Australian Ringneck - *Platycercus zonarius* Recorded on four censuses from four sites, all within the Creekline habitat. Pairs were observed on Edward Creek at Sites 6 and 10, and at Site 122 near Marda Pool. A group of three was recorded from Site 124 at Jilan Jilan Pool.

CUCULIDAE

- Pallid Cuckoo - *Cuculus pallidus.* Often recorded from its call, this species was recorded from Edward Creek at Site 6 on three occasions, also from *Eucalyptus camaldulensis* / *E. victrix* low forest in Eramurra Creek and flying overhead at Site 2.
- Black-eared Cuckoo - *Chrysococcyx osculans.* A single bird was observed calling from an emergent shrub at Site 1, and another heard calling at the same site. Two birds heard calling at Site 2.
- Horsfield's Bronze-Cuckoo - *Chrysococcyx basalis.* Rare. Recorded on two occasions. Single birds recorded from the coastal dunes of Cape Preston and from Edward Creek at Site 10.

CENTROPODIDAE

- Pheasant Coucal - *Centropus phasianinus.* Restricted to the creekline vegetation. Calls were often heard at Site 6 and 10, with two birds seen amongst the branches of a Eucalypt at the former site. One bird seen walking across a track at Site 99. Single birds also recorded from Site 122 near Marda Pool and Site 124 at Jilan Jilan Pool.

STRIGIDAE

- Southern Boobook - *Ninox novaeseelandiae.* Recorded from the access track on most nights of the survey. A single pair was seen roosting in the same Eucalypt on Edward Creek at Site 6 each morning of the survey. Also heard calling from Site 10 whilst mist-netting for bats.

PODARGIDAE

- Tawny Frogmouth - *Podargus strigoides.* Rare. Single bird heard calling and one observed in an *Acacia* thicket at Site 10 on Edward Creek.

CAPRIMULGIDAE

- Spotted Nightjar - *Eurostopodus argus.* Seen sitting in the middle of the access track on most nights of the survey, mostly as single birds but on one occasion as a group of five.

HALCYONIDAE

- Blue-winged Kookaburra - *Dacelo leachii.* Restricted to the Creekline vegetation, particularly *Eucalyptus camaldulensis* / *E. victrix* low forest. Recorded from its calls or by the presence of single birds in tall Eucalypts at Sites 6 and 10 on Edward Creek, one group of three birds was also recorded from Site 6. Single birds recorded from Site 124 at Jilan Jilan Pool.
- Red-backed Kingfisher - *Todiramphus pyrrhopygia.* A single bird was seen perched in a Eucalypt at Eramurra Creek.
- Sacred Kingfisher - *Todiramphus sanctus.* Common, typically recorded from creekline vegetation. Recorded from dense creekline vegetation at Site 10 on six occasions, one bird seen eating a large grasshopper. Also recorded from Site 122 near Marda Pool and Site 124 at Jilan Jilan Pool. A pair was frequently seen in tall shrubs adjacent to Site 1. Also recorded from two localities within mangals.
- Collared Kingfisher - *Todiramphus chloris.* Recorded from the edge of mangals on three occasions.

MEROPIDAE

- Rainbow Bee-eater - *Merops ornatus.* Recorded on 11 occasions from a variety of habitats, but predominantly adjacent to creeklines. Single birds recorded from Edward Creek at Sites 6 and 10. Also recorded as single birds from Site 122 near Marda Pool, Site 124 at Jilan Jilan Pool and Site 85 at Eramurra Creek. A pair recorded flying above samphire at Site 8. Single birds seen flying over Sites 1 and 7.

MALURIDAE

- Variegated Fairy-wren - *Malurus lamberti.* Common. Recorded as single birds, pairs or in small groups of between three and six. Observed in a variety of habitats including creeklines (Sites 6, 10, 122 and 124), snakewood on cracking clay (Sites 1 and 2), drainage lines on low stony hills (Site 7) and in *Acacia* shrublands on coastal dunes (Transect 201).
- White-winged Fairy-wren - *Malurus leucopterus.* Moderately common. The single day investigation for this species, which was conducted jointly with CALM and the WA Museum, confirmed that the species present was the common Blue and White Fairy Wren and not the restricted Black and White race. Typically recorded from the more open habitats especially the low snakewood shrublands and coastal dunes. Recorded from its conspicuous calls or observed in small groups of two to nine individuals. Singles recorded from the cracking clay habitat at Site 1 and a small group of four birds recorded from the same habitat at Site 2. Singles and a family of six recorded from the *Triodia* hummock grassland at Site 5, seen in emergent *Acacia* shrubs in drainage foci. Single recorded from the banks of Edward Creek at Site 6 and small groups of three and four from the snakewood adjacent to Site 10. Recorded on two occasions from the samphire at Site 8 including from a single call and as a group of six. Families also recorded from the *Spinifex* clumps on the foredunes of Cape Preston.
- Rufous-crowned Emu-wren - *Stipiturus ruficeps.* Calls of this species recorded from the *Triodia angusta* hummock grassland at Site 5. This species is well out of its known range and the calls need to be confirmed with sightings (pers. comm. Mr. R. Johnstone).
- Striated Grasswren - *Amytornis striatus.* A single bird seen running / flying over low *Triodia* on the rocky slopes of the Central Ore Body. As with the Rufous-crowned Emu-wren this species is well out of its known range and may well represent an isolated population (pers. comm. Mr. R. Johnstone).

PARDALOTIDAE

- Red-browed Pardalote - *Pardalotus rubricatus.* One bird recorded from a young Eucalypt on a tributary of Edward Creek at Site 10.

ACANTHIZIDAE

- Redthroat - *Pyrrholaemus brunneus.* Very common in *Acacia coriacea* shrublands on the coastal dunes of Cape Preston. Typically recorded from its conspicuous call and as single or pairs in dense shrubs. Also recorded from Mesquite shrubland on the banks of the Fortescue River.
- Dusky Gerygone - *Gerygone tenebrosa.* Recorded from mangals at a variety of sites. Typically as singles (four records) or twos (four records), and on one occasion as a group of four.

MELIPHAGIDAE

- Yellow-throated Miner - *Manorina flavigula.* Uncommon, recorded only from Creekline habitats. Recorded as single birds or in twos from Sites 6 and 10.
- Singing Honeyeater - *Lichenostomus virescens.* Very common throughout the project area particularly in the *Acacia coriacea* shrublands on the coastal dunes of Cape Preston. Recorded on 40 occasions typically as single birds or pairs, but also recorded in groups of three, four and occasionally five. Recorded from the following habitats; cracking clay (Sites 1 and 2), rocky hills (Site 4), stony low hills (Site 7), creekline (Site 10), and coastal dunes of Cape Preston.
- White-plumed Honeyeater - *Lichenostomus penicillatus.* Common, restricted to creeklines with either *Eucalyptus camaldulensis* or *E. victrix*. Recorded as singles or in groups of up to eight from Edward Creek at Sites 6 and 10, near Marda Pool at Site 122, Jilan Jilan at Pool Site 124 and Eramurra Creek at Site 85.
- Brown Honeyeater - *Lichmera indistincta.* Generally rare, although moderately common in mangals. A single bird was recorded from dense vegetation on the banks of Edward Creek at Site 10. Numerous individuals were recorded from the mangals at the southern boundary of Cape Preston.

PETROICIDAE

- Hooded Robin - *Petroica cucullata.* Scarce. A pair was observed in the *Acacia xiphophylla* at Site 2.

POMATOSTOMIDAE

- Grey-crowned Babbler - *Pomatostomus temporalis.* Scarce. Two birds recorded from an *Acacia coriacea* shrub on the banks of Edward Creek at Site 10.

PACHYCEPHALIDAE

- Crested Bellbird - *Oreoica gutturalis.* Moderately common. Ten records of this species, made primarily from its call. Recorded from Sites 1, 2, 4, 7 and 10.
- Mangrove Golden Whistler - *Pachycephala melanura.* Common, restricted to mangals. Ten records of this species from the mangals at the southern boundary of Cape Preston.
- White-breasted Whistler - *Pachycephala lanioides.* Uncommon, restricted to mangals. Recorded on three occasions from mangals over water.

DICRURIDAE

- ?Leaden Flycatcher - *Myiagra rubecula.* Vagrant. Single female of what was thought to be a Leaden Flycatcher was recorded from Edward Creek at Site 10. The individual was observed perched in a branch three meters above ground and was observed at night whilst spotlighting. The bird was seen by two observers for approximately five minutes. If it was a Leaden Flycatcher, it is likely that this individual was transported to the locality by Tropical Cyclone Steve which passed over the Kimberley region before recrossing the coast close to Cape Preston.
- Magpie-lark - *Grallina cyanoleuca.* Moderately common. Recorded on eleven occasions as single birds, pairs or in groups of three individuals. Typically associated with creeklines. A pair and a single bird were recorded from tall Eucalypts adjacent to Site 1, single birds at Site 6 and singles, pairs and a group of three from Site 10. A single bird from Jilan Jilan Pool at Site 124 and a pair from Site 84 on Eramurra Creek.
- Mangrove Grey Fantail - *Rhipidura phasiana.* Uncommon, restricted to mangals. Five records of either singles or pairs from the mangrove communities at the southern boundary of Cape Preston.
- Willie Wagtail - *Rhipidura leucophrys.* Common. Recorded on 24 censuses mostly from creeklines but also cracking clay and the coastal dunes of Cape Preston.

CAMPEPHAGIDAE

- Black-faced Cuckoo-shrike - *Coracina novaehollandiae.* Common. Recorded as singles or in groups of two to four. Typically from wooded creeklines but also adjacent habitats. Recorded from Sites 1, 6, 7, 8, 10, 84, 113, 122 and 124.

ARTAMIDAE

- White-breasted Woodswallow - *Artamus leucorynchus.* Moderately common. Small groups of between two and four birds seen flying over mangals and adjacent habitats including the samphire at Site 8.
- Black-faced Woodswallow - *Artamus cinereus.* Uncommon. Recorded on five censuses from a range of habitats including a single from Site 6, two from the coastal dunes on Cape Preston, small groups of four from the burnt rocky hills on the Southern Ore Body and at Site 4, and a group of five over Site 1.

CRACTICIDAE

- Pied Butcherbird - *Cracticus nigrogularis.* Moderately common. Recorded on 14 censuses from nine sites. Often recorded from its call. Seen as singles, twos, threes and in one case as a group of five. Most commonly recorded from the creekline sites (6, 10, 124 and a transect along the Fortescue River). Also from a rocky gully in the Southern Ore Body, stony low hill at Site 7, coastal dunes on Cape Preston and adjacent to the mangals at the southern boundary of Cape Preston.
- Australian Magpie - *Cracticus tibicen.* Scarce. Recorded on two occasions, two birds recorded from Edward Creek at Site 10 and another two recorded from Site 84.

CORVIDAE

- Little Crow - *Corvus bennetti.* Scarce. Recorded on one occasion from its call.
- Torresian Crow - *Corvus orru.* Uncommon. Twenty eight records from seven censuses across three sites. Single recorded from Site 6 and three small groups of 4, 5 and 6 recorded from Site 10.

HIRUNDINIDAE

- Welcome Swallow - *Hirundo neoxena.* Rare. Tentatively recorded as a Welcome Swallow. A single individual flying towards the mangals at the southern boundary of Cape Preston was observed from Site 4. It is unlikely that the individual would have been a Barn Swallow (known to occur from Cape Keraudren to Exmouth Gulf between September and December).
- Tree Martin - *Hirundo nigricans.* Uncommon. Observed on eight censuses from six sites. Recorded most commonly in twos, but also as a single and groups of six and seven. Single bird recorded over the mangals at the western mouth of the tidal creek at the base of Cape Preston. Pairs recorded from the samphire community at Site 8, *Triodia angusta* hummock grassland at Site 5, and Edward Creek at Sites 6 and 10. A group of six recorded from Site 10 and a group of seven from the Fortescue River (Transect MF).
- Fairy Martin - *Hirundo ariel.* Twenty nests recorded from a culvert under the North West Coastal Highway at Eramurra Creek.

ZOSTEROPIDAE

- Yellow White-eye - *Zosterops luteus.* Common. Largely restricted to the mangals but also from adjacent habitats and one record of four birds from Edward Creek over 5 km from the nearest mangals. All observations were of groups of between three and eight individuals.

SYLVIIDAE

- Spinifex-bird - *Eremiornis carteri.* Moderately common. Largely restricted to habitats dominated by *Triodia* (Sites 4 and 5) where it was typically recorded as singles and occasionally as twos. Also recorded from patches of *Triodia* at Site 1. These records represent knew records for this part of the Pilbara (pers. comm. Mr. R. Johnstone).
- Brown Songlark - *Cincloramphus cruralis.* Scarce. Recorded on two occasions as singles from Sites 5 and 113.

ALAUDIDAE

- Singing Bushlark - *Mirafra javanica.* Very common. Recorded throughout the project area from a variety of habitats including cracking clays (Sites 1 and 2 - 71 records), *Triodia* hummock grassland (Site 5 - three records), low stony hills (Site 7 - three records), samphire (Site 8 - six records) and coastal dunes (Transect 150 - three records). Most abundant in the grasslands on cracking clay; absent from the mangals, creeklines and rocky hills.

PASSERIDAE

- Zebra Finch - *Taeniopygia guttata.* Common. Recorded on 30 censuses from a variety of habitat types including cracking clay (Sites 1 and 2), rocky hills (Site 4), *Triodia* hummock grassland (Site 5), creeklines (Sites 6, 10, 84 and 122), stony hills (Site 7), samphire (Site 8), mangals (Transects 150 and 154) and coastal dunes (Transect 201). Recorded as single birds, pairs and in groups from two to eight.
- Painted Finch - *Emblema pictum.* Moderately common. Recorded from 19 censuses across five habitats including cracking clay (Sites 1 and 2 - 10 records), rocky hills (Site 4 - four records), stony hills (Site 7 - 18 records) and creeklines (Site 84 - three records).

MOTACILLIDAE

- Australian Pipit - *Anthus australis.* Moderately common. Recorded from most open habitats including cleared vehicle tracks in vegetation associations with moderately dense cover, and on the beach. Typically seen as singles or twos. During censuses, singles were recorded from Sites 1, 4 and 10. Singles also recorded from beach transects on four occasions and from a transect across the Southern Ore Body (much of which was burnt). Twos recorded from Site 8 on three occasions and from coastal dunes (Transect 150) on one occasion.

6.6.4.8 Reptiles

The most applicable of the regional reviews is that of the herpetofauna of the Onslow Region (Storr & Harold, 1985). These authors documented 96 species of herpetofauna from 12 families and 49 genera, which compares to 114 species from the Exmouth area documented by Storr & Hanlon (1980). Clearly these tallys would need to be reviewed in light of additional collections and taxonomic changes subsequent to publication.

The current survey recorded 228 records of 57 reptile species comprising one sea-turtle, seven agamids (dragon lizards), two varanids (monitors), eight geckos, four pygopodids (legless lizards), 22 skinks, three pythons, six elapids (frontfanged snakes), three blind snakes and one sea-snake. One additional skink *Cryptoblepharus carnabyi* was tentatively identified from a rock pile within the project area. A new species of *Ctenotus* was identified during the course of the survey.

Evidence of nesting by sea-turtles was observed on one beach however the species involved was unclear.

The survey also recorded two hylid frogs, *Litoria rubella* and *Cyclorana maini*. Calls of a third frog were tentatively identified as belonging to *Uperoleia russelli.*

HYLIDAE

- *Litoria rubella.* Recorded from Site 10 at Edward Creek during spotlighting activities.
- *Cyclorana maini.* Very common. Large numbers of individuals were recorded across a range of habitats, although most records came from the drainage line and samphire habitats. Twenty-two records came from Sites 6 and 10 established in drainage lines. Sixteen trapping events were recorded from Site 8 established in a samphire flat. Single records also came from Sites 2 and 5. The samphire was bordered by coastal dunes, an extensive area of mudflats, rocky hills and lay just below Preston Creek.
- *Uperoleia russelli.* Calls of this species were recorded from Edward Creek at Site 10, amongst clumps of reeds in a gravel river bed.

CHELONIDAE

- *Chelonia mydas.* A number of green turtles were seen both in Preston Creek and in the water near the beach along the western side of Cape Preston.
- *Chelonia* sp.. Body holes were noted on a broad beach on the western side of Cape Preston. It is unclear which species of turtle is using these beaches for nesting, since Greens, Flatbacks and Hawksbills are all known to nest in the region. Loggerheads have also been recorded from Exmouth and the Muiron Islands.

AGAMIDAE

- *Amphibolurus gilberti.* Positive identification of this species was made from the mangrove communities but none were captured. No assessment of its abundance was made.
- *Amphibolurus longirostris.* Moderately common to common along the creeklines and larger drainage systems of the project area. One large male (R141373) was captured from Site 6 during the survey. Juvenile animals were also very common in the *Spinifex longifolius* clumps on the coastal dunes especially near Site 9. One individual (R141302) was pit-trapped from Site 9.
- *Ctenophorus caudicinctus.* Moderately common. This species is not as abundant at this locality as in parts of the eastern Pilbara. Six individuals were recorded during the survey, comprising four (including R141345) from beneath rocks on a granite outcrop at Site 75, one (R141305) from cracking clay at Marda Well and one from the banks of Edward Creek at Site 6 (R141337). This species' low abundance may in part be a result of the fire which had burnt much of the suitable habitat within the project area.
- *Ctenophorus isolepis.* Very common on sandy substrates, particularly coastal dunes (eg. Site 9). Despite the abundance of this species, relatively few were captured. Seven were pit-trapped on the pale coastal sands of the dunes at Site 9 (including R141364), one was pit-trapped on samphire at Site 8 and another animal (R141315) was hand captured from coastal dunes vegetated with *Spinifex longifolius* adjacent to Site 8.
- *Ctenophorus nuchalis.* Scarce. A single animal was pit-trapped from samphire at Site 8.
- *Pogona minor mitchelli.* Moderately common across a variety of habitats including cracking clays (Site 2), rocky hills (Site 4), coastal dunes (Site 9) and creeklines (several opportunistic collections).
- *Tympanocryptus cephala.* Although only recorded twice, this cryptic species could easily have been overlooked on occasions. One animal (R141336) was excavated during construction of the fence-line at Site 1 whilst a second (R141351) was pit-trapped at the same site. Habitat at this site comprised cracking clay vegetated with a variety of native grasses including *Chrysopogon fallax*.

GEKKONIDAE

- *Diplodactylus conspicillatus.* A single individual (R141359) was trapped from Site 3 during the survey. This species is probably more common than this record suggests, and targeted spotlighting would undoubtedly yield further records.
- *Diplodactylus mitchelli.* A single individual (R141285) was pit-trapped from Site 3 (a low stony hill vegetated with *Triodia wiseana*).
- *Diplodactylus savagei.* One animal (R141346) pit-trapped from Site 5 (stony plain vegetated with *Triodia angusta*).
- *Gehyra Pilbara* Single animal (R141314) hand captured from a rock pile at Site 4. No termitaria were seen in the project area.
- *Gehyra punctata.* Very common. Recorded from rock piles and other rocky habitats including a granite outcrop and windrows where rocks had piled up. Twenty-four individuals were recorded across four sites, including five captures from the granite outcrop at Site 75 (R141386 - 389, R141392), 17 captures from amongst rocks at Site 4 (including R141295, R141299, R141312, R141332-33, R141344, R141352), and one capture from Site 1 (R141338) and Site 3 (R141284).
- *Gehyra variegate.* Uncommon. This species was largely restricted to drainage lines where it was found under bark of dead trees (n=3). On the coastal dunes (Site 9) it was found in a number of microhabitats, including one animal (R141282) inside a large baler shell.
- *Heteronotia binoei.* Eight animals recorded from six sites including Sites 1 (R141355), 2, 5 (R141347), 6, 7 and 10.
- *Nephrurus wheeleri cinctus.* Although just one individual (R141385) was pit-trapped from Site 7, several more were observed on the North West Coastal Highway whilst spotlighting. It is likely that additional individuals would be located within the project area given the opportunity to do further spotlighting.

PYGOPODIDAE

- *Delma nasuta.* Two animals (including R141317) pit-trapped from Site 7 (low stony hill).
- *Delma pax.* A single animal (R141311) pit-trapped from the banks of Edward Creek at Site 6.
- *Lialis burtonis.* Moderately common. Typically observed crossing vehicle tracks in a range of habitats including samphire (Site 8) (R141384) and rocky hills (Site 4). Numerous specimens also seen crossing the North West Coastal Highway whilst spotlighting.
- *Pygopus nigriceps.* Pit-trapped on four occasions from three sites, including Sites 1 (R141353), 2 (R141383) and 6. Also captured opportunistically from cracking clays adjacent to Site 3.

SCINCIDAE

- *Carlia munda.* Commonly recorded species, particularly from Edward Creek (Site 6) where 14 capture events were recorded (including R141283, R141316 and R141354). Five records from Site 1 (including R141350) and single capture events at Sites 2 and 10.
- *Carlia tricantha.* A single adult male (R141292) was recorded from samphire (Site 8).
- *Cryptoblepharus plagiocephalus.* One individual was observed on the branches of a dead Eucalypt at Site 6. Unfortunately the animal avoided capture.
- *Cryptoblepharus carnabyi.* Observed on a rock pile near Site 86. Unlike *C. plagiocephalus,* which is grey, this second individual was a coppery colour.
- *Ctenotus* sp. nov.. Single specimen (R141577) captured from stony clay soil vegetated with *Triodia* at Site 2. According to Mr. Greg Harold (pers. comm.) this may represent the Pilbara form of *Ctenotus uber*.
- *Ctenotus* affin. *Helenae.* Typically recorded from stony substrates vegetated with *Triodia wiseana*. One animal (R141280) recorded from the loamy soil on the banks of Edward Creek at Site 6. Two individuals were pit-trapped from the stony islands within expanses of cracking clay at Site 2 (including R141300), one record from Site 4 (R141307) and two records from the low stony hill at Site 7 (including R141301).
- *Ctenotus* affin. *Robustus.* Pit-trapped on cracking clay or creeklines contiguous with cracking clay. A single individual (R141372) was recorded from Site 1, whilst two animals (including R141379) were collected from Site 10.
- *Ctenotus duricola.* Collected from stony soils at Site 4 and Site 7 (R141296).
- *Ctenotus grandis titan.* Four individuals (including R141390) collected from the stony soils at Site 7.
- *Ctenotus pantherinus ocellifer.* Recorded from a range of habitats predominantly vegetated with *Triodia* species. The single exception was a juvenile animal hand-collected from the pit fence-line set in samphire at Site 8. A single individual (R141391) was trapped at Site 1, two (R141310 and R141377) were recorded from Site 3, a single animal was recorded from Site 4 and another was collected from a sand chenier on the mudflat at the base of Cape Preston.
- *Ctenotus saxatilis.* Nine records from rocky substrates, comprising seven (including R141380) from Site 4 and two from Site 7. Adult animals were captured using medium-sized Elliott traps whilst juveniles were pit-trapped.
- *Ctenotus serventyi.* Three records of this species, all from sandy substrates. Two individuals (including R141288) captured on the pale coastal dunes at Site 9 and a single animal (R141304) from a chenier in the mudflats at the base of Cape Preston.
- *Cyclodomorphus melanops melanops.* Recorded from *Triodia wiseana* hummock grassland and from creeklines. Two individuals were collected from Site 6 (Edward Creek), and one animal was collected from each of Sites 3 (low stony hill) (R141329), 5 (stony plain) (R141375) and 7 (low stony hill).
- *Egernia depressa.* Recorded from rocky habitats. One individual captured from beneath an exfoliating slab of granite at Site 75, a second (R141371) was captured in an Elliott trap at Site 3 and a third was observed in a rock pile at Site 4.
- *Glaphyromorphus isolepis.* Three records (including R141382) of this species, all from the banks of Edward Creek at Site 6.

- *Lerista bipes.* Very common in the pale sands of the coastal sand dunes of Cape Preston. Nine individuals (including R141339 - 41, R141361 - 62) were captured from Site 9, with numerous tracks observed throughout the dunes.
- *Lerista elegans.* Recorded on two occasions. One individual (R141330) pit-trapped from a mosaic of dense *Cenchrus* and *Triodia* on the banks of Edward Creek at Site 10 and the second (R141334) from *Triodia angusta* hummock grassland on heavy stony soils at Site 5.
- *Lerista muelleri.* Four specimens recorded from three sites. Note that this species was identified as true *L. muelleri* according to the latest revision of the species complex (Mr. Laurie Smith WA Museum, pers. comm.). Two animals (R141298 and R141357) pit-trapped from the dense *Cenchrus* on the banks of Edward Creek at Site 6, one (R141369) hand captured from the pit fence-line at Site 4 and another pit-trapped within dense grasses at Site 1.
- *Menetia greyii.* Nineteen records of this very common species. Pit-trapped from seven sites typically vegetated with *Triodia wiseana*. Apparently absent from the creekline and sand dune sites. One from Site 1, three (including R141363 and R141365) from Site 2, six (including R141331 and R141356) from Site 4, six also (including R141348, R141360, R141368 and R141370) from Site 5, one (R141367) from Site 7 and one (R141297) from Site 8.
- *Menetia surda.* Uncommon. Pit-trapped (R141342) from the banks of Edward Creek at Site 6 and also from the *Triodia angusta* hummock grassland at Site 5 (R141291).
- *Proablepharus reginae.* One animal (R141290) hand-captured from *Triodia wiseana* hummock grassland on rocky skeletal soil at Site 4.
- *Tiliqua multifasciata.* Six records of this species from four sites. Captured in pits and medium sized Elliott traps. A single animal (R141289) recorded from a mosaic of native grasses and *Triodia wiseana* at Site 2. Single records also from the banks of Edward Creek at Sites 6 and 10, and three records from a narrow drainage feature at Site 7.

VARANIDAE

- *Varanus acanthurus.* Uncommon. Recorded on five occasions and always on rocky habitat. Two individuals (including R141395) were collected from beneath rocks on a granite outcrop at Site 74, one individual (R141394) was collected from beneath a large rock on the Central Ore Body and single animals were trapped at Sites 2 (cracking clay) and 7 (low stony hill).
- *Varanus panoptes.* Uncommon. Observed on three occasions during the survey. Recorded from Sites 2, 4 and 10.

TYPHLOPIDAE

- *Rhamphotyphlops diversus ammodytes.* One animal (R141313) pit-trapped from heavy soils associated with the samphire habitat at Site 8 and a second pit-trapped from cracking clay at Site 2 (R141306).
- *Rhamphotyphlops grypus.* A single specimen (R141287) pit-trapped from the stony soils adjacent to a drainage feature at Site 7.
- *Rhamphotyphlops hamatus.* Pit-trapped from stony soils at Site 3 (R141303).

BOIDAE

- *Antaresia perthensis.* One individual seen crossing the North West Coastal Highway near the intersection with the access road. Additional road kills were seen frequently on the North West Coastal Highway between the access road and the Fortescue Roadhouse.
- *Antaresia stimsoni.* A single road kill recorded from the North West Coastal Highway close to the proposed access corridor.
- *Aspidites melanocephalus.* One individual hand-captured from the access road adjacent to Site 75 and a second seen crossing the track near Site 105.

ELAPIDAE

- *Acanthophis wellsi.* One animal observed basking on the track adjacent to Site 8 and a second observed on the North West Coastal Highway adjacent to the proposed access corridor. Additional sightings were made on the North West Coastal Highway on most nights of the survey, including numerous road kills. One freshly killed individual (R141281) was vouchered.
- *Demansia psammophis cupreiceps.* Four animals recorded including three from the clayey soils of Sites 1 (including R141396) and 2 (R141402). One specimen also recorded from the *Triodia wiseana* hummock grassland at Site 7.
- *Parasuta monachus.* Recorded on three occasions from or adjacent to creeklines. Two animals (R141399 and R141401) pit-trapped from the banks of Edward Creek at Site 6 and the third (R141293) observed crossing the access track adjacent to Eramurra Creek whilst spotlighting.
- *Parasuta punctata.* Recorded twice. One animal (R141397) hand-captured from clayey soils at Site 1 and the second (R141398) from *Triodia wiseana* hummock grassland on stony soils at Site 3.
- *Pseudechis australis.* Two records of this species, both from the access track adjacent to Site 85. The records may represent the same individual.
- *Pseudonaja nuchalis.* One individual seen basking in the open between *Triodia wiseana* hummocks on the rocky slopes at Site 4.

HYDROPHIIDAE

- *Hydrelaps darwiniensis.* Several individuals observed amongst the mangroves.

7.0 Discussion

7.1 Flora and Vegetation

7.1.1 Flora

A total of 500 vascular flora species, from 64 Families and 196 Genera were recorded within the Cape Preston Project Area. This total includes 482 (96.4%) native species and 18 (3.6%) introduced (weed) or non-endemic species. Appendix G provides a full list of vascular plant species recorded during the 200 and 2006 surveys. Results of other surveys are available in the respective survey reports and are not listed in this report.

Families with the highest representation were Poaceae (Grass family – 73 native taxa; 4 introduced taxa); Papilionaceae (Pea family – 44 native taxa); and the Malvaceae (Mallow Family – 49 native taxa, 2 introduced taxa).

None of the species recorded during either the flora surveys conducted between 2000 and 2006 surveys were found to be exhibiting a range extension from recorded occurrences, as documented by the WA State Herbarium (DEC, 2006).

In comparison to other bioregions of Western Australia, flora species richness is generally poor in the Pilbara and the diversity of the project area was found to be relatively low. Only 500 species were collectively recorded within a total area of 34,302 ha. This represents poor species diversity for such a large project area with relatively diverse vegetation composition. Most of the species diversity is represented in areas of better quality vegetation, concentrated around the ore body and other stony rises.

Ten Priority Flora species were identified to potentially occur within the project area through DEC Threatened and Priority Flora Database searches. Three of the Priority Flora species identified during these searches were recorded during the surveys, namely *Goodenia pascua* (P3) within vegetation community Hp; *Goodenia* sp. East Pilbara (AA Mitchell PRP 727) (P1), occurring within PP2 and *Phyllanthus aridus* (P3) within vegetation community Pf1. The communities that these species have been recorded in are regarded as significant, due to supporting these flora populations.

Previously it has been reported (HGM, 2001) that an additional three priority species have been identified to occur within the project area. These three species have been deemed to be adequately distributed and were removed from the Declared and Priority Flora List in 2008. These former Priority species are:

- Abutilon trudgenii formerly P3;
- Eriachne tenuiculmis formerly P3; and
- Sida sp. Wittenoom formerly P3.

No species listed as Declared Rare Flora (DRF) by the DEC under the *Wildlife Conservation Act, 1950*, or as Threatened under the *EPBC Act* were recorded within the project area. None of the species recorded were found to be exhibiting a range extension from recorded occurrences, as documented by the WA State Herbarium (DEC, 2006).

Throughout the entire project area, two of the total 18 weed species recorded are listed as Declared Plants by the Department of Agriculture, pursuant to the *Agriculture and Related Resources Protection Act, 1976.* These species are **Prosopis pallida* (Mesquite) and **Datura leichhardtii* (Native Thornapple) (Department of Agriculture, 2006). Under the Act, landholders are obliged to carry out management measures to control the spread of these weeds. The recommendations for each species are detailed in Appendix I. Additional to the recorded Declared Plants, Buffel Grass (**Cenchrus ciliaris*) is also a significant weed recorded prolifically throughout most of the project area.

7.1.2 Vegetation Communities

A total of 80 vegetation communities were recorded within the entire Cape Preston project area, combining 2000 and 2006 survey results. The Land Systems represented by these vegetation communities are the Boolgeeda, Cheerawarra, Horseflats, Littoral, Macroy, Newman, Paraburdoo, River, Rocklea and Yamerina Land Systems. Vegetation units of the Paraburdoo System dominate representation within the project area. These areas and particularly areas of the Newman Land System were found to be in better condition than most of the grassy flats due to lower occurrence of cattle grazing.

Vegetation communities of the River Land System (Rc1, Rc2, Rc3, Rc4, Rf1 and Rf2) are regarded as significant due to being limited to specific landforms, being creek lines and rivers as well as due to their spatial distribution, being represented by long narrow occurrence along waterways. This spatial distribution makes the vegetation vulnerable to continual decline in the event of disturbances, particularly clearing, as connectivity relies on continual occurrence across the landscape. Such areas are also important for faunal movement.

The Boolgeeda Land System vegetation, represented by only vegetation community Bx1 is locally significant as it occurs only as a single thin swathe in the project area. However, there are significant areas of this Land System (but not necessarily this specific vegetation type) to the north-east and south-west of the project area.

The suite of Bx1, Lp and Pc communities will have the highest proportion of their surveyed area cleared for infrastructure and mine development.

7.1.3 Vegetation Condition

The condition of the vegetation within the project area ranges from Completely Degraded to Very Good with those areas of Very Good condition vegetation concentrated around the ore body. The pit area exhibits the best quality vegetation due to the rugged and inhospitable terrain limiting cattle grazing. In this regard, it is recommended that clearing of good vegetation be minimised as far as practicable.

The majority of the vegetation is in Good condition and weed invasion is relatively high throughout both the project area and the region, due to intensive pastoral activity for a number of years. **Cenchrus ciliaris* (Buffel Grass) occurs extensively throughout the grassy plains, and is often dominant along waterways and drainage lines in the region. A high degree of erosion is also present throughout much of the project area, particularly along waterways due to a long history of cattle activity.

Impacts on biodiversity of the project area will be limited by clearing highly degraded vegetation, where possible, in preference to good condition vegetation.

7.1.4 Impacts on Mangrove Communities

Approximately 3.56% of the project area's mangrove community will be removed for mine infrastructure.

The coastal mangroves at Cape Preston are classified as a Type 'A' conservation area. The site has been identified as the most southern occurrence of true shore mangrove formation in the Pilbara (Semeniuk, 1997).

The Environmental Protection Authority (EPA) Guidance Statement No. 1 – *Guidance Statement for the protection of tropical arid zone mangroves along the Pilbara coastline* (2001) includes the Cape Preston mangroves as one of several populations that occur within areas that have been 'designated for industrial development, associated ports or related uses. Within this context, the Cape Preston populations are considered to be "Mangrove areas of very high conservation value (designated *regionally significant*)" and are classified under Guideline 3 as outlined in the Guidance Statement. The EPA's operational objective for Guideline 3 areas is that no development should take place that would significantly reduce the mangrove habitat or ecological function of the mangroves in these areas. In this regard, liaison with relevant stakeholders will need to take place prior to any further consideration of developments that have the potential to impact, either directly or indirectly.

Specifically, in accordance with the objectives of Guideline 3, the outcomes in terms of managing impacts on the Cape Preston Mangrove populations would include:

- mangroves should not decline because of altered water flow or salinity (no significant alteration of tidal flow to mangroves with the key objective being to maintain existing tidal patterns);
- water quality in undisturbed mangrove areas adjacent to the development should meet the ANZECC Water Quality Guidelines, unless there is ecological justification for it not doing so;
- existing groundwater flow, freshwater inflows and quality should be maintained in undisturbed mangrove areas;
- mangrove decline should not occur through secondary effects such as shading or dust settlement; and
- sedimentation patterns should be maintained so that erosion and deposition within mangrove habitats is within natural variations.

7.2 Fauna

The Hamersley – Pilbara region is one of Australia's 15 National Biodiversity hotspots and provides habitat for a number of threatened, endemic and fire sensitive species and communities (DEWHA, 2007). The Hamersley Range provides relatively protected habitats for many species including the Ghost Bat, Mulgara and Spectacled Hare-wallaby, and the aquifers support endemic cave-dwelling animals.

A number of species of conservation significance were recorded in the project area during the 2000 and 2006 survey efforts. These species are summarised in Table 13 below.

Table 13: DEC Threatened Fauna Species potentially present within the Balmoral South Iron Ore Project Area

Species	Common Name	WA Conservation Category	EPBC Conservation Category	IUCN Threatened Species Category
Dasycercus cristicauda	Mulgara or Minyiminyi	Schedule 1	Vulnerable	Vulnerable
Pezoporus occidentalis	Night Parrot	Schedule 1	Critically Endangered	Critically Endangered
Falco peregrinus	Peregrine Falcon	Schedule 4		
Mormopterus loriae cobourgiana	Little North-Western Mastiff Bat	Priority 1	N/A	N/A
Merops ornatus	Rainbow Bee-Eater	N/A		
Haliaeetus leucogaster	White Bellied-Sea Eagle	N/A		
Chelonia mydas	Green Turtle	N/A		
Lagorchestes conspicillatus leichardti	Spectacle Hair Wallaby	Priority 3	N/A	N/A
Limnodromus semipalmatus	Asian Dowitcher	Priority 3		
Leggadina lakedownensis	Lakeland Downs Mouse or Kerakenga	Priority 4	N/A	Near Threatened
Pseudomys chapmani	Western Pebble Mound Mouse	Priority 4	N/A	Least Concern
Ardeotis australis	Bustard	Priority 4	N/A	Near Threatened
Burhinus grallarius	Bush Stone-Curlew	Priority 4	N/A	Near Threatened
Numenius madagascariensis	Eastern Curlew	Priority 4	N/A	Least Concern
Hydromys chrysogaster	Water Rat	Priority 4	N/A	N/A
Falco hypoleucos	Grey Falcon	Priority 4	N/A	N/A
Lophoictinia isura	Square-tailed Kite	Priority 4	N/A	N/A
Esacus neglectus	Beach Stonecurlew	Priority 4	N/A	N/A
Sterna (albifrons) sinensis	White-shafted Tern (Little Tern)	Priority 4	N/A	N/A

Of these species, only the Lakeland Downs Mouse is considered likely to reside within the project area. The preferred habitat of this species is cracking clays, which are widespread throughout the project area.

