Miralga Creek Iron Ore Project

Detailed Flora and Vegetation Survey 2019

ATLAS IRON PTY LTD

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Miralga Creek Iron Ore Project, Detailed Flora and Vegetation Survey

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EXECUTIVE SUMMARY

The Atlas Iron Pty Ltd (Atlas) Miralga Creek Iron Ore Project is located 50 kilometres (km) west northwest of Marble Bar, approximately 100 km from Port Hedland. Atlas commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake a detailed flora and vegetation survey across the Project to support environmental approvals.

A desktop review of the Study Area found that there are 13 significant flora taxa known from within 50 km of the Study Area. Nine vegetation system association and 10 land systems are present within the Study Area. There are no known occurrences of significant vegetation types within the Study Area or within a 50 km radius of the Study Area.

The search of the DoEE SPRAT database with regard to MNES listed under the EPBC Act did not return any TECs as likely or known to occur within the Desktop search area.

A search of the Ramsar Database and Nationally Important Wetlands Database using the Protected Matters Search Tool's Interactive Map did not return occurrences within the Study Area.

A targeted and detailed survey for flora and vegetation was undertaken from the 13th – 19th May and the 27th – 31st May 2019. A total of 107 non-permanent flora survey quadrats measuring 50 m x 50 m were established. Analysis of the data collected using the Chao-2 estimator showed the recorded number of taxa within quadrats is equivalent to 93.9 % of the estimated taxon richness in the Study Area, indicating that the area was adequately sampled.

No Threatened Ecological Communities (TEC) or Priority Ecological Communities (PEC) were recorded during the survey.

A total of 380 discrete vascular flora taxa, one known hybrid and one putative hybrid were recorded in the Study Area, including 360 native taxa and 20 introduced taxa. These taxa represent 54 families and 157 genera. Average native taxon richness per quadrat was 31.4 (± 18.8), with the greatest number of taxa recorded in a single quadrat being 98, and the lowest number being three.

A total of 16 significant flora taxa were recorded during the survey, including eight Priority flora and eight taxa considered significant for other reasons. No Threatened flora were recorded within the Study Area. The listed taxa recorded were *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), *Euphorbia inappendiculata* var. *inappendiculata* (P2), *Eragrostis crateriformis* (P3), *Euphorbia clementii* (P3), *Oldenlandia* sp. Hamersley Station (A.A Mitchell PRP 1479) (P3), *Triodia basitricha* (P3), *Triodia chichesterensis* (P3) and *Goodenia nuda* (P4).

The taxa considered significant for other reasons as per EPA (2016a, b) were *Abutilon* aff. *hannii* and *Polymeria* sp. (potentially undescribed), and *Cyperus microcephalus* subsp. *saxicola, Desmodium campylocaulon, Dodonaea petiolaris, Fimbristylis nuda, Ophioglossum lusitanicum* and *Scleria rugosa* (significant range extension/disjunct record).

A total of twelve vegetation types (VTs) were defined and mapped in the Study Area which represent five broad groups of vegetation, based on soils and topography:

- Group 1 – granite and dolorite hills and ranges (VTs 1 and 2);
- Group 2 – hills and steep slopes on ironstone (VTs 3 and 4);
- Group 3 – rivers and claypans on alluvial sediments (VTs 5, 6 and 12);
- Group 4 – minor drainage lines and sheet flow on flood plains (VTs 7 - 9) and
- Group 5 - sandy and stony plains (VTs 10 and 11).

VTs 2, 6, 9 and 11 are considered to be of local or potential local significance in the Study Area due to their limited mapped extent and provision of habitat for significant taxa. VT 1 was widespread in the Study Area but can also be considered locally significant due to provision of habitat for the significant flora taxon *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), which was only recorded in this VT.

VT 2 is likely to be regionally restricted given its species composition however there have been relatively few detailed surveys in the local area and a broader regional search may identify similar habitats in the region. VTs 6 and 9 are both considered regionally significant due to their distributions on soil and landforms that are uncommon in the region. VT 11 is considered potentially regionally significant due to its lack of representation within the Atlas regional vegetation dataset however it occurs on soil and landform types that are considered relatively common in the region.

Based on the presence of the obligate phreatophytes *Melaleuca argentea* and *Eucalyptus camaldulensis*, as well as the facultative phreatophyte *Eucalyptus victrix*, and the potential facultative phreatophytes *Melaleuca glomerata* and *Atalaya hemiglauca*, there is the potential that all or portions of vegetation in the Study Area mapped as VT 5 are Groundwater Dependent Ecosystems (GDEs).

DEFINITIONS

Term	Definition
ß	Beta
°C	Degrees celsius
Þ	Significance
ALA	Atlas of Living Australia
AWC	Australian Weeds Committee
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
cm	Centimetres
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DoEE	Department of the Environment and Energy
DPaW	Department of Parks and Wildlife
DPIRD	Department of Primary Industries and Regional Development
DSO	Direct Shipping Ore
e.g.	*exempli gratia* "for example"
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESCAVI	Executive Steering Committee for Australian Vegetation Information
et al.	*et alia* "and others"
GDA	Geocentric Datum of Australia
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
IBRA	Interim Biogeographic Regionalisation for Australia
i.e.	*id est* "in other words"
indet.	indeterminate
INDVAL	A statistical method for analysing indicator species (indicator value)
km	Kilometres
m	Metres
mm	Millimetres
MNES	Matters of National Environmental Significance
P	Priority
PATN	Software package for statistical analysis
PC-Ord	Software package for multivariate statistical analysis of ecological communities
PEC	Priority Ecological Community
Pty Ltd	Proprietary Limited
sp.	Species (singular)
spp.	Species (plural)
SPRAT	Species Profile and Threats
TEC	Threatened Ecological Community
TP List	Threatened and Priority Flora List
TPFL	Threatened and Priority Flora (Database)
UPGMA	Unweighted Pair Group Method with Arithmetic Mean
VT	Vegetation Type
WA	Western Australia
WA Herb.	Western Australian Herbarium
WC Act	Wildlife Conservation Act 1950 (superseded by the *Biodiversity Conservation Act 2016*)
WoNS	Weed of National Significance
Woodman Environmental	Woodman Environmental Consulting Pty Ltd

1. INTRODUCTION

1.1 Project Overview

The Atlas Iron Pty Ltd (Atlas) Miralga Creek Iron Ore Project is located 50 kilometres (km) west northwest of Marble Bar, approximately 100 km from Port Hedland.

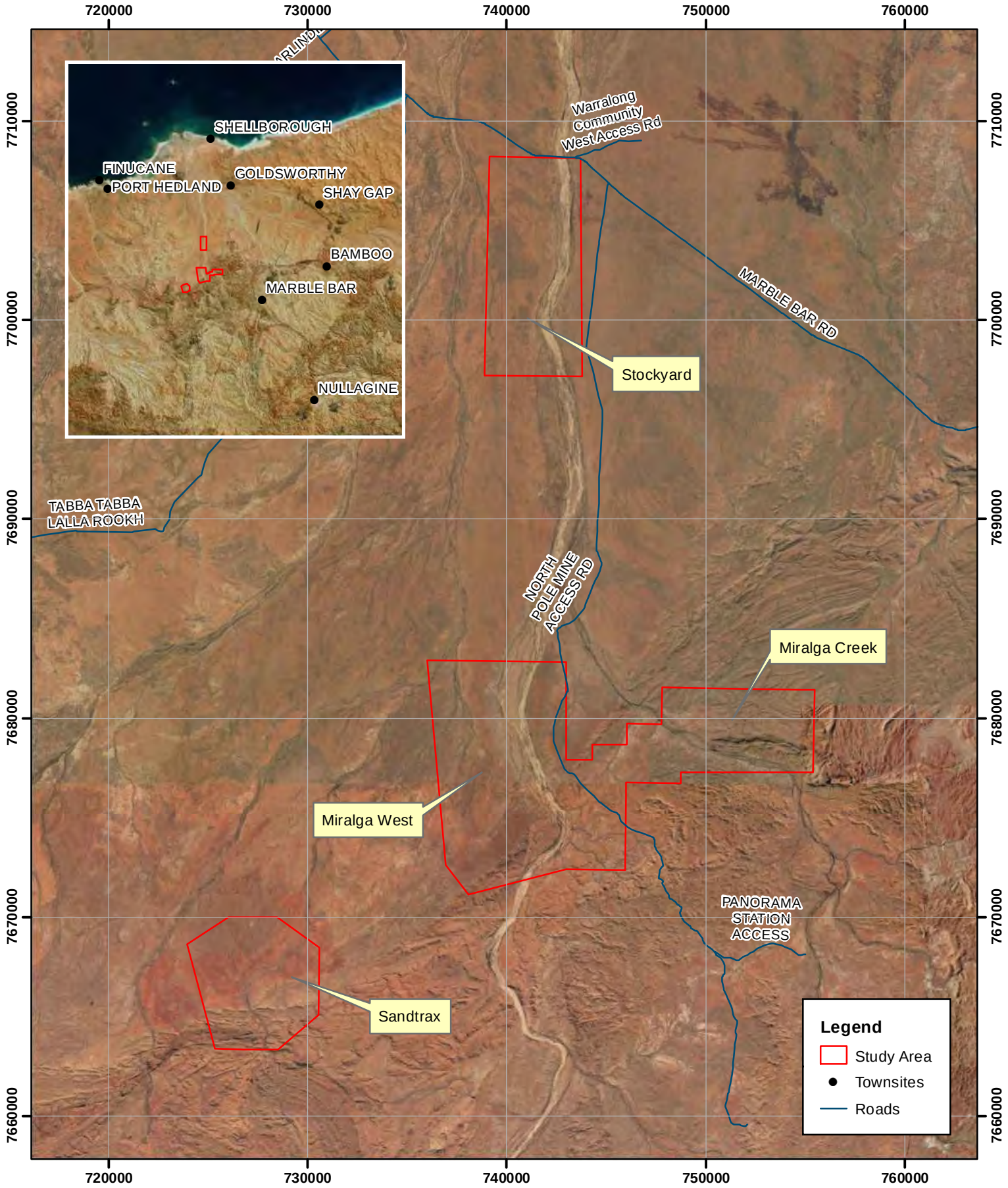
Atlas commissioned Woodman Environmental Consulting Pty Ltd (Woodman Environmental) to undertake a detailed flora and vegetation survey across the Project (the Study Area) (Figure 1) to support environmental approvals.

1.2 Study Area Definition

The extent of the Study Area was in part provided by Atlas and amended to incorporate potential groundwater draw-down zones. The Study Area is 21,501.4 hectares (ha) in size and is located in the Shire of East Pilbara on Eginbah, Coongan, Strelley and Panorama pastoral stations. It is comprised of three separate areas: Sandtrax in the southwest (3,559.1 ha); Miralga West/Miralga Creek in the centre (12,755.5 ha) and two Stockyard locations in the north (5,186.8 ha), with the following proposed project components:

- Bore Fields
- Access Road
- Haul Roads
- Laydown
- Pits (Sandtrax, Miralga West and Miralga Creek)
- ROMs
- Ramp
- Stockpile (topsoil)
- Stockyard
- Waste Dump

A Desktop Study Area has been defined for interrogation of databases and searches for relevant literature; the Desktop Study Area considers the Study Area with a 40 km buffer, as shown on Figure 1.



Study Area Location	Author: Debbie Woodman	
	WEC Ref: Atlas19-07-01	
WOODMAN ENVIRONMENTAL	Filename: Atlas19-07-01-f01.mxd	**Figure**
	Scale: 1:250,000 (A4)	1
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Atlas19-07-01.	Revision: 0 - 01 November 2019	

1.3 Aim and Objectives

The aim of the survey was to provide relevant botanical information to support the approvals process for the Project. The flora and vegetation survey of the Study Area was conducted in accordance with relevant guidance documents.

The overall objectives of the assessment were to:

- Identify locations and determine the extent of populations of flora taxa occurring within the Study Area that are one of the following (hereafter referred to as significant flora taxa), to provide context for impact assessment:
    - Listed Threatened Species under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act);
    - Threatened Flora under the *Biodiversity Conservation Act 2016* (Western Australia (WA)) (BC Act);
    - Priority Flora taxa as classified by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA); and
    - Other significant flora taxa as defined by the Environmental Protection Authority (EPA) (2016a; b);
- Identify locations and determine the extent of introduced flora taxa, with particular focus on those that are Weeds of National Significance (WoNS), or Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act);
- Identify, map and describe Vegetation Types (VTs) that occur within the Study Area, with particular focus on the following (hereafter referred to as significant vegetation), to provide context for impact assessment:
    - Listed Threatened Ecological Communities (TECs) under the EPBC Act;
    - TECs as classified by DBCA and endorsed by the WA Minister for the Environment;
    - 'Priority Ecological Communities' (PECs) as classified by DBCA;
    - Areas of wetland or riparian vegetation that are ground or surface water-dependent; and
    - Other significant vegetation as defined by EPA (2016a, 2016b).

The survey and reporting works comply with the following documents:

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

1.4 Level of Assessment

The flora and vegetation survey of the Study Area conformed to the requirements of both a Targeted Survey and Detailed as defined in Section 4 of the 'Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment' (EPA 2016a). This is considered appropriate for the Project, as a detailed survey is necessary for significant proposals to adequately address the EPA's objective for Flora and Vegetation, as a preliminary or key environmental factor of assessment. The Project is also located in an area

(the Pilbara) that is known to support a moderate diversity of flora and vegetation relative to other areas of the state, including significant flora taxa and vegetation types (EPA 2016a). This report presents the results of the desktop study and field survey of the Study Area. The results of the desktop study, which included a review of known information relevant to the Study Area through all sources of literature available, are presented in Section 2.4. The results of the field survey of the Study Area are presented in Section 5.

2. BACKGROUND

2.1 Climate

The Study Area is located within the Pilbara region as classified by Beard (1990). The climate is classified as arid tropical, with precipitation received mainly over the summer months. Average annual precipitation is 250-300 millimetres (mm), which is generally slightly higher than most of the Eremaean Province of Western Australia because of the influence of relatively frequent tropical cyclones that occur from November to April (Beard 1990; Bureau of Meteorology 2019a).

Figure 2 displays monthly precipitation totals and average maximum temperature for the preceding six months leading up to the field survey date (November 2018-April 2019), as well as long-term average monthly maximum temperature (2000-2019) and average monthly precipitation (2000-2019) recorded for Marble Bar (all months shown), the nearest meteorological station to the Study Area (Bureau of Meteorology 2019b).

The precipitation in the six months preceding the 2019 field survey was above the long-term average, with a total of 341.4 mm received compared to the long-term average of 325.7 mm for the same period. This was the result of a cyclone in March 2019 in which Marble Bar received 246.2 mm of rainfall, 160.7 mm above the long-term average for the month of March. The other five months prior to the 2019 survey experienced below average rainfall (Figure 2). The monthly mean maximum temperature was above the long-term average for the six months prior to the survey, with a mean maximum temperature of 3.6°C higher in February and 2.9°C higher in January than the long-term average (Figure 2).

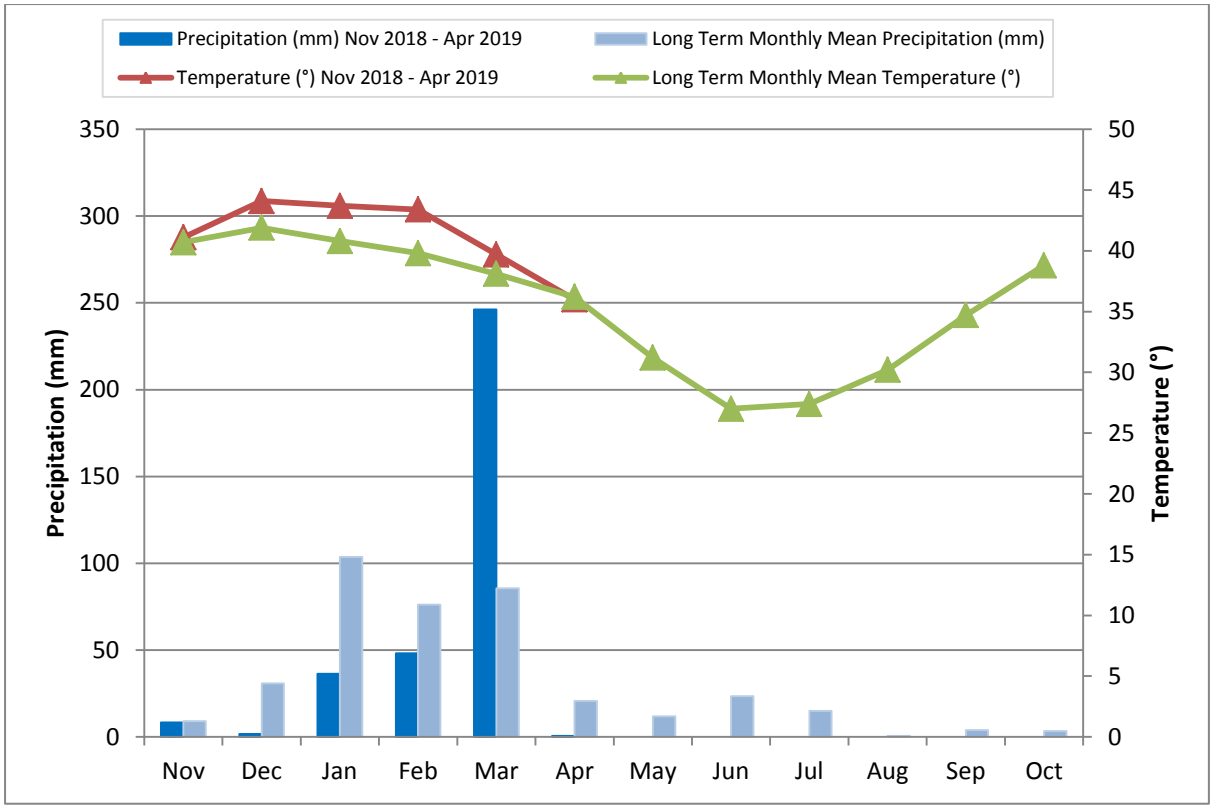


Figure 2: **Average Daily Maximum Temperature and Total Precipitation for November 2018 – April 2019, and Long-Term Average Monthly Maximum Temperature and Precipitation, for Marble Bar (Bureau of Meteorology 2019)**

2.2 Geology, Landforms and Soils

The Study Area is located in the Pilbara region (Fortescue Botanical District) as defined by Beard (1975; 1990). This is equivalent to the Pilbara Interim Biogeographic Regionalisation for Australia (IBRA) region (Commonwealth of Australia 2012). The Pilbara region is formed of a basement of Archaean granite and volcanics, overlain by massive deposits of Proterozoic sediments and volcanics (Beard 1990). This region is generally mountainous, rising to 1250 metres (m), with hard alkaline red soils on plains and pediments, and shallow and skeletal soils on ranges. The Study Area traverses two physiographic regions as defined by Beard (1975); the Abydos Plain and the George Ranges. This area is also equivalent to the Chichester IBRA subregion (Commonwealth of Australia 2012).

The Abydos Plain is alluvial in origin near the coast, and of Archaean granite origin further inland. It consists of a variety of features including alluvial plains, pediplains, low stony hills and dissected pediments, low granite outcrops and tors, and basic dykes. It is divided into a number of isolated sections by the George Ranges. The main soils are hard alkaline red soils, some areas with coarse textured A-horizons to 45 centimetres (cm) thick, while other areas have shallow stony A-horizons in addition to patches of calcrete. On the eastern part of the plain near the De Grey River, the soils are chiefly neutral and acidic red earths, while on the inland plains behind the George Ranges the chief soils are earthy loams and coarse sands overlying granite within 90 cm of the soil surface. The alluvial plains along the coast generally consist of red earthy sands with extensive areas of red earths, and hard red soils

along creek lines. Deep cracking clays occur in the vicinity of residuals of basic and ultrabasic rocks in the Roebourne area (Beard 1975).

The George Ranges are a rough, steep and abrupt range dissected by a number of rivers through narrow gorges. These ranges consist of Archaean and Lower Proterozoic rocks of sedimentary and volcanic origin, with basic lavas along with dolomites, tuff, banded-iron formations and dolerite dykes, with some narrow valley-plains and high-level gently undulating areas of limited extent. The soils are generally shallow and stony, with large areas without soil cover. Chief soils are brown loams with significant areas of earthy loams soils, with hard alkaline red soils occurring on lower slopes, and cracking and non-cracking clays on valley floors (Beard 1975).

2.3 Land Tenure

As mentioned in Section 1.2, the Study Area is located on and surrounded by pastoral station as well as two small reserves (R12747 and R13618), and a small area of Unallocated Crown Land (UCL). The Study Area is covered by numerous mining leases, exploration licences, prospecting licences, miscellaneous leases; a retention licence, and a mineral lease S.A. (Department of Mines, Industry Regulation and Safety 2019).

2.4 Desktop Study

Prior to commencement of the field survey, a review of all publicly available flora and vegetation data relevant to the Project was undertaken. This included obtaining and reviewing copies of reports of previous biological surveys carried out within the vicinity of the Study Area and interrogation of relevant databases and other sources as listed in Table 1.

Table 1: Searches Undertaken for the Desktop Study of the Study Area

Source	Search Attributes	Search Purpose
DBCA Threatened and Priority Ecological Communities Databases	Study Area with 50 km buffer - DBCA dataset request (DBCA 2019a)	Obtain records of DBCA-classified TECs and/or DBCA-classified PECs within or within the vicinity of the Study Area
DBCA TEC and PEC lists	Review of current DBCA TEC and PEC lists (DBCA 2018, 2019c)	Identify whether there are any other additional DBCA listed TECs or PECs which could occur within the vicinity of the Study Area
DBCA Significant Flora Databases (WA Herbarium specimen database and Threatened and Priority Flora (TPFL) database)	Study Area with 50 km buffer - DBCA dataset request (DBCA 2019b)	Obtain records of listed significant flora within or within the vicinity of the Study Area
Department of the Environment and Energy (DoEE) Species Profile and Threats (SPRAT) Database (interrogated using the Protected Matters Search Tool)	Study Area with 50 km buffer (DoEE 2019a)	Identify taxa or ecological communities listed as Threatened (also referred to as Matters of National Environmental Significance (MNES)) under the EPBC Act that have the potential to occur within or within the vicinity of the Study Area

Source	Search Attributes	Search Purpose
DoEE Protected Matters Search Tool Interactive Map	Ramsar and Nationally Important Wetlands Databases (DoEE 2019b)	Identify Ramsar and Nationally Important Wetlands that have the potential to occur within or within the vicinity of the Study Area
DBCA *NatureMap* (WA Herbarium and TPFL records) (DBCA 2007-)	Study Area with 40 km buffer	Confirm significant flora records and identify introduced flora and known from the vicinity of the Study Area
2018 Statewide Vegetation Statistics incorporating the CAR Reserve Analysis (Government of Western Australia 2019)	Study Area	Identify extent of Vegetation System Associations within the Study Area
An inventory and condition survey of the Pilbara region, Western Australia, Technical Bulletin No. 92 (Van Vreeswyk *et al.* 2004)	Study Area	Identify extent of Land Systems within the Study Area

2.4.1 Regional Flora

The results of the DBCA WA Herbarium specimen database and TPFL database search returned 13 significant vascular flora taxa known to occur from within 50 km of the Study Area (and hence may potentially occur in the Study Area). This list is presented in Table 2. Of these, *Pityrodia* sp. *Marble Bar* (G. Woodman & D. Coultas GWDC Opp 4) is a listed Threatened (T) species. The remaining 12 taxa were Priority (P) flora taxa (DBCA 2019b). Appendix A presents conservation codes for Western Australia flora (DBCA 2019d).

A search of *NatureMap* was also undertaken (DBCA 2007-) to check for any recently added records and confirm the records returned from the DBCA WA Herbarium specimen database and TPFL database search.

The search of the DoEE SPRAT database (DoEE 2019a) with regard to MNES listed under the EPBC Act did not identify any additional flora taxa listed as Threatened Species, or habitat for such taxa, as known or likely to occur in the desktop study area. The results of the DoEE database search are presented in Appendix B.

Table 2: Significant Flora Returned from DBCA and DoEE Database Searches (DBCA 2019b; DoEE 2019a)

Taxon	Status	Source
Acacia cyperophylla var. *omearana*	P1	DBCA
Bulbostylis burbidgeae	P4	DBCA
Eragrostis crateriformis	P3	DBCA
Euphorbia clementii	P2	DBCA
Euphorbia inappendiculata var. *inappendiculata*	P2	DBCA
Heliotropium murinum	P3	DBCA
Heliotropium muticum	P3	DBCA
Nicotiana umbratica	P3	DBCA
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	T	DBCA; DoEE
Ptilotus mollis	P4	DBCA
Rothia indica subsp. *australis*	P3	DBCA
Triodia basitricha	P3	DBCA
Triodia chichesterensis	P3	DBCA

A search of the WA Herbarium specimen database for records of introduced taxa within 40 km of the Study Area was performed using *NatureMap* (DBCA 2007-). A total of six introduced taxa were returned as presented in Table 3. No Declared Pests listed under the BAM Act (DPIRD 2019), and no listed WoNS (AWC 2019) were returned from this search.

DBCA prioritises weeds in each region, based on their invasiveness, ecological impact, potential and current distribution and feasibility of control based on the *Weed Prioritisation Process* (DBCA 2013a). Table 3 presents the ecological impact and invasiveness ratings for each introduced taxon for the Pilbara Region (DBCA 2014).

The search of the DoEE SPRAT database with regard to MNES listed under the EPBC Act identified three significant invasive introduced flora taxa or habitat for the taxa, likely to occur within the Study Area (Table 3; DoEE 2019a). Of these, **Parkinsonia aculeata* is a listed WoNS (Australian Weeds Committee (AWC) 2019) and is a Declared Pest under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) (Department of Primary Industries and Regional Development (DPIRD) 2019).

Table 3: Introduced Flora Returned from *NatureMap* and SPRAT Searches (DBCA 2007-; DoEE 2019a)

Taxon	Common Name (WA Herbarium 1998-)	Source	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
**Aerva javanica*	Kapok Bush	NatureMap	High	Rapid
**Cenchrus ciliaris*	Buffel Grass	NatureMap, DoEE	High	Rapid
**Euphorbia hirta*	Asthma Plant	NatureMap	Low	Slow
**Flaveria trinervia*	Speedy Weed	NatureMap	-	-
**Parkinsonia aculeata*	Parkinsonia	DoEE	High	Rapid
**Portulaca pilosa*	Djanggarra	NatureMap	-	-
**Prosopis* spp.	Mesquite	DoEE	High	Rapid
**Vachellia farnesiana*	Mimosa Bush	NatureMap	High	Rapid

2.4.2 Regional Vegetation

2.4.2.1 Vegetation Types

The Study Area is located in the Pilbara IBRA region, specifically within the Chichester IBRA Subregion (Commonwealth of Australia 2012). The vegetation of the subregion is comprised of shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* hummock grasslands on plains, and *Eucalyptus leucophloia* tree steppes on the ranges (Kendrick and McKenzie 2001).

Beard (1975) mapped the vegetation of the Pilbara region based on physiographic units, at a scale of 1:1,000,000. As previously mentioned, the Study Area traverses the Abydos Plain and George Ranges physiographic regions within the Pilbara region.

The Abydos Plain is characterised by four broad associations: Shrub steppe, Dwarf-shrub steppe, Grass plains and the Coastal Complex. Of these, shrub steppe is the only association relevant to the Study Area. Shrub steppe is the main community of the granite plain, which is dominated by the *Acacia pyrifolia-Triodia epactia* (formerly *T. pungens*) association, with

hummock grasses dotted with widely-spaced shrubs. The plain is broken by stony rises and hills with small ranges, with *T. epactia* usually replaced by *T. wiseana, T. longiceps* or *T. angusta*, with scattered shrubs. Larger ranges tend to possess mainly Triodia, with only a few scattered shrubs and trees. Major creeks and rivers are wooded with *Eucalyptus camaldulensis* and *Melaleuca argentea* (formerly *M. leucadendron*) (Beard 1975).

The George Ranges consist of tree steppe on the high rocky parts, often with only a sparse occurrence of trees, dominated by *Eucalyptus leucophloia* (formerly *E. brevifolia*) and hummock grasses of *Triodia epactia* and *T. brizoides*. The lower slopes are generally comprised of shrub steppe of *Acacia bivenosa* and *T. epactia*, while the valleys contain *A. pyrifolia* (Beard 1975).

Shepherd *et al.* (2002) mapped and described vegetation system associations in the Chichester IBRA subregion utilising mapping undertaken by Beard (1975). Vegetation system associations were described at a scale of 1:250,000.

Nine vegetation system associations occur in the Study Area as summarised in Table 4 and presented on Figure 3. Table 4 also presents the current extent of each vegetation system association in relation to its pre-European extent, and the percentage of the current extent of each vegetation system association currently protected for conservation (in DBCA-managed land) (Government of Western Australia 2019). All vegetation system associations have been subject to very limited clearing; with the exception of Abydos Plain_619, the majority have had less than 1 % cleared since European settlement. Only three of the vegetation system associations are represented in the conservation estate (Table 4).

