Biota Environmental Sciences

Brockman Syncline 4 Marra Mamba Vegetation and Flora Survey

Prepared for Rio Tinto Pty Ltd

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1.0 Introduction

1.1 Project Background

Rio Tinto Pty Ltd (Rio Tinto) is conducting a series of baseline biological surveys at future development sites to provide early identification of environmental constraints and potential approvals issues. As part of this initiative, Biota Environmental Sciences (Biota) was commissioned in August 2012 to conduct a vegetation and flora survey of portions of the Marra Mamba deposit, which is located 49 km west-northwest of Tom Price, 20 km south of the Brockman 2 operational mine and 5 km south and east of the Brockman Syncline 4 (BS4) operational mine (Figure 1.1).

The current survey of the Marra Mamba deposit includes four sections, as shown on Figure 1.1. The surveyed Marra Mamba deposit covers a total area of 943 ha. Collectively, these surveyed areas are hereafter referred to as the study area. Previous surveys conducted in close proximity to the study area are indicated in Figure 1.2.

1.2 Scope of the Study and Purpose of this Report

Biota was commissioned to undertake a baseline botanical survey of the BS4 Marra Mamba study area in order to collate information suitable for a future Environmental Impact Assessment (EIA) of any future development project. This report presents the results obtained during a botanical survey of the study area in 2012.

The primary objectives of the baseline botanical survey were to:

- undertake a Level 2 vegetation and flora survey consistent with the WA Environmental Protection Authority (EPA) Guidance Statement 51 (EPA 2004) and EPA Position Statement No 3 (EPA 2002);
- describe and map the vegetation types occurring within the study area;
- document the flora assemblage of the study area using accepted sampling techniques, including quadrat-based floristic sampling; and
- assess local and regional significance of vegetation types and flora species within the study area, including discussion of any Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs), and Threatened or Priority flora (see Appendix 1).

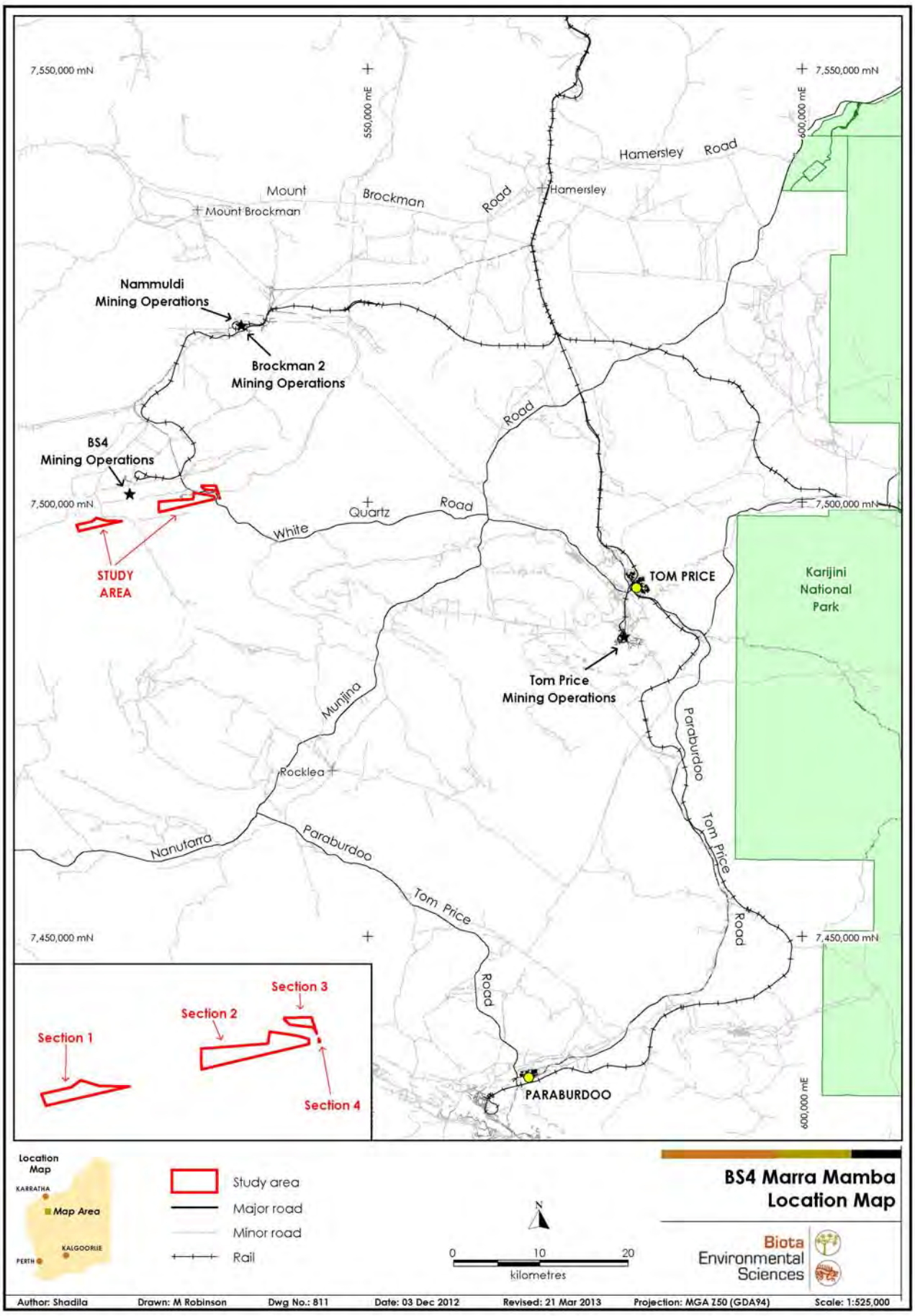

Figure 1.1: Location of the Marra Mamba study area.

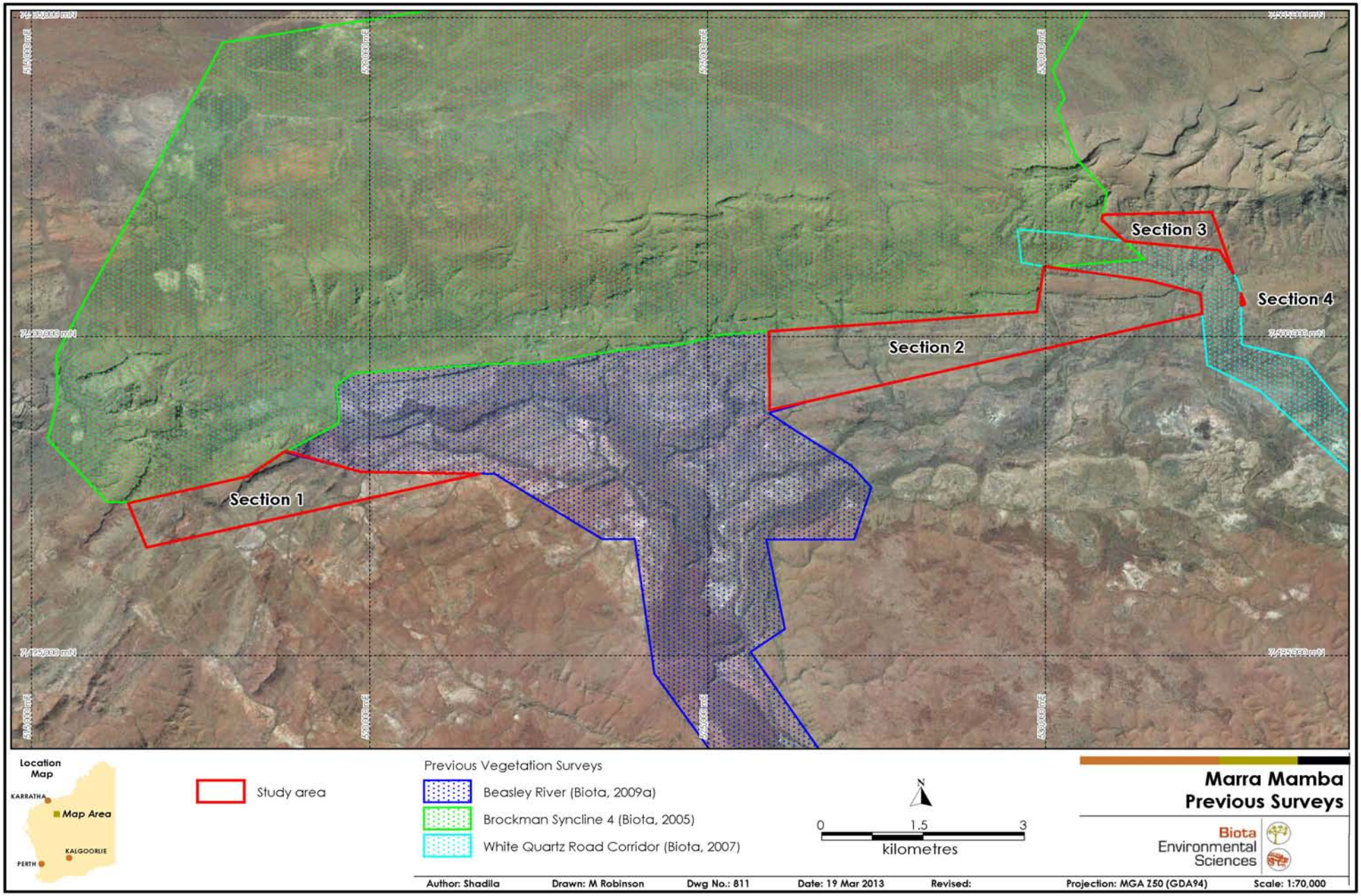

Figure 1.2: Location of previous surveys conducted in the Marra Mamba area.

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2.0 Methodology

2.1 Database Searches

A search of the Department of Environment and Conservation (DEC) NatureMap Database was conducted (DEC and WAM 2012). The search area comprised the central point of the study area buffered by a distance of 40 km. Existing flora and vegetation reports from the local area were also reviewed. The information derived from these sources was used for comparison with data collected during the field survey.

2.2 Field Survey

2.2.1 Survey Team and Timing

The field survey was conducted between 30 August and 4 September 2012 by six botanists from Biota: Rachel Butler, Preeti Chukowry, Ciaran Gibson, Louis de Kock, Scott Werner and Dr Shadila Venkatasamy. A total of 36 person days were spent on the field component of the study.

2.2.2 Seasonal Conditions

Although rainfall in January 2012 was considerably higher than average (Figure 2.1), the area received only 105.8 mm of rain during the six months preceding the survey (March – August 2012) (Bureau of Meteorology 2012)[1]. This is below the long-term average of 138 mm (1974 – 2012)[1] for the same monthly period (Bureau of Meteorology 2012). As a result, conditions at the time of the field survey were slightly drier than would normally be expected for that time of year, and thus did not represent an optimal period for the collection of annual and cryptic perennial species.

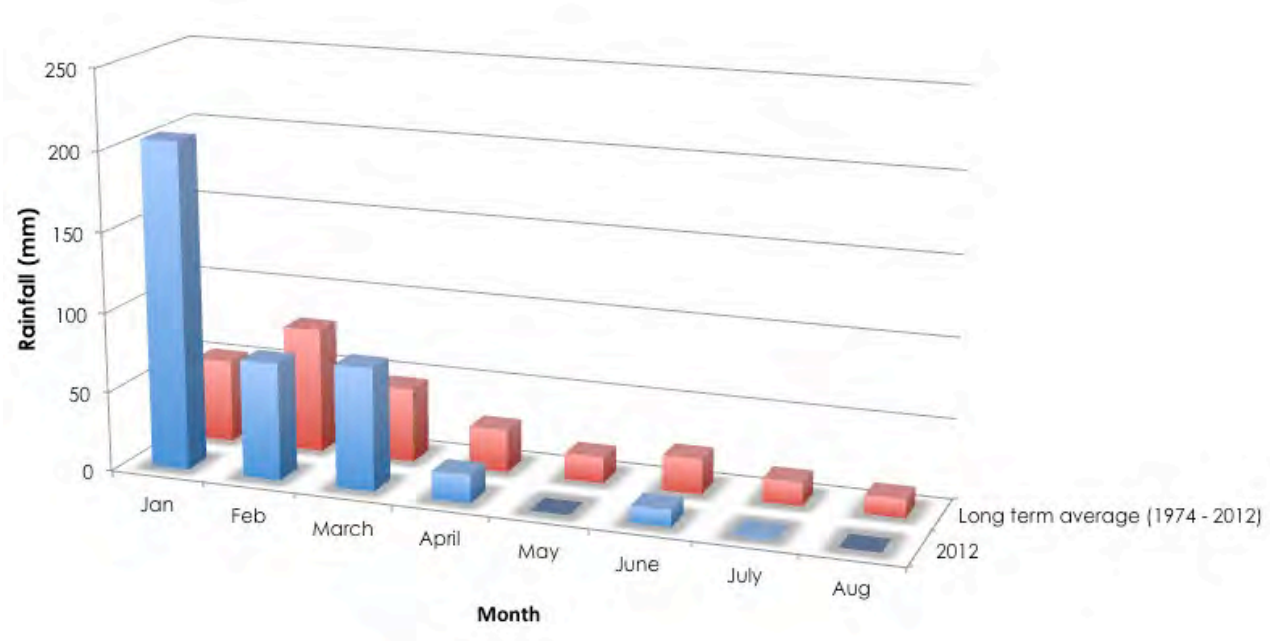

Figure 2.1: Monthly rainfall recorded at Bureau of Meteorology weather station no. 007185 at Paraburdoo for 2012 and the long-term average (1974-2012) for the same station.
(Data sourced from http://www.bom.gov.au/climate/data.)

[1] Data for Bureau of Meteorology weather station no. 007185 at Paraburdoo. This is the closest weather recording station to the study area with a complete data set for rainfall.

2.2.3 Assessment of Floristic Quadrats

During the course of the study, 31 floristic survey quadrats were established in representative habitats and vegetation types through the study area. The quadrats were 2,500 m^2 in area, typically 50 m by 50 m. This size has been demonstrated to be adequately large to sample species presence in the Pilbara, while still small enough to fit within most uniform vegetation types.

The quadrats were permanently marked using steel fence droppers at all four corners. Optical squares and measuring tapes were used to correctly position the quadrat sides. A photograph representing the vegetation at each quadrat was taken.

The following parameters were recorded for all quadrats:

- Location: AMG coordinates (WGS84 datum, zone 50K; ±5 m) were recorded at all four corners using a handheld Global Positioning System (GPS).
- Vegetation Description: Broad description based on the height and estimated cover value of dominant species after Aplin's (1979) modification of the vegetation classification system of Specht (1970) (see Appendix 2).
- Habitat: Description of landform and habitat.
- Soil: Broad description of soil type and stony surface mantle.
- Disturbance Details: Condition ranked according to the scale developed by Trudgen (1988) as shown in Appendix 2.
- Percentage Foliar Cover: Cover values were visually estimated as a percentage for each species.