Additional to these Priority species, one undescribed species of rodent (*Pseudomys* sp. Hamersley) and two undescribed skinks (*Ctenotus* aff. *robustus* and *Ctenotus* sp. nov.) of possible conservation significance were recorded. The majority of these species have been recorded from other sites in the Pilbara, but their regional conservation status remains unclear.

During the 2006 field fauna survey, no Schedule fauna species were recorded in the project area. Only one priority species (the Australian Bustard) was recorded.

Two EPBC listed species were recorded within the project area: The White-bellied Sea Eagle and Rainbow Bee-eater. No other EPBC listed species were sighted. Based on the area's prevalent habitats, it is considered that the following EPBC listed species could also potentially exist within the project area:

- Pilbara Olive Python (*Liasis olivacea barroni*)
- Mulgara (*Dasycercus cristicauda*)
- Barn Swallow *(Hirundo rustica)*
- Listed marine turtles

The 2006 field survey recorded a total of 104 vertebrate species and a total of 114 individuals were captured, identified at site and released.

The October 2006 survey confirmed that the project area supports a diverse reptilian assemblage with 37 species recorded. The diversity of species recorded can partly be attributed to the range of habitats sampled, with creek lines and cracking clays dominated by *Triodia spp.* yielding the highest number of species. Many of the expected reptile species prefer rocky habitats, which comprise only a very small proportion of the Balmoral South Project area.

The undescribed species of skink, *Ctenotus* aff. r*obustus* was also recorded during the 2006 survey. Although the WA Museum has yet to formerly describe this species, positive identification was made using photographs housed at the Museum.

The majority of bird species recorded during 2006 were identified along the Fortescue River and relatively well vegetated creek lines. Most of the species observed in these areas were recorded near ephemeral pools. Two EPBC-listed migratory terrestrial bird species were sighted in the project area (discussed above).

A desktop assessment of suitable habitat types was conducted in 2008 (Phoenix Environmental Sciences, 2008a), which was followed up by a targeted survey (Phoenix Environmental Sciences, 2008b – in prep). The desktop assessment determined that the likelihood of there being suitable habitat to support populations of Mulgara is very low. It also concluded that there may be suitable habitat for the olive python, which is currently under investigation as part of a broader fauna survey currently underway. To date, no individuals have yet been sighted. Given that the Olive Python is known from records throughout the Pilbara management strategies should be developed for this project.

In general, it has been determined over the course of the 2000 and 2006 field surveys that the fauna habitats within the project area are all regarded as well represented in the region and none are regraded as regionally significant or unique. Many years of livestock grazing has reduced the quality of available fauna habitat. Of some importance are the habitats of the cracking clays (Hp vegetation type), due to the potential presence of *Leggadina lakedownensis, Ctenotus* aff. *robustus* and *Ctenotus* sp. nov and the major drainage lines (eg De Boulay Creek) as they represent the most fauna rich habitats in the area.

Impacts on fauna in the project area will largely occur due to habitat loss or modification. Minimal impacts on fauna are likely to result from operational activities such as dust and noise. The majority of potential faunal impacts identified are likely to have no adverse long term impact on the environment and can be managed through the implementation of routine management procedures and safeguards.

7.3 Recommended Management Measures

7.3.1 Flora

In general terms, impacts on flora and vegetation communities will be managed through a process of workforce education, avoidance, minimising disturbance, monitoring impacts, implementation of remedial strategies where practical and rehabilitation. Key management measures include:

- ensuring that detailed design minimises impact on areas of significant vegetation communities, such as vegetation along creeklines and communities containing Priority Flora species. Communities containing Priority Flora species include:
  - Hp which contains *Goodenia pascua* (P3);
  - PP2 which contains *Goodenia* sp. East Pilbara (AA Mitchell PRP 727) (P1); and
  - Pf1 which contains *Phyllanthus aridus* (P3).
- retaining large trees where possible, particularly along creeklines.
- timing clearing activities of certain habitats to avoid key nesting periods for significant fauna;
- clearly delineating areas to be cleared on project drawings and in the field and ensuring that personnel on site, including contractors and subcontractors, know which areas to avoid;
- implementing procedures to prevent any vehicular activity outside the areas to be cleared;
- implementing management measures for the control of *Prosopis pallida* (Mesquite) and *Datura leichhardtii* (Native Thornapple);
- implementing dust suppression measures to minimise dust impacts on adjacent vegetation; and
- progressively rehabilitating disturbed areas in accordance with the site rehabilitation procedure.

To assess the impacts on vegetation during construction and operation of the project, monitoring sites should be installed at key locations to assess:

- phreatophytic vegetation condition (to monitor impacts from dewatering);
- vegetation condition adjacent to ground disturbing activities (to monitor impacts from dust);
- weed infestations across the project area (to monitor the spread and control of weed species);
- rehabilitation areas (to monitor success against completion criteria); and
- control sites for all of the above.

A Decommissioning and Closure Plan should be developed in the early phase of the project and updated throughout the life of the project. This will ensure that progressive rehabilitation activities achieve landform stability, maintain public safety, provide compatible land use and aim towards the establishment of sustainable ecosystems as a long-term goal. Mine closure planning is an ongoing process and mine closure, including rehabilitation, will be further defined through stakeholder consultation, detailed engineering design and various studies.

7.3.2 Fauna

Key recommended management actions include:

- implementing a catch and release relocation programme prior to any ground disturbing activity, particularly for significant fauna;
- timing clearing activities of certain habitats to avoid key nesting periods for significant fauna,
- minimising the loss of fauna linkage corridors such as Du Boulay Creek and other drainage lines within the project area;
- reducing vehicle movements during peak fauna movement periods as determined through a log of fauna deaths (species, location and time);
- imposing speed restrictions to reduce the risk of collisions with fauna;

- minimising the time that trenches or holes are left open and if it is necessary for a trench to remain open for extended periods, install suitable escape ramps at regular intervals along the trench and undertake regular monitoring;
- minimising fencing in areas where fauna are known to move and using “fauna-friendly” fencing such as fencing with reduced mesh size and no top wires;
- retaining possible hollow logs and large boulders as fauna habitats within rehabilitation sites;
- prohibition of feral animals on site, including cats; and
- undertaking a feral animal control program on site for cats, rats, dogs and other feral animals.

A fauna monitoring programme will be implemented for the early detection of potential impacts that the project may have on local fauna. The monitoring will include:

- inspecting fence lines, trenches and open excavations to ensure that fauna are not trapped;
- checking for breeding or nesting sites prior to clearing activities;
- undertaking targeted surveys for threatened fauna species considered likely to occur in the project area. This includes areas that are deemed likely to support the Olive Python:
  - Rc2 which is a major drainage line;
  - other major drainage lines; and
  - Nr and ROr (rockpiles).
- undertaking a marine turtle nest survey to determine the significance of potentially impacted beaches on local turtle populations. If surveys show that impacted areas are significant nesting areas, then management measures to prevent or minimise disturbance to those areas should be implemented; and
- undertaking feral animal surveys to ensure that there is no long term increase in abundance and distribution.

7.4 Statutory Obligations

7.4.1 Priority Flora and Fauna

Priority flora and fauna species have been recorded within the project area. Priority flora and fauna lists are administered by the DEC and while listed species do not have the same legal status as the DRF and Scheduled Fauna, they are considered in the approvals process pursuant to the *Environmental Protection Act (1986)*. Priority flora and fauna are listed because either they are being considered for addition to the DRF or Fauna Schedule list or there is insufficient information to accurately determine their conservation status. Consultation with the DEC regarding the proposed impacts to areas containing known populations of Priority flora and fauna species should be undertaken.

7.4.2 EPBC listed Species

Several EPBC listed fauna species have the potential to exist within the project area, including the Pilbara Olive Python, the Mulgara, a number of listed marine turtles and two species of migratory terrestrial birds. In accordance with the EPBC Act, a referral must be submitted to the DEWHA for a determination on whether the project has the potential to significantly impact upon these species, if present.

7.4.3 Significant Vegetation Communities

The significance of communities is determined by a range of factors, including whether they support populations of priority flora and/or they are limited to specific landform types. The two mentioned factors both contribute to a suite of communities in the project area being regarded as significant. There is no legislative protection for significant communities, particularly in the Pilbara Region however, again, it is advisable that the DEC be consulted regarding the proposed impacts to areas containing such communities in order to evaluate the appropriate measures in which to proceed.

7.4.4 Declared Plants (Pest Weeds)

Certain weed species that are considered noxious or pest weeds and particularly where they pose threats to agriculture or the natural environment are listed as Declared Plants by the Department of Agriculture. These listings are pursuant to the *Agriculture and Related Resources Protection Act, 1976.* The project area supports populations of the Declared Plant species **Prosopis pallida* (Mesquite) and **Datura leichhardtii* (Native Thornapple) (Department of Agriculture, 2006). In accordance with the Act, the proponent will be required to implement measures to control the spread of these declared plants.

7.4.5 Migratory Birds

The Commonwealth Government has entered into agreements with Japan and China to protect migratory birds and birds in danger of extinction and their environment (JAMBA and CAMBA agreements). Under these agreements, there is an obligation for developments to ensure protection for the listed migratory bird species and their habitats. In this instance, the project has the potential to impact on two species of migratory birds covered by the agreements and therefore the proposal must be referred to DEWHA. It is unlikely, however, that any impact will be significant.

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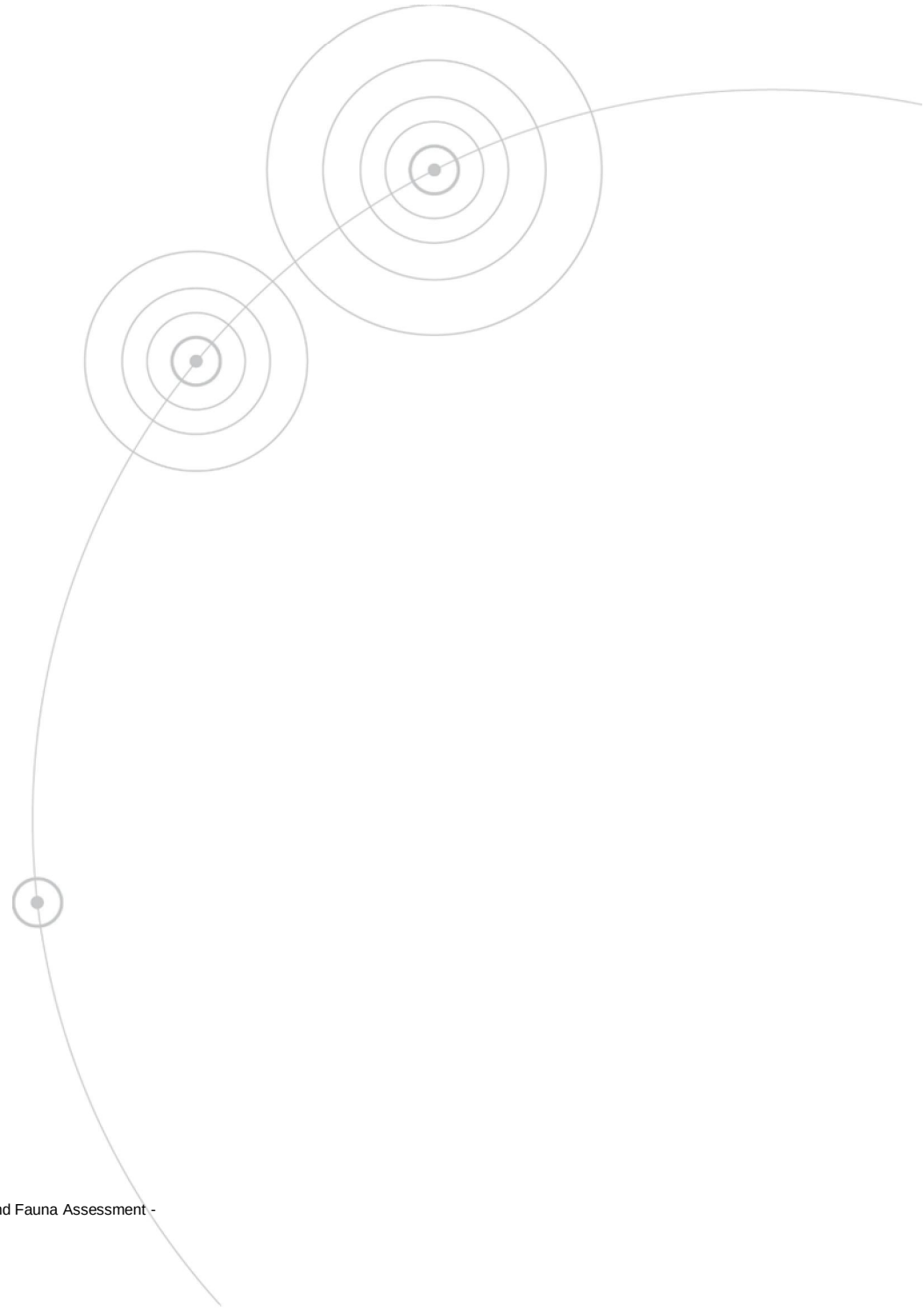
Appendix A: PATN Analysis Report



1.0 INTRODUCTION

1.1 Purpose of this report

This report presents the results and brief presentation of floristic analyses carried out to provide classification to assist recognition of plant communities in study my Maunsell in the Pilbara.

1.2 Levels of classification provided

While a classification of the site data was a fundamental part of the analysis, that prepared requires field knowledge for corroboration.

That provided is based in intuition based on experience of how the nature of the clustering.

1.2 Location

The data used in the analyses are from survey areas roughly in the Pilbara.

1.3 Data provided by Maunsell

The data were provided in a spreadsheet as abundance. Each site had co-ordinates and had been allocated to a vegetation community. A limited number of sites had descriptions of soil and landforms.

The area sampled at each site was not disclosed.

Data provided included observations outside of quadrats. Several of the samples were from transects and these were not used.

2.0 METHODS

2.1 Data Preparation

The data was imported into the Microsoft Access database ("Maunsell.mdb"). All relevant data used for preparing the analysis and the products of the PATN analyses were incorporated into that database. The queries used to carry out the analysis are also incorporated into this database. At some quadrats, several records of the same taxon were provided and these were reconciled to one per quadrat and cover adjusted. One site (#4) had no species recorded as being in a quadrat and was excluded.

2.2 Comparisons made

The data assembled were run as two dataset; one with the species being considered as either presence or absent from a site and the other a transformation of cover. (Experience has shown that results using the absolute cover values tended to be "overly" influenced by the species with large cover. The transformation is the Domin Kranjina scale which is roughly the square root of cover.)

Presence absence has been proven appropriate for assessing the regional nature of the variation in site composition of quadrat data in earlier analyses of Pilbara bioregion data. Data including the cover of species at sites tends to be more useful when analysing datasets from smaller areas.

Only data from species present in quadrats were included in the analysis.

2.3 PATN analyses carried out

Several modules of the numerical classification package PATN (Belbin 1987) were used for the analyses. The default parameter settings were used. A brief account of some of the methods used in PATN is provided in Appendix 1.

The PATN modules used were ASO (calculation of similarity matrix), FUSE (classification), DEND (representation of classification) and SSH (a form of ordination to display relationship of sites to the whole dataset). The results of the analyses were imported into a database so that site characteristics could be joined with the groups formed in the analysis.

For each dataset the modules were run twice;

- first with the sites as the classified objects (ie the species as the attributes), and
- then with the species as the classified objects (ie the sites as the attributes).

In this way both site and species groups were generated. The whole data matrix can then be presented with the rows being ordered by the species groupings and the columns ordered by the site groupings. This provides a way of inspecting how well the data conform with the classifications. Most of the interpretation is made from the

classification of sites. The species groups are used to support the interpretations more than to identify species that may be expected to occur in similar habitats.

The dendrogram represents the way the classified rows (sites or species in the respective data sets) fuse. This can be used to construct groups of rows by "cutting" at a particular value or cutting to obtain a particular number of groups. For the purpose of this study, two "cuts" were made for each of the sites to form "9 group", and "16 group" classifications and for the species to form "20 group", and "40 group" classifications. While these are arbitrary, they provide an opportunity to make interpretations of the nature of the classification.

In addition to the classifications described above, an ordination of the site and species data was carried out using the SSH (semi-strong hybrid multi-dimensional scaling) module of the PATN package (Belbin 1987). This was performed to diagrammatically present some of the relationships between sites. (But the results are not presented here.) Commonly, there is too much variation in the datasets to allow useful interpretations to be made using this technique. Interpretation from the preliminary analysis suggested that in this case it is to some degree useful.

2.4 Summaries made

The PATN results were imported into the Access database where it was joined and summarised with Access queries. Key portions were exported to Excel in which the two-way table was formatted for easier visualisation and charts of geographic distribution were constructed.

3.0 LIMITATIONS

The results are a presentation of a view of the data structure.

The classifications have been prepared to provide a basis for interpreting variation in site floristic composition. The absolute composition of groups defined by these analyses should not be interpreted as real communities. A process of review and refinement aided by field knowledge is required. This has not been done.

4.0 RESULTS

The objective of the analysis is to provide a classification of sites that are a robust representation of the floristic composition of the sampled plant communities.

The analysis showed that while there were differences in the classification using the cover compared to that using presence absence data, there was significant accord (Table 1).

Table 1 Comparison between site classification using cover vs presence absence data.

		Presence absence classification														
	GP9 à	1	2	2	2	3	3	3	4	5	5	6	7	8	8	9
	GP15 à	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GP9	GP16															
1	1	2														
1	2		3	1												
1	3				2											
2	4					1										
2	5					1	1									
2	6					1										
3	7							1								
4	8											1				
5	9								1							
6	10											1	1			
6	11												2			
7	12									2						
7	13									4						
7	14										1					
8	15													2	1	
9	16															1

Because of the accord, and because most vegetation units are at least based on abundance of taxa, it was decided to continue the interpretation based on the cover data.

Figure 1 is the dendrogram from the classifiation of sites using cover data. While the 9 and 16 groups defined are to a degree arbitrary, they appear to represent a classification moderately similar to the vegetation classification (Table 2)

Figure 1

GP9	GP16	site	Community	data
				11/24/06 05:43:35.45 dend Maunsell cover Nov 2006
				0.3000 0.3944 0.4889 0.5833 0.6778 0.7722 0.8667 0.9611 1.0556 1.1500
1	1	1	Nh	
1	1	2	Px1	
1	2	5	Roh1b	
1	2	8	Roh1b	
1	2	25	Nh2	
1	2	11	Roh1b	
1	3	32	Nh2	
1	3	34	Roh1	
2	4	7	Bg	
2	5	13	PP2	
2	5	19	Nh	
2	6	15	Sg	
3	7	10	Tt	
4	8	16	LH	
5	9	33	Px1	
6	10	9	HP	
6	10	12	HP	
6	11	30	HP	
6	11	31	Px2	
7	12	14	Ag	
7	12	26	Rf1	
7	13	20	AS1	
7	13	23	Px2	
7	13	27	AS1	
7	13	29	AS1	
7	14	28	ASG	
8	15	17	Rf2	
8	15	18	Rf2	
8	15	21	Rf1	
9	16	22	Rf1	
				0.3000 0.3944 0.4889 0.5833 0.6778 0.7722 0.8667 0.9611 1.0556 1.1500

Table 2 Comparison of classification using cover data with the Veg communities defined. (Communities ordered to emphasise the accord between the two methods.)

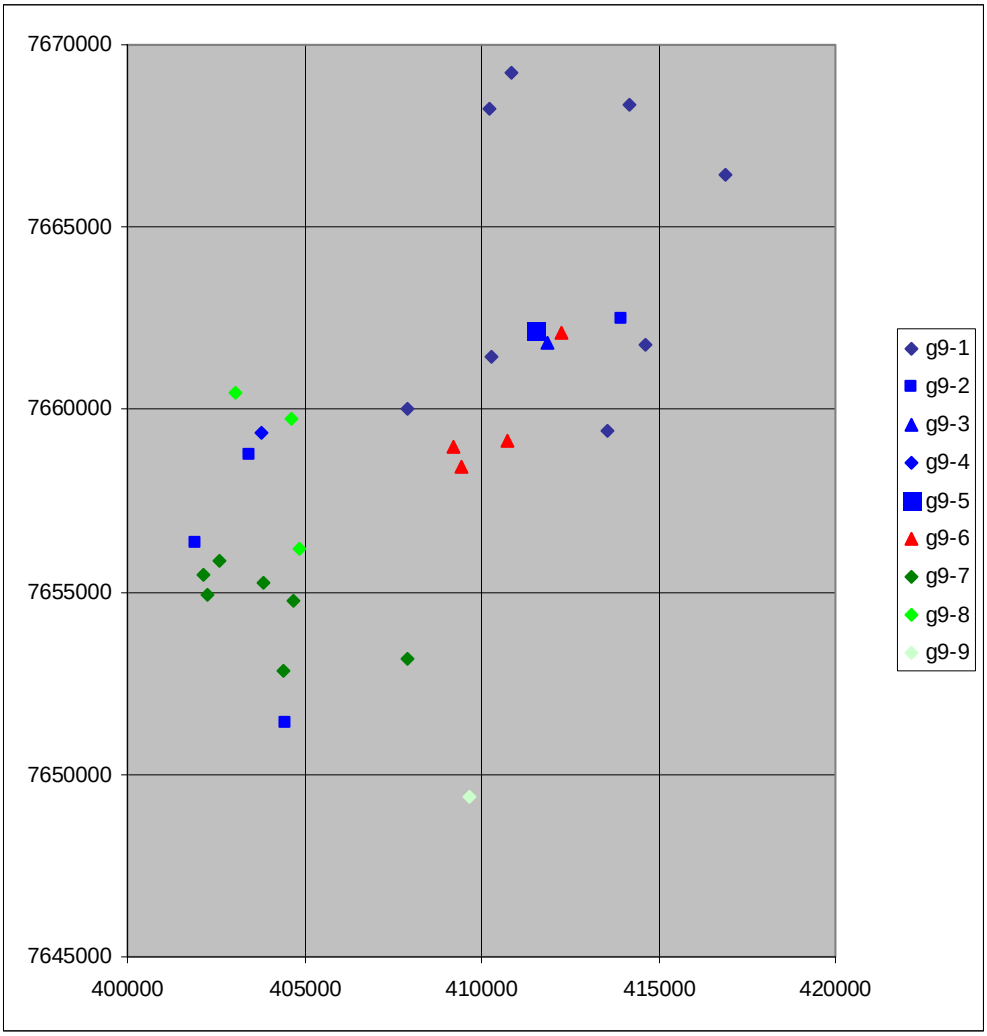
		Vegetation Communities																
GP9	GP16	Nh	Px1	Roh1b	Nh2	Roh1	Bg	PP2	Sg	Tt	LH	HP	Px2	Ag	AS1	ASG	Rf2	Rf1
1	1	1	1															
1	2			3	1													
1	3				1	1												
2	4						1											
2	5	1						1										
2	6								1									
3	7									1								
4	8										1							
5	9		1															
6	10											2						
6	11											1	1					
7	12													1				1
7	13												1		3			
7	14															1		
8	15																2	1
9	16																	1

The classification of species when combined with the site classification enables a closer examination of the differences in composition between the groups defined. This is presented in “cover species by sites” sheet in the Maunsell_output.xls file. No attempt is made to review or refine the classification. However, it can be seen that there is modest fidelity for species for different groups of sites.

The queries MC_9_species site_freq and MC_16_species site_freq provide lists of species present in each of the 9 and 16 groups respectively. Those that occurred in the greatest proportion of sites in a group are listed first for each group. Thus it is possible to construct a list of most frequently present species for each site group.

The distribution of groups appears to have a modest geographic basis (Figure 2). The classification using presence absence data was also geographically based.

Figure 2 distribution of Group 9 groups from classification of sites using cover data.



5.0 DISCUSSION

The accord between the classification of the sites using either presence absence or cover data suggests that the definition of communities by these methods is robust. This is reinforced by the degree of accord between these classifications and the vegetation communities defined by traditional means.

The moderate geographical base to the distribution of these communities is consistent with other studies in the Pilbara. On the face of it this is probably related to the geographic variation of parent material and landforms of the area.

6.0 REFERENCES

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APPENDIX 1: Brief Account of Some of PATN Functions

A package of computer routines commonly referred to as PATN provide a suite of useful techniques has been developed over a number of years (Belbin 1987). These have involved state of the art development with significant investigations of the robustness of techniques and appropriateness of use (eg Faith et al 1987). This package is a PC based menu driven interface to a DOS operating system.

The options available in this package are wide. However, there is a commonly used set which, through the extensive research of the developers of PATN, are recognised to be reasonably robust. These were used by Gibson et.al. (1994), Weston et al (1992) and Griffin (1994). Partly because of the desire to follow the same methodology, they were used in this analysis.

Classification

Many mathematical methods have been developed to group (classify) abstract (floristic) units. Some attempt to identify discriminating attributes (species) that might be used as if in a key to define progressively (and hierarchically) more and more homogeneous (floristic) units. Typically these are called divisive classifications and may use one (monothetic) or a number (polythetic) of attributes (species) in each division. This tends to not be favoured for species rich vegetation with low dominance.

Other classifications tend to start from the object (site) and aggregate these with most similar object. Fundamental to the technique is the association matrix that describes how similar each (object) (site) is to each other (object). Similarity between pairs of objects is a function of the attributes (species) they share and the attributes (species) they do not share. It may also include or ignore abundance measures (cover, biomass, frequency scores for species). Different formulas have been found to emphasise different characteristics of the data and might, therefore, be useful in different situations. It is implicit that the formula should generate a similarity coefficient that reflects “ecological” distances. Detailed studies of robustness and suitability of these are numerous (eg Faith et al 1987).

The association matrix (or at least an association coefficient) is just the first step in agglomerative techniques. There are as many methods of agglomerating as there are methods for calculating similarity coefficients. Two basic systems are used; hierarchical and non-hierarchical.

Hierarchical agglomeration techniques progressively create fewer and fewer abstract groups of objects until all are grouped into one. The groups take on the "combined" attributes of the objects. These new groups by definition become more and more heterogeneous as new objects are joined. Once an object joins a group, it remains with it until there is just one group of all sites.

Non-hierarchical methods attempt to divide up ecological space by identifying nodes or areas of concentrations of objects; effectively by a series of "cookie cutters". One such technique involves many iterations to "place" the "cookie cutters" in a way to achieve an "optimal solution". Different size "cookie cutters" implies different degrees of similarity. While there might be an expectation that objects grouped together at a certain similarity will stay together when the similarity is widened (to include objects that are less similar). This need not be the case, hence it being described non-hierarchical.

Ordination

Implicit in any ordination technique, and there are many, is that a coefficient can be calculated to represent the ecological distance between objects. The variation between objects can be represented in multi-dimensional space. This abstract space is defined to have n-1 axes where n is the number of objects. Also implicit is that the distribution of objects in this space is not random and therefore, optimum solutions can be computed which shows the much of the differences can be represented on just a few axes.

This technique is particularly useful in attempting to describe the influence of environmental variables. It, however, has difficulty in representing relationships between data sets that contain objects that have little or nothing in common.

Main Programs

For each data set, ASO created a symmetric association matrix made up of pair-wise calculations of similarity "distance". The "distance" was 1 minus the Czekanowski coefficient that is the number of species in common divided by the average number of species in the two sites being compared. The more similar are the sites the smaller the distance. This can therefore vary form 0 for absolutely identical to 1 for absolutely different. The latter is a very common occurrence but former is very rare except in very simple communities with just a few species. In moderately rich shrub communities, sites from the same stand have a value of about 0.25 to 0.4.

Using each of these matrices, the routine FUSE classified the sites using the "unweighted pair-group mean average" fusion method. This hierarchical, agglomerative classification "fuses" the most similar sites first in such a way that all sites (by definition) are eventually fused together. FUSE both determines the fusion order and calculates a measure of the distance between the sites (or groups of sites). Since the group "average" calculation is influenced by its contributing sites, it needs to be appreciated that the addition or subtraction of sites from the data set will change the overall fusion. Some of the fusion strategies tend to create groups of odd sites (ones with little in common), especially if there are many similar sites in other groups.

DEND provides a one dimensional, graphic (dendritic or tree) representation of the fusions. Within a "branch", the site sequence is arbitrary, and sites can be swapped and branches can be rotated so long as no branches cross. The greater the distance (along a branch) between junctions, the more distinct the fusing components are from each other. Belonging to a branch implies a relative affinity. However, care must be taken in assigning meaning to higher order branches for experience has shown that these fusions can often be arbitrary. This is particularly the case where the data set is highly heterogeneous and these branches (groups of sites) may have almost nothing in common.

A number of summary routines were used to assist in the interpretation. GDF provides group membership from the output of FUSE for a user-defined number of groups. NNB provides from the association matrix a list of n nearest neighbours for each site.

SSH is a general purpose multi-dimensional scaling algorithm. This groups of techniques is believed to be the most robust form of ordination available and the algorithm available in PATN has been shown to be superior to a wide range of other ordination methods such as principal components/co-ordinates, reciprocal averaging and detrended correspondence analysis.

Just as the sites can be grouped according to the similarity of their species composition, so too the species can be grouped according to the number of sites in which they occur. To do so, the data matrix was transposed so that the species were the rows and the sites were the columns. A big difference in classifying species is how to calculate a sensible similarity coefficient between a species that for example occurs at very few sites and one that occurs at most. This stretches the meaning of "average" number of species that is used in the numerator of the Czekanowski coefficient. TWOSTEP is an alternate method that attempts to generate a more

"sensible" measure of similarity. This was used in the current analysis as it was in Gibson et.al. (1994).

Once the association matrix was generated, the same routines used above for the sites were performed.

TWINSPAN

This was not used because of experience with this kind of classification and the analysis of others. Eg Belbin states in the help file for PATN

"What can I say? It is included because I had to make it compatible with PATN to test its properties. It is a divisive-polythetic algorithm that some ecologists like. Tests suggest that flexible UPGMA (FUSE) and ALOC are generally significantly better."

APPENDIX 2: List of Sheets in "Maunsell Output.xls"

Cover Dendrogram of sites using species coded cover value community code name, Group 9 and Group 16 numbers, coordinates and some site attributes.

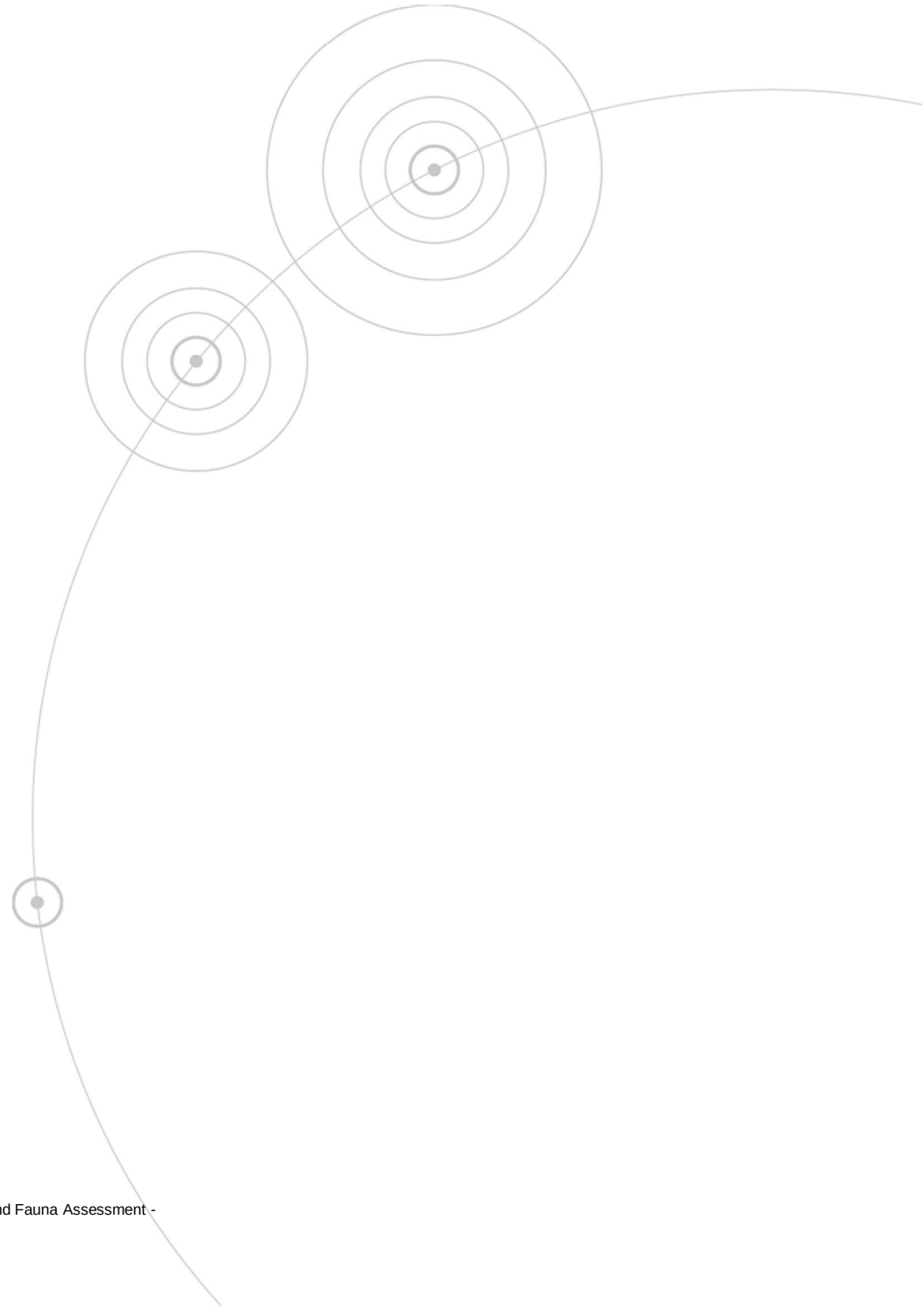
cover_distn scatter plot of GP9 classification on eastings and northings

cover species by sites Matrix of all species (rows) by All sites with the species and sites ordered by the respective dendrograms. The classifications are emphasised by highlighting.

pres_abs Dendrogram of sites using species presence or absence with community code, Group 9 and Group 15 numbers, coordinates and some site attributes.

pres_abs_distn scatter plot of GP9 classification on eastings and northings

Appendix B: Individual Quadrat data used for PATN Analysis



APPENDIX B: VASCULAR FLORA QUADRAT DATA USED FOR PATN ANALYSIS

T denotes transects (not quadrats)

* Denotes introduced (weed) species

GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
410871	76669236	1	Nh	*Acacia bivenosa*	3
		1	Nh	*Acacia monticola*	1
		1	Nh	*Corchorus laniflorus*	<1
		1	Nh	*Erodium* sp.	<1
		1	Nh	*Glycine ?tomentella*	<1
		1	Nh	*Glycine ?tomentella*	<1
		1	Nh	*Goodenia stobbsiana*	<1
		1	Nh	*Paspalidium ?tabulatum*	1.5
		1	Nh	*Ptilotus ?auriculifolius/macrocephalus*	2
		1	Nh	*Ptilotus clementii*	<1
		1	Nh	*Ptilotus exaltatus* var. *exaltatus*	4
		1	Nh	*Ptilotus villosiflorus*	4
		1	Nh	*Senna ?notabilis*	1
		1	Nh	*Senna glutinosa ssp pruinosa*	7
		1	Nh	*Sida cardiophylla*	<1
		1	Nh	*Solanum horridum*	1
		1	Nh	*Triodia wiseana*	60
410252	7668255	2	Px1	*Acacia bivenosa*	2
		2	Px1	*Acacia xiphophylla*	5
		2	Px1	*Corchorus laniflorus*	<1
		2	Px1	*Glycine ?tomentella*	2
		2	Px1	*Gomphrena canescens* subsp. *canescens*	<1
		2	Px1	*Ptilotus ?auriculifolius/macrocephalus*	<1
		2	Px1	*Ptilotus clementii*	<1
		2	Px1	*Ptilotus exaltatus* var. *exaltatus*	40
		2	Px1	*Ptilotus villosiflorus*	<1
		2	Px1	*Salsola tragus* subsp. *tragus*	0.5
		2	Px1	*Sclerolaena uniflora*	<1
		2	Px1	*Senna glutinosa ssp pruinosa*	2
		2	Px1	*Senna glutinosa* subsp. *glutinosa*	<1
		2	Px1	*Senna glutinosa* subsp. *x luerssenii*	1
		2	Px1	*Triodia wiseana*	40
409817	7666886	T3	Nc	**Cencrus ciliaris*	1.5
		T3	Nc	**Prosopis pallida*	1
		T3	Rf1	*Acacia bivenosa*	4
		T3	Nc	*Acacia coriaceae* subsp. *pendens*	1
		T3	Nc	*Alternanthera nodiflora*	0.5
		T3	Nc	*Ammannia multiflora*	3
		T3	Rf1	*Cassytha capillaris*	<0.5
		T3	Rf1	*Corchorus laniflorus*	0.5
		T3	Nc	*Cyperus bifax*	0.5
		T3	Nc	*Eucalyptus victrix*	8
		T3	Rf1	*Glycine ?tomentella*	2
		T3	Nc	*Goodenia lamprosperma*	0.5
		T3	Nc	*Goodenia stobbsiana*	<1
		T3	Nc	**Malvastrum americanum*	1
		T3	Nc	*Miulus gracilis*	1.5