Table 4: Vegetation System Associations Intersecting the Study Area (Government of Western Australia 2019)

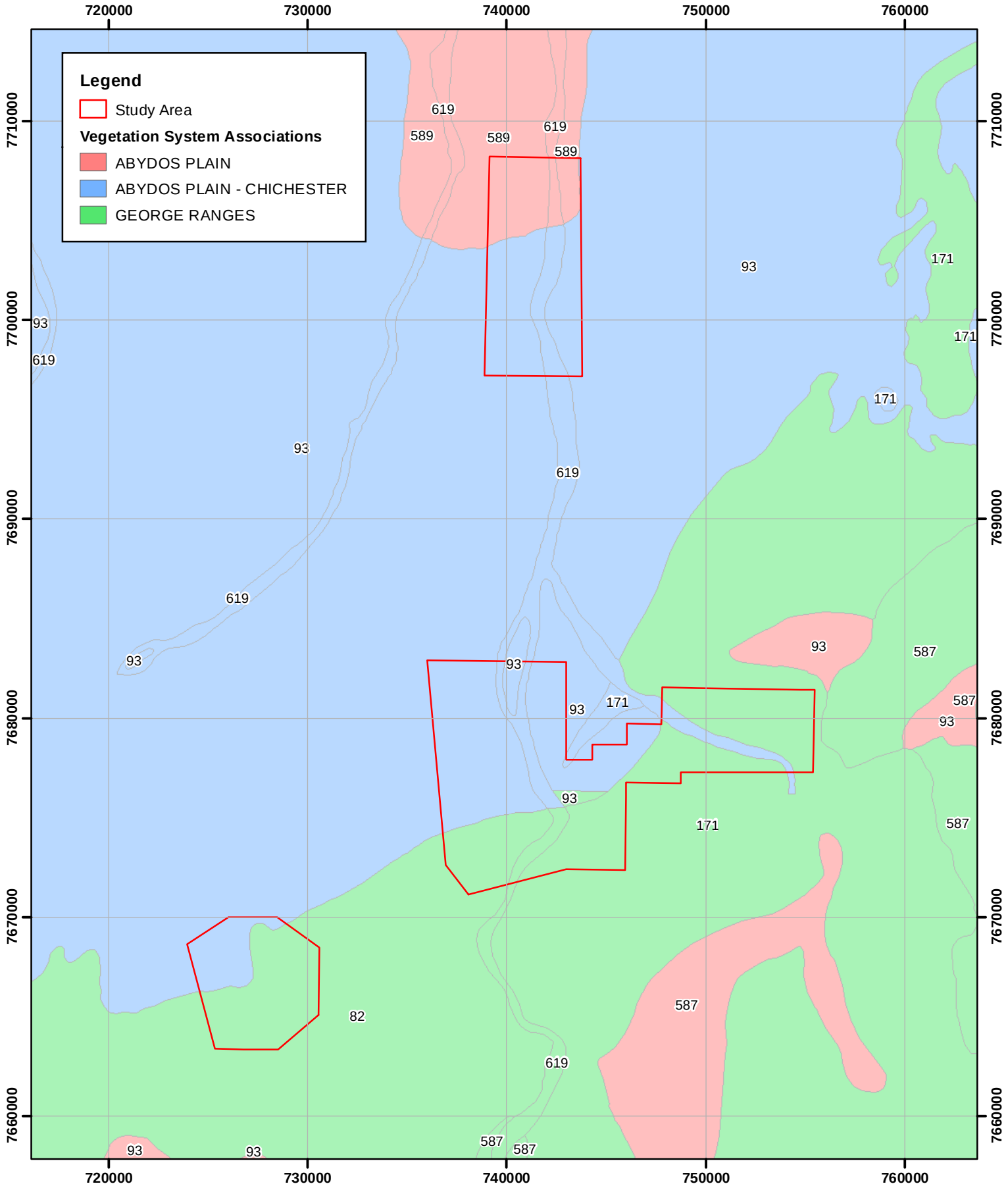
Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining (%)	Percentage of Current Extent Protected for Conservation
Abydos Plain_589	Mosaic: Short bunch grassland - savanna / grass plain (Pilbara) / Hummock grasslands, grass steppe; soft spinifex	597,147.91	99.58	2.03
Abydos Plain_619	Medium woodland; river gum (*Eucalyptus camaldulensis*)	42,551.05	97.62	0
Abydos Plain-Chichester_93	Hummock grasslands, shrub steppe; kanji over soft spinifex	2,478,504.06	99.86	0.54
Abydos Plain-Chichester_171	Hummock grasslands, low tree steppe; snappy gum over soft spinifex & *Triodia brizoides*	56,180.57	100	0
Abydos Plain-Chichester_619	Medium woodland; river gum (*Eucalyptus camaldulensis*)	71,200.58	99.96	0.33
George Ranges_82	Hummock grasslands, low tree steppe; snappy gum over *Triodia wiseana*	316,855.11	99.90	0
George Ranges_93	Hummock grasslands, shrub steppe; kanji over soft spinifex	8,902.19	100	0

Vegetation System Association	Description	Current Extent (ha)	Percentage of Pre-European Extent Remaining (%)	Percentage of Current Extent Protected for Conservation
George Ranges_171	Hummock grasslands, low tree steppe; snappy gum over soft spinifex & *Triodia brizoides*	269,728.31	99.52	0
George Ranges_619	Medium woodland; river gum (*Eucalyptus camaldulensis*)	4,402.59	100	0

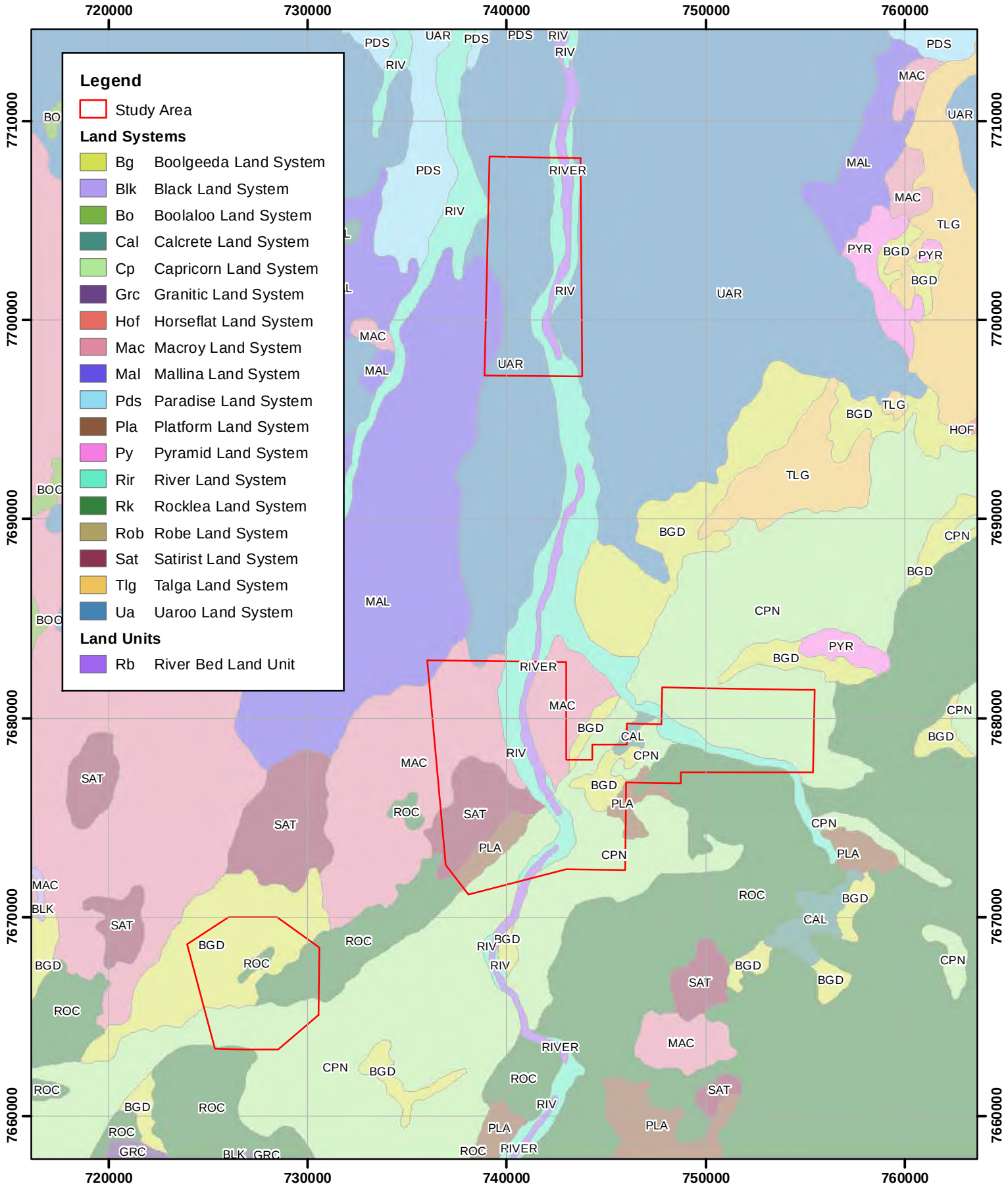
In 2004, the Department of Agriculture described land systems within the Pilbara IBRA region, considering general ecological information, vegetation physiognomy and composition, patterns of variation, conservation status, gradational association and land system representation (Van Vreeswyk *et al.* 2004). The Study Area contains 10 land systems as summarised in Table 5 and presented on Figure 4.

Table 5: Land Systems Intersecting the Study Area (Van Vreeswyk *et al*. 2004)

Land System	Mapped Extent (ha)	Description of Land System
Boolgeeda	774,800	Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands or mulga shrublands
Calcrete	144,400	Low calcrete platforms and plains supporting shrubby hard spinifex grasslands
Capricorn	529,600	Hills and ridges of sandstone and dolomite supporting low shrublands or shrubby spinifex grasslands
Macroy	1,309,500	Stony plains and occasional tor fields based on granite supporting hard and soft spinifex grasslands
Mallina	255,700	Sandy surfaced alluvial plains supporting soft spinifex (and occasionally hard spinifex) grasslands
Platform	157,000	Dissected slopes and raised plains supporting hard spinifex grasslands
River Land	408,800	Active flood plains, major rivers and banks supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands (including the River Bed Land Unit – no vegetation)
Rocklea	2,299,300	Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands
Satirist	37,700	Stony plains and low rises supporting hard spinifex grasslands, and gilgai plains supporting tussock grasslands
Uaroo	768,100	Broad sandy plains supporting shrubby hard and soft spinifex grasslands



Vegetation System Associations of the Study Area	Author: Debbie Woodman	N
	WEC Ref: Atlas19-07-01	
WOODMAN ENVIRONMENTAL	Filename: Atlas19-07-01-f03.mxd	**Figure**
	Scale: 1:250,000 (A4)	3
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Atlas19-07-01.	Revision: 0 - 01 November 2019	



Land Systems of the Study Area	Author: Debbie Woodman	
	WEC Ref: Atlas19-07-01	
WOODMAN ENVIRONMENTAL	Filename: Atlas19-07-01-f04.mxd	**Figure**
	Scale: 1:250,000 (A4)	4
	Projection: GDA 1994 MGA Zone 50	
This map should only be used in conjunction with WEC report Atlas19-07-01.	Revision: 0 - 01 November 2019	

2.4.2.2 Significant Vegetation

The search of the DBCA TEC and PEC database informed that no known occurrences of significant vegetation types occur within the Study Area or within a 50 km radius of the Study Area (DBCA 2019a). Appendix C presents definitions, categories and criteria for TECs and PECs (DBCA 2013b).

The search of the DoEE SPRAT database with regard to MNES listed under the EPBC Act did not return any TECs as likely or known to occur within the search area (DoEE 2019a). The results of the DoEE search are presented in Appendix B.

A search of the Ramsar Database and Nationally Important Wetlands Database using the Protected Matters Search Tool's Interactive Map did not return occurrences within the Study Area. The closest significant wetland or riparian vegetation is the De Grey River, a Nationally Important Wetland, located approximately 50 km to the north of the Study Area (DoEE 2019b).

2.4.3 Local Flora and Vegetation Surveys

A number of flora and vegetation surveys have been conducted in the vicinity of the Study Area as summarised in Table 6.

Table 6: Summary of Flora and Vegetation Surveys Previously Conducted in the Vicinity of the Study Area

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Flora, Vegetation and Fauna of the Proposed Expansion at Wodgina	60 km south-west of the Study Area	Mattiske Consulting (2000)	Not specified	214 taxa; 112 genera; 46 families.	18 vegetation units; no TECs or PECs identified.	*Acacia aphanoclada* (P1) listed though identification appears to be incorrect based on FloraBase records (WA Herbarium 1998-) and therefore is not considered further	3 taxa: **Aerva javanica*; **Cenchrus ciliaris*; **Sagina apetala.*
Hope Downs Iron Ore rail and port facility Project	Corridor runs 100 km north, to 200 km south of the Study Area, 60 km west of the Study Area	Biota Environmental and Trudgen (2002)	286 quadrats	763 taxa; 263 genera; 72 families	131 vegetation types; 71 vegetation associations identified.	5 taxa: *Bulbostylis burbidgeae* (P4); *Euphorbia clementii* (P3); *Gymnanthera cunninghamii* (P3); *Indigofera ixocarpa* (P2); *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3);	*8 taxa:* **Cenchrus setiger;* **Echinochloa colona*; **Eragrostis minor*; **Euphorbia hirta;* **Opuntia stricta*; **Sigesbeckia orientalis;* **Sonchus oleraceus;* **Tridax procumbens*
Proposed FMG Rail Stage A Corridor	Corridor runs 100 km north, to 150 km south of the Study Area, 60 km west of the Study Area	Biota Environmental (2004)	97 quadrats	762 taxa; 218 genera; 69 families	122 vegetation types identified.	10 taxa: *Bulbostylis burbidgeae* (P4); *Eremophila spongiocarpa* (P1); *Euphorbia clementii* (P3); *Goodenia nuda* (P4); *Goodenia* sp. East Pilbara (A.A. Mitchell PRP 727) (P3); *Gymnanthera cunninghamii* (P3); *Indigofera ixocarpa* (P2); *Paspalidium retiglume* (P2); *Stylidium weeliwolli* (P3); *Themeda* sp. Hamersley Station (M.E. Trudgen 11431) (P3)	11 taxa: **Aerva javanica;* **Bipens bipinnata;* **Cenchrus ciliaris;* **Cenchrus setiger;* **Chloris virgata;* **Citrullus colocynthus;* **Datura leichhardtii*; **Malvastrum americanum;* **Setaria verticillata;* **Solanum nigrum;* **Stylosanthes hamata*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Sulphur Spring Project (formerly Panorama Project)	20 km south-west of Study Area Total ha unknown	Mattiske Consulting (2007)	Summary of Trudgen *et al.* (2002) and Trudgen (2006; 2007)	514 taxa; 161 genera; 58 families	18 vegetation alliances (summarisation of original 52 vegetation alliances mapped over the Panorama Springs project area); No TECs or PECs identified, no vegetation alliances considered to be of conservation significance	4 taxa: *Euphorbia clementii* (P3); *Gymnanthera cunninghamii* (P3); *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (Threatened); *Ptilotus mollis* (P4)	9 taxa: **Aerva javanica*; **Argemone ochroleuca*; **Cenchrus ciliaris*; **Cynodon dactylon*; **Ricinus communis*; **Setaria verticillata*; **Solanum nigrum*; **Vachellia farnesiana*
Talison Minerals Wodgina Operations and Mt Francisco: Vegetation and Flora Survey and DRF and Priority Targeted Search	60km south-west of the Study Area	Outback Ecology (2008)	Survey area traversed on foot.	111 taxa; 69 genera; 36 families	11 vegetation units; no TECs or PECs identified.	-	3 taxa: **Aerva javanica*; **Passiflora foetida* var. *hispida*; **Cenchrus ciliaris*.
Wodgina DSO Project Flora and Vegetation Assessment	60km south-west of the Study Area	Outback Ecology (2009)	41 quadrats; 66 relevès over 550 ha.	122 taxa; 67 genera; 38 families.	12 vegetation units; no TECs or PECs identified.	1 taxon: *Terminalia supranitifolia* (P3)	1 taxon: *Aerva javanica*
Turner River Hub (TRH) Project Flora, Vegetation and Mangal Studies	60km south-west of the Study Area	Woodman Environmental (2011a)	17 quadrats within the Study Area	Full number of taxa not relevant given survey area extends far beyond the Study Area	11 vegetation units within the Study Area	2 taxa within the Study Area: *Euphorbia clementii* (P3); *Terminalia supranitifolia* (P3); *Triodia chichesterensis* (P3)	2 taxa: *Aerva javanica*; *Cenchrus ciliaris*
Wodgina Ore Stockpile Area Flora and Vegetation Assessment	60km south-west of the Study Area	Woodman Environmental (2011b)	3 relevès over 12 ha	19 dominant taxa	3 vegetation units; no TECs or PECs identified.	1 taxon: *Euphorbia clementii* (P3)	1 taxon: **Cenchrus ciliaris*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Abydos Direct Shipping Ore (DSO) Project	20 km south-west of Study Area (19,218ha)	Woodman Environmental (2012a) – mining project and infrastructure corridor to GNH	133 quadrats established, all vascular plant species recorded; 5 detailed recording sites, dominant species only recorded (May, Jul 2008; May/Jun, Aug 2010; Sep 2011)	261 taxa; 2 hybrids; 112 genera; 40 families	10 VTs (one split into two sub-types); No TECs or PECs identified, no VTs considered of regional conservation significance	4 taxa: *Abutilon* aff. *hannii* (potentially undescribed); *Euphorbia clementii* (P3); *Gymnanthera cunninghamii* (P3); *Heliotropium muticum* (P3); *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (Threatened)	4 taxa: **Aerva javanica*; **Cenchrus ciliaris*; **Citrullus colocynthis*; **Malvastrum americanum*
	(316ha)	Woodman Environmental (2012b) – camp and haul road corridor to Marble Bar Road	18 detailed recording sites, dominant species only recorded (June 2012)	62 taxa; 40 genera; 20 families	8 vegetation alliances; No TECs or PECs identified, no vegetation alliances considered to be of conservation significance		
Mt Webber DSO Project	60 km south of Study Area (10,920ha)	Woodman Environmental (2012c) - mining area and Public Road Upgrade (PRU)	117 quadrats established in mining area (July and August 2010); 87 flora survey quadrats established in PRU (April 2012)	354 taxa; 139 genera; 50 families	16 VTs; No TECs or PECs identified, no VTs considered of regional conservation significance	8 taxa: *Abutilon* aff. *hannii* (potentially undescribed); *Acacia* sp. indet. (indeterminate) (potentially undescribed); *Bulbostylis burbidgeae* (P4); *Gomphrena leptophylla* (P3); *Gymnanthera cunninghamii* (P3); *Heliotropium murinum* (P3); *Nicotiana umbratica* (P3); *Ptilotus mollis* (P4); *Rothia indica* subsp. *australis* (P3)	9 taxa: **Aerva javanica*; **Cenchrus ciliaris*; **Chloris barbata*; **Citrullus lanatus*; **Cynodon dactylon*; **Flaveria trinervia*; **Malvastrum americanum*; **Vachellia farnesiana*
		Woodman Environmental (2013a) - PRU supplementary survey	21 quadrats established (April 2013)	Additional 12 taxa to Woodman Environmental (2012c)			
Wodgina Proposed Tower Base and Access Road Flora and Vegetation Assessment	60km south-west of the Study Area	Woodman Environmental (2012d)	8 relevès over 4.2 ha	33 dominant taxa	5 vegetation units; no TECs or PECs identified.	1 taxon: *Terminalia supranitifolia* (P3)	2 taxa: **Aerva javanica*; **Cenchrus ciliaris.*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Flora and Vegetation Studies for the Hercules Project	60km south-west of the Study Area	Woodman Environmental (2012e)	68 quadrats over 1583.9 ha	211 taxa; 105 genera; 43 families.	6 vegetation units; no TECs or PECs identified.	3 taxa: *Euphorbia clementii* (P3); *Terminalia supranitifolia* (P3); *Triodia chichesterensis* (P3)* *Vigna triodiophila* (P3)	6 taxa: **Aerva javanica*; **Cenchrus ciliaris*; **Cynodon dactylon*; **Flaveria trinervia*; **Passiflora foetida* var. *hispida*; **Trianthema portulacastrum.*
Hercules DSO Project Conservation Significant Flora Assessment	60km south-west of the Study Area	Woodman Environmental (2013b)	Survey area traversed.	-	-	1 taxon: *Terminalia supranitifolia* (P3)	-
Wodgina Proposed Tower Base and Access Road Flora and Vegetation Assessment – Additional Assessment	60km south-west of the Study Area	Woodman Environmental (2013c)	8 relevès over 2.74 ha	26 dominant taxa	5 vegetation units; no TECs or PECs identified.	1 taxon: *Terminalia supranitifolia* (P3)	2 taxa: **Aerva javanica*; **Cenchrus ciliaris.*
Great Northern Highway (GNH) Upgrade Project Flora and Vegetation Assessment	60km south-west of the Study Area	Woodman Environmental (2013d)	5 quadrats within the Study Area	Full number of taxa not relevant given survey area extends far beyond the Study Area	4 vegetation units within the Study Area	No taxa within the Study Area	2 taxa within the Study Area **Aerva javanica*; **Cenchrus ciliaris.*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Corunna Downs Project	70 km south-east of Study Area (19,095ha)	Woodman Environmental (2016) – Level 2 Flora and Vegetation Assessment	357 quadrats (Mar/Apr, May 2014; May 2016)	411 taxa; 2 hybrids; 177 genera; 63 families	15 VTs; No TECs or PECs identified, four VTs considered of potential regional conservation significance (VT 3, 6, 7, 8)	16 taxa: *Abutilon* aff. *hannii* (potentially undescribed); *Acacia levata* (P3); *Acrostichum speciosum* (significantly disjunct record); *Cochlospermum macnamarae* (P1); *Eragrostis crateriformis* (P3); *Eriocaulon pusillum* (significantly disjunct record); *Heliotropium murinum* (P3); *Nicotiana umbratica* (P3); *Oldenlandia* sp. (potentially undescribed); *Portulaca ?digyna* (potentially undescribed or significantly disjunct record); *Ptilotus mollis* (P4); *Rostellularia adscendens var. latifolia* (P3); *Rothia indica subsp. australis* (P3); *Schoenus* sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07) (P1); *Stylidium weeliwolli* (P3); *Swainsona thompsoniana* (P3)	18 taxa: **Aerva javanica*; *?*Amaranthus viridis*; **Argemone ochroleuca*; **Calotropis procera*; **Cenchrus ciliaris*; **Cenchrus setiger*; **Chloris barbata*; **Cynodon dactylon*; **Echinochloa colona*; **Flaveria trinervia*; **Malvastrum americanum*; **Passiflora foetida* var. *hispida*; **Portulaca pilosa*; **Setaria verticillata*; **Solanum nigrum*; **Sonchus oleraceus*; **Tribulus terrestris*; **Vachellia farnesiana*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Coongan Gorge Realignment Environmental Impact Assessment and Environmental Management Plan	50 km east of Study Area (43.64ha)	GHD (2017) – Biological Assessments - M030 Material Pit Extraction Area 356 SLK; Coongan Gorge Road Realignment (Level 1 flora and vegetation surveys)	Coongan Gorge: 23 quadrats (May 2016) M030 Pit: 12 quadrats (May 2016)	Coongan Gorge: 120 taxa 79 genera 39 families M030 Pit: 89 taxa 55 genera 30 families	Coongan Gorge: 9 VTs; No TECs or PECs identified, none considered of potential regional conservation significance M030 Pit: 7 VTs; No TECs or PECs identified, none considered of potential regional conservation significance	Nil for both surveys	Coongan Gorge: 10 taxa (separate report not attached) M030 Pit: 2 taxa **Calotropis procera*; **Cenchrus ciliaris*
Flora and Vegetation of the Cassiterite Pit Extension and EWL Extension	60km south-west of the Study Area	Western Botanical (2017)	7 quadrats; 37 releves over 110.12 ha	114 taxa; 65 genera; 31 families	5 vegetation units; no TECs or PECs identified.	1 taxon: *Terminalia supranitifolia* (P3)	5 taxa: **Aerva javanica*; **Cenchrus ciliaris;* **Chloris barbata*; **Passiflora foetida*; **Physalis angulata*.
Wodgina Mine Site and Proposed Airstrip Flora, Vegetation and Fauna Assessment	60km south-west of the Study Area	360 Environmental Pty Ltd (360 Environmental) (2018a)	17 relevès over 988 ha	56 taxa; 34 genera; 18 families.	8 vegetation units; no TECs or PECs identified.	2 taxa: *Terminalia supranitifolia* (P3); *Heliotropium muticum* (P3)	4 taxa: **Aerva javanica*; **Calotropis procera*; **Cenchrus ciliaris;* **Passiflora foetida* var. *hispida.*
Wodgina Mine and Additional Gas Pipeline Flora, Vegetation, Fauna and Targeted Northern Quoll Assessment	60km south-west of the Study Area	360 Environmental (2018b)	20 relevés over 1869 ha.	79 taxa; 51 genera; 25 families.	18 vegetation units; no TECs or PECs identified.	-	2 taxa: **Aerva javanica*; **Cenchrus ciliaris*

Project	Location and Size	Study	Parameters of Survey	Number of Taxa	Vegetation	Significant Flora Taxa	Introduced Taxa
Wodgina Mine Flora, Vegetation and Fauna Assessment Addendum	60km south-west of the Study Area	360 Environmental (2018c)	5 relevés over 96 ha.	43 taxa; 28 genera; 18 families	8 vegetation units: no TECs or PECs identified.	1 taxon: *Terminalia supranitifolia* (P3)	5 taxa: **Aerva javanica*; **Calotropis procera*; **Cenchrus ciliaris;* **Cyperus ?rotundus*; **Passiflora foetida* var. *hispida*
Wodgina Aerodrome Detailed Flora and Vegetation Survey	60km south-west of the Study Area	360 Environmental (2018d)	7 quadrats; 4 relevès over 469 ha	62 taxa; 36 genera; 20 families	2 vegetation units: no TECs or PECs identified.	1 taxon: *Heliotropium muticum* (P3)	-
Wodgina Study Area Detailed Flora and Vegetation Survey	60km south-west of the Study Area	Woodman Environmental (2019a)	113 quadrats over 4,385 ha	215 native taxa and 3 hybrids; 43 families; 110 genera	12 vegetation units, of which one may be locally significant due to characterisation of priority flora	6 taxa: *Euphorbia clementii* (P3) *Heliotropium muticum* (P3) *Terminalia supranitifolia* (P3) *Triodia chichesterensis* (P3) *Vigna triodiophila* (P3) *Abutilon* aff. hanii (potentially undescribed)	8 taxa during survey: **Aerva javanica* **Calotropis procera* **Cenchrus ciliaris* **Cenchrus setiger* **Chloris barbata* **Cynodon dactylon* **Flaveria trinerva* **Passiflora foetida* var. *hispida*

2.4.4 Summary of Significant Flora, Vegetation and Introduced Flora

2.4.4.1 Significant Flora

A list of significant flora taxa that are known from within or in the vicinity of the Study Area is presented in Table 7. This list has been compiled from the results of searches of the DBCA Threatened Flora Databases and the results of local surveys as outlined in Section 2.4.1 and 2.4.3, respectively.

A total of 31 significant flora taxa are known from within the vicinity of the Study Area, including one Threatened taxon, 28 Priority taxa and two non-listed taxa. These are presented on Figure 5 where location information is available and they fall within the desktop study area. One of these taxa *Euphorbia clementii* (P3) is currently known from within the Study Area.

One location of *Pityrodia* sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4) (T) was returned from the DBCA database search as located within the Sandtrax survey area. However, this record is believed to be erroneous and the result of a data entry or transcribing error. The record is from Ecologia (2012) located to the south of this survey area, with no overlap. In addition, the habitat at the point location is definitely not suitable for this taxon.

Table 7: Significant Flora Taxa Known from the Vicinity of the Study Area

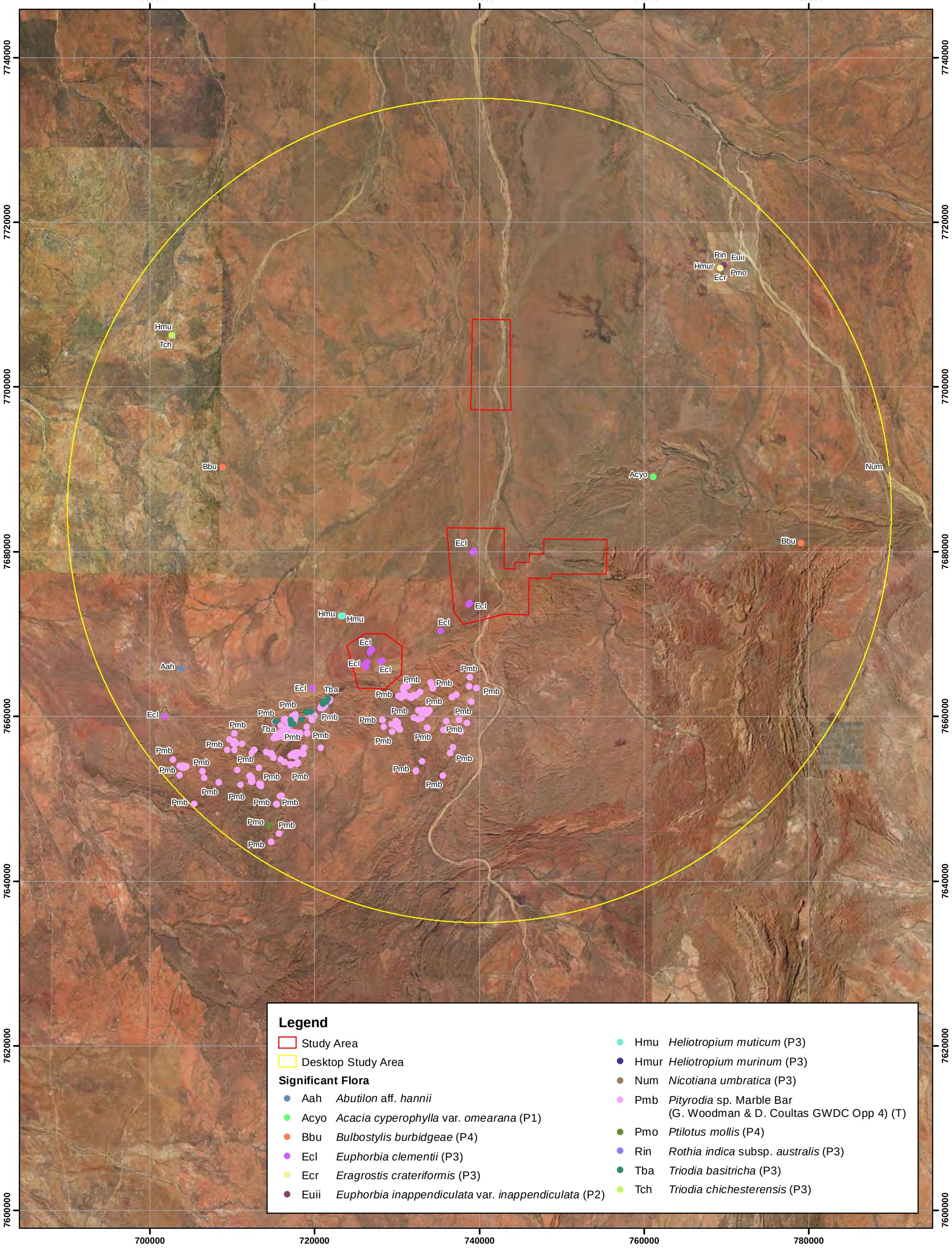
Taxon	Status	Source[#]	Flowering Period (WA Herbarium 1998-)	Habit and Habitat (WA Herbarium 1998-)
Abutilon aff. *hannii*	Potentially undescribed	Other	Jun - Sep	Erect shrub to 1 m. Drainage lines, floodplains, calcrete plains
Acacia cyperophylla var. *omearana*	P1	WA Herb.	Mar - Apr	Tree, 4–10 m high, 'minni-ritchi' bark. Stony and gritty alluvium. Along drainage lines
Acacia levata	P3	Other	May	Spreading shrub to 3 m high. Granite outcrops and hill slopes
Bulbostylis burbidgeae	P4	TPFL, WA Herb., Other	Mar, Jun - Aug	Tufted, erect to spreading annual, grass-like or herb (sedge), 0.03-0.25 m high. Granitic soils. Granite outcrops, cliff bases
Cochlospermum macnamarae	P1	Other	May	Spreading, multi-stemmed shrub to 2 m high. Granite outcrops
Eragrostis crateriformis	P3	WA Herb., Other	Jan - May or Jul	Annual grass to 0.4 m high. Seasonally wet areas, flats
Eremophila spongiocarpa	P1	Other	Jun - Aug*	Compact, succulent-leaved shrub, to 1 m high. Alluvial clay.
Euphorbia clementii	P3	WA Herb., Other	Apr - Jun	Erect herb to 0.6 m high. Stony undulating plains
Euphorbia inappendiculata var. inappendiculata	P2	WA Herb.	Aug	Prostrate annual herb. On clay.
Gomphrena leptophylla	P3	Other	Mar - Sep	Prostrate to erect, spreading annual herb to 0.15 m. Sand, sandy to clayey loam, granite, quartzite. Open flats, sandy creek beds, edges salt pans and marshes, stony hillsides
Goodenia nuda	P4	Other	Apr - Aug	Erect, perennial herb to 0.5 m high. Red-brown sandy loam in seasonally moist depressions, claypans, edge of drainage lines, floodplains
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	P3	Other	Mar, May, Aug - Oct	Erect annual or biennial herb to 0.2 m high. On calcrete, drainage lines.
Gymnanthera cunninghamii	P3	Other	Jan - Dec	Erect shrub to 2 m high. Sandy soils on islands in river and creek channels
Heliotropium murinum	P3	WA Herb., Other	May, Sep	Short-lived perennial, herb to 0.4 m high. Red sand plains, stony granitic plains
Heliotropium muticum	P3	WA Herb., Other	May, Jul, Aug, Oct, Nov	Ascending to spreading perennial herb to 0.3 m high. Sandy plains
Indigofera ixocarpa	P2	Other	Mar, Jun	Shrub, to 1 m high. Skeletal red soils over massive ironstone.
Nicotiana umbratica	P3	WA Herb., Other	Apr - Jun	Erect annual or short-lived perennial herb to 0.7 m high. Granite outcrops and cliffs
Paspalidium retiglume	P2	Other	Apr	Tufted annual, grass-like or herb, 0.1-0.5 m high on clay.
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	Threatened	TPFL, Other	Aug - Sep	Erect, woolly shrub to 1.2 m. Steep south-facing sandstone or ironstone slopes

Taxon	Status	Source[#]	Flowering Period (WA Herbarium 1998-)	Habit and Habitat (WA Herbarium 1998-)
Portulaca ?digyna	Potentially undescribed or significantly disjunct record	Other	Apr - Jun	Succulent, prostrate annual, herb to 0.15 m high. Pink-purple flowers. Stony clay pan
Ptilotus mollis	P4	WA Herb., Other	May, Sep	Compact, perennial shrub, to 0.5 m high, soft grey foliage. Stony hills and screes
Rostellularia adscendens var. *latifolia*	P3	Other	Apr - May	Herb or shrub to 0.3 m high. Creeks, rocky hills
Rothia indica subsp. *australis*	P3	WA Herb., Other	Apr - Aug	Prostrate or spreading annual herb to 0.3 m high. Sandy soils, sandhills, sandy flats
Schoenus sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07)	P1	Other	Apr (Woodman Environmental)	Annual tufted grass-like sedge to 0.15 m. Granite seepage area on brown sandy loam
Swainsona thompsoniana	P3	Other	Mar - Jun, Aug	Prostrate herb to 0.2 m high. Cracking clay, floodplains, claypans, creeklines
Stylidium weeliwolli	P3	Other	Mar - Oct	Annual herb, 0.1-0.25 m high, with 4 rod-shaped throat appendages, pink/red flowers
Terminalia supranitifolia	P3	Other	Feb, Mar, May, Jul, Dec	Spreading tree to 3 m high. Among rock outcrops on slopes and cliffs.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	Other	Aug	Tussocky perennial, grass, 0.9-1.8 m high. Red clay in claypans, plains
Triodia basitricha	P3	WA Herb.	Jun - Jul	Perennial hummock grass up to 0.8 m high. Rocky and gravelly slopes of hills.
Triodia chichesterensis	P3	WA Herb., Other	Mar	Low perennial hummock grass up to 0.4 m high. Quartz or calcrete.
Vigna triodiophila	P3	Other	May – Sep+	Prostrate spreading slender vine. Basalt rockpiles.