A summary of all quadrat data is provided in Appendix 3.

2.2.4 Vegetation Description and Mapping

Vegetation types identified from aerial photography were ground-truthed during foot traverses through the study area. The boundaries of the four sections of the study area were loaded onto hand-held GPS units to ensure that the targeted areas were traversed.

Descriptions were recorded for each vegetation type observed in the field. Vegetation descriptions were based on the height and estimated cover value of dominant species using Aplin's (1979) modification of the vegetation classification of Specht (1970).

Descriptions were made for each quadrat (see Section 2.2.3), and were also recorded as mapping notes during foot traverses. Mapping notes were sampling sites conducted over an area of smaller scale than a quadrat; these notes were typically brief, with only dominant and commonly associated species being recorded. Mapping notes were taken primarily during foot traverses of the area with the objective of detecting boundaries and changes in vegetation types. Typical information recorded at a mapping note location included notes on the habitat, landscape and vegetation type, usually with a representative photograph and often with opportunistic specimen collections to supplement the species list.

Similar vegetation descriptions from quadrats and mapping notes were grouped to establish the vegetation types for the study area. Vegetation descriptions that shared a suite of perennial species with a similar range of cover values were considered to be alike.

Each vegetation type was given a short alphanumeric code for simplicity, comprising a letter denoting the broad landform (H for hills and slopes; P for plains; D for drainage lines and floodplains), followed by a number sequence. This coding is used to refer to the vegetation types throughout this report, including on vegetation maps and the map legend (Appendix 4). To allow ease of comparison with other studies, each vegetation type was also assigned a longer alphabetic code, comprising a string of mixed capital and lowercase letters representing the dominant species of the tallest stratum to the lowest stratum. The abbreviation comprised the first

letter (or in some cases two or three letters to ensure a unique code) from each of the genus and species names (for example: *Acacia xiphophylla* = Ax; *Themeda triandra* = THt). Both codes and a full description for each unit are presented in Section 4.1.

Vegetation types were first drafted in the field onto hard-copy maps, using the most recent aerial imagery available. Boundaries were drawn around types and later verified using the field data and digital imagery. The maps were created and consolidated using GIS software (Quantum GIS, ArcView and MapInfo), and point locations of conservation significant flora and weeds were added. All maps in this report were produced using the MapInfo package (version 11).

2.2.5 Rare Flora Searches

No specific targeted rare flora searches were performed as part of this survey. Foot traverses were carried out as part of the vegetation mapping exercise and to gain access to quadrat locations. These provided the opportunity for opportunistic recording of species, but did not represent a blanket coverage of the area. The species listing presented as part of this report is intended to be indicative of the flora of the area and should not be considered to be comprehensive.

2.2.6 Specimen Identification, Nomenclature and Data Entry

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and assigned a unique number to facilitate tracking of data. These were pressed in the field, and dried using heaters. These voucher specimens were identified by using flora keys, consulting appropriate publications, checking voucher reference collections, and comparing the specimens to the collections held at the WA Herbarium.

Biota botanists identified most specimens, the majority of which were confirmed by Michi Maier. A Pilbara flora expert, Mr Malcolm Trudgen of M.E. Trudgen and Associates, was consulted for the more complex plant identifications, including but not limited to taxa within the Euphorbiaceae and Malvaceae families. In addition, Chenopodiaceae expert Paul Wilson from the WA Herbarium also confirmed the *Atriplex codonocarpa* specimen, and is currently examining specimens of *Sclerolaena* for final determination.

Nomenclature was checked against the current listing of scientific names recognised by the WA Herbarium and updated as necessary. The only out-dated nomenclature retained was that relating to *Cassia*. This genus is currently recognised as *Senna* (see Randell 1989) by the WA Herbarium. Biota has continued to use the older *Cassia* classification by Symon (1966), perceiving it to be a more realistic level of separation of the taxa. The older *Cassia* classification distinguished the taxa at a specific rather than sub-specific level; for example, *Cassia helmsii* is currently recognised as *Senna artemisioides* subsp. *helmsii.* A more detailed discussion is provided in Trudgen and Casson (1998). A comparison of nomenclature under the two classifications is presented in Appendix 5.

2.3 Limitations of this Study

Some limitations of the field survey are discussed below; these are factors that must be considered when reviewing and applying the results of this study. Despite the limitations, the survey is believed to give a reasonable representation of the flora and vegetation of the study area.

- A number of vegetation units were described solely using mapping notes. Whilst it is always the intention to establish at least two quadrats in each vegetation unit, this is often difficult to achieve. This was the case for the current study area, which was small in size, comprised of a number of very small vegetation units, and involved only one field survey. Replication of quadrat sampling in vegetation units may be addressed if a second phase of sampling is conducted.

- While foot traverses and quadrat sampling were conducted throughout the study area, no systematic searches were conducted for Threatened and Priority flora or introduced flora. The final species list should therefore be taken as indicative rather than exhaustive.
- Even though conditions during the survey were adequate for the collection of ephemeral flora and cryptic perennial species, some species may not have been present or identifiable at the time of survey.
- Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically sampled, as is typical for surveys of this nature.

3.0 Existing Environment

3.1 IBRA Bioregion and Subregion

3.1.1 Pilbara Bioregion

The study area lies within the Pilbara bioregion, one of 89 bioregions defined by the Interim Biographic Regionalisation for Australia (IBRA) (DSEWPaC 2012).

The Pilbara bioregion is divided into four subregions:

- Chichester (PIL1): Archaean granite and basalt plains supporting shrub steppes *of Acacia pyrifolia* over *Triodia pungens* hummock grasses, with Snappy Gum (*Eucalyptus leucophloia*) steppes occurring on the ranges;
- Fortescue Plains (PIL2): alluvial plains and river frontages with salt marsh, Mulga-bunch grass and short grass communities on alluvial plains and River Gum (*Eucalyptus camaldulensis*) woodlands fringing drainage lines;
- Hamersley (PIL3): mountainous area of Proterozoic ranges and plateaus with low Mulga (*Acacia aneura*) woodland over bunch grasses on fine textured soils, and Snappy Gum over *Triodia brizoides* on the skeletal sandy soils of the ranges; and
- Roebourne Plains (PIL4): quaternary alluvial plains with a grass savanna and shrub steppe of *Acacia translucens* over *Triodia pungens* and marine alluvial flats with samphire, *Sporobolus* and Mangal.

The study area is located towards the centre of the Hamersley subregion (see Kendrick 2003).

3.2 Conservation Reserves in the Locality

The main conservation reserve in the locality, and also the closest to the study area, is Karijini National Park, located within 100 km to the east.

3.3 Land Systems

Land systems mapping covering the study area has been prepared by Agriculture Western Australia (Van Vreeswyk et al. 2004). Land systems are comprised of repeating patterns of topography, soils and vegetation (Christian and Stewart 1953) (i.e. a series of "land units" that occur on characteristic physiographic units within the land system).

The land systems mapping for WA was primarily carried out to provide descriptions and locations of the biophysical resources of WA. The description of each land system includes an evaluation of soils and vegetation condition, particularly susceptibility to erosion, fire effects and degradation by livestock[2]. The mapping provides an indication of the spatial extent of each land system and identifies systems with a small representation, which are most likely to support restricted vegetation units.

A total of 105 land systems have been identified and mapped in the Pilbara bioregion[3], with 63 land systems occurring in the Hamersley subregion. The study area intersects four of these

[2] These evaluations, particularly susceptibility to erosion, are a general indication only and will vary depending on the underlying landform.

[3] This information was obtained by merging the Ashburton land system mapping (Payne et al. 1988) and Pilbara land system mapping (Van Vreeswyk et al. 2004) and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView (v. 3.2).

(Newman, Platform, Robe and Rocklea), as summarised in Table 3.1. All of these land systems are relatively extensive in terms of their area within the Pilbara bioregion.

The distribution of the land systems in the locality is illustrated in Figure 3.1. Lower slopes and minor stony plains of the Rocklea land system dominate the majority of the study area, comprising most of Section 1 and Section 2. The Newman land system covers ridges located in the north of Section 1, northeast of Section 2, north and south of Section 3, and north of Section 4. Buttes of the Robe land system occur in the centre of Section 2 and the south of Section 4. The Platform land system, which includes dissected slopes and raised plains, covers the majority of the southern part of Section 3.

3.4 Beard's Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a scale of 1:1,000,000. The study area is located on the Hamersley Plateau, which is within the Fortescue Botanical District of the Eremaean Botanical Province as defined by Beard. The vegetation of this province is typically open, and frequently dominated by spinifex, wattles and occasional Eucalypts.

The study area occurs within a single unit mapped by Beard (see Figure 3.2):

- Hamersley 567: This unit comprises Mulga (*Acacia aneura*) and Kanji (*Acacia pyrifolia*) open shrubland over Soft Spinifex (*Triodia pungens*) and Buck Spinifex (*T. basedowii*) open hummock grassland.

Given the broad nature of Beard's mapping, this unit is only broadly applicable to the vegetation occurring within the study area.

3.5 Significant Vegetation Communities Known from the Locality

TECs are described by the DEC as biological assemblages occurring in a particular habitat, which are under threat of modification or destruction from various processes (DEC 2012a). TECs listed by the DEC are conservation significant at the State level and are protected as Environmentally Sensitive Areas under the *Environmental Protection Act 1986*.

Eighteen of the 69 TECs listed in Western Australia are also nationally recognised and listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act),* but these do not include the two TECs described from the Pilbara bioregion (DEC 2012a).

PECs are biological (flora and fauna) communities that are recognised to be of significance, but do not meet the criteria for a TEC (DEC 2012b). There are five categories of PECs, none of which are protected under legislation. The framework for ranking communities of conservation significance in WA is presented in Appendix 1.

None of the described TECs or PECs occur within or in the vicinity of the study area.

Table 3.1: Land systems intersected by the study area (Payne et al. 1988, van Vreeswyk et al. 2004).

Land System	Description	Total Area of Land System in the Pilbara Bioregion (ha)	Area of Land System within the Study Area (ha)	Percentage of Land System Mapped for the Bioregion that Occurs in the Study Area (%)
Newman (RGENEW)	Rugged jaspilite plateaus, ridges and mountains supporting hard spinifex grasslands. Component landforms include plateaus, ridges, mountains and hills (70%), lower slopes (20%), stony plains (5%), and narrow drainage floors with channels (5%).	1,458,000	86.7	0.006
Platform (RGEPLA)	Dissected slopes and raised plains supporting hard spinifex grasslands. Component landforms include stony upper plains (25%), dissected slopes (60%), and drainage floors (15%).	157,000	44.2	0.028
Robe (RGEROB)	Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands. Component landforms include low plateaus, mesas and buttes (60%), lower slopes (20%), gravelly plains (15%), and drainage floors and channels (5%).	128,859	39.2	0.030
Rocklea (RGEROC)	Basalt hills, plateaus, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft spinifex) grasslands. Component landforms include hills, ridges, plateaus and upper slopes (65%), lower slopes (15%), stony plains and interfluves (10%), gilgai plains (1%), upper drainage lines (4%), and drainage floors and channels (5%).	2,881,200	772.7	0.027

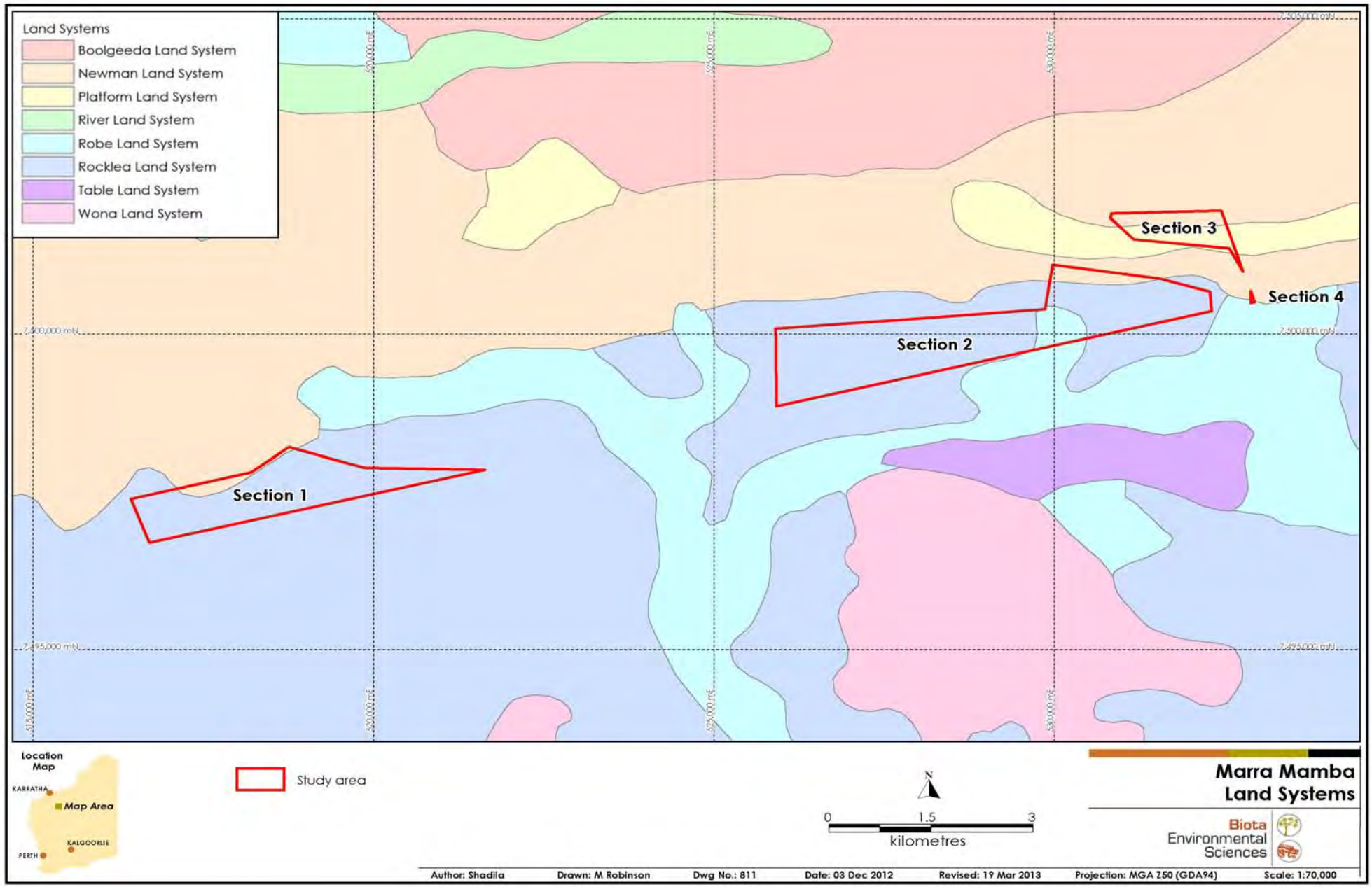

Figure 3.1: Land systems in the locality including the study area.