APPENDIX B: VASCULAR FLORA QUADRAT DATA USED FOR PATN ANALYSIS

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		T3	Nc	**Passiflora foetida*	1.5
		T3	Rf1	*Petalostylis labicheoides*	40
		T3	Nc	*Rostellularia adscendens* subsp. *clementii*	0.5
		T3	Rf1	*Senna glutinosa* subsp. *x luerssenii*	0.5
		T3	Nc	*Sida rohlenae*	<1
		T3	Nc	*Stemodia grossa*	<1
		T3	Rf1	*Triodia wiseana*	60
413475	7667899	4	Hp	*Dichanthium serium* subsp. *humilis*	na
		4	Hp	*Enneapogon caerulescens*	na
		4	Hp	*Eragrostis setifolia*	na
		4	Hp	*Eragrostis tenellula*	na
		4	Hp	*Eragrostis xerophila*	na
		4	Hp	*Eriachne aff. mucronata*	na
		4	Hp	*Indigofera linifolia*	na
		4	Hp	*Indigofera trita*	na
		4	Hp	**Malvastrum americanum*	na
		4	Hp	*Ptilotus aervoides*	na
		4	Hp	*Ptilotus exaltatus* var. *exaltatus*	na
		4	Hp	*Ptilotus gomprenoides* subsp. *gomphrenoides*	na
		4	Hp	*Rynochosia minima*	na
		4	Hp	*Sida rohlenae*	na
		4	Hp	*Sporobolus australasicus*	na
		4	Hp	*Stemodia kingii*	na
		4	Hp	*Streptoglossa liatroides*	na
		4	Hp	*Tephrosia clementii*	na
		4	Hp	*Themeda triandra*	na
414164	7668363	5	Roh1b	*Corchorus laniflorus*	6
		5	Roh1b	*Crotalaria medicaginea*	<0.5
		5	Roh1b	*Dichanthium sericeum* subsp. *humilius*	2
		5	Roh1b	*Eremophila maculata*	<0.5
		5	Roh1b	*Euphorbia coghlanii*	<0.5
		5	Roh1b	*Glycine ?tomentella*	2
		5	Roh1b	*Glycine ?tomentella*	<0.5
		5	Roh1b	*Glycine ?tomentella*	<0.5
		5	Roh1b	*Gomphrena canescens* subsp. *canescens*	<0.5
		5	Roh1b	*Goodenis microptera*	<0.5
		5	Roh1b	*Indigofera linifolia*	<0.5
		5	Roh1b	*Indigofera trita*	<0.5
		5	Roh1b	*Polycarpea holtzei*	<0.5
		5	Roh1b	*Polycarpea longiflora*	<0.5
		5	Roh1b	*Pterocaulon sphaeranthoides*	<0.5
		5	Roh1b	*Ptilotus exaltatus* var. *exaltatus*	<0.5
		5	Roh1b	*Ptilotus helipteroides*	<0.5
		5	Roh1b	*Rynochosia minima*	<0.5
		5	Roh1b	*Trichodesma zeylanicum* var. *grandiflorum*	<0.5
		5	Roh1b	*Triodia wiseana*	50
		5	Roh1b	*Triumfetta clementii*	1

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
416067	7665584	T6	Rc1	**Cenchrus ciliaris*	3
		T6	Rc1	**Cenchrus ciliaris*	4
		T6	Rc1	*Acacia bivenosa*	<1
		T6	Rc1	*Acacia coriacea* var. *coriacea*	5
		T6	Rc1	*Acacia inaequilatera*	<1
		T6	Rc1	*Acacia inaequilatera*	0.5
		T6	Rc1	*Adriana urticoides* var. *hookeri*	<1
		T6	Rc1	*Corchus walcottii*	<1
		T6	Rc1	*Crotalaria novae - hollandiae* subsp. *crassipes*	<1
		T6	Rc1	*Cyperus vaginatus*	10
		T6	Rc1	*Cyperus vaginatus*	2
		T6	Rc1	*Eragrostis tenellula*	<1
		T6	Rc1	*Eucalyptus victrix*	10
		T6	Rc1	*Glycine ?tomentella*	1
		T6	Rc1	*Gomphrena canescens* subsp. *canescens*	<1
		T6	Rc1	*Haloragis gossei*	<1
		T6	Rc1	*Hibiscus austrinus*	0.5
		T6	Rc1	*Hybanthus auranticus*	<1
		T6	Rc1	**Malvastrum americanum*	<1
		T6	Rc1	**Malvastrum americanum*	<0.5
		T6	Rc1	*Melaleuca linophylla*	20
		T6	Rc1	*Melaleuca linophylla*	50
		T6	Rc1	*Nicotiana rosulata* subsp. *rostulata*	<1
		T6	Rc1	*Operculina aequisepala*	<1
		T6	Rc1	*Pterocaulon sphacelatum*	0.5
		T6	Rc1	*Sesbania cannabina*	1
		T6	Rc1	*Sesbania cannabina*	5
		T6	Rc1	*Sida fibulifera*	<1
		T6	Rc1	*Triodia* aff. *epactia*	3
		T6	Rc1	*Triodia* aff. *epactia*	4
413941	7662471	7	Mr4	**Cenchrus ciliaris*	<0.5
		7	Mr4	**Prosopis pallida*	<0.5
		7	Mr4	*Acacia bivenosa*	0.5
		7	Mr4	*Aristida contorta*	2.5
		7	Mr4	*Crotalaria medicaginea*	<0.5
		7	Mr4	*Enneapogon caerulescens*	5
		7	Mr4	*Eremophila maculata*	<0.5
		7	Mr4	*Euphorbia coghlanii*	<0.5
		7	Mr4	*Gomphrena canescens subsp. canescens*	2
		7	Mr4	*Gomprena cunninghamii*	<0.5
		7	Mr4	*Indigofera colutea*	1
		7	Mr4	*Indigofera linifolia*	0.5
		7	Mr4	*Ptilotus aervoides*	5
		7	Mr4	*Ptilotus exaltatus* var. *exaltatus*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		7	Mr4	*Ptilotus helipteroides*	<0.5
		7	Mr4	*Rynochosia minima*	1.5
		7	Mr4	*Sida rohlenae*	6
		7	Mr4	*Sporobolus australasicus*	0.5
		7	Mr4	*Themeda triandra*	<0.5
		7	Mr4	*Triodia wiseana*	60
414648	7661787	8	Roh1b	*Aristida contorta*	1
		8	Roh1b	*Corchorus laniflorus*	4
		8	Roh1b	*Glycine ?tomentella*	1
		8	Roh1b	*Gomprena cunninghamii*	1
		8	Roh1b	*Goodenia microptera*	0.5
		8	Roh1b	*Polycarpea longiflora*	<0.5
		8	Roh1b	*Ptilotus ?auriculifolius/macrocephalus*	1
		8	Roh1b	*Ptilotus exaltatus* var. *exaltatus*	2
		8	Roh1b	*Rynochosia minima*	<0.5
		8	Roh1b	*Solanum diversiflorum*	<0.5
		8	Roh1b	*Solanum horridum*	1.5
		8	Roh1b	*Tephrosia supina*	<0.5
		8	Roh1b	*Themeda triandra*	<0.5
		8	Roh1b	*Triodia wiseana*	70
		8	Roh1b	*Triumfetta clementii*	1
412242	7662112	9	Hp	**Prosopis pallida*	1
		9	Hp	*Dichanthium sericeum* subsp. *humilius*	35
		9	Hp	*Enneapogon caerulescens*	1
		9	Hp	*Eragrostis xerophila*	55
		9	Hp	*Eremophila maculata*	<0.5
		9	Hp	*Goodenia pascua* (P3)	<0.5
		9	Hp	**Malvastrum americanum*	<0.5
		9	Hp	*Ptilotus exaltatus* var. *exaltatus*	<0.5
		9	Hp	*Sesbania cannabina*	<0.5
		9	Hp	*Sida rohlenae*	5
		9	Hp	*Sporobolus australasicus*	10
		9	Hp	*Stemodia kingii*	0.5
411863	7661829	10	Mr6	**Cenchrus ciliaris*	3
		10	Mr6	**Prosopis pallida*	1
		10	Mr6	*Acacia bivenosa*	6
		10	Mr6	*Acacia inaequilatera*	1
		10	Mr6	*Alternanthera nodiflora*	<0.5
		10	Mr6	*Amaranthus pallidiflorus*	<0.5
		10	Mr6	*Dichanthium sericeum* subsp. *humilius*	15
		10	Mr6	*Dichanthium sericeum* subsp. *humilius*	0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		10	Mr6	*Eragrostis tenellula*	7
		10	Mr6	*Eriachne aff. mucronata*	10
		10	Mr6	*Erodium sp.*	<0.5
		10	Mr6	*Gomphrena canescens* subsp. *canescens*	<0.5
		10	Mr6	*Goodenia forrestii*	<0.5
		10	Mr6	*Grevillea pyramidalis*	0.5
		10	Mr6	*Hybanthus auranticus*	<0.5
		10	Mr6	*Indigofera colutea*	<0.5
		10	Mr6	*Indigofera linifolia*	0.5
		10	Mr6	*Indigofera trita*	<0.5
		10	Mr6	*Ipomoea muellerii*	0.5
		10	Mr6	*Marselia drummondii*	<0.5
		10	Mr6	*Pterocaulon sphacelatum*	<0.5
		10	Mr6	*Rynochosia minima*	0.5
		10	Mr6	*Sida rohlenae*	1
		10	Mr6	*Solanum horridum*	<0.5
		10	Mr6	*Sporobolus australasicus*	1
		10	Mr6	*Trichodesma zeylanicum* var. *grandiflorum*	<0.5
		10	Mr6	*Triodia* aff. *epactia*	50
		10	Mr6	*Triodia pungens*	2
		10	Mr6	*Triodia wiseana*	6
		10	Mr6	*Triumfetta clementii*	0.5
416894	766415	11	Roh1b	*Acacia ancistrocarpa*	0.5
		11	Roh1b	*Acacia bivenosa*	<0.5
		11	Roh1b	*Alternanthera nodiflora*	<0.5
		11	Roh1b	*Aristida holathera*	5
		11	Roh1b	*Corchorus laniflorus*	1
		11	Roh1b	*Cymbopogon procerus*	3
		11	Roh1b	*Glycine ?tomentella*	5
		11	Roh1b	*Glycine ?tomentella*	<0.5
		11	Roh1b	*Indigofera linifolia*	<0.5
		11	Roh1b	*Mukia maderaspatana*	0.5
		11	Roh1b	*Polycarpea longiflora*	0.5
		11	Roh1b	*Ptilotus exaltatus* var. *exaltatus*	<0.5
		11	Roh1b	*Rynochosia minima*	<0.5
		11	Roh1b	*Senna glutinosa* subsp. *pruinosa*	2
		11	Roh1b	*Senna glutinosa* subsp. *glutinosa*	<0.5
		11	Roh1b	*Solanum horridum*	0.5
		11	Roh1b	*Stemodia grossa*	<0.5
		11	Roh1b	*Templetonia aff. hookeri*	<0.5
		11	Roh1b	*Tribulus suberosus*	0.5
		11	Roh1b	*Trichodesma zeylanicum* var. *grandiflorum*	<0.5
		11	Roh1b	*Triodia wiseana*	60
		11	Roh1b	*Triumfetta clementii*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
410742	7659121	12	Hp	*Dichanthium fecundum*	1
		12	Hp	*Dichanthium sericeum* subsp. *humilius*	45
		12	Hp	*Eragrostis xerophila*	50
		12	Hp	*Goodenia forrestii*	0.5
		12	Hp	*Indigofera colutea*	<0.5
		12	Hp	*Indigofera linifolia*	<0.5
		12	Hp	*Ptilotus exaltatus* var. *exaltatus*	<0.5
		12	Hp	*Ptilotus gomphrenoides* var. *conglomeratus*	<0.5
		12	Hp	*Rynochosia minima*	<0.5
		12	Hp	*Scleroleana bicornis*	0.5
		12	Hp	*Sporobolus australasicus*	<0.5
		12	Hp	*Stemodia kingii*	<0.5
		12	Hp	*Streptoglossa liatroides*	1
		12	Hp	*Themeda triandra*	10
404481	7651400	13	Pp2	**Cenchrus ciliaris*	1
		13	Pp2	**Prosopis pallida*	1
		13	Pp2	*Acacia bivenosa*	0.5
		13	Pp2	*Acaia inaequilatera*	0.5
		13	Pp2	*Boerhavia paludosa*	<0.5
		13	Pp2	*Corchorus laniflorus*	<0.5
		13	Pp2	*Dichanthium sericeum* subsp. *humilius*	0.5
		13	Pp2	*Eremophila maculata*	<0.5
		13	Pp2	*Eriachne benthamii*	1
		13	Pp2	*Eucalyptus sp.*	1
		13	Pp2	*Euphorbia australis*	0.5
		13	Pp2	*Glycine ?tomentella*	<0.5
		13	Pp2	*Gomphrena canescens* subsp. *canescens*	<0.5
		13	Pp2	*Heliptropium chrysocarpum*	<0.5
		13	Pp2	*Indigofera linifolia*	<0.5
		13	Pp2	*Mukia maderaspatana*	<0.5
		13	Pp2	*Pterocaulon sphaeranthoides*	<0.5
		13	Pp2	*Ptilotus aervoides*	<0.5
		13	Pp2	*Scleroleana costata*	<0.5
		13	Pp2	*Senna glutinosa* subsp. *x luerssenii*	1
		13	Pp2	*Sida rohlenae*	<0.5
		13	Pp2	*Solanum horridum*	<0.5
		13	Pp2	*Sporobolus australasicus*	<0.5
		13	Pp2	*Themeda triandra*	<0.5
		13	Pp2	*Triodia wiseana*	20
		13	Pp2	*Triumfetta clementii*	1

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Easting	Northing				
402140	7655455	14	Mr6	**Cenchrus ciliaris*	60
		14	Mr6	**Prosopis pallida*	5
		14	Mr6	*Acacia inaequilatera*	1
		14	Mr6	*Acacia sclerosperma* subsp. *sclerosperma*	<0.5
		14	Mr6	*Acacia synchronicia*	<0.5
		14	Mr6	*Acaia inaequilatera*	2
		14	Mr6	**Aerva javanica*	1
		14	Mr6	*Aristida contorta*	1
		14	Mr6	*Brachyachne convergens*	<0.5
		14	Mr6	**Citrullus lanatus*	<0.5
		14	Mr6	*Corchorus laniflorus*	0.5
		14	Mr6	*Desmodium filiforme*	<0.5
		14	Mr6	*Dichanthium fecundum*	5
		14	Mr6	*Dichanthium sericeum* subsp. *humilius*	5
		14	Mr6	*Eragrostis xerophila*	5
		14	Mr6	*Eremophila maculata*	<0.5
		14	Mr6	*Euphorbia coghlanii*	<0.5
		14	Mr6	*Gomphrena canescens* subsp. *canescens*	1
		14	Mr6	*Goodenia forrestii*	<0.5
		14	Mr6	*Indigofera colutea*	<0.5
		14	Mr6	*Indigofera linifolia*	<0.5
		14	Mr6	*Ipomoea muellerii*	<0.5
		14	Mr6	**Malvastrum americanum*	<0.5
		14	Mr6	*Mukia maderaspatana*	<0.5
		14	Mr6	*Polygala aff. Isingii*	<0.5
		14	Mr6	*Polymeria ambigua*	<0.5
		14	Mr6	*Pterocaulon sphaeranthoides*	<0.5
		14	Mr6	*Ptilotus exaltatus* var. *exaltatus*	1
		14	Mr6	*Ptilotus helipteroides* var. *helipteroides*	<0.5
		14	Mr6	*Rynochosia minima*	<0.5
		14	Mr6	*Solanum horridum*	1
		14	Mr6	*Sporobolus australasicus*	2
		14	Mr6	*Tephrosia supina*	1
		14	Mr6	*Themeda triandra*	2
		14	Mr6	*Triumfetta clementii*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
401935	7656352	15	Mr6	**Cenchrus ciliaris*	1
		15	Mr6	**Prosopis pallida*	2
		15	Mr6	*Acacia xiphophylla*	1
		15	Mr6	*Acaia inaequilatera*	<0.5
		15	Mr6	*Aristida contorta*	45
		15	Mr6	*Enneapogon caerulescens*	30
		15	Mr6	*Eragrostis tenellula*	1
		15	Mr6	*Eremophila maculata*	<0.5
		15	Mr6	*Eriachne aff. helmsii*	<0.5
		15	Mr6	*Eriachne benthamii*	25
		15	Mr6	*Eriachne benthamii*	<0.5
		15	Mr6	*Glycine ?tomentella*	<0.5
		15	Mr6	*Gomphrena canescens* subsp. *canescens*	<0.5
		15	Mr6	*Indigofera linifolia*	<0.5
		15	Mr6	*Pterocaulon sphaeranthoides*	<0.5
		15	Mr6	*Ptilotus aervoides*	<0.5
		15	Mr6	*Rynochosia minima*	<0.5
		15	Mr6	*Solanum horridum*	<0.5
		15	Mr6	*Themeda triandra*	5
		15	Mr6	*Triodia wiseana*	<0.5
		15	Mr6	*Triumfetta clementii*	2
403771	7659346	16	Mr5	**Cenchrus ciliaris*	1
		16	Mr5	**Prosopis pallida*	30
		16	Mr5	*Abutilon lepidum*	<0.5
		16	Mr5	*Alectryon oleifolius*	<0.5
		16	Mr5	*Boerhavia repleta*	<0.5
		16	Mr5	*Enneapogon caerulescens*	5
		16	Mr5	*Eragrostis xerophila*	<0.5
		16	Mr5	*Heliptropium heteranthum*	<0.5
		16	Mr5	**Malvastrum americanum*	<0.5
		16	Mr5	*Ptilotus aervoides*	5
		16	Mr5	*Ptilotus exaltatus* var. *exaltatus*	<0.5
		16	Mr5	*Ptilotus gomphrenoides* var. *conglomeratus*	20
		16	Mr5	*Scleroleana costata*	<0.5
		16	Mr5	*Sesbania cannabina*	<0.5
		16	Mr5	*Sida rohlenae*	<0.5
		16	Mr5	*Solanum horridum*	<0.5
		16	Mr5	*Sporobolus australasicus*	5
		16	Mr5	*Triumfetta clementii*	<0.5

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Easting	Northing				
404609	7659765	17	Rf2	**Cenchrus ciliaris*	25
		17	Rf2	**Prosopis pallida*	50
		17	Rf2	**Aerva javanica*	1
		17	Rf2	*Corchorus laniflorus*	0.5
		17	Rf2	*Desmodium filiforme*	<0.5
		17	Rf2	*Eucalyptus victrix*	1
		17	Rf2	*Gomphrena canescens* subsp. *canescens*	<0.5
		17	Rf2	*Indigofera colutea*	<0.5
		17	Rf2	*Mukia maderaspatana*	<0.5
		17	Rf2	*Solanum horridum*	<0.5
		17	Rf2	*Triumfetta clementii*	<0.5
403068	7660439	18	Rf2	**Cenchrus ciliaris*	80
		18	Rf2	**Prosopis pallida*	60
		18	Rf2	*Gomphrena canescens* subsp. *canescens*	<0.5
		18	Rf2	*Indigofera colutea*	<0.5
		18	Rf2	*Polygala aff. Isingii*	<0.5
		18	Rf2	*Scleroleana costata*	<0.5
403473	7658783	19	Nh	**Cenchrus ciliaris*	<0.5
		19	Nh	*Acacia bivenosa*	<0.5
		19	Nh	*Aristida contorta*	<0.5
		19	Nh	*Aristida contorta*	<0.5
		19	Nh	*Autilon cryptopetalum*	2
		19	Nh	*Corchorus laniflorus*	1.5
		19	Nh	*Eriachne benthamii*	<0.5
		19	Nh	*Eriachne pulchella* subsp. *dominii*	<0.5
		19	Nh	*Euphorbia boophthona*	<0.5
		19	Nh	*Evolvulus alsinoides* var. *villosicalyx*	<0.5
		19	Nh	*Glycine ?tomentella*	<0.5
		19	Nh	*Glycine ?tomentella*	<0.5
		19	Nh	*Glycine ?tomentella*	<0.5
		19	Nh	*Gomphrena canescens* subsp. *canescens*	<0.5
		19	Nh	*Gomphrena canescens* subsp. *canescens*	<0.5
		19	Nh	*Gomprena cunninghamii*	<0.5
		19	Nh	*Goodenia forrestii*	<0.5
		19	Nh	*Haloragis gossei*	<0.5
		19	Nh	*Heliptropium heteranthum*	<0.5
		19	Nh	**Malvastrum americanum*	<0.5

APPENDIX B: VASCULAR FLORA QUADRAT DATA USED FOR PATN ANALYSIS

T denotes transects (not quadrats)

* Denotes introduced (weed) species

GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		19	Nh	*Ptilotus exaltatus var. exaltatus*	1
		19	Nh	*Scleroleana costata*	<0.5
		19	Nh	*Senna artemisioides* subsp. *oligophylla*	1
		19	Nh	*Sida rohlenae*	<0.5
		19	Nh	*Solanum horridum*	<0.5
		19	Nh	*Sporobolus australasicus*	<0.5
		19	Nh	*Themeda triandra*	<0.5
		19	Nh	*Tribulus hirstus*	<0.5
		19	Nh	*Triodia wiseana*	30
		19	Nh	*Triumfetta clementii*	<0.5
402623	7655852	20	Mr3	**Cenchrus ciliaris*	20
		20	Mr3	*Acacia coriacea* var. *coriacea*	3
		20	Mr3	*Acacia sclerosperma* subsp. *sclerosperma*	5
		20	Mr3	*Acacia victoriae*	3
		20	Mr3	*Acaia inaequilatera*	20
		20	Mr3	*Aristida contorta*	<0.5
		20	Mr3	*Boerhavia coccinea*	<0.5
		20	Mr3	*Brachyachne convergens*	20
		20	Mr3	*Chrysopogon fallax*	<0.5
		20	Mr3	*Corchorus laniflorus*	0.5
		20	Mr3	*Dichanthium fecundum*	1
		20	Mr3	*Dichanthium sericeum* subsp. *humilius*	1
		20	Mr3	*Eremophila longiflora*	<0.5
		20	Mr3	*Eremophila maculata*	<0.5
		20	Mr3	*Eriachne aff. helmsii*	<0.5
		20	Mr3	*Euphorbia coghlanii*	<0.5
		20	Mr3	*Gomphrena canescens* subsp. *canescens*	<0.5
		20	Mr3	*Gomphrena canescens* subsp. *canescens*	<0.5
		20	Mr3	*Indigofera linifolia*	<0.5
		20	Mr3	*Ipomoea muellerii*	0.5
		20	Mr3	*Ptilotus gomphrenoides* var. *conglomeratus*	10
		20	Mr3	*Rynochosia minima*	<0.5
		20	Mr3	*Sida rohlenae*	0.5
		20	Mr3	*Solanum horridum*	<0.5
		20	Mr3	*Sporobolus australasicus*	0.5
		20	Mr3	*Themeda triandra*	<0.5
		20	Mr3	*Triumfetta clementii*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
404883	7656160	21	Rf1	**Cenchrus ciliaris*	60
		21	Rf1	**Prosopis pallida*	1
		21	Rf1	*Acacia coriaceae* subsp. *pendens*	1
		21	Rf1	**Aerva javanica*	<0.5
		21	Rf1	*Eucalyptus victrix*	1
		21	Rf1	*Euphorbia schultzii*	<0.5
		21	Rf1	*Indigofera colutea*	<0.5
		21	Rf1	*Indigofera linifolia*	<0.5
		21	Rf1	*Mukia maderaspatana*	<0.5
		21	Rf1	*Triodia pungens*	2
409649	7649380	22	Rf1	**Cenchrus ciliaris*	20
		22	Rf1	*Acacia coriaceae* subsp. *pendens*	1
		22	Rf1	*Alternanthera nodiflora*	1
		22	Rf1	*Basilicum polystachyon*	0.5
		22	Rf1	*Corchorus laniflorus*	1
		22	Rf1	*Eualia aurea*	5
		22	Rf1	*Eucalyptus victrix*	20
		22	Rf1	*Goodenia lamprosperma*	0.5
		22	Rf1	**Malvastrum americanum*	0.5
		22	Rf1	*Mukia maderaspatana*	0.5
		22	Rf1	*Operculina aequisepala*	2
		22	Rf1	*Rostellularia adscendens* var. *clementii*	3
		22	Rf1	*Sesbania cannabina*	<0.5
		22	Rf1	*Sporobolus australasicus*	<0.5
407890	7653193	23	Px2	**Cenchrus ciliaris*	30
		23	Px2	**Prosopis pallida*	2
		23	Px2	*Acacia amplicepes*	1
		23	Px2	*Acacia amplicepes*	<0.5
		23	Px2	*Acacia coriacea* subsp. *pendens*	<0.5
		23	Px2	*Acacia coriacea* var. *coriacea*	5
		23	Px2	*Acacia xiphophylla*	<0.5
		23	Px2	*Acaia inaequilatera*	20

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		23	Px2	*Chrysopogon fallax*	2
		23	Px2	*Corchorus laniflorus*	1
		23	Px2	*Dichanthium fecundum*	<0.5
		23	Px2	*Dichanthium sericeum* subsp. *humilius*	10
		23	Px2	*Eragrostis xerophila*	30
		23	Px2	*Eremophila maculata*	<0.5
		23	Px2	*Gomprena cunninghamii*	1
		23	Px2	*Indigofera linifolia*	2
		23	Px2	*Ipomoea muellerii*	<0.5
		23	Px2	**Malvastrum americanum*	<0.5
		23	Px2	*Ptilotus gomphrenoides* var. *conglomeratus*	1.5
		23	Px2	*Rynochosia minima*	1
		23	Px2	*Rynochosia minima*	<0.5
		23	Px2	*Scleroleana costata*	1.5
		23	Px2	*Scleroleana costata*	<0.5
		23	Px2	*Sida rohlenae*	1
		23	Px2	*Solanum horridum*	<0.5
		23	Px2	*Tephrosia supina*	0.5
		23	Px2	*Themeda triandra*	<0.5
		23	Px2	*Triodia pungens*	0.5
		23	Px2	*Xerochloa imberbis*	1
407535	7655380	T24	Rf1	**Cenchrus ciliaris*	10
		T24	Rf1	*Acacia coriacea* subsp. *pendens*	0.5
		T24	Rf1	*Alternanthera nodiflora*	0.5
		T24	Rf1	*Ammannia multiflora*	1
		T24	Rf1	*Basilicum polystaehyon*	0.5
		T24	Rf1	*Blumea tenella*	<0.5
		T24	Rf1	*Centripeda minima*	1
		T24	Rf1	*Chrysopogon fallax*	20
		T24	Rf1	*Corchorus laniflorus*	1
		T24	Rf1	*Cyperus vaginatus*	1.5
		T24	Rf1	*Eragrostis xerophila*	30
		T24	Rf1	*Eriachne aff. helmsii*	5
		T24	Rf1	*Eriachne benthamii*	20
		T24	Rf1	*Eucalyptus camaldulensus*	20
		T24	Rf1	*Eucalyptus victrix*	20
		T24	Rf1	*Eulalia aurea*	0.5
		T24	Rf1	*Euphorbia australis*	<0.5
		T24	Rf1	**Malvastrum americanum*	2
		T24	Rf1	*Marselia drummondii*	0.5
		T24	Rf1	*Mimulus gracilis*	0.5
		T24	Rf1	*Rostellularia adscendens* subsp. *clementii*	0.5
		T24	Rf1	*Sesbania cannabina*	0.5
		T24	Rf1	*Sporobolus australasicus*	10

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
407936	7659997	25	Nh2	*Acacia bivenosa*	0.5
		25	Nh2	*Corchorus laniflorus*	2
		25	Nh2	*Eremophila maculata*	0.5
		25	Nh2	*Glycine ?tomentella*	0.5
		25	Nh2	**Malvastrum americanum*	1
		25	Nh2	*Nicotiana rosulata* subsp. *rostulata*	2
		25	Nh2	*Polycarpea holtzei*	0.5
		25	Nh2	*Pterocaulon sphaeranthoides*	0.5
		25	Nh2	*Ptilotus ?auriculifolius/macrocephalus*	10
		25	Nh2	*Ptilotus exaltatus* var. *exaltatus*	2
		25	Nh2	*Sclerolaena uniflora*	0.5
		25	Nh2	*Solanum horridum*	1
		25	Nh2	*Tephrosia supina*	1
		25	Nh2	*Trichodesma zeylanicum* var. *grandiflorum*	0.5
		25	Nh2	*Triodia wiseana*	50
		25	Nh2	*Triumfetta clementii*	2
404389	7652864	26	Rf1	**Cenchrus ciliaris*	60
		26	Rf1	**Prosopis pallida*	2
		26	Rf1	*Acacia ampliceps*	0.5
		26	Rf1	*Acacia ancistrocarpa*	2
		26	Rf1	*Brachyachne convergens*	10
		26	Rf1	*Chrysopogon fallax*	10
		26	Rf1	*Cullen lachnostachys*	2
		26	Rf1	*Dichanthium fecundum*	20
		26	Rf1	*Eragrostis xerophila*	5
		26	Rf1	*Eriachne aff. helmsii*	1
		26	Rf1	*Eucalyptus victrix*	20
		26	Rf1	*Eulalia aurea*	1
		26	Rf1	*Euphorbia coghlanii*	1
		26	Rf1	*Gomphrena canescens* subsp. *canescens*	1
		26	Rf1	*Indigofera linifolia*	<0.5
		26	Rf1	*Ipomoea muellerii*	1
		26	Rf1	**Malvastrum americanum*	<0.5
		26	Rf1	*Mukia maderaspatana*	<0.5
		26	Rf1	*Pterocaulon sphaeranthoides*	2
		26	Rf1	*Rynochosia minima*	<0.5
		26	Rf1	*Solanum horridum*	1
		26	Rf1	*Sporobolus australasicus*	2
		26	Rf1	*Swainsonia kingii*	<0.5
		26	Rf1	*Triodia pungens*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
404682	7654768	27	Mr3	**Cenchrus ciliaris*	5
		27	Mr3	*Acaia inaequilatera*	6
		27	Mr3	*Aristida contorta*	2
		27	Mr3	*Brachyachne convergens*	10
		27	Mr3	*Chrysopogon fallax*	<0.5
		27	Mr3	*Corchorus laniflorus*	<0.5
		27	Mr3	*Dichanthium fecundum*	3
		27	Mr3	*Dichanthium sericeum* subsp. *humilis*	3
		27	Mr3	*Eragrostis xerophila*	3
		27	Mr3	*Eremophila forrestii* subsp. *forrestii* (ms)	<0.5
		27	Mr3	*Eriachne aff. helmsii*	0.5
		27	Mr3	*Euphorbia australis*	0.5
		27	Mr3	*Gomprena cunninghamii*	0.5
		27	Mr3	*Indigofera linifolia*	5
		27	Mr3	*Ipomoea muellerii*	0.5
		27	Mr3	**Malvastrum americanum*	<0.5
		27	Mr3	*Polygala aff. Isingii*	<0.5
		27	Mr3	*Pterocaulon sphaeranthoides*	<0.5
		27	Mr3	*Ptilotus gomphrenoides* var. *conglomeratus*	10
		27	Mr3	*Solanum horridum*	1
		27	Mr3	*Tephrosia supina*	<0.5
		27	Mr3	*Themeda triandra*	0.5
		27	Mr3	*Triodia pungens*	1
		27	Mr3	*Triodia wiseana*	0.5
		27	Mr3	*Triraphia mollis*	1
403819	7655233	28	Mr6	**Cenchrus ciliaris*	20
		28	Mr6	**Prosopis pallida*	2
		28	Mr6	*Acacia marramba*	20
		28	Mr6	*Acacia victoriae*	<0.5
		28	Mr6	*Acacia victoriae*	15
		28	Mr6	*Alectryon oleifolium*	2
		28	Mr6	*Aristida contorta*	1
		28	Mr6	*Brachyachne convergens*	10
		28	Mr6	*Chrysopogon fallax*	5
		28	Mr6	*Dichanthium sericeum* subsp. *humilius*	1
		28	Mr6	*Eragrostis xerophila*	20
		28	Mr6	*Eriachne aff. helmsii*	<0.5
		28	Mr6	*Evolvulus alsinoides* var. *villosicalyx*	0.5
		28	Mr6	*Gomphrena canescens* subsp. *canescens*	0.5
		28	Mr6	*Indigofera colutea*	<0.5
		28	Mr6	*Indigofera linifolia*	1
		28	Mr6	*Ptilotus gomphrenoides* var. *conglomeratus*	<0.5
		28	Mr6	*Rynochosia minima*	<0.5
		28	Mr6	*Sida rohlenae*	<0.5

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
		28	Mr6	*Themeda triandra*	<0.5
402275	7654927	29	Mr3	**Cenchrus ciliaris*	20
		29	Mr3	*Acacia ampliceps*	<0.5
		29	Mr3	*Acacia ancistrocarpa*	2
		29	Mr3	*Acacia coriacea* subsp. *pendens*	2
		29	Mr3	*Acacia coriacea* var. *coriacea*	5
		29	Mr3	*Acaia inaequilatera*	10
		29	Mr3	*Aristida contorta*	10
		29	Mr3	*Autilon cryptopetalum*	0.5
		29	Mr3	*Brachyachne convergens*	2
		29	Mr3	*Chrysopogon fallax*	1
		29	Mr3	*Corchorus laniflorus*	<0.5
		29	Mr3	*Dactyloctenium radulans*	<0.5
		29	Mr3	*Dichanthium sericeum* subsp. *humilius*	1
		29	Mr3	*Eragrostis xerophila*	2
		29	Mr3	*Eriachne aff. helmsii*	0.5
		29	Mr3	*Eriachne benthamii*	2
		29	Mr3	*Eriachne pulchella* subsp. *dominii*	<0.5
		29	Mr3	*Evolvulus alsinoides* var. *villosicalyx*	<0.5
		29	Mr3	*Glycine ?tomentella*	<0.5
		29	Mr3	*Gomphrena canescens* subsp. *canescens*	<0.5
		29	Mr3	*Indigofera colutea*	0.5
		29	Mr3	*Indigofera linifolia*	1
		29	Mr3	*Ipomoea muellerii*	0.5
		29	Mr3	**Malvastrum americanum*	<0.5
		29	Mr3	*Polygala aff. Isingii*	<0.5
		29	Mr3	*Sida rohlenae*	1
		29	Mr3	*Solanum horridum*	1
		29	Mr3	*Themeda triandra*	<0.5
		29	Mr3	*Triodia pungens*	2
		29	Mr3	*Triraphia mollis*	10
		29	Mr3	*Triumfetta clementii*	1
409448	7658456	30	Hp	*Dichanthium fecundum*	20
		30	Hp	*Eragrostis xerophila*	40
		30	Hp	*Goodenia forrestii*	0.5
		30	Hp	*Indigofera trita*	<0.5
		30	Hp	*Rynochosia minima*	0.5
		30	Hp	*Scleroleana costata*	10
		30	Hp	*Sida rohlenae*	<0.5
		30	Hp	*Streptoglossa liatroides*	5
		30	Hp	*Xerochloa imberbis*	30

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GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
409214	7658963	31	Px2	**Prosopis pallida*	<0.5
		31	Px2	*Acacia xiphophylla*	20
		31	Px2	*Dichanthium fecundum*	60
		31	Px2	*Enneapogon caerulescens*	3
		31	Px2	*Eragrostis xerophila*	40
		31	Px2	*Gomprena cunninghamii*	1
		31	Px2	*Indigofera colutea*	<0.5
		31	Px2	*Indigofera trita*	<0.5
		31	Px2	**Malvastrum americanum*	0.5
		31	Px2	*Ptilotus exaltatus* var. *exaltatus*	0.5
		31	Px2	*Rynochosia minima*	0.5
		31	Px2	*Scleroleana bicornis*	1
		31	Px2	*Sida rohlenae*	0.5
		31	Px2	*Sporobolus australasicus*	2
		31	Px2	*Streptoglossa liatroides*	1.5
		31	Px2	*Xerochloa imberbis*	1
410282	7661433	32	Nh2	*Acacia bivenosa*	5
		32	Nh2	*Aristida contorta*	1
		32	Nh2	*Autilon cryptopetalum*	0.5
		32	Nh2	*Chrysopogon fallax*	<0.5
		32	Nh2	*Corchorus laniflorus*	1
		32	Nh2	*Enneapogon caerulescens*	<0.5
		32	Nh2	*Eriachne pulchella* subsp. *dominii*	1
		32	Nh2	*Glycine ?tomentella*	2
		32	Nh2	*Pterocaulon sphaeranthoides*	<0.5
		32	Nh2	*Ptilotus ?auriculifolius/macrocephalus*	15
		32	Nh2	*Senna glutinosa ssp pruinosa*	0.5
		32	Nh2	*Solanum lasiophyllum*	1
		32	Nh2	*Tephrosia clementii*	<0.5
		32	Nh2	*Themeda triandra*	0.5
		32	Nh2	*Triodia wiseana*	30
		32	Nh2	*Triumfetta clementii*	0.5
411517	7662145	33	Px1	**Cenchrus ciliaris*	15
		33	Px1	*Acacia xiphophylla*	15
		33	Px1	*Aristida contorta*	0.5
		33	Px1	*Peplidium a* ff. sp. E Evol. Fl. Fauna Arid Australia	0.5
		33	Px1	*Pterocaulon sphaeranthoides*	<0.5
		33	Px1	*Ptilotus exaltatus* var. *exaltatus*	1
		33	Px1	*Scleroleana costata*	25
		33	Px1	*Sida rohlenae*	0.5
		33	Px1	*Sporobolus australasicus*	1
		33	Px1	*Triodia wiseana*	10
		33	Px1	*Xerochloa imberbis*	<0.5

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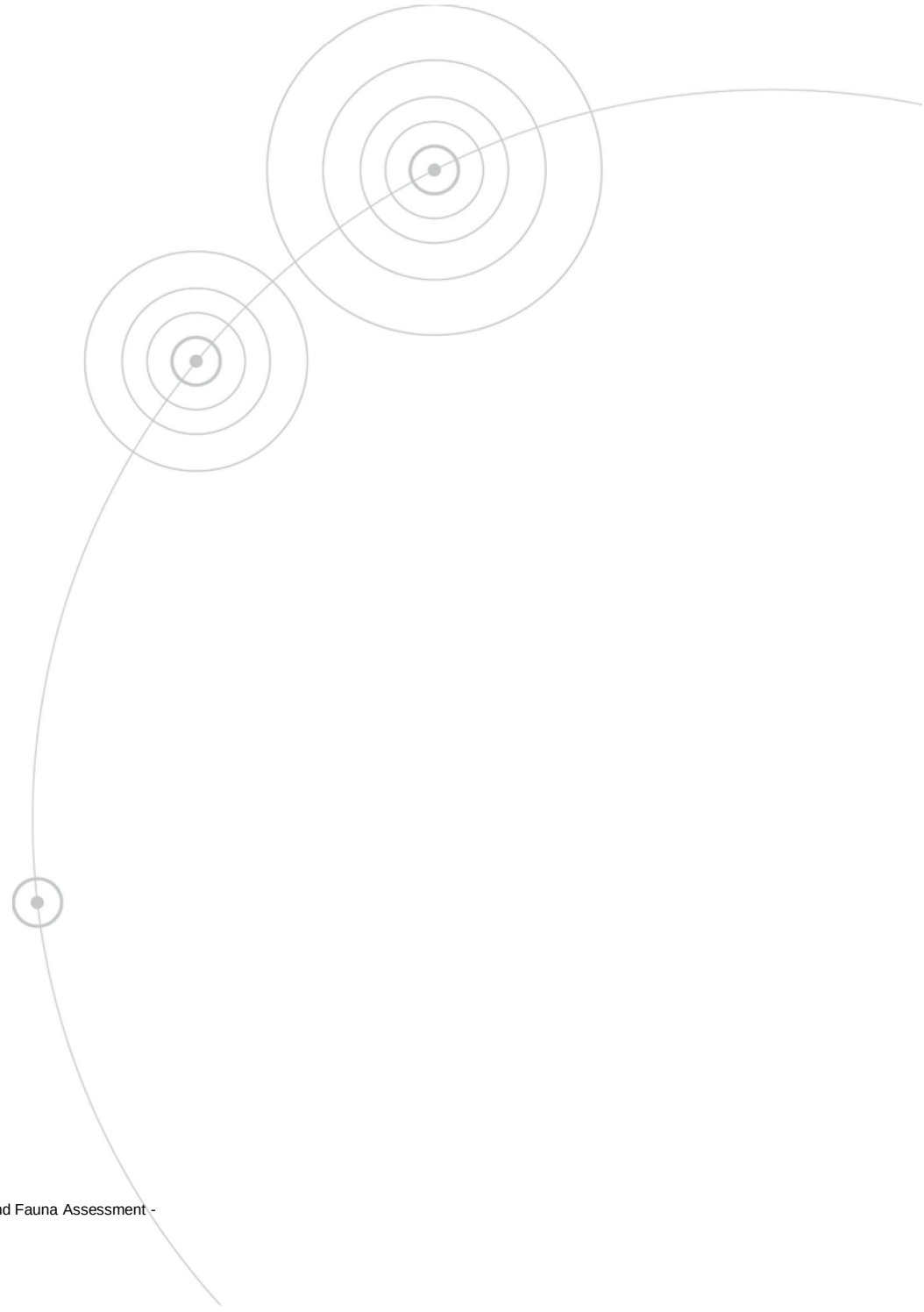
GPS		Quadrat No.	Vegetation	*Species*	%Cover A
Easting	Northing				
413577	7659444	34	Roh1b	*Acacia ancistrocarpa*	<0.5
		34	Roh1b	*Corchorus laniflorus*	10
		34	Roh1b	*Eremophila maculata*	0.5
		34	Roh1b	*Eriachne pulchella* subsp. *dominii*	2
		34	Roh1b	*Euphorbia australis*	<0.5
		34	Roh1b	*Evolvulus alsinoides* var. *villosicalyx*	<0.5
		34	Roh1b	*Glycine ?tomentella*	1
		34	Roh1b	*Gomprena cunninghamii*	<0.5
		34	Roh1b	**Malvastrum americanum*	1
		34	Roh1b	*Polycarpea holtzei*	0.5
		34	Roh1b	*Ptilotus obovatus*	0.5
		34	Roh1b	*Senna glutinosa ssp pruinosa*	2
		34	Roh1b	*Solanum lasiophyllum*	0.5
		34	Roh1b	*Themeda triandra*	0.5
		34	Roh1b	*Trichodesma zeylanicum* var. *grandiflorum*	<0.5
		34	Roh1b	*Triodia wiseana*	30
		34	Roh1b	*Triumfetta clementii*	1

Appendix C: Review of Survey Effort at Cape Preston



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Review of Flora Survey Effort – Mineralogy Central Block Project

Context and Background

In reviewing the previous flora studies in the Mineralogy Central Block Project (the Project) area, it is evident that extensive studies have been undertaken by a range of specialists in the flora and vegetation. As indicated in the reports to date, the area contains a range of flora species and plant communities that may be locally or regionally significant. Whilst several key flora and vegetation values were recognized, an issue was raised during the Project environmental impact assessment process on the *Goodenia* species that occur on the cracking clay environments within the infrastructure corridor for the Project.