[#] Note: Sources of records are:

- TPFL – DBCA Threatened and Priority Flora Database
- WA Herb. – WA Herbarium specimen database
- Other – Local surveys listed in Table 6

*Sourced from Brown & Buirchell (2011), +Sourced from Holland & Butcher (2016)



WOODMAN ENVIRONMENTAL

N

This map should only be used in conjunction with WEC report Atlas19-07-01.

Significant Flora known from the Vicinity of the Study Area

Revision: 0 - 01 Nov 2019 Scale: 1:400,000 (A3)

Author: Debbie Woodman

WEC Ref: Atlas19-07-01

Filename: Atlas19-07-01-f05.mxd

Projection: GDA 1994 MGA Zone 50

Figure 5

2.4.4.2 Introduced Flora

A list of introduced flora taxa known from the vicinity of the Study Area is presented in Table 8. This has been compiled from WA Herbarium specimen data (DBCA 2007-), DoEE SPRAT database (DoEE 2019a) (Section 2.4.1) and from local flora surveys (Section 2.4.3). A total of 36 introduced taxa are known to occur in the vicinity of the Study Area. Of these, **Calotropis procera* and **Parkinsonia aculeata* are Declared Pests (shaded pink in Table 8) however they are considered to be exempt from management or control requirements with regard to agriculture (DPIRD 2019). **Parkinsonia aculeata* is also a listed WoNS (AWC 2019). Fifteen of these introduced taxa are ranked as having High ecological impact for the DBCA Pilbara Region (DBCA 2014).

Table 8: Introduced Flora Taxa Known from the Vicinity of the Study Area

Taxon	Common Name (WA Herbarium 1998-)	Source[#]	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
**Aerva javanica*	Kapok Bush	DBCA (2007-), Other	High	Rapid
*?*Amaranthus viridis*	Green Amaranth	Other	Low	Slow
**Argemone ochroleuca*	Mexican Poppy	Other	Unknown	Rapid
**Bidens bipinnata*	Bipinnate Beggartick	Other	Unknown	Rapid
**Calotropis procera*	Calotrope	Other	-	-
**Cenchrus ciliaris*	Buffel Grass	DBCA (2007-), Other	High	Rapid
**Cenchrus setiger*	Birdwood Grass	Other	High	Rapid
**Chloris barbata*	Purpletop Chloris	Other	High	Rapid
**Chloris virgata*	Feathertop Rhodes Grass	Other	High	Rapid
**Citrullus colocynthis*	-	Other	Unknown	Medium
**Citrullus lanatus*	Pie Melon	Other	Unknown	Medium
**Cynodon dactylon*	Couch	Other	High	Rapid
* *Cyperus ?rotundus*	Nut grass	Other	Unknown	Unknown
**Datura leichhardtii*	Native Thornapple	Other	Unknown	Unknown
**Echinochloa colona*	Awnless Barnyard Grass	Other	High	Rapid
**Eragrostis minor*	Smaller Stinkgrass	Other	-	-
**Euphorbia hirta*	Asthma Plant	DBCA (2007-), Other	Low	Slow
**Flaveria trinervia*	Speedy Weed	DBCA (2007-)	-	-
**Malvastrum americanum*	Spiked Malvastrum	Other	High	Rapid
**Opuntia stricta*	Common Prickly Pear	Other	High	Rapid
**Parkinsonia aculeata*	Parkinsonia	Other	High	Rapid
**Passiflora foetida* var. *hispida*	Stinking Passion Flower	Other	High	Rapid
**Physalis angulata*	Cutleaf Ground Cherry	Other	Unknown	Unknown
**Portulaca pilosa*	Djanggara	Other	-	-
**Prosopis* spp.	Mesquite	DoEE	High	Rapid
**Ricinus communis*	Castor Oil Plant	Other	-	-
**Sagina apetala*	Annual Pearlwort	Other	-	-
**Setaria verticillata*	Whorled Pigeon Grass	Other	High	Rapid
**Sigesbeckia orientalis*	Indian Weed	Other	Unknown	Rapid
**Solanum nigrum*	Black Berry Nightshade	Other	Low	Rapid
**Sonchus oleraceus*	Common Sowthistle	Other	Low	Rapid
**Stylosanthes hamata*	Verano Stylo	Other	High	Medium

Taxon	Common Name (WA Herbarium 1998-)	Source[#]	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
**Trianthema portulacastrum*	Giant Pigweed	Other	-	-
**Tribulus terrestris*	Caltrop	Other	Unknown	Medium
**Tridax procumbens*	Tridax	Other	-	-
**Vachellia farnesiana*	Mimosa Bush	Other	High	Rapid

[#] Note: Sources of records are:

- DBCA (2007-) – WA Herbarium specimen database; Other – Local surveys listed in Table 6

2.4.4.3 Significant Vegetation

Table 9 lists potentially significant vegetation as returned from the desktop study. The closest survey area to this Study Area, the Abydos DSO project area (Woodman Environmental 2012a) contained no VTs considered to be of regional conservation significance. Therefore, potentially significant vegetation listed in Table 9 refers to those described in the next most recent and closest survey to the Study Area (Corunna Downs). No records of significant vegetation were returned from the results of searches of DBCA's TEC and PEC Database and DoEE's SPRAT Database.

A total of four VTs considered to be significant vegetation are known from the vicinity of the Study Area. None of these VTs are listed as TECs or PECs in Western Australia however they are considered of potential regional significance within the Pilbara based on client datasets collated by Woodman Environmental.

Table 9: Significant Vegetation Known from the Vicinity of the Study Area

Vegetation Type	Photographic Representation	Reason for Significance	Source
VT 3 - Low open woodland of mixed species dominated by species including *Corymbia ferriticola*, *Ficus brachypoda*, *Terminalia canescens* over tall sparse shrubland usually dominated by *Acacia pruinocarpa* and *Acacia tumida* var. *pilbarensis* over low open mixed grassland dominated by *Triodia epactia*, *Cymbopogon ambiguus* and *Eriachne mucronata*, on red to brown sand to clay loam on ironstone or metamorphosed granite outcropping, in steep gorges, often with semi-permanent water (Corunna Downs Project)		**Considered Potentially Regionally Significant** Considered to be a refuge and contain unusual taxa, one of which is considered significant (*Acrostichum speciosum*); Known from one other small occurrence in the region, and likely to be a refuge in a regional context	Woodman Environmental (2016)
VT 6 - Tall hummock grassland dominated by *Triodia longiceps* with tall isolated shrubs of *Acacia synchronicia* on red or brown sandy to clay loams on stony plains, interspersed with low sparse forbland of mixed species including *Sida fibulifera, Rhynchosia minima, Tephrosia* sp. clay soils (S. van Leeuwen *et al.* PBS 0273), *Crotalaria dissitiflora* subsp. *benthamiana, Cullen graveolens* and *Eriachne flaccida* on brown cracking clay in clay pans (Corunna Downs Project)		**Considered Potentially Regionally Significant** Regional extent unknown and therefore potentially restricted within the region; Occurs on claypan sites which are generally restricted in the region; Habitat for the significant flora taxon *Swainsona thompsoniana* (P3)	Woodman Environmental (2016)
VT 7 - Tall sparse shrubland dominated by species including *Acacia bivenosa, Acacia synchronicia* and *Dichrostachys spicata* over mid hummock grassland dominated by *Triodia longiceps* over low sparse tussock grassland and chenopod shrubland dominated by *Cenchrus ciliaris* and *Sclerolaena hostilis* on brown clay loam on flats and in open depressions (Corunna Downs Project)		**Considered Potentially Regionally Significant** Regional extent unknown and therefore potentially restricted within the region; Habitat for the significant flora taxon *Eragrostis crateriformis* (P3)	Woodman Environmental (2016)

Vegetation Type	Photographic Representation	Reason for Significance	Source
VT 8 - Low isolated shrubs dominated by *Melaleuca glomerata* over mid hummock grassland dominated by *Triodia longiceps* over low mixed sedgeland, grassland and forbland of mixed species including *Schoenus falcatus*, *Trianthema cusackianum* and *Stemodia grossa* on white to brown clay to clayey sand with occasional calcrete and dolerite stones, at the head of drainage lines (Corunna Downs Project)		**Considered Potentially Regionally Significant** Knowledge of potential regional extent is limited, existing occurrences are all small in area, and therefore is potentially restricted within the region; Substrate and species composition unusual	Woodman Environmental (2016)

3. METHODS

3.1 Personnel and Licensing

Table 10 lists the personnel involved in both fieldwork and plant identifications for the survey. All field team leaders have had previous experience undertaking similar surveys, with the Project Manager having extensive previous experience in conducting flora surveys in the Pilbara Bioregion. All other team members have had previous experience assisting with or conducting surveys.

All plant material in was collected under scientific licence; *Flora Taking (Biological Assessment) License* and *Authorisation to Take or Disturb Threatened Species* pursuant to the BC Act (Sections 40, 274 and 275), as listed in Table 10.

Table 10: Personnel and Licensing Information

Personnel	Role	Flora Collecting Permit (BC Act)
Bethea Loudon	Project Manager, Field Team Leader, Plant Identifications	FB62000049, TFL 24-1819
David Coultas	Field Team Leader	FB62000051, TFL 23-1819
Leah Firth	Field Team Member	FB62000055
Brian Morgan	Field Team Leader	FB62000075
Kelli McCreery	Field Team Member	SL012488
Marco Pratissoli	Field Team Leader	FB62000057
Emalyn Loudon	Field Team Assistant	-

3.2 Aerial Photography Interpretation and Survey Design

Initial interpretation of ortho-rectified aerial photography at a scale of 1:5,000 was conducted to determine preliminary vegetation patterns present within the Study Area, with quadrats allocated based on these patterns. A minimum of three quadrats were allocated to each discernible vegetation pattern where possible; such replication is required for meaningful results to be produced following classification analysis of quadrat data, and to provide local context for VT distribution.

3.3 Field Survey Methods

The field survey comprised of two components: a Targeted Survey for significant flora and vegetation, and a Detailed Survey for vegetation. These components were undertaken in conjunction from 13th May to 19th May 2019 and 27th May to 31st May 2019.

A total of 107 non-permanent flora survey quadrats measuring 50 m x 50 m were established during the survey. This quadrat size is the indicative size used in flora and vegetation surveys in the Pilbara Bioregion, as outlined in Table 1 of the Technical Guidance for Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a). Quadrat locations were selected to ensure that at least three quadrats were surveyed within each vegetation pattern initially identified from aerial photography interpretation (if possible).

All vascular flora taxa that were visually identifiable within each quadrat were recorded. At least one reference specimen of most taxa (excluding common, distinctive taxa) encountered was collected for verification and identification purposes.

The following information was recorded at each quadrat:

- Personnel;
- Unique quadrat number;
- Date of survey;
- GPS (Global Positioning System) coordinates (GDA (Geocentric Datum of Australia) 94);
- Site photograph;
- Topography (including landform type and aspect);
- Soil colour and type (including the presence of any rock outcropping and surface stones);
- Vegetation condition (EPA 2016a; scale presented in Appendix D);
- Approximate time since fire;
- Presence and type of disturbance (if any);
- Percentage foliage cover (for each taxon, including cover within the quadrat of individuals rooted outside of the quadrat);
- Height (m) (average for each taxon, excluding climbers/aerial shrubs); and
- Additional flora taxa present outside of the quadrat but within the vegetation type of the quadrat (no cover recorded).

Mapping notes of vegetation pattern boundaries and distribution was undertaken while traversing the Study Area on foot, to aid in mapping polygons of vegetation patterns that were not allocated quadrats. Not all vegetation pattern polygons received quadrats because of time and access constraints, however many polygons could be confidently allocated to a final VT using a combination of mapping notes and aerial photograph interpretation. Additional flora taxa were also recorded opportunistically in the Study Area via a search in the general vicinity of each quadrat, and during traverses on foot between quadrats.

Targeted survey was undertaken for significant vegetation, with a list of significant VTs that may potentially be encountered compiled as part of the Desktop Study component of this survey (Table 9). If any occurrences of significant vegetation were encountered, the boundary of the significant vegetation was to be recorded, either via walking the boundary and recording the GPS track log, or by recording GPS waypoints. This allows for the accurate calculation of the spatial areas of occurrences of significant vegetation types.

Targeted survey for significant flora taxa was undertaken as part of the survey, with a list of significant flora taxa potentially to be encountered compiled as part of the Desktop Study component of this survey (Table 7). Areas of potential habitat around and between quadrats within the Study Area were traversed on foot to locate and record plants. If populations of known significant flora taxa were identified, a representative collection of material was made, and the abundance and spatial distribution (using GPS coordinates) of individuals within each population was recorded. Locations of any introduced flora taxa encountered

while traversing between quadrats were recorded using the same method as for significant flora taxa.

All areas traversed in the Study Area are mapped as track logs in Figure 6, along with quadrat locations.

3.4 Plant Collection and Identification

Specimens of any unknown taxa were collected and pressed for later identification at the WA Herbarium. External experts of particular families or genera were consulted for any specimens considered to be difficult to identify or of taxonomic interest.

Taxon nomenclature generally follows *FloraBase* (WA Herbarium 1998-) with all names checked against the current DBCA *Max* database to ensure their validity. In cases where names of plant taxa have been published recently in scientific literature but have not yet been adopted on *FloraBase*, nomenclature in the published literature is followed. The conservation status of each taxon was checked against *FloraBase*, which provides the most up-to-date information regarding the conservation status of flora taxa in Western Australia.

Specimens of interest, including significant flora taxa, range extensions of taxa and potential new taxa, will be sent to the WA Herbarium for consideration for vouchering as soon as practicable. However this process is via donation and the WA Herbarium may not voucher all specimens, in accordance with its own requirements. The specimen vouchering will be supported by completed Threatened and Priority Flora Report Forms submitted to DBCA (Species and Communities Branch) in the case of listed significant flora (e.g. Threatened and Priority flora taxa).

720000 730000 740000 750000 760000

7710000 7700000 7690000 7680000 7670000 7660000

Legend

- Quadrats
- Track Log
- Study Area

720000 730000 740000 750000 760000

WOODMAN ENVIRONMENTAL

This map should only be used in conjunction with WEC report Atlas19-07-01.

N

Track Logs and Quadrats

Revision: 0 - 01 Nov 2019 Scale: 1:150,000 (A3)

Author: Debbie Woodman

WEC Ref: Atlas19-07-01

Filename: Atlas19-07-01-f06.mxd

Projection: GDA 1994 MGA Zone 50

Figure

6

3.5 Floristic Analysis

Classification analysis of floristic data from the Study Area was conducted using the 107 quadrats established in the Study Area.

The analysis used 382 taxa, with taxa belonging to several categories removed prior to analysis, as listed below:

- Ephemeral or annual taxa – the presence of ephemeral or annual taxa is strongly influenced by seasonal conditions, with fewer taxa and individuals usually present following below-average rainfall;
- Introduced taxa – introduced taxa were removed as their distributions are generally defined by the presence of disturbance (e.g. clearing, animal movement) rather than particular natural habitat types;
- Hybrids – hybrids are usually the result of random reproductive events that produce small numbers (often only one) of sterile offspring, and are not usually associated with particular habitat types; and
- Taxa where identification was unclear – taxa were removed from the analysis where identification was unclear due to poor available material in the field. However, if such a taxon was known to be unique within the dataset, it was included in the analysis.

All taxa removed from the classification analysis (excluding annual taxa, introduced taxa and singletons) are presented in Appendix E. Six entities were amalgamated, four of which are variants, with the reasoning for the amalgamations also explained in Appendix E.

A single-layer data matrix (i.e. presence/absence data only) was used in the classification analysis. PATN (V3.12) (Belbin and Collins 2009) was utilised to perform the classification and ordination analysis of the data matrix. The Bray-Curtis coefficient was used to generate an association matrix for the classification analysis. This association matrix consisted of pairwise coefficients of similarities between quadrats based on floristic data. Agglomerative hierarchical clustering, using flexible Unweighted Pair Group Method with Arithmetic Mean (UPGMA) (ß=-0.1), was used to generate a quadrat classification dendrogram (Sneath and Sokal 1973).

3.6 Vegetation Type Definition, Mapping and Description

The classification analysis of Study Area floristic data aggregated quadrats into a cluster classification. The resulting dendrogram and taxon group matrix were initially examined at a cluster level determined by PATN as potentially appropriate for the dataset, to determine the plausibility of clusters with regard to taxon groups, as well as field observations and indicator taxon analysis. This process determined a final number of clusters, which were considered to represent VTs.

Quadrats within each group were manually compared to determine the level in the dendrogram at which to delineate VTs. The manual comparison was also utilised to identify any quadrats that had been misclassified by the analysis. Such misclassification of quadrats has occurred in previous floristic analyses conducted by Woodman Environmental, with

higher numbers of quadrats deemed misclassified in previous floristic analyses of Pilbara region quadrat datasets (e.g. Woodman Environmental 2014b) compared to floristic analyses of quadrat datasets from areas outside the Pilbara region. A number of factors potentially contribute to quadrat misclassification, including disturbance history (fire or grazing – both particularly common factors in the Pilbara bioregion), low quadrat representation, naturally low taxon richness, placement of quadrats within ecotones, and the relatively homogenous species composition of vegetation in the Pilbara region across widely differing soil, substrate and topographical types (Woodman Environmental field observations). This process determined a final number of clusters that were considered to represent VTs.

VT descriptions have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (Executive Steering Committee for Australian Vegetation Information (ESCAVI) 2003), as stipulated by EPA (2016a). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data are produced nation-wide. It should be noted that the NVIS system utilises vegetation descriptions derived from structural characteristics of the individual community units, while the VTs presented in this report are defined based on the results of a floristic analysis, excluding any structural data. VTs therefore may include multiple structural types. Considering the effect of disturbance factors such as fire on vegetation structure, this approach is designed to provide a map of VTs that reflect taxon composition and the influences of the physical and chemical environment rather than disturbance history.

It should also be noted that this report describes VTs at the NVIS Sub-Association level, rather than the Association level as stipulated by EPA (2016a). This level is considered more appropriate for the vegetation of the Study Area, as often the vegetation possessed one or more additional strata to the traditional three-stratum classification system used at the Association level.

For each VT, indicator taxa were defined via Indicator Taxon Analysis (INDVAL). This was conducted using PC-Ord (V6.08) (McCune and Mefford 2011) via the method of Dufrene and Legendre (1997). This generates INDVAL values (a measure of taxon fidelity to a given VT), which range from 0 to 100; an INDVAL value of 100 indicates that a taxon is present in all quadrats within a particular VT, and absent from all other quadrats included in the analysis. The INDVAL values were then tested for significance of the indicator taxa using a Monte Carlo permutation test. Indicator taxa were defined as taxa with an INDVAL value > 20, and a significance Þ (significance) value of <0.05, <0.01 and <0.001.

The locations of quadrats within each VT were used in conjunction with aerial photograph interpretation and field notes taken during survey to develop VT mapping polygon boundaries. These VT mapping polygon boundaries were then digitised using Geographic Information System (GIS) software.

3.7 Vegetation Condition Mapping

Vegetation condition was described using the vegetation condition scale presented in EPA (2016a) (Appendix D). Notes on vegetation condition were taken during the field survey via

vehicle traverses along tracks, and during foot traverses undertaken to search for significant flora taxa or while traversing between quadrats. Vegetation condition was also recorded at all quadrats. Vegetation condition category polygon boundaries were also progressively drawn on aerial photography as far as possible, while completing the foot and vehicle traverses of the Study Area. These polygon boundaries were then digitised using GIS software as for VT polygon boundaries.

Due to the nature of the clearing operations associated with exploration and the age of aerial photography, boundaries of areas cleared for exploration were not always able to be captured accurately in the field. Areas mapped as Cleared are areas mapped as cleared in the field, namely new or upgraded tracks; drill pads were not delineated.

3.8 Significant Flora and Vegetation

3.8.1 Significant Flora

EPA (2016b) defines flora taxa to be considered significant for a range of reasons, including, but not limited to the following:

- Being identified as a Threatened or Priority species (listed significant taxa – includes taxa listed under both State and Commonwealth legislation);
- Locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems);
- New species or anomalous features that indicate a potential new species;
- Representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- Unusual species, including restricted subspecies, varieties or naturally occurring hybrids; and
- Relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

Significant taxa recorded within the Study Area are discussed in Section 5.1.1.2, with reference to the above categories. In these sections, point locations, individuals and populations known from the Study Area are discussed. In many cases, the number of populations identified is considered to be a tentative estimate. A population in the context of this survey is defined as a discrete group of individuals of a taxon separated by more than 500 m from the nearest discrete group of individuals (DBCA 2017). Recording of significant taxa was undertaken while conducting the quadrat survey and opportunistically, therefore not all potential habitat was not comprehensively searched and it is therefore likely that additional plants would be present in these areas. Similarly, searches adjacent to the locations where taxa were recorded could record additional individuals between locations separated by 500 m in the Study Area.

3.8.2 Significant Vegetation

As per EPA (2016b), vegetation may be considered significant for a range of reasons, including, but not limited to the following:

- Being identified as a Threatened (under both Commonwealth legislation or the WA Government TEC endorsement process) or Priority Ecological Community (listed significant vegetation);
- Having restricted distribution;
- Degree of historical impact from threatened processes;
- A role as a refuge; and
- Providing an important function required to maintain ecological integrity of a significant ecosystem.

There is no Pilbara-wide VT dataset to allow for determination of the regional extent of VTs. However floristic analysis of quadrats from the nearby Atlas Iron Corunna Project, along with review of previous floristic analyses and VTs as produced by Woodman Environmental (2012a, c; e; 2013e, 2016; 2019a), provides a relatively geographically-widespread VT dataset with a reasonable level of context when considering the regional distribution and potential significance of VTs mapped in the Study Area. VTs are considered to be of potential regional significance if there is potential for them to be restricted in the wider region as a result of uncommon substrates or other factors including refugia for restricted, significant taxa (e.g. P1, P2, Threatened) or are characterised by such taxa. The remaining significant vegetation criteria as listed above were applied to VTs mapped in the Study Area, to determine whether a VT is significant in a local or regional context (with 'local' referring to the Study Area).

A number of TECs and PECs listed in Western Australia, particularly those in the Pilbara Bioregion, have not been defined by floristic analysis with only broad descriptions often provided. The vegetation of the Study Area was therefore manually compared to such descriptions to determine whether any vegetation may represent a TEC or PEC. The two TECs currently known to occur within the Pilbara Bioregion are not listed under the EPBC Act (DBCA 2018b; DoEE 2019c); no conservation advice or recovery plans exists for these two communities (DBCA 2019c; DoEE 2019c).

4. ADEQUACY AND LIMITATIONS OF SURVEY

4.1 Adequacy of Survey

The Study Area covers 21,501.4 ha, with 107 quadrats established within it during the 2019 survey (1 quadrat per 201 ha; . Quadrats were established in all preliminary vegetation patterns discernible by initial aerial photograph interpretation (see Section 3.3), both to adequately sample variation in vegetation throughout the Study Area, and to ensure adequacy of sampling for vascular plant taxa. The number of quadrats established in the Study Area is considered to be an acceptable number given the low diversity of topography and soil types noted in the Study Area.

To provide an indication of the adequacy of this survey, a taxon accumulation curve was produced using PC-Ord (McCune and Mefford 2011). Taxon accumulation curves represent a theoretical model of the relationship between sampling intensity and taxon accumulation; when sampling intensity is increased, taxon accumulation is reduced, and a taxon accumulation curve becomes asymptotic.

The taxon accumulation curve was generated using all native taxa (including annual, ephemeral, perennial and known hybrids) recorded within each quadrat. Taxon accumulation calculations for the Study Area were then undertaken utilising the Chao-2 estimator for species richness (Chao 1987), and compared to the actual number of taxa recorded in the Study Area. This gives some indication as to whether sufficient quadrats have been surveyed to adequately sample the species richness in the Study Area. As the generation of species accumulation curves includes quadrat data only and not taxa recorded during targeted searching or opportunistically, the indication of adequacy of survey provided is considered to be conservative.

Figure 7 presents the species accumulation curve generated from quadrat data from the Study Area. The curve presented in this figure has begun to plateau, indicating that it is likely that species richness has been adequately sampled. Using the Chao-2 estimator, the recorded number of taxa within quadrats is equivalent to 93.9 % of the estimated taxon richness in the Study Area. The estimated number of native taxa in the Study Area using Chao-2 was 374; in comparison, when all records of taxa from other sampling sources are included, 361 native taxa (excluding putative hybrids) were recorded in the Study Area (see Section 5.1.1.1).

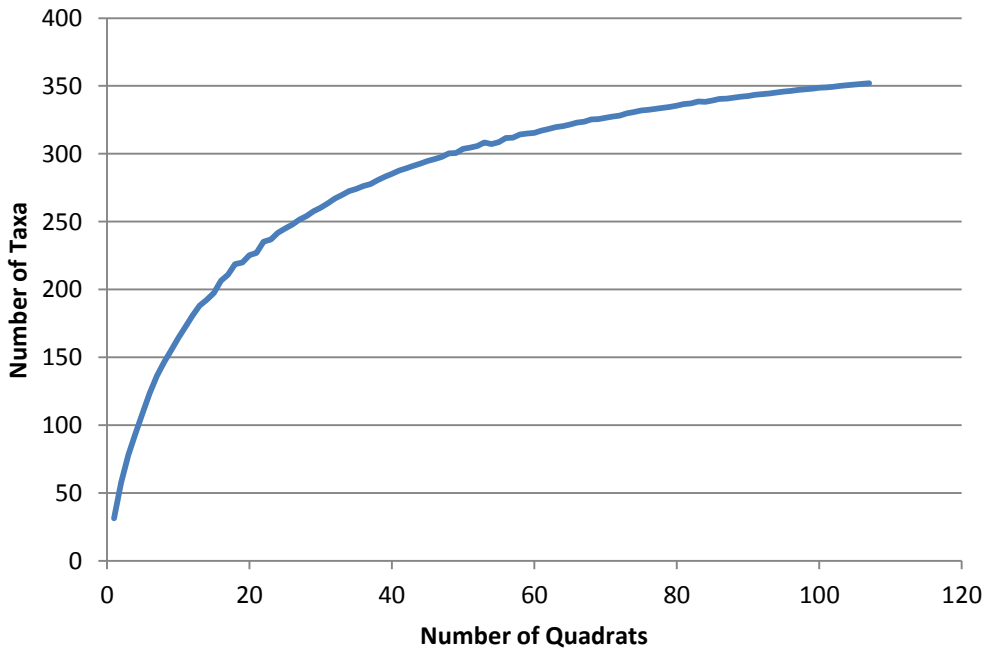


Figure 7: Study Area Quadrat Data Species Accumulation Curve

Another adequacy of survey measure is that developed by Mueller-Dombois and Ellenberg (1974), who suggest that an adequacy cut-off point might be when a 10 % increase in quadrats surveyed results in a 5 % (or less) increase in taxa recorded. This measure was also calculated using all native taxa recorded within each quadrat. The number of quadrats established in the Study Area satisfies this adequacy measure suggested by Mueller-Dombois and Ellenberg (1974), with the final taxon increase value of 1.63 % recorded following the final 10 % increase in quadrats.

Based on this adequacy of survey measure, it is further identified that the Chao-2 estimation of number of taxa is potentially an overestimation of the number of species expected to be present. The addition of further quadrats would unlikely provide a significant increase in confidence of the Chao-2 estimate, and is likely a reflection the diversity of native taxa and vegetation types present within the Study Area rather than inadequacy of survey.

4.2 Limitations of Survey

Table 11 presents the limitations of the flora and vegetation survey of the Study Area in accordance with EPA (2016a).