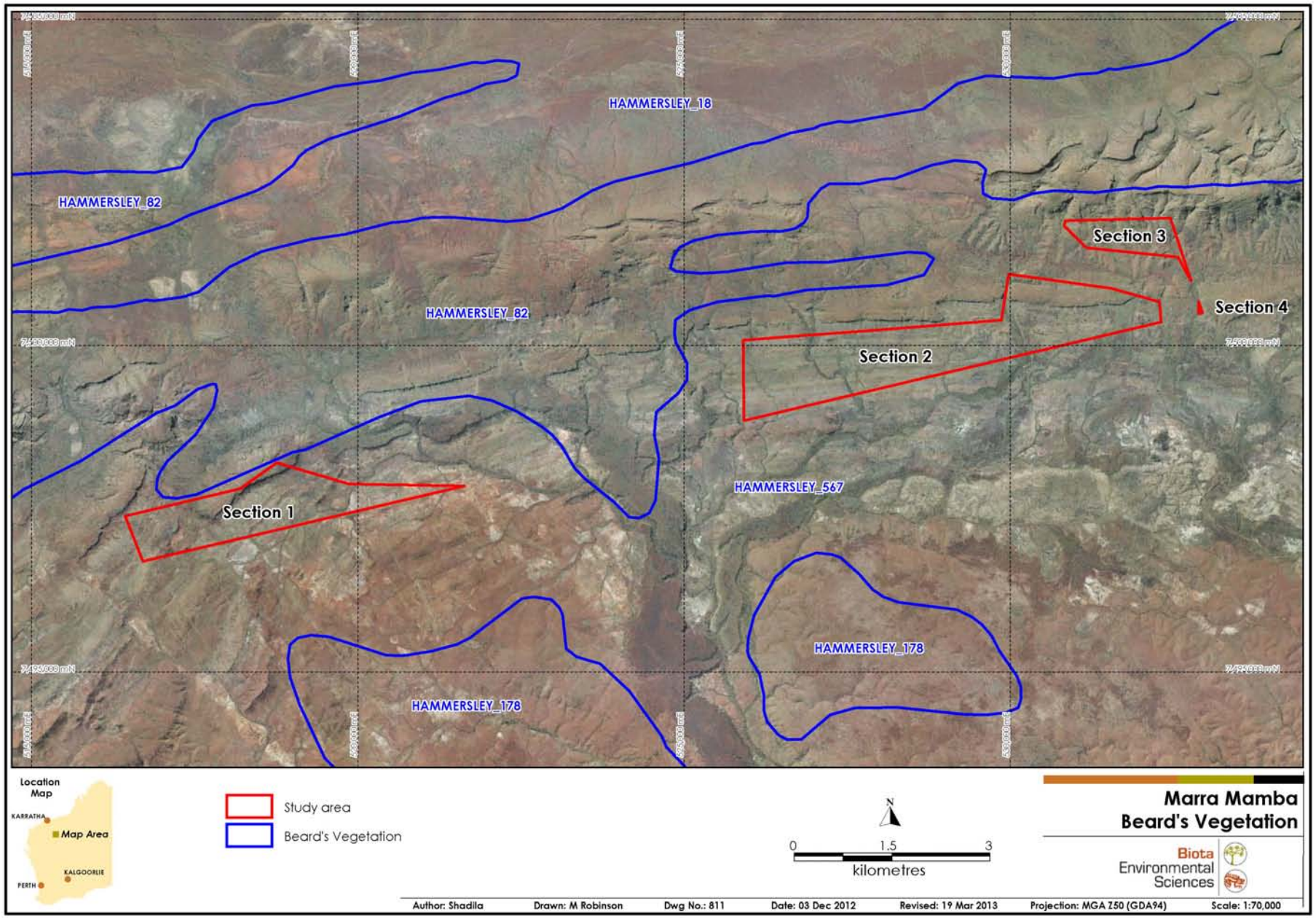

Figure 3.2: Vegetation units mapped by Beard (1975) for the locality including the study area.

3.6 Significant Flora Species Known from the Locality

The framework under which significant species are classified in WA is provided in Appendix 1.

3.6.1 Threatened Flora

Three Threatened Flora species (*Lepidium catapycnon*, *Thryptomene wittweri* and *Aluta quadrata*) are known from the Pilbara bioregion. *Lepidium catapycnon* and *Thryptomene wittweri* are listed as Threatened flora under the Commonwealth *EPBC Act* as well as the WA *Wildlife Conservation Act 1950* . *Aluta quadrata* has only recently been listed (State of Western Australia 2012) and is currently only recognised as Threatened under the *Wildlife Conservation Act 1950.*

These species are described briefly below:

- *Lepidium catapycnon* (Hamersley Lepidium) is a woody perennial herb or low shrub occurring mainly on hillsides in skeletal soils. It typically occurs in hummock grasslands on low stony hills and occasionally stony plains. This relatively short-lived shrub species is often recorded from areas that have been recently disturbed, apparently persisting for only a few years. Now known from a number of locations in the Hamersley Range, *Lepidium catapycnon* extends broadly from Tom Price across to Newman. This species has not been recorded by Biota within 40 km of the study area, however it has been listed as occurring according to the Nature Map Database search results[4] (DEC and WAM 2012). Although there is suitable habitat for this species in the study area, it has not been recorded previously in the Brockman locality, despite intensive rare flora searches (see Table 3.2).
- *Thryptomene wittweri* is a spreading, perennial shrub occurring in skeletal stony soils on breakaways and in drainage channels, typically high in the landscape on mountains of greater than 1,000 m elevation. *Thryptomene wittweri* has not been previously recorded within 40 km of the study area, and there is no suitable habitat for this species in the study area.
- *Aluta quadrata* is a perennial shrub occurring mainly in rocky gullies, although it sometimes extends down along the creeklines draining the gullies, or out onto the adjacent ridge slopes and crests. This species is currently thought to be restricted to the southern flanks of the range of hills surrounding Paraburdoo, where it occurs over an east-west range of approximately 40 km. *Aluta quadrata* has not been previously recorded within 40 km of the study area, and there is no suitable habitat for this species in the study area. Given this and the restricted distribution of this species, it would not occur in the study area.

3.6.2 Priority Flora

Based on the database searches and literature reviews conducted for this study, a total of 27 Priority flora species have been recorded in the locality of the study area (i.e. within 40 km). In addition, one species of interest (*Josephinia* sp.) has been found in the locality (see Section 3.6.3). A brief description of each of these species and the corresponding survey/data source from which they were recorded is provided in Table 3.2.

Of the 27 Priority species, two have been recorded from the study area (*Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) and *Ptilotus subspinescens*), while another species is considered likely to occur (*Rostellularia adscendens* var. *latifolia*) (see Section 5.4). A further eight Priority flora species could possibly occur in the study area, as potentially suitable habitat is present (see Table 3.2). The remaining 16 Priority species are considered unlikely or would not occur in the study area, as there is limited or no suitable habitat.

[4] There is no spatial data for this record.

3.6.3 Other Flora of Interest

Josephinia is an ephemeral species that germinates quickly and has a very short reproductive cycle. This has contributed to a lack of knowledge regarding the taxonomic diversity within the genus. Currently three entities are listed as occurring in the Pilbara (DEC 2012c), only one of which is formally described; *Josephinia eugeniae, Josephinia* sp. Mt Edgar Station (N.T. Burbidge 1194) and the Priority 1 species *Josephinia* sp. Marandoo (M.E. Trudgen 1554). It is likely that there are other additional undescribed entities in this genus, and considerable work is required to determine the taxonomic relationships for this group. One location of *Josephinia* was recorded (Biota 2007) within 40 km of the study area. The specimen was not identified to species level, however it may be of conservation significance. It is unlikely that any species of *Josephinia* would be present in the study area, as suitable habitat is not considered to be present.

Table 3.2: Priority flora species previously recorded from the Marra Mamba locality.

Species	Habit	Habitat	Source of Record										Likelihood of Occurrence within Study Area
			NatureMap	(Biota 2005)	(Biota 2007)	(Biota 2009a)	(Biota 2009b)	(Biota 2010a)	(Biota 2010b)	(Biota 2011)	(Biota 2012a)	(Biota 2012b)	
Threatened													
Lepidium catapycnon	Perennial herb or shrub.	Skeletal soils on stony plains and hill slopes.	✔										Unlikely; only a small amount of suitable habitat (stony hills) in the study area; not previously recorded in the Brockman locality despite intensive rare flora searches; nearest known populations are at Tom Price.
Priority 1													
Brachyscome sp. Wanna Munna Flats (S. van Leeuwen 4662)	Annual herb.	Clayey plains, usually in Mulga woodland.	✔										Unlikely; Mulga woodland present in the study area does not occur on clayey plains.
Goodenia pedicellata	Single-stemmed perennial herb.	Rocky clayey soils; rocky slopes and crests of small hills.	✔										Possible; rocky slopes and crests of small hills in study area may comprise suitable habitat.
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)	Small tree or shrub.	Steep, rocky hill slopes, often with Mulga.									✔		Known to occur.
Hibiscus sp. Mt Brockman (E. Thoma ET 1354)	Erect spindly shrub.	Range crests and slopes.	✔								✔		Unlikely; no particularly suitable habitat.
Sida sp. Hamersley Range (K. Newbey 10692)	Low shrub.	Skeletal stony soils; rocky hills, breakaways.	✔				✔						Possible; rocky hills and breakaways in the stud area may contain suitable habitat.
Priority 2													
Gompholobium karijini	Erect shrub.	Ironstone gravel, Robe Pisolite, on tall hills.	✔										Would not occur; no suitable habitat.
Spartothamnella puberula	Spindly shrub.	Rocky loam, sandy or skeletal soils, usually on hills.	✔										Possible; skeletal soils on hills in the study area may comprise suitable habitat.
Priority 3													
Astrebla lappacea	Tufted perennial grass.	Clay to clay-loam on plains.	✔						✔				Would not occur; no suitable habitat.
Dampiera anonyma	Low perennial shrub.	Skeletal soils over banded ironstone; hill summits, slopes (above 1000 m).	✔								✔	✔	Would not occur; no suitable habitat.
Eremophila magnifica subsp. *velutina*	Shrub.	Skeletal soils over ironstone on tall hills and breakaways.	✔							✔		✔	Would not occur; no suitable habitat.
Glycine falcata	Perennial herb.	Occurs mainly on clay along drainages and on plains.	✔										Would not occur; no suitable habitat.
Goodenia sp. East Pilbara (A.A. Mitchell PRP 727)	Annual to biennial herb.	Low undulating plains, calcrete.	✔							✔		✔	Unlikely; no particularly suitable habitat.
Iotasperma sessilifolium	Erect herb.	Cracking clay, black loam; edges of waterholes, plains.	✔										Would not occur; no suitable habitat.
Indigofera sp. Bungaroo Creek (S. van Leeuwen 4301)	Low to medium shrub.	Drainage lines.	✔			✔		✔			✔	✔	Possible; drainage lines in the study area may comprise suitable habitat.
Nicotiana umbratica	Erect, short-lived annual or perennial herb.	Shallow soils, rock outcrops, riverbeds.	✔									✔	Possible; rocky outcrops and riverbeds in the study area may comprise suitable habitat.
Oldenlandia sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading, annual herb.	Cracking clay.				✔							Would not occur; no suitable habitat.
Ptilotus subspinescens	Low shrub.	Stony plains and gentle rocky scree slopes with a calcareous substrate; semi-saline colluvial plains.	✔	✔	✔	✔					✔	✔	Known to occur.
Rhagodia sp. Hamersley Station (M. Trudgen 17794)	Shrub.	Under Mulga, usually on clay plains.	✔										Unlikely; no suitable clay plains habitat.
Rostellularia adscendens var. latifolia	Herb or low shrub.	Various; creeks, rocky hills, calcrete.			✔						✔		Likely; drainage lines in particular may comprise suitable habitat.
Sida sp. Barlee Range (S. van Leeuwen 1642)	Low spreading shrub.	Skeletal soils on steep rocky slopes.	✔				✔	✔		✔	✔	✔	Would not occur; no suitable habitat.
Swainsona sp. Hamersley Station (A.A. Mitchell 196)	Prostrate annual, herb.	Crab-holed clay plains.	✔										Would not occur; no suitable habitat.
Themeda sp. Hamersley Station (M.E. Trudgen 11431)	Annual tussock grass.	Clay pans, grass plains.	✔										Would not occur; no suitable habitat.
Priority 4													
Acacia bromilowiana	Tree or shrub.	Skeletal loamy soils on rocky hills, breakaways, scree slopes, gorges and associated creek beds.	✔						✔		✔		Possible; skeletal soils on rocky hills in the study area may comprise suitable habitat.
Goodenia nuda	Herb.	Clay loam to clay soils, particularly in drainage areas.	✔									✔	Unlikely; no particularly suitable habitat.
Eremophila magnifica subsp. *magnifica*	Shrub.	Rocky slopes of tall hills, breakaways.		✔			✔				✔	✔	Would not occur; no suitable habitat.

Species	Habit	Habitat	Source of Record										Likelihood of Occurrence within Study Area
			NatureMap	(Biota 2005)	(Biota 2007)	(Biota 2009a)	(Biota 2009b)	(Biota 2010a)	(Biota 2010b)	(Biota 2011)	(Biota 2012a)	(Biota 2012b)	
Ptilotus mollis	Compact perennial shrub.	Stony hills and screes.	✔								✔		Possible; stony hills and screes in the study area may comprise suitable habitat.
Ptilotus trichocephalus	Prostrate herb.	Sandy soils, colluvial plains.	✔			✔							Possible; colluvial plains in the study area may comprise suitable habitat.
Species of Interest													
Josephinia sp.	Small, upright ephemeral herb.	Plains, often with Mulga.			✔								Unlikely; no particularly suitable habitat.

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4.0 Vegetation of the Study Area

4.1 Description of Vegetation Types

Thirty-five vegetation types were described for the study area. These were described at approximately the sub-association level (Level VI as per the National Vegetation Information System (NVIS)[5]). Table 4.1 shows the area that each vegetation type occupies within the study area.

Table 4.1: Area of each vegetation type in the study area.