In response to this issue, the Project Proponent, Mineralogy Pty Ltd, committed to further survey work in the Project area, with this commitment being incorporated into the Project Audit Table in Element 635:P3.

Element 635:P3 states that the Proponent is required to undertake a flora survey – in particular in the cracking clay environment - and if any specimens of the Priority (P1) *Goodenia pallida* are identified, a management strategy will be developed with DEC.

Mineralogy made a submission on 21 June 2007 to the Department of Environment and Conservation (DEC) on flora surveys conducted to date on the infrastructure corridor in accordance with Element 635:P3. The DEC responded on 20 August 2007, recommending that Mineralogy undertake further flora surveys, during appropriate seasons and after suitable rainfall events, prior to construction of the infrastructure corridor.

The following advice is provide in response to the DEC comments on Mineralogy's original submission, and to put forward the case that Mineralogy has complied with the requirements of Element 635:P3.

Survey Effort for Project

The survey effort and the timing of flora surveys carried out in the Project area has been extensive and comprehensive. In any survey it is never feasible to cover every species in every community or land system. At best, botanists and ecologists have to work within the environments and try and define the values within the constraints of the survey effort and the seasons. The flora work conducted for the Project exceeds many others with similar impacts.

In terms of personnel, the survey work has been carried out by some of the major botanists and ecologists working in the Pilbara Region; these include Mr Malcolm Trudgen, Ms Michi Maier, Ms Vicki Long and experienced botanists from the Mattiske Consulting Pty Ltd team. These specialists are very experienced people with many decades of experience in the Pilbara flora.

Goodenia Taxon in Project Area

As stated above, the key objective of Element 635:P3 is the identification and management of any *Goodenia pallida* specimens found along the route of the Project's infrastructure corridor. However, based on a review of the survey work conducted to date in the Project area, it is apparent that there is considerable confusion on the different Goodenia specimens identified in the Project area. The following aims to clarify this matter.

The earlier work by Halpern Glick and Maunsell (HGM), undertaken with Michi Maier of Biota and Malcolm Trudgen of M.E. Trudgen and Associates (HGM, 2001), highlighted *Goodenia omearana* (ms) P1 as a small herb collected only once within the survey area, from tussock grassland on clay soils at Flora Sample Site M27 in the Paraburdoo cracking clays [M27 will be avoided by the Project infrastructure corridor]. Trudgen and Biota highlighted the preference of *Goodenia omearana* (Family: Goodeniaceae) for "tussock grasslands on clay soils of the Paraburdoo land system". At the time, HGM (2001) noted that this taxon was more typical of calcareous soils and was known from relatively few populations in the Weeli Wolli Springs - Marillana Creek area in the eastern Pilbara. In reviewing the MAX database (DEC, 2007a) it appears that this taxon is synonymous with *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (P1) known from 7 records in the eastern section of the Pilbara Bioregion.

The additional flora survey work detailed in HGM (2003) highlighted the *Goodenia omearana* (ms) (P1) as having been recorded in the HGM (2001) survey. In addition, HGM (2003) made reference to findings from CALM's databases, which included *Goodenia pallida*. It was noted in HGM (2003) that neither *Goodenia omearana* (ms) nor *Goodenia pallida* were recorded in the June and July 2003 flora survey. This result is considered significant, as during HGM's 2003 survey, particular attention was paid to the potential threatened species on a range of environments including the cracking clays, which was known to support *Goodenia pallida*. HGM (2003) noted that other annual/ephemeral species have been recorded on some habitats (including the cracking clay communities). *Goodenia forrestii* (P3) was recorded (HGM, 2003).

Additional work undertaken in 2006 by HGM on the Balmoral South project area (HGM, 2006) highlighted the presence of *Goodenia forrestii* and *Goodenia pascua* (P3) on the Hp - Horseflat systems (HGM, 2006). *Goodenia pascua* was identified only once from the Hp community (HGM, 2006).

Flora surveys by Mattiske Consulting Pty Ltd in 2007 on potential campsites and airstrip options for the Project did not identify any new collections of *Goodenia* Priority species (Mattiske Consulting, 2007).

The more recent report by Astron (2007) concentrated on mapping a gap in the vegetation in Project leases G08/52 and G08/53. This survey work did not highlight any Priority Goodenia species.

Potential Cracking Clay Areas

The cracking clays were observed in a range of communities, although the main concentration occurred in the Horseflats (Hp, Hp1) and Paraburdoo (Px1 and Px2) communities as defined by HGM (2002). On the basis of calculations done for the Project's proposed disturbance areas, 17.1 % of the Horseflats, 14.8 % of Px1 and 11.0 % of Px2 may be disturbed under the Project. Therefore, the risk of disturbing large areas of the cracking clay communities is relatively low. Consequently, large portions of the cracking clay areas will not be impacted on by the Project.

Summary

There has been a range of *Goodenia* species recorded in the area covered by the Project's proposed infrastructure corridor. Several of the *Goodenia* species within the region are recognized as Priority species (DEC, 2007b).

Several questions arise in relation to these species. Firstly, the MAX database (DEC, 2007a) states that *Goodenia omearana* (ms) is synonymous with *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (P1), which is known from 7 records in the eastern section of the Pilbara Bioregion. However, subsequent to HGM (2001), reference to *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) was less evident and a greater emphasis was placed on *Goodenia pallida* and *Goodenia pascua*.

The issue then arises as to why the Audit Table in Element 635:P3 concentrated on the *Goodenia pallida* taxon. In reviewing the location of the proposed infrastructure corridor, only a relatively low proportion (i.e. 11 – 17 %) of the Horseflats and Paraburdoo units that occur on cracking clays will be impacted on by the Project. Therefore, there appears to be minimal risk associated with the proposed vegetation clearing in these cracking clay communities.

Further, one could then ask the question of why were the other Priority species (mentioned in the assessment process) not included in the Audit Table, despite some of these Priority species also being annuals or ephemerals. Part of the reason appears to relate to the level of knowledge on these species and their regional distribution. In this context, *Goodenia pallida* is only known from two collections in the State Herbarium from areas on the coastal region near Karratha.

Conclusion and Recommendation

In summary, whilst it appears that *Goodenia* species prefer the cracking clay environments, the concept of a potential occurrence (rather than a recorded occurrence) influencing the Project at this stage appears unwarranted. This comment is particularly relevant as the initial *Goodenia* species recorded at Site M27 in the Paraburdoo cracking clays was recorded as *Goodenia omerana* (ms), which is now synonymous with *Goodenia* sp. East Pilbara (A.A. Mitchell PRP727).

As *Goodenia pallida* has not been recorded in the Project area, the infrequent and unreliable rainfall events and the low risk of disturbing most of the Horseflat and Paraburdoo mapping units that occur on cracking clays i.e. the habitat that the *Goodenia* is most likely to occur on, it is considered that Mineralogy has adequately satisfied the survey requirements of Audit Table Element 635:P3, and, as no *Goodenia pallida* specimens were identified in the Project area, Mineralogy should not be required to prepare a management strategy on this species.

References

Astron (2007). General Purpose Leases G08/52 and G08/53, Additional Vegetation Survey and Mapping. Prepared for CP Mining Management, June 2007.

DEC (2007a). MAX Database. Department of Environment and Conservation, 2007 Perth.

DEC (2007b). Western Australian Flora Conservation Codes and Threatened Flora Listing. http://florabase.calm.wa.gov.au/help/conscodes.

HGM (2001). Austeel Biological Survey Phase I. Prepared for Austeel Pty Ltd, February 2001.

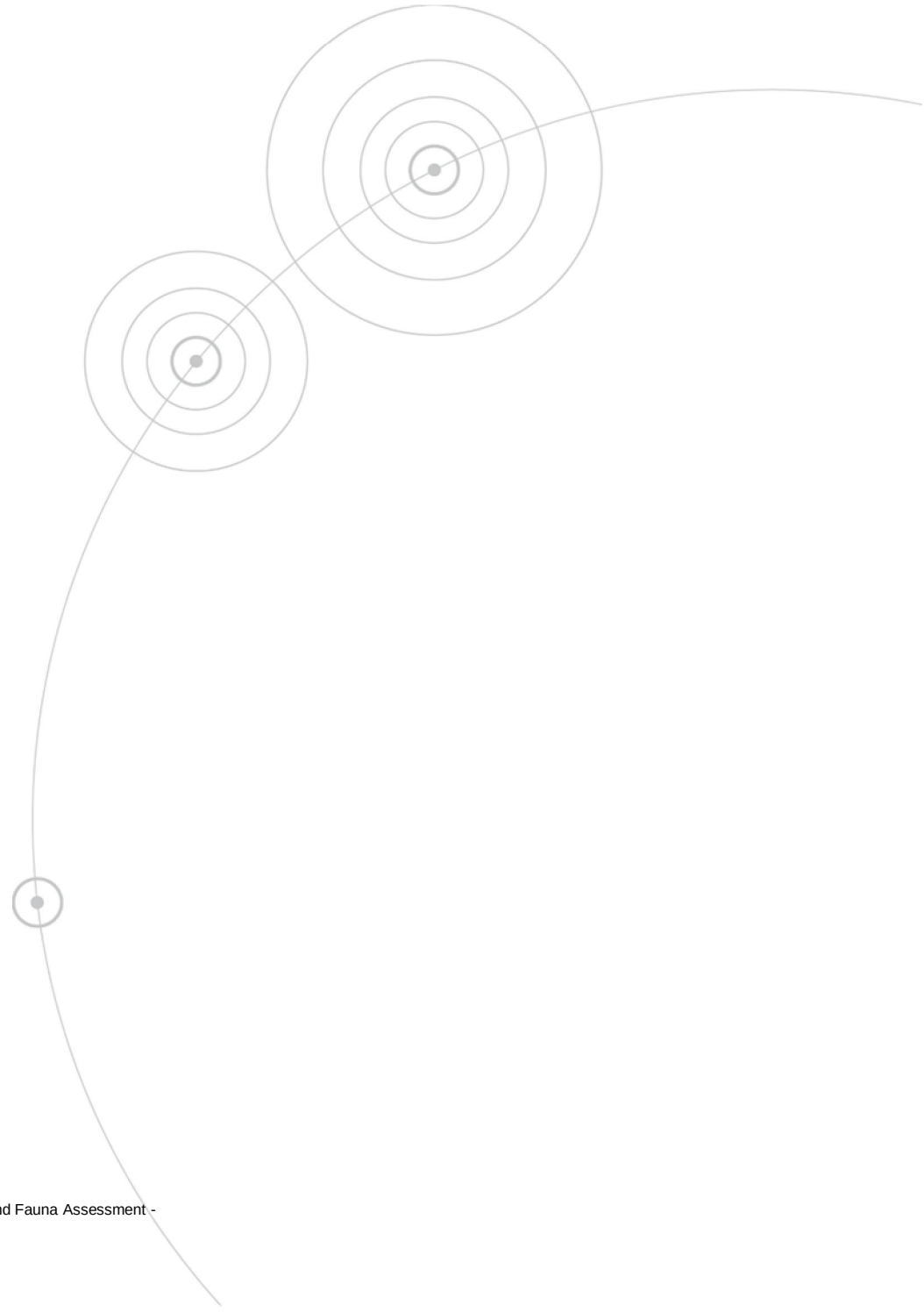
HGM (2003). Cape Preston Iron Ore Development, Seasonal Biological Survey – Threatened Flora. Prepared for Austeel Pty Ltd, November 2003.

HGM (2006). Balmoral South Environmental Impact Assessment, Flora and Fauna Survey. Prepared for International Minerals, November 2006.

Mattiske Consulting (2007). Flora and Vegetation Survey of Cape Preston Potential Campsites and Airstrips. Prepared for CP Mining Management Pty Ltd, April 2007.

Dr E M Mattiske
19 December 2007

Appendix D: Summary of Vascular Flora Species Recorded within the Cape Preston Iron Ore Project Area – 2000 to 2007



APPENDIX D: SUMMARY OF VASCULAR PLANT SPECIES RECORDED WITHIN THE CAPE PRESTON IRON ORE PROJECT AREA BETWEEN 2000 AND 2007.

Note: * denotes introduced species

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
7	ADINATACEAE		*Cheilanthes sieberi* subsp. *sieberi*	1		
13	MARSILEACEAE		*Marsilea drummondii*	1		
			Marsilea hirsuta	1		
20	TYPHACEAE		*Typha domingensis*		1	
29	HYDROCHARITACEAE		*Vallisneria* sp.			1
31	POACEAE	*	*Cenchrus ciliaris*	1	1	
		*	*Cenchrus setigerus*	1		
		*	*Cenchrus* sp.	1		
		*	*Setaria verticillata*	1		
			Aristida ?holathera	1		
			Aristida contorta	1		
			Aristida holathera	1		
			Aristida inaequiglumis	1	1	
			Aristida latifolia	1		
			Aristida sp.	1		
			Bothriochloa ewartiana	1	1	1
			Brachyachne convergens	1	1	1
			Brachyachne prostrata	1		
			Chloris pectinata	1		
			Chrysopogon fallax	1	1	
			Cymbopogon ambiguus	1	1	
			Cymbopogon bombycinus	1		
			Cymbopogon obtectus	1		
			Cymbopogon procerus	1		
			Dactyloctenium radulans	1		
			Dichanthium fecundum	1		
			Dichanthium sericeum subsp. *humilius*	1		
			Dichanthium sericeum subsp. *sericeum*	1		
			Digitaria brownii	1	1	
			Digitaria ctenantha	1	1	
			Enneapogon avenaceus	1	1	
			Enneapogon caerulescens	1		
			Enneapogon caerulescens var. *occidentalis*	1	1	
			Enneapogon oblongus	1	1	1
			Enteropogon acicularis	1	1	1
			Eragrostis cumingii	1	1	
			Eragrostis dielsii	1		
			Eragrostis eriopoda	1		
			Eragrostis falcata	1		
			Eragrostis setifolia	1	1	1
			Eragrostis tenellula	1	1	
			Eragrostis xerophila	1	1	
			Eriachne aff. *helmsii*	1		
			Eriachne aff. *mucronata*	1		
			Eriachne aristidea	1		
			Eriachne benthamii	1		
			Eriachne mucronata	1		
			Eriachne ovata	1		
			Eriachne pulchella	1		
			Eriachne pulchella subsp. *dominii (*Hartley) Lazarides	1		
			Eriachne tenuiculmis	1	1	
			Eulalia aurea	1	1	1
			Iseilema dolichotrichum	1	1	
			Iseilema eremaeum	1		
			Iseilema membranaceum	1		
			Panicum decompositum	1		
			Paraneurachne muelleri	1	1	
			Paspalidium ?tabulatum	1		1
			Paspalidium clementii	1		

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
31	POACEAE (cont.)		*Paspalidium tabulatum*	1		
			Perotis rara	1		
			Schizachyrium fragile	1	1	
			Setaria surgens	1		
			Sorghum plumosum	1		
			Spinifex longifolius			1
			Sporobolus australasicus		1	1
			Sporobolus virginicus		1	1
			Themeda triandra		1	
			Tragus australianus			1
			Triodia aff. *epactia*		1	1
			Triodia angusta			1
			Triodia epactia		1	
			Triodia pungens			1
			Triodia wiseana		1	
			Tripogon loliiformis		1	
			Triraphis mollis			1
			Urochloa gilesii subsp. *occidentalis*		1	
			Urochloa holosericea subsp. *velutina*			1
			Urochloa sp. "glabrous apices"		1	1
			Whiteochloa airoides			1
			Xerochloa imberbis		1	
			Yakirra australiensis		1	
32	CYPERACEAE		*Bulbostylis barbata*	1		
			Cyperus bifax	1		
			Cyperus blakeanus	1	1	
			Cyperus bulbosus	1		
			Cyperus iria	1		
			Cyperus squarrosus	1		
			Cyperus vaginatus	1		
			Fimbristylis depauperata	1		
			Fimbristylis dichotoma	1		
			Fimbristylis microcarya	1	1	
			Schoenoplectus laevis	1		
			Schoenoplectus litoralis	1		
87	MORACEAE		*Ficus aculeata*	1		
			Ficus brachypoda	1		
			Ficus opposita var. *aculeata*	1		
			Ficus opposita var. *indecora*	1		
			Ficus platypoda var. *minor*	1		
90	PROTEACEAE		*Grevillea pyramidalis*	1		
			Hakea lorea	1		
			Hakea lorea subsp. suberea	1	1	1
92	SANTALACEAE		*Santalum lanceolatum*	1		
105	CHENOPODIACEAE	*	*Salsola tragus*	1		
		*	*Salsola tragus* subsp. *tragus*	1		
			Atriplex bunburyana	1	1	
			Atriplex codonocarpa	1		
			Atriplex isatidea	1	1	1
			Atriplex semilunaris	1		
			Chenopodium melanocarpum forma *leucocarpum*	1		
			Dissocarpus paradoxus	1	1	1
			Dysphania plantaginella	1		
			Dysphania rhadinostachya	1	1	
			Enchylaena tomentosa	1		
			Halosarcia halocnemoides subsp. *tenuis*	1		1
			Halosarcia indica subsp. *leiostachya*	1		
			Halosarcia pruinosa	1		
			Halosarcia pterygosperma subsp. *denticulata*	1		
			Maireana georgei	1		
			Maireana melanocoma	1		
			Maireana planifolia	1		
			Maireana tomentosa	1		
			Neobassia astrocarpa	1		
			Rhagodia eremaea	1		

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
105	CHENOPODIACEAE (cont.)		*Rhagodia preissii* subsp. *obovata*	1		
			Rhynchosia cf. minima	1		
			Rhynchosia minima	1	1	1
			Sclerolaena cornishiana	1	1	
			Sclerolaena costata	1		
			Sclerolaena eriacantha	1		
			Sclerolaena glabra	1		
			Sclerolaena hostilis	1	1	
			Sclerolaena uniflora	1		
			Scleroleana bicornis	1		
			Scleroleana costata	1		
			Threlkeldia diffusa		1	
106	AMARANTHACEAE	*	*Aerva javanica*	1	1	
			Achyranthes aspera	1		
			Alternanthera angustifolia	1		1
			Alternanthera nana	1	1	
			Alternanthera nodiflora	1		
			Amaranthus mitchellii	1		
			Amaranthus pallidiflorus	1	1	1
			Gomphrena canescens	1		
			Gomphrena canescens subsp. *canescens*	1		
			Gomphrena cunninghamii	1		
			Gomphrena sordida	1		
			Hemichroa diandra	1	1	1
			Ptilotus ?auriculifolius/macrocephalus	1		1
			Ptilotus aervoides	1		
			Ptilotus astrolasius	1		
			Ptilotus auriculifolius	1	1	1
			Ptilotus axillaris	1		
			Ptilotus calostachyus	1		
			Ptilotus carinatus	1		
			Ptilotus clementii	1		
			Ptilotus exaltatus	1		
			Ptilotus exaltatus var. *exaltatus*	1		
			Ptilotus fusiformis var. *fusiformis*	1		
			Ptilotus gomphrenoides var. *conglomeratus*	1		
			Ptilotus gomprenoides var. *gomphrenoides*	1		
			Ptilotus helipteroides	1		
			Ptilotus helipteroides var. *helipteroides*	1		
			Ptilotus murrayi var. *murrayi*	1		
			Ptilotus obovatus	1		
			Ptilotus polystachyus	1		
			Ptilotus roei	1		1
			Ptilotus villosiflorus	1	1	
107	NYCTAGINACEAE		*Boerhavia burbidgeana*	1		
			Boerhavia coccinea	1		1
			Boerhavia gardneri	1		
			Boerhavia paludosa	1		
			Boerhavia repleta	1	1	
			Boerhavia type 1	1		1
			Boerhavia type 2	1		
			Commicarpus australis	1		1
108	GYROSTEMONACEAE		*Codonocarpus cotinifolius*	1	1	
110	AIZOACEAE		*Trianthema* aff. *kimberleyi* (MET 15 060)		1	
			Trianthema triquetra		1	
			Trianthema turgidifolia			1
			Zaleya galericulata			1
110A	MOLLUGINACEAE		*Glinus lotoides*	1		
			Mollugo molluginis	1		
111	PORTULACACEAE		*Portulaca oleracea*	1		
			Portulaca pilosa	1		
113	CARYOPHYLLACEAE		*Cassytha capillaris*	1	1	1
			Polycarpaea corymbosa var. *corymbosa*	1		
			Polycarpaea holtzei	1		
			Polycarpaea longiflora (pale form)	1	1	
122	MENISPERMACEAE		*Tinospora smilacina*		1	
135	PAPAVERACEAE	*	*Argemone ochroleuca*	1		

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
137A	CAPPARACEAE		*Capparis spinosa var. nummularia*	1		
			Capparis umbonata	1		
			Cleome oxalidea	1	1	
			Cleome viscosa	1		
160	SURIANACEAE		*Stylobasium spathulatum*			1
163	MIMOSACEAE	*	*Prosopis pallida* (Declared Plant - Noxious Weed)	1		
		*	*Vachellia farnesiana*			1
			Acacia ampliceps	1	1	
			Acacia ancistrocarpa	1	1	
			Acacia arida	1		
			Acacia bivenosa	1	1	1
			Acacia coriacea	1	1	
			Acacia coriacea subsp. *coriacea*	1	1	
			Acacia coriacea subsp. *pendens*	1		
			Acacia elachantha (golden hairy variant)	1		
			Acacia farnesiana	1	1	1
			Acacia inaequilatera	1	1	
			Acacia marramamba	1	1	
			Acacia monticola	1		1
			Acacia pyrifolia	1		
			Acacia sclerosperma	1		
			Acacia sclerosperma subsp. *sclerosperma*	1		1
			Acacia synchronicia	1		1
			Acacia tenuissima	1	1	
			Acacia trachycarpa	1	1	1
			Acacia tumida	1	1	
			Acacia victoriae	1		
			Acacia xiphophylla	1		
			Neptunia aff. *dimorphantha* (M27)	1	1	1
			Neptunia dimorphantha	1	1	
164	CAESALPINIACEAE		*Petalostylis labicheoides*	1		
			Senna ?notabilis	1		
			Senna artemisioides subsp. *oligophylla*	1		
			Senna artemisioides subsp. *oligophylla* (sericea form)	1		
			Senna artemisioides subsp. *oligophylla* (thinly sericeous)	1	1	
			Senna artemisioides subsp. *oligophylla x helmsii*	1		
			Senna glaucifolia	1		1
			Senna glutinosa subsp. *chatelainiana*	1	1	
			Senna glutinosa subsp. *glutinosa*	1	1	1
			Senna glutinosa subsp. *glutinosa x ?pruinosa*	1		
			Senna glutinosa subsp. *glutinosa x luerssenii*	1		1
			Senna glutinosa subsp. *pruinosa*	1		
			Senna glutinosa subsp. *pruinosa x ?glutinosa*	1		
			Senna glutinosa subsp. *x luerssenii*	1		
			Senna hamersleyensis	1		
			Senna notabilis	1		1
			Senna sp.	1	1	
			Senna sp.Karajini(M.E.Trudgen 10392)	1		
			Senna venusta	1		
165	PAPILIONACEAE		*Alysicarpus rugosus*	1		
			Canavalia rosea	1		
			Crotalaria cunninghamii	1		
			Crotalaria dissitiflora subsp. benthamiana	1	1	
			Crotalaria medicaginea	1		
			Crotalaria novae - hollandiae subsp. crassipes	1		
			Crotalaria novae-hollandiae	1		
			Crotalaria ramosissima	1		
			Cullen graveolens	1	1	
			Cullen lachnostachys	1	1	

Family No.	Family	*Species*	HGM (2000)	Maunsell (2006)	Mattiske (2007)
165	PAPILIONACEAE (cont.)	*Cullen leucanthum*	1	1	
		Cullen pogonocarpum	1		
		Desmodium filiforme	1		
		Desmodium muelleri	1		
		Erythrina vespertilio	1		
		Glycine ?tomentella	1		
		Glycine canescens	1		
		Indigastrum parviflorum	1		
		Indigofera colutea	1		
		Indigofera linifolia	1		
		Indigofera monophylla	1		
		Indigofera sessiliflora	1		1
		Indigofera trita	1		
		Isotropis atropurpurea	1		
		Keraudrenia nephrosperma	1	1	
		Lotus australis	1	1	1
		Sesbania cannabina	1	1	
		Swainsona canescens			1
		Swainsona colutoides		1	
		Swainsona formosa		1	
		Swainsona kingii		1	
		Swainsona leeana		1	1
		Templetonia aff. *hookeri*		1	1
		Tephrosia aff. *clementii* (1) (M1/M2)			1
		Tephrosia aff. *clementii* type 2 (M35.14)		1	
		Tephrosia aff. *densa*		1	
		Tephrosia aff. *supina* (ME Trudgen 12,357)		1	
		Tephrosia clementii			1
		Tephrosia rosea		1	
		Tephrosia rosea var. *clementii*		1	
		Tephrosia supina		1	
		Tephrosia uniovulata			1
		Vigna lanceolata var. *lanceolata*		1	1
		Zornia muelleriana			1
167	GERANIACEAE	*Erodium* sp.	1		
173	ZYGOPHYLLACEAE	*Tribulus astrocarpus*			1
		Tribulus hirsutus			1
		Tribulus occidentalis			1
		Tribulus platypterus			1
		Tribulus suberosus		1	
183	POLYGALACEAE	*Polygala* aff. *isingii*	1	1	1
		Polygala sp.	1		
185	EUPHORBIACEAE	*Adriana tomentosa*	1	1	
		Adriana urticoides var. *hookeri*	1	1	
		Euphorbia aff. *australis* type 1 (erect stems)	1		
		Euphorbia aff. *australis* type 2 (prostrate)	1	1	
		Euphorbia aff. *drummondii* (MET 15211)	1	1	1
		Euphorbia australis	1	1	
		Euphorbia boophthona	1		
		Euphorbia coghlanii	1		
		Euphorbia schultzii	1	1	1
		Euphorbia tannensis subsp. *eremophila*	1		1
		Flueggea virosa subsp. *melanthesoides*	1		
		Leptopus decaisnei	1		
		Leptopus decaisnei var. *decaisnei*	1		
		Phyllanthus aridus (P3)	1		1
		Phyllanthus lacunellus	1		
		Phyllanthus maderaspatensis var. *angustifolius*	1		
202	STACKHOUSIACEAE	*Stackhousia intermedia*		1	1
207	SAPINDACEAE	*Alectryon oleifolius*	1		
		Dodonaea coriaceae	1	1	
215	RHAMNACEAE	*Ventilago viminalis*		1	1
220	TILIACEAE	*Corchorus carnarvonensis*	1		
		Corchorus laniflorus	1		
		Corchorus lasiocarpus	1		
		Corchorus parviflorus	1		

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
220	TILIACEAE (cont.)		*Corchorus tridens*	1		
			Corchorus walcottii	1		1
			Triumfetta appendiculata		1	1
			Triumfetta chaetocarpa		1	
			Triumfetta clementii			1
			Triumfetta maconochieana		1	
221	MALVACEAE	*	*Hibiscus austrinus*	1	1	
		*	*Malvastrum americanum*	1		
			Abutilon ?lepidioicum	1		
			Abutilon aff. *lepidum* (1) (MET 15 352)	1		
			Abutilon aff. *lepidum* (2) (MET 15 970)	1		
			Abutilon aff. *lepidum* (3) (MET 16 120)	1		
			Abutilon amplum	1		
			Abutilon cryptopetalum	1	1	
			Abutilon cunninghamii	1		
			Abutilon fraseri	1		
			Abutilon lepidum	1	1	1
			Abutilon macrum	1		
			Abutilon malvifolium	1		
			Abutilon otocarpum	1		1
			Abutilon oxycarpum subsp. *prostratum*	1		1
			Abutilon trudgenii	1		
			Gossypium australe	1		
			Gossypium robinsonii	1	1	1
			Hibiscus aff. *coatesii* (site 664)	1		
			Hibiscus aff. *platychlamys* (M35.11)	1		
			Hibiscus aff. *platychlamys* (M39.14)	1		
			Hibiscus aff. *platychlamys* (M9.15)	1	1	1
			Hibiscus aff. *platychlamys* (MET 15 067)	1		
			Hibiscus aff. *platychlamys* (site 1139)	1	1	
			Hibiscus brachysiphonius (P3)	1		
			Hibiscus coatesii	1		
			Hibiscus leptocladus	1		
			Hibiscus panduriformis	1		
			Hibiscus sturtii var. platychlamys	1		
			Sida ?cardiophylla (juvenile)	1		1
			Sida aff. *cardiophylla* (M79.27)	1		1
			Sida aff. *cardiophylla* (site 1086)	1	1	1
			Sida aff. *fibulifera* (M100.22)	1	1	1
			Sida aff. *fibulifera* (M37.16)	1		
			Sida aff. *fibulifera* (M69.12)	1	1	
			Sida aff. *fibulifera* (M85.15)	1		
			Sida aff. *fibulifera* (MET Site 1308)	1	1	
			Sida aff. *fibulifera* (MET Site 1346)	1		
			Sida aff. *fibulifera* (oblong; MET 15 220)	1		
			Sida aff. *fibulifera* 'var. L'	1		
			Sida atrovirens ms	1		
			Sida cardiophylla	1		
			Sida clementii	1		
			Sida echinocarpa	1	1	
			Sida fibulifera	1		
			Sida pilbarensis ms	1		
			Sida rohlenae	1		
			Sida sp. 'rugose'	1		
			Sida sp. Wittenoom (W.R. Barker 1962)	1		
223	STERCULIACEAE	*	*Melochia pyramidata*	1		
			Melhania oblongifolia	1		
			Waltheria indica			1
235	ELATINACEAE		*Bergia pedicellaris*	1		
236	FRANKENIACEAE		*Frankenia ambita*	1		
			Frankenia pauciflora	1		
243	VIOLACEAE		*Hybanthus aurantiacus*	1		
248	PASSIFLORACEAE	*	*Passiflora foetida*	1		
263	THYMELEACEAE		*Pimelea ammocharis*	1		
265	LYTHRACEAE		*Ammannia baccifera*	1	1	
			Ammannia multiflora	1		1

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
269	RHIZOPHORACEAE		*Bruguiera exaristata*	1	1	
			Ceriops tagal	1		
			Rhizophora stylosa	1	1	1
273	MYRTACEAE		*Corymbia aspera*	1		
			Corymbia hamersleyana	1		1
			Eucalyptus camaldulensis	1		
			Eucalyptus sp.	1		
			Eucalyptus victrix	1		
			Melaleuca argentea	1		
			Melaleuca glomerata	1	1	
			Melaleuca linophylla	1	1	
276	HALORAGACEAE		*Haloragis gossei*	1		
281	APIACEAE		*Trachymene oleracea*			1
292	MYRSINACEAE		*Aegiceras corniculatum*	1		1
293	PRIMULACEAE		*Samolus repens*	1	1	1
294	PLUMBAGINACEAE		*Aegialitis annulata*	1		
			Muellerolimon salicorniaceum	1		
			Plumbago zeylanica	1		1
301	OLEACEAE		*Jasminum didymum* subsp. *lineare*	1		
304	APOCYNACEAE		*Wrightia saligna*			1
305	ASCLEPIADACEAE		*Cynanchum floribundum*	1		
			Sarcostemma viminale subsp. *australe*	1		1
307	CONVOLVULACEAE		*Bonamia media*	1		
			Bonamia media var. *?media*	1		
			Bonamia media var. *villosa*	1		
			Bonamia pannosa	1		
			Convolvulus remotus	1		
			Evolvulus alsinoides	1	1	1
			Evolvulus alsinoides var. *villosicalyx*	1		
			Evolvulus sp.	1	1	
			Ipomoea coptica	1		
			Ipomoea costata	1		
			Ipomoea muelleri	1	1	
			Ipomoea pes-caprae	1		
			Ipomoea polymorpha	1		
			Operculina aequisepala	1	1	1
			Polymeria aff. *ambigua*	1		
			Polymeria ambigua	1		
			Polymeria calycina	1		
			Porana commixta	1	1	1
307A	CUSCUTACEAE		*Cuscuta victoriana*	1	1	
310	BORAGINACEAE		*Ehretia saligna*	1		1
			Heliotropium chrysocarpum	1		
			Heliotropium crispatum	1		
			Heliotropium cunninghamii	1		
			Heliotropium foliatum	1		
			Heliotropium heteranthum	1		
			Heliotropium inexplicitum	1		
			Heliotropium ovalifolium	1		1
			Heliotropium sp. 1	1		1
			Trichodesma zeylanicum			1
			Trichodesma zeylanicum subsp. *zeylanicum*		1	
			Trichodesma zeylanicum var. *grandiflorum*		1	
			Trichosanthes cucumerina			1
312	AVICENNIACEAE		*Avicennia marina*	1	1	
313	LAMIACEAE		*Basilicum polystachyon*	1	1	
			Clerodendrum floribundum var. *angustifolium*	1		
			Clerodendrum tomentosum	1		
315	SOLANACEAE	*	*Datura leichhardtii*	1		
			Nicotiana benthamiana	1		
			Nicotiana rosulata subsp. *rosulata*	1	1	
			Solanum diversiflorum	1	1	
			Solanum gabrielae	1		1
			Solanum horridum	1		
			Solanum lasiophyllum	1		