Table 11: Limitations of the Flora and Vegetation Survey of the Study Area

Limitation	Limitation of Survey	Comment
Effort and Extent	Potential	Detailed survey and targeted survey undertaken across entire Study Area. Multiple quadrats were established in each vegetation pattern identified in the Study Area. The targeted survey involved transects or opportunistic searching of suitable habitat across the Study Area. All significant taxa identified as potentially occurring in the Study Area (Table 7) were searched for as part of the targeted survey. Time constraints restricted intensive/additional targeted survey, with targeted searching of all potential habitat not undertaken, with resultant plant numbers and occupancy not considered extensive particularly for *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), *Goodenia nuda* (P4), *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3), and *Triodia chichesterensis* (P3). Appropriate sampling techniques for detailed vegetation survey (quadrat establishment, foot transects) were employed. Ease of access to parts of the Study Area enabled detailed vegetation type and condition mapping to be undertaken in parts of the Study Area via foot and vehicle transects. However large areas were not easily accessible or were recently burnt, therefore mapping reliability is potentially reduced.
Competency /experience of the team carrying out the survey	No	Project Manager/Field Team Leader has extensive experience (11 years) in conducting similar assessments in the Pilbara Bioregion, and in other areas of Western Australia. Personnel conducting plant identifications have had > 11 years' experience, including in identifying collections from the Pilbara.
Proportion of flora identified, recorded and/or collected.	No	All vascular groups that were present during the detailed survey were sampled. A high proportion of both perennial and annual vascular taxa were recorded based on the intensity and method of survey, and adequate rainfall prior to survey (see timing/weather/season/cycle below). Unknown vascular taxa were collected, with specimens identified at the WA Herbarium. Adequacy of survey measures indicate a high percentage of taxa expected to occur in the Study Area was recorded using Chao-2 estimator (93.9 %), and the number of quadrats established in the Study Area satisfies the criterion suggested by Mueller-Dombois and Ellenberg (1974), with an increase of 1.63 % in species recorded per increase of 10 % of quadrats.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data	No	Good contextual information for the Study Area was available prior to the survey. Sources of information used included government databases (DBCA, DoEE), previous unpublished reports and data from the vicinity of the Study Area (Mattiske 2000, 2007; Biota and Trudgen 2002; Biota 2004; GHD 2017; Outback Ecology 2008, 2009; Woodman Environmental 2011a, b; 2012a, b, c, d, e; 2013a, b, c, d; 2014a, b, c; 2016; Western Botanical 2017; 360 Environmental 2018a, b, c, d), as well as numerous general sources pertaining to the climate, geomorphology, flora and vegetation of the Pilbara Bioregion (see Section 2).

Limitation	Limitation of Survey	Comment
Timing/weather/season/cycle	No	The survey was conducted within the appropriate season for survey in the Pilbara Bioregion (6-8 weeks post wet season: May 2019 (EPA 2016a)). The flowering period was considered by Woodman Environmental to be average at the time of the survey. Rainfall in the six months prior to the survey was above-average with significant rainfall (well above-average) occurring in March 2019 as the result of a cyclone. The mean maximum temperature was above-average for the six months prior to the survey. This period is considered to be the most important in terms of influencing the quality of a given flowering season and general vegetation condition in the Pilbara however these climatic conditions were not detrimental and did not affect the outcomes of the survey. All taxa were identifiable.
Disturbances (e.g. fire, flood, accidental human intervention etc.), which affected results of survey	Potential	A large proportion of the Study Area was relatively recently burnt (within the last 12 months), which limited the areas in which quadrats could be placed. Quadrats were placed in unburnt areas of similar vegetation where possible, and mapping notes taken where recently burnt. The remainder of the Study Area had not been significantly affected by fire in recent years.
Remoteness and/or access problems	Minor	Flooding from a recent cyclone has caused restricted access over several river crossings within the study area which limited access to a small number of sites. Otherwise, there were no impediments to access within the Study Area, with numerous tracks present to and within all parts of the Study Area. All areas were accessible on foot from adjacent tracks and roads.

5. RESULTS

5.1 Field Survey

5.1.1 Flora of the Study Area

5.1.1.1 Vascular Flora Census

A total of 380 discrete vascular flora taxa, one known hybrid and one putative hybrid were recorded in the Study Area during this survey, including 360 native taxa and 20 introduced taxa. These taxa represent 54 families and 157 genera. The most well-represented families were Fabaceae (73 taxa), Poaceae (61 taxa) and Malvaceae (35 taxa), and Cyperaceae (21 taxa). Of the discrete flora taxa recorded, the life-cycle of 135 taxa (36 %) were classified as annual, and 245 taxa (64 %) were classified as perennial.

Average native taxon richness per quadrat was 31.4 (± 18.8), with the greatest number of taxa recorded in a single quadrat being 98, and the lowest number being three. A full list of taxa is presented in Appendix F, with raw quadrat data and parameters presented in Appendix G.

5.1.1.2 Summary of Significant Flora Taxa

Table 12 presents a list of significant flora taxa recorded in the Study Area, together with location information. A total of 16 significant flora taxa were recorded during this survey of the Study Area, including eight Priority flora taxa and eight taxa considered significant for other reasons as per EPA (2016a, 2016b). No Threatened flora taxa were recorded within the Study Area. Table 12 also presents the VTs within which each significant flora taxon was recorded. Locations of significant flora taxa are presented in Appendix H and on Figures 8.1-8.37; the legend is presented on Figure 8.38 (Appendix I). Note, where plants were not counted at the time of the survey, each location record has been given a count of one.

Table 12: Summary of Significant Flora Taxa Recorded within the Study Area

Taxon	Significance Status	Number of Locations Recorded in Study Area	Number of Individuals Recorded in Study Area	Vegetation Type
Abutilon aff. *hannii*	Potentially undescribed	1	1	5
Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05)	P1	3	37	1
Cyperus microcephalus subsp. *saxicola*	Significant range extension	2	2	1, 2
Desmodium campylocaulon	Fills large gap in known distribution	2	2	6
Dodonaea petiolaris	Significant range extension	3	3	1
Eragrostis crateriformis	P3	17	2976	5, 6, 7, 9
Euphorbia clementii	P3	29	4696	3, 6, 7, 10, 12
Euphorbia inappendiculata var. *inappendiculata*	P2	3	1700	6
Fimbristylis nuda	Significant disjunct record	2	2	2

Taxon	Significance Status	Number of Locations Recorded in Study Area	Number of Individuals Recorded in Study Area	Vegetation Type
Goodenia nuda	P4	1	30	7
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	P3	2	2	6
Ophioglossum lusitanicum	Significant range extension	1	10	2
Polymeria sp.	Potentially undescribed	2	2	7
Scleria rugosa	Significant disjunct record	2	2	2
Triodia basitricha	P3	31	13869	1, 3, 4, 11
Triodia chichesterensis	P3	1	500	10

5.1.1.3 Listed Significant Flora Taxa

Eight listed significant flora taxa were recorded during this survey of the Study Area, as detailed below.

***Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1)**

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1) is a shrub to unknown height (Plate 1), which occurs on sandy clay loam with exposed ironstone bedrock within the Study Area. It is only known from one location on the Florabase data set (DBCA 2007-) and is believed to only occur in two populations, one near Marble Bar and one on Yarrie/Callawa station (J. Bull Pers. Com).

Plate 1: *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1) (Photographs: Woodman Environmental)

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1) was recorded at 3 point locations in the Study Area with a total of 37 individuals recorded (Table 12) (Appendix H; Figures 8.17 and 8.18 (Appendix I)). The taxon was recorded on south-facing cliffs and very steep

ironstone slopes, in the Study Area, with all locations occurring within VT 1. These locations are additional to those known in the region.

It is possible that more locations of *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1) occur within the Study Area, as not all suitable habitat has been surveyed. Further survey may be required to determine the number of plants present within the Study Area if this taxon is likely to be impacted; plant counts were only recorded at one of the three point locations.

***Eragrostis crateriformis* (P3)**

Eragrostis crateriformis (P3) is a delicate, ephemeral grass to 0.4 m high (Plate 2), which occurs on clay creek banks and in clay depressions (WA Herbarium 1998-). This taxon occurs over a range of approximately 1,370 km in Western Australia, from near Onslow in the west to near Balgo Hills in the Tanami Desert in the east (DBCA 2007-). It also occurs in the Northern Territory ((Atlas of Living Australia (ALA) 2019)). There are 51 records of this taxon in Western Australia, representing approximately 30 populations. Three of these populations occur in the DBCA-managed Millstream-Chichester National Park and Meentheena Station Conservation Reserve (DBCA 2007-).

Plate 2: *Eragrostis crateriformis* (P3) (Photographs: Woodman Environmental)

Eragrostis crateriformis (P3) was recorded at 17 point locations in the Study Area with a total of 2976 individuals recorded (Table 12) (Appendix H; Figures 8.5, 8.6, 8.12, 8.13, 8.21, 8.29 (Appendix I)). The taxon was recorded in VTs 5, 6, 7 and 9 which are all minor drainage lines and sheet flow areas. Although the Study Area is within the known range of this taxon, the records within the Study Area fill a small gap within this range, with the closest known records occurring approximately 40 km to the northeast (DBCA 2007-).

***Euphorbia clementii* (P3)**

Euphorbia clementii (P3) is an erect herb growing to 0.6 m high occurring on gravelly hillsides and stony grounds (WA Herbarium 1998-) (Plate 3). This taxon is endemic to

Western Australia (ALA 2019), with the main range of its distribution extending over a distance of 190 km from Wodgina in the west to northeast of Marble Bar. Two outliers, one located 120 km east-northeast of Nullagine (160 km southeast of the taxon's main range and represented by a specimen at the WA Herbarium), and the second located 100 km west-northwest of Newman (215 km south of main range, a TPFL record without a vouchered specimen). The latter location consists of atypical vegetation composition and no reproductive material present on *Euphorbia clementii* (P3) (DBCA 2007-) and is therefore potentially dubious. There are 35 location records of *Euphorbia clementii* (P3) in Western Australia, including the two outlying records. These records represent approximately 18 populations, none of which occur in DBCA-managed tenure (DBCA 2007-).

Plate 3: *Euphorbia clementii* (P3) (Photographs: Woodman Environmental)

Euphorbia clementii (P3) was recorded from 29 point locations in the Study Area with 4696 individuals recorded (Table 12) (Appendix H). These point locations represent 9 populations (as shown on Figures 8.12 – 8.36 (Appendix I)). The taxon was recorded on plains and outwash slopes, and in minor drainage lines or areas of sheet flow. This taxon is typically a fire-responder (and relatively short-lived) and was observed in large numbers in recently burnt areas within the Study Area. *Euphorbia clementii* (P3) has previously been recorded at the nearby Abydos DSO Project (Woodman Environmental 2012a).

***Euphorbia inappendiculata var. inappendiculata* (P2)**

Euphorbia inappendiculata var. *inappendiculata* (P2) is a small, prostrate many branched annual herb (Plate 4). This taxon occurs over a range of approximately 486 km in Western Australia, from near Newman in the east to near Port Hedland in the north (DBCA 2007-). There are 8 records of this taxon in Western Australia, representing approximately 7 populations, one of which is located in the Barlee Range Nature Reserve (DBCA 2007-).

Plate 4: ***Euphorbia inappendiculata var. inappendiculata*** **(P2) (Photograph: Woodman Environmental)**

Euphorbia inappendiculata var. *inappendiculata* (P2) was recorded at three point locations in the Study Area with a total of 1700 individuals recorded (Table 12) (Appendix H; Figure 8.21 (Appendix I)). The taxon was recorded in cracking claypans of red sandy clay in the Study Area within VT 6. These point locations represent one population (as shown on Figure 8.21 (Appendix I)).

Goodenia nuda **(P4)**

Goodenia nuda (P4) is an erect to ascending herb to 0.5m high (Plate 5), which predominantly occurs on seasonally inundated clay soils and drainage lines. It has also been recorded from scoured river beds and hillsides (WA Herbarium 1998-). This taxon occurs over a range of approximately 900 km in Western Australia, from near Wiluna in the south to near Port Hedland in the north (DBCA 2007-). There are 121 records of this taxon in Western Australia, representing approximately 78 populations ((Atlas of Living Australia (ALA) 2019)), some of which occur on DBCA managed tenure within Karijini National Park.

Plate 5: *Goodenia nuda* (P4) (Photographs: K.C. Richardson)

Goodenia nuda (P4) was recorded at one location in the Study Area with a total of 30 individuals noted (Table 12) (Appendix H; Figure 8.12 (Appendix I)). The taxon was recorded in a minor drainage line within VT 7.

Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)

Oldenlandia sp. Hamersley Station (A.A Mitchell PRP 1479) (P3) is a spreading annual herb to 0.1 m high (Plate 6), which occurs on cracking clay and basalt soils, on gently undulating plains (WA Herbarium 1998-). This taxon occurs over a range of approximately 700 km in Western Australia, from Newman to Karratha (DBCA 2007-). There are 32 records of this taxon in Western Australia, representing approximately 25 populations. Three of these populations occur in the DBCA-managed Millstream-Chichester National Park (DBCA 2007-).

Plate 6: *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3) (scanned specimen collected by Woodman Environmental)

Oldenlandia sp. Hamersley Station (A.A Mitchell PRP 1479) (P3) was recorded at 2 point locations in the Study Area with a total of 2 individuals recorded (Table 12) (Appendix H; Figure 8.21 (Appendix I)). The taxon was recorded in cracking claypans of red sandy clay in the Study Area within VT 6.

***Triodia basitricha* (P3)**

Triodia basitricha (P3) is a perennial hummock grass growing up to 0.8 m high (Plate 7), occurring on rocky and gravelly slopes of hills (WA Herbarium 1998-). This taxon occurs over a range of approximately 760 km in Western Australia, from west of Innawanga to west of Marble Bar (DBCA 2007-). There are 26 records of this taxon in Western Australia, representing approximately 19 populations. Two of these populations occur in the DBCA-managed Millstream-Chichester National Park (DBCA 2007-).

Plate 7: ***Triodia basitricha*** **(P3) (Photograph: Woodman Environmental)**

Triodia basitricha (P3) was recorded at 31 point locations in the Study Area with a total of 13869 individuals recorded (Table 12) (Appendix H; Figure 8.17; 8.18, 8.29, 8.36 (Appendix I)). This taxon was recorded on sandy loam soils with exposed or underlying bedrock, within VTs 1, 3, 4 and 11.

Triodia chichesterensis **(P3)**

Triodia chichesterensis (P3) is a low perennial hummock grass growing up to 0.4 m high (Plate 8), occurring on quartz or calcrete soils (WA Herbarium 1998-). This taxon occurs over a range of approximately 90 km in Western Australia, from south of Port Hedland to Abydos (DBCA 2007-). There are 16 records of this taxon in Western Australia, representing approximately 10 populations.

Triodia chichesterensis (P3) was recorded at one point location in the Study Area with a total of 500 individuals recorded (Table 12) (Appendix H; Figure 8.21 (Appendix I)). This taxon was recorded on clay loam soils within VT 10.

Plate 8: ***Triodia chichesterensis*** **(P3) (Photograph: Woodman Environmental)**

5.1.1.4 Other Significant Flora Taxa

Two potentially undescribed flora taxa that are of potential significance were recorded within the Study Area. In addition, six known unlisted taxa were recorded whose occurrence in the Study Area represent a significant disjunct record (and large range extension) and are therefore also of significance. These taxa are detailed below.

Abutilon* aff. *hannii

One collection was made within the Study Area of an entity that has previously been identified by a specialist taxonomist at the WA Herbarium as *Abutilon* aff. *hannii*.

This entity matches a small number of collections from the Pilbara Bioregion, one of which is currently lodged as *Abutilon hannii*. However these collections differ significantly in indumentum characters from all other *A. hannii* collections in Western Australia (which are all from the Kimberley Bioregion). Although there has been speculation as to whether these collections may represent introgression between *A. macrum* and *A. hannii*, this was considered to be very unlikely given that the typical *A. hannii* does not occur anywhere near the Pilbara. Therefore, this entity may represent an undescribed taxon; however as *Abutilon* is currently under active revision it may fall within the concept of a described taxon upon publication of this revision (M. Hislop *pers. comm.* 2014, 2016).

Abutilon aff. *hannii* is a shrub to 1 m found growing in drainage lines, floodplains, calcrete plains (WA Herbarium 1998-; Woodman Environmental 2012a, 2012c, 2016). It was recorded at one location in the Study Area within VT 5 (Table 12) (Appendix H; Figure 8.36, (Appendix I)).

Only one individual could be said to definitively occur in the Study Area as no specific survey for this entity at the recorded location was undertaken, however plant numbers are likely to

be low as few individuals are generally recorded when encountered. No additional locations were recorded while traversing the Study Area between quadrats.

This entity has been recorded nearby in Atlas Iron's Corunna Project (Woodman Environmental 2016), McPhee Creek Rail Project (Woodman Environmental 2014c), Abydos DSO Project (Woodman Environmental 2012a) and Mt Webber DSO Project (Woodman Environmental 2012c), in low plant numbers and few locations. As this taxon appears to be fairly uncommon in the Pilbara region, and is not currently known from any conservation reserves, it is considered that it should be treated as being of significance, pending taxonomic resolution.

Cyperus microcephalus subsp. saxicola

This taxon is an erect, tufted perennial, grass-like or herb (sedge), growing 0.2-0.4 m high. It generally flowers Jun to July and its preferred habitat is rock crevices. It is widespread in the Kimberley region but has only been previously recorded at one location in the Pilbara. The collection represents a range extension of 100km from that previous Pilbara record. It was recorded at 2 locations within the Study Area, within VTs 1 and 2 (Table 12) (Appendix H; Figure 8.18 (Appendix I)).

Desmodium campylocaulon

Desmodium campylocaulon is a scrambling annual herb growing to 0.3 m high. The recording of this taxon in the Study Area fills a large locality hole, with the nearest record 125 km to the south-south-west. It was recorded at 2 locations within the Study Area, within VT 6 (Table 12) (Appendix H; Figure 8.21 (Appendix I)). It is otherwise known from numerous locations in the Pilbara region.

Dodonaea petiolaris

Dodonaea petiolaris is an erect shrub growing to 2 m high, commonly found on sandy and loamy soils on rocky hillsides and ridges. The recording of this taxon in the Study Area represents a range extension to the north, with the nearest record 150 km to the south-south-west. It was recorded at 3 locations within the Study Area, within VT 1 (Table 12) (Appendix H; Figures 8.17, 8.18 (Appendix I)). It is otherwise known from numerous locations in Western Australia.

Fimbristylis nuda

Fimbristylis nuda is a tufted, spreading annual, grass-like sedge, growing 0.05-0.17 m high. Its preferred habitat is damp sand or grey sandy clay along watercourses. Florabase records only show this taxon occurring in the Kimberley region, with the nearest vouchered specimen collected 490 km north-east of the Study Area (WA Herbarium 1998-). It was recorded at 2 locations within the Study Area, within VT 2 (Table 12) (Appendix H; Figures 8.17, 8.18 (Appendix I)).

Ophioglossum lusitanicum

Ophioglossum lusitanicum is a rhizomatous, perennial, herb growing to 0.01-0.15 m high. Its preferred habitat is yellow sands or loams in shallow soil pockets subject to flooding,

amongst rocks or along streambanks. Collection of this taxon within the Study Area represents a range extension to the north, with the nearest vouchered specimen collected 200 km south-east of the Study Area (WA Herbarium 1998-). It was recorded at 1 location within the Study Area, within VT 2 (Table 12) (Appendix H; Figure 8.18 (Appendix I)).

***Polymeria* sp.**

This collection represents a potentially undescribed taxon as it does not match well with any of the currently accepted *Polymeria* species M. Hislop Pers Com.). The genus is currently under revision by a taxonomist in Brisbane. It was recorded at 2 locations within the Study Area, within VT 7 (Table 12) (Appendix H; Figures 8.12, 8.22 (Appendix I)).

Scleria rugosa

Scleria rugosa is a tufted, often decumbent annual, grass-like or herb (sedge), 0.1-0.55 m high, with fibrous, red roots. Its preferred habitat is peaty clay or sand around pool edges and watercourses. Collection of this taxon within the Study Area represents a significant range extension with this taxon only previously recorded in the Kimberley region, 630 km north of the Study Area (WA Herbarium 1998-). It was recorded at 2 locations within the Study Area, within VT 2 (Table 12) (Appendix H; Figures 8.17, 8.18 (Appendix I)).

5.1.1.5 Other Taxa of Interest

Fimbristylis neilsonii

Fimbristylis neilsonii is a tufted perennial, grass-like or herb (sedge), 0.15-0.8 m high. Its preferred habitat is siliceous loamy sands. Collection of this taxon within the Study Area represents a 60 km range extension to the north of previous known locations (WA Herbarium 1998-). It is poorly collected in Western Australia, with only 8 specimens collected in the Pilbara and 8 in the Kimberley region.

***Sida macropoda* (sens lat.)**

Collection of this taxon within the Study Area represents a 60 km range extension to the west of previous known locations (WA Herbarium 1998-). It is poorly collected in Western Australia, with only 10 specimens collected in the Pilbara and 10 in the Kimberley region. The genus is currently under revision.

5.1.1.6 Likelihood of Occurrence of Further Listed Significant Flora Taxa

As detailed in Section 2.4.4.1, a total of 29 listed significant flora taxa were identified through the desktop review as occurring near the Study Area prior to survey. Of these, seven were recorded within the Study Area during this survey (Table 12). It is considered that the remaining 22 taxa would have been identifiable during the survey period, either because the survey period coincided with the taxon's flowering period, or the taxon can be identified reliably when in fruit or when sterile. It is also considered that although traverses and some opportunistic searching were employed for survey for significant flora taxa, survey effort for some taxa was limited by the combination of recent fires, extent of survey area and time constraints. It is therefore possible that other significant flora taxa could conceivably occur in the Study Area.

An assessment of the potential for other significant flora taxa to occur in the Study Area is presented in Table 13, based on habitats mapped in the Study Area, characteristics of the significant flora taxa and distribution listed in Table 7. Please note the following definitions of likelihood of occurrence:

Very Unlikely: No suitable habitat mapped in the Study Area; no known records and distribution of the taxon are not in close proximity to Study Area.

Unlikely: Suitable habitat is either not present in the Study Area or possibly present in the Study Area but taxon likely to have been recorded if present; known locations or general distribution not in close proximity to the Study Area.

Potential: Suitable habitat was mapped in the Study Area, or could conceivably be present in the Study Area (in terms of taxa where suitable habitat is not well defined); known locations or distribution of taxon in close proximity to Study Area. It is considered possible but not likely that these taxa are present.

The assessment in Table 13 is a conservative assessment due to the lack of previous survey in the area and the reduced ability to survey large sections due to recent fires.

Table 13: Likelihood of Occurrence of Other Listed Significant Flora Taxa within the Study Area

Taxon	Status	Potential of Occurrence
Acacia cyperophylla var. *omearana*	P1	**Potential**. Suitable habitat is present in the Study Area. Nearest records approximately 9 km north of the Study Area. Highly visible tree so would have been found if present along tracks and near quadrats.
Acacia levata	P3	**Potential**. Suitable habitat is present in the Study Area. Nearest record approximately 70 km to the south east of the Study Area.
Bulbostylis burbidgeae	P4	**Potential.** Suitable habitat is present in the Study Area Nearest known records approximately 22km to east of Study Area.
Cochlospermum macnamarae	P1	**Unlikely**. Similar soil types to the preferred habitat for this taxon are present within the Study Area, however the species composition at those locations is very different to that within the Study Area. Nearest known records approximately 70 km to the south east of the Study Area.
Gomphrena leptophylla	P3	**Very Unlikely.** Prefers salt pans and marshes which are not present in the Study Area. Known to occur approximately 60 km to the south of Study Area.
Goodenia sp. East Pilbara (A.A Mitchell PRP 727)	P3	**Unlikely**. Similar soil types to the preferred habitat for this taxon are present within the Study Area, however the species composition at those locations is very different to that within the Study Area. Nearest known records approximately 60 km to the west of the Study Area.
Gymnanthera cunninghamii	P3	**Potential**. Suitable habitat is present in the Study Area. Nearest record approximately 20 km to south-west of Study Area.
Heliotropium murinum	P3	**Potential**. Suitable habitat is present in the Study Area. Nearest record approximately 25 km to the east of the Study Area.
Heliotropium muticum	P3	**Potential**. Suitable habitat is present in the Study Area. Nearest record is approximately 1 km to north of Study Area.

Taxon	Status	Potential of Occurrence
Indigofera ixocarpa	P2	**Very Unlikely**. Suitable habitat is not present in the Study Area. Nearest known records approximately 60 km to the west of the Study Area.
Nicotiana umbratica	P3	**Unlikely**. Habitat for this taxon includes deep granite gorges which were not mapped in the Study Area. Nearest records approximately 30 km to east of Study Area.
Paspalidium retiglume	P2	**Potential**. Habitat for this taxon is VT 6 mapped in the Study Area. Nearest known records approximately 60 km to the west of the Study Area
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	Threatened	**Potential**. Habitat for this taxon is present within the Study Area. Nearest known records are approximately 1 km south of the Study Area boundary. Highly visible shrub so would have been found if present along tracks and near quadrats.
Ptilotus mollis	P4	**Potential**. Habitat for this taxon is present within the Study Area. Nearest known records approximately 18 km to the south-west of the Study Area
Rostellularia adscendens var. *latifolia*	P3	**Unlikely**. Similar soil types to the preferred habitat for this taxon are present within the Study Area, however the species composition at those locations is very different to that within the Study Area. Nearest record is 70 km to the east of Study Area.
Rothia indica subsp. *australis*	P3	**Potential**. Habitat for this taxon is present within the Study Area. Nearest record approximately 25 km to the east of the Study Area
Schoenus sp. Marble Bar (D. Coultas & S. Coultas DCSC-Opp 07)	P1	**Very Unlikely**. One record only known from the Pilbara recorded in a granite seep, which has not been mapped in the Study Area.
Swainsona thompsoniana	P3	**Unlikely**. Suitable habitat is not present in the Study Area. Cracking clays were noted in VT 6 but of a different colour and herb stratum composition to known locations. Nearest known records approximately 70 km to the south east of the Study Area.
Stylidium weeliwolli	P3	**Very Unlikely**. No suitable habitat for taxon in Study Area. Nearest record is approximately 70 km to the south east of Study Area.
Terminalia supranitifolia	P3	**Very Unlikely**. No suitable habitat for taxon in Study Area. Nearest record is approximately 60 km to the south west of Study Area.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	P3	**Unlikely**. Limited potential to occur on clays on plains (VT 6), however main distribution of this taxon is to the south and south-west. Nearest record approximately 60 km to south of Study Area.
Vigna triodiophila	P3	**Unlikely**. No suitable habitat for taxon in Study Area. Nearest record approximately 60 km to the north west of Study Area.

5.1.1.7 Distribution Extensions and Distribution Gaps

Table 14 presents taxa where the collections from the Study Area represent extensions to the known distribution of such taxa, or otherwise fill gaps within the known distribution of such taxa, by 50 km or more according to *NatureMap* (DBCA 2007-). Many of these taxa may typically occur in the area however may not be well-vouchered.

With the exception of *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), *Cyperus microcephalus* subsp. *saxicola*, *Eriachne* sp. Dugald River (B.K. Simon+ 3007), *Euphorbia inappendiculata* var. *inappendiculata* (P2), *Drosera burmanni*, *Fimbristylis neilsonii*, *Fuirena ciliaris*, *Hibiscus verdcourtii*, *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3) and *Sida macropoda*, the remaining 22 taxa are relatively common in the Pilbara or occur across a large range. The presence of *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), *Cyperus microcephalus* subsp. *saxicola*, *Desmodium campylocaulon*, *Dodonaea petiolaris*, *Heliotropium tanythrix*, and *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3) within the Study Area represents significant range extensions of 100 km or more for these taxa.

Table 14: Taxa Where Collections Represent Range Extensions to the Known Ranges of these Taxa, or Fill Distribution Gaps (DBCA 2007-)

Taxon	Description	Comments
Abutilon otocarpum	Fills gap in known distribution	Nearest record 50 km to S; numerous records in Pilbara
Acacia arida	Fills gap in known distribution	Nearest records 70 km to NW and NE; numerous records in the Pilbara. Recorded from Abydos DSO Project (Woodman Environmental 2012a)
Boerhavia repleta	Fills gap in known distribution	Nearest record 55 km to W; numerous records in Pilbara
Chloris pectinata	Fills gap in known distribution	Nearest record 90 km to NE; numerous records in Pilbara
Clerodendrum tomentosum var. *lanceolatum*	Fills gap in known distribution	Nearest record 60 km to WSW; numerous records in Pilbara. Recorded from Abydos DSO Project (Woodman Environmental 2012a)
Clerodendrum tomentosum var. *tomentosum*	Fills gap in known distribution	Nearest record 90 km to ENE; numerous records in Pilbara
Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1)	Range extension	Nearest record 100 km to ENE; one other recorded location in Pilbara/WA (reportedly recorded from near Marble Bar which is ~40 km to SE)
Cyperus microcephalus subsp. *saxicola*	Range extension	Nearest record 100 km to E (this being the only known record in the northern Pilbara); common to southern Pilbara. Record is at limit/extreme of range
Cyperus pulchellus	Fills gap in known distribution	Nearest record 50 km to SSE; numerous records in Pilbara
Desmodium campylocaulon	Fills gap in known distribution	Nearest record 125 km to SSW; numerous records in Pilbara
Dodonaea petiolaris	Range extension	Nearest record 150 km to SSW; numerous records in Pilbara
Drosera burmanni	Fills gap in known distribution	Nearest record 70 km to W; only a few records in Pilbara but numerous in Kimberley (underwent recent taxonomic review)
Drosera finlaysoniana	Fills gap in known distribution	Nearest record 50 km to NNW; numerous records in Pilbara. Recorded from Abydos DSO Project (Woodman Environmental 2012a)

Taxon	Description	Comments
Eragrostis setifolia	Fills gap in known distribution	Nearest record 70 km to NNW; numerous records in Pilbara
Eriachne glauca var. *glauca*	Fills gap in known distribution	Nearest record 70 km to WNW; numerous records in Pilbara
Eriachne sp. Dugald River (B.K. Simon+ 3007)	Fills gap in known distribution	Nearest record 70 km to SW; only 8 records in Pilbara and Kimberley however has only recently been identified as occurring in WA (similar to and confused with *E. ciliata* - separation of the two only became apparent following the fieldtrip)
Euphorbia inappendiculata var. *inappendiculata* (P2)	Fills gap in known distribution	Nearest record 50 km to NE; few records in Pilbara
Fimbristylis neilsonii	Fills gap in known distribution	Nearest record 60 km to NW/NE; only 8 records in the Pilbara and 8 in the Kimberley – poorly vouchered or naturally sparse?
Fuirena ciliaris	Fills gap in known distribution	Nearest record 50 km to NW; only 11 records in the Pilbara and numerous in the Kimberley – poorly vouchered or naturally sparse? Recorded from Abydos DSO Project (Woodman Environmental 2012a)
Glinus oppositifolius	Fills gap in known distribution	Nearest record 50 km to NNW; numerous records in Pilbara
Goodenia nuda (P4)	Fills gap in known distribution	Nearest record 60 km to WSW; numerous records in Pilbara
Grevillea wickhamii subsp. *macrodonta*	Fills gap in known distribution	Nearest record 50 km to N; numerous records in Pilbara
Heliotropium tanythrix	Fills gap in known distribution	Nearest record 100 km to ESE; numerous records in Pilbara
Hibiscus verdcourtii	Fills gap in known distribution	Nearest record 50 km to SE; 17 records in the Pilbara, only 1 in the Kimberley; prefers clay habitats
Leptosema anomalum	Fills gap in known distribution	Nearest 60 km to NE and SW; numerous records in Pilbara. Recorded from Abydos DSO Project (Woodman Environmental 2012a)
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)	Range extension	Significant range extension, nearest record 130 km to SSW
Rostellularia adscendens var. *clementii*	Fills gap in known distribution	Nearest record 80 km to N; numerous records in Pilbara
Rotala diandra	Fills gap in known distribution	Nearest record 70 km to NNE; numerous records in Pilbara
Scaevola parvifolia subsp. *pilbarae*	Fills gap in known distribution	Nearest record 85 km to W; numerous records in Pilbara
Sida macropoda (sens lat.)	Range extension	Nearest record 60 km to E; 10 records in Pilbara and 10 in Kimberley; taxonomy under revision, issues with key, limited material. Recorded at Atlas Iron's McPhee Creek Project (Woodman Environmental 2013e)
Tephrosia sp. D Kimberley Flora (R.D. Royce 1848)	Fills gap in known distribution	Nearest record 50 km to NE; numerous records in Pilbara

5.1.1.8 Introduced Taxa

A total of 20 introduced flora taxa were recorded within the Study Area. Table 15 presents a list of these introduced flora taxa together with location information, and ecological impact and invasiveness ratings for each one under the DBCA *Weed Prioritisation Process* (DBCA 2013a) for the Pilbara Region (DBCA 2014). Locations of introduced flora taxa are presented in Appendix H and Figures 9.1 – 9.37 (Appendix J); the legend is presented on Figure 9.38 of Appendix J.