Mapping Unit / Vegetation Sub-Association	Area (ha)	Proportion of Study Area (%)
Vegetation of Hills and Slopes		
H1: ElAprAatTw	22.05	2.34
H2: ElAexAprTw	63.13	6.70
H3: AanAprTe	0.15	0.02
H4: AanGtTbrTlo	0.71	0.08
H5: AanTbrTe	1.19	0.13
H6: AanTaTe	1.6	0.17
H7: AanTbr	0.09	0.01
H8: ElAanAciGbTe	0.84	0.09
H9: ElAmAexTw	46.24	4.90
H10: ElAmTwTm	11.86	1.26
H11: ElTw	28.79	3.05
H12: ElAiTw	87.74	9.31
Vegetation of Plains		
P1: ElAiTwTeTbrTaTlo	228.79	24.27
P2: ElAiTwTbrTloTa	136.02	14.43
P3: ElTloTaTeTw	29.03	3.08
P4: ElTeTwTaTlo	86.99	9.23
P5: ElTwTloTa	61.83	6.56
P6: ElAexTloTbrTw	40.97	4.35
P7: ElAbAexTaTw	23.13	2.45
P8: ElMeTaTw	12.47	1.32
P9: AanAxTeTw	1.88	0.20
P10: AxAanTaTe	8.94	0.95
P11: AxTaTe	1.15	0.12
P12: AxTbr	0.57	0.06
P13: AxTlo	7.47	0.79
P14: EsMeTaTw	2.29	0.24
Vegetation of Drainage Lines and Floodplains		
Drainage Lines		
D1: ExAciAbPlTHtCEc	5.08	0.54
D2: ExAciPlAbTHtTe	11.79	1.25
D3: ElAciPlSsGOrTe	2.81	0.30
D4: ElAmoGOrTe	1.12	0.12
D5: AciAbTHtCEc	0.30	0.03
D6: AciPlGOrApyTe	0.63	0.07
D7: PlAmoTe	0.62	0.07
Floodplains		
D8: AtuPlApyAbTe	0.58	0.06
D9: ElAbTe	13.96	1.48

[5] For a description of the various levels of the NVIS Information Hierarchy, go to http://www.environment.gov.au/erin/nvis/publications/avam/section-2-1.html#hierarchy.

Each vegetation type is described in the following sections, grouped within the major landform unit in which it was found to occur: hills and slopes (Section 4.1.1), plains (Section 4.1.2) or drainage lines and floodplains (Section 4.1.3). The distribution of the units is indicated on the mapping in Appendix 4, while representative photographs are presented in Plate 4.1 to Plate 4.35.

Wattle taxa in the *Acacia aneura* species complex are broadly referred to by the common name of Mulga. Various species have been separated out of this complex and published, most recently by Maslin and Reid (2012). Given that even the published taxa are often difficult to separate, and as there are still unresolved taxa within this species complex, *Acacia 'aneura'* has been applied in this report in the following vegetation descriptions to refer to Mulga of any sort. More detailed information regarding the specific forms of Mulga are specified within the notes for individual vegetation types, where available.

4.1.1 Vegetation of Hills and Slopes

H1: ElAprAatTw *Eucalyptus leucophloia* scattered low trees over *Acacia pyrifolia, A. atkinsiana* tall open shrubland over *Triodia wiseana* hummock grassland

Habitat	This unit occurred on the crest of a ridge in the northern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. exilis, A. marramamba, A. pruinocarpa, A. synchronicia, Cassia pruinosa.* Low Shrubs: *Cassia helmsii, Ptilotus obovatus, P. rotundifolius, Tribulus suberosus.* Grasses: *Aristida holathera* var. *holathera, Cymbopogon ambiguus, Eriachne mucronata, E. pulchella.* Herbs: *Oldenlandia crouchiana, Polycarpaea holtzei, Pterocaulon sphacelatum.*
Vegetation condition	Excellent.
Described from	Quadrats MMF20, MMF25; mapping notes.
Photo	Plate 4.1.

H2: ElAexAprTw *Eucalyptus leucophloia* scattered low trees over *Acacia exilis, A. pruinocarpa* open shrubland over *Triodia wiseana* open hummock grassland

Habitat	This unit occurred on the crest of a ridge in the northeastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. maitlandii, A. marramamba, A. synchronicia, Cassia pruinosa.* Low Shrubs: *Goodenia stobbsiana, Indigofera monophylla, Keraudrenia nephrosperma, Ptilotus astrolasius, Solanum lasiophyllum, Tribulus suberosus.* Grasses: *Aristida holathera* var. *holathera, Eriachne mucronata* (typical form), *Paraneurachne muelleri, Schizachyrium fragile*. Herbs: *Bonamia* sp. Dampier (A.A. Mitchell PRP 217), *Oldenlandia crouchiana*.
Vegetation condition	Excellent.
Described from	Quadrats MMF15, MMF17; mapping notes.
Photo	Plate 4.2.

H3: AanAprTe *Acacia 'aneura'* woodland over *A. pyrifolia* scattered tall shrubs over *Triodia epactia* open hummock grassland

Habitat	This unit occurred on the crest of a ridge in the northwestern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia xiphophylla, A. pruinocarpa, Eremophila forrestii* subsp. *forrestii.* Low Shrubs: *Ptilotus obovatus*.
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.*? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.3.

H4: AanGtTbrTlo *Acacia 'aneura'*, *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) low open woodland over *Triodia brizoides, T. longiceps* very open hummock grassland

Habitat	This unit occurred on the slope of a hill in the western part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia marramamba, Cassia luerssenii, Eremophila forrestii subsp. forrestii, Eucalyptus leucophloia* subsp. *leucophloia.* Low Shrubs: *Goodenia stobbsiana, Hibiscus burtonii, Maireana georgei, Scaevola acacioides, Solanum horridum.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Cymbopogon ambiguus, Eriachne mucronata* (typical form).
Vegetation condition	Excellent.
Described from	Quadrat MMF23; mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.* ? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.4.

H5: AanTbrTe *Acacia 'aneura'* low open woodland over *Triodia brizoides, T. epactia* scattered hummock grasses

Habitat	This unit occurred on mesas in the southwestern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia marramamba, Cassia glutinosa, C. pruinosa, Eucalyptus leucophloia* subsp. *leucophloia, Grevillea berryana.* Low Shrubs: *Eremophila cuneifolia, Solanum lasiophyllum.* Grasses: *Aristida contorta, Cymbopogon ambiguus, Eriachne mucronata* (typical form).
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.* ? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.5.

H6: AanTaTe *Acacia 'aneura'* woodland over *Triodia angusta, T. epactia* scattered hummock grasses

Habitat	This unit occurred on a hill crest and slopes in the eastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia xiphophylla, Cassia luerssenii, Grevillea berryana.* Low Shrubs: *Eremophila cuneifolia, Maireana georgei, Ptilotus calostachyus.* Grasses: *Eriachne pulchella, Sporobolus australasicus.* Herbs: *Evolvulus alsinoides* var. *villosicalyx.*
Vegetation condition	Good.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.* ? *incurvaneura* based on Maslin and Reid (2012). Some parts of this vegetation type had been patchily burnt more than 5 years ago.
Photo	Plate 4.6.

H7: AanTbr *Acacia 'aneura'* woodland over *Triodia brizoides* very open hummock grassland

Habitat	This unit occurred in two small stands on the crests and slopes of hills in the eastern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. marramamba, Eucalyptus leucophloia* subsp. *leucophloia, Grevillea berryana.* Low Shrubs: *Goodenia stobbsiana, Ptilotus calostachyus, Solanum lasiophyllum.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Cymbopogon ambiguus, Eriachne mucronata* (typical form), *Paraneurachne muelleri.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.*? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.7.

H8: ElAanAciGbTe *Eucalyptus leucophloia, Acacia 'aneura', A. citrinoviridis, Grevillea berryana* woodland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on the mid-slope of a ridge in the eastern part of Section 3 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. marramamba, A. pruinocarpa, Eremophila forrestii* subsp. *forrestii.* Grasses: *Eriachne mucronata* (typical form).
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.*? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.8.

H9: ElAmAexTw *Eucalyptus leucophloia* scattered low trees over *Acacia maitlandii, A. exilis* open shrubland over *Triodia wiseana* hummock grassland

Habitat	This unit occurred on the upper slopes of a ridge in the northern part of Section 3 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia kempeana, A. pruinocarpa, A. sibirica, A. trudgeniana, Cassia ferraria.* Low Shrubs: *Corchorus lasiocarpus* subsp. *parvus, Indigofera monophylla, Keraudrenia nephrosperma, Ptilotus astrolasius.* Grasses: *Amphipogon sericeus, Aristida contorta, A. holathera* var. *holathera, Eriachne aristidea, E. pulchella, Triodia epactia.* Herbs: *Bonamia* sp. Dampier (A.A. Mitchell PRP 217), *Goodenia microptera*, *Peripleura virgata, Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Excellent.
Described from	Quadrats MMF05, MMF28; mapping notes.
Photo	Plate 4.9.

H10: ElAmTwTm *Eucalyptus leucophloia* scattered low trees over *Acacia maitlandii* open shrubland over *Triodia wiseana, T. melvillei* hummock grassland

Habitat	This unit occurred on the lower slopes of a ridge in the southern part of Section 3 (Appendix 4, Map 2). This was the only vegetation type in which the spinifex *Triodia melvillei* was recorded.
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. bivenosa, A. elachantha, A. marramamba, A. trudgeniana.* Low Shrubs: *Corchorus lasiocarpus* subsp. *parvus, Goodenia stobbsiana*, *Hibiscus sturtii* var. *campylochlamys, Indigofera monophylla, Keraudrenia nephrosperma.* Grasses: *Amphipogon sericeus, Aristida contorta, A. holathera* var. *holathera, Cymbopogon ambiguous, Paraneurachne muelleri.* Herbs: *Euphorbia* sp. (site 1089), *Oldenlandia crouchiana.*
Vegetation condition	Excellent.
Described from	Quadrat MMF07; mapping notes.
Photo	Plate 4.10.

H11: ElTw *Eucalyptus leucophloia* scattered low trees over *Triodia wiseana* hummock grassland

Habitat	This unit occurred mostly on the lower slopes of a ridge in Section 3. The same vegetation type was also observed on plains in the eastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. exilis, A. maitlandii, A. pruinocarpa, Corymbia hamersleyana.* Low Shrubs: *Indigofera monophylla, Scaevola spinescens, Tephrosia rosea* var. *glabrior, Tribulus suberosus.* Grasses: *Cymbopogon ambiguus, Eriachne mucronata* (typical form), *Paraneurachne muelleri*, *Themeda triandra.* Herbs: *Euphorbia alsiniflora, Pterocaulon sphacelatum.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.11.

H12: ElAiTw *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland

Habitat	This unit occurred on the low hills and rises in the central part of Section 1.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. sibirica, A. synchronicia, Corymbia hamersleyana, Hakea lorea* subsp. *lorea.* Low Shrubs: *Cassia oligophylla* x *helmsii, Corchorus* aff. *parviflorus, Solanum horridum, Tribulus suberosus.* Grasses: *Aristida contorta, Cymbopogon ambiguus, Enneapogon caerulescens, Sporobolus australasicus, Triodia angusta, T. epactia.* Herbs: *Euphorbia* sp. (FMLMC-10), *Oldenlandia crouchiana, Salsola australis, Trichodesma zeylanicum* var. *zeylanicum.*
Vegetation condition	Very Good to Excellent.
Described from	Quadrats MMF16, MMF18, MMF27, MMF29; mapping notes.
Photo	Plate 4.12.

Plate 4.1: Vegetation unit H1.

Plate 4.2: Vegetation unit H2.

Plate 4.3: Vegetation unit H3.

Plate 4.4: Vegetation unit H4.

Plate 4.5: Vegetation unit H5.

Plate 4.6: Vegetation unit H6.

Plate 4.7: Vegetation unit H7.

Plate 4.8: Vegetation unit H8.

Plate 4.9: Vegetation unit H9.

Plate 4.10: Vegetation unit H10.

Plate 4.11: Vegetation unit H11.

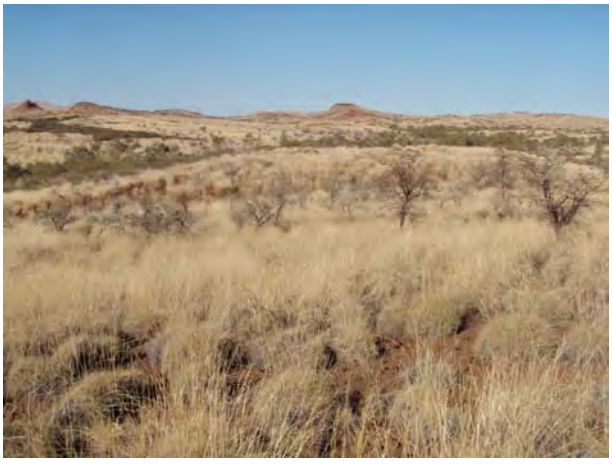

Plate 4.12: Vegetation unit H12.

4.1.2 Vegetation of Plains

P1: ElAiTwTeTbrTaTlo *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana, T. epactia, T. brizoides, T. angusta, T. longiceps* open hummock grassland

Habitat	This unit occurred broadly over the plains and undulating plains in the central part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. bivenosa, A. synchronicia, Corymbia hamersleyana, Eremophila longifolia.* Low Shrubs: *Corchorus lasiocarpus* subsp. *lasiocarpus, Indigofera monophylla, Ptilotus rotundifolius.* Grasses: *Aristida contorta, Cymbopogon ambiguus, Enneapogon caerulescens, Eragrostis eriopoda, Eriachne pulchella.* Herbs: *Cleome viscosa, Euphorbia* sp. (FMLMC-10), *Goodenia microptera, Heliotropium chrysocarpum, Oldenlandia crouchiana, Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Very Good to Excellent.
Described from	Quadrats MMF02, MMF04, MMF06, MMF09, MMF14; mapping notes.
Notes	• The dominance of the various *Triodia* species within the spinifex stratum varied considerably with location and could not be delineated separately on the mapping. *Triodia wiseana* was distributed throughout this vegetation type, and *T. epactia* was abundant near the minor and major flowlines. *Triodia brizoides* was observed on stony areas, while *T. angusta* and *T. longiceps* were found in patches on the plains. • *Acacia inaequilatera* was more numerous on the low rises in the southern part of this vegetation unit.
Photo	Plate 4.13.