Family No.	Family		Species	HGM (2000)	Maunsell (2006)	Mattiske (2007)
316	SCROPHULARIACEAE		*Mimulus gracilis*	1	1	
			Peplidium aff. sp. E Evol. Fl. Fauna Arid Australia (A.S. Weston 12768)	1		1
			Peplidium sp. E (Flora of Australia)	1		
			Stemodia grossa			1
			Stemodia kingii			1
			Striga squamigera			1
317	BIGNONIACEAE		*Dolichandrone heterophylla*	1	1	1
325	ACANTHACEAE		*Dicladanthera forrestii*	1		
			Rostellularia adscendens var. *clementii*	1	1	1
326	MYOPORACEAE		*Eremophila forrestii*	1	1	1
			Eremophila forrestii subsp. *forrestii ms*	1		
			Eremophila longifolia	1		1
			Eremophila maculata	1	1	
			Myoporum acuminatum	1		
331	RUBIACEAE		*Oldenlandia crouchiana*	1	1	
			Oldenlandia sp. 'gilgai'	1		
			Synaptantha tillaeacea var. *tillaeacea*		1	
337	CUCURBITACEAE	*	*Citrullus lanatus*	1		
		*	*Cucumis melo* subsp. *agrestis*	1	1	1
			Mukia aff. maderaspatana sp. A	1		
			Mukia aff. maderaspatana sp. B	1	1	
			Mukia aff. maderaspatana sp. C	1	1	1
			Mukia aff. maderaspatana sp. D	1	1	
			Mukia aff. maderaspatana sp. E	1	1	
			Mukia aff. maderaspatana sp. F	1		
			Mukia maderaspatana	1		
			Mukia sp. D Flora of Australia (A.A.Mitchell PRP 1121)	1		
341	GOODENIACEAE		*Goodenia forrestii*	1		
			Goodenia lamprosperma	1		
			Goodenia microptera	1	1	1
			Goodenia pascua (P3)	1	1	
			Goodenia sp. 1	1	1	1
			Goodenia sp. East Pilbara (AA Mitchell PRP 727)(P1)	1		
			Goodenia stobbsiana	1		1
			Scaevola acacioides	1	1	1
			Scaevola spinescens	1	1	1
			Scaevola thesioides subsp. *thesioides*	1	1	1
345	ASTERACEAE	*	*Bidens bipinnata*	1		
			Blumea tenella	1		
			Centipeda minima	1		
			Flaveria australasica	1		
			Lawrencia viridigrisea	1	1	1
			Pentalepis trichodesmoides	1	1	
			Pluchea dunlopii	1		
			Pluchea ferdinandi-muelleri	1		
			Pluchea rubelliflora	1		
			Pterocaulon sphacelatum	1	1	1
			Pterocaulon sphaeranthoides	1		1
			Streptoglossa decurrens			1
			Streptoglossa liatroides			1
			Streptoglossa sp.		1	
			Vittadinia / Minuria sp.			1
			Vittadinia obovata		1	

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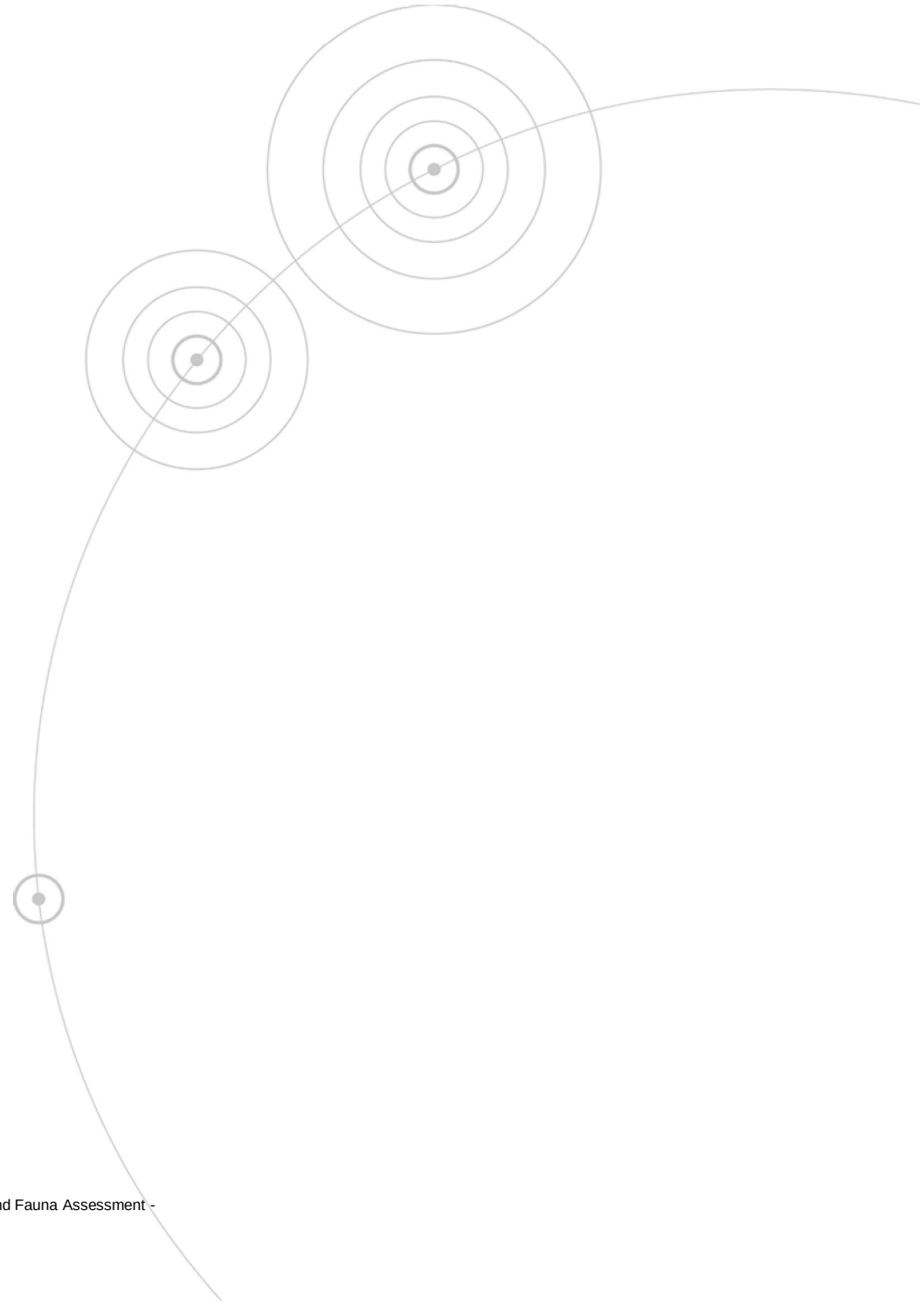
Appendix E: Vegetation Community Maps



Bx1	*Acacia xiphophylla* open shrubland over *Triodia epactia* hummock grassland
Hc1	*Acacia sclerosperma* high shrubland over *Chrysopogon fallax* tussock grassland
Hp	Hpg1 - *Eragrostis xerophila* open tussock grassland
	Hpg2 - *Eriachne benthamii* tussock grassland
	Hpg3 - *Xerochloa imberbis* grassland
	Hps1 - *Sida aff. fibulifera* low shrubland over very open herbland
Lb	Beaches
Ld1	*Acacia bivenosa* low open shrubland over *Spinifex longifolius* grassland
Ld2	*Acacia coriacea, A. bivenosa* open shrubland to shrubland over scattered grasses
Ld3	Acacia coriacea, A. bivenosa open shrubland over Triodia epactia curly spinifex grassland
Ld4	*Acacia coriacea scattered shrubs over mixed low shrubland and Triodia pungens, *Cenchrus ciliaris curly spinifex / tussock grassland*
Ld5	Saline low shrubland
Lm	Mangals
Lp1	*Triodia angusta* hummock grassland on sandy plain
Ls1	Halosarcia spp. scattered low shrubs
Ls2	*Halosarcia halocnemoides* subsp. *tenuis* low open shrubland to low open heath
Mp1	*Acacia bivenosa, A. ancistrocarpa shrubland over Triodia wiseana hummock grassland*
Mr3	Low Shrubland of *Acacia* spp. over a **Cenchrus ciliaris* and *Brachyachne convergens* Grassland
Mr4	Low Shrubland dominated by *Ptilotus aervoides* and *Sida rohlenae* over a Mid Dense Hummock Grassland of *Triodia wiseana* and *Enneapogon caerulescens*
Mr5	Very Open Mixed Herbland with infestation of Mesquite (**Prosopis pallida*)
Mr6	Closed Tussock Grassland dominated by *Enneapogon caerulescens, Aristida contorta* and *Eriachne benthamii*
Nc	Variable low open woodlands and/or high shrublands over spinifex and/or tussock grasslands
Nh	Triodia wiseana hummock grassland with scattered emergent *Acacia* or *Senna* shrubs

Nh1	*Triodia wiseana* hummock grassland
Nh2	*Acacia bivenosa* , *A ancistrocarpa* open shrubland over *Triodia wiseana* hummock grassland
Nh3	*Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland
Nr	Scattered tall shrubs dominated by *Acacia coriaceae* over lianes, spinifex and/or bunch grass.
Nr3	*Acacia coriacea* scattered tall shrubs over **Cenchrus ciliaris* , *Cymbopogon ambiguus* open tussock grassland
Pc	Open to sparse tall woodlands of *Eucalyptus camaldulensis* and/or *Eucalyptus victrix* over tall shrubs dominated by Acacia coriacea over herbs, grasses or Spinifex
Pc2	*Eucalyptus victrix* open woodland over *Acacia coriacea* high shrubland over **Cenchrus* species tussock grassland
Pc3	*Eucalyptus victrix* open woodland over *Acacia coriacea* high open shrubland over *Triodia epactia* open curly spinifex grassland and **Cenchrus ciliaris* open tussock grassland
Pc4	*Eucalyptus victrix* scattered trees over *Acacia ancistrocarpa* high open shrubland over *Sorghum* open annual tussock grassland and *Triodia wiseana* very open hummock grassland
Pf1	Scattered patches of *Corymbia hamersleyana* low open woodland over patches of *Acacia trachycarpa* high shrubland over **Cenchrus ciliaris* closed tussock grassland
Pp1	*Acacia bivenosa* open shrubland over *Indigofera trita* low open shrubland over *Triodia wiseana* hummock grassland
Pp2	*Triodia angusta* hummock grassland with patches of open herbland
Px1	*Acacia xiphophylla* open shrubland over patches of *Triodia wiseana* hummock grassland
Px2	*Acacia xiphophylla* open shrubland over patches of *Eragrostis xerophila* tussock grassland
ROc1	*Corymbia hamersleyana* low woodland over *Acacia bivenosa* high shrubland over *Triodia wiseana* hummock grassland
ROc2	*Acacia coriacea* high shrubland over hummock / tussock grassland
ROc3	*Acacia sclerosperma* high shrubland over **Cenchrus ciliaris* , *Themeda triandra* tussock grassland and *Triodia wiseana* open hummock grassland
ROc4	*Acacia coriacea, A. bivenosa* high shrubland over mixed shrubs and grasses
ROc5	*Acacia ampliceps* high shrubland over *Triodia angusta* hummock grassland and tussock grasses
ROh1	*Triodia wiseana* hummock grassland with scattered emergent low shrubs
ROh1a	*Triodia wiseana* hummock grassland
ROh1b	*Indigofera monophylla* low open shrubland over *Triodia wiseana* hummock grassland
ROh2	Triodia wiseana hummock grassland with scattered Acacia tall shrubs

ROh2b	*Acacia ancistrocarpa* , *A. bivenosa* open shrubland over *Triodia wiseana* hummock grassland
ROpl	*Triodia angusta* hummock grassland
ROr	Scattered tall shrubs dominated by Acacia coriacea over lianes, spinifex and/or bunch grasses (mosaic of ROr1/ ROr2/ ROr3)
ROr1	*Acacia coriacea, Ficus platypoda* high open shrubland over lianes dominated by *Canavalia rosea*
ROr3	*Acacia coriacea, A. bivenosa* scattered tall shrubs over *Cymbopogon ambiguus* tussock grassland
ROx1	*Acacia xiphophylla* open shrubland over patches of *Triodia wiseana* hummock grassland
Rc1	Scattered riverine trees and shrubs
Rc2	Cadjeput *Melaleuca argentea* , River Redgum *Eucalyptus camaldulensis* open forest over patches of *Acacia coriacea* high shrubland over **Cenchrus* species tussock grassland
Rc3	*Eucalyptus camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over patches of *Cyperus vaginatus* sedgeland
Rc4	*Eucalyptus victrix, E. camaldulensis* woodland over patches of *Melaleuca glomerata* high shrubland over **Cenchrus* species tussock grassland
Rf1	*Eucalyptus victrix* open woodland over **Cenchrus* species tussock grassland
Rf2	Mesquite **Prosopis pallida* hybrid high shrubland to open scrub
Roh1b	*Indigofera monophylla* low open shrubland over *Triodia wiseana* hummock grassland
Ropl	*Triodia angusta* hummock grassland
Yc1	*Avicennia marina* high shrubland over patches of *Schoenoplectus litoralis* open sedgeland
Yp1	Mosaic of patches of *Triodia angusta* hummock grassland with open herblands and Mesquite scattered tall shrubs
Disturbed	

International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.01

September 2008

0 500 1,000 1,500

Meters

1:25,000

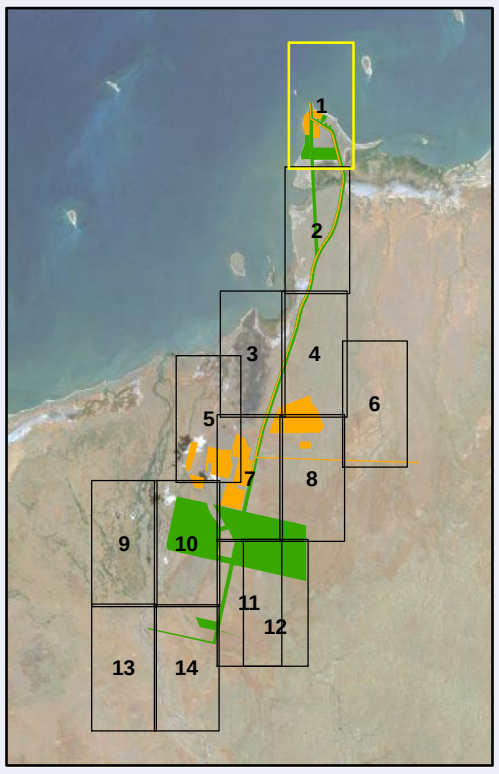
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Fauna Transect (2000)
- Fauna Transect (2006)
- Balmoral South Footprint
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.02

September 2008

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Meters

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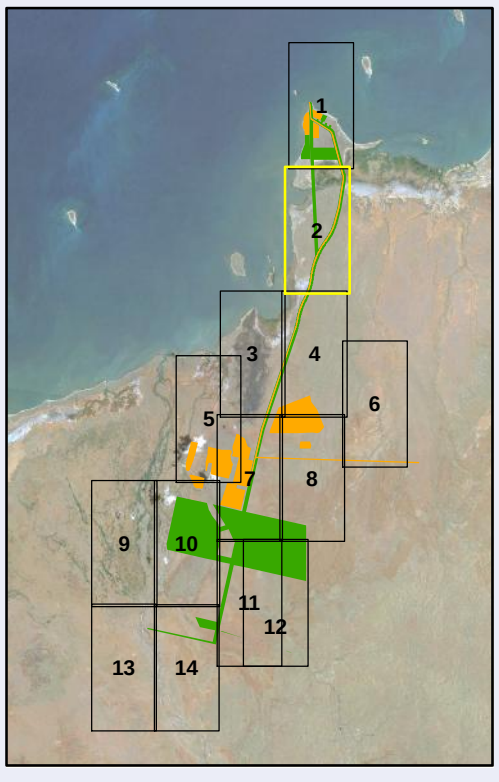
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.03

September 2008

0 500 1,000 1,500

Meters

1:25,000

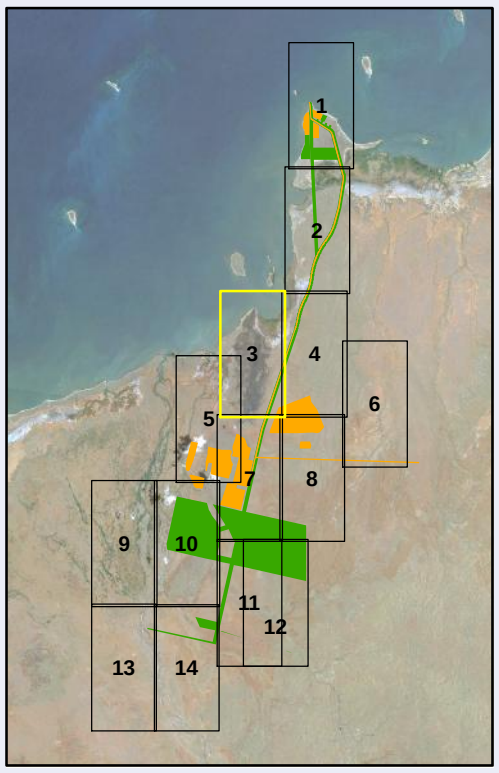
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.04

September 2008

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Meters

1:25,000

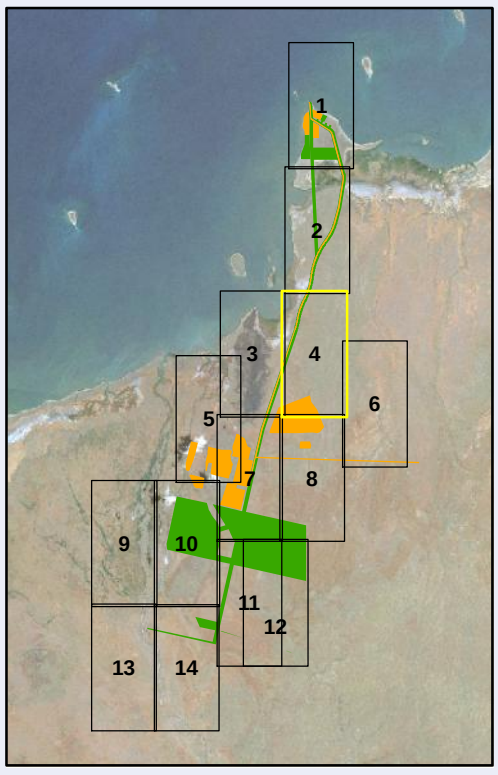
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.05

September 2008

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Meters

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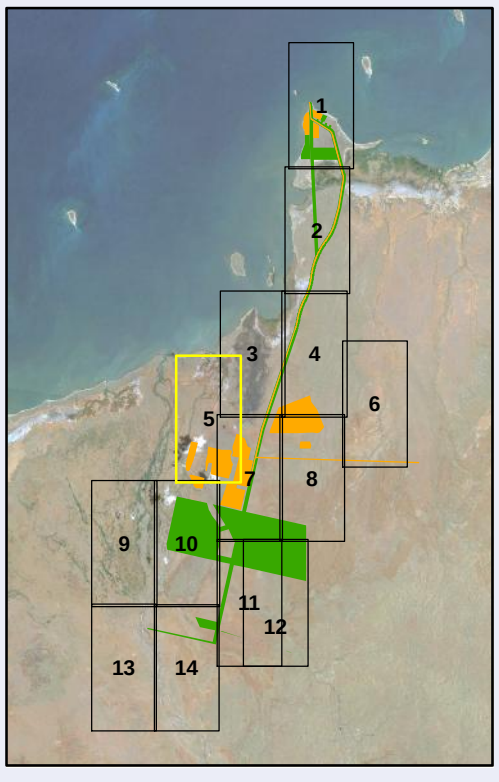
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.06

September 2008

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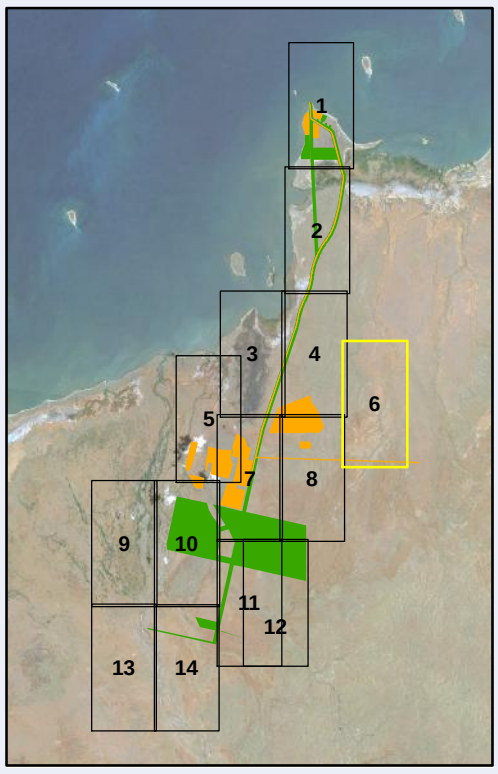
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Fauna Transect (2000)
- Fauna Transect (2006)
- Balmoral South Footprint
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.07

September 2008

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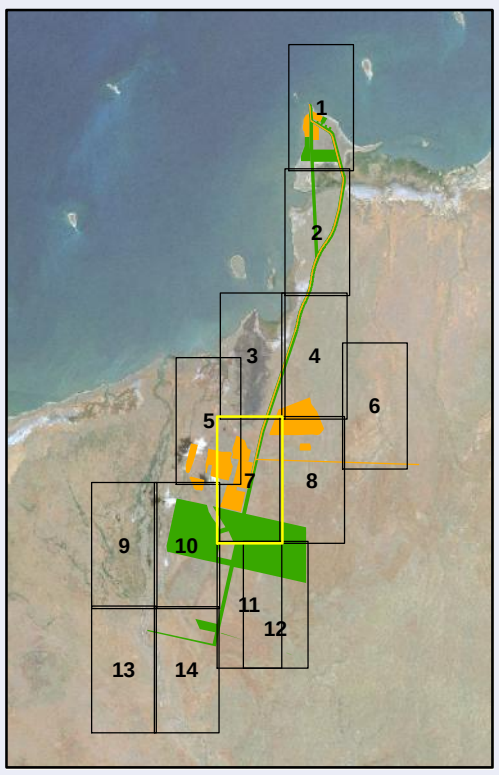
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Fauna Transect (2000)
- Fauna Transect (2006)
- Balmoral South Footprint
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.08

September 2008

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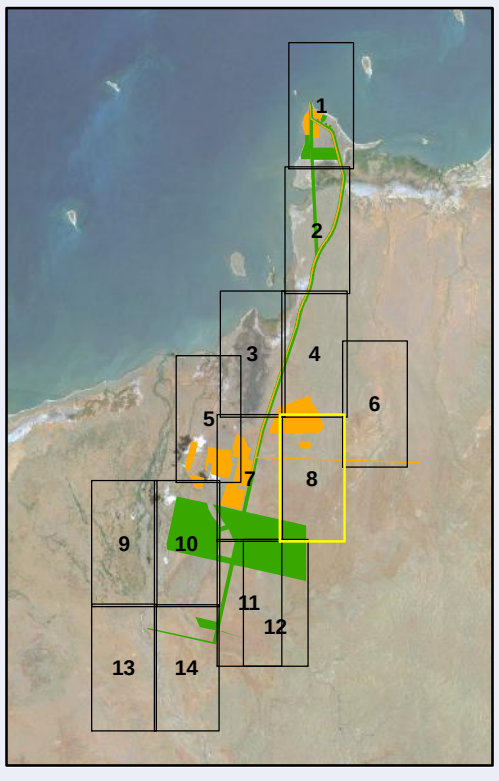
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.09

September 2008

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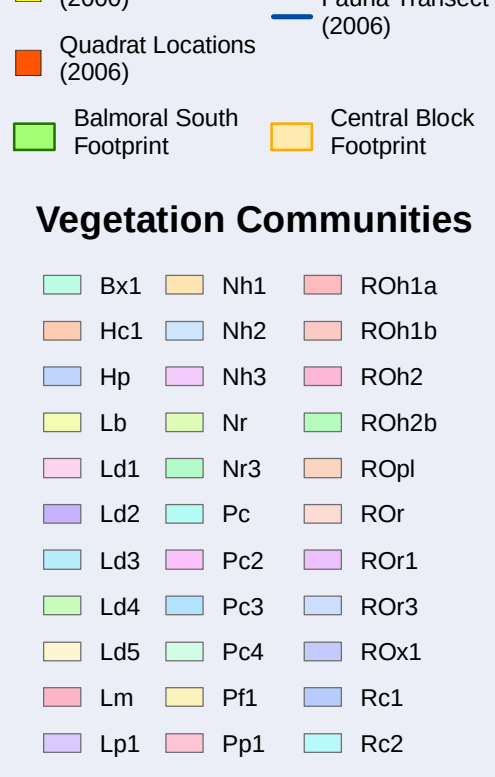
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Fauna Transect (2000)
- Fauna Transect (2006)
- Balmoral South Footprint
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.10

September 2008

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Meters

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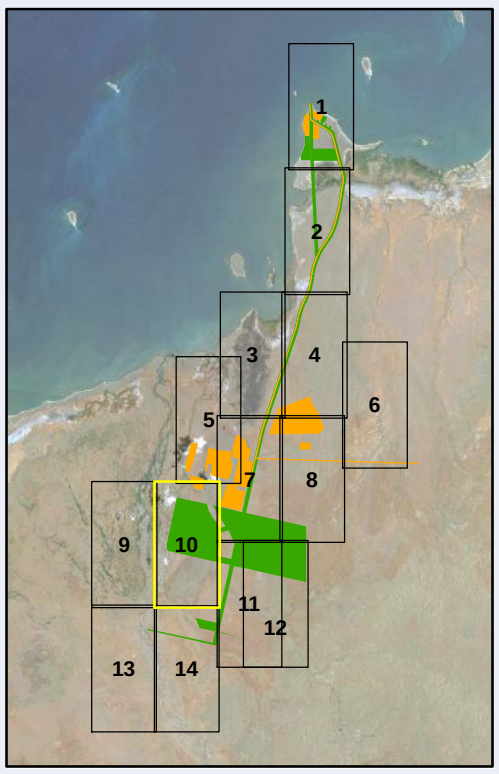
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.11

September 2008

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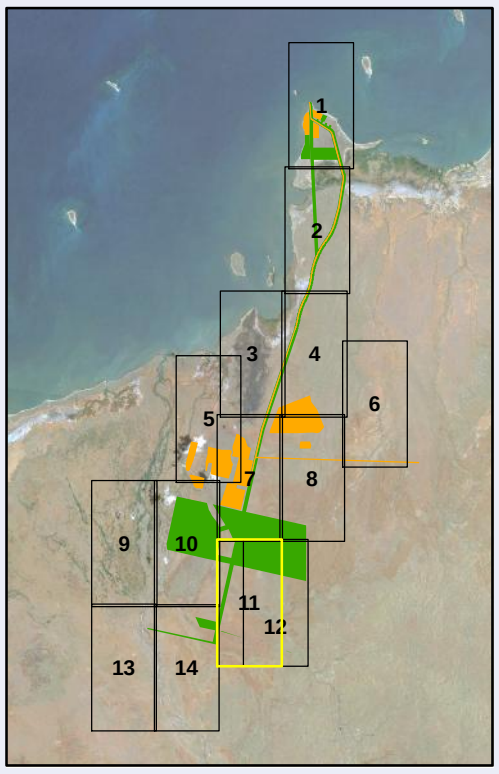
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.12

September 2008

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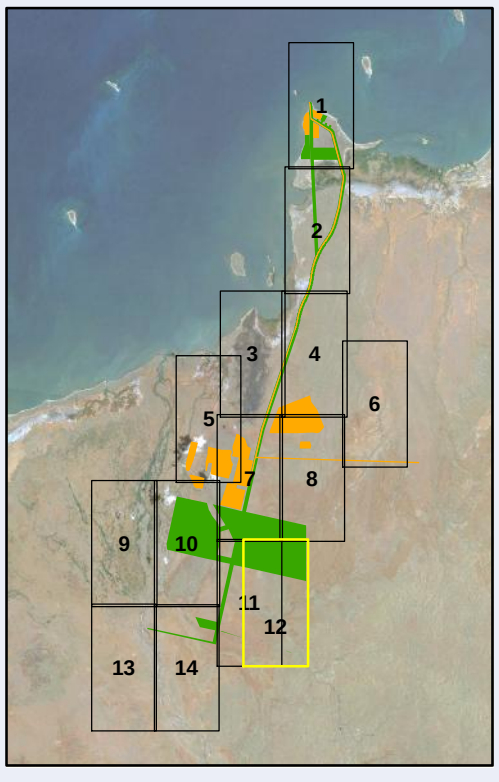
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.13

September 2008

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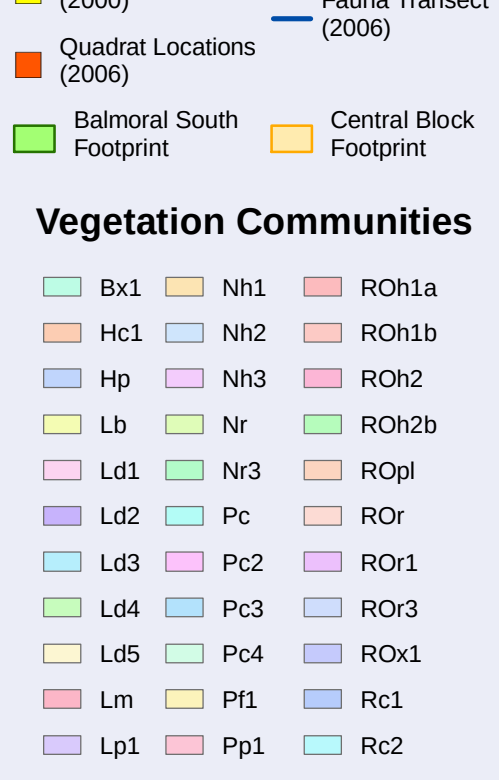
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Balmoral South Footprint
- Fauna Transect (2000)
- Fauna Transect (2006)
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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International Minerals

Cape Preston Vegetation Communities & Disturbance Areas

Figure 5.14

September 2008

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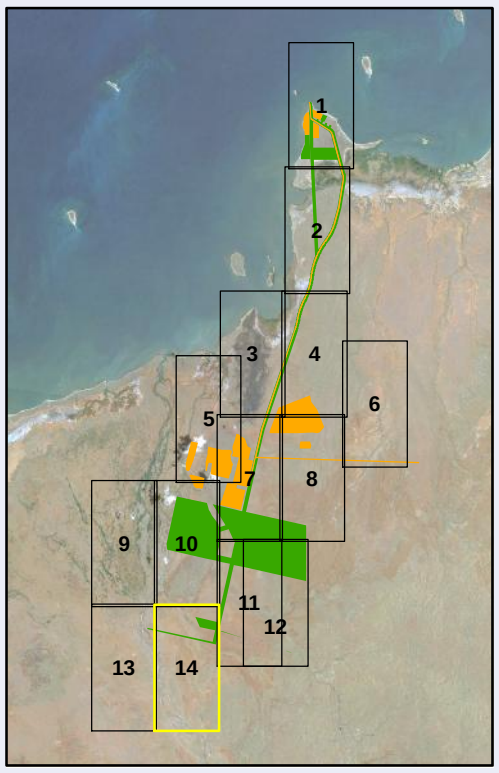
International Minerals
ACN 058 341 638

MAUNSELL | AECOM

- Priority Flora
- Quadrat Locations (2000)
- Quadrat Locations (2006)
- Fauna Transect (2000)
- Fauna Transect (2006)
- Balmoral South Footprint
- Central Block Footprint

Vegetation Communities

Bx1	Nh1	ROh1a
Hc1	Nh2	ROh1b
Hp	Nh3	ROh2
Lb	Nr	ROh2b
Ld1	Nr3	ROpl
Ld2	Pc	ROr
Ld3	Pc2	ROr1
Ld4	Pc3	ROr3
Ld5	Pc4	ROx1
Lm	Pf1	Rc1
Lp1	Pp1	Rc2
Ls1	Pp2	Rc3
Ls2	Px1	Rc4
Mp1	Px2	Rf1
Mr3	ROc1	Rf2
Mr4	ROc2	Roh1b
Mr5	ROc3	Ropl
Mr6	ROc4	Yc1
Nc	ROc5	Yp1
Nh	ROh1	Disturbed



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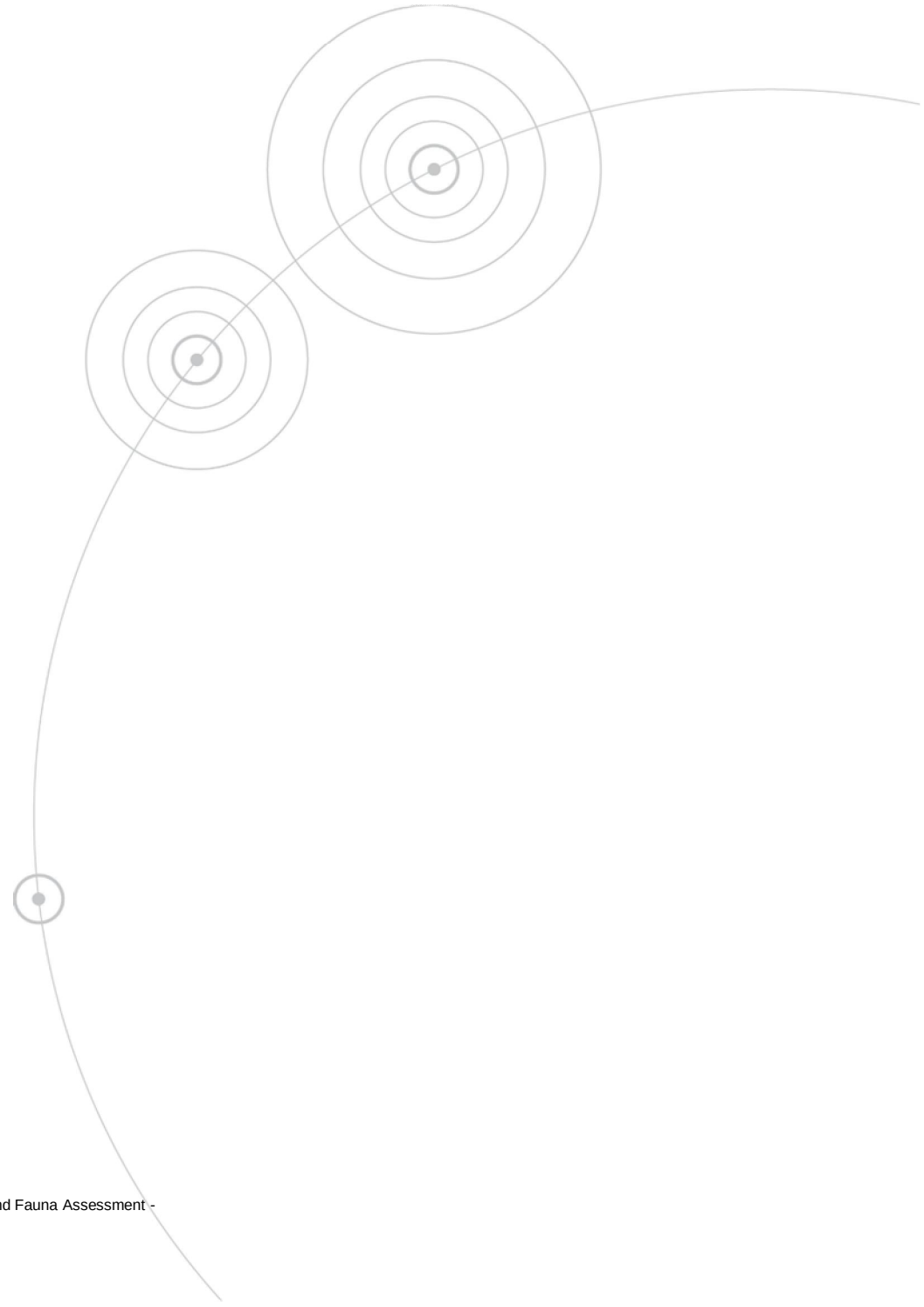
Appendix F: DEC and EPBC Database Search Enquiry



Department of Conservation and Land Management

Conserving the nature of WA

Your reference:
Our reference: 2006F000108V
Enquiries: Kelly Poultney

Phone: 9334 0123
Fax: 9334 0278
Email: kellyp@calm.wa.gov.au

Maunsell Australia
PO Box 81
LEEDERVILLE WA 6902

Attention: Kellie Honczar

Dear Ms Honczar

REQUEST FOR RARE FLORA INFORMATION

I refer to your request of 10 May 2006 for information on rare flora in the Cape Preston area. The search co-ordinates used were 21^0 00' - 21^0 19' S and 115^0 56' - 116^0 17' E.