Of the 20 introduced taxa, **Calotropis procera* is a Declared Pest (shaded in pink in Table 15) however it is considered to be exempt from management or control requirements with regard to agriculture (DPIRD 2019).

**Calotropis procera* (Calotrope) (Plate 9) is a shrub to small tree, 1-4 m tall, with purple and white flowers from January to December (WA Herbarium 1998-). The milky sap of this taxon can cause a rash or irritation upon contact (Hussey *et al.* 2007; Western Australian Herbarium 1998-). This introduced taxon is widespread within the north of Western Australia and has been recorded north of Kununurra to south of Port Hedland, with a range of approximately 1250 km (DBCA 2007-). **Calotropis procera* was rated as High under the Environmental Weed Strategy for Western Australia, due to its high level of invasiveness, wide current or potential distribution and its ability to change the structure, composition and function of ecosystems (CALM 1999). This taxon is on the Priority Alert list for notification to the DBCA if this taxon is recorded on DBCA managed lands.

**Calotropis procera* was recorded at 24 locations within the Study Area within VTs 1, 5, 7, 8 and 9 (Table 15; Figures 9.1 – 9.37 (Appendix J); Appendix H). This taxon was also previously recorded by Woodman Environmental within the Corunna study area (Woodman Environmental 2016).

Plate 9: *Calotropis procera* (Calotrope) (Photo: Woodman Environmental)

No introduced taxa listed as WoNS (AWC 2019) were recorded in the Study Area. Eleven of the introduced taxa are ranked as having High ecological impact for the DBCA Pilbara Region; the remainder are either Unknown (indicating that not enough information was known about the impacts or invasiveness and further research is required before a rating can be allocated) or have not been ranked (potentially due to them not being recorded on DBCA managed lands) (DBCA 2014).

Table 15: Summary of Introduced Taxa Recorded within the Study Area

Taxon	Common Name (WA Herbarium 1998-)	Number of Point Locations Recorded in Study Area	Estimated Number of Plants Recorded in Study Area	Vegetation Type	Ecological Impact (DBCA 2014)	Invasiveness (DBCA 2014)
**Aerva javanica*	Kapok Bush	28	468	1, 5, 6, 7, 8, 9	High	Rapid
**Argemone ochroleuca*	Mexican Poppy	2	11	5	Unknown	Rapid
**Calotropis procera*	Calotrope	24	257	1, 5, 7, 8, 9	-	-
**Cenchrus ciliaris*	Buffel Grass	50	94,660	1, 5, 6, 7, 8, 9, 10	High	Rapid
**Cenchrus setiger*	Birdwood Grass	16	462	5, 7, 9, 10	High	Rapid
**?Chenopodium* sp.		1	1	5	Unknown	Unknown
**Chloris virgata*	Feathertop Rhodes Grass	2	2	7, 9	High	Rapid
**Citrullus colocynthis*		5	15	5, 6	Unknown	Medium
**Cynodon dactylon*	Couch	4	72	5	High	Rapid
**Cyperus rotundus*	Nut Grass	5	14	1, 2, 5	Unknown	Unknown
**Echinochloa colona*	Awnless Barnyard Grass	9	44	1, 5, 6, 7	High	Rapid
**Flaveria trinervia*	Speedy Weed	3	3	5	-	-
**Malvastrum americanum*	Spiked Malvastrum	1	1	5	High	Rapid
**Passiflora foetida* var. *hispida*	Stinking Passion Flower	2	6	5	High	Rapid
**Portulaca pilosa*	Djanggara	1	1	5	-	-
**Setaria verticillata*	Whorled Pigeon Grass	4	105	5, 7	High	Rapid
**Solanum nigrum*	Black Berry Nighshade	1	1	5	Low	Rapid
**Stylosanthes hamata*	Verano Stylo	1	1	8	High	Medium
**Tribulus terrestris*	Caltrop	4	4	5, 6, 7	Unknown	Medium
**Vachellia farnesiana*	Mimosa Bush	7	19	5, 7, 9, 10	High	Rapid

5.1.2 Vegetation of the Study Area

5.1.2.1 Classification Results

Classification of Study Area Quadrats

The PATN software package (Belbin and Collins 2009) initially suggested that an 11-cluster classification of quadrats may be appropriate for the Study Area quadrat data. The resulting dendrogram (Appendix K) and taxon group matrix (Appendix L) were therefore initially examined at the 11-cluster level, to determine the plausibility of clusters with regard to taxon groups, also field observations and indicator taxon analysis (based on the initial analysis).

This examination found that six clusters contained quadrats that did not adequately fit with the bulk of quadrats grouping together in these clusters. These quadrats (MCK020, MCK038, MCK042, MCK046, MCK063, MCK076, MCK080, MCK104, MCK118) were considered to have been misclassified by the classification analysis and were manually reassigned following detailed investigation of individual quadrat datasets (including soil, topography and taxon composition/dominant taxa), and examination of field notes and the taxon group matrix (Appendix N).

The taxon composition of these quadrats appears to have been affected by disturbance history, low species richness reducing the ability of the analysis to place them properly or low quadrat representation of the vegetation in which they were placed. These factors likely influenced their clustering with seemingly unrelated quadrats; they were then reassigned to the most appropriate group. The re-assignment of these quadrats is indicated in the dendrogram in Appendix K, with the resultant indicator taxon analysis based on final groupings presented in Appendix M. The list of all quadrats manually reassigned and the reasoning for the reassignment is presented in Appendix N. Appendix O presents the vascular plant taxa recorded within each VT (excluding opportunistic records).

In addition, the two branches within cluster 4 were split to create VTs 4 and 12. The five quadrats within this branch (VT 12) differed from the remaining quadrats in the absence of taxon from Group C and the presence of taxon from Group H. They were also very species poor, with no exposed bedrock evident, unlike the other quadrats within VT 4.

This change resulted in twelve clusters being identified, which are considered to represent VTs in the Study Area. These clusters are ordered from one to twelve from top to bottom in the dendrogram in Appendix K, and are labelled on the taxon group matrix in Appendix L.

5.1.2.2 Vegetation Types

As outlined in Section 5.1.2.1, twelve VTs were defined based on the results of the classification analysis and subsequent examination. This analysis initially split the vegetation types into 2 Super Groups; Super Group 1 Hills and minor drainage lines in hills/ranges and associated outwash areas and Super Group 2 Major drainage lines and plains.

The twelve VTs described represent five broad groups of vegetation, based on soils and topography:

- Group 1 – granite and dolorite hills and ranges (VTs 1 and 2);
- Group 2 – hills and steep slopes on ironstone (VTs 3 and 4);
- Group 3 – rivers and claypans on alluvial sediments (VTs 5, 6 and 12);
- Group 4 – minor drainage lines and sheet flow on flood plains (VTs 7 - 9) and
- Group 5 - .sandy and stony plains (VTs 10 and 11).

Table 16: Summary of Vegetation Types Mapped in the Study Area

VT	Summary	Photograph
1	**Description:** Isolated clumps of trees, mainly represented by *Eucalyptus leucophloia*, *Corymbia hamersleyana* or *Corymbia ferriticola*, over mid to tall isolated shrubs of mixed Acacia species including *Acacia inaequilatera*, *A. tumida* var. *pilbarensis* and *A. orthocarpa*, and *Grevillea wickhamii* subsp. *hispidula* over low sparse shrubland of *Solanum phlomoides*, *Senna glutinosa* subsp. *glutinosa* and *Clerodendrum tomentosum* var. *lanceolatum* over hummock grassland to open hummock grassland dominated by *Triodia brizoides*, and less commonly *Triodia wiseana* and *Triodia epactia*, over isolated clumps of tussock grasses of *Cymbopogon ambiguus, Eriachne mucronata* and *Cyperus hesperius* on steep mid to upper slopes, usually adjoining cliff faces, with exposed granite, dolerite, ironstone or occasional quartz bedrock with skeletal red-brown sandy loam **Area mapped (Proportion of Study Area):** 1,836.1 ha (8.5 %) **Sampling:** 20 quadrats (MCK001, MCK003, MCK007, MCK009, MCK012, MCK014, MCK015, MCK017, MCK040, MCK042, MCK047, MCK049, MCK051, MCK065, MCK069, MCK070, MCK083, MCK101, MCK105, MCK107) **Average Native Taxon Richness per Quadrat:** 28.9 ± 11.6 **Taxon Grouping and Indicator Taxa:** represented by taxa from Taxon Groups A, C and J (Appendix L). Significant indicator taxa – *Eucalyptus leucophloia, Senna glutinosa subsp. glutinosa, Solanum phlomoides, Triodia brizoides* (Appendix M). **CS Flora Taxa:** *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), *Triodia basitricha* (P3) **Notes**: All of the quadrats within this VT were relatively species rich despite fire ages of greater than 5 years. Outcropping was usually present within this VT (see Plate 10), on steeper slopes however in some areas this outcropping was reduced (see Plate 11); particularly lower on the slopes.	 **Plate 10:** VT 1 (Quadrat MCK003)  **Plate 11:** VT 1 (Quadrat MCK105), lower slope, less exposed dolerite

VT	Summary	Photograph
2	**Description:** Low woodland of *Terminalia circumalata* over tall isolated clumps of shrubs to tall shrubland of *Acacia tumida* var. *pilbarensis* and *Ehretia saligna* var. *saligna* over low isolated clumps of hummock grasses to mid open hummock grassland of *Triodia epactia* on red-brown sandy loam with granite or sandstone outcropping in drainage lines of gorges. **Area mapped (Proportion of Study Area**): 33 ha (0.15 %) **Sampling:** 3 quadrats (MCK008, MCK077, MCK110) **Average Native Taxon Richness per Quadrat:** 38 ± 14.5 **Taxon Grouping and Indicator Taxa:** represented by taxa from Taxon Group C, G and J (Appendix L). Significant indicator taxa - *Acacia tumida var. pilbarensis*, *Clerodendrum tomentosum*, *Cymbopogon ambiguus*, *Cyperus pulchellus*, *Ehretia saligna* var. *saligna*, *Eriachne mucronata, Eriachne tenuiculmis, Ficus brachypoda, Senna venusta, Sida* sp. Articulation below (A.A. Mitchell PRP 1605), *Stemodia viscosa, Tephrosia rosea* var. *clementii, Tephrosia virens, Terminalia circumalata, Tinospora smilacina, Triumfetta propinqua* (Appendix M). **CS Flora Taxa:** None recorded	 **Plate 12:** VT 2 (Quadrat MCK077)
3	**Description:** Open to sparse tall shrubland of *Acacia orthocarpa*, *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* subsp. *hispidula* over hummock grassland of *Triodia epactia* on moderate to steep upper slopes and crests of metamorphic quartz, sandstone and granite hills and ridges with red-brown sandy loam soils. **Area mapped (Proportion of Study Area):** 2,134.7 ha (9.9 %) **Sampling:** 10 quadrats (MCK002, MCK006, MCK038, MCK056, MCK073, MCK075, MCK079, MCK102, MCK111, MCK114) **Average Native Taxon Richness per Quadrat:** 8.7 ± 3.3 **Taxon Grouping and Indicator Taxa**: represented by taxa from Taxon Group J (Appendix L). Indicator taxa – *Acacia orthocarpa* (Appendix M). **CS Flora Taxa:** *Euphorbia clementii* (P3), *Triodia basitricha* (P3)	 **Plate 13:** VT 3 (Quadrat MCK002)

VT	Summary	Photograph
4	**Description:** Mid to tall isolated clumps of shrubs of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula* and *Acacia orthocarpa* with occasional emergent *Eucalyptus leucophloia* over open hummock grassland to hummock grassland dominated by *Triodia basitricha* (P3) and/or *Triodia epactia* with isolated clumps of low shrubs including *Ptilotus calyostachyus* and *Bonamia pilbarensis* mainly on gentle but occasionally on steep crests, influenced by ironstone or granite and occasionally quartz or jasper, on red-brown sandy clay loam soils. **Area mapped (Proportion of Study Area):** 595.1 ha (2.8 %) **Sampling:** 8 quadrats (MCK005, MCK011, MCK013, MCK052, MCK067, MCK071, MCK103, MCK108,) **Average Native Taxon Richness per Quadrat:** 17.5 ± 7.1 **Taxon Grouping and Indicator Taxa:** represented by taxa from Taxon Group J (Appendix L). Significant Indicator taxa – *Dampiera candicans, Grevillea wickhamii* subsp. *hispidula, Ptilotus calostachyus, Triodia basitricha* (P3) (Appendix M). **CS Flora Taxa:** *Triodia basitricha* (P3), **Notes**: Upper stratum species composition within VT 4 was quite variable dependent on position within the landscape. Species richness was moderate to poor, with fire age generally greater than 5 years.	 **Plate 14:** VT 4 (Quadrat MCK013)  **Plate 15:** VT 4 (Quadrat MCK052) on steeper slopes where Acacia cover is higher and more exposed bedrock

VT	Summary	Photograph
5	**Description:** Mid to low woodland dominated by *Eucalyptus camaldulensis*, *Eucalyptus victrix*, *Melaleuca glomerata* and/or *Melaleuca argentea* over tall open shrubland of *Atalaya hemiglauca* , *Flueggea virosa* subsp. *melanthesoides* and *Acacia trachycarpa* over sparse low shrubland and grassland of mixed species, occasionally dominated by **Cenchrus ciliaris* on major drainage lines or rivers on brown sandy to clay loam with alluvial river stones, with occasional tall shrubland of *Acacia pyrifolia*, *Acacia trachycarpa* and *Atalaya hemiglauca* with sparse *Corymbia hamersleyana* over low mixed shrubs and grassland dominated by **Cenchrus ciliaris* on brown sandy-clay loam on floodplains associated with river systems. **Area mapped (Proportion of Study Area):** 2,820.8 ha (13.1 %) **Sampling:** 11 quadrats (MCK004, MCK019, MCK037, MCK041, MCK055, MCK064, MCK078, MCK080, MCK106, MCK109, MCK119) **Average Native Taxon Richness per Quadrat:** 40.0 ± 11.0 **Taxon Grouping and Indicator Taxa**: represented by taxa from Taxon Groups F and G (Appendix L). Numerous indicator taxa were recorded, the most significant being *Acacia trachycarpa, Atalaya hemiglauca, Crotalaria cunninghamii* and *Eucalyptus camaldulensis.* (Appendix M). **Significant Taxa:** *Eragrostis crateriformis* (P3) **Notes:** VT 5 was mapped along all major drainage lines within the Study Area. Species composition and structure was highly variable depending on position within the drainage line, soil composition and levels of regular inundation. Species richness was high in the drainage lines but poor to moderate where this VT was mapped on flood plains. Species from Group F, which are predominantly groundwater dependent, were only dominant within this VT. The noted time since burn was generally greater than the previous VTs, with most being estimated at greater than 10 years. Invasive weeds were also more common within this VT, with **Cenchrus ciliaris*, **Calotropis procera* and/or **Aerva javanica* present in all quadrats.	 **Plate 16:** VT 5 (Quadrat MCK064) showing regularly inundated drainage line dominated by *Eucalyptus* spp.  **Plate 17:** VT 5 (Quadrat MCK004) showing areas dominated by *Melaleuca* spp.

VT	Summary	Photograph
6	**Description:** Open shrubland to sparse shrubland of *Acacia synchronicia* over open grassland and herbfield of mixed species, dominated by *Eragrostis setifolia*, *Cullen graveolens*, *Cynodon convergens*, *Desmodium filiforme*, *Dichanthium sericeum* subsp. *humilius*, *Neptunia dimorphantha*, *Sida fibulifera* and *Triodia epactia* on red sandy clay in claypans. **Area mapped (Proportion of Study Area):** 186.5 ha (0.8 %) **Sampling:** 2 quadrats (MCK029, MCK057) **Average Native Taxon Richness per Quadrat:** 43.5 ± 0.7 **Taxon Grouping and Indicator Taxa**: Represented by taxa from Taxon Group M (Appendix L). Numerous indicator taxa were recorded, the most significant being *Eragrostis setifolia, Streptoglossa* ?*bubakii, Tephrosia* sp. clay soils (S. van Leeuwen et al PBS 0273) and *Abutilon malvifolium* (Appendix M). **CS Flora Taxa:** *Eragrostis crateriformis* (P3), *Euphorbia clementii* (P3), *Euphorbia inappendiculata* subsp. *inappendiculata* (P2), *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3).	 **Plate 18:** VT 6 (Quadrat MCK029)

VT	Summary	Photograph
7	**Description:** Open woodland of *Corymbia hamersleyana* and occasionally *Corymbia flavescens* or *Terminalia circumalata* over tall open shrubland to sparse shrubland of mixed Acacia species dominated by *Acacia tumida* var. *pilbarensis*, *Acacia acradenia* and *Acacia pyrifolia* var. *pyrifolia* over low sparse shrubland of mixed species including *Corchorus parviflorus*, *Hybanthus aurantiacus* and *Indigofera monophylla* over sparse grassland and sparse hummock grassland of species including *Chrysopogon fallax*, *Eriachne tenuiculmis*, *Triodia epactia* and occasionally **Cenchrus ciliaris* on minor drainage lines and plains on red-brown sandy loam to clay loam. **Area mapped (Proportion of Study Area):** 2,648 ha (12.3 %) **Sampling:** 16 quadrats (MCK010, MCK020, MCK021, MCK025, MCK026, MCK027, MCK030, MCK031, MCK032, MCK043, MCK045, MCK053, MCK058, MCK061, MCK063, MCK112) **Average Native Taxon Richness per Quadrat:** 59.7 ± 18.3 **Taxon Grouping and Indicator Taxa:** Represented by Taxon Groups H and J, with some species from Group G (Appendix L). Significant Indicator taxa – *Bonamia pannosa, Gossypium australe, Hybanthus aurantiacus, Indigofera monophylla* (Appendix M). **CS Flora Taxa:** *Eragrostis crateriformis* (P3), *Euphorbia clementii* (P3), *Goodenia nuda* (P4) **Notes:** The time since last burn was recorded as being >5 years in all but one quadrat. This VT was in all minor drainage lines within the Study Area and was quite widespread. These areas would experience seasonal water flow captured from adjacent landforms but are unlikely to contain groundwater dependent vegetation. This VT was relatively species rich in comparison to other VTs.	 **Plate 19:** VT 7 (Quadrat MCK020) in minor drainage line  **Plate 20:** VT 7 (Quadrat MCK112)on flood plain

VT	Summary	Photograph
8	**Description:** Isolated clumps of *Corymbia hamersleyana* over low open shrubland to sparse shrubland of *Acacia stellaticeps* over hummock grassland of *Triodia lanigera* and occasionally *Triodia epactia* on red-brown sand to sandy loam on plains. **Area mapped (Proportion of Study Area):** 3,111.6 ha (14.5 %) **Sampling:** 6 quadrats (MCK048, MCK082, MCK085, MCK087, MCK089, MCK120) **Average Native Taxon Richness per Quadrat:** 40.0 ± 5.7 **Taxon Grouping and Indicator Taxa:** Taxa represented by Taxon Groups H and J. Numerous indicator taxa were recorded, the most significant being *Bonamia alatisemina, Eriachne obtusa, Goodenia microptera* and *Grevillea wickhamii* subsp. *macrodonta* (Appendix M). **CS Flora Taxa:** None recorded	 **Plate 21:** VT 8 (Quadrat MCK048)
9	**Description:** Occasional low open shrubland of *Acacia stellaticeps* over hummock grassland usually dominated by *Triodia longiceps* and/or *Triodia epactia* and occasionally **Cenchrus ciliaris* on red brown sands and clay loam in basins and open depressions on plains. **Area mapped (Proportion of Study Area):** 192.6 ha (0.9 %) **Sampling:** 4 quadrats (MCK033, MCK035, MCK046, MCK117) **Average Native Taxon Richness per Quadrat:** 45.0 ± 5.6 **Taxon Grouping and Indicator Taxa:** Represented by taxa from Taxon Groups K and H (Appendix L). Numerous indicator taxa were recorded, the most significant being *Xerochloa barbata, Pluchea ferdinandi-muelleri* and *Cullen martinii* (Appendix M). **CS Flora Taxa:** *Eragrostis crateriformis* (P3)	 **Plate 22:** VT 9 (Quadrat MCK033)

VT	Summary	Photograph
10	**Description:** Tall isolated shrubs of mixed Acacia species including *Acacia inaequilatera* and *Acacia bivenosa* with occasional isolated trees of *Corymbia hamersleyana* over hummock grassland dominated by *Triodia lanigera*, and occasionally *Triodia epactia*, *Triodia wiseana* and/or *Triodia brizoides* with isolated small shrubs on red-brown clay loam to sandy-clay loam on undulating plains, midslopes to crests of low gentle rises influenced by ironstone, granite, dolerite and occasionally calcrete. **Area mapped (Proportion of Study Area):** 6,522.8 ha (30.33 %) **Sampling:** 17 quadrats (MCK016, MCK018, MCK022, MCK024, MCK039, MCK044, MCK059, MCK062, MCK068, MCK074, MCK076, MCK100, MCK104, MCK113, MCK115, MCK116, MCK118) **Average Native Taxon Richness per Quadrat:** 20.5 ± 8.0 **Taxon Grouping and Indicator Taxa:** Represented by taxa from Taxon Groups J and H (Appendix L). Significant Indicator taxa – *Cleome uncifera* subsp. *uncifera* and *Triodia wiseana* (Appendix M). **CS Flora Taxa:** *Euphorbia clementii* (P3), *Triodia chichesterensis* (P3) **Notes:** VT 10 was relatively species poor, will all quadrats except 1, recording greater than 5 years since fire. The lower stratum was consistently dominated by *Triodia* spp, with the upper and mid stratums dominated by a variety of species which varied based on position in the landscape.	 **Plate 23:** VT 10 (Quadrat MCK016) with exposed rock mid-slope  **Plate 24:** VT 10 (Quadrat MCK018) no exposed rock on plain

VT	Summary	Photograph
11	**Description:** Sparse shrubland to isolated shrubs of *Acacia stellaticeps* and *Acacia spondylophylla* over hummock grassland of *Triodia lanigera* with isolated shrubs including *Goodenia stobbsiana* on red-brown sandy clay loam on flats to low rises underlain by granite or dolerite. **Area mapped (Proportion of Study Area):** 111.7 ha (0.5 %) **Sampling:** 4 quadrats (MCK050, MCK054, MCK060, MCK081,) **Average Native Taxon Richness per Quadrat:** 17.3 ± 1.5 **Taxon Grouping and Indicator Taxa:** Represented by taxa from Taxon Groups H and J (Appendix L). Significant Indicator taxa – *Acacia spondylophylla, Goodenia stobbsiana, Hakea lorea* subsp. *lorea* (Appendix M). **Significant Taxa:** *Triodia basitricha* (P3) **Notes:** VT 11 was similar to VT 10 but differed in the absence of species from Group C.	 **Plate 25:** VT 11 (Quadrat MCK050)
12	**Description:** Isolated shrubs of mixed Acacia species over hummock grassland of *Triodia epactia* and occasionally *Triodia brizoides* on low rises and lower slopes on red-brown sandy loam with granite or ironstone influence. **Area mapped (Proportion of Study Area):** 1,161.5 ha (5.4 %) **Sampling:** 6 quadrats (MCK023, MCK028, MCK034, MCK036, MCK066, MCK072) **Average Native Taxon Richness per Quadrat:** 15.0 ± 4.4 **Taxon Grouping and Indicator Taxa:** Represented by taxa from Taxon Groups J and N (Appendix L). Significant Indicator taxa – none (Appendix M). **CS Flora Taxa:** *Euphorbia clementii* (P3) **Notes:** The quadrats in the VT were originally grouped with VT 4 but were split off due to the absence of taxa from Group C and the presence of taxa from Group H. Areas mapped as VT 12 had no exposed bedrock.	 **Plate 26:** VT 12 (Quadrat MCK036)

5.1.2.3 Other Areas Described

Areas where natural vegetation has been completely removed, with no native taxa remaining, have been mapped as 'Cleared Land' (C). This includes major roads and tracks, and areas cleared for mining purposes. A total of 147 ha of 'Cleared Land' have been mapped, representing 0.68 % of the Study Area.

5.1.2.4 Significant Vegetation

There are no known locations of listed significant vegetation, as listed by the DoEE (EPBC Act) or otherwise listed by the DBCA (2016; 2019a), occurring within 40 km of the Study Area (see section 2.4.2). A review of the published TEC and PEC listings for Western Australia (2016; 2019a) against the descriptions of the VTs in Table 16 has identified no vegetation types representing listed TECs or PECs as listed by DBCA or the DoE.

The VTs mapped within the Study Area were assessed against regional data for potential wider distribution utilising classification analysis of data with the Atlas regional vegetation dataset. VTs were also qualitatively compared with those VTs presented in Table 9, which have been identified as being potentially regionally significant in nearby survey areas. VT 9 within the Study Area is considered to be similar to VT 7 in Table 9. That VT is potentially regionally significant as its regional extent is unknown and it is restricted within both study areas (Woodman Environmental 2016).

Vegetation may be considered of potential regional significance if they have the potential to be restricted in the wider region as a result of uncommon substrates or other factors. VT 6 was mapped on a claypan, which are relatively restricted in the region. In addition, the significant flora taxa *Eragrostis crateriformis* (P3), *Euphorbia clementii* (P3), *Euphorbia inappendiculata* var. *inappendiculata* (P2) and *Oldenlandia* sp. Hamersley Station (A.A. Mitchell PRP 1479) were recorded within this VT during the survey and thus it provides suitable habitat for these taxa. VT 2 is of potential regional significance as it occurs in shallow gorge/creek areas which provide habitat for significant flora taxa; *Fimbristylis nuda* and *Scleria rugosa* were only recorded within this VT. These taxa have never been previously recorded in the Pilbara region, with both common in the Kimberley. *Cyperus microcephalus* subsp. *saxicola* and *Ophioglossum lusitanicum* were also recorded within this VT, again representing significant range extensions for these taxa and indicating bthat this VT is potentially restricted in the region.

No other VTs mapped in the Study Area are considered to be regionally significant in that they would be considered to provide refugia for flora taxa (for example seepage areas), or otherwise providing an important function required to maintain ecological integrity of a significant ecosystem (as defined by EPA 2016a) other than VT 5 which characterises the significant river communities in the Study Area.

VTs may be considered locally significant due to their limited mapped extent within the Study Area, or due to the provision of suitable habitat for Threatened, P1, P2 or potentially undescribed flora taxa. VTs have been termed potentially regionally significant in this assessment where they are absent from, or have a limited representation in the Atlas regional vegetation dataset. VTs 2, 6, 9 and 11 are considered to be of potential local

significance in the context of the Study Area due to their limited mapped extent in the Study Area (they each comprise equal to or less than 1 % of the Study Area) and also regionally significant due to their limited distribution in the Atlas regional vegetation dataset and the restricted nature of their habitats. VT 2 in particular is habitat for several flora taxa that are more typical of the Kimberley region and therefore comprising a potentially relictual vegetation type. VT 1 can also be considered locally significant due to provision of habitat for the significant flora taxon *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1). However, when considered in a regional context, VT 1 is likely to be represented elsewhere as indicated in the Atlas regional vegetation dataset.

Table 17 presents a summary of the potential local and regional significance of VTs mapped in the Study Area.

Table 17: Potential Significance of Vegetation Types in the Study Area

VT	Local Significance	Potential Regional Significance
1	**Considered to be of local significance**: • Extent mapped is >1% of the Study Area (8.0%) • Habitat for the significant flora taxon *Corchorus* sp Yarrie (J. Bull & D. Roberts CAL 01.05) (P1), which is entirely restricted to this VT in the Study Area	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately to widely distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)
2	**Considered to be of local significance:** • Extent mapped is only 0.15% of Study Area • Provides suitable habitat for other significant flora taxa which represent extensive range extensions	**Considered to be of potential regional significance**: • Does not align with listed TEC or PEC • Has floristic similarities to two quadrats in creeklines at Abydos DSO project, however has a suite of unique taxa therefore distribution in the region is unknown. • Contains flora not previously recorded in the Pilbara, indicating regional restriction.
3	**Not considered to be of local significance:** • Extent mapped is >1% (9.9%) of Study Area • Habitat for two P3 taxa, both of which are widespread through multiple VTs within the Study Area	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately to widely distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)

VT	Local Significance	Potential Regional Significance
4	**Not considered to be of local significance:** • Extent mapped is >1% (2.8%) of Study Area • Habitat for *Triodia basitricha* (P3) taxa, which is widespread through multiple VTs within the Study Area	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately to widely distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)
5	**Not considered to be of local significance:** • Extent mapped is >1% of the Study Area (13.2%) • No significant flora taxa recorded within this VT • Provides suitable habitat for the undescribed taxon *Abutilon* aff. *hannii*	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially widely distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)
6	**Considered to be of local significance:** • Extent mapped is only 0.8% of Study Area • Habitat for *Euphorbia inappendiculata* var. *inappendiculata* (P2) Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479 which are entirely restricted to this VT in the Study Area. • Also provides habitat *Euphorbia clementii* (P3) and *Eragrostis crateriformis* (P3) as well as *Desmodium campylocaulon* (large range extension)	**Considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Occurs on claypan sites which are generally restricted in the region • Equivalent to VT 6 (from Woodman Environmental 2016) as per Table 9
7	**Not considered not to be of local significance:** • Extent mapped is >1% of the Study Area (12.3%) • Provides habitat for *Euphorbia clementii* (P3) and *Eragrostis crateriformis* (P3) which are also widespread in other VTs • Provides habitat for *Goodenia nuda* (P4)	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset

VT	Local Significance	Potential Regional Significance
8	**Not considered to be of local significance:** • Extent mapped is >1% (14.5%) of Study Area • No significant flora taxa recorded within this VT	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)
9	**Considered to be of local significance:** • Extent mapped is only 0.9% of Study Area • Restricted to only a few occurrences • Habitat for the significant flora taxon *Eragrostis crateriformis* (P3)	**Considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Regional extent unknown with similarity to few quadrats in the regional Atlas dataset and therefore potentially restricted within the region • Some similarity to VT 7 (from Woodman Environmental 2016) as per Table 9
10	**Not considered to be of local significance:** • Extent mapped is >1% (30.1%) of Study Area • Habitat for the significant flora taxa *Euphorbia clementii* and *Triodia chichesterensis* (P3)	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)
11	**Considered to be of local significance:** • Extent mapped is only 0.5% of Study Area • Restricted to the eastern section of the Study Area • Habitat for the significant flora taxon *Triodia basitricha* (P3)	**Considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Not represented in the Atlas dataset therefore regional extent unknown and therefore potentially restricted within the region
12	**Not considered to be of local significance:** • Extent mapped is >1% (5.4%) of Study Area • Habitat for the significant flora taxon *Euphorbia clementii* (P3)	**Not considered to be of potential regional significance:** • Does not align with listed TEC or PEC • Is not equivalent to VTs which are potentially regionally significant as listed by other regional studies • Potentially moderately distributed in region due to geology and soil type • Is floristically similar to other areas as indicated by the analysis of regional Atlas dataset • Has not had large historical impact by threatening processes (such as clearing for mining)

5.1.2.5 Wetlands and Riparian Vegetation

There are no Nationally Important Wetlands or RAMSAR wetlands located within the Study Area. The closest significant wetland or riparian vegetation is the De Grey River, a Nationally

Important Wetland, located approximately 50 km to the north of the Study Area (DoEE 2019b).