P2: ElAiTwTbrTloTa *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana, T. brizoides, T. longiceps, T. angusta* open hummock grassland

Habitat	This unit occurred on plains and undulating plains in the western part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. exilis, A. maitlandii, A. synchronicia, Cassia glutinosa, C. luerssenii.* Low Shrubs: *Corchorus lasiocarpus* subsp. *lasiocarpus, Goodenia stobbsiana, Indigofera monophylla.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Cymbopogon ambiguus, Enneapogon caerulescens, Eriachne mucronata* (typical form), *Triodia epactia.* Herbs: *Evolvulus alsinoides* var. *villosicalyx, Goodenia microptera, Heliotropium inexplicitum, Oldenlandia crouchiana, Pterocaulon sphacelatum.*
Vegetation condition	Excellent.
Described from	Quadrats MMF01, MMF03; mapping notes.
Notes	The dominance of the various *Triodia* species within the spinifex stratum varied considerably with location and could not be delineated separately on the mapping. *Triodia wiseana* was distributed throughout this vegetation type, while *T. brizoides* was observed in stony areas, and *T. angusta* and *T. longiceps* were found in patches on the plains.
Photo	Plate 4.14.

P3: ElTloTaTe(Tw) *Eucalyptus leucophloia* scattered low trees over *Triodia longiceps, T. angusta, T. epactia*, (*T. wiseana*) hummock grassland

Habitat	This unit occurred on the plains and undulating plains in the northwestern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa* (wispy/weeping form), *A. exilis*, *Templetonia egena.* Low Shrubs: *Corchorus lasiocarpus* subsp. *parvus, Maireana georgei.* Grasses: *Aristida holathera* var. *holathera, Eulalia aurea*. Herbs: *Cleome viscosa, Evolvulus alsinoides* var. *villosicalyx, Goodenia microptera*.
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The dominance of the various *Triodia* species within the spinifex stratum varied with location and could not be delineated separately. *Triodia epactia* was encountered mostly near flowlines and drainage areas. *Triodia longiceps* and *Triodia angusta* were more uniformly distributed throughout this vegetation unit, while patches of *Triodia wiseana* were also observed.
Photo	Plate 4.15.

P4: ElTeTwTaTlo *Eucalyptus leucophloia* scattered low trees over *Triodia epactia, T. wiseana, T. angusta, T. longiceps* very open hummock grassland

Habitat	This unit occurred on plains in the eastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia ancistrocarpa, A. atkinsiana, A. bivenosa, A. kempeana, A. maitlandii, A. synchronicia, Cassia glutinosa.* Low Shrubs: *Corchorus lasiocarpus* subsp. *parvus, Eremophila cuneifolia, Hibiscus sturtii* var. *platychlamys, Maireana georgei.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Cymbopogon ambiguus, Enneapogon caerulescens, E. polyphyllus, Triodia brizoides.* Herbs: *Goodenia forrestii, G. microptera, Gomphrena canescens, G. cunninghamii, Lepidium pholidogynum, Salsola australis.*
Vegetation condition	Excellent.
Described from	Quadrats MMF11, MMF13; mapping notes.
Notes	The dominance of the various *Triodia* species within the spinifex stratum varied considerably with location and could not be delineated separately on the mapping. *Triodia epactia* was distributed throughout this vegetation unit due to the presence of a number of flowlines and drainage areas. *Triodia wiseana* was encountered in most habitats, while patches of *T. angusta* and *T. longiceps* were also observed.
Photo	Plate 4.16.

P5: ElTwTloTa *Eucalyptus leucophloia* scattered low trees over *Triodia wiseana, T. longiceps, T. angusta* open hummock grassland

Habitat	This unit occurred on plains in the western and central parts of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. bivenosa* (wispy/weeping form), *A. synchronicia, A. tetragonophylla, Cassia oligophylla* x *helmsii.* Low Shrubs: *Ptilotus obovatus, Scaevola spinescens* (narrow form), *Solanum lasiophyllum.* Grasses: *Aristida holathera* var. *holathera, Eriachne mucronata* (typical form), *E. pulchella.* Herbs: *Evolvulus alsinoides* var. *villosicalyx, Heliotropium heteranthum*, *Polycarpaea corymbosa, Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Excellent.
Described from	Quadrats MMF21, MMF31; mapping notes.
Notes	The dominance of the various *Triodia* species within the spinifex stratum varied considerably with location and could not be delineated separately on the mapping. *Triodia wiseana* was distributed throughout this vegetation unit, while patches of *T. longiceps* and *T. angusta* were also encountered.
Photo	Plate 4.17.

P6: ElAexTloTbrTw *Eucalyptus leucophloia* scattered low trees over *Acacia exilis* scattered shrubs over *Triodia longiceps, T. brizoides, T. wiseana* hummock grassland

Habitat	This unit occurred on plains in the central part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. exilis, A. synchronicia, Cassia luerssenii, Corymbia hamersleyana, Templetonia egena.* Low Shrubs: *Goodenia stobbsiana, Maireana georgei, M. melanocoma, Ptilotus calostachyus, Solanum lasiophyllum.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Eriachne mucronata* (typical form), *Paraneurachne muelleri, Triodia angusta.*
Vegetation condition	Excellent.
Described from	Quadrat MMF33; mapping notes.
Notes	*Triodia wiseana, T. longiceps* and *T. angusta* were uniformly distributed throughout this vegetation unit.
Photo	Plate 4.18.

P7: ElAbAexTaTw *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered tall shrubs over *A. exilis* open shrubland over *Triodia angusta, T. wiseana* open hummock grassland

Habitat	This unit occurred on calcareous plains in the eastern part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa* (wispy/weeping form), *A. maitlandii, A. synchronicia, Cassia pruinosa.* Low Shrubs: *Corchorus lasiocarpus* subsp. *lasiocarpus, Ptilotus calostachyus, P. rotundifolius.* Grasses: *Cymbopogon ambiguus, Paraneurachne muelleri.* Herbs: *Goodenia microptera, Oldenlandia crouchiana, Swainsona maccullochiana.*
Vegetation condition	Excellent.
Described from	Quadrat MMF24; mapping notes.
Photo	Plate 4.19.

P8: ElMeTaTw *Eucalyptus leucophloia* scattered low trees over *Melaleuca eleuterostachya* open shrubland over *Triodia angusta, T. wiseana* open hummock grassland

Habitat	This unit occurred on calcareous plains in the easternmost part of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. inaequilatera, Cassia luerssenii.* Low Shrubs: *Solanum lasiophyllum, Tecticornia disarticulata.* Grasses: *Aristida contorta, Enneapogon caerulescens, Eriachne pulchella, Iseilema dolichotrichum, Paraneurachne muelleri.* Herbs: *Heliotropium chrysocarpum, Oldenlandia crouchiana, Ptilotus nobilis* subsp. *nobilis, Sclerolaena eriacantha.*
Vegetation condition	Excellent.
Described from	Quadrat MMF26; mapping notes.
Photo	Plate 4.20.

P9: AanAxTeTw *Acacia 'aneura', A. xiphophylla* low open woodland over *Triodia epactia, T. wiseana* very open hummock grassland

Habitat	This unit occurred on plains in the northeastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, A. pruinocarpa, A. xiphophylla, Cassia luerssenii, Eremophila forrestii subsp. forrestii.* Low Shrubs: *Goodenia stobbsiana, Maireana georgei, Ptilotus calostachyus, Solanum lasiophyllum, Tribulus suberosus.* Grasses: *Aristida contorta, A. holathera* var. *holathera, Enneapogon polyphyllus, Eriachne aristidea, Sporobolus australasicus.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Notes	The Mulga form recorded from this area was identified as *A.* ? *incurvaneura* based on Maslin and Reid (2012).
Photo	Plate 4.21

P10: AxAanTaTe *Acacia xiphophylla, A. 'aneura'* low open woodland over *Triodia angusta, T. epactia* scattered hummock grasses

Habitat	This unit occurred in three small stands on plains in the eastern part of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. bivenosa, A. synchronicia, A. tenuissima, Cassia luerssenii.* Low Shrubs: *Corchorus crozophorifolius, Eremophila cuneifolia, Keraudrenia nephrosperma, Ptilotus astrolasius, Tribulus suberosus.* Grasses: *Aristida contorta, Brachyachne prostrata, Enneapogon caerulescens, E. polyphyllus, Eriachne mucronata* (typical form). Herbs: *Evolvulus alsinoides* var. *villosicalyx, Goodenia forrestii, G. microptera, Sclerolaena eriacantha.*
Vegetation condition	Excellent.
Described from	Quadrat MMF10; mapping notes.
Notes	The Mulga forms recorded from this area were identified as *A.* ? *incurvaneura*, *A.* ? *aptaneura* and *A.* ? *pteraneura* based on Maslin and Reid (2012). *Acacia* ? *incurvaneura* was found to be the most common. *Acacia* ? *pteraneura* was encountered in the southeastern area, while *A.*? *aptaneura* co-occurred with *A.* ? *incurvaneura* in the largest representative area of this vegetation unit.
Photo	Plate 4.22.

P11: AxTaTe *Acacia xiphophylla* low open woodland over *Triodia angusta, T. epactia* scattered hummock grasses

Habitat	This unit occurred in four small stands on plains in the eastern half of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa, Cassia glutinosa, C. luerssenii.* Low Shrubs: *Eremophila cuneifolia, Maireana thesioides, Solanum lasiophyllum, Tribulus suberosus.* Grasses: *Aristida contorta, *Cenchrus ciliaris, Enneapogon polyphyllus.* Herbs: *Ptilotus helipteroides, Sclerolaena eriacantha.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.23.

P12: AxTbr *Acacia xiphophylla* low woodland over *Triodia brizoides* scattered hummock grasses

Habitat	This unit occurred in four small stands on plains along the northwestern edge of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Cassia luerssenii, C. oligophylla.* Low Shrubs: *Enchylaena tomentosa* var. *tomentosa, Maireana georgei.* Grasses: *Sporobolus australasicus.* Herbs: *Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.24.

P13: AxTlo *Acacia xiphophylla* low woodland over *Triodia longiceps* scattered hummock grasses

Habitat	This unit occurred in several small stands on plains in the western and central parts of Section 1 (Appendix 4, Map 1).
Other associated species	Trees and Tall Shrubs: *Cassia glutinosa* x *luerssenii, C. oligophylla.* Low Shrubs: *Eremophila cuneifolia, Ptilotus obovatus, Sida* aff. *fibulifera* (MET var. 'L'), *Solanum lasiophyllum.* Grasses: *Aristida latifolia.* Herbs: *Salsola australis, Streptoglossa bubakii.*
Vegetation condition	Excellent.
Described from	Quadrat MMF19; mapping notes.
Photo	Plate 4.25.

P14: EsMeTaTw *Eucalyptus socialis* low open mallee woodland over *Melaleuca eleuterostachya* low open shrubland over *Triodia angusta, T. wiseana* hummock grassland

Habitat	This unit occurred in a single stand on calcareous plains in the eastern part of Section 1 (Appendix 4, Map 1). This was the only unit from which *Eucalyptus socialis* subsp. *eucentrica* was recorded.
Other associated species	Trees and Tall Shrubs: *Acacia bivenosa* (wispy/weeping form), *Capparis umbonata, Cassia luerssenii, Eremophila longifolia, Eucalyptus leucophloia* subsp. *leucophloia.* Herbs: *Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Excellent.
Described from	Quadrat MMF22; mapping notes.
Photo	Plate 4.26.

Plate 4.13: Vegetation unit P1.

Plate 4.14: Vegetation unit P2.

Plate 4.15: Vegetation unit P3.

Plate 4.16: Vegetation unit P4.

Plate 4.17: Vegetation unit P5.

Plate 4.18: Vegetation unit P6.

Plate 4.19: Vegetation unit P7.

Plate 4.20: Vegetation unit P8.

Plate 4.21: Vegetation unit P9.

Plate 4.22: Vegetation unit P10.

Plate 4.23: Vegetation unit P11.

Plate 4.24: Vegetation unit P12.

Plate 4.25: Vegetation unit P13.

Plate 4.26: Vegetation unit P14.

4.1.3 Vegetation of Drainage Lines and Floodplains

D1: ExAciAbPlTHtCEc *Eucalyptus xerothermica*, *Acacia citrinoviridis* scattered low trees over *A. bivenosa, Petalostylis labicheoides* tall open shrubland over *Themeda triandra, *Cenchrus ciliaris* open tussock grassland

Habitat	This unit occurred in moderate-sized creeks through the plains in Section 1 (Appendix 4, Map 1), draining east into the Beasley River. In some areas, these creeks had a calcareous loamy substrate.
Other associated species	Trees and Tall Shrubs: *Acacia pyrifolia* var. *pyrifolia, A. atkinsiana, Gossypium australe* (Burrup Peninsula form), *G. robinsonii.* Grasses: *Cymbopogon procerus, Enneapogon lindleyanus, Eulalia aurea, Paraneurachne muelleri.* Herbs: **Malvastrum americanum, Pluchea rubelliflora, Pterocaulon sphacelatum, Stemodia grossa.*
Vegetation condition	Good: presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes.
Photo	Plate 4.27.

D2: ExAciPlAbTHtTe *Eucalyptus xerothermica, Acacia citrinoviridis* low open woodland over *Petalostylis labicheoides* scattered tall shrubs over *Acacia bivenosa* open shrubland over *Triodia epactia* very open hummock grassland over *Themeda triandra* scattered tussock grasses

Habitat	This unit occurred in moderate-sized creeks in the western half of Section 2 (Appendix 4, Map 2), draining southwest into the Beasley River. It was distinguished from unit D1 by the absence of Buffel Grass (**Cenchrus ciliaris*).
Other associated species	Trees and Tall Shrubs: *Androcalva luteiflora, Corymbia hamersleyana, Gossypium robinsonii.* Low Shrubs: *Indigofera rugosa, Sida* sp. spiciform panicles (E. Leyland s.n. 14/8/90). Grasses: *Cymbopogon ambiguus, Eriachne aristidea, E. tenuiculmis, Paraneurachne muelleri, Triodia longiceps.* Herbs: *Alternanthera nana, Evolvulus alsinoides* var. *villosicalyx, Goodenia microptera, Phyllanthus maderaspatensis, Pterocaulon sphacelatum, Salsola australis.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.28.

D3: ElAciPlSsGOrTe *Eucalyptus leucophloia, Acacia citrinoviridis* scattered low trees over *Petalostylis labicheoides, Stylobasium spathulatum, Gossypium robinsonii* tall shrubland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred in moderate-sized creeks in the central part of Section 2 (Appendix 4, Map 2), draining southwest into the Beasley River.
Other associated species	Trees and Tall Shrubs: *Acacia atkinsiana, A. bivenosa, A. maitlandii, Androcalva luteiflora, Codonocarpus cotinifolius.* Low Shrubs: *Hibiscus sturtii* var. *campylochlamys, Hybanthus aurantiacus, Indigofera monophylla, Tephrosia rosea* var. *glabrior.* Grasses: **Cenchrus ciliaris, Eriachne mucronata* (typical form), *E. tenuiculmis, Paspalidium clementii, Themeda triandra.* Herbs: *Euphorbia biconvexa, Euphorbia* sp. (site 1089), *Evolvulus alsinoides* var. *villosicalyx, Lepidium pedicellosum, Pterocaulon sphacelatum, Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Good: scattered individuals of **Cenchrus ciliaris.*
Described from	Quadrat MMF12; mapping notes.
Photo	Plate 4.29.