A search was undertaken for this area of **(1)** the Department's *Threatened (Declared Rare) Flora* database (there were no records retrieved on this database for this particular area), **(2)** the *Western Australian Herbarium Specimen* database for priority species opportunistically collected in the area of interest (for results, *if any*, see "WAHERB"- coordinates are GDA94 – see condition number 9 in the attached 'Conditions in Respect of Supply') and **(3)**, the Department's *Declared Rare and Priority Flora List* [there were no records retrieved on this database for this particular area]. The results are attached electronically to this email.

Attached also are the conditions under which this information has been supplied. Your attention is specifically drawn to the seventh point, which refers to the requirement to undertake field investigations for the accurate determination of rare flora occurrence at a site. *The information supplied should be regarded as an indication only of the rare flora that may be present and may be used as a target list in any surveys undertaken.*

The information provided does not preclude you from obtaining and complying with, where necessary, land clearing approvals from other agencies.

An invoice for $200 (plus GST) to supply this information will be forwarded.

It would be appreciated if any populations of rare flora encountered by you in the area could be reported to this Department to ensure their ongoing management.

If you require any further details, or wish to discuss rare flora management, please contact my Principal Botanist, Dr Ken Atkins, on (08) 9334 0425.

Yours faithfully

KPoultney
.....
for Keiran McNamara
EXECUTIVE DIRECTOR
17 May, 2006

Please note: Co-ordinates supplied for all data search requests must be provided in latitude/longitude format, 'eastings and northings' are no longer suitable. Thank you.

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

RARE FLORA INFORMATION

CONDITIONS IN RESPECT OF SUPPLY OF INFORMATION

1. All requests for data to be made in writing to the Executive Director, Department of Conservation and Land Management, Attention: Threatened Flora Database Officer, Species and Communities Branch.

2. The data supplied may not be supplied to other organisations, nor be used for any purpose other than for the project for which they have been provided, without the prior written consent of the Executive Director, Department of Conservation and Land Management.

3. Specific locality information for Declared Rare Flora is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for DRF may not be used in public reports without the written permission of the Executive Director, Department of Conservation and Land Management. Publicly available reports may only show generalised locations or, where necessary, show specific locations without identifying species. The Department is to be contacted for guidance on the presentation of rare flora information.

4. Note that the Department of Conservation and Land Management respects the privacy of private landowners who may have rare flora on their property. Rare flora locations identified in the data as being on private property should be treated in confidence, and contact with property owners made through the Department of Conservation and Land Management.

5. Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data provided, they may be present. The Department of Conservation and Land Management accepts no responsibility for this.

6. Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.

7. **It should be noted that the supplied data do not necessarily represent a comprehensive listing of the rare flora of the area in question. Its comprehensiveness is dependant on the amount of survey carried out within the specified area. The receiving organisation should employ a botanist, if required, to undertake a survey of the area under consideration.**

8. Acknowledgment of the Department of Conservation and Land Management as source of the data is to be made in any published material. Copies of all such publications are to be forwarded to the Department of Conservation and Land Management, Attention: Principal Botanist, Species and Communities Branch.

9. The development of the PERTH Herbarium database was not originally intended for electronic mapping (eg. GIS ArcView). The latitude and longitude coordinates for each entry are not verified prior to being databased. It is only in recent times that collections have been submitted to PERTH with GPS recorded in latitude and longitude coordinates. Therefore, be aware when using this data in ArcView that some records may not plot to the locality description given with each collection.

THE DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

DECLARED RARE AND PRIORITY FLORA LIST

for Western Australia

CONSERVATION CODES

R: Declared Rare Flora - Extant Taxa

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

X: Declared Rare Flora - Presumed Extinct Taxa

Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.

1: Priority One - Poorly known Taxa

Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

ABBREVIATIONS USED IN THREATENED FLORA DATABASE PRINTOUTS

VESTING

AGR	Chief Exec Dept of Agriculture
ALT	Aboriginal Land Trust
BAP	Baptist Union of WA Inc
BSA	Boy Scouts Association
CC	Conservation Comission – NPNCA - LFC
CGT	Crown Grant in Trust
COM	Commonwealth of Australia
CRO	Crown Freehold-Govt Ownership
DOL	Dept of Land Administration
DPU	Ministry for Planning
EXD	Exec Direc CALM
FRE	Freehold
HOW	Homeswest
ILD	Industrial Lands Develop. Auth
JOI	Joint Vesting-NPNCA & Shire
LAC	LandCorp
LFC	Lands and Forests Commission
MAG	Minister for Agriculture
MED	Ministry of Education
MHE	Minister for Health
MIN	Minister for Mines
MPL	Ministry for Planning
MPR	Minister for Prisons
MRD	Main Roads WA
MTR	Minister for Transport
MWA	Minister for Water Resources
MWO	Minister for Works
NAT	Natural Trust of Australia WA
NON	Not Vested
NPN	NPNCA
OTH	Other
PRI	Private
RAI	Westrail
SEC	Western Power
SHI	Shire
SPC	State Planning Commission
TEL	Telstra
TGR	Timber Govt Requirement
TOW	TOWN
UNK	Unknown
WAT	Water Corporation
WEL	Minister Community Welfare
WRC	Water & Rivers Commission
XPL	Ex-Pastoral Lease

PURPOSES

ABR	Aboriginal Reserve
AER	Aerodrome
CAM	Camping
CAR	Caravan park
CEM	Cemetery
CFA	Conservation of Fauna
CFF	Conservation Of Flora & Fauna
CFL	Conservation of Flora
CHU	Church
CPK	Car Park
COM	Common
CON	Conservation Park
DEF	Defence
DRA	Drain
EDE	Educational Endowment
EDU	Educational purposes UWA
ENE	Enjoyment of Natural Environ.
EXC	Excepted from sale
EXL	Exploration Lease
EXP	Experimental Farm
FIR	Firing Range
FOR	State Forest
GHA	Grain Handling
GOL	Golf
GRA	Gravel Pit
GRE	Green Belt
GVT	Government Requirements
HAR	Harbour Purposes
HEP	Heritage Purposes
HER	Heritage trail
HOS	Hospital
KEN	Kennels
MIN	Mining lease
MUN	Municipal Purposes
NPK	National Park
NRE	Nature Reserve
OTH	Other
PAC	Public access
PAR	Parkland (& Recreation)
PAS	Pastoral lease
PFL	Protection of Flora
PIC	Picnic ground
PLA	Plantation
POS	Public Open Space
PPA	Public parkland
PRS	Prison site
PUT	Public Utility
QUA	Quarry
RAD	Radio Station
RAC	Racecourse
REC	Recreation
REH	Rehabilitation
RNP	Re-establish Native Plants
RRE	Railway Reserve
RUB	Rubbish
SAN	Sand
SCH	School-site
SET	Settlers requirements
SHI	Shire Requirements
SHO	Showgrounds
SNN	Sanitary
STO	Stopping place
TIM	Timber
TOU	Tourism
TOW	Town-site
TRA	Training Ground
TRI	Trig station
TVT	Television transmitting
UNK	Unknown
UTI	Utilities
VCL	Vacant Crown Land
VER	Road Verge
VPF	Vermin Proof Fence
WAT	Water
WCO	Water & Conservation of F & F
WOO	Firewood

* Please note that LFC now comes under the Conservation Commission.

WAHERB SPECIMEN DATABASE
GENERAL ENQUIRY

Acacia glaucocaesia
Domin (Mimosaceae)
CONSERVATION STATUS:P3
Coll.: C.A. Gardner 3079 Date: 18 08 1932 (PERTH 00155284)
LOCALITY Mardie Station, Fortescue River WA
LAT 21 Deg 11 Min 0.000 Sec S LONG 115 Deg 59 Min 0.000 Sec E
6 - 20 ft, stems glaucous, flowers pale yellow, scented. Hard red loam on plains.
Previous det.: Acacia glaucocaesia Domin

Goodenia nuda
E.Pritz. (Goodeniaceae)
CONSERVATION STATUS:P3
Coll.: J.F. Smith 132 Date: 31 07 2002 (PERTH 06258832)
LOCALITY By side of management track on Mardie Station WA
LAT 21 Deg 6 Min 35.300 Sec S LONG 115 Deg 59 Min 36.700 Sec E
Erect herb 0.3 m high x 0.2 m wide. Flowers yellow. Plain. Dry, red sand. Mesquite scrub.
Total weed cover up to 25% of site.
Frequency:2-5 plants over 1 sq m.

Goodenia pascua
Carolin (Goodeniaceae)
CONSERVATION STATUS:P3
Coll.: R. Carolin 7846 Date: 11 08 1970 (PERTH 02611783)
LOCALITY 127 miles from Onslow on Roebourne road WA
LAT 21 Deg 18 Min Sec S LONG 116 Deg 8 Min Sec E
Corolla yellow with brown throat. In red soil. Annual grassland, Acacia shrub steppe.

Gunniopsis sp. Fortescue (M.E. Trudgen 11019)
PN (Aizoaceae)
CONSERVATION STATUS:P1
Coll.: M. Trudgen 11019 Date: (PERTH 03456927)
LOCALITY Fortescue WA
LAT 21 Deg 3 Min 0.000 Sec S LONG 116 Deg 5 Min 59.000 Sec E
*See Comments

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: A. Sharp s.n. Date: 05 03 1953 (PERTH 01745603)
LOCALITY Mardie WA
LAT 21 Deg 11 Min 12.000 Sec S LONG 115 Deg 58 Min 54.000 Sec E
Previous det.: Owenia acidula F. Muell.

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: B.H. Sharpe s.n. Date: 10 12 1949 (PERTH 04006755)
LOCALITY Mardie Station WA
LAT 21 Deg 11 Min 0.000 Sec S LONG 115 Deg 59 Min 0.000 Sec E

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: B.H. Sharpe s.n. Date: 10 12 1949 (PERTH 04006763)
LOCALITY Mardie Station WA
LAT 21 Deg 11 Min 0.000 Sec S LONG 115 Deg 59 Min 0.000 Sec E

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: G.B. Barnett s.n. Date: (PERTH 04006798)
LOCALITY Mardi Station WA
LAT 21 Deg 11 Min 0.000 Sec S LONG 115 Deg 59 Min 0.000 Sec E
Wild pepper tree.

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: B.H. Sharpe s.n. Date: 10 12 1949 (PERTH 04006771)
LOCALITY Mardie Station WA
LAT 21 Deg 11 Min 0.000 Sec S LONG 115 Deg 59 Min 0.000 Sec E

Owenia acidula
F.Muell. (Meliaceae)
CONSERVATION STATUS:P3
Coll.: J.S. Beard 4564 Date: 19 08 1966 (PERTH 06233953)
LOCALITY Mardie Station WA
LAT 21 Deg 11 Min Sec S LONG 115 Deg 59 Min Sec E
Small tree 10 ft. Leaves pseudopinnate.
Near creek. Shrub steppe.

21.4707 °S 115.882 °E / 20.8749 °S 116.415 °E Mardie (plus ~15km buffer)

*	Date	Certainty	Seen	Location Name	Method

Schedule 1 - Fauna that is rare or is likely to become extinct

Pezoporus occidentalis **Night Parrot** *0 records*

This nocturnal species is known to inhabit treeless or sparsely wooded spinifex (Triodia spp) near water. A record occurs approximately 12km south of the search areas south west corner.

Priority One: Taxa with few, poorly known populations on threatened lands

Mormopterus loriae cobourgiana **Little North-western Mastiff Bat** *1 records*

This species occurs along the northwest coast and is known to roost in mangroves.

2000	1	20	Cape Preston	Caught or trapped

Priority Three: Taxa with several, poorly known populations, some on conservation lands

Lagorchestes conspicillatus leichardti **Spectacled Hare-wallaby (mainland)** *1 records*

This species has declined in many parts of its range and is vulnerable to cat and fox predation. It inhabits tropical grasslands and also suffers from the impacts of frequent fires.

1979	1	1	Mardie	Day sighting

Priority Four: Taxa in need of monitoring

Leggadina lakedownensis **Lakeland Downs Mouse (Kerakenga)** *3 records*

This secretive species is known to occur in the Pilbara and the Kimberley. Its populations rise and fall dramatically, probably in response to climatic fluctuations and availability of seeds.

2000	1	1	Mardie	Caught or trapped
2000	1	1	Mardie	Caught or trapped
2000	1	1	Mardie	Caught or trapped

Pseudomys chapmani **Western Pebble-mound Mouse (Ngadji)** *2 records*

This species is well-known for the characteristic pebble-mounds which it constructs over underground burrow systems. These mounds are most common on spurs and lower slopes of rocky hills.

1994	1		Mardie Stn	
2000	1	0	Mardie	Definite signs

Ardeotis australis **Australian Bustard** *1 records*

This species is uncommon and may occur in open or lightly wooded grasslands.

2000	1	6	Mardie	

Burhinus grallarius **Bush Stonecurlew** *1 records*

A well camouflaged, ground nesting bird which prefers to ‘freeze’ rather than fly when disturbed. It inhabits lightly timbered open woodlands.

2000	1	2	Mardie	Day sighting

Numenius madagascariensis **Eastern Curlew** *1 records*

This species is a migratory visitor and has been observed on reef flats and sandy beaches along the West Australian coast and in coastal estuaries.

2000	1	11	Cape Preston	

21.4707 °S 115.882 °E / 20.8749 °S 116.415 °E Mardie (plus ~15km buffer)

*	*Date*	*Certainty*	*Seen*	*Location Name*	*Method*

***** Information relating to any records provided for listed species:-
Date: date of recorded observation
Certainty (of correct species identification): 1=Very certain; 2=Moderately certain; and 3=Not sure.
Seen: Number of individuals observed.
Location Name: Name of reserve or nearest locality where observation was made
Method: Method or type of observation

Shaw, Jamie

From: Morley, Mia [MiaM@calm.wa.gov.au]
Sent: Wednesday, 10 May 2006 4:17 PM
To: Gibbs, Kellie
Subject: Results of TEC Search - Karratha (maunsell)
Follow Up Flag: Follow up
Flag Status: Green
Attachments: Conditions of supplying TEC data.doc; threatened_flora_and_fauna_searches.pdf

Hi Kellie,

I refer to your request of 10th May 2006 for information on threatened ecological communities occurring within the following search area: -21.0224065, 115.94147018 and -21.2952314, 116.28175524. I have assumed that the co-ordinates for the SE corner are 7645000, 425500 instead of 7645000, 4255000..

A search was undertaken for these areas of the Department's Threatened Ecological Communities database. Please note that there are no known occurrences of threatened ecological communities recorded within this boundary.

Attached also are the conditions under which this information has been supplied. The information supplied should be regarded as an indication only of the threatened ecological communities that may be present.

It would be appreciated if any occurrences of threatened ecological communities encountered by you in the area could be reported to this Department to ensure their ongoing management.

An invoice for $110 (including GST) for the supply of this information will be forwarded.

Please find a copy of information for flora, fauna and TEC Search requirements attached.

Regards

Mia

Mia Morley
Ecologist - TEC Database
Species and Communities Branch
CALM Woodvale
Email: miam@calm.wa.gov.au
Phone: 9405 5170
Fax: 9306 1641

-----Original Message-----
From: Honczar, Kellie [mailto:Kellie.Honczar@maunsell.com]
Sent: Wednesday, 10 May 2006 12:46 PM
To: Morley, Mia
Subject: Threatened Ecological Community Database Search

Hi Mia,

Could you please carry out a Threatened Ecological Community Database enquiry for the area within the following co-ordinates:

MGA 94 Zone 50
NW corner: 7675000N, 390000E
SE corner: 7645000N, 4255000E

or

WGS 84
NW corner: 115deg., 57'
SE corner: 116deg., 18'

The area is south of Cape Preston, south-south east of Karratha.

The results of the enquiry will be used in a desktop assessment of flora and fauna values in the area, proposed for Nickel exploration. The data will feed into referrals for environmental approval.

Please let me know if there are any problems.

Regards,

Kellie Honczar
Environmental Scientist - Botanist
Maunsell Australia Pty Ltd
629 Newcastle Street
PO Box 81
Leederville WA 6902
ABN 20 093 846 925
Tel 9281 6246
Fax 9281 6294
Mob 0408 766 346
kellie.honczar@maunsell.com

Australian Government
Department of the Environment and Water Resources

Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

26 April 2007 12:57

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

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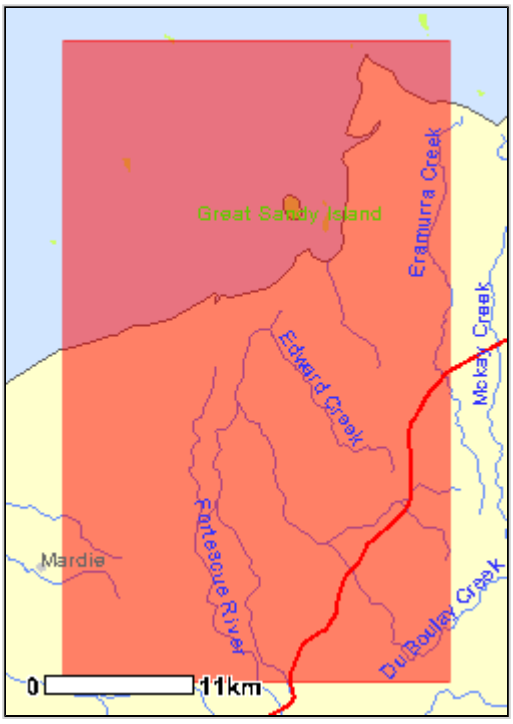
Search Type: Area

Buffer: 0 km

Coordinates: -21.27527,115.9925, -21.27527,116.2633, -20.82388,116.2633, -20.82388,115.9925



Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Significance: (Ramsar Sites)	None
Commonwealth Marine Areas:	Relevant
Threatened Ecological Communities:	None
Threatened Species:	12
Migratory Species:	27

Other Matters Protected by the EPBC Act

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

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

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Places on the RNE:	1
Listed Marine Species:	59
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

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

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Areas [Dataset Information]

Approval may be required for a proposed activity that is likely to have a significant impact on the environment in a Commonwealth Marine Area, when the action is outside the Commonwealth Marine Area, or the environment anywhere when the action is taken within the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Within 3 Nautical Mile Limit

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Macronectes giganteus * Southern Giant-Petrel	Endangered	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus * Blue Whale	Endangered	Species or species habitat may occur within area
Dasycercus cristicauda * Mulgara	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis * Southern Right Whale	Endangered	Species or species habitat may occur within area
Megaptera novaeangliae * Humpback Whale	Vulnerable	Species or species habitat known to occur within area
Rhinonicteris aurantius (Pilbara form) * Pilbara Leaf-nosed Bat	Vulnerable	Community likely to occur within area
Reptiles		
Caretta caretta * Loggerhead Turtle	Endangered	Species or species habitat may occur within area
Chelonia mydas * Green Turtle	Vulnerable	Breeding likely to occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Vulnerable	Species or species habitat may occur within area
Eretmochelys imbricata * Hawksbill Turtle	Vulnerable	Breeding likely to occur within area
Natator depressus *	Vulnerable	Breeding likely to occur within area

Flatback Turtle		
Sharks		
Rhincodon typus * Whale Shark	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow	Migratory	Species or species habitat may occur within area
Merops ornatus * Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Migratory	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Migratory	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Migratory	Species or species habitat may occur within area
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift	Migratory	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Migratory	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Migratory	Breeding known to occur within area
Migratory Marine Species		
Mammals		
Balaenoptera edeni Bryde's Whale	Migratory	Species or species habitat may occur within area
Balaenoptera musculus * Blue Whale	Migratory	Species or species habitat may occur within area
Dugong dugon Dugong	Migratory	Species or species habitat likely to occur within area
Eubalaena australis * Southern Right Whale	Migratory	Species or species habitat may occur within area

Megaptera novaeangliae * Humpback Whale	Migratory	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Migratory	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Migratory	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)	Migratory	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta * Loggerhead Turtle	Migratory	Species or species habitat may occur within area
Chelonia mydas * Green Turtle	Migratory	Breeding likely to occur within area
Dermochelys coriacea * Leathery Turtle, Leatherback Turtle, Luth	Migratory	Species or species habitat may occur within area
Eretmochelys imbricata * Hawksbill Turtle	Migratory	Breeding likely to occur within area
Natator depressus * Flatback Turtle	Migratory	Breeding likely to occur within area
Sharks		
Rhincodon typus Whale Shark	Migratory	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Dataset Information]	Status	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift	Listed - overfly marine area	Species or species habitat may occur within area
Ardea alba Great Egret, White Egret	Listed - overfly marine area	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Listed - overfly marine area	Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel	Listed - overfly marine area	Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole	Listed - overfly marine area	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle	Listed	Species or species habitat likely to occur within area

Hirundo rustica Barn Swallow	Listed - overfly marine area	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel	Listed	Species or species habitat may occur within area
Merops ornatus ***** Rainbow Bee-eater	Listed - overfly marine area	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel	Listed - overfly marine area	Species or species habitat may occur within area
Puffinus pacificus Wedge-tailed Shearwater	Listed	Breeding known to occur within area
Mammals		
Dugong dugon Dugong	Listed	Species or species habitat likely to occur within area
Ray-finned fishes		
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish	Listed	Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish	Listed	Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish	Listed	Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Negros Pipefish	Listed	Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish	Listed	Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish	Listed	Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish	Listed	Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish	Listed	Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish	Listed	Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish	Listed	Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Seadragon, Ribboned Pipefish	Listed	Species or species habitat may occur within area

Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish	Listed	Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse	Listed	Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse	Listed	Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse	Listed	Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse	Listed	Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish	Listed	Species or species habitat may occur within area
Solegnathus hardwickii Pipehorse	Listed	Species or species habitat may occur within area
Solegnathus lettiensis Indonesian Pipefish, Gunther's Pipehorse	Listed	Species or species habitat may occur within area
Solenostomus cyanopterus Blue-finned Ghost Pipefish, Robust Ghost Pipefish	Listed	Species or species habitat may occur within area
Syngnathoides biaculeatus Double-ended Pipehorse, Alligator Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bend Stick Pipefish, Short-tailed Pipefish	Listed	Species or species habitat may occur within area
Trachyrhamphus longirostris Long-nosed Pipefish, Straight Stick Pipefish	Listed	Species or species habitat may occur within area
Reptiles		
Acalyptophis peronii Horned Seasnake	Listed	Species or species habitat may occur within area
Aipysurus apraefrontalis Short-nosed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus duboisii Dubois' Seasnake	Listed	Species or species habitat may occur within area
Aipysurus eydouxii Spine-tailed Seasnake	Listed	Species or species habitat may occur within area
Aipysurus laevis Olive Seasnake	Listed	Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Seasnake	Listed	Species or species habitat may occur within area
Astrotia stokesii Stokes' Seasnake	Listed	Species or species habitat may occur within area
Caretta caretta ***** Loggerhead Turtle	Listed	Species or species habitat may occur within area
Chelonia mydas ***** Green Turtle	Listed	Breeding likely to occur within area
Dermochelys coriacea ***** Leathery Turtle, Leatherback Turtle, Luth	Listed	Species or species habitat may occur within area

Disteira kingii Spectacled Seasnake	Listed	Species or species habitat may occur within area
Disteira major Olive-headed Seasnake	Listed	Species or species habitat may occur within area
Emydocephalus annulatus Turtle-headed Seasnake	Listed	Species or species habitat may occur within area
Ephalophis greyi North-western Mangrove Seasnake	Listed	Species or species habitat may occur within area
Eretmochelys imbricata ***** Hawksbill Turtle	Listed	Breeding likely to occur within area
Hydrelaps darwiniensis Black-ringed Seasnake	Listed	Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Seasnake	Listed	Species or species habitat may occur within area
Hydrophis elegans Elegant Seasnake	Listed	Species or species habitat may occur within area
Hydrophis mcdowelli	Listed	Species or species habitat may occur within area
Hydrophis ornatus a seasnake	Listed	Species or species habitat may occur within area
Natator depressus ***** Flatback Turtle	Listed	Breeding likely to occur within area
Pelamis platurus Yellow-bellied Seasnake	Listed	Species or species habitat may occur within area
Whales and Other Cetaceans [Dataset Information]	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale	Cetacean	Species or species habitat may occur within area
Balaenoptera musculus ***** Blue Whale	Cetacean	Species or species habitat may occur within area
Delphinus delphis Common Dolphin	Cetacean	Species or species habitat may occur within area
Eubalaena australis ***** Southern Right Whale	Cetacean	Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus	Cetacean	Species or species habitat may occur within area
Megaptera novaeangliae ***** Humpback Whale	Cetacean	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca	Cetacean	Species or species habitat may occur within area
Sousa chinensis Indo-Pacific Humpback Dolphin	Cetacean	Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin	Cetacean	Species or species habitat may occur within area
Tursiops aduncus (Arafura/Timor Sea	Cetacean	Species or species habitat likely to

populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations)		occur within area
Tursiops aduncus Spotted Bottlenose Dolphin	Cetacean	Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin	Cetacean	Species or species habitat may occur within area

Places on the RNE [Dataset Information]
Note that not all Indigenous sites may be listed.

Natural

Coastal Islands Mary Anne to Regnard WA

Extra Information

State and Territory Reserves [Dataset Information]

Great Sandy Island Nature Reserve, WA

Caveat

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

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

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

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

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

Only selected species covered by the migratory and marine provisions of the Act have been mapped.

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

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

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

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

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

Acknowledgments

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

- New South Wales National Parks and Wildlife Service
- Department of Sustainability and Environment, Victoria
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Environmental Protection Agency, Queensland
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- National Herbarium of NSW
- Royal Botanic Gardens and National Herbarium of Victoria
- Tasmanian Herbarium
- State Herbarium of South Australia
- Northern Territory Herbarium
- Western Australian Herbarium
- Australian National Herbarium, Atherton and Canberra
- University of New England
- Other groups and individuals

ANUCliM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Last updated:

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Memorandum

Date:	16 November 2006
To:	Jamie Shaw
From:	Richard Sharp
File/ref number:	60019851
Subject:	Balmoral South Project - EPBC Act Analysis

Distribution: Project File

Analysis

Based on the limited information that Paul Holmes and yourself have provided me, I have analysed the proposed action known as the Balmoral South Project and its potential impact on matters of national environmental significance (NES) in the context of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The results of my analysis are as follows:

- I found that the area to be affected by the proposed action is likely to be inhabited by a threatened mammal species known as Mulgara *Dasycercus cristicauda*. This species is listed as vulnerable under the EPBC Act. It inhabits spinifex and colonies of this species are known to occur in drainage lines amongst the sandy plains and sand dunes. I note that the Balmoral South Project is located across the drainage system of the Fortescue River which I assume contains spinifex. If a population of Mulgara exists in the area of the proposed action and this population is a key source population for breeding then it could be considered an important population. This means that any destruction of spinifex or any fragmentation of this important population through the construction of water pipelines or roads is likely to have a significant impact on this vulnerable species.

- I found that the area to be affected by the proposed action is likely to be inhabited by a threatened mammal species known as the Pilbara Leaf-nosed Bat *Rhinonicteris aurantius (Pilbara form)*. This species is listed as vulnerable under the EPBC Act. Colonies of this species are known to roost in abandoned mines and caves. I note that road kills of this species have been recorded in the locality of the Balmoral South Project, near the Fortescue River roadhouse. If a population of the Pilbara Leaf-nosed Bat exists in the area of the proposed action and this population is a key source population for breeding then it could be considered an important population. This means that any modification or destruction to abandoned mines or caves is likely to have a significant impact on this vulnerable species.

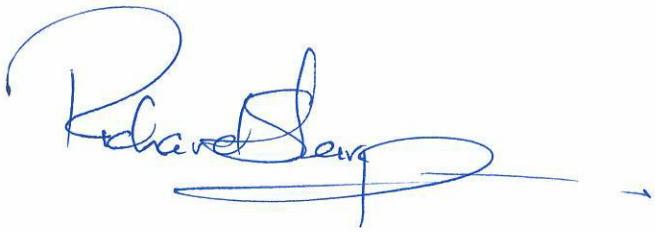
- I found that the area to be affected by the proposed action is likely to be inhabited by a threatened reptile species known as the Olive Python (Pilbara subspecies) *Morelia olivacea barroni*. This species is listed as vulnerable under the EPBC Act. It prefers water holes located in close proximity to rock outcrops. I note that the Balmoral South Project is located across the drainage system of the Fortescue River which I assume contains water holes. If a population of the Olive Python exists in the area of the proposed action and this population is a key source population for breeding then it could be considered an important population. This means that any destruction of rock outcrops near water holes is likely to have a significant impact on this vulnerable species.

- I found that the area to be affected by the proposed action is also likely to contain habitat for two terrestrial and three wetland bird species which are all listed as migratory under the EPBC Act. I note that these migratory species are widely distributed across Australia and therefore I have assumed that the area of the proposed action is not likely to contain important habitat that supports an ecologically significant proportion of the Australian population of each of these bird species.

Recommendation

I am of the opinion that there is exists 'some potential' for the proposed action to impact on nationally listed threatened species and therefore I recommend that the proposed action be referred to the Minister for Environment and Heritage for approval.

It should be noted that there is a degree of uncertainty regarding my findings and that this could be improved if a more detailed description of the affected area was provided for the analysis and that this included vegetation characteristics, water and geological features, and existing developments.



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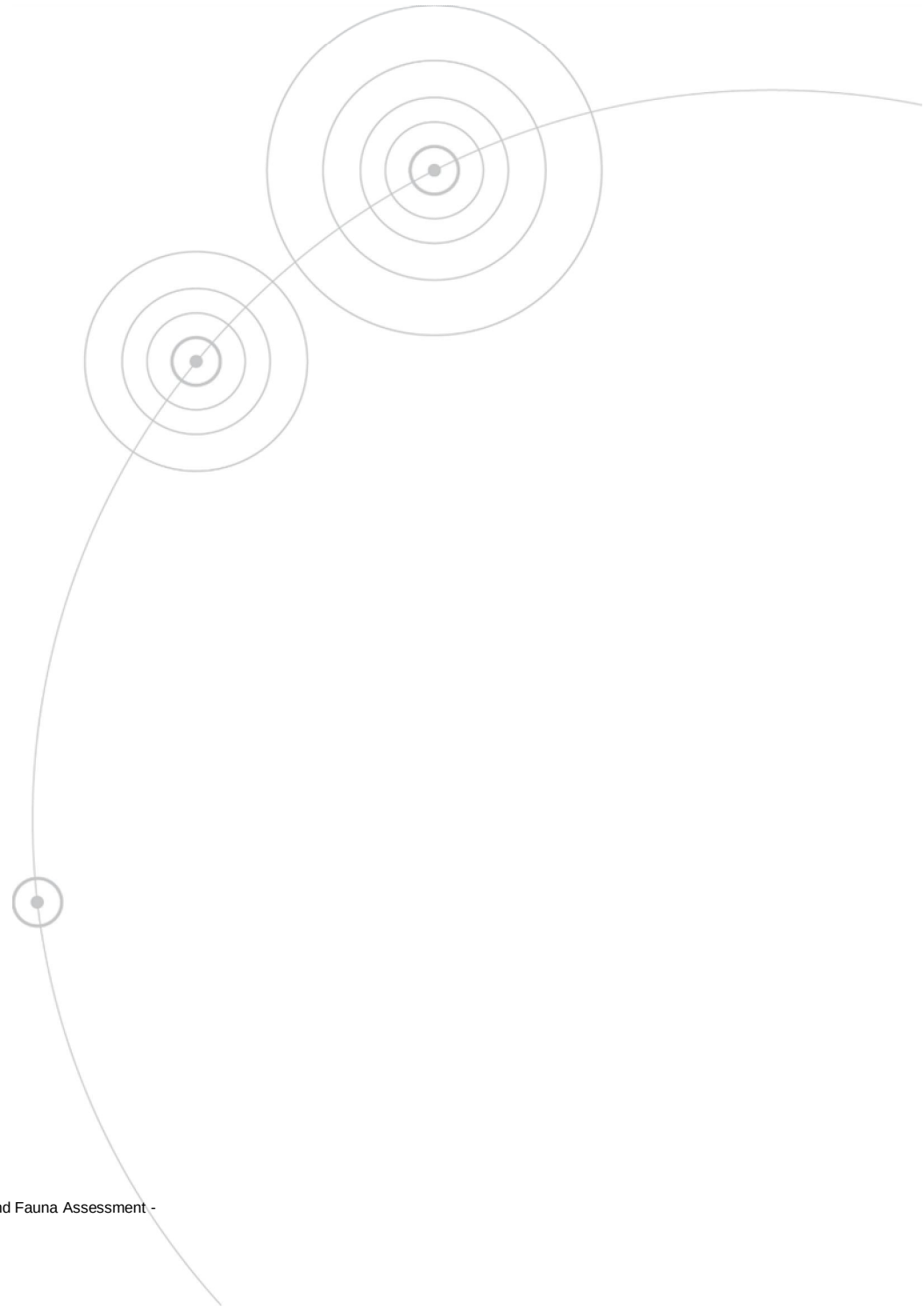
Appendix G: Summary of Vegetation Community Areas within the Project Area



Summary of Vegetation Community Grouped According to Land System Type within Project Area

Land System	Veg. type	Total area (ha)
Boolgeeda	Bx1	127.66
Horseflats	Hp	689.66
Littoral	Lb	1.06
	Ld1	0.23
	Ld2	71.19
	Ld3	8.79
	Ld4	15.1
	Lh2	0
	Lm	13.29
	Lp1	71.97
	Lp3	1.3
	Lp4a	6.55
	Lp4b	5.79
	Lp5	1.52
	Ls1	104.58
	Ls2	37.04
	Ls3a	1.15
	Ls3b	0
Newman	Nc	74.68
	Nh	300.72
	Nh2	80.75
	Nh3	32.38
	Nr3	0.16
N/A	Water course	0
N/A	ROH1	14.98
N/A	Mudflat	16.63

Land System	Veg. type	Total area (ha)
Paraburdoo	Pc	228.82
	Pc2	5.56
	Pc3	1.44
	Pf1	0.02
	Pp1	63.87
	Pp2	40.59
	Px1	559.69
	Px2	935.47
Rocklea	Rc1	10.33
	Rc2	0
	Rc3	10.79
	Rc4	20.85
	ROc2	49.57
	ROc3	0
	ROc5	1.01
	ROpl	33.6
	MR4	226.58
River	Rf1	262.96
	Rf2	169.33
	ROh1a	8.96
	ROh1b	832.63
	ROh2	141.54
	ROr	1.39
	ROr2	0.22
	Total	**5282.45**

Appendix H: 2006 Fauna Survey Report

Balmoral South Iron Ore Project
Fauna Survey

Australasian Resources

December 2006

MAUNSELL | AECOM

Fauna Survey

Prepared for

Australasian Resources

Prepared by

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December 2006

60020130

Quality Information

Document Fauna Survey

Ref 60020130

Date December 2006

Prepared by Ian Harris, Elizabeth Zajc, Clayton Pritchard

Reviewed by Jamie Shaw

For Information

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	11/12/2006			

Table of Contents

1.0 Introduction

The Balmoral South project is based on part of the extensive Balmoral magnetite deposit in the south west Pilbara Region of Western Australia. The Balmoral deposit is located within existing Mining Leases and other *Mining Act* tenements held by Mineralogy Pty Ltd (Mineralogy) and the deposit is divided into the Southern, Central and Northern "blocks". The Balmoral South project focuses on the Southern Block. The project proposed for the Central Block is here referred to as the Mineralogy Project, since they are the proponent for the environmental assessment process.

A fauna survey was completed for the Balmoral South Project Area. The survey was conducted in order to gather data on fauna species richness and distribution throughout the Project Area. The data is used to inform the environmental assessment process for the Project.

Previous fauna surveys for the general project area were conducted for the Mineralogy Project including the mine, plant, tailings and waste dump sites, as well as the conveyor corridor and port facilities (Halpern Glick Maunsell, 2000). This survey indicates fauna diversity which may be present at this adjacent site.

An additional survey was conducted between 21st and 29th October 2006. The work consisted of trapping for frogs, reptiles and mammals within the lease areas; bird surveys on the lease areas and along the Fortescue River and Du Boulay Creek; targeted fauna searches along defined transects; micro-habitat searches; and spot-lighting searches within the lease areas and on adjacent roads. This report discusses the methods and results from this 2006 survey.

1.1 Project Background

The Balmoral South Project will consist of mining of an average of 77Mtpa comprising of 42 Mtpa of iron ore and 35Mtpa of waste for a minimum of 25 years. The ore will be concentrated and processed on-site in preparation for subsequent export through the adjacent Cape Preston port facility (to be built by the Mineralogy Project). Therefore, the project footprint is proposed to consist of the mine, two waste dumps, a tailings dam, a gas power plant, and a concentrator and processing plant complex. Additionally, an accommodation camp will be built on-site to house a portion of the estimated 700 permanent workers for the mine. This footprint area is estimated to be 2,692ha.

1.2 Survey Personnel

The fauna survey was led by Mr. Ian Harris, an experienced fauna biologist. He was assisted by Mr. Clayton Pritchard.

2.0 Methods

The fauna survey was conducted during nine days from 21st to 29th October, 2006. The fauna assessment and preparation of this report have been carried out with reference to the Environmental Protection Authority (EPA) guidance and position statements on fauna surveys (EPA 2002, 2004). The survey was conducted by qualified fauna biologists, and with a systematic sampling effort in order to representatively survey the project area.

2.1 Licences and Permits

The fauna sampling for this survey was conducted under DEC Regulation 17 "Licence To Take For Scientific Purposes" No SF005496.

2.2 Field Survey

The main field component of the fauna survey was conducted between the 21st and 29th of October 2006. Work consisted of:

- trapping for frogs, reptiles and mammals within the lease areas;
- bird surveys on the lease areas, Fortescue River and Du Boulay creek;
- targeted searches along defined transects;
- turning over rocks and searching micro-habitats; and
- spotlighting within the lease areas and on roads adjacent to the lease areas.