There are numerous watercourses (minor to medium creeklines and the Shaw River) present within the Study Area. Where the vegetation responds to such availability of water and can be defined separately from adjacent vegetation, these areas have been mapped as VTs 2, 5 and 7 (Figures 8.0 – 8.38 (Appendix I)). These VTs cover an area of 33 ha, 2,850.4 ha and 2,646.4 ha respectively; which is 0.15 %, 13.3 % and 12.3 % respectively of the entire Study Area.

VT 2 comprises the vegetation of ephemeral creeks in the shallow gorges within the higher topography of the Study Area. This VT is poorly represented in the Study Area (0.15%) and wider region and potentially comprises habitats that could be refugia for flora or fauna species. VT 5 comprises vegetation of the deeper alluvial soils of rivers and major creeklines. This VT is well represented locally and is also widespread regionally. VT 7 comprises vegetation of the minor ephemeral creeklines of the Study Area and is common within the Study Area and also regionally.

Typical obligate phreatophytic taxa of the Pilbara, such as *Melaleuca argentea*, or to a lesser extent *Eucalyptus camaldulensis*, were only recorded within VT 5 and therefore the vegetation of this VT is likely to be either fully or in part groundwater dependent (Department of Water 2010). The presence of phreatophytic vegetation is further discussed in section 6.3.

VTs 6 and 9 comprise vegetation of depressions and claypan areas which would rely predominantly on rainfall but also potentially on surface water flows. These VTs cover 186.5 ha (0.8 %) and 192.6 ha (0.9 %) respectively of the Study Area and therefore are considered potentially locally significant and are poorly represented in Atlas'regional vegetation dataset indicating they are likely to be regionally restricted also.

5.1.3 Vegetation Condition

Vegetation condition mapping polygons are displayed in Figures 9.0 – 9.37 (Appendix J). Table 18 provides areas of each condition type mapped in the Study Area. The majority of vegetation within the Study Area was in Excellent condition.

Table 18: Vegetation Condition Types Mapped in the Study Area

Condition Type	Area Mapped (ha)	Proportion of Study Area (%)
Excellent	17,196.7	80
Very Good	1,170.1	5.4
Good	2,618.2	12.2
Poor	20.3	0.1
Degraded	349	1.6
Completely Degraded	147	0.7

It was noted in the field that introduced taxa such as *Cenchrus ciliaris* and *Aerva javanica* were common adjacent to tracks and roads within the study area. This is typical of disturbed sites in the Pilbara region, with both of these taxa being commonly distributed throughout. Vegetation condition polygons were only adjusted to lower condition rankings in areas where notes regarding severe infestations away from cleared areas and tracks were taken.

5.1.3.1 Stockyard Survey Area

The vegetation of survey area is relatively undisturbed and largely intact with a few minor occurrences of introduced species and was largely in Excellent condition (Figures 9.1 to 9.8). The only areas not in Excellent condition were in the major drainage areas mapped as VT 5. These recorded a lower condition score as a result of the presence of high densities of aggressive introduced flora taxa, and high grazing and trampling impacts from cattle. These scores varied from Good to Degraded, depending on the levels of introduced taxa and trampling impacts recorded. Condition scores were often correlated with the size of the drainage feature, with large creeks and rivers tending to be ranked lower than smaller flow lines and creeks.

5.1.3.2 Miralga Creek and Miralga West Survey Area

Vegetation within this survey area ranged between Excellent and Degraded condition (Figures 9.9 to 9.31). As with Stockyard, the areas not in Excellent condition were the major and minor drainage lines of VTs 5 and 7, as well as the claypan areas of VT6. These areas recorded varying levels of weed invasion and animal disturbance. The weed species *Cenchrus ciliaris* was often one of the dominant taxa in the lower stratum of VT 5 occasionally to the extent that native perennial grass taxa were almost entirely absent. *Aerva javanica* was also often frequent in the shrub layer in such areas. The presence of the significant introduced taxon *Calotropis procera* also reflects the high level of disturbance caused by cattle in the areas where these taxa were recorded

5.1.3.3 Sandtrax Survey Area

The majority of intact vegetation within this survey areas was in Excellent condition (Figures 9.32-9.37). Some areas of VTs 5 and 7 were mapped as Very Good or Good condition due varying levels of weed invasion. The occurrence/density of introduced species was highest along these drainage lines, with small occurrences on rock outcrops, as the result of pastoral activities and introduction by animals or wind/water flow.

6. DISCUSSION

6.1 Flora of the Study Area

A total of 380 discrete vascular flora taxa, one known hybrid and one putative hybrid were recorded in the Study Area by this survey, including 360 native taxa and 20 introduced taxa. Using the Chao-2 estimator, the recorded number of taxa within quadrats is equivalent to 93.9 % of the estimated taxon richness in the Study Area. It is considered that the addition of further quadrats would be unlikely to provide a significant increase in confidence of the Chao-2 and hence species richness indicating that sampling for this study is adequate for the purpose of impact assessment.

Overall the Study Area is considered to be of moderate floristic diversity. The taxa total is comparable to the Abydos DSO Project flora and vegetation assessment which recorded slightly less taxa in a similar size survey area (Woodman Environmental 2012c). The number of taxa is lower than that recorded at Corunna (Woodman Environmental 2016), probably due to the smaller number of VTs present. It is considered that this survey captured a relatively high number of ephemeral taxa, with 135 taxa classified as annuals recorded (36% of the flora taxa recorded).

A very high number of the taxa recorded during this survey (31) were found to be range extensions or to fill gaps in the known distribution of the taxon. This is a reflection of both the location of the Study Area (traversing two physiographic regions) and the lack of previous local surveys.

In terms of the eight listed and eight significant flora as defined in EPA 2016a recorded in the Study Area, these were not searched for across the Study Area in detail. Many of these taxa were not expected to occur and the impact of recent fire reduced the ability to search for all significant taxa between and away from quadrats. The identities of most of these taxa were confirmed during specimen identification following completion of field sampling, therefore there are likely to be additional locations of most of these within the Study Area.

Of the remaining 22 significant flora taxa which were determined through the desktop review to potentially occur in the Study Area, a further ten taxa have the potential to occur in the Study Area mainly due to the presence of appropriate habitat.

Of the twenty introduced taxa recorded in the Study Area, one Declared Pest (*Calotropis procera*) was recorded at 24 locations. The most common weeds in the Study Area were *Aerva javanica* and *Cenchrus ciliaris*. These are also ranked as having a high ecological impact and invasiveness ranking of rapid (DBCA 2014). The presence and distribution of these taxa have implications for management during ground disturbance activities.

6.2 Vegetation of the Study Area

The vegetation of the Study Area is considered to be moderately diverse, with the number of VTs and their distribution being largely related to the various soils and topography present in the Study Area. The number of VTs mapped is higher than those mapped as part

of the Abydos DSO Project flora and vegetation assessment which recorded 10 VTs, in a similar size survey area (Woodman Environmental 2012a). Survey of the Corunna project recorded 15 VTs in a similar size survey area (Woodman Environmental 2016).

As noted in Section 5.1.2.4, several of the VTs mapped in the Study Area may be of some local and regional significance. However, without a comprehensive regional vegetation dataset to provide context for assessments of significance of VTs, it is not possible to be certain of the regional distribution and therefore significance of any of the VTs. Notwithstanding this, it appears certain that the majority of the VTs mapped in the Study Area extend outside the Study Area, based on field observations and aerial photography, and most are likely to occur relatively extensively in the wider region as indicated in the Atlas regional vegetation dataset. Exceptions to this include:

VT 2 is likely to be regionally restricted given its species composition however there are relatively few detailed surveys in the local area with available data and a broader regional search may identify similar habitats in the region.

VTs 6 and 9 are both considered regionally significant due to their distributions on soil and landforms that are uncommon in the region. This conclusion was supported by an analysis of the Study Area data with Atlas' regional vegetation dataset.

VT 11 is considered regionally significant due to its lack of representation within the Atlas regional vegetation dataset however it occurs on soil and landform types that are considered relatively common in the region.

6.3 Identification of Groundwater Dependent Ecosystems

The phreatophytes recorded in the Study Area are predominantly facultative (either known based on the literature or presumed based on gross morphology and habitat preference). Based on the presence of the obligate phreatophytes *Melaleuca argentea* and *Eucalyptus camaldulensis*, as well as the facultative phreatophyte *Eucalyptus victrix*, and the potential facultative phreatophytes *Melaleuca glomerata* and *Atalaya hemiglauca*, there is the potential that all areas of vegetation in the Study Area mapped as VT 5 are Groundwater Dependent Ecosystems (GDEs).

Melaleuca glomerata and *Atalaya hemiglauca* appear to generally be considered at least partially facultative phreatophytes, primarily based on their presence in major river channels where groundwater is known to be close to the surface (Loomes 2010a, 2010b; Loomes and Braimbridge 2010). This appears to not have been substantiated by any specific investigation; only Loomes (2010a) has investigated depth to water ranges for some of these species, however this investigation considered a limited number of sample sites, all of which were in significant drainage channels. Recent assessment of small pockets of stressed vegetation at Atlas Iron's Mt Webber DSO Project (Woodman Environmental 2019b) found groundwater drawdown impacts to the obligate phreatophytes *Melaleuca argentea* and *Eucalyptus camaldulensis* with localised impact to *Melaleuca glomerata* individuals located on a shallow sandbar that had been supported by a shallow groundwater table. All other

taxa including *Atalaya hemiglauca* appeared to not suffer observable stress indicating a low likelihood that other presumed facultative taxa are phreatophytic in nature.

Eucalyptus victrix is another species that has been suggested to be a facultative phreatophyte in some situations (AQ2 2015; Eastham 2015; Loomes and Braimbridge 2010; Loomes 2010a), however it is generally considered to be a vadophyte (AQ2 2015). This is supported by Woodman Environmental's multi-year monitoring of vegetation considered at risk of impact from dewatering at Atlas's Pardoo minesite, east of Port Hedland. In an area east of the Bobby deposit, where the pre-dewatering depth to water was known to be between 5 and 10 m (Woodman Environmental 2012f), drawdown of nearly 10 m from pre-dewatering levels was observed at a bore adjacent to a monitoring site in a stand of *E. victrix* over a 3-year period (Woodman Environmental, 2013f). No impacts to the health of *E. victrix* that could be related to drawdown were observed over this drawdown period (Woodman Environmental 2012f, 2012g, 2013f, 2014).

Monitoring of groundwater drawdown impacts at Pardoo indicated that impacts of drawdown were confined to the two tree species *M. argentea* and *E. camaldulensis* with changes in mid and lower storey vegetation not recorded. *Melaleuca argentea* is known to be an obligate phreatophyte (Graham 2001; cited in Department of Water 2010), and *Eucalyptus camaldulensis* can be obligate or facultative depending on the specific hydrological characteristics of a site (Department of Water 2010). It is considered that these occurrences can only be GDE if groundwater is located within 10 m of the ground surface.

Groundwater level data supplied by Atlas for the Study Area indicates groundwater is within 10m of the surface along the Shaw River and likely to be within 10m in areas mapped as VT 5. Vegetation containing *Melaleuca argentea* is a GDE, as this species is known to be an obligate phreatophyte, and has a planiform root system adapted to areas of very shallow groundwater (2-3 m below ground level) (Department of Water 2010). *Eucalyptus camaldulensis* is usually an obligate phreatophyte, being found in riparian zones, however has been found higher in the landscape on floodplains where the groundwater is up to 21 m below ground level (Department of Water 2010). This species has a bimorphic root system (surface lateral roots and a tap root) capable of utilising both groundwater and soil water from the unsaturated soil profile, and is likely to be a facultative phreatophyte in areas where groundwater is not shallow. In the Study Area, these species have only been recorded in major creeks and in the Shaw River channel and associated tributaries within VT 5. These two obligate phreatophytes were not recorded in all quadrats within VT 5, and some areas of this VT occurred on floodplains away from the alluvials of the river and creek channels. Therefore it is considered unlikely that all areas of VT 5 will be obligate GDEs.

Extraction of groundwater in the vicinity of GDEs has the potential to impact on the health of this vegetation. The spatial extent of any impacts of groundwater drawdown on vegetation will be mediated by the rate and depth of drawdown, with the severity of impacts directly related to the distribution of the obligate phreatophytes present.

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Hercules DSO Project Conservation Significant Flora Assessment. Unpublished report (Report ref. Atlas12-02-01) prepared for Atlas Iron Limited, March 2013.

Woodman Environmental Pty Ltd (2013c)
Wodgina Proposed Tower Base and Access Road Flora and Vegetation Assessment – Addendum Report. Unpublished report (Report ref. Atlas13-13-01) prepared for Atlas Iron Limited, March 2013.

Woodman Environmental Pty Ltd (2013d)
Great Northern Highway Upgrade Project Flora and Vegetation Assessment. Unpublished report (Report ref. Atlas13-07-01) prepared for Atlas Iron Limited, November 2013.

Woodman Environmental Pty Ltd (2013e)
McPhee Creek Project Flora and Vegetation Assessment. Unpublished report (Report ref. Atlas11-65-01) prepared for Atlas Iron Limited, January 2013.

Woodman Environmental Consulting Pty Ltd (2013f)
Pardoo Direct Shipping Ore Project – Groundwater Drawdown – Vegetation Health Monitoring 2013. Unpublished report (Atlas13-05-02 Rev 0), prepared for Atlas Iron Ltd, December 2013.

Woodman Environmental Consulting Pty Ltd (2014)
Pardoo Direct Shipping Ore Project – Groundwater Drawdown – Vegetation Health Monitoring 2014. Unpublished report (Atlas14-10-01 Rev 0), prepared for Atlas Iron Ltd, October 2014.

Woodman Environmental (2016)
Corunna Downs Project, Level 2 Flora and Vegetation Assessment. Unpublished report (Atlas16-15-01) prepared for Atlas Iron Limited, December 2016.

Woodman Environmental Consulting Pty Ltd (Woodman Environmental) (2019a)
Wodgina Expansion Project Detailed Flora and Vegetation Assessment. Unpublished report (MRL18-37-01 Rev 1) prepared for Mineral Resources Ltd, May 2019.

Woodman Environmental Consulting Pty Ltd (2019b)
Mt Webber Mine – Southern Haul Road Production Bores Groundwater Dependent Vegetation Assessment. Unpublished report (Atlas19-14-01 Rev D), prepared for Atlas Iron Ltd, August 2019.

Woodman Environmental Consulting Pty Ltd (2019 *in prep*.)
Pardoo Direct Shipping Ore Project – Groundwater Drawdown – Vegetation Health Monitoring 2019. Unpublished report (Atlas19-26-01 Rev A), prepared for Atlas Iron Ltd, in prep.

Western Botanical (2017)
Interim Report on the Flora and Vegetation of the Cassiterite Pit Extension and EWL Extension. Unpublished report (Report ref. WB877) prepared for Rapallo Group Pty Ltd and Mineral Resources Limited, December 2017.

360 Environmental Pty Ltd (2018a)
Wodgina Mine Site and Proposed Airstrip Flora, Vegetation and Fauna Report. Unpublished report (Report ref. 2548AB) prepared for Mineral Resources Limited, February 2018.

360 Environmental Pty Ltd (2018b)
Wodgina Mine and Additional Gas PipelineFlora, Vegetation, Fauna and Targeted Northern Quoll Report. Unpublished report (Report ref. 2596AB) prepared for Mineral Resources Limited, May 2018.

360 Environmental Pty Ltd (2018c)
Wodgina Mine Flora, Vegetation and Fauna Assessment Addendum. Unpublished report (Report ref. 2745AB) prepared for Mineral Resources Limited, July 2018.

360 Environmental Pty Ltd (2018d)
Wodgina Aerodrome Detailed Flora and Vegetation Survey. Unpublished report (Report ref. 2825AC) prepared for Mineral Resources Limited, July 2018.

Appendix A: Conservation Codes for Western Australian Flora and Fauna (DBCA 2019d)

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

CONSERVATION CODES

For Western Australian Flora and Fauna

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

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016.*

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

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

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

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

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

CR **Critically endangered species**

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

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

EN **Endangered species**

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

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

VU **Vulnerable species**

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

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

Conservation codes for Western Australian flora and fauna

Extinct species

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

EX **Extinct species**

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

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

EW **Extinct in the wild species**

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

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

Specially protected species

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

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

MI **Migratory species**

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

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

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

CD **Species of special conservation interest (conservation dependent fauna)**

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

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

OS **Other specially protected species**

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

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

Conservation codes for Western Australian flora and fauna

P **Priority species**

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

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

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

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

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

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

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

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

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

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.
(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

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

Last updated 3 January 2019

Appendix B: Results of Search of the Department of the Environment and Energy Database with Regard to Environmental Matters of National Significance (DoEE 2019a)

Australian Government
Department of the Environment and Energy

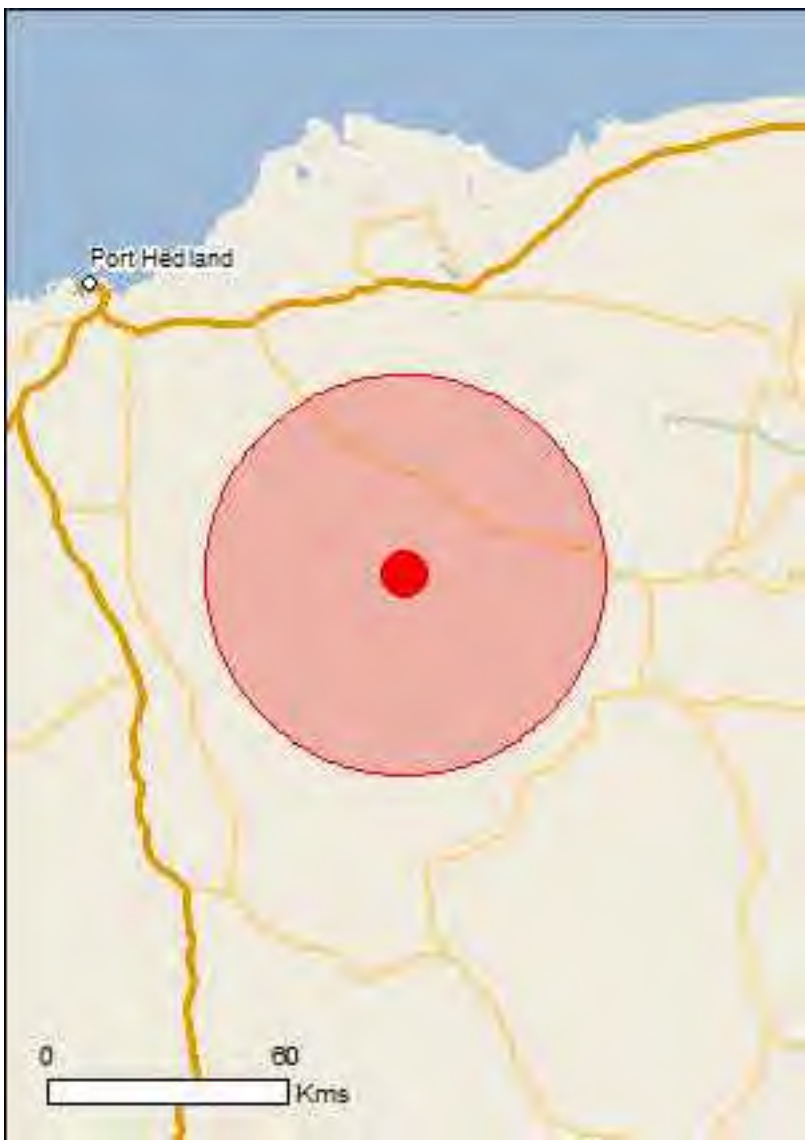
EPBC Act Protected Matters Report

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

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

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

Report created: 06/08/19 16:14:15



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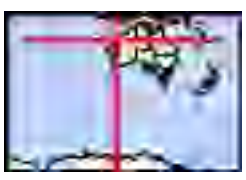

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	10
Listed Migratory Species:	12

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Breeding likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Roosting known to occur within area
Plants		
Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) [88310]	Endangered	Species or species habitat known to occur within area
Reptiles		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]		
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Invasive Species	[Resource Information]

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

Name	Status	Type of Presence

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Prosopis spp. Mesquite, Algaroba [68407]		Species or species habitat likely to occur within area
Reptiles		
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat may occur within area

Caveat

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

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

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

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

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

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

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-20.91926 119.3079

Acknowledgements

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

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

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

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

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Appendix C: Definitions, Categories and Criteria for Threatened and Priority Ecological Communities (DBCA 2013a)

1. GENERAL DEFINITIONS

Ecological Community: A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:
Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising underground watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B):

A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% **and either or both** of the following apply (i or ii):

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;

iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).

Endangered (EN)

An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B, or C):

A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement **and either or both** of the following apply (i or ii):

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, **and one or more** of the following apply (i, ii or iii):

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)

An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet

been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES PRIORITY ECOLOGICAL COMMUNITY LIST

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities:

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities:

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more

localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities:

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) Communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;

(iii) Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities:

Communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

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

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities:

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Current as of January 2013

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

Condition Ranking	Description
E (Excellent)	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
VG (Very Good)	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
G (Good)	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
P (Poor)	Still retains basic vegetation structure or ability to regenerate it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
VP (Very Poor)	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species
D (Completely Degraded)	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Appendix E: Vascular Plant Taxa Amalgamated in or Omitted from the Floristic Analysis

Description	Taxon	Reasoning
Amalgamated Taxa	*Bonamia* aff. *pilbarensis*	Difference is based on foliage colour/hair density, both have winged seeds; may not have been differentiated between in the field by all teams
	Bonamia pilbarensis	
	Clerodendrum tomentosum var. *lanceolatum*	Difference is based on leaf shape, occupy same habitat, mostly juvenile plants observed
	Clerodendrum tomentosum var. *tomentosum*	
	Eriachne ciliata	Although both are annuals and are automatically excluded from the analysis, these taxa were amalgamated for the purposes of taxon richness calculations and the species accumulation curve; these two taxa are very similar, separation of the two was only learnt after the fieldwork was undertaken, specimens collected were identified as *E.* sp. Dugald River (B.K. Simon+ 3007) with *E. ciliata* records being field IDs and potentially incorrect
	Eriachne sp. Dugald River (B.K. Simon+ 3007)	
Omitted Taxa	*?Abutilon* sp.	Indeterminate identification, unable to amalgamate as other similar taxa present that are difficult to discern in the absence of fruit or more mature material
	Acacia sphaerostachya	Believed to be a hybrid (Maslin, B.R., van Leeuwen, S. and Reid, J. 2010)
	Acacia ?trachycarpa x *tumida* var. *pilbarensis*	Known hybrid, indeterminate identification (sterile)
	Cheilanthes brownii	Geophyte perennial
	Cheilanthes sieberi subsp. *sieberi*	Geophyte perennial
	Drosera burmanni	Geophyte perennial
	Fimbristylis dichotoma	Geophyte perennial
	Fimbristylis neilsonii	Geophyte perennial (or potentially annual rather than perennial)
	Heliotropium ?pachyphyllum	Indeterminate identification, unable to amalgamate as two similar taxa present that are difficult to discern in the absence of fruit
	?Hibiscus austrinus	Indeterminate identification
	Ophioglossum reticulatum	Geophyte perennial
	Pterocaulon ?sphaeranthoides	Indeterminate identification, unable to amalgamate as similar taxon present, poor material
	?Ptilotus fusiformis	Indeterminate identification
	Senna glutinosa subsp. x *luerssenii*	Known hybrid
	Sida ?clementii	Indeterminate identification, unable to amalgamate as two similar taxa present that are difficult to discern in the absence of fruit
	?Themeda triandra	Indeterminate identification

Appendix F: Vascular Plant Taxa Recorded in the Study Area

Acanthaceae	*Rostellularia adscendens* var. *clementii*
Aizoaceae	*Trianthema cusackianum*
	Trianthema oxycalyptrum var. *oxycalyptrum*
	Trianthema pilosum
	Trianthema triquetrum
Amaranthaceae	**Aerva javanica*
	Alternanthera denticulata
	Alternanthera nana
	Amaranthus undulatus
	Gomphrena canescens
	Gomphrena cunninghamii
	Gomphrena leptoclada subsp. *leptoclada*
	Ptilotus astrolasius
	Ptilotus auriculifolius
	Ptilotus axillaris
	Ptilotus calostachyus
	Ptilotus exaltatus
	Ptilotus fusiformis
	?*Ptilotus fusiformis*
	Ptilotus gomphrenoides
	Ptilotus incanus
	Ptilotus murrayi
Apocynaceae	**Calotropis procera*
	Carissa lanceolata
Araliaceae	*Trachymene oleracea* subsp. *oleracea*
Asteraceae	*Blumea tenella*
	Centipeda minima subsp. *macrocephala*
	**Flaveria trinervia*
	Pentalepis trichodesmoides subsp. *trichodesmoides*
	Pluchea dentex
	Pluchea ferdinandi-muelleri
	Pluchea rubelliflora
	Pluchea tetranthera
	Pterocaulon serrulatum var. *velutinum*
	Pterocaulon sphacelatum
	Pterocaulon sphaeranthoides
	Pterocaulon ?*sphaeranthoides*
	Rhodanthe margarethae
	Streptoglossa ?*bubakii*
	Streptoglossa decurrens
	Streptoglossa tenuiflora

Bignoniaceae	*Dolichandrone occidentalis*
Boraginaceae	*Ehretia saligna* var. *saligna* *Heliotropium chrysocarpum* *Heliotropium crispatum* *Heliotropium cunninghamii* *Heliotropium heteranthum* *Heliotropium pachyphyllum* *Heliotropium* ?*pachyphyllum* *Heliotropium skeleton* *Heliotropium tanythrix* *Heliotropium tenuifolium* *Trichodesma zeylanicum* var. ?*zeylanicum*
Campanulaceae	*Lobelia arnhemiaca* *Wahlenbergia tumidifructa*
Capparaceae	*Capparis spinosa* subsp. *nummularia*
Caryophyllaceae	*Polycarpaea corymbosa* *Polycarpaea holtzei* *Polycarpaea involucrata* *Polycarpaea longiflora*
Celastraceae	*Stackhousia intermedia* *Stackhousia muricata*
Chenopodiaceae	*?*Chenopodium* sp. *Dysphania plantaginella* *Dysphania rhadinostachya* subsp. *rhadinostachya* *Dysphania sphaerosperma* *Salsola australis* *Sclerolaena hostilis*
Cleomaceae	*Cleome uncifera* subsp. *uncifera* *Cleome viscosa*
Combretaceae	*Terminalia circumalata*
Convolvulaceae	*Bonamia alatisemina* *Bonamia erecta* *Bonamia linearis* *Bonamia media* *Bonamia pannosa* *Bonamia* aff. *pilbarensis* *Bonamia pilbarensis* *Evolvulus alsinoides* var. *decumbens* *Evolvulus alsinoides* var. *villosicalyx*

Convolvulaceae cont'd	*Ipomoea coptica*
	Ipomoea muelleri
	Ipomoea polymorpha
	Operculina aequisepala
	Polymeria ambigua
	Polymeria sp.
Cucurbitaceae	*Austrobryonia pilbarensis*
	**Citrullus colocynthis*
	Cucumis melo
	Cucumis variabilis
	Trichosanthes cucumerina
Cyperaceae	*Bulbostylis barbata*
	Cyperus blakeanus
	Cyperus difformis
	Cyperus hesperius
	Cyperus iria
	Cyperus ixiocarpus
	Cyperus microcephalus subsp. *saxicola*
	Cyperus pulchellus
	**Cyperus rotundus*
	Cyperus squarrosus
	Cyperus vaginatus
	Fimbristylis depauperata
	Fimbristylis dichotoma
	Fimbristylis microcarya
	Fimbristylis neilsonii
	Fimbristylis nuda
	Fimbristylis simulans
	Fuirena ciliaris
	Lipocarpha microcephala
	Schoenoplectus subulatus
	Scleria rugosa
Droseraceae	*Drosera burmanni*
	Drosera finlaysoniana
Elatinaceae	*Bergia pedicellaris*
Euphorbiaceae	*Adriana tomentosa*
	Euphorbia australis var. *subtomentosa*
	Euphorbia biconvexa
	Euphorbia careyi
	Euphorbia clementii (P3)
	Euphorbia coghlanii
	Euphorbia inappendiculata var. *inappendiculata* (P2)

Euphorbiaceae cont'd	*Euphorbia tannensis* subsp. *eremophila*
	Euphorbia trigonosperma
	Euphorbia vaccaria var. *vaccaria*
Fabaceae	*Acacia acradenia*
	Acacia ampliceps
	Acacia ancistrocarpa
	Acacia arida
	Acacia bivenosa
	Acacia colei var. *colei*
	Acacia coriacea subsp. *pendens*
	Acacia eriopoda
	Acacia hilliana
	Acacia inaequilatera
	Acacia maitlandii
	Acacia orthocarpa
	Acacia pruinocarpa
	Acacia ptychophylla
	Acacia pyrifolia var. *pyrifolia*
	Acacia retivenea subsp. *clandestina*
	Acacia sclerosperma subsp. *sclerosperma*
	Acacia sericophylla
	Acacia sphaerostachya
	Acacia spondylophylla
	Acacia stellaticeps
	Acacia synchronicia
	Acacia trachycarpa
	Acacia ?*trachycarpa x tumida* var. *pilbarensis*
	Acacia tumida var. *pilbarensis*
	Alysicarpus muelleri
	Cajanus marmoratus
	Crotalaria cunninghamii
	Crotalaria dissitiflora subsp. *benthamiana*
	Crotalaria medicaginea var. *neglecta*
	Crotalaria ramosissima
	Cullen graveolens
	Cullen leucanthum
	Cullen leucochaites
	Cullen martinii
	Cullen pogonocarpum
	Cullen stipulaceum
	Desmodium campylocaulon
	Desmodium filiforme
	Dichrostachys spicata
	Erythrina vespertilio