D4: ElAmoGOrTe *Eucalyptus leucophloia* scattered low trees over *Acacia monticola, Gossypium robinsonii* tall open shrubland over *Triodia epactia* scattered hummock grasses

Habitat	This unit occurred in minor flowlines draining to the south across the lower ridge slopes of Section 3 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia citrinoviridis, A. marramamba, A. trudgeniana, Clerodendrum floribundum* var. *angustifolium.* Low Shrubs: *Indigofera monophylla, Ptilotus calostachyus.* Grasses: *Themeda triandra.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.30.

D5: AciAbTHtCEc *Acacia citrinoviridis, A. bivenosa* tall open shrubland over *Themeda triandra, *Cenchrus ciliaris* open tussock grassland

Habitat	This unit occurred in moderate-sized creeks with a calcareous loamy substrate in the eastern part of Section 1 (Appendix 4, Map 1), draining north through the plains into the Beasley River system. It was similar to unit D1 but occurred in slightly smaller creeklines, and as a result lacked *Eucalyptus xerothermica* in the overstorey.
Other associated species	Trees and Tall Shrubs: *Acacia exilis, Gossypium robinsonii, Petalostylis labicheoides, Stylobasium spathulatum.*
Vegetation condition	Good; presence of **Cenchrus ciliaris* in the grass understorey.
Described from	Mapping notes.
Photo	Plate 4.31.

D6: AciPlGOrApyTe *Acacia citrinoviridis* scattered low trees over *Petalostylis labicheoides, Gossypium robinsonii, A. pyrifolia* tall open shrubland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred in a moderate-sized creek through the plains in the east of Section 2 (Appendix 4, Map 2), eventually draining southwest into the Beasley River system.
Other associated species	Trees and Tall Shrubs: *Acacia tumida* var. *pilbarensis, Cassia glutinosa, C. luerssenii, C. oligophylla, Gossypium robinsonii.* Low Shrubs: *Corchorus crozophorifolius, Tephrosia rosea* var. *glabrior.* Grasses: **Cenchrus ciliaris, Enneapogon polyphyllus, Sporobolus australasicus.* *Herbs: Boerhavia coccinea, Cleome viscosa, Dysphania rhadinostachya* subsp. *rhadinostachya, Polycarpaea longiflora, Pterocaulon sphacelatum, Salsola australis.*
Vegetation condition	Good: scattered individuals of **Cenchrus ciliaris.*
Described from	Mapping notes.
Photo	Plate 4.32.

D7: PlAmoTe *Petalostylis labicheoides, Acacia monticola* tall open shrubland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred in a minor flowline running south along the ridge slopes of Section 3 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia marramamba, Cassia glutinosa.* Low Shrubs: *Corchorus lasiocarpus* subsp. *parvus, Goodenia stobbsiana, Sida* sp. Shovelanna Hill (S. van Leeuwen 3842). Grasses: *Eriachne mucronata* (typical form).
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.33.

D8: AtuPlApyAbTe *Acacia tumida, Petalostylis labicheoides*, *A. pyrifolia, A. bivenosa* tall shrubland over *Triodia epactia* very open hummock grassland

Habitat	This unit occurred on the floodplain that encompassed Section 4 of the study area (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia citrinoviridis, Gossypium robinsonii.* Low Shrubs: *Corchorus crozophorifolius, Ptilotus obovatus, Tephrosia rosea* var. *glabrior.* Grasses: *Eriachne tenuiculmis, Themeda triandra.* Herbs: *Goodenia forrestii, Pterocaulon sphacelatum.*
Vegetation condition	Excellent.
Described from	Mapping notes.
Photo	Plate 4.34

D9: ElAbTe *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia epactia* hummock grassland

Habitat	This unit occurred on a broad floodplain in the east of Section 2 (Appendix 4, Map 2).
Other associated species	Trees and Tall Shrubs: *Acacia ancistrocarpa, A. citrinoviridis, A. pyrifolia var. pyrifolia, A. synchronicia, Cassia glutinosa.* Low Shrubs: *Indigofera monophylla, Maireana georgei, Solanum lasiophyllum, Tribulus suberosus.* Grasses: *Aristida contorta, Enneapogon caerulescens, E. polyphyllus, Sporobolus australasicus.* Herbs: *Cleome viscosa, Euphorbia* sp. (site 1089), *Pterocaulon sphacelatum, Ptilotus nobilis* subsp. *nobilis.*
Vegetation condition	Excellent.
Described from	Quadrat MMF08; mapping notes.
Photo	Plate 4.35.

Plate 4.27: Vegetation unit D1.

Plate 4.28: Vegetation unit D2.

Plate 4.29: Vegetation unit D3.

Plate 4.30: Vegetation unit D4.

Plate 4.31: Vegetation unit D5.

Plate 4.32: Vegetation unit D6.

Plate 4.33: Vegetation unit D7.

Plate 4.34: Vegetation unit D8.

Plate 4.35: Vegetation unit D9.

4.2 Vegetation Condition

The vegetation condition ranking was based on the degree of weed presence, human impact, feral animals and livestock activities, and the perceived structural integrity of the vegetation as a result.

Overall, the vegetation of the study area was in Very Good to Excellent condition. The main disturbance factor within the area was weed invasion by **Cenchrus ciliaris* (Buffel Grass), which reduced condition to Good. However, infestations of **Cenchrus ciliaris* were predominantly restricted to a few drainage systems in vegetation units D1 and D5. The hills and stony plains comprising the landscape of the study area represent arid habitats that are not favourable for

either weed invasion or grazing, thus explaining the relatively scarce number of weed records from all habitats except drainage lines.

4.3 Conservation Significance of the Vegetation Units

None of the vegetation types represent TECs listed either under the Commonwealth *EPBC Act* or the WA *Environmental Protection Act 1986* (see Section 3.5).

None of the vegetation types represent PECs listed by the WA DEC (see Section 3.5).

All of the habitats in the study area are widespread in the locality. The vegetation types in the study area are considered to be of Low conservation significance, being representative of the vegetation occurring in similar habitats throughout the locality. Note that this is not meant to imply that the vegetation in the study area is of no conservation value, as all intact native vegetation is inherently valuable.

The vegetation types comprising a substantial amount of Mulga over spinifex hummock grasses (units H5, H6 and H7) do not fall into the same category as the "lower slope mulga" ecosystem at risk identified by Kendrick (2003). It is understood that this ecosystem at risk refers to Mulga communities over a moderate to dense cover of spinifex, which results in the fire-sensitive Mulga overstorey being particularly vulnerable to impacts from burning. These vegetation types have therefore not been assigned any conservation significance ranking above the general vegetation.

5.0 Flora of the Study Area

5.1 Overview

A total of 235 native vascular flora taxa from 95 genera and 39 families have been recorded from the study area. This includes two Priority flora species (discussed in Section 5.4). Four introduced flora species were also recorded (see Section 5.5).

5.2 Dominant Families and Genera

The dominant plant families and genera (native taxa only) recorded from the study area are presented in Table 5.1. Species in these groups are typically frequently encountered in vegetation in the region due to their prevalence in the Eremaean flora.

Table 5.1: Dominant plant families and genera in the study area.

Family	Number of Native Taxa
Fabaceae	53
Poaceae	33
Malvaceae	32
Genus	Number of Native Taxa
Acacia	25
Cassia	18
Ptilotus	11
Sida	8

5.3 Species Richness – Regional Context

When compared to other study areas that have been surveyed in the broader region, the total number of native species recorded from the study area is within the range expected for a study area of this size in this locality (see Figure 5.1).

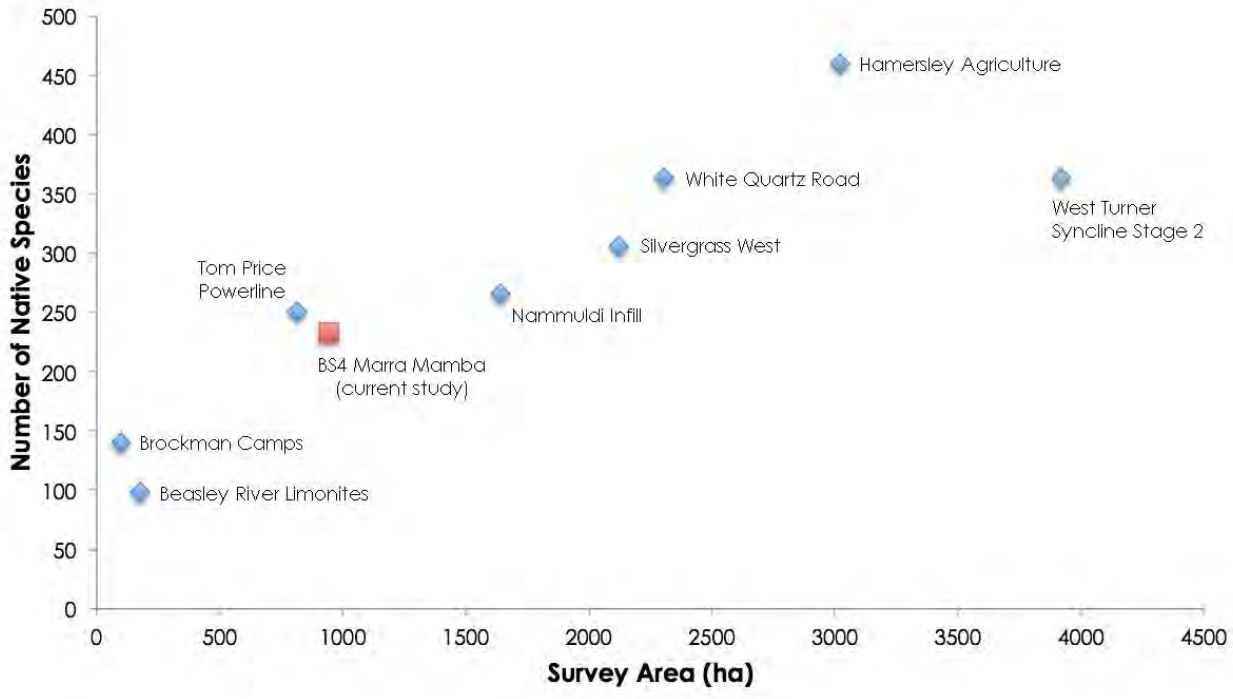

Figure 5.1: Number of native species recorded from the study area in relation to other surveys in the locality.

5.4 Flora of Conservation Significance

5.4.1 Threatened Flora

No Threatened Flora listed under the Federal *EPBC Act* or the WA *Wildlife Conservation Act 1950* have been recorded within the study area.

None of the Threatened Flora species listed for the Pilbara are expected to occur within the study area, due to a lack of suitable habitat and/or a distribution that does not overlap with this locality (see Section 3.6.1).

5.4.2 Priority Flora

Two Priority flora species were recorded in the study area:

- *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) Priority 1

  Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) is a tall shrub to low tree growing to 6 m in height. The leaves of this species are divided, with each segment more or less terete (circular in cross-section), making them very similar in appearance to *Grevillea nematophylla* subsp. *supraplana* and somewhat similar to *Grevillea berryana* (Plate 5.1). The flowers are quite unlike *Grevillea nematophylla,* being similar to *Grevillea berryana* but distinguished by the absence of glandular hairs on the inflorescence stem and on the flora bracts (Steven Dillon, WA Herbarium, pers. comm. 2012). *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) was recorded from four locations on the top of small, steep rocky hills in the west of the study area (see Table 5.2 and Appendix 4). This species was recorded in association with species from the *Acacia "aneura"* complex (vegetation unit H4), which is typical for this taxon.

- *Ptilotus subspinescens* Priority 3

  Ptilotus subspinescens is a compact shrub to 0.8 m in height, with distinctive spinescent and virtually leafless branchlets (Plate 5.2). This species is commonly recorded on stony plains and adjacent low stony rises, typically with a calcareous silty soil substrate. *Ptilotus subspinescens* was recorded from four locations on rocky plains within the study area (see Table 5.2 and Appendix 4).

Plate 5.1: Scanned specimen of *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ01.01) (Priority 1).

Plate 5.2: *Ptilotus subspinescens* (Priority 3).

Table 5.2: Locations of Priority flora in the study area.

Source of Record	Location		No. of individuals
	Easting (GDA94)	Northing (GDA94)	
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) (Priority 1)			
MMF23	517348	7497202	20
Opportunistic	517362	7497219	5
Opportunistic	519456	7497755	5
Opportunistic	517339	7497083	8
Ptilotus subspinescens (Priority 3)			
Opportunistic	519426	7497776	58
Opportunistic	530001	7500049	3
Opportunistic	519371	7497754	20
Opportunistic	521099	7497840	20
	521194	7497847	

5.4.3 Unresolved Taxa

Family: Chenopodiaceae

- *Sclerolaena ? minuta*

  Sclerolaena specimens collected from the study area were assigned a preliminary determination of *S. ? minuta*. Paul Wilson (WA Herbarium) identified two of those specimens as *Sclerolaena minuta* and is examining the rest to determine their taxonomic classification. The occurrence of *S. minuta* within the study area represents a range extension as this species has been recorded 10-40 km towards the east of Newman (DEC 2012c).

Family: Fabaceae

- *Acacia "aneura"* (Mulga) species complex

  Three entities from the *Acacia* "*aneura*" species complex (namely, *Acacia ? aptaneura, A.* ? i*ncurvaneura* and *A. ? pteraneura*) were recorded in the study area (see Appendix 5). A revision of the *Acacia "aneura"* complex is currently being undertaken by Mr Bruce Maslin of the WA Herbarium and a number of species descriptions have recently been published (Maslin and Reid 2012). Preliminary names were assigned to the specimens collected from the study area using the species descriptions provided by Maslin and Reid (2012). However, as a taxonomic key for the determination of species within the *Acacia* "*aneura*" complex is not yet available, these identifications may be required to be revised in future.

- *Cassia* genus

  Cassia is a complex genus exhibiting a high degree of hybridization. Some *Cassia* specimens collected from the study area were assigned preliminary names only, with further work required to resolve their identity. It is unlikely that any of these taxa represent conservation significant taxa, and many of the specimens are believed to be hybrids.