Opportunistic observations were made at all times during the field survey.

2.2.1 Survey Locations

Survey locations concentrated on areas which had been under-sampled in previous surveys. Vegetation mapping and aerial photography of the project areas was reviewed prior to the field survey in an effort to locate potential fauna trapping sites. Nominated areas were inspected on site and assessed for suitability and accessibility. Four transect sites were identified, representing a large proportion of the project area. These areas were defined on the requirements of a range of vertebrate species, including reptiles, mammals and birds and were partially dependant on the level of cattle grazing activity in the immediate area.

A description of the habitat and soil types at each trapping transect is provided.

a) Transect 1 – North - Western section of the bore field lease

Location: E 402683.63 N 7655308.79 to E 402937.18 N 7654982.24 (GDA 95 Zone 50). Soil association generally heavy clay with occasional sandy rises. The transect encompassed transitions between vegetation systems SG, LAGS and RF2.

Figure 1 Typical habitat of transect 1

b) Transect 2 – Southern section of bore field

Location: E 404900.30, N7654171.64 to E 404508.44 N 7654513.55 (GDA 94 Zone 50). The soil association is generally heavy clay with occasional stony and sandy rises. The transect encompassed vegetation system RF1.

Figure 2 Typical habitat of Transect 2

c) Transect 3 – North western end of tailings dam

Location: E 413651.26 N 7666543.71 to E 413271.74 N 7666696.26 (GDA 94 Zone 50). Soils were clays and cracking clays that encompassed vegetation systems HP and Px2.

Figure 3 Typical habitat of transect 3.

d) Transect 4 – Eastern block tailings dam and Du Boulay Creek

Location: E 411368 N 7661768 to E 411274.75 N 7662132.55 (GDA 94, Zone 50).

Figure 4 Typical habitat of transect 4.

Bird surveys generally followed the four transects. For each transect, the bird survey extended 500 m beyond the end of the trapping transect. Additionally, bird surveys were conducted along the Fortescue River and Du Boulay Creek. Additional bird transects (BFTs) were located in the survey area.

Numerous non-systematic surveys were conducted to gather additional fauna data for the greater survey area. Night-time spot-lighting surveys were conducted by vehicle and by foot to increase data on fauna diversity in the Project Area.

2.2.2 Trapping for frogs, reptiles and mammals

Methods employed for the sampling of vertebrate species included the use of pitfall, funnel and small box (Elliot) traps within the lease areas. Traps were deployed in four transects with the aim of sampling both differing vegetation communities and soil types (Table 1).

Table 1 Trapping grid locations and trap effort

Site	Location	Date Set-up	Date Closed	Nights Open	Pit Traps	Elliott Traps	Funnel Traps	Pit Trap Effort	Elliott Trap Effort	Funnel Trap Effort	Total Trap Effort (trap nights)
1		21/10/06	27/10/06	5	10	10	10	50	50	50	150
2		22/10/06	27/10/06	5	10	10	10	50	50	50	150
3		23/10/06	28/10/06	5	10	10	10	50	50	50	150
4		24/10/06	29/10/06	5	10	10	10	50	50	50	150
Total								200	200	200	600

Each transect line was approximately 300m and comprised of 10 pitfall traps, each placed at an interval of approximately of 25 - 30m, with Elliott traps placed adjacent to every pitfall (10 Elliott traps per transect). Pitfall traps were 40 L PVC buckets with a 25 cm high flywire drift fence extending approximately 2.5m on either side of the pitfall.

Each pitfall fence was linked to a 15 cm wide and 60 cm long funnel trap. Funnel traps were set up at the end of each drift fence with the funnel's 5cm entrance bisected by the fence. Each funnel trap was covered with shade cloth and, where possible, positioned under the cover of vegetation. Elliott traps were positioned under vegetation to provide maximum cover and baited with a mixture of rolled oats, peanut butter and sardines.

Sampling site selection and trap placement was hampered by intensive trampling by livestock and reduced vegetation cover, presumably caused by grazing pressure. Consequently, the pitfall traps were spaced at 25 – 30 m intervals in order to reduce damage by grazing livestock. The survey did not use continuously linked pitfall traps because interference by cattle was considered likely. By spacing the traps, it was felt that interference by cattle may have been reduced, as all the trap effort was not confined to a single location. Furthermore, spacing the pitfalls allowed a degree of flexibility in placement and helped capture varying soil types over short distances.

Due to the high temperatures during the survey period, trap clearing commenced at first light and was concluded by 8am each day. Elliot traps were closed each morning and then re-opened in the late afternoon. Funnel traps were left unzipped during the heat of the day and then re-set in the late afternoon. The procedure of closing and opening traps, whilst time consuming, was necessary to help reduce the chance of fauna mortality due to over-heating or dehydration.

Each transect was operated for a total of five nights equating to a total of 200 pitfall, 200 Elliott and 200 funnel trap nights.

Taxonomic identification and nomenclature was according to appropriate and current sources. Reptiles taxonomy follows Storr *et al.* (1999), Storr *et al.* (2002) and Cogger (2000); mammal taxonomy follows How *et al*. (2001), Menkhorst and Knight (2004); and frogs nomenclature follows Tyler *et al.* (2000). The taxonomic order of reptiles and mammals presented in this report are generally based on the Western Australian Museum. Where a discrepancy exists between reference, taxonomy follows that used by the Western Australian Museum.

2.2.3 Bird Surveys

Bird sampling was conducted in conjunction with the checking of traps. Both visual and auditory cues were used to identify species, and each sighting was recorded. Bird survey transect, therefore, corresponded to vertebrate trap transects with the addition of extended sampling of approximately 500 m past the last trap. Targeted surveys were also conducted along the Fortescue River, in the central tailings dam area, along Du Boulay Creek and in the central bore field. Opportunistic observations were also recorded whilst driving around site and during night time spotlighting surveys. Avian taxonomy and nomenclature follows Christidis and Boles (1994) and Simpson and Day (1999). The taxonomic order of birds presented in this report follows that of Christidis and Boles (1994).

2.2.4 Spotlighting

Spotlighting surveys were conducted in order to search for nocturnal species. They was conducted on five nights commencing at approximately 1900 hrs and concluded at approximately

2200 hrs. Spotlighting was conducted from a vehicle over all access tracks within the survey areas. Portions of the creek lines within the tailings dam area were traversed on foot.

2.3 Survey Limitations

A number of limitations were experienced during the October 2006 survey. A selection of suitable trapping sites was difficult to establish due to the extent of cattle grazing on Balmoral Station. A large portion of the survey area is currently heavily stocked, and vegetated ground cover in many areas was not present. This extensive grazing resulted in interference with trap lines, particularly at sites one and two. This may have resulted in under-sampling in these areas.

Climatic conditions during the survey also limited trapping duration. The high temperatures increased the demand on trap opening/closing, and this in turn lead to a reduced amount of opportunistic search. Species that are difficult to trap or observe may be under represented in this survey.

Lastly, an extensive bat survey was not conducted as a part of this fauna survey. Bats have been identified as important fauna that may inhabit the Project Area. The schedule 1 species, *Mormopterus loriae cobourgiana* (Little North-Western Bat), has been identified as possibly occurring in the Project Area. Any bat observations were incidental, and the survey did not target bat habitat areas.

3.0 Results

3.1 Desktop Surveys

Initial information was gathered for background fauna information for the Project Area. A search for threatened and priority fauna was conducted to gather information on vulnerable species in the Project Area. A database search was conducted by the Department of Environment and Conservation (DEC), for the project area 21.4707°S 115.882° E / 20.8749°S 116.415°E (Mardie plus 15 km buffer). The search identified one threatened species.

Seven Priority species were identified in the database search. These priority fauna are not necessarily considered threatened under the *Wildlife Conservation Act, 1950*, but they are poorly known or poorly represented in the conservation estate. The four classifications of priority fauna are listed in Table 2.

Table 2 Explanation of Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring

The desktop search for fauna of concern for the Project Area influenced the field survey. Survey personnel were particularly aware of the identification of these species. Targeted surveys were conducted for some of these species. Only one Priority 4 species was identified during the 2006 field survey. The following threatened and Priority fauna were identified in the database search:

3.1.1 Schedule 1

- *Pezoporus occidentalis* (Night Parrot). This species was not recorded during the field survey. It has been recorded approximately 12km south of the search area, where it inhabits areas dominated by *Triodia spp*.

3.1.2 Priority 1

- *Mormopterus loriae cobourgiana* (Little North-western Bat). This species was not recorded during the field survey. It was recorded in 2000 in the mangrove vegetation community at Cape Preston, west of the survey area.

3.1.3 Priority 3

- *Lagorchestes conspicillatus leichardti* (Spectacle Hair Wallaby). This species was not recorded during the field survey. It is known to have declined from many parts of its home range. This species is susceptible to predation by introduced carnivores.

3.1.4 Priority 4

- *Leggadina lakedownensis* (Lakeland Downs Mouse, Kerakenga). This species was not recorded during the field trip. It has been recorded on Mardie station, with three individuals captured or trapped in 2000. Prior surveys (HGM 2001) suggest that the preferred habitat of this species may be crackling clay, as cracking clays are wide-spread throughout the project area. It is expected that this species will occur in the project area.

- *Pseudomys chapmani* (Western Pebble Mound Mouse). This species was not recorded during this field trip. It is known to inhabit low slopes and rocky hills. A single active mound was observed at Mardie in a 2000 survey; however, despite searching the small area of potentially suitable habitat (stony slopes and rises), no evidence of this species was encountered in the project area.

- *Ardeotis australis* (Bustard). This species was recorded at four locations in the survey area, including sites two, three, four and along the Fortescue River. It was also observed outside of the survey area in the general location of the Balmoral shearing shed.

- *Burhinus grallarius* (Bush Stonecurlew). This species was not recorded during this field trip; it was recorded along the North West Coastal Highway in 2000.

- *Numenius madagascariensis* (Eastern Curlew). This species was not recorded during this field survey. It has been recorded along the mud flats adjacent to mangroves west of the Project Area.

3.2 Field Survey

The October 2006 field survey recorded a total of 104 vertebrate species, with faunal groups represented in table 2. A total of 114 individuals were captured, identified at site and released.

Table 3 Total species recorded during field survey

Faunal Group	Total
Native Mammals	6
Introduced Mammals	3
Avifauna	57
Reptiles	37
Amphibians	1
Total	**104**

3.2.1 Reptiles

A total of 37 reptile and one amphibian species were recorded during the October 2006 field survey . The 37 species were represented by 114 individual captures, 39.5% of which were attributed to the Scincidae (Skinks), 28% Gekkonidae (Geckoes) and 20.2% Agamidae (Dragons). The Boidae (Pythons), Elapidae (Front Fanged Snakes), Pygopodidae (Legless Lizards), Typhlopidae (Blind Snakes) and Varanidae (Monitors) all contributed < 5% of total captures. Appendix 1 summarises data recorded for all reptile species recorded. Each species is discussed in the following annotation.

Agamidae

- *Ctenophorus caudicinctus caudicinctus*. Uncommon. One individual was captured at Site 3 (T23) on a stony rise over clay.

- *Ctenophorus isolepis isolepis*. Uncommon. It was recorded from Site 2 at Traps 11 and 13 and at Site 4, Traps 36 and 40. *Triodia* spp. was the dominant vegetation in all areas in which this species was found.

- *Ctenophorus nuchalis*. Uncommon. This species was recorded from Site 2 at Traps 14 and 15 and from Site 4 at Trap 40. All sites were dominated by *Triodia* spp.

- *Lophognathus longirostris*. Common. This species was regularly observed at Site 4 along the creek, and it was trapped at Site 4 in Traps 35 and 38. It was also recorded from vegetated areas along Fortescue River and associated feeder creeks.

- *Tympanocryptis cephalus*. This species is uncommon, with only four individuals trapped at Site 3. All four were captured at Trap 23 on a small rise of stony ground over heavy clay. Individuals ranged in size, indicating that the same individual was not re-captured.

- *Pogona mitchelli*. Individuals captured at Site 2 from Trap 18 where the vegetation was dominated by grasses and *Triodoa* spp.; from Site 3, Traps 23 & 29 on unvegetated areas of stones over clay; and from Site 4 Trap 31, which consisted of course sand dominated by *Triodia* spp.

Boidae

- *Antaresia perthensis*. Only one individual was observed during a spotlighting transect of the northern end of the tailings dam area. This individual was recorded near a rocky ridge on the edge of the lease area.

Elapidae

- *Pseudonaja nuchalis.* One individual was observed dead on a road adjacent to Site 3.

- *Pseudechis australis.* Only one individual was sighted near Trap 10 at Site 1. An individual was also recorded dead on the North west Highway; however, this individual was outside of the survey area.

- *Acanthophis wellsi*. One individual was observed during a spotlighting excursion at the northern end of the tailings dam area. This individual was recorded near a rocky ridge on the edge of the lease area.

Gekkonidae

- *Diplodactylus conspicillatus*. This species is considered relatively common, with individuals captured over a variety of soil and vegetation types at Sites 1, 2, 3, and 4.

- *Diplodactylus savagei*. Only one individual was captured at Site 3 in an area of cracking clays at Trap 30. No other sightings of this species were recorded.

- *Gehyra pilbara.* Two individuals were captured at Sites 2 in cracking clay and at Site 4 along the creek bank in coarse sandy soil.

- *Gehyra variegate.* This is the most common gecko species captured. Individuals were recorded across a range of soil types at Sites 2, 3, and 4.

- *Nephrurus levis occidentalis.* Two individuals were captured: one at Site 4, Trap 40 and one at northern section of the bore field lease.

- *Heteronotia binoei.* Three individuals were captured at Site 4 at Traps 34 & 37 and one individual was captured whilst spotlighting the northern section of the bore field lease.

Pygopodidae

- *Lialis burtonis.* One individual was captured on crackling clays at Site three, Trap 26.

- *Pygopus nigriceps.* Two individuals were captured: one at Site 2 on sandy loam dominated by *Triodia* spp. and one at Site 3 on an area of crackling clay with little ground cover.

Scincidae

- *Ctenotus schomburgkii*. Individuals were captured over a range of soil types including coarse sand, gravel and cracking clays. Captures included: one at Site 1, three at Site 2, one at Site 3 and two at Site 4.

- *Ctenotus duricola.* Two individuals were captured, one at Site 1 in a well grassed area and one at Site three on cracking clays.

- *Ctenotus affin helenae.* Individuals were captured at Sites 1, 2 and 4. With the exception of Site 1, this species was typically captured from areas of stone and gravel substrate dominated by *Triodia* spp. The majority of individuals were captured at Site 4 along Du Boulay Creek.

- *Ctenotus pantherinus ocellifer.* One individual was captured in Trap 32 at Site 4. The soil type at this location was gravel to coarse sand dominated by *Triodia* spp.

- *Ctenotus rufescens.* One individual was captured on a stony rise over clay at Trap 28, Site three.

- *Ctenotus affin robustus.* One individual was recorded at Site three. This species has not yet been classified by the Museum of Western Australia; however, its presence has previously been recorded in the Pilbara. Photographs of this individual were presented to the Museum, and its identity was confirmed.

- *Ctenotus saxatilis.* Two individuals were captured from Traps 35 & 38 at Site 4.

- *Glaphyromorphus isolepis.* There was only one record of this species from Trap 38 along Du Boulay Creek.

- *Lerista bipes.* This species was commonly trapped in the sandy substrates at Site 2, and it was also recorded from Site 1.

- *Lerista muelleri.* Three individuals were captured: one at Site 1 and two from Site 4.

- *Menetia greyii.* Four individuals were captured at Site 1, in areas of grass on clay; two individuals were captured at an area of grass on clay at Site 2; and one individual was captured from a sandy substrate at Site 4.

- *Morethia ruficauda exquisite.* Three individuals were captured among *Triodia* spp. in Trap 15 at Site 2.

- *Notoscincus ornatus ornatus.* One individual was captured at Site 4 in River bank vegetation.

Typhlopidae

- *Ramphotyphlops grypus.* One individual was captured in a grassed area over clay at Site 1.

Varanidae

- *Varanus acanthurus.* Two captured individuals were at Site 1: one in funnel Trap 9 and one in Elliott Trap 10.

- *Varanus brevicauda*. One individual was captured at Site 2 in Trap 12 and another was observed at Trap 14 Site 2.

- *Varanus gigantus.* One individual was recorded as road kill at the northern end of the tailings dam lease.

- *Varanus panopties.* One individual was captured on the access track through the tailings dam lease.

- *Varanus gouldii.* One individual was observed at Site 2 basking at the base of an Acacia tree.

Amphibians

- *Cyclorana maini* (Mains Frog). One individual was recorded whilst spotlighting adjacent to the tailings dam lease area.

3.2.2 Birds

A total of 57 bird species were recorded during the survey of the project area, representing 31 families. The 57 species were represented by approximately 1844 records, 40% of which were attributed to one family group, Cacatuidae, with Galas, Little Corellas and Cockatiels observed in large groups (Appendix 2). The family Passeridae was well represented by *Taeniopygia guttata (*Zebra Finch) accounting for 18% of total sightings and the family Columbidae, represented by *Geophaps plumifera* (Spinifex Pigeon) and *Ocyphaps lophotes (Crested Pigeon)* accounting for 11.3% of sightings. A total of 41 species were represented by less that 30 sightings, with 5 species represented by between 30 - 40 individuals, and they include: *Coturnix ypsilophora* (Brown Quail), *Phalacrocorax sulcirostris* (Little Black Cormorant), *Pelecanus conspicillatus* (Australian Pelican), *Vanellus tricolor (*Banded Lapwing*)* and *Merops ornatus* (Bee Eater).

Of particular interest was the recording of two species listed as migratory species under the *Environmental Protection and Biodiversity Act 1999* (EPBC act):

a) *Merops ornatus* Bee Eater (recorded regularly throughout the survey area), and

b) *Haliaeetus leucogaster* White - bellied sea eagle (one sighting recorded).

Records of breeding behavior were made for only one species, *Dromaius novaehollandiae* (Emu). Two adult males were observed on different occasions, one with four chicks and the other with two chicks. Appendix 2 summarises data recorded for bird species present. Each species is discussed in the following annotation.

Casuariidae

- *Dromaius novaehollandiae* (Emu). Common. This species was recorded on five occasions, from Sites 1, 4, the River, BDT2 and BDT3. Adult birds with chicks were observed on two occasions, at the River and at BDT2.

Phasianidae

- Coturnix ypsilophora (Brown Quail). Common. This species was recorded on five occasions from Sites 1, 2, 4, River and BDT2 in small groups. Individuals were recorded from grasses on each occasion.

Anatidae

- *Anas superciliosa* (Black Duck). Uncommon. Individuals were recorded on three occasions from water holes along the River and Du Boulay Creek.
- *Anas gracilis* (Grey Teal)

Uncommon. This species was recorded on one occasion at the River.

Phalacrocoracidae

- *Phalacrocorax sulcirostris* (Little Black Cormorant). Uncommon. Recorded on two occasions: one flock of 30 individuals was observed on the River and five individuals were observed at Du Boulay Creek.

Pelecanidae

- *Pelecanus conspicillatus* (Australian Pelican). Uncommon. One flock of 33 individuals was observed on the River late in the afternoon.

Ardeidae

- *Ardea pacifica* (White-Necked Heron). Uncommon. This species was recorded at three locations: Site 4, at the River and at BDT3. Individuals were regularly observed at the same water bodies each day, indicating the same birds were regularly seen.

- *Egretta garzetta* (Little Egret). Uncommon. Individuals were recorded from three locations: Site 4, the River and BDT3. Individuals were sighted daily at the same locations.

- *Egretta novaehollandiae* (White-Faced Heron). Uncommon. Individuals were recorded from three locations: Site 4, the River and BDT3. Individuals were sighted daily at the same locations.

Threskiornidae

- *Threskiornis spinicollis* (Straw Necked Ibis). Uncommon. Individuals were recorded on three occasions from Site 4, the River and BDT3; at each time they were observed foraging adjacent to remaining water bodies.

Accipitridae

- *Accipiter fasciatus* (Brown Goshawk). Uncommon. This species was recorded on three occasions from Sites 3, 4 and the River. Two individuals were observed whilst flying and the third individual was observed while perched on a dead trees.

- *Aquila audax* (Wedge - Tail Eagle). Uncommon. This species was recorded on six occasions from Sites 1, 2, 3, 4, the River and BDT1. These same individuals may have been observed more than once.

- *Milvus migrans affinis* (Black Kite). Scarce. A single bird was observed on three occasions at Sites 3, the River and BDT2.

- *Hieraaetus morphnoides* (Little Eagle). Single individuals were observed on different days at three locations: Sites 2, 4 and the River. These sightings were possibly the same individuals.

- *Haliastur sphenurus* (Whistling Kite). A single bird was recorded on different days at Sites 3, 4, the River and BDT2. Three sightings at the River transect possibly reflect observation of the same individual.

- *Haliaeetus leucogaster* (White - Bellied Sea Eagle). There was a single sighting of this species at the River. The individual was observed moving along the River between two large water bodies.

Falconidae

- *Falco berigora* (Brown Falcon). This species was observed on only two occasions: once at Site 3 and once at the River.

- *Falco cenchroides cenchroides* (Nankeen Kestrel). Individuals were recorded at three locations: Sites 2,4 and the River.

Gruidae

- *Grus rubicunda* (Brolga). Three individuals were recorded daily at the same large body of water along the River.

Otididae

- *Ardeotis australis* (Australian Bustard). This species was recorded once at four locations: Sites 2, 3, 4 and the River. It was also observed on Balmoral adjacent to the shearing shed and on the road linking Northwest Highway. Both sites are outside of the Project Area.

Turnicidae

- *Turnix velox* (Little Button Quail). Uncommon. This species was recorded at two locations: Site 1 and at the River. On both occasions it was observed in pairs.

Charadriidae

- *Elseyornis melanops* (Black Fronted Dotterel). Four pairs were recorded regularly at the same large body of water along the River.

- *Vanellus tricolor* (Banded Lapwing). Common. This species was recorded at seven locations: Sites 1, 2 ,3, 4, the River, BDT1 and BDT3. As many as twelve individuals were observed at one time. This species was observed at livestock watering points throughout the greater area.

Laridae

- *Sterna caspia* (Caspian Tern). Uncommon. A single individual was recorded at two locations: Site 4 and the River. Individuals were observed flying low over water bodies, circling, and then landing at the water's edge.

Columbidae

- *Ocyphaps lophotes* (Crested Pigeon). Common. This species was recorded at seven sites in large groups. Large flocks were observed at water bodies and stock troughs. Also, this species was observed as individuals or pairs throughout the greater area.

- *Geophaps plumifera* (Spinifex Pigeon). Common. This species was recorded at all locations. Large flockls were observed along the River and stony creek lines. It was often observed at stock watering points and along access tracks throughout the site.

- *Geopelia cuneata* (Diamond Dove). A single pair was recorded from Site 4 adjacent to a creek line, and a group of six individuals were recorded at the River.

- *Geopelia striata placida* (Peaceful Dove). This species was recorded at three locations, each time adjacent to the River or creek lines. The largest group recorded comprised of four individuals drinking at the River.

Cacatuidae

- *Nymehicus hollandicus* (Cockatiel). Common. This species was observed in flocks of up to 30 at Sites 1, 2, 3, 4, the River and BDT3. It was regularly seen throughout survey area, particularly during the early morning along the River.

- *Cacatua roseicapilla* (Galah). Common. This species was observed in large flocks at all sites except for Site BDT1. It was observed in large numbers around water holes and stock troughs.

- *Cacatua sanguinea* (Little Corella). Common. This species was observed in large flocks at Sites 1, 2, 4, the River and BDT2. It was observed in large numbers around water holes and stock troughs.

Psittacidae

- *Melopsittacus undulatus* (Budgerigar). Uncommon. One flock of approximately 20 individuals was recorded from Site 1 late in the afternoon.

Cuculidae

- *Cuculus pallidus* (Pallid Cuckoo). Uncommon. Individuals were recorded form Sites 4 and the River. Both individuals were observed in *Eucalyptus* sp. adjacent to a water body.

Podargidae

- *Podargus streigoides* (Tawney Frogmouth). Uncommon. A single individual was recorded whilst spotlighting along the River.

Caprimulgidae

- *Eurostopodus argus* (Spotted Nightjar). Uncommon. A single individual was observed whilst spotlighting on the main access track adjacent to the River.

Halcyonidae

- *Dacelo leachii leachii* (Blue Winged Kookaburra). Uncommon. A single individual was recorded on one occasion from the River. The individual was recorded drinking from a water body early in the morning.

- Todiramphus sanctus (Sacred Kingfisher). Uncommon. Individuals were recorded at Sites 4, the River and BDT3. Each individual was recorded adjacent to water bodies.

Meropidae

- Merops ornatus (Bee Eater). Common. Recorded from Sites, 2, 3, 4, river, BDT2 and BDT3. Often observed along the banks of water courses in small groups and feeding as singles or in pairs above survey areas.

Maluridae

- *Malurus lamberti* (Variegated Fairy Wren). This species was recorded from five locations: Sites 1, 2, 4, the River and BDT1. This species was generally observed in association with small shrubs.

- *Malurus leucopterus* (White Winged Fairy wren). Uncommon. This species was observed at Site 2 and one sighting at the River. It was often heard at Site 2 but only visually recorded twice, and both observations may have been the same individual.

Pardalotidae

- Gerygone tenebrosa (Dusky Gerygone) Uncommon. Individuals were recorded at Sites 2, 4 and the River. Individuals were observed in the crowns of large eucalyptus trees.

Meliphagidae

- *Lichmera indistincta indistincta* (Brown Honeyeater). Uncommon. This species was recorded at Sites 4, the River, BDT2 and BDT3, and it was seen as individuals or pairs. It was only recorded once from each site.

- *Lichenostomus virescens* (Singing Honeyeater). This species was recorded at Sites 1, 2, 3, 4 and the River. However, only single birds or pairs were observed. It was also observed outside of the project area closer to the coast.

- *Manorina flavigula* (Yellow Throated Miner). Moderately common. This species was recorded at sites 1, 2, 4, the River, BDT2 and BDT3 with greater numbers observed along the River and creek line of Site 4.

Dicruridae

- *Grallina cyanoleuca* (Magpie Lark). Moderately common. This species was observed at Sites 3, 4, the River and BDT1, with larger numbers recorded from along the creek at Site 4 and the River.

- *Rhipidura leucophrys* (Wagtails). Moderately common. This species was recorded at all sites with the exception of Site BDT2. It was recorded as individuals at all sites.

Campephagidae

- *Coracina novaehollandiae* (Cuckoo Shrike)

Common. This species was recorded from all sites as individuals or in pairs. Greater numbers were observed along the creek at Site 4 and the River.

Artamidae

- *Artamus cinereus* (Black Faced Woodswallow). Uncommon. This species was recorded from at sites, 1, 2, 3, 4, and river. Recorded as individuals or in pairs.

- *Artamus minor* (Little Woodswallow). Uncommon. One pair was recorded at Sites 1 and individuals were observed at Sites 3 and 4.

- *Cracticus nigrogularis* (Pied Butcherbird). Uncommon. This species was recorded along the creek at Site 4 and the River. Repeated sightings at Site 4 indicate that it may have been the same individual.

- *Artamus personatus* (Masked Woodswallow). Uncommon. Pairs were observed at Sites 3, the River and BDT2. Individuals were recorded at Site 4.

- *Gymnorhina tibicen* (Magpie). Uncommon. An individual was recorded from the creek line at Site 4 and one individual was observed drinking at the River.

Corvidae

- *Corvus orru* (Torresian Crow). Uncommon. This species was recorded on six occasions from Sites 1, 2, 3, 4, the River and BDT2, and they were mostly observed in pairs.

Motacillidae

- *Anthus novaeseelandiae* (Richards Pipit). Uncommon. Individuals were recorded at Sites 2, 4 and the River.

Passeridae

- *Taeniopygia guttata* (Zebra Finch). Common. This species was observed in large numbers at all occasions, particularly from around water bodies and stock troughs.

Hirundinidae

- *Hirundo neoxena* (Welcome Swallow). Uncommon. Two individuals were recorded at the River. Another possible sighting was at the Fortescue River Bridge, outside of the survey area.

- *Hirundo nigricans* (Tree Martins). Uncommon. This species was seen in pairs or individuals along the River on numerous occasions.

3.2.3 Native Mammals

A total of nine mammal species were recorded during the field survey, including six native species and three introduced species. The most commonly recorded native species was *Macropus robustus erubescens* (Euro) and *Macropus rufus* (Red Kangaroo). Moderate numbers of both these species were recorded early in the mornings and during spotlighting events, often with young at foot.

Whilst searching the remains of the old shearer's quarters on Balmoral station, approximately ten bats were recorded roosting in old cupboards. Three individuals were captured and identified as belonging to the family *Vespertilionidae*. Positive identification of these individuals beyond the family group was not achieved. Although these bats were not located within the lease area, they would be expected to feed around water bodies, such as the Fortescue River and so were included in the results.

The species *Sminthopsis macroura* (Stripe Faced Dunart) and *Pseudomys hermannsburgensis* (Inland Sandy Mouse) were also recorded during the field survey. Scats of *Tachyglossus acueatu*s (Echidna) were also observed. Appendix 3 summarises mammal species recorded, and each species is discussed in the following annotation.

Tachyglossidae

- *Tachyglossus acueatus* (Echidna). Scats of this species were observed on a rocky out-crop at the northern end of the tailings dam area. Prior to the October field survey, one individual was recorded by the botanical team to the west of the tailings dam area.

Dasyuridae

- *Sminthopsis macroura* (Stripe Faced Dunnart). Four individuals were captured: two from a sparse area of *Triodia* spp. at Traps 13 and 12 at Site 2 and two at Site 4, Trap 40, an area dominated by *Triodia* spp.

Macropodidae

- *Macropus robustus erubescens* (Euro). Common. The Euro was commonly sighted during the day along creek lines at Sites 4, the River and BDT3. This particular species was recorded in abundance on spotlighting excursions through out the survey area, particularly on grassy plains.

- *Macropus rufus* (Red Kangaroo). Common. This species was recorded at all sites with the exception of Site 2. It was commonly sighted early in the morning and on spotlighting excursions throughout the study areas and beyond.

Muridae

- *Pseudomys hermannsburgensis* (Inland Sandy Mouse). Two individuals were captured at Site 2 in Traps 11 and 12.

Vespertilionidae

- *Vespertilionidae* spp. Approximately ten individuals were observed in old cupboards in the Balmoral shearing quarters adjacent to the survey area.

3.2.4 Introduced Mammals

A number of introduced mammals were observed at the project site.

Muridae

- *Mus musculus* (House Mouse). Four individuals were captured at Site 2, three of which were captured from Trap 19 on different days. This suggests that the same animal may have been captured repetitively.

Canidae

- *Canis lupus dingo* (Dingo). A single set of large dog tracks was observed on the track that bisects Site 4 at Du Boulay Creek.

Felidae

- *Felis catus* (Feral Cat). A single individual was recorded during a spotlighting excursion at the northern section of the bore field location.

4.0 Discussion

4.1 Reptiles

The October 2006 survey recorded 37 species and this confirmed that the Project Area supports a diverse reptilian assemblage. The diversity of species recorded can partly be attributed to the range of habitats sampled, with creek lines and cracking clays dominated by *Triodia* spp. yielding the highest number of species. The species *Ctenotus* aff *robustus* has not yet been described, and its distribution is poorly understood. However, it has been recorded in previous surveys throughout the Pilbara region. Further sampling of the area would be required to determine its distribution.

A search of the Western Australian Museums Fauna Base identified a potential 65 reptile species occurring in this region. Biota Environmental services identified 60 species during a 2000 survey in an area adjacent to the proposed development site. The relatively high number of species recorded may reflect the size of the survey area and the range of habitat sites encountered. It should be noted that many of the expected species prefer rocky habitats, which comprise only a very small proportion of the survey area.

4.2 Birds

The majority of species recorded during the field survey were identified along the Fortescue River and relatively well-vegetated creek lines. Most of the species observed in these areas were recorded in ephemeral pools. Three species of conservation significance were recorded:

- White - Bellied Sea Eagle (EPBC listed as migratory);
- Rainbow Bee Eater (EPBC listed as migratory); and
- Bustard (Priority four).

Simpson and Day (1999) describe the habitat of the White Bellied Sea Eagle as large rivers, lakes coastal seas and islands. This species is considered widespread but erratic in distribution and rarely common (Flegg 2002).

The Rainbow Bee Eater was observed on numerous occasions, particularly along the River and creek lines. They are widespread in distribution. They prefer to excavate burrows for the purpose of breeding, and they often use the banks of rivers and streams. Flegg (2002) described the Rainbow Bee Eater as quite common.

The Australian Bustard is a nomadic species that prefers open grassland, light scrub, open woodland and occasionally agricultural fields (Flegg 2002). It has declined in numbers as a result of disturbances such as the introduction of predators, land clearing, livestock grazing and illegal hunting. This species is regarded as wide spread, but generally scarce.

4.3 Mammals

No mammal species of conservation significance were recorded during the field survey. A targeted search of low stony rises failed to identify any signs of the priority species *Pseudomys*

chapmani (Western Pebble Mound Mouse) and targeted trapping of cracking clays failed to record *Leggadina lakedownensis* Lakeland Downs Mouse. This may have been partly due to unsuitable habitat and many years of livestock grazing.

4.4 Conclusions and Recommendations

The number of species recorded in creek lines and along the Fortescue River suggests that these areas are of significance to local vertebrate populations. Consequently, disturbance of these areas should be minimised as much as possible. The general Project Area did not appear to contain habitat unique to the area. In fact, many years of livestock grazing has reduced the quality of available fauna habitat.

As a result of the October 2006 field survey the following recommendations are made:

- Conduct bat census in the project area to determine if the Schedule 1 species *Mormopterus loriae cobourgiana* (Little North-Western Bat) is present;
- Plan construction activities to minimise the impacts on the Fortescue River and Du Boulay Creek by the creation of buffer zones around water courses;
- Conduct groundwater modelling to determine the effects on the Fortescue River vegetation;
- Develop and implement environmental awareness training for all site personnel, including awareness of local fauna and the potential for road kills;
- Conduct an additional vertebrate fauna survey in autumn, as per Environmental Protection Authority (EPA) guidelines for Level Two surveys;
- Develop ongoing fauna monitoring program, including the monitoring of fauna sightings and fauna fatalities; and
- Liaise with DEC in relation to potential effects on Migratory species.