Fabaceae cont'd	*Indigofera colutea*
	Indigofera linifolia
	Indigofera linnaei
	Indigofera monophylla
	Indigofera trita subsp. *trita*
	Isotropis atropurpurea
	Leptosema anomalum
	Neptunia dimorphantha
	Petalostylis labicheoides
	Rhynchosia australis
	Rhynchosia minima
	Senna artemisioides subsp. *oligophylla*
	Senna glutinosa subsp. *glutinosa*
	Senna glutinosa subsp. *pruinosa*
	Senna glutinosa subsp. *x luerssenii*
	Senna notabilis
	Senna symonii
	Senna venusta
	Sesbania cannabina
	**Stylosanthes hamata*
	Swainsona formosa
	Templetonia hookeri
	Tephrosia clementii
	Tephrosia rosea var. *clementii*
	Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)
	Tephrosia sp. clay soils (S. van Leeuwen et al. PBS 0273)
	Tephrosia sp. D Kimberley Flora (R.D. Royce 1848)
	Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)
	Tephrosia supina
	Tephrosia virens
	**Vachellia farnesiana*
	Vigna lanceolata var. *lanceolata*
	Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)
	Zornia albiflora
Goodeniaceae	*Dampiera candicans*
	Goodenia forrestii
	Goodenia lamprosperma
	Goodenia microptera
	Goodenia muelleriana
	Goodenia nuda (P4)
	Goodenia stobbsiana
	Goodenia triodiophila

Goodeniaceae cont'd	*Scaevola amblyanthera* var. *centralis*
	Scaevola parvifolia subsp. *pilbarae*
Haloragaceae	*Gonocarpus ephemerus*
	Haloragis gossei
Lamiaceae	*Clerodendrum floribundum* var. *angustifolium*
	Clerodendrum tomentosum var. *lanceolatum*
	Clerodendrum tomentosum var. *tomentosum*
Lauraceae	*Cassytha capillaris*
Loganiaceae	*Mitrasacme connata*
Lythraceae	*Ammannia baccifera*
	Ammannia multiflora
	Rotala diandra
Malvaceae	*Abutilon* aff. *hannii*
	Abutilon lepidum
	Abutilon malvifolium
	Abutilon otocarpum
	?*Abutilon* sp.
	Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)
	Abutilon sp. Pilbara (W.R. Barker 2025)
	Corchorus elachocarpus
	Corchorus incanus subsp. *incanus*
	Corchorus parviflorus
	Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (P1)
	Corchorus tridens
	Gossypium australe
	Gossypium robinsonii
	?*Hibiscus austrinus*
	Hibiscus brachychlaenus
	Hibiscus coatesii
	Hibiscus goldsworthii
	Hibiscus leptocladus
	Hibiscus sturtii var. *campylochlamys*
	Hibiscus sturtii var. *platychlamys*
	Hibiscus verdcourtii
	**Malvastrum americanum*
	Melhania oblongifolia
	Melhania aff. *oblongifolia*
	Seringia nephrosperma
	Sida clementii
	Sida ?*clementii*
	Sida echinocarpa

Malvaceae cont'd	*Sida fibulifera*
	Sida macropoda
	Sida rohlenae subsp. *rohlenae*
	Sida sp. Articulation below (A.A. Mitchell PRP 1605)
	Sida sp. Pilbara (A.A. Mitchell PRP 1543)
	Triumfetta clementii
	Triumfetta maconochieana
	Triumfetta propinqua
	Waltheria indica
	Waltheria virgata
Marsileaceae	*Marsilea hirsuta*
Menispermaceae	*Tinospora smilacina*
Molluginaceae	*Glinus oppositifolius*
	Hypertelis cerviana
	Trigastrotheca molluginea
Montiaceae	*Calandrinia pentavalvis*
	Calandrinia sp.
	Calandrinia stagnensis
	Calandrinia tepperiana
Moraceae	*Ficus aculeata* var. *indecora*
	Ficus brachypoda
Myrtaceae	*Corymbia candida*
	Corymbia ferriticola
	Corymbia flavescens
	Corymbia hamersleyana
	Corymbia zygophylla
	Eucalyptus camaldulensis
	Eucalyptus leucophloia subsp. *leucophloia*
	Eucalyptus victrix
	Melaleuca argentea
	Melaleuca glomerata
	Melaleuca linophylla
Nyctaginaceae	*Boerhavia burbidgeana*
	Boerhavia coccinea
	Boerhavia gardneri
	Boerhavia repleta
	Boerhavia ?*repleta*
	Boerhavia sp.
Onagraceae	*Ludwigia perennis*

Ophioglossaceae	*Ophioglossum lusitanicum*
Orobanchaceae	*Striga curviflora*
Papaveraceae	**Argemone ochroleuca*
Passifloraceae	**Passiflora foetida* var. *hispida*
Phyllanthaceae	*Flueggea virosa* subsp. *melanthesoides* *Notoleptopus decaisnei* var. *decaisnei* *Phyllanthus erwinii* *Phyllanthus exilis* *Phyllanthus maderaspatensis*
Plantaginaceae	*Stemodia grossa* *Stemodia viscosa*
Poaceae	*Aristida burbidgeae* *Aristida contorta* *Aristida holathera* var. *holathera* *Aristida hygrometrica* *Aristida inaequiglumis* *Bothriochloa ewartiana* **Cenchrus ciliaris* **Cenchrus setiger* *Chloris pectinata* **Chloris virgata* *Chrysopogon fallax* *Cymbopogon ambiguus* *Cynodon convergens* **Cynodon dactylon* *Cynodon prostratus* *Dactyloctenium radulans* *Dichanthium fecundum* *Dichanthium sericeum* subsp. *humilius* **Echinochloa colona* *Enneapogon caerulescens* *Enneapogon lindleyanus* *Eragrostis crateriformis* (P3) *Eragrostis cumingii* *Eragrostis desertorum* *Eragrostis dielsii* *Eragrostis eriopoda* *Eragrostis setifolia* *Eragrostis tenellula* *Eriachne aristidea* *Eriachne benthamii*

Poaceae cont'd	*Eriachne ciliata*
	Eriachne glauca var. *glauca*
	Eriachne mucronata
	Eriachne obtusa
	Eriachne pulchella subsp. *dominii*
	Eriachne sp. Dugald River (B.K. Simon+ 3007)
	Eriachne tenuiculmis
	Eulalia aurea
	Iseilema dolichotrichum
	Iseilema vaginiflorum
	Paraneurachne muelleri
	Paspalidium clementii
	Paspalidium rarum
	Paspalidium tabulatum
	Perotis rara
	Schizachyrium fragile
	**Setaria verticillata*
	Sporobolus australasicus
	Themeda triandra
	?*Themeda triandra*
	Triodia angusta
	Triodia basitricha (P3)
	Triodia brizoides
	Triodia chichesterensis (P3)
	Triodia epactia
	Triodia lanigera
	Triodia longiceps
	Triodia schinzii
	Triodia wiseana
	Urochloa holosericea subsp. *velutina*
	Xerochloa barbata
	Yakirra australiensis var. *australiensis*
Polygalaceae	*Polygala galeocephala*
	Polygala glaucifolia
Portulacaceae	*Portulaca conspicua*
	Portulaca oleracea
	**Portulaca pilosa*
Proteaceae	*Grevillea pyramidalis* subsp. *leucadendron*
	Grevillea wickhamii subsp. *hispidula*
	Grevillea wickhamii subsp. *macrodonta*
	Hakea lorea subsp. *lorea*

Pteridaceae	*Cheilanthes brownii*
	Cheilanthes sieberi subsp. *sieberi*
Rubiaceae	*Oldenlandia crouchiana*
	Oldenlandia galioides
	Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479) (P3)
	Synaptantha tillaeacea var. *tillaeacea*
Sapindaceae	*Atalaya hemiglauca*
	Dodonaea coriacea
	Dodonaea petiolaris
Solanaceae	*Nicotiana benthamiana*
	?*Nicotiana* sp.
	Solanum cleistogamum
	Solanum diversiflorum
	Solanum horridum
	**Solanum nigrum*
	Solanum phlomoides
Thymelaeaceae	*Pimelea ammocharis*
Violaceae	*Hybanthus aurantiacus*
Zygophyllaceae	*Tribulopis angustifolia*
	Tribulus hirsutus
	Tribulus macrocarpus
	Tribulus occidentalis
	Tribulus platypterus
	Tribulus suberosus
	**Tribulus terrestris*

Appendix G: Raw Data Recorded within Quadrats in the Study Area

Site Name:	MCK001
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727406.75E 7663396.5N
Vegetation Type:	1
Landform Type:	Mid Slope
Slope Class:	Very Steep (37 degrees)
Aspect:	S
Soil Type:	Sandy Clay Loam
Soil Colour:	Brown
Rock Outcrop:	Granite, 10-20% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	3 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus leucophloia* subsp. *leucophloia*
Mid Stratum 1:	*Senna glutinosa* subsp. *glutinosa*
Lower Stratum 1:	*Corchorus parviflorus*, *Indigofera monophylla*
Lower Stratum 2:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	0.4	0.1
Acacia hilliana	0.4	0.1
Acacia spondylophylla	0.6	0.1
Acacia tumida var. *pilbarensis*	1	0.1
Amaranthus undulatus	0.1	0.1
Bonamia pilbarensis	0.1	0.1
Bulbostylis barbata	0.1	0.1
Cassytha capillaris		0.1
Cheilanthes brownii	0.1	0.1
Cleome viscosa	0.1	0.1

Clerodendrum tomentosum var. *lanceolatum*	0.2	0.1
Corchorus parviflorus	0.4	0.1
Corymbia hamersleyana	2	0.1
Cucumis variabilis		0.1
Cymbopogon ambiguus	0.3	0.1
Cyperus hesperius	0.2	0.1
Dodonaea coriacea	0.6	0.1
Eriachne mucronata	0.4	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Eucalyptus leucophloia subsp. *leucophloia*	4.5	4
Euphorbia tannensis subsp. *eremophila*	0.8	0.1
Euphorbia trigonosperma	0.1	0.1
Flueggea virosa subsp. *melanthesoides*	1	0.1
Gomphrena cunninghamii	0.1	0.1
Goodenia stobbsiana	0.2	0.1
Grevillea wickhamii subsp. *hispidula*	0.3	0.1
Hibiscus coatesii	0.5	0.1
Hibiscus leptocladus	0.4	0.1
Hibiscus sturtii var. *campylochlamys*	0.5	0.1
Hybanthus aurantiacus	0.3	0.1
Indigofera monophylla	0.4	1
Oldenlandia crouchiana	0.1	0.1
Ptilotus astrolasius	0.4	0.1
Ptilotus calostachyus	0.6	0.1
Senna glutinosa subsp. *glutinosa*	1	0.1
Senna notabilis	0.1	0.1
Sida sp. Articulation below (A.A. Mitchell PRP 1605)	1	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.4	0.1
Solanum cleistogamum	0.1	0.1
Solanum phlomoides	0.2	0.1
Trachymene oleracea subsp. *oleracea*	0.1	0.1
Tribulus suberosus	0.7	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia brizoides	0.4	90
Triodia epactia	0.3	0.1
Triodia wiseana	0.4	0.1
Triumfetta maconochieana	0.4	0.1

PHOTO

Site Name:	MCK002
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727546.24E 7663820.87N
Vegetation Type:	3
Landform Type:	Crest, Crest on upper slope (other)
Slope Class:	Very Steep (37 degrees)
Aspect:	N
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Granite, 20-50% bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia orthocarpa*, *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula*
Lower Stratum 1:	*Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia hilliana	0.4	0.5
Acacia orthocarpa	4	3
Acacia tumida var. *pilbarensis*	3.5	2
Corymbia hamersleyana	2	
Eriachne mucronata	0.2	0.1
Eriachne pulchella subsp. *dominii*	0.2	0.1
Grevillea wickhamii subsp. *hispidula*	2.8	0.5
Triodia epactia	0.5	2.5

PHOTO

Site Name:	MCK003
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 726437.96E 7663873.32N
Vegetation Type:	1
Landform Type:	Mid Slope
Slope Class:	Very Steep (37 degrees)
Aspect:	S
Soil Type:	Sandy Clay Loam
Soil Colour:	Brown
Rock Outcrop:	Ironstone, 10-20% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Ironstone
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	5 years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus leucophloia* subsp. *leucophloia*
Upper Stratum 2:	*Acacia pruinocarpa*, *Atalaya hemiglauca*
Mid Stratum 1:	*Senna glutinosa* subsp. *glutinosa*
Lower Stratum 1:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Abutilon sp. Dioicum (A.A. Mitchell PRP 1618)	0.9	0.1
Acacia inaequilatera	1	0.1
Acacia pruinocarpa	4	1
Amaranthus undulatus	0.1	0.1
Aristida burbidgeae	0.1	0.1
Atalaya hemiglauca	2	0.2
Boerhavia sp.	0.5	0.1
Bulbostylis barbata	0.1	0.1
Cheilanthes brownii	0.5	0.1

Cleome viscosa	0.1	0.1
Clerodendrum tomentosum var. *lanceolatum*	0.4	0.1
Corchorus parviflorus	0.2	0.1
Corymbia ferriticola	0.8	0.1
Cucumis variabilis	0.3	0.1
Cymbopogon ambiguus	0.8	0.1
Cyperus hesperius	0.3	0.1
Ehretia saligna var. *saligna*	0.6	0.1
Enneapogon caerulescens	0.1	0.1
Eriachne mucronata	0.4	0.1
Eucalyptus leucophloia subsp. *leucophloia*	5	3
Euphorbia trigonosperma	0.1	0.1
Flueggea virosa subsp. *melanthesoides*	1.5	0.1
Gomphrena cunninghamii	0.2	0.1
Indigofera monophylla	0.6	0.1
Nicotiana benthamiana	0.1	0.1
Notoleptopus decaisnei var. *decaisnei*	0.9	0.1
Oldenlandia crouchiana	0.1	0.1
Paspalidium clementii	0.1	0.1
Polycarpaea holtzei	0.1	0.1
Polycarpaea longiflora	0.1	0.1
Ptilotus auriculifolius	0.1	0.1
Ptilotus incanus	0.3	0.1
Senna glutinosa subsp. *glutinosa*	1.2	0.2
Sida macropoda	0.4	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.2	0.1
Solanum cleistogamum	0.1	0.1
Solanum phlomoides	0.6	0.1
Sporobolus australasicus	0.1	0.1
Streptoglossa decurrens	0.05	0.1
Tinospora smilacina	0.1	0.1
Trachymene oleracea subsp. *oleracea*	0.1	0.1
Tribulus hirsutus	0.1	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.1	0.1
Trichosanthes cucumerina	0.1	0.1
Triodia brizoides	0.4	90
Triodia epactia	0.5	0.1
Triodia wiseana	0.3	0.1
Triumfetta maconochieana	0.8	0.1

PHOTO

Site Name:	MCK004
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727834.76E 7663792.31N
Vegetation Type:	5
Landform Type:	Drainage Line
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Northern Vegetation Condition - VG - Very Good
Disturbance:	Grazing, Exotic Weeds
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus camaldulensis*, *Eucalyptus victrix*
Upper Stratum 2:	*Terminalia circumalata*
Mid Stratum 1:	*Acacia ampliceps*, *Acacia coriacea* subsp. *pendens*, *Acacia trachycarpa*, *Atalaya hemiglauca*, *Melaleuca glomerata*, *Melaleuca linophylla*, *Petalostylis labicheoides*
Lower Stratum 1:	**Cenchrus ciliaris*
Lower Stratum 2:	*Cyperus vaginatus*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Abutilon aff. *hannii*	0.4	0.1
Acacia ampliceps	7	4
Acacia coriacea subsp. *pendens*	5	5
Acacia pyrifolia var. *pyrifolia*	0.5	0.1
Acacia trachycarpa	6	0.5
Acacia ?trachycarpa x tumida var. *pilbarensis*	2.2	0.1
Acacia tumida var. *pilbarensis*	2.3	0.1
Amaranthus undulatus	0.15	0.1
Atalaya hemiglauca	2.5	1
**Calotropis procera*	1.4	0.1

**Cenchrus ciliaris*	0.8	0.3
Clerodendrum tomentosum var. *tomentosum*	0.5	0.1
Corchorus parviflorus	0.3	0.1
Crotalaria cunninghamii		0.1
Cucumis melo		0.1
Cymbopogon ambiguus	0.5	0.1
Cyperus vaginatus	0.6	0.3
Dactyloctenium radulans	0.1	0.1
Enneapogon lindleyanus	0.1	0.1
Eragrostis cumingii	0.1	
Eriachne tenuiculmis	0.1	0.1
Eucalyptus camaldulensis	12	20
Eucalyptus victrix	14	1.5
Euphorbia australis var. *subtomentosa*	0.1	0.1
Euphorbia trigonosperma	0.2	0.1
Ficus aculeata var. *indecora*	3.2	0.2
Flueggea virosa subsp. *melanthesoides*	2.5	5
Gossypium robinsonii	0.5	0.1
Hybanthus aurantiacus	0.2	0.1
Melaleuca glomerata	4	40
Melaleuca linophylla	3	8
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Operculina aequisepala	0.2	0.1
Paspalidium clementii		0.1
Petalostylis labicheoides	2.5	2
Phyllanthus maderaspatensis	0.3	0.1
Polymeria ambigua	0.1	0.1
Rhynchosia minima		0.1
Senna notabilis	0.1	0.1
Sesbania cannabina	0.3	0.1
**Setaria verticillata*	0.3	0.1
Solanum diversiflorum	0.2	0.1
Sporobolus australasicus	0.1	0.1
Terminalia circumalata	4	0.5
Tinospora smilacina		0.1
Triodia epactia	0.4	0.1

PHOTO

Site Name:	MCK005
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 726779.24E 7663963.22N
Vegetation Type:	4
Landform Type:	Crest
Slope Class:	Gently Inclined (3 degrees)
Aspect:	SW
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Ironstone, 20-50% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Ironstone
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	3 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula*
Lower Stratum 1:	*Corchorus parviflorus*, *Dampiera candicans*, *Sida* sp. Pilbara (A.A. Mitchell PRP 1543), *Solanum phlomoides*
Lower Stratum 2:	*Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia coriacea subsp. *pendens*		
Acacia inaequilatera	1.6	0.1
Acacia ptychophylla		
Acacia tumida var. *pilbarensis*	1.8	2
Amaranthus undulatus	0.1	0.1
Bonamia pilbarensis	0.1	0.1
Bulbostylis barbata	0.1	0.1
Cleome viscosa	0.2	0.1
Corchorus parviflorus	0.5	2
Cymbopogon ambiguus	0.6	0.1
Cyperus hesperius	0.2	0.1

Dampiera candicans	0.4	0.2
Eriachne mucronata	0.2	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Eucalyptus leucophloia subsp. *leucophloia*	3	0.1
Goodenia stobbsiana	0.3	0.1
Grevillea wickhamii subsp. *hispidula*	1.8	0.5
Polycarpaea holtzei	0.1	0.1
Ptilotus calostachyus	0.6	0.1
Ptilotus incanus	0.2	0.1
Senna glutinosa subsp. *glutinosa*	1.3	0.1
Senna symonii	0.9	0.1
Senna venusta	0.5	0.1
Seringia nephrosperma	0.7	0.1
Sida sp. Articulation below (A.A. Mitchell PRP 1605)	1.2	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.5	1
Solanum phlomoides	0.7	0.2
Tephrosia virens	0.8	0.1
Tribulus suberosus	0.6	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia basitricha (P3)	0.2	0.2
Triodia epactia	0.4	70
Triumfetta maconochieana	0.4	0.1

PHOTO

Site Name:	MCK006
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727997.95E 7663846.21N
Vegetation Type:	3
Landform Type:	Upper Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	W
Soil Type:	Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Granite, 10-20% bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula*
Lower Stratum 1:	*Triodia epactia*
Lower Stratum 2:	*Acacia hilliana*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia hilliana	0.4	0.2
Acacia orthocarpa	4.5	0.1
Acacia tumida var. *pilbarensis*	4	5
Corymbia hamersleyana		
Dampiera candicans	0.5	0.1
Eriachne mucronata	0.3	0.1
Grevillea wickhamii subsp. *hispidula*	3.5	0.2
Solanum phlomoides	0.4	0.1
Triodia epactia	0.5	60

PHOTO

Site Name:	MCK007
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727599.12E 7665441.27N
Vegetation Type:	1
Landform Type:	Upper Slope
Slope Class:	Very Steep (37 degrees)
Aspect:	SE
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Granite, 20-50% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm, 600-2000mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus leucophloia* subsp. *leucophloia*, *Terminalia circumalata*
Mid Stratum 1:	*Atalaya hemiglauca*, *Flueggea virosa* subsp. *melanthesoides*
Mid Stratum 2:	*Cymbopogon ambiguus*
Lower Stratum 1:	*Indigofera trita* subsp. *trita*
Lower Stratum 2:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia inaequilatera	1.5	0.1
**Aerva javanica*	0.4	0.1
Amaranthus undulatus	0.1	0.1
Atalaya hemiglauca	3	1
Boerhavia burbidgeana	0.1	0.1
Boerhavia gardneri	0.3	0.1
Boerhavia sp.	0.1	0.1
Bulbostylis barbata	0.1	0.1
Cleome viscosa	0.1	0.1

Corymbia hamersleyana	2	0.1
Cucumis variabilis		0.1
Cymbopogon ambiguus	0.6	1
Cyperus hesperius	0.2	0.1
Eriachne mucronata	0.4	0.1
Eucalyptus leucophloia subsp. *leucophloia*	5	1
Evolvulus alsinoides var. *villosicalyx*	0.2	0.1
Flueggea virosa subsp. *melanthesoides*	2	0.2
Gomphrena cunninghamii	0.1	0.1
Gossypium australe	1	0.1
Indigofera monophylla	0.6	0.1
Indigofera trita subsp. *trita*	0.4	0.2
Nicotiana benthamiana	0.1	0.1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Polycarpaea longiflora	0.1	0.1
Polygala glaucifolia	0.1	0.1
Senna glutinosa subsp. *glutinosa*	0.8	0.1
Solanum cleistogamum	0.2	0.1
Solanum phlomoides	0.1	0.1
Terminalia circumalata	5	1
Tribulus suberosus	0.6	0.1
Triodia brizoides	0.4	85
Triodia wiseana	0.6	0.5

PHOTO

Site Name:	MCK008
Site Type:	QUADRAT
Dimensions:	250m x 10m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727940.17207985E 7663688.84477209N
Vegetation Type:	2
Landform Type:	Drainage Line
Slope Class:	Moderately Inclined (10 degrees)
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Granite, 10-20% bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Ficus brachypoda*, *Terminalia circumalata*
Upper Stratum 2:	*Acacia tumida* var. *pilbarensis*, *Ehretia saligna* var. *saligna*
Lower Stratum 1:	*Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia coriacea subsp. *pendens*	0.3	0.1
Acacia tumida var. *pilbarensis*	5	2
Bulbostylis barbata	0.1	0.1
Cheilanthes sieberi subsp. *sieberi*	0.2	0.1
Cleome viscosa	0.3	0.1
Clerodendrum tomentosum var. *tomentosum*	1.3	0.1
Cymbopogon ambiguus	0.3	0.1
Cyperus hesperius	0.2	0.1
Cyperus pulchellus	0.3	0.1
Ehretia saligna var. *saligna*	6	0.5
Eragrostis cumingii	0.1	0.1
Eriachne ciliata	0.2	0.2

Eriachne mucronata	0.3	0.1
Ficus brachypoda	4	1
Fimbristylis microcarya	0.2	0.1
Lipocarpha microcephala	0.1	0.1
Ludwigia perennis		0.1
Oldenlandia galioides	0.1	0.1
Solanum diversiflorum	0.2	0.1
Tephrosia virens	1	0.1
Terminalia circumalata	4.5	15
Tinospora smilacina		0.1
Trachymene oleracea subsp. *oleracea*	0.1	0.1
Triodia epactia	0.4	3

PHOTO

Site Name:	MCK009
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	14/05/2019
GPS Location:	GDA94 Zone 50 727700.26E 7665344.07N
Vegetation Type:	1
Landform Type:	Upper Slope, low undulating hills (other)
Slope Class:	Steep (23 degrees)
Aspect:	SW
Soil Type:	Sandy Loam
Soil Colour:	Brown
Rock Outcrop:	Dolerite, 10-20% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Dolerite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia inaequilatera*
Lower Stratum 1:	*Triodia wiseana, Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	1.8	0.1
Acacia inaequilatera	3	0.4
Bonamia pilbarensis	0.1	0.1
Corchorus parviflorus	0.7	0.1
Corymbia hamersleyana	2	0.1
Hakea lorea subsp. *lorea*	1.5	0.1
Polygala glaucifolia	0.1	0.1
Senna glutinosa subsp. *glutinosa*	0.8	0.1
Solanum phlomoides	0.3	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.1	0.1
Triodia brizoides	0.4	5
Triodia wiseana	0.5	85

PHOTO

Site Name:	MCK010
Site Type:	QUADRAT
Dimensions:	100m x 25m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 727635.03E 7664660.73N
Vegetation Type:	7
Landform Type:	Drainage Line, Creek banks and bed (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Ironstone, Calcrete (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>8 years

DOMINANT TAXA IN VEGETATION STRATA

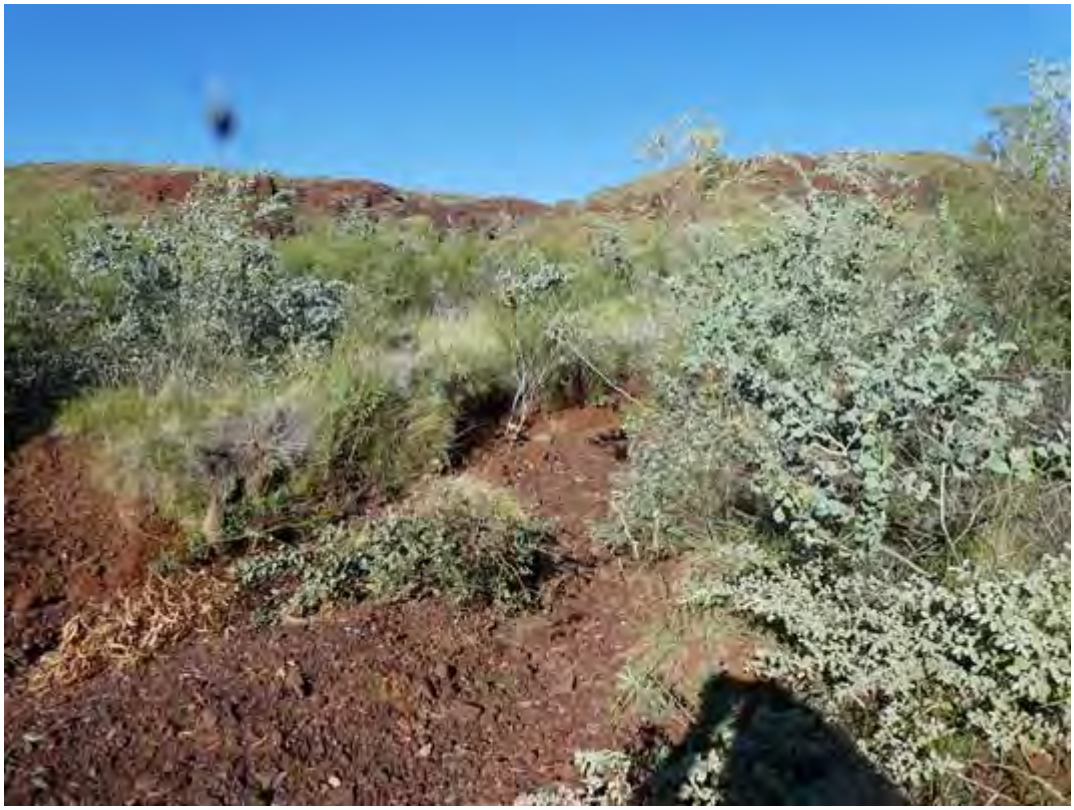
Upper Stratum 1:	*Corymbia hamersleyana*
Mid Stratum 1:	*Acacia pyrifolia* var. *pyrifolia*, *Petalostylis labicheoides*
Lower Stratum 1:	*Corchorus parviflorus*, *Indigofera monophylla*, *Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Abutilon lepidum		0.1
Acacia acradenia	4.5	0.2
Acacia pyrifolia var. *pyrifolia*	3.5	25
Acacia tumida var. *pilbarensis*	5	0.5
Atalaya hemiglauca	2.8	0.2
Boerhavia coccinea	0.1	0.1
Bulbostylis barbata	0.1	0.1
Cleome viscosa	0.5	0.1
Corchorus parviflorus	0.4	15
Corymbia hamersleyana	5.5	1
Cucumis melo	0.1	0.1
Cymbopogon ambiguus	0.3	0.1
Cyperus hesperius	0.4	0.1

Dampiera candicans	0.1	0.1
Eriachne mucronata	0.3	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Euphorbia australis var. *subtomentosa*	0.1	0.1
Euphorbia careyi	0.2	0.1
Euphorbia tannensis subsp. *eremophila*	0.1	0.1
Fimbristylis simulans	0.1	0.1
Gomphrena cunninghamii	0.1	0.1
Goodenia stobbsiana	0.3	0.1
Gossypium australe	1.5	0.1
Grevillea wickhamii subsp. *hispidula*	2.5	0.2
Hibiscus sturtii var. *campylochlamys*	0.4	0.1
Hybanthus aurantiacus	0.1	0.1
Indigofera monophylla	0.5	1
Isotropis atropurpurea	0.5	0.1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Paspalidium clementii	0.1	0.1
Petalostylis labicheoides	2.8	20
Phyllanthus maderaspatensis	0.5	0.1
Polycarpaea corymbosa	0.1	0.1
Polycarpaea holtzei	0.1	0.1
Polycarpaea longiflora	0.1	0.1
Ptilotus astrolasius	0.2	0.1
Ptilotus calostachyus	0.4	0.1
Senna artemisioides subsp. *oligophylla*	1.8	0.1
Senna glutinosa subsp. *glutinosa*	1.4	0.1
Solanum horridum	0.2	0.1
Solanum phlomoides	0.6	0.1
Tephrosia rosea var. *clementii*	0.7	0.5
Trachymene oleracea subsp. *oleracea*	0.1	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.2	0.1
Trigastrotheca molluginea	0.2	0.1
Triodia epactia	0.3	12
Triumfetta propinqua	0.5	0.2
Waltheria virgata	0.6	0.2

PHOTO



Site Name:	MCK011
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 726604.4E 7664195.44N
Vegetation Type:	4
Landform Type:	Crest
Slope Class:	Gently Inclined (3 degrees)
Aspect:	SW
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Ironstone
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia tumida* var. *pilbarensis*
Lower Stratum 1:	*Acacia ptychophylla*
Lower Stratum 2:	*Triodia basitricha*, *Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia inaequilatera	2	0.1
Acacia ptychophylla	0.6	1.5
Acacia tumida var. *pilbarensis*	2.5	1
Bonamia pilbarensis	0.1	0.1
Bulbostylis barbata	0.1	0.1
Corchorus parviflorus	1	0.1
Dampiera candicans	0.4	0.2
Eriachne pulchella subsp. *dominii*	0.1	0.1
Fimbristylis simulans	0.1	0.1
Goodenia stobbsiana	0.5	0.1
Grevillea wickhamii subsp. *hispidula*	2.2	0.5
Ptilotus astrolasius	0.6	0.1

Ptilotus calostachyus	1	0.1
Seringia nephrosperma	0.9	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.3	0.1
Solanum phlomoides	0.7	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia basitricha (P3)	0.4	10
Triodia epactia	0.5	65
Triumfetta maconochieana	0.2	0.1
Triumfetta propinqua	0.5	0.1

PHOTO

Site Name:	MCK012
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 727503.56E 7664713.37N
Vegetation Type:	1
Landform Type:	Upper Slope
Slope Class:	Moderately Inclined (10 degrees)
Aspect:	S
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Dolerite, 2-10% bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Dolerite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

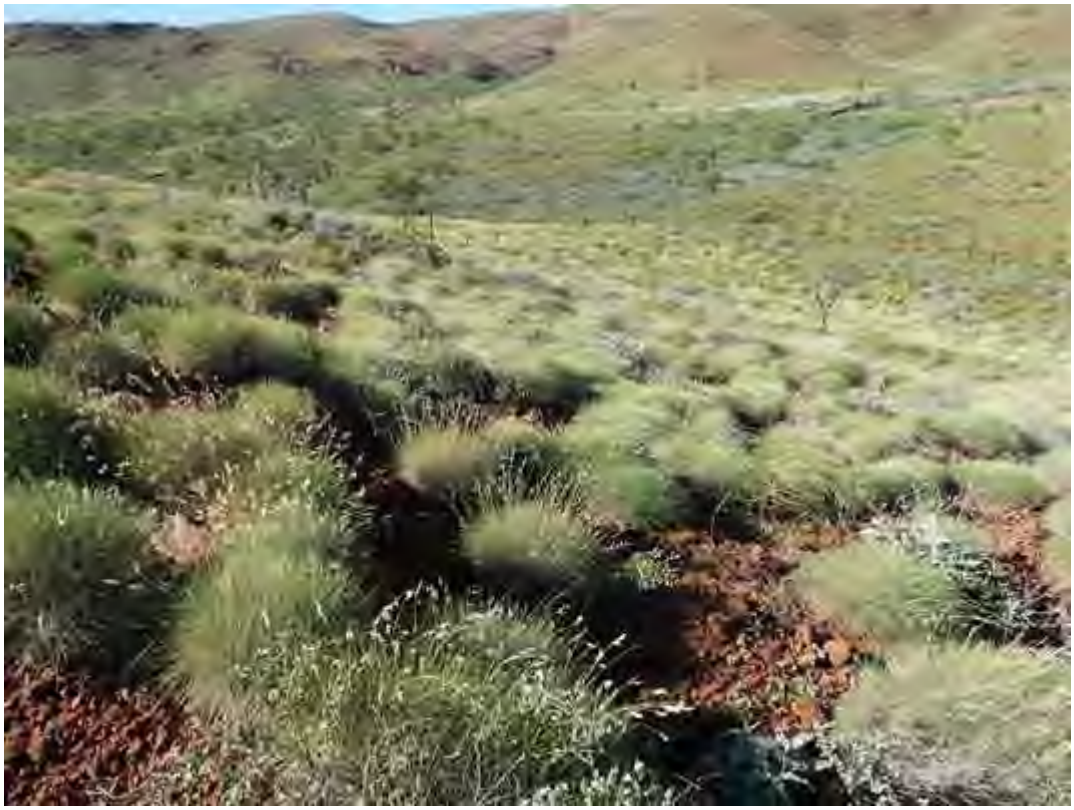
Upper Stratum 1:	*Corymbia hamersleyana*
Mid Stratum 1:	*Acacia inaequilatera*
Mid Stratum 2:	*Hakea lorea* subsp. *lorea*
Lower Stratum 1:	*Corchorus parviflorus*, *Indigofera monophylla*, *Triodia brizoides*
Lower Stratum 2:	*Triodia wiseana*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Abutilon lepidum	0.1	0.1
Acacia acradenia	0.4	0.1
Acacia bivenosa	0.5	0.1
Acacia inaequilatera	4.5	0.5
Acacia ptychophylla	0.6	0.1
Acacia pyrifolia var. *pyrifolia*	0.5	0.1
Acacia spondylophylla	0.4	0.1
Boerhavia gardneri	0.2	0.8
Cleome viscosa	0.1	0.1

Clerodendrum tomentosum var. *lanceolatum*	0.1	0.1
Corchorus parviflorus	1	1
Corymbia hamersleyana	4	0.2
Eriachne sp. Dugald River (B.K. Simon+ 3007)	0.1	0.1
Euphorbia tannensis subsp. *eremophila*	0.8	0.1
Fimbristylis dichotoma	0.1	0.1
Gomphrena cunninghamii	0.1	0.1
Goodenia muelleriana	0.1	0.1
Grevillea wickhamii subsp. *hispidula*	0.4	0.1
Hakea lorea subsp. *lorea*	3	0.3
Heliotropium skeleton	0.1	0.1
Hybanthus aurantiacus	0.2	0.1
Indigofera monophylla	0.4	1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Oldenlandia crouchiana	0.1	0.1
Polycarpaea longiflora	0.2	0.1
Polygala glaucifolia	0.1	0.1
Ptilotus astrolasius	0.5	0.1
Ptilotus calostachyus	0.5	0.1
Rhynchosia minima	0.1	0.1
Senna glutinosa subsp. *glutinosa*	1.5	0.1
Solanum phlomoides	0.5	0.1
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	0.1	0.1
Trachymene oleracea subsp. *oleracea*	0.1	0.1
Tribulus suberosus	0.2	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.1	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia brizoides	0.3	30
Triodia epactia	0.3	0.1
Triodia wiseana	0.5	10
Triumfetta clementii	0.4	0.1
Triumfetta propinqua	0.2	0.1

PHOTO



Site Name:	MCK013
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 725902.2E 7664039.15N
Vegetation Type:	4
Landform Type:	Crest
Slope Class:	Gently Inclined (3 degrees)
Aspect:	W
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Ironstone, <2% bedrock exposed
CF Abundance:	>90%
CF Sizes:	60-200mm
CF Types:	Ironstone
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* subsp. *hispidula*
Mid Stratum 2:	*Petalostylis labicheoides*
Lower Stratum 1:	*Acacia ptychophylla*
Lower Stratum 2:	*Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia inaequilatera	2	0.1
Acacia ptychophylla	0.7	0.5
Acacia tumida var. *pilbarensis*	3	2
Bonamia pilbarensis	0.1	0.1
Dampiera candicans	0.7	0.1
Fimbristylis simulans	0.1	0.1
Grevillea wickhamii subsp. *hispidula*	2.5	0.2
Petalostylis labicheoides	1.6	0.5
Ptilotus calostachyus	0.6	0.1
Solanum phlomoides	0.8	0.1

Tephrosia virens	0.8	0.1
Triodia basitricha (P3)	0.4	0.5
Triodia epactia	0.6	90

PHOTO

Site Name:	MCK014
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 728404.19832606E 7664860.87808114N
Vegetation Type:	1
Landform Type:	Upper Slope, Mid and lower slope too (other)
Slope Class:	Very Steep (37 degrees)
Aspect:	N
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Calcrete (other), 2-10% bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm
CF Types:	Granite, Calcrete (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus leucophloia* subsp. *leucophloia*
Mid Stratum 1:	*Acacia orthocarpa*
Lower Stratum 1:	*Triodia brizoides*
Lower Stratum 2:	*Indigofera monophylla*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	0.7	0.1
Acacia inaequilatera	2.2	1
Acacia orthocarpa	3.5	1.5
Boerhavia gardneri	0.2	0.1
Bonamia aff. *pilbarensis*	0.1	0.1
Clerodendrum tomentosum var. *lanceolatum*	0.8	0.1
Corchorus parviflorus	0.4	0.1
Corymbia hamersleyana	0.5	0.1
Cymbopogon ambiguus	0.4	0.1

Eriachne mucronata	0.1	0.1
Eucalyptus leucophloia subsp. *leucophloia*	5	0.5
Euphorbia tannensis subsp. *eremophila*	0.7	0.1
Fimbristylis microcarya	0.1	0.1
Grevillea wickhamii subsp. *hispidula*	2.2	0.1
Heliotropium skeleton	0.3	0.1
Hibiscus coatesii	0.3	0.1
Hybanthus aurantiacus	0.1	0.1
Indigofera monophylla	0.4	0.2
Ptilotus calostachyus	0.4	0.1
Senna artemisioides subsp. *oligophylla*	0.4	0.1
Senna glutinosa subsp. *glutinosa*	0.6	0.1
Senna glutinosa subsp. *pruinosa*	0.4	0.1
Sida sp. Articulation below (A.A. Mitchell PRP 1605)	0.4	0.1
Solanum phlomoides	0.3	0.1
Tephrosia virens	0.8	0.1
Tribulus suberosus	0.7	0.1
Triodia brizoides	0.4	45
Triodia wiseana	0.4	0.2

PHOTO

Site Name:	MCK015
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 727139.45E 7663812.18N
Vegetation Type:	1
Landform Type:	Mid Slope
Slope Class:	Very Steep (37 degrees)
Aspect:	S
Soil Type:	Sandy Loam
Soil Colour:	Brown
Rock Outcrop:	Granite, 2-10% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus leucophloia* subsp. *leucophloia*
Lower Stratum 1:	*Acacia hilliana*
Lower Stratum 2:	*Triodia brizoides*, *Triodia epactia*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	2	0.1
Acacia hilliana	0.6	1.5
Acacia tumida var. *pilbarensis*	3	0.2
Corchorus parviflorus	0.4	0.1
Corymbia hamersleyana	0.5	0.1
Dampiera candicans	0.2	0.1
Dodonaea coriacea	0.7	0.1
Eriachne mucronata	0.4	0.1
Eucalyptus leucophloia subsp. *leucophloia*	5	1.5
Goodenia stobbsiana	0.3	0.1
Grevillea wickhamii subsp. *hispidula*	2.2	0.1
Indigofera monophylla	0.8	0.1

Oldenlandia crouchiana	0.1	0.1
Polygala glaucifolia	0.1	0.1
Senna glutinosa subsp. *glutinosa*	1	0.1
Solanum phlomoides	0.5	0.1
Triodia brizoides	0.3	45
Triodia epactia	0.4	50

PHOTO

Site Name:	MCK016
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 727500.39E 7666832.17N
Vegetation Type:	10
Landform Type:	Mid Slope, crest and slope of low rise on plain (other)
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	NW
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	Granite, <2% bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia inaequilatera*
Lower Stratum 1:	*Corchorus parviflorus, Indigofera monophylla, Senna glutinosa* subsp. *glutinosa*
Lower Stratum 2:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia inaequilatera	3.5	0.4
Acacia trachycarpa	1.2	0.1
Boerhavia coccinea	0.2	0.1
Boerhavia gardneri	0.2	0.1
Bulbostylis barbata	0.1	0.1
Cleome viscosa	0.2	0.1
Corchorus parviflorus	0.6	0.2
Enneapogon caerulescens	0.1	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Euphorbia australis var. *subtomentosa*	0.1	0.1
Euphorbia clementii (P3)	0.2	0.1
Gomphrena cunninghamii	0.1	0.1

Goodenia muelleriana	0.1	0.1
Heliotropium heteranthum	0.1	0.1
Heliotropium tenuifolium	0.1	0.1
Indigofera monophylla	0.3	0.2
Iseilema dolichotrichum	0.1	0.1
Portulaca oleracea	0.1	0.1
Ptilotus astrolasius	0.2	0.1
Ptilotus auriculifolius	0.1	0.1
Ptilotus calostachyus	0.7	0.1
Senna glutinosa subsp. *glutinosa*	1.9	0.2
Senna glutinosa subsp. *pruinosa*	0.7	0.1
Senna notabilis	0.1	0.1
Senna symonii	1.3	0.1
Solanum phlomoides	0.8	0.1
Sporobolus australasicus	0.2	0.1
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	0.1	0.1
Tribulus hirsutus	0.1	0.1
Trigastrotheca molluginea	0.2	0.1
Triodia brizoides	0.4	50
Triodia longiceps	0.4	0.5
Triodia wiseana	0.4	0.3

PHOTO

Site Name:	MCK017
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 726876.44E 7665357.4N
Vegetation Type:	1
Landform Type:	Crest
Soil Type:	Sandy Loam
Soil Colour:	Brown
Rock Outcrop:	Quartz (other), >50% bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm, 200-600mm, 600-2000mm
CF Types:	Granite, Quartz (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Terminalia circumalata*
Mid Stratum 1:	*Gossypium australe*
Lower Stratum 1:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia coriacea subsp. *pendens*	1	0.1
Acacia inaequilatera	2	0.1
Amaranthus undulatus	0.1	0.1
Atalaya hemiglauca	1.3	0.1
Bonamia pilbarensis	0.1	0.1
Bulbostylis barbata	0.1	0.1
**Cenchrus ciliaris*	0.4	0.1
Cleome viscosa	0.1	0.1
Clerodendrum tomentosum var. *lanceolatum*	0.1	0.1
Corymbia hamersleyana	1.3	0.1
Cucumis variabilis		0.1
Cymbopogon ambiguus	0.5	0.1
Cyperus hesperius	0.3	0.1

Dampiera candicans	0.3	0.1
Dichrostachys spicata	1.5	0.1
Ehretia saligna var. *saligna*	1.5	0.1
Eriachne mucronata	0.4	0.1
Ficus brachypoda	4	0.7
Flueggea virosa subsp. *melanthesoides*	0.5	0.1
Gomphrena cunninghamii	0.1	0.1
Gossypium australe	0.7	0.2
Grevillea wickhamii subsp. *hispidula*	1.5	0.1
Hakea lorea subsp. *lorea*	0.8	0.1
Hibiscus goldsworthii	1	0.1
Indigofera trita subsp. *trita*	0.3	0.1
Polycarpaea holtzei	0.1	0.1
Solanum cleistogamum	0.1	0.1
Solanum phlomoides	0.9	0.1
Tephrosia sp. B Kimberley Flora (C.A. Gardner 7300)	0.6	0.1
Terminalia circumalata	4	3
Tinospora smilacina		0.1
Tribulus suberosus	1	0.1
Triodia brizoides	0.4	50

PHOTO

Site Name:	MCK018
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	16/05/2019
GPS Location:	GDA94 Zone 50 738525.13E 7680656.14N
Vegetation Type:	10
Landform Type:	Plain
Slope Class:	Level (0 degrees)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	2-10%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	(other) - Cattle tracks
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia ancistrocarpa*, *Acacia inaequilatera*
Lower Stratum 1:	*Triodia lanigera*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia ancistrocarpa	2.5	3
Acacia bivenosa	2.3	1
Acacia inaequilatera	3.5	1
Cleome uncifera subsp. *uncifera*	0.2	0.1
Goodenia microptera	0.2	0.1
Goodenia stobbsiana	0.2	0.1
Indigofera monophylla	0.4	0.1
Ptilotus astrolasius	0.3	0.1
Ptilotus calostachyus	0.4	0.1
Senna symonii	1.5	0.1
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	0.4	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia lanigera	0.8	60

PHOTO

Site Name:	MCK019
Site Type:	QUADRAT
Dimensions:	25m x 100m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 727098.43E 7665439.52N
Vegetation Type:	5
Landform Type:	Drainage Line
Aspect:	NNW
Soil Type:	Sandy Loam
Soil Colour:	Brown
Rock Outcrop:	No bedrock exposed
CF Abundance:	50-90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	river stone (other)
Vegetation Condition:	Northern Vegetation Condition - G - Good
Disturbance:	Grazing, Exotic Weeds
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Eucalyptus victrix*
Mid Stratum 1:	*Acacia trachycarpa*, *Melaleuca glomerata*, *Melaleuca linophylla*
Lower Stratum 1:	*Triodia epactia*
Lower Stratum 2:	**Cenchrus ciliaris*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia coriacea subsp. *pendens*	4.5	0.5
Acacia pyrifolia var. *pyrifolia*	2.1	0.1
Acacia trachycarpa	4	1
**Aerva javanica*	0.2	0.1
Amaranthus undulatus	0.1	0.1
Atalaya hemiglauca	3.5	0.5
Boerhavia sp.	0.1	0.1
Bulbostylis barbata	0.1	0.1
**Cenchrus ciliaris*	0.5	10
**Cenchrus setiger*	0.5	0.5
Cleome viscosa	0.4	0.1
Corchorus parviflorus	0.5	0.1

Crotalaria cunninghamii	0.1	0.1
Cucumis variabilis	0.1	0.1
Cullen leucanthum	0.1	0.1
Cymbopogon ambiguus	1.2	0.1
Cyperus vaginatus	0.4	0.1
Dactyloctenium radulans	0.1	0.1
Dysphania rhadinostachya subsp. *rhadinostachya*	0.1	0.1
Eragrostis tenellula	0.1	0.1
Eriachne tenuiculmis	0.4	0.5
Eucalyptus victrix	8	10
Euphorbia australis var. *subtomentosa*	0.1	0.1
Euphorbia trigonosperma	0.2	0.1
**Flaveria trinervia*	0.1	0.1
Flueggea virosa subsp. *melanthesoides*	2.5	0.5
Grevillea wickhamii subsp. *hispidula*	3	0.1
Heliotropium tenuifolium	0.1	0.1
Hybanthus aurantiacus	0.1	0.1
Indigofera linifolia	0.1	0.1
Indigofera trita subsp. *trita*	0.1	0.1
Melaleuca glomerata	3.5	1
Melaleuca linophylla	3.5	1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Oldenlandia crouchiana	0.1	0.1
Operculina aequisepala		0.1
Petalostylis labicheoides	0.7	0.1
Phyllanthus erwinii	0.1	0.1
Phyllanthus maderaspatensis	0.2	0.1
Polymeria ambigua	0.1	0.1
Portulaca oleracea	0.1	0.1
Rhynchosia minima		0.1
Sesbania cannabina	0.1	0.1
**Setaria verticillata*	0.2	0.1
Solanum diversiflorum	0.1	0.1
Sporobolus australasicus	0.1	0.1
Stemodia grossa	0.1	0.1
Swainsona formosa	0.1	0.1
Tephrosia rosea var. *clementii*	0.2	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.1	0.1
Triodia epactia	0.5	0.5
Waltheria indica	0.2	0.1

PHOTO

Site Name:	MCK020
Site Type:	QUADRAT
Dimensions:	15m x 166m
Survey Date:	16/05/2019
GPS Location:	GDA94 Zone 50 737302.69E 7680315.41N
Vegetation Type:	7
Landform Type:	Other, minor flow line (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	0%
Vegetation Condition:	Northern Vegetation Condition - VG - Very Good
Disturbance:	Grazing
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Corymbia flavescens*
Upper Stratum 2:	*Corymbia hamersleyana*
Mid Stratum 1:	*Acacia inaequilatera*, *Acacia tumida* var. *pilbarensis*
Mid Stratum 2:	*Acacia ancistrocarpa*
Lower Stratum 1:	*Corchorus parviflorus*, *Indigofera monophylla*
Lower Stratum 2:	*Chrysopogon fallax*, *Polymeria ambigua*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia ancistrocarpa	3	3
Acacia colei var. *colei*	1.6	3
Acacia inaequilatera	2.5	1
Acacia stellaticeps	0.4	0.1
Acacia tumida var. *pilbarensis*	4.5	20
Alternanthera nana	0.2	0.1
Aristida holathera var. *holathera*	0.4	0.1
Bonamia erecta	0.2	0.1
Bonamia pannosa	0.1	0.1
Bulbostylis barbata	0.1	0.1
Carissa lanceolata	0.3	6.5
**Cenchrus ciliaris*	0.4	0.1

Chrysopogon fallax	1	4
Corchorus parviflorus	0.4	1
Corymbia flavescens	11	1.5
Corymbia hamersleyana	6	20
Crotalaria medicaginea var. *neglecta*	0.1	0.1
Dichanthium sericeum subsp. *humilius*	0.1	0.1
Eragrostis cumingii	0.1	0.1
Eriachne obtusa	2.2	0.1
Eulalia aurea	1.4	1
Euphorbia biconvexa	0.2	0.1
Evolvulus alsinoides var. *villosicalyx*	0.1	0.1
Ficus aculeata var. *indecora*	2	0.1
Goodenia microptera	0.2	0.1
Goodenia muelleriana	0.1	0.1
Goodenia nuda (P4)	0.3	0.1
Grevillea pyramidalis subsp. *leucadendron*	1.6	0.1
Hakea lorea subsp. *lorea*	2.1	0.1
Hibiscus sturtii var. *campylochlamys*	0.2	0.1
Hybanthus aurantiacus	0.4	0.1
Indigofera monophylla	0.4	2
Indigofera trita subsp. *trita*	0.4	0.1
Isotropis atropurpurea	0.3	0.1
Marsilea hirsuta	0.1	0.1
Neptunia dimorphantha	0.2	0.1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Phyllanthus maderaspatensis	0.1	0.1
Pluchea tetranthera	0.4	0.1
Polymeria ambigua	0.2	5
Polymeria sp.	0.1	0.1
Rhynchosia minima	0.1	0.1
Scaevola amblyanthera var. *centralis*	0.3	0.1
Senna glutinosa subsp. *glutinosa*	1.1	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.4	0.1
Sporobolus australasicus	0.1	0.1
Tephrosia rosea var. *clementii*	0.6	0.5
Tephrosia supina	0.3	0.1
Themeda triandra	0.5	0.1
Trichodesma zeylanicum var. ?*zeylanicum*	0.1	0.1
Triodia epactia	0.5	1
Triodia longiceps	0.8	0.1
Waltheria indica	0.3	0.1

PHOTO

Site Name:	MCK021
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 726618.95E 7666613.01N
Vegetation Type:	7
Landform Type:	Other, undulating plain (other)
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	NW
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Granite, Ironstone, Quartz (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Corymbia hamersleyana*
Mid Stratum 1:	*Acacia acradenia*, *Acacia inaequilatera*, *Acacia tumida* var. *pilbarensis*
Lower Stratum 1:	*Triodia brizoides*

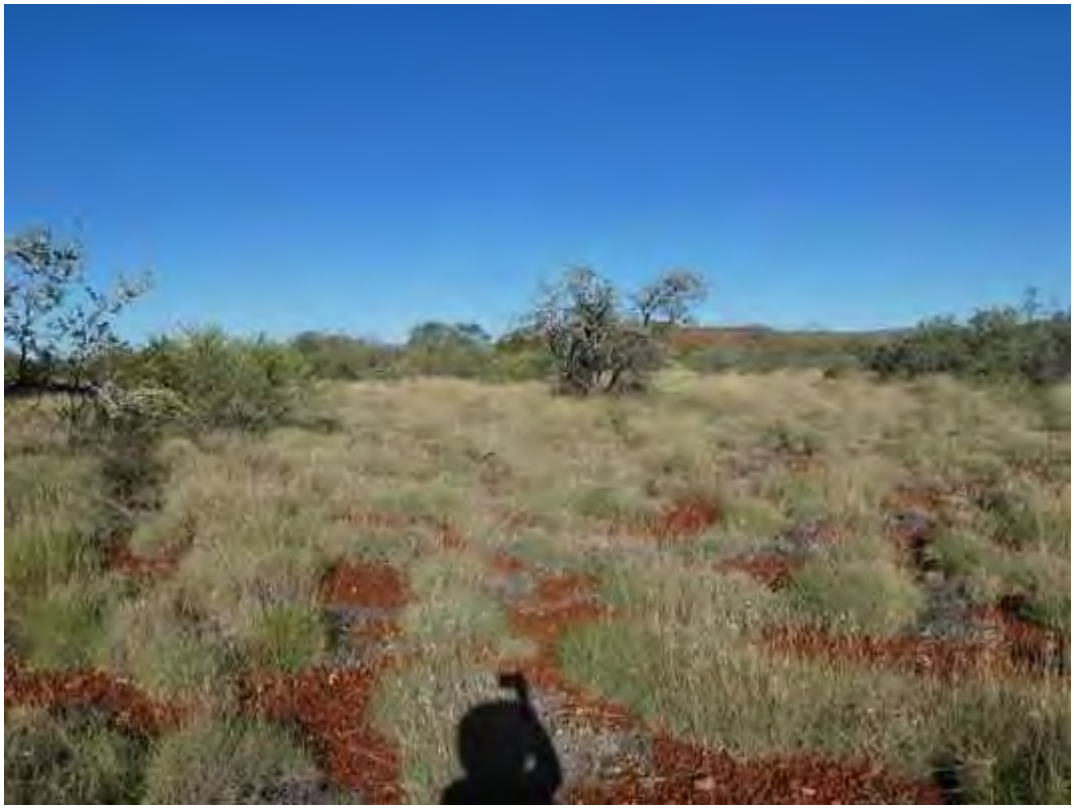
SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	2	3
Acacia ancistrocarpa	1.8	0.1
Acacia bivenosa	2	1
Acacia inaequilatera	3.5	0.5
Acacia synchronicia	1.5	0.1
Acacia tumida var. *pilbarensis*	3	1
Aristida holathera var. *holathera*	0.4	0.1
Bonamia erecta	0.3	0.1
Bonamia pannosa	0.1	0.1
Bonamia pilbarensis	0.1	0.1
Bulbostylis barbata	0.1	0.1
Chrysopogon fallax	0.4	0.1

Cleome uncifera subsp. *uncifera*	0.3	0.1
Cleome viscosa	0.2	0.1
Corchorus parviflorus	0.6	0.1
Corymbia hamersleyana	6	0.5
Cucumis variabilis	0.1	0.1
Dichanthium sericeum subsp. *humilius*	0.2	0.1
Eriachne obtusa	0.1	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Euphorbia clementii (P3)	0.1	0.1
Goodenia lamprosperma	0.4	0.1
Goodenia microptera	0.3	0.1
Goodenia muelleriana	0.1	0.1
Goodenia stobbsiana	0.3	0.1
Gossypium australe	1	0.1
Heliotropium skeleton	0.3	0.1
Heliotropium tenuifolium	0.1	0.1
Hibiscus sturtii var. *campylochlamys*	0.4	0.1
Indigofera monophylla	0.1	0.1
Notoleptopus decaisnei var. *decaisnei*	0.1	0.1
Paraneurachne muelleri	0.3	0.1
Paspalidium clementii	0.1	0.1
Petalostylis labicheoides	2	0.1
Pluchea dentex	0.6	0.1
Pluchea tetranthera	0.7	0.1
Polycarpaea holtzei	0.1	0.1
Pterocaulon ?sphaeranthoides	0.6	0.1
Ptilotus astrolasius	0.3	0.1
Ptilotus calostachyus	0.7	0.1
Senna glutinosa subsp. *glutinosa*	2	0.1
Senna notabilis	0.1	0.1
Sida echinocarpa	0.5	0.1
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.7	0.1
Solanum diversiflorum	0.2	0.1
Solanum phlomoides	0.4	0.1
Sporobolus australasicus	0.1	0.1
Tephrosia clementii	0.1	0.1
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	0.1	0.1
Tribulus hirsutus	0.1	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia brizoides	0.4	80
Triodia epactia	0.5	1
Triodia lanigera	0.5	0.1
Triumfetta clementii	0.1	0.1

Yakirra australiensis var. *australiensis*	0.1	0.1

PHOTO



Site Name:	MCK022
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	16/05/2019
GPS Location:	GDA94 Zone 50 737358.09E 7679874.57N
Vegetation Type:	10
Landform Type:	Other, low stoney rise on plain (other)
Slope Class:	Very Gently Inclined (1 degree)
Soil Type:	Sandy Clay Loam
Soil Colour:	Red-Brown (other)
Rock Outcrop:	No bedrock exposed
CF Abundance:	20-50%
CF Sizes:	2-6mm, 6-20mm, 20-60mm
CF Types:	Ironstone, Quartz (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>10 Years

DOMINANT TAXA IN VEGETATION STRATA

Upper Stratum 1:	*Acacia ancistrocarpa*, *Acacia inaequilatera*
Mid Stratum 1:	*Indigofera monophylla*
Lower Stratum 1:	*Triodia brizoides*, *Triodia lanigera*
Lower Stratum 2:	*Goodenia stobbsiana*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia ancistrocarpa	2.2	0.5
Acacia inaequilatera	3	1
Bonamia aff. *pilbarensis*	0.1	0.1
Cassytha capillaris		0.1
Cleome uncifera subsp. *uncifera*	0.3	0.1
Corchorus parviflorus	0.3	0.1
Eriachne obtusa	0.2	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Euphorbia tannensis subsp. *eremophila*	0.6	0.1
Goodenia stobbsiana	0.3	0.2
Grevillea wickhamii subsp. *hispidula*	2.5	0.3
Indigofera monophylla	0.6	0.3

Paraneurachne muelleri	0.5	0.1
Ptilotus astrolasius	0.4	0.1
Ptilotus calostachyus	0.4	0.1
Senna symonii	0.8	0.1
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	0.3	0.1
Tephrosia sp. NW Eremaean (S. van Leeuwen et al. PBS 0356)	0.3	0.1
Trigastrotheca molluginea	0.2	0.1
Triodia brizoides	0.4	30
Triodia epactia	0.4	1
Triodia lanigera	0.5	7

PHOTO

Site Name:	MCK023
Site Type:	QUADRAT
Dimensions:	50m x 50m
Survey Date:	15/05/2019
GPS Location:	GDA94 Zone 50 726708.56E 7666538.24N
Vegetation Type:	12
Landform Type:	Other, Low rise (other)
Slope Class:	Very Gently Inclined (1 degree)
Aspect:	N
Soil Type:	Sandy Clay Loam
Soil Colour:	Red
Rock Outcrop:	No bedrock exposed
CF Abundance:	>90%
CF Sizes:	2-6mm, 6-20mm, 20-60mm, 60-200mm
CF Types:	Granite, Ironstone, Quartz (other)
Vegetation Condition:	Northern Vegetation Condition - E - Excellent
Disturbance:	None
Fire:	>5 Years

DOMINANT TAXA IN VEGETATION STRATA

Mid Stratum 1:	*Acacia inaequilatera*
Lower Stratum 1:	*Triodia brizoides*

SPECIES LIST

Taxon Name	Av. Ht (m)	Cover (%)
Acacia acradenia	1.5	0.1
Acacia inaequilatera	3	0.5
Bulbostylis barbata	0.1	0.1
Eriachne pulchella subsp. *dominii*	0.1	0.1
Goodenia stobbsiana	0.2	0.1
Grevillea wickhamii subsp. *hispidula*	3	0.1
Heliotropium heteranthum	0.1	0.1
Polygala glaucifolia	0.1	0.1
Ptilotus calostachyus	0.3	0.1
Tephrosia clementii	0.3	0.1
Trigastrotheca molluginea	0.1	0.1
Triodia brizoides	0.7	95
Triodia epactia	0.8	0.1

Triodia lanigera	0.6	0.5

PHOTO