- *Tephrosia* genus

  One undescribed taxa within the genus *Tephrosia* was identified by Mr Malcolm Trudgen (M.E. Trudgen and Associates) as *Tephrosia* aff. *clementii* (see Appendix 5). This species has been recorded from other areas in the Pilbara (Biota internal records).

Family: Euphorbiaceae

- *Euphorbia* genus

  Three undescribed *Euphorbia* species were recorded from the study area (see Appendix 5). These entities were identified with the assistance of Mr Malcolm Trudgen, using informal names assigned in a reference set held by M.E. Trudgen and Associates. Further work is needed to allocate formal phrase names to these *Euphorbia* taxa. All three entities have been recorded in previous studies in the region, and none are considered to be rare or restricted (Biota internal records).

Family: Malvaceae

Numerous undescribed taxa within the Malvaceae family are regularly recorded from the Pilbara bioregion. Undescribed taxa within the genera *Abutilon, Corchorus* and *Sida* have been identified from the study area by Mr Malcolm Trudgen (M.E. Trudgen and Associates) (see Appendix 5). All of these taxa have been recorded from other areas in the Pilbara (Biota internal records).

5.5 Introduced Flora

Four introduced flora species (weeds) were recorded from the study area. Details of the records are presented in Table 5.3 and locations are shown on the vegetation map in Appendix 4.

None of the weeds recorded are listed as Declared Plants for the Pilbara region under the *Agriculture and Related Resources Protection Act 1976,* nor are any specified as Weeds of National Significance (WONS) (Thorp and Lynch 2000)[6]. However, all the species recorded in the study area are ranked as weeds with High ecological impact according to DEC (2012d).

Each of the recorded species is discussed briefly below:

- **Cenchrus ciliaris* (Buffel Grass)

  Buffel Grass was introduced by pastoralists as a fodder species. This perennial grass forms dense tussock grasslands, particularly along creeklines, floodplains and in sandy areas. Buffel Grass grows to 1 m tall and has purple flowers present for most the year. This species has demonstrated allelopathic capacities, whereby it releases chemicals that inhibit the growth of other plants, and it competes aggressively and effectively with native flora species (Cheam 1984a, 1984b). Buffel Grass was recorded from 19 locations in the study area, including from creeklines, floodplains, rocky plains and hill slopes (see Table 5.3 and Appendix 4).

- **Malvastrum americanum* (Spiked Malvastrum)

  Spiked Malvastrum typically occurs in Mulga vegetation, drainage lines and on floodplains, and can also be recorded on steep hill slopes and on rockpiles. It is an erect, perennial herb or shrub to 1.3 m high, with yellow or orange flowers from April to July. This species was recorded from four locations in the study area, all of which were in creeklines (see Table 5.3 and Appendix 4).

- *Setaria verticillata* (Whorled Pigeon Grass)

  Whorled Pigeon Grass is a loosely tufted annual grass that has a distinctive inflorescence, consisting of numerous bristles with recurved spines. This species commonly occurs in disturbed areas, on the edges of rivers and creeks and in shrublands from the Kimberley to the Pilbara (Hussey et al. 1997). Whorled Pigeon Grass was recorded from one location in a creekline in the study area (see Table 5.3 and Appendix 4).

- **Vachellia farnesiana* (Mimosa Bush)

  Mimosa Bush is a spreading, thorny shrub to 4 m high, with dark grey bark, pinnate leaves, and yellow flowers in winter. This species is widespread from the Kimberley to near Perth, typically occurring along drainage systems and in adjacent low-lying areas (Hussey et al. 1997). Mimosa Bush was observed at four locations in the study area, all of which were associated with creeklines (see Table 5.3 and Appendix 4).

[6] For the current WONS listing, go to http://www.weeds.org.au/WoNS/

Table 5.3: Records of introduced species in the study area.

Site	Location		No. Individuals / % Cover
	Easting	Northing	
**Cenchrus ciliaris*			
MMF06	528108	7500097	1
MMF09	527446	7499673	0.1%
MMF12	530167	7500136	0.1%
Opportunistic	530114	7500289	2
Opportunistic	526919	7500038	>100
Opportunistic	517380	7497309	1,000
Opportunistic	530457	7500511	3
Opportunistic	517142	7497384	20
Opportunistic	520085	7497762	5
Opportunistic	517793	7497083	20
Opportunistic	519871	7497627	>150
Opportunistic	516766	7496991	200
Opportunistic	517442	7497187	100
Opportunistic	531762	7500319	3
Opportunistic	531863	7500399	>50
Opportunistic	527090	7499577	>50
Opportunistic	516794	7497343	50
Opportunistic	517062	7497384	50
Opportunistic	519516	7497487	>200
**Malvastrum americanum*			
Opportunistic	527686	7499636	3
Opportunistic	526427	7499062	5
Opportunistic	527090	7499577	10
Opportunistic	517442	7497187	5
**Setaria verticillata*			
Opportunistic	527090	7499577	5
**Vachellia farnesiana*			
Opportunistic	519871	7497627	>20
Opportunistic	516766	7496991	2
Opportunistic	519516	7497487	5
Opportunistic	517442	7497187	>20

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7.0 Glossary

Annual (plant)	A plant that lives for only one year.
Biota	Biota Environmental Sciences.
Conservation Significant	A plant that is recognised to be rare, unusual, new or poorly sampled; may be assigned a formal conservation ranking (see Appendix 1 for more on conservation framework).
Cover value	Species were quantified by estimating the "birds-eye-view" percentage of the ground occupied in a survey area; the percentage was called the cover value.
Cryptic	Plants that die back to a perennial root-stock under dry conditions; considered cryptic (meaning hidden) because although they are consistently present, it is difficult to tell unless suitable conditions prevail.
DEC	WA Department of Environment and Conservation.
Dominant species	The species that occurred most abundantly in a vegetation stratum or in an area.
EPA	Environmental Protection Authority of Western Australia.
EPBC Act	The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999.*
Ephemeral	A plant that lives a very short time; less than one year or, usually, less than six months.
Flora keys	Botanical publications containing a series of questions regarding the plant's characteristics, which aid in the identification of the taxon.
Foot traverse	Consists of walking through an area to confirm or note vegetation types (usually sampling a narrow corridor/cross section of vegetation) and/or to search for flora species.
Ground-truth	The on-ground/site study of an area to confirm vegetation patterns suggested by aerial photography or remote image sensing.
Opportunistic	A plant species collected from outside the formal quadrat and relevé sampling sites; sometimes abbreviated to Opp.
Perennial	A plant that lives for more than two growing seasons.
PEC	Priority Ecological Community (see Appendix 1 for more on the conservation framework).
Priority Flora	Flora listed by the DEC as requiring additional information to properly evaluate their conservation significance (see Appendix 1 for more on the conservation framework).
Quadrat	A square or rectangular sample area of fixed size in which all species present are recorded. The standard quadrat area for the Pilbara bioregion is 2,500 m^2 (usually 50 m by 50 m, although quadrat shape may be modified to fit narrow habitats or to ensure that uniform vegetation is sampled).
Relevé	An unbounded flora survey site (usually with a similar area to a quadrat) in which most species present are recorded; a reduced level of site information is typically recorded for relevés.
Stratum (plural: Strata)	A horizontal level of vegetation defined by growth habitat and/or height (e.g. low trees).
Taxon (plural: Taxa)	Used in this report to denote a taxonomic group at species level or below (e.g. subspecies, varieties, forms, etc).
TEC	Threatened Ecological Community (see Appendix 1 for more on the conservation framework).

Threatened Flora	Flora protected by legislation; either listed under the *EPBC Act* or the WA *Wildlife Conservation Act 1950* (formerly known as Declared Rare Flora). See Appendix 1 for more on the conservation framework.
*	Used prior to a species name to denote a weed species.

Appendix 1

Framework for Conservation Significance Ranking of Communities and Species in WA

A. Definitions, Categories and Criteria for Threatened and Priority Ecological Communities

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 (e.g. 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" (e.g. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, e.g. 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 micro-organisms; 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

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 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, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. 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 with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities
Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

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

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

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

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

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

(a) 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.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) 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.

Reference:
DEC (2010): Definitions, Categories and Criteria for Threatened and Priority Ecological Communities: http://www.dec.wa.gov.au/content/view/849/2017/, accessed on 17th July 2012.

B. Conservation Codes for Western Australian Flora

In Western Australia, all native flora species are protected under the *Wildlife Conservation Act 1950,* making it an offence to remove or harm native flora species without approval. In addition to this basic level of statutory protection, a number of plant species are assigned an additional level of conservation significance based on the fact that there are a limited number of known populations, some of which may be under threat.

B1: Threatened Flora

Under the *Wildlife Conservation Act 1950*, the Minister for the Environment may declare species of flora to be protected if they are considered to be in danger of extinction, rare or otherwise in need of special protection. Schedules 1 and 2 deal with those species that are threatened and those that are presumed extinct, respectively.

T: Threatened Flora (Declared Rare Flora — Extant)

Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*).

Threatened Flora (Schedule 1) are further ranked by the DEC according to their level of threat using IUCN Red List criteria:

- CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild;
- EN: Endangered – considered to be facing a very high risk of extinction in the wild; or
- VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

X: Presumed Extinct Flora (Declared Rare Flora — Extinct)

Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the *Wildlife Conservation Act 1950*).

B2: Priority Flora

Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora List 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 flora. Taxa 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 for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring. Conservation Dependent species are placed in Priority 5.

- P1: Priority One – Poorly-known taxa: taxa that are known from one or a few collections or sight records (generally <5), all of which are on lands not managed for conservation (e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases, etc.), or are under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
- P2: Priority Two – Poorly-known taxa: taxa that are known from one or a few collections or sight records (generally <5), at least some of which are on lands not under imminent threat of habitat destruction or degradation (e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc.). Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
- P3: Priority Three – Poorly-known taxa: taxa that are known from collections or sight records from several localities, at least some of which are not under imminent threat; or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
- P4: Priority Four - Rare taxa, Near Threatened taxa and other taxa in need of monitoring:
  a) Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
  b) Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
  c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

- P5: Priority Five: Conservation Dependent taxa: taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Note that of the above classifications, only Threatened flora have statutory standing. The Priority flora classifications are employed by the DEC to manage and classify their database of species considered potentially rare or at risk, but these categories have no legislative status. Note also that proposals that appear likely to affect Threatened flora require formal written approval from the Minister for the Environment under Section 23(f) of the *Wildlife Conservation Act 1950* in addition to the requirements of the *Environmental Protection (Native Vegetation Clearing) Regulations 2004*.

Reference:
DEC (2011). Listing of Species and Ecological Communities: http://www.dec.wa.gov.au/content/view/852/2010/1/1/, accessed on 16th July 2012.

Appendix 2

Vegetation Structural Classes and Condition Scale

Vegetation Structural Classes*

Stratum	Canopy Cover (%)				
	70-100%	30-70%	10-30%	2-10%	<2%
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland	Scattered tall trees
Trees 10-30 m	Closed forest	Open forest	Woodland	Open woodland	Scattered trees
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland	Scattered low trees
Shrubs over 2 m	Tall closed scrub	Tall open scrub	Tall shrubland	Tall open shrubland	Scattered tall shrubs
Shrubs 1-2 m	Closed heath	Open heath	Shrubland	Open shrubland	Scattered shrubs
Shrubs under 1 m	Low closed heath	Low open heath	Low shrubland	Low open shrubland	Scattered low shrubs
Hummock grasses	Closed hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland	Scattered hummock grasses
Grasses, Sedges, Herbs	Closed tussock grassland / bunch grassland / sedgeland / herbland	Tussock grassland / bunch grassland / sedgeland / herbland	Open tussock grassland / bunch grassland / sedgeland / herbland	Very open tussock grassland / bunch grassland / sedgeland / herbland	Scattered tussock grasses / bunch grasses / sedges / herbs

* Based on Muir (1977), and Aplin's (1979) modification of the vegetation classification system of Specht (1970): Aplin T.E.H. (1979). The Flora. Chapter 3 *In* O'Brien, B.J. (ed.) (1979). *Environment and Science.* University of Western Australia Press; Muir B.G. (1977). Biological Survey of the Western Australian Wheatbelt. Part II: Vegetation and habitat of Bendering Reserve. *Records of the Western Australian Museum, Suppl.* No. 3; Specht R.L. (1970). Vegetation. *In The Australian Environment.* 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale*

E = Excellent (=Pristine of BushForever) Pristine or nearly so; no obvious signs of damage caused by the activities of European man.
VG = Very Good (= Excellent of BushForever) Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as **Ursinia anthemoides* or **Briza* spp., or occasional vehicle tracks.
G = Good (= Very Good of BushForever) More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as **Ehrharta* spp.
P = Poor (= Good of BushForever) Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some more aggressive ones such as **Ehrharta* spp.
VP = Very Poor (= Degraded of BushForever) 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 including very aggressive species.
D = Completely Degraded (= Completely Degraded of BushForever) Areas that are completely or almost completely without native species in the structure of their vegetation; ie. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

* Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Appendix 3

Raw Data from Sampling Sites Established in the Marra Mamba Study Area

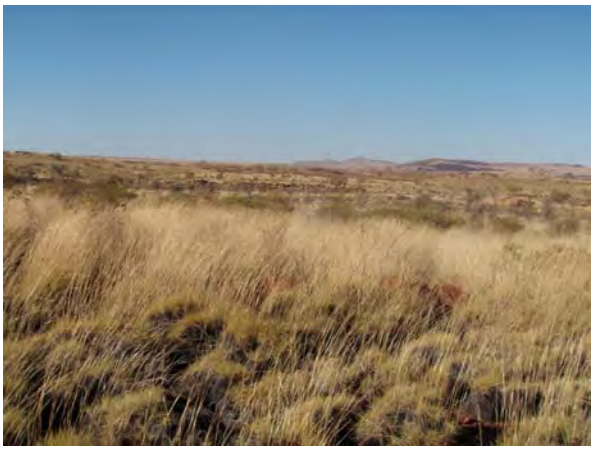
Marra Mamba Flora Site MMF01

Described	PLSW	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	526576	mE	7499680	mN	117.258586 E	-22.609461 S

Habitat SW-facing slope of low rise amongst undulating plain.
Soil Brown sandy-clay.
Rock Type Sandstone/dolomite fine gravel, coarse gravel, pebbles, cobbles (51-70% covering) with outcropping.
Vegetation *Acacia exilis* tall open shrubland over *A. bivenosa* scattered shrubs over *Triodia wiseana* very open hummock grassland.
Veg Condition Excellent.
Fire Age Mostly no sign of recent fire; south corner of quadrat burnt 3-5 years ago.
Notes Elevation: 516 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon lepidum	0.1	120	MMF01-12	
Acacia bivenosa	1	180		
Acacia exilis	2	230	MMF01-01	
Acacia inaequilatera	0.1	40		Juvenile
Acacia maitlandii	0.1	190		
Aristida contorta	0.1	25		
Aristida holathera var. *holathera*	0.1	30	MMF01-03	
Cassia glutinosa	0.1	120		
Cassia helmsii	0.1	150		
Cassia luerssenii	0.1	45		
Cassia oligophylla x *helmsii*	0.1	40	MMF01-04	
Cassia pruinosa	0.1	190		
Corchorus lasiocarpus subsp. *lasiocarpus*	0.1	100	MMF01-19	
Cymbopogon ambiguus	0.1	80	MMF01-13	
Enneapogon caerulescens	0.1	40	MMF01-20	
Eremophila fraseri subsp. *fraseri*	0.1	110	MMF01-21	
Eriachne aristidea	0.1	30		
Eriachne mucronata (typical form)	0.1	40	MMF01-10	
Eriachne pulchella (subsp. not determined)	0.1	10		
Euphorbia boophthona	0.1	20		
Evolvulus alsinoides var. *villosicalyx*	0.1	20		
Goodenia microptera	0.1	20		
Goodenia stobbsiana	0.1	30		
Gossypium australe (Burrup Peninsula form)	0.1	20		
Gossypium australe (Whim Creek form)	0.1	90		
Heliotropium inexplicitum	0.1	9	MMF01-23	
Indigofera monophylla	0.1	50	MMF01-07	
Jasminum didymum subsp. *lineare*	0.1	90		
Oldenlandia crouchiana	0.1	20		
Paraneurachne muelleri	0.1	40		
Paspalidium clementii	0.1	25	MMF01-16	
Peripleura virgata	0.1	30	MMF01-17	
Polycarpaea corymbosa	0.1	10		
Polycarpaea holtzei	0.1	5		
Pterocaulon serrulatum var. *velutinum*	0.1	20	MMF01-18	
Pterocaulon sphacelatum	0.1	40	MMF01-09	
Pterocaulon sphaeranthoides	0.1	20	MMF01-08	
Ptilotus astrolasius	0.1	30		

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Ptilotus auriculifolius	0.1	10		
Ptilotus calostachyus	0.1	60		
Ptilotus clementii	0.1	25		
Ptilotus nobilis subsp. *nobilis*	0.1	10		Dead
Ptilotus rotundifolius	0.1	100		
Rhynchosia minima	0.1	40		
Sida echinocarpa	0.1	10	MMF01-15	
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	0.1	30		
Solanum horridum	0.1	10	MMF01-22	
Solanum lasiophyllum	0.1	30		
Sporobolus australasicus	0.1	10		
Stackhousia muricata	0.1	25	MMF01-11	
Swainsona maccullochiana	0.1	60	MMF01-05	
Themeda triandra	0.1	30		
Trachymene oleracea subsp. *oleracea*	0.1	20		
Trichodesma zeylanicum var. *zeylanicum*	0.1	150		
Triodia epactia	0.1	40	MMF01-06	
Triodia wiseana	9	190	MMF01-02	



Marra Mamba Flora Site MMF02

Described	RB/PC	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	528672	mE	7499808	mN	117.278978 E	-22.608271 S

Habitat Undulating plain (gentle north-facing aspect).
Soil Red-brown sandy loam.
Rock Type > 70% ironstone and dolomite fine gravel, coarse gravel, pebbles, cobbles, rocks/stones, large rocks.
Vegetation *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* open hummock grassland.
Veg Condition Very Good; cattle scats present.
Fire Age No sign of recent fire.
Note Elevation - 512 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon dioicum	0.1	4	MMF02-07	
Acacia inaequilatera	1	210		
Aristida contorta	0.1	10		
Cassia luerssenii	0.1	100		
Cassia oligophylla x helmsii	0.1	40	MMF02-02	
Cassia pruinosa	0.1	150	MMF02-03	
Cleome viscosa	0.1	15		Dead
Cymbopogon ambiguus	0.1	90	MMF02-06	
Enneapogon caerulescens	0.1	25		
Eriachne pulchella	0.1	5		
Euphorbia sp. (FMLMC-10)	0.1	5	MMF02-11	
Hibiscus coatesii	0.1	25	MMF02-10	
Indigofera monophylla	0.1	50	MMF02-05	
Oldenlandia crouchiana	0.1	10		Dead
Paraneurachne muelleri	0.1	40		
Ptilotus auriculifolius	0.1	20		Dead
Ptilotus rotundifolius	0.1	70		
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90	0.1	30	MMF02-09	
Solanum lasiophyllum	0.1	30	MMF02-04	
Sporobolus australasicus	0.1	10		
Swainsona maccullochiana	0.1	20	MMF02-08	
Triodia wiseana	20	30	MMF02-01	

Marra Mamba Flora Site MMF03

Described	PLSW	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	526350	mE	7500061	mN	117.256381 E	-22.606023 S

Habitat Gentle south-facing plain amongst undulating hills.
Soil Red-brown sandy clay.
Rock Type 1-10% chert/ironstone fine gravel, coarse gravel, pebbles, cobbles.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia longiceps, T. brizoides* very open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.5	110		
Acacia maitlandii	0.1	40		
Acacia synchronicia	0.1	25		
Capparis lasiantha	0.1	100	MMF03-09	
Cassia luerssenii	0.1	80		
Cassia pruinosa	0.1	140		
Corchorus lasiocarpus (subsp. not determined)	0.1	15		
Enneapogon caerulescens	0.1	10		
Eriachne pulchella	0.1	10		
Eucalyptus leucophloia subsp. *leucophloia*	1.5	450		
Goodenia microptera	0.1	30		
Gossypium robinsonii	0.1	190		
Iseilema dolichotrichum	0.1	5	MMF03-04	
Paraneurachne muelleri	0.1	40		
Polycarpaea holtzei	0.1	5		
Ptilotus aervoides	0.1	1	MMF03-03	
Ptilotus astrolasius	0.1	45		
Ptilotus nobilis subsp. *nobilis*	0.1	25		
Sclerolaena ? minuta	0.1	15	MMF03-07	
Sclerolaena eriacantha	0.1	20	MMF03-06	
Sporobolus australasicus	0.1	10		
Tephrosia aff. *clementii*	0.1	20	MMF03-08	Material inadequate
Triodia brizoides	5	60	MMF03-02	
Triodia longiceps	3	60	MMF03-01	
Triodia wiseana	0.1	60		

Marra Mamba Flora Site MMF04

Described	RB/PC	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	528179	mE	7499590	mN	117.274185 E	-22.610248 S

Habitat Moderate north-facing rocky slope and crest of a low hill.
Soil Red-brown sandy loam.
Rock Type Continuous surface layer of ?dolerite fine gravel, coarse gravel, pebbles, cobbles and rocks/stones.
Vegetation *Acacia exilis* scattered shrubs over *Triodia wiseana* open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Note Elevation - 503 m.
Eucalyptus leucophloia subsp. *leucophloia* scattered low trees and *Acacia inaequilatera* scattered tall shrubs in broader landscape.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	50		
Acacia exilis	1	150	MMF04-02	
Cassia oligophylla x *helmsii*	0.1	45	=MM02-02	
Cassia pruinosa	0.1	120		
Eragrostis eriopoda	0.1	20	MMF04-04	
Eucalyptus leucophloia subsp. *leucophloia*	0.1	550		
Oldenlandia crouchiana	0.1	15		dead
Paraneurachne muelleri	0.1	35		
Ptilotus auriculifolius	0.1	30		dead
Ptilotus nobilis subsp. *nobilis*	0.1	5		
Sida echinocarpa	0.1	25	MMF04-05	
Triodia angusta	0.1	45	MMF04-03	
Triodia wiseana	20	40	MMF04-01	

Marra Mamba Flora Site MMF05

Described	PLSW	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	530976	mE	7501747	mN	117.301357 E	-22.590714 S

Habitat Moderate SW-facing hill / midslope.
Soil Red-brown sandy-clay.
Rock Type 11-30% cover of banded iron formation / ironstone fine gravel, coarse gravel, pebbles, cobbles, rocks/stones, large rocks and angled outcropping.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia exilis* scattered shrubs over *Indigofera monophylla* scattered low shrubs over *Triodia wiseana* (*T. epactia*) very open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia exilis	1	180		
Acacia kempeana	0.1	120	MMF05-11	
Acacia maitlandii	0.1	90		
Acacia pruinocarpa	0.1	140		
Acacia sibirica	0.1	80	MMF05-10	
Acacia trudgeniana	0.1	90	MMF05-02	
Acacia trudgeniana	0.1	100	MMF05-15	
Amphipogon sericeus	0.1	30		Sterile
Aristida contorta	0.1	15		
Aristida holathera var. holathera	0.1	30		
Bonamia sp. Dampier (A.A. Mitchell PRP 217)	0.1	6		
Cassia ferraria	0.1	240	MMF05-08	
Cassia glutinosa	0.1	180		
Cassia helmsii	0.1	50		
Cassia pruinosa	0.1	200		
Cassia pruinosa x ?	0.1	70	MMF05-14	
Corchorus lasiocarpus subsp. *parvus*	0.1	90	MMF05-04	
Dampiera candicans	0.1	50		
Eriachne aristidea	0.1	25		
Eriachne mucronata (arid form) (MET 12 736)	0.1	40	MMF05-07	
Eriachne mucronata (typical form)	0.1	35	MMF05-09	
Eriachne pulchella (subsp. not determined)	0.1	10		
Eucalyptus leucophloia subsp. *leucophloia*	0.5	450		
Goodenia microptera	0.1	30		
Goodenia stobbsiana	0.1	20		
Hakea chordophylla	0.1	200		
Indigofera monophylla	1	30	MMF05-01	
Jasminum didymum subsp. *lineare*	0.1	40		
Keraudrenia nephrosperma	0.1	70	MMF05-12	
Paraneurachne muelleri	0.1	40		
Peripleura virgata	0.1	20	MMF05-13	
Ptilotus astrolasius	0.1	30		
Ptilotus calostachyus	0.1	160		
Ptilotus nobilis subsp. *nobilis*	0.1	6		
Ptilotus rotundifolius	0.1	40		
Sida sp. Pilbara (A.A. Mitchell PRP 1543)	0.1	40	MMF05-06	
Triodia epactia	1	30		Sterile
Triodia wiseana	4	25	MMF05-05	

Marra Mamba Flora Site MMF06

Described	RB/PC	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	528108 mE	7500097 mN		117.273485 E	-22.605670 S	
Habitat	Stony undulating plain in series of rolling plains with gentle southerly aspect.						
Soil	Red-brown silty loam.						
Rock Type	Continuous layer (70%) of angular ironstone gravel, stones and small rocks.						
Vegetation	*Triodia brizoides, T. angusta* very open hummock grassland.						
Veg Condition	Good; scats of feral herbivores present; one individual of **Cenchrus ciliaris*.						
Fire Age	No sign of recent fire.						
Note	Elevation - 512 m.						

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	120		
Acacia exilis	0.1	30	MMF06-07	
Acacia synchronicia	0.1	30		
Aristida contorta	0.1	20		
Brachyachne prostrata	0.1	1		
Cassia glutinosa	0.1	160		
Cassia luerssenii	0.1	50		
Cassia oligophylla x *helmsii*	0.1	70	MMF06-02	
Cassia pruinosa	0.1	120		
**Cenchrus ciliaris*	0.1	25		X1
Corchorus lasiocarpus subsp. *lasiocarpus*	0.1	35	MMF06-14	
Enneapogon caerulescens	0.1	20		
Eremophila cuneifolia	0.1	15	MMF06-12	
Eremophila longifolia	0.1	120	MMF06-08	
Eriachne aristidea	0.1	15		
Eriachne pulchella	0.1	10	MMF06-19	
Eucalyptus leucophloia subsp. *leucophloia*	0.1	200		
Goodenia microptera	0.1	30		
Goodenia stobbsiana	0.1	20		
Heliotropium chrysocarpum	0.1	15	MMF06-17	
Iseilema dolichotrichum	0.1	4	MMF06-18	
Jasminum didymum subsp. *lineare*	0.1	40	MMF06-06	
Ptilotus nobilis subsp. *nobilis*	0.1	35		
Ptilotus obovatus	0.1	15		
Sclerolaena ? minuta	0.1	20	MMF06-04	
Sclerolaena ? minuta	0.1	20	MMF06-03	
Sclerolaena eriacantha	0.1	10	MMF06-13	
Sida aff. *fibulifera* (MET var. 'L')	0.1	15	MMF06-15	
Sida echinocarpa	0.1	40	MMF06-11	
Solanum lasiophyllum	0.1	35	=MMF02-04	
Sporobolus australasicus	0.1	20		
Streptoglossa bubakii	0.1	30		
Templetonia egena	0.1	150	MMF06-09	
Tribulus suberosus	0.1	25		
Triodia angusta	5	20	MMF06-05	
Triodia brizoides	10	25	MMF06-01	
Triodia epactia	0.1	30	MMF06-10	
Triodia wiseana	0.1	50	MMF06-16	

Marra Mamba Flora Site MMF07

Described	PLSW	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	532246	mE	7501459	mN	117.313719 E	-22.593292 S

Habitat Hilltop / ridgetop.
Soil Red to red-brown sandy clay.
Rock Type 11-30% covering of ironstone coarse gravel, pebbles, cobbles.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia, Corymbia deserticola* subsp. *deserticola* scattered low trees over *Triodia wiseana* open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Note Elevation - 587 m.
Very minimal (1 m wide) rehabilitated track running through center of quadrat - increases species abundance and % cover of *Triodia* spp. very slightly.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia atkinsiana	0.1	40		
Acacia bivenosa	0.1	70		
Acacia elachantha	0.1	150	MMF07-10	
Acacia maitlandii	0.1	70		
Acacia marramamba	0.1	110	MMF07-12	
Acacia trudgeniana	0.1	120	MMF07-07	
Amphipogon sericeus	0.1	30		Sterile
Aristida contorta	0.1	15		
Aristida holathera var. *holathera*	0.1	25		
Cassia glutinosa	0.1	60	MMF07-08	
Cassia glutinosa	0.1	120		
Cassia oligophylla x *helmsii*	0.1	45	MMF07-04	
Cassia pruinosa	0.1	160		
Codonocarpus cotinifolius	0.1	350		
Corchorus lasiocarpus subsp. *parvus*	0.1	30	MMF07-01	
Corymbia deserticola subsp. *deserticola*	0.5	130		
Cymbopogon ambiguus	0.1	80	MMF07-05	
Dodonaea coriacea	0.1	70		
Eriachne pulchella	0.1	10		
Eucalyptus leucophloia subsp. *leucophloia*	0.5	420		
Euphorbia sp. (site 1089)	0.1	10	MMF