5.0 References

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Appendix 1 Reptile Survey Results

Species	Site 1	Site 2	Site 3	Site 4	Spot 1	Spot 2	Total
Agamidae							
Ctenophorus caudicinctus caudicinctus			1				**2**
Ctenophorus isolepis isolepis		3		4			**7**
Ctenophorus nuchalis		2		1			**3**
Lophognathus longirostris				2			**2**
Pogona mitchelli		1	2	2			**5**
Tympanocryptis cephalus			4				**4**
Boidae							
Antaresia perthensis					1		**1**
Elapidae							
Acanthophis wellsi					1		**1**
Pseudechis australis	1						**1**
Pseudonaja nuchalis			1				**1**
Furina ornata					1		**1**
Gekkonidae							
Diplodactylus conspicillatus	4	3	2	1			**10**
Diplodactylus savagei			1				**1**
Gehyra pilbara		1		1			**2**
Gehyra variegata		1	9	5			**15**
Heteronotia binoei				3		1	**3**
Nephrurus levis occidentalis				1		1	**1**
Pygopodidae							
Lialis burtonis			1				**1**
Pygopus nigriceps		1	1				**2**
Scincidae							
Ctenotus schomburgkii	1	3	1	2			**7**
Ctenotus duricola	1		1				**2**
Ctenotus affin helenae	1	3		5			**9**
Ctenotus pantherinus ocellifer				1			**1**
Ctenotus rufescens			1				**1**
Ctenotus affin robustus			1				**1**
Ctenotus saxatilis				2			**2**
Glaphyromorphus isolepis				1			**1**

Species	Site 1	Site 2	Site 3	Site 4	Spot 1	Spot 2	Total
Lerista bipes	1	6					**7**
Lerista muelleri	1			2			**3**
Menetia greyii	4	2		1			**7**
Morethia ruficauda exquisita		3					**3**
Notoscincus ornatus ornatus				1			**1**
Typhlopidae							
Ramphotyphlops grypus	1						**1**
Varanidae							
Varanus acanthurus	2						**2**
Varanus brevicauda		1					**1**
Varanus gigantus					1		**1**
Varanus gouldii		1					**1**
Varanus panopties			1				**1**
Total	16	30	27	35	6	2	
	114						**37**
Amphibians							
Cyclorana maini (Mains Frog)					1		**1**

Appendix 2 Bird Survey Results

	1	2	3	4	River	BDT1	BDT2	BDT3	Total
Casuariidae									
Dromaius novaehollandiae (Emu)	4			2	6		6	1	**19**
Phasianidae									
Coturnix ypsilophora (Brown Quail)	6	8		4	10		6		**34**
Anatidae									
Anas superciliosa (Black Duck)				5	10			3	**18**
Anas gracilis (Grey Teal)					3				**3**
Phalacrocoracidae									
Phalacrocorax sulcirostris (Little Black Cormorant)				5	30			1	**36**
Pelecanidae									
Pelecanus conspicillatus (Australian Pelican)					33				**33**
Ardeidae									
Ardea pacifica (White-necked Heron)				10	15			3	**28**
Egretta garzetta (Little Egret)				2	5			2	**9**
Egretta novaehollandiae (White -faced Heron)				6	3			1	**10**
Threskiornidae									
Threskiornis spinicollis (Straw -necked Ibis)				2	5			2	**9**

	1	2	3	4	River	BDT1	BDT2	BDT3	Total
Accipitridae									
Accipiter fasciatus (Brown Goshawk)			1	1	2				**4**
Aquila audax (Wedge - tail Eagle)	2	2	1	1	4	2			**12**
Milvus migrans affinis (Black kite)			1		1		1		**3**
Hieraaetus morphnoides (Little Eagle)		2		1	2				**5**
Haliastur sphenurus(Whistling Kite)			2	1	3		1		**7**
Haliaeetus leucogaster (White - bellied Sea Eagle)					1				**1**
Falconidae									
Falco berigora (Brown Falcon)			1		1				**2**
Falco cenchroides cenchroides (Nankeen Kestral)		1		1	1				**3**
Gruidae									
Grus rubicunda (Brolga)					3				**3**
Otididae									
Ardeotis australis (Australian Bustard)		2	2	2	4				**10**
Turnicidae									
Turnix velox (Little Button Quail)	2				2				**4**
Charadriidae									
Elseyornis melanops (Black fronted Dotterel)					8				**8**
Vanellus tricolor (Banded Lapwing)	6	6	10	8	3	12		3	**48**
Laridae									
Sterna caspia (Caspian Tern)				1	1				**2**

	1	2	3	4	River	BDT1	BDT2	BDT3	Total
Columbidae									
Ocyphaps lophotes (Crested Pigeon)	6	12	16	25	30	10		3	**103**
Geophaps plumifera (Spinifex Pigeon)	4	10	10	36	20	6	13	6	**105**
Geopelia cuneata (Diamond Dove)				2	6				**8**
Geopelia striata placida (Peaceful Dove)				1	4		2		**5**
Cacatuidae (Cockatoos)									
Nymehicus hollandicus (Cockatiel)	13	10	20	20	30			7	**100**
Cacatua roseicapilla (Galah)	10	50	50	100	100		18	12	**340**
Cacatua sanguinea (Little Corella)	16	60		100	100		21		**297**
Psittacidae									
Melopsittacus undulatus (Budgerigar)	20								**20**
Cuculidae									
Cuculus pallidus (Pallid Cuckoo)				1	1				**2**
Podargidae									
Podargus streigoides (Tawney Frogmouth)					1				**1**
Caprimulgidae									
Eurostopodus argus (Spotted Nightjar)					1				**1**
Halcyonidae									
Dacelo leachii leachii (Blue -winged Kookaburra)					1				**1**

	1	2	3	4	River	BDT1	BDT2	BDT3	Total
Todiramphus sanctus (Sacred Kingfisher)				1	1			1	**3**
Meropidae									
Merops ornatus (Bee Eater)		10	2	4	10		4	2	**32**
Maluridae									
*Malurus lamberti (*Variegated fairy - wren)	2	6		2	2	4			**16**
*Malurus leucopterus (*White – winged Fairy – wren)		4			2				**6**
Pardalotidae									
Gerygone tenebrosa (Dusky Gerygone)		2		1	2				**5**
Meliphagidae									
Lichmera indistincta indistincta (Brown Honeyeater)				2	1		1	2	**6**
Lichenostomus virescens (Singing Honeyeater)	1	2	1	1	4				**9**
Manorina flavigula (Yellow Throated Minor)	2	2		5	4		2	2	**17**
Dicruridae									
Grallina cyanoleuca (Magpie Lark)			1	6	8	2			**17**
Rhipidura leucophrys (Wagtails)	1	1	1	3	3	1		1	**11**
Campephagidae									
Coracina novaehollandiae (Cuckoo Shrike)	2	3	2	6	11	2	3	1	**30**
Artamidae									
Artamus cinereus (Black faced Woodswallow)	4	4	3	3	2				**16**

	1	2	3	4	River	BDT1	BDT2	BDT3	Total
Artamus minor (Little Woodswallow)	2		1	1					**4**
Artamus personatus (Masked Woodswallow)			2	3	2		2		**9**
Cracticus nigrogularis (Pied Butcherbird)				3	2				**5**
Gymnorhina tibicen (Magpie*)*				1	1				**2**
Corvidae									
Corvus orru (Torresian Crow)	1	2	4	2	2		2		**13**
Motacillidae									
Anthus novaeseelandiae (Richards Pipit)		1		1	1				**3**
Passeridae									
Taeniopygia guttata (Zebra Finch)	100	30	32	> 30	100	20	9	13	**334**
Hirundinidae									
Hirundo neoxena (Welcome Swollow)					2				**2**
Hirundo nigricans (Tree martins)					10				**>10**
	20	**23**	**21**	**42**	**55**	**9**	**15**	**19**	
Total Species	**57**							**Total**	**1844**

Appendix 3 Mammal Survey Results

C = Common, T = Tracks and S = Scats

Mammals	Site 1	Site 2	Site 3	Site 4	River	BDT1	BDT2	BDT3	Total
Tachyglossidae									
Tachyglossus acueatus (Echidna)	S								1
Dasyuridae									
Sminthopsis macroura (Stripe Faced Dunart)		2		2					4
Macropodidae									
Macropus robustus erubescens (Euro)				C	C			C	C
Macropus rufus (Red Kangaroo)	C		C	C	C	C	C	C	C
Muridae									
Mus musculus (House Mouse)		4							2
Pseudomys hermannsburgensis (Inland Sandy Mouse)		2							3
Vespertilionidae									
Vespertilionidae spp									10
Felidae									
Felis catus (Feral Cat)	1								1

Mammals	Site 1	Site 2	Site 3	Site 4	River	BDT1	BDT2	BDT3	Total
Canidae									
Canis lupus dingo (Dingo)				T					T
									9

Appendix I: Recommended Weed Control Methods

Algaroba (**Prosopis pallida*)

Category: P1

Location: for the whole of the State.

Category: P2

Location: for the whole of the State, except for the area on Mardie Station bordered by the coast, the boundary between Mardie and Karratha stations, the North West Coastal Highways, Peter's Creek and the boundary between Yarraloola and Mardie stations.

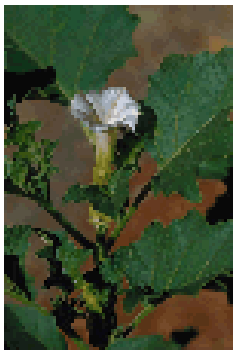
Category: P4

Location: for the area on Mardie Station bordered by the coast, the boundary between Mardie and Karratha stations, the North West Coastal Highway, Peter's Creek and the boundary between Yarraloola and Mardie stations.

Standard Control Codes (these may vary for individual plants)

P1 **REQUIREMENTS** Prohibits movement	The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2 **REQUIREMENTS** Aims to eradicate infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.
P4 **REQUIREMENTS** Aims to prevent infestation spreading beyond existing boundaries of infestation.	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants:- • within 100 metres inside of the boundaries of the infested property • within 50 metres of roads and highwater mark on waterways • within 50 metres of sheds, stock yards and houses Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.

Native Thornapple (**Datura leichhardtii*)



Category: P1

Location: for the whole of the State except the municipal districts of Ashburton, Broome, Derby-West Kimberley, East Pilbara, Halls Creek, Port Headland, Roeburne and Whyndam-East Kimberley.

Category: P3

Location: for the municipal districts of the City of Albany, Broomehill, Chapman Valley, Collie, Cranbrook, Denmark, Dumbleyung, the City of Geraldton, Greenough, Harvey, Irwin, Jerramungup, Gnowangerup, Katanning, Kent, Kojonup, Mandurah, Mullewa, Murray, Northampton, Plantagenet, Ravensthorpe, Serpentine-Jarrahdale, Tambellup, Wagin, Waroona, West Arthur and Woodanilling.

Category: P4

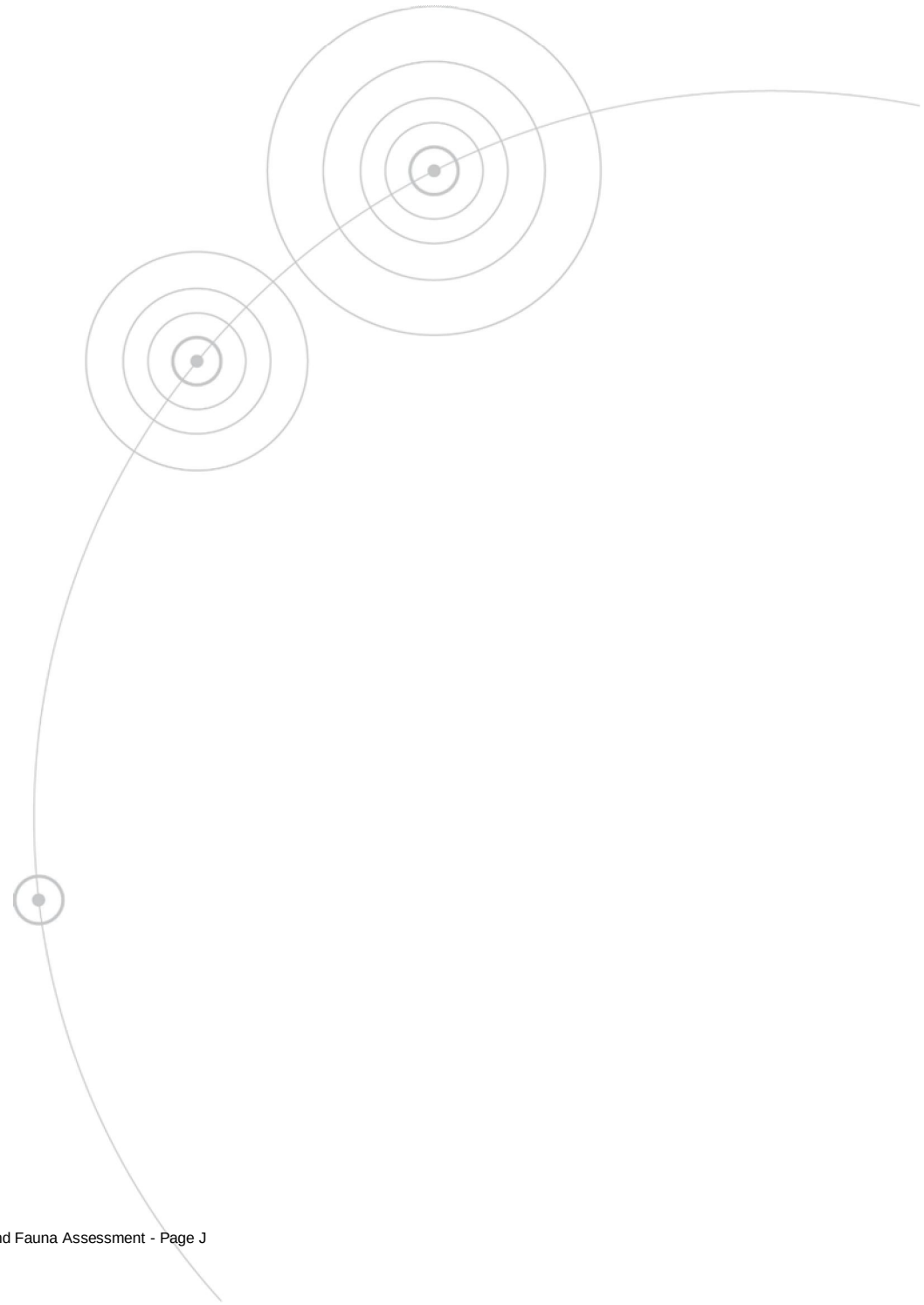
Location: for the municipal districts of Augusta-Margaret River, Boddington, Boyup Brook, Bridgetown-Greenbushes, Brookton, Bruce Rock, the City of Bunbury, Busselton, Capel, Carnarvon, Chittering, Coolgardie, Corrigin, Cuballing, Cue, Cunderdin, Dandaragan, Dalwallinu, Dardanup, Donnybrook-Balingup, Dowerin, Dundas, Esperance, Exmouth, Gingin, the City of Kalgoorlie-Boulder, Kelleberrin, Koorda, Laverton, Leonora, Manjimup, Meekatharra, Menzies, Merredin, Moora, Mt Magnet, Mt Marshall, Mukinbudin, Murchison, Nannup, Narembeen, Narrogin, Nungarin, Ngaanyatjarraku, Pingelly, Sandstone, Shark Bay, Tammin, Trayning, Upper Gascoyne, Victoria Plains, Wandering, Westonia, Wickepin, Wiluna, Williams, Wongan-Ballidu, Wyalkatchem, Yalgoo and Yilgarn.

Standard Control Codes (these may vary for individual plants)

P1 REQUIREMENTS Prohibits movement	The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P3 REQUIREMENTS Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants:- • Within 100 metres inside of the boundaries of the infestation • within 50 metres of roads and highwater mark on waterways • within 50 metres of sheds, stock yards and houses Treatment must be done prior to seed set each year. Of the remaining infested area:- Where plant density is 1-10 per hectare treat 100% of infestation. Where plant density is 11-100 per hectare treat 50% of infestation. Where plant density is 101-1000 per hectare treat 10% of infestation.

	Properties with less than 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.
P4 **REQUIREMENTS** Aims to prevent infestation spreading beyond existing boundaries of infestation.	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants:- • within 100 metres inside of the boundaries of the infested property • within 50 metres of roads and highwater mark on waterways • within 50 metres of sheds, stock yards and houses Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.

Appendix J: Targeted Fauna Desktop Assessment



PHOENIX
ENVIRONMENTAL SCIENCE

Maunsell AECOM / International Minerals Pty Ltd

Targeted Fauna Assessment (Mulgara and Pilbara Olive Python)

Balmoral South (Stage 1)

Cape Preston Iron Ore Project

Version 2

September 2008

Targeted Fauna Assessment (Mulgara and Pilbara Olive Python)

Project: Balmoral South Stage 1

Prepared for Maunsell AECOM on behalf of International Minerals Pty Ltd

Prepared by: Phoenix Environmental Sciences Pty Ltd

Author:	Morgan O'Connell, Jarrad Clark
Reviewer:	Karen Crews
Version:	2
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CONTENTS

TABLES AND FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND

International Minerals Pty Ltd intends to develop the Balmoral South (Stage 1) Iron Ore Project within the Cape Preston Iron Ore Precinct, located approximately 80km south-west of Karratha, Western Australia. Maunsell Pty Ltd, on behalf of International Minerals, is preparing the Public Environmental Review for the proposal which is due to be submitted to the Environmental Protection Authority in September 2008.

Two previous biological surveys have been undertaken in the Balmoral South project area:

- Austeel Biological Survey Phase 1 (Biota and Trudgen, 2001); and
- Balmoral South Environmental Impact Assessment Flora and Fauna Survey (Maunsell AECOM, 2006).

A desktop assessment as part of the latter survey suggested the potential for Mulgara (*Dasycercus cristicauda*) and Olive Python (*Liasis olivacea barroni*[1]), both species of national significance listed under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), to occur in the area. However, neither survey identified either species as occurring within the project area.

Comments subsequently received by Maunsell from the Department of the Environment, Water, Heritage and the Arts (DEWHA) indicate that targeted surveys to determine the presence of, or suitability to support, Mulgara and Pilbara Olive Python are required in suitable habitat within the project footprint for International Minerals (Figure 1).

1.2 SCOPE OF WORK / OBJECTIVES

Phoenix Environmental Science Pty Ltd (Phoenix) has been commissioned by Maunsell AECOM to assess the likelihood of two species, Mulgara (*Dasycercus cristicauda*) and Pilbara Olive Python (*Liasis olivaceus barroni*) (referred to as *Morelia olivacea barroni* in Maunsell AECOM 2006), occurring within the study area marked in green in Figure 1. The scope of work was limited a desktop review of available literature and publicly accessible databases followed by a field-based habitat assessment, which was incorporating into other fauna surveys taking place at the time.

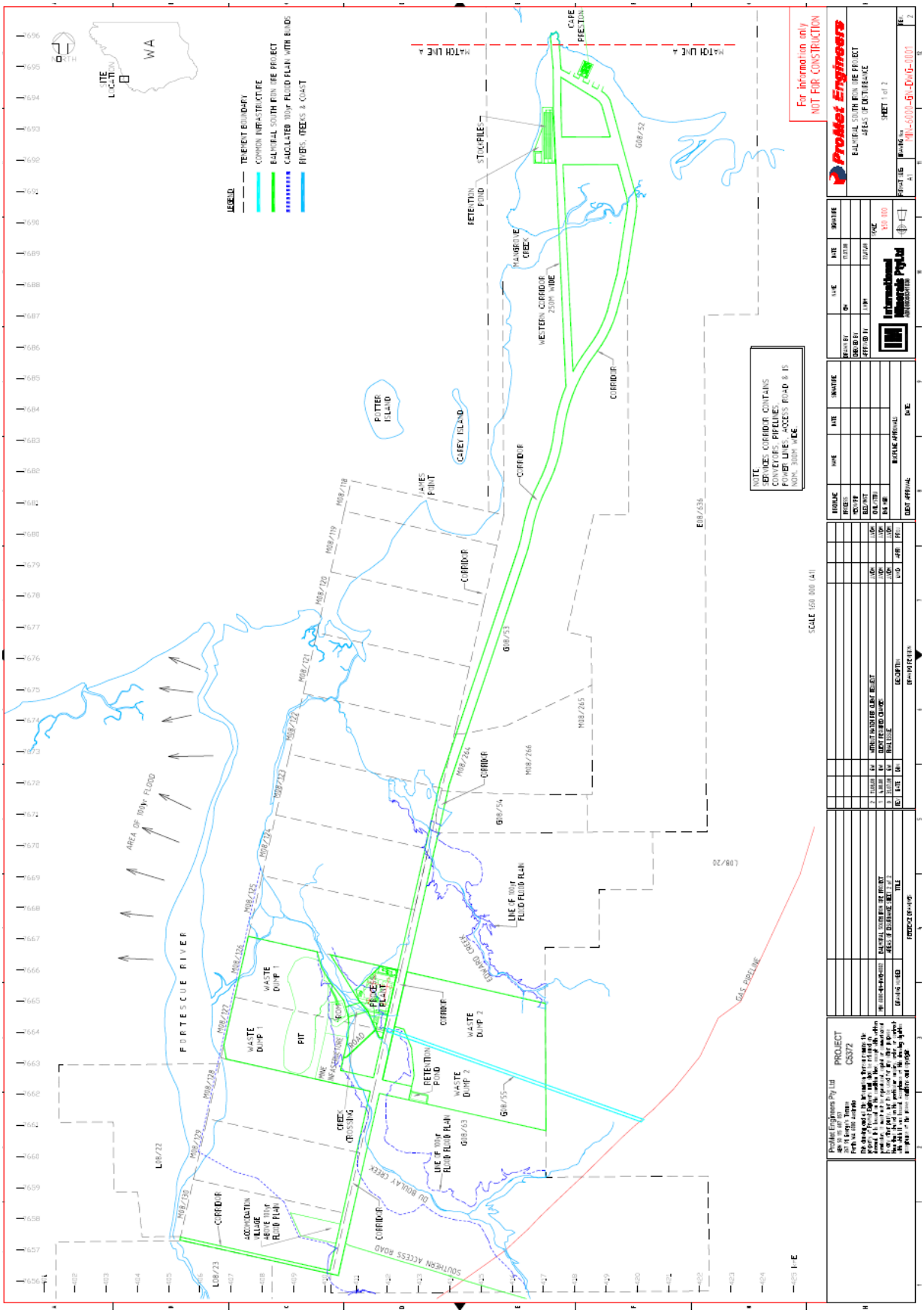

Figure 1-1 International Minerals Project Area (the study area).

2.0 METHODOLOGY

2.1 DATABASE SEARCHES

The following databases were searched as part of this assessment:

- The EPBC Act Protected Matters Database provided by DEWHA (DEWHA, 2008). This database provides a list of species protected under the EPBC Act likely to occur in the search area, and is determined using bioclimatic modeling; and
- The Department of Environment and Conservation's (DEC's) Rare and Threatened Species Database. This database provides a list of species listed under the WA *Wildlife Conservation Act 1950* or those species deemed by the DEC to be of conservation priority.

2.2 FIELD ASSESSMENT

The field-based methods essentially involved visiting specific areas identified (below) as having the greatest potential as habitat for both species and looking for signs of their habitation. These included locating Mulgara burrows, scats and footprints in deep sandy areas with *Triodia basedowii* (where present), and actively searching for Olive Pythons within rock piles and outcrops close to water. Morgan O'Connell, who has targeted survey experience with both species' undertook the field-based assessment.

2.3 LITERATURE REVIEW

Two previous biological surveys that have been undertaken within the project area were reviewed as part of this assessment. These comprised:

- Austeel Biological Survey Phase 1 (Biota and Trudgen, 2001); and
- Balmoral South Environmental Impact Assessment Flora and Fauna Survey (Maunsell AECOM, 2006).

Biota and Trudgen (2001) completed detailed vegetation mapping of the area, which enabled a desktop assessment of available habitat within the project area to be undertaken. Sixty-four terrestrial vegetation units were described for the study area (Biota and Trudgen, 2001). These were used to compare against known preferred habitats and vegetation types for the Mulgara and Pilbara Olive Python.

Vegetation and soils were assessed on their ability to support Mulgara and their burrows. Habitat deemed suitable for Mulgara consists of *Triodia basedowii* (or similar) hummock grassland on sandy loam plains.

Vegetation mapping was assessed to determine the substrate of the area and if any rocky outcrops, boulders, rock sheets or gorges exist on site. These sorts of rock formations, accompanied with water, form suitable habitat for the Pilbara Olive Python.

2.4 SPECIALIST CONSULTATION

The following people were contacted in order to obtain specialist advice on species ecology, previous records from within the vicinity of the project area and likely presence of species within the project area:

- David Pearson – DEC;
- Dr Peter Mawson - DEC;
- Dr Pip Masters;
- Peter Kendrick – DEC; and
- Dr Tamra Chapman - DEC.

Only Dr Tamra Chapman was able to be contacted during the time allocated for this review. A request was submitted to Dr Chapman to obtain locations of nearest records to the project area for both species.

3.0 MULGARA

3.1 TAXONOMY

Mulgara (*Dasycercus cristicauda)* are dasyurid marsupials found in the arid areas of Australia. A review of taxonomy in 2000 resulted in this species being split into two species, based primarily on tail morphology. The name *D. cristicauda* (Krefft, 1867) was retained and a new species *D. hillieri* (Adams *et. al*., 2000) was created. *D. hillieri* remains indistinguishable from *D. cristicauda* (Strahan, 2008).

A further taxonomic revision (Woolley, 2006) resulted in the Western Australian populations of Mulgara being reclassified as *D. blythi.* This species is primarily distinguished from *D. cristicauda* by tail morphology, having a 'brush-tail' rather than a 'crest-tail.' Due to ambiguity of the species up until recently, however, the exact distribution of *D. cristicauda* and *D. blythi* is unclear.

Currently, the DEWHA refers to both *D. cristicauda* and *D. hillieri*. Following taxonomic review, *D. cristicauda* has been renamed *D. blythi*, while *D. hillieri* has been renamed *D. blythi.*

For the purpose of this report, descriptions of Mulgara are that of the brush-tailed Mulgara (*D. blythi*) according to Woolley (2008). It must be noted, however, that this species corresponds with *D. cristicauda* as identified by DEWHA.

3.2 DESCRIPTION

The brush-tailed Mulgara (hereafter referred to as Mulgara) is a robust, carnivorous marsupial with body mass up to about 190g and head-body length to about 18cm. The tail is short, slightly enlarged at the base and tapering to a point (Pavey *et. al*., 2006). The Mulgara is a broadly carnivorous species with invertebrates making up the majority of its diet. It is an annual breeder, mating in autumn and winter with juveniles emerging in late winter and spring (Gibson and Cole, 1992; Figure 2).

3.3 CONSERVATION SIGNIFICANCE

Mulgara are listed as Vulnerable under the EPBC Act. This species is also listed as Schedule 1 under the WA *Wildlife Conservation Act 1950*. Schedule 1 is described as fauna that is rare or likely to become extinct. According to Maxwell *et. al*. (1996), the Mulgara has declined over 50 – 90% of its original range.

Figure 3-1 Mulgara (*Dasycercus cristicauda*; juvenile) taken at Wiluna. Picture courtesy of Simon Pynt

3.4 DISTRIBUTION

Mulgara are found across the arid areas of Australia. This species occurs in central and southern Northern Territory, western Queensland, northern and central South Australia and central and northern Western Australia. Records in WA are from the Great Victoria Desert, Goldfields, Gascoyne, Sandy Desert and Pilbara regions.

3.5 HABITAT

Mulgara are most frequently found in habitats dominated by mature spinifex (*Triodia* sp.; Baker, 1996). This species is nocturnal and spends the day in its burrow, which is approximately 0.5m deep. These burrow systems often consist of two or three side burrows and pop holes (Strahan, 2008). Burrows occur in the flats between low sand dunes or on low flat sandy plains. Burrows are most commonly dug at the base of spinifex hummocks, in particular that of *Triodia basedowi*. Burrows are round at the entrance, angled at approximately 45° with a distinctive runway. Scats are often present near the entrance.

The abundance of Mulgara in high *Triodia* cover is greater when compared to burnt areas with lower cover (Masters, 1993). Non-burnt areas are more likely to provide habitat for Mulgaras. It is thought that colonies are found in association with paleo-drainage systems or drainage lines in sand dunes or sand plains. Populations are known to occur in close proximity to mining activity.

3.6 LIKELIHOOD OF PRESENCE

Vegetation mapping conducted by Biota and Trudgen (2001) provides a description of each vegetation type occurring in the project area, grouped under the land system in which they predominantly occur. Many of the vegetation types occurring in the project area lack suitable characteristics to support Mulgara. The areas with these vegetation

types were therefore immediately ruled out as having the potential to support this species. A number of vegetation types are 'of interest' however. An assessment of the suitability of each of these vegetation types to support Mulgara is provided in Table 1.

According to the DEC's threatened fauna database, Mulgara have not been previously recorded in the project area. They were also not identified in either of two previous surveys as occurring within the study area (Biota and Trudgen, 2001; Maunsell AECOM, 2006).

Table 3-1 Vegetation types (Biota and Trudgen, 2001) and their suitability for Mulgara.

Veg. type	Description	Suitability	Mulgara occurrence
Ld3	Backing dunes. Open shrubland over *Triodia epactia* curly spinifex grassland.	Presence of spinifex and a sandy substrate. No formation of a hummock grassland.	Unlikely - Lack of hummock grassland.
Ld4	Sandy plains / dunes. Scattered shrubs over mixed low shrubland and *Triodia pungens, Cenchrus cilliaris* curly spinifex / tussock grassland.	Presence of spinifex and a sandy substrate. No formation of a hummock grassland.	Unlikely – No formation of a hummock grassland.
Nh1-Nh5	Low hills and slopes. Open to scattered shrubland over *Triodia wiseana* hummock grassland.	Presence of hard hummock forming spinifex. Site descriptions within this vegetation make note of very shallow soils, stony hills, skeletal soils, ridge crests.	Unlikely – Site descriptions within this vegetation make note of very shallow soils, stony hills, skeletal soils, ridge crests.
Nc	Minor flowlines. Variable low open woodlands and / or high shrublands over *Triodia wiseana* hummock grassland	Presence of hard hummock forming spinifex. Most site descriptions make note of gravelly soil or soil with pebbles on surface.	Unlikely – Most site descriptions make note of gravelly soil or soil with pebbles on surface.
ROh1	ROh1a and ROh1b. Low hills and slopes. *Triodia wiseana* hummock grassland.	Presence of hard hummock forming spinifex. Stony hillslopes.	Unlikely – Stony hillslopes.
ROh2	ROh2a and ROh2b. Scattered to open shrubland over *Triodia wiseana*	Presence of hard hummock forming spinifex. Vegetation sites all make note of skeletal soils,	Unlikely – Vegetation sites all make note of skeletal soils,

Veg. type	Description	Suitability	Mulgara occurrence
	hummock grassland.	gravelly soil, pebble surface layer and cobbles.	gravelly soil, pebble surface layer and cobbles.
ROp1	*Triodia angusta* hummock grassland.	Presence of hard hummock forming spinifex. Gravelly pebbly loam amongst pebbles. Also a very thin strip of vegetation 12-15m wide.	Unlikely – Gravelly pebbly loam amongst pebbles. Also a very thin strip of vegetation 12-15m wide.
ROc	ROc1 – ROc5. Minor flowlines, scattered trees over shrubland over *T. wiseana* or *T. angusta.*	Presence of hard hummock forming spinifex. All sites excluding a few mention pebbles, cobbles or boulders. Some sites have sandy loam soil. This vegetation type is a thin strip often sampled using elongated quadrats to obtain sufficient area to sample.	Unlikely – All sites excluding a few mention pebbles, cobbles or boulders. Some sites have sandy loam soil. This vegetation type is a thin strip often sampled using elongated quadrats to obtain sufficient area to sample.
Pp1	Pp1 – Pp2. Stony plains. Open shrubland, over low open shrubland, over *T. wiseana* / *angusta* hummock grassland.	Presence of hard hummock forming spinifex. Soil consists of red clayey loam with a surface layer of pebbles and stones.	Unlikely – Soil consists of red clayey loam with a surface layer of pebbles and stones.
Mp1	Shrubland over *T. wiseana* hummock grassland.	Presence of hard hummock forming spinifex. Brown calcareous loam with surface scatters of quartz and other pebbles.	Unlikely – Brown calcareous loam with surface scatters of quartz and other pebbles.
Yp1	Plains. Mosaic of patches of *T. angusta* hummock grassland with open herblands and mesquite scattered tall shrubs.	Presence of spinifex in mosaic.	Possible to unlikely. Disturbance footprint 1.5 to 2km from vegetation type.

4.0 OLIVE PYTHON

4.1 TAXONOMY

The Olive Python was first discovered in northern Australia, and described as *Liasis olivaceus* (Gray, 1842). This was later reclassified as *L. olivaceus olivaceus*. A disjunct population of Olive Python living in the Pilbara region was described as *L. olivaceus barroni* (Smith, 1981). The Pilbara Olive Python is endemic to Australia but has distant relatives living in Indonesia and New Guinea.

4.2 DESCRIPTION

The Pilbara Olive Python is one of Australia's largest snakes, growing up 6.5m (Wilson & Swan, 2008). The upper surface is a dull grey / olive colour that at times appears to shimmer, while its ventral surfaces are white to cream (Figure 3).

Figure 4-1 Pilbara Olive Python (*Liasis olivaceus barroni*) taken at Cattle Gorge, Central Pilbara.

4.3 CONSERVATION SIGNIFICANCE

The Pilbara Olive Python is listed as Vulnerable under the EPBC Act. This species is listed as Schedule 1 under the WA *Wildlife Conservation Act 1950*. Schedule 1 is described as fauna that is rare or likely to become extinct.

4.4 DISTRIBUTION

The Pilbara Olive Python is restricted to gorges and escarpments of the Pilbara and Gascoyne region (Wilson & Swan, 2008). This species occurs from the Burrup Penisula, Ord Ranges and Meentheena south to Nanutarra and Newman (Storr *et. al.*, 2002). A recent discovery of a sub-adult python was made approximately 70km east of Port Hedland at the site of the proposed Pardoo Iron Ore shipping facility.

4.5 HABITAT

The Pilbara Olive Python is primarily found in gorges and dissected drainage lines. Recent radio tracking has shown that individuals are usually in close proximity to water and rock outcrops (DEWHA, 2008). Home ranges are generally restricted, but large distances can be traveled in the search for mates. This species has also been recorded up on top of large ridges.

4.6 LIKELIHOOD OF PRESENCE

Vegetation mapping conducted by Biota and Trudgen (2001) provides a description of each vegetation type occurring in the project area, grouped under the land system in which they predominantly occur. Many of the vegetation types occurring in the project area lack suitable characteristics to support the Pilbara Olive Python. The areas with these vegetation types were therefore immediately ruled out as having the potential to support this species. A number of vegetation types are 'of interest' however. An assessment of the suitability of each of these vegetation types to support the Pilbara Olive Python is provided in Table 2.

According to the DEC's threatened fauna database, Pilbara Olive Pythons have not been previously recorded in the project area. They were also not identified in either of two previous surveys as occurring within the study area (Biota and Trudgen, 2001; Maunsell AECOM, 2006).

That being said Olive Pythons are also known to travel considerable distances during the breeding season and therefore it is possible for them to travel from surrounding areas into the site. For Pilbara Olive Python these areas include:

- Rc2 (vegetation quadrat site M126) – a major drainage line;
- Any other major drainage lines, to determine if there is any dissection or gorge formation along the flowline; and
- Nr and ROr – rockpiles. An inspection of a few of the rockpiles to determine extent and size.

Table 4-1 Vegetation types (Biota and Trudgen, 2001) and their suitability for Pilbara Olive Python

Veg type	Description	Suitability	Python occurrence
Nh	Nh1 - Nh5. Low hills and slope.	Some vegetation site sheets mention rock outcropping.	Unlikely – No mention of water nearby, rock outcropping in small isolated patches.
Nc	Nc1 – Nc4. Minor flowlines	Minor flowlines are present but no dissection or gorge like areas have been created in this landform.	Unlikely – No dissection or gorge like areas have been created in this landform.
Nr	Nr1 – Nr4. Rockpiles. Scattered tall shrubs, over lianes, spinifex and bunch grasses.	Vegetation sites mention small outcrops, breakaways, boulders and rocky ridgelines. *Ficus platypoda* is mentioned as a dominant at Nr1 and Nr2. This species is commonly associated with rocky areas.	Possible if water is nearby.
ROc	ROc1 – ROc5. Minor flowlines. Low woodland to high shrubland, over mixed shrubs, over *Triodia wiseana*.	Vegetation sites mention pebbles and rocks. No mention of dissection or gorge like areas. No mention of water bodies.	Unlikely – No mention of dissection or gorge like areas. No mention of water bodies.
ROr	ROr1 – ROr3. Rockpiles. Scattered tall shrubs over, lianes, spinifex or bunch grasses.	*F. platypoda* at some vegetation types. Rocky outcrop and boulders. Some rocky outcrops and boulders consist of siliceous material. No mention of dissection or gorge like areas. No mention of water bodies.	Unlikely – No mention of dissection or gorge like areas. No mention of water bodies.

Pc	Pc1 – Pc2. Woodland, over high shrubland, over open herbland or tussock grassland.	Vegetation sites mention some rock outcropping, pebbles etc. No mention of dissection or gorge like areas. Melaleuca is present in some sites but is not dominant. Melaleuca is often associated with gorge areas.	Unlikely – No mention of dissection or gorge like areas.
Mr	Mr1 – Mr2. Sheet and boulder outcrops. Low sedgeland. High open shrubland, over low shrubland, over spinifex and low open herbland.	Vegetation sites mention some rock outcropping and sheets. No mention of dissection or gorge like areas. No mention of water nearby.	Unlikely – No mention of dissection or gorge like areas. No mention of water nearby.
Rc	Rc1 – Rc4. Open forest to woodland, over high shrubland, over tussock grassland or sedgeland.	Rc2 consists of an open forest of *Melaleuca argentea* and *Eucalyptus camaldulensis. M*. *argentea* is often associated with permanent water pools. The vegetation site makes note of a permanent pool. This is the only recorded location of *M*. *argentea* for the survey but it is noted that the entire river system was not traversed.	Possible

5.0 CONCLUSION

5.1 MULGARA

Cape Preston site vegetation data (Biota and Trudgen 2001) was cross referenced against known Olive Python and Mulgara habitat (Phoenix 2008). The results suggested that the occurrence of suitable habitat for these species is unlikely, however there were a few locations where habitat had the potential to occur. These sites were visited between the 25th of August and the 1st of September 2008.

The vegetation mapping and vegetation site descriptions from Biota and Trudgen (2001) were heavily relied upon in arriving at the selection of these sites. All available data was incorporated, e.g. Soil type, habitat, notes and vegetation descriptions, but personal communication from external experts was also critical in choosing sites to visit.

The literature review suggested that Mulgara occurrence in the study area was unlikely and the field-based assessment strongly supported this conclusion. No burrows or evidence of Mulgara presence (tracks or scats in prospective areas) was observed.

The lack of sandy loam soils was identified though the literature review as the key to limiting their presence within the area. At Cape Preston, the majority of the vegetation communities contain a high degree of pebbles / rocks or a pebbly surface layer and the soils in the study area are often referred to as shallow or skeletal, which do not support Mulgara, whom require deeper sandy loam soils in which a burrow can be constructed.

Much of the study area is Nh and ROh (low hills and slopes), Px (clayey and stony clayey plains) and Pp (stony plains). If habitat does exist for Mulgara at Cape Preston it will be confined to small areas not identified in the broadscale vegetation mapping (and therefore not picked up in the site selection process) or an anomaly within an identified vegetation type, e.g. a stony plain with spinifex (hummock forming) that is not stony and therefore, consists of a suitable sandy loam lacking rocks or pebbles.

Spinifex is present in its hummock forming habit at Cape Preston, but *Triodia basedowii* is not present (the only hummock grass species from which Mulgara is known to occur). Ld2 and Ld3 (coastal sand dunes with curly spinifex) were considered unlikely to support Mulgara prior to sites visitation, and this assumption was upheld by the field assessment. It is possible Yp1 (hummock grassland with open herblands) may support Mulgara, however Yp1 occurs approximately 1.5 to 2.0km from the project area and is thus well outside of the impact footprint of the project and was consequently not visited.

5.2 OLIVE PYTHON

Review of the literature suggested that the presence of the Pilbara Olive Python was also unlikely, but possible, mainly because the species is known to roam over large areas in search of mates, food and water, but also because it was considered difficult to discount the presence of potential habitat for the species, using remote means only.

Consequently the major drainage lines and a number of rockpiles were investigated for the presence of pythons. None were located using standard foraging techniques and indeed all sites visited were considered unlikely to harbour the Pilbara Olive Python due to the lack of available surface water and the generally un-incised topography of the landscape.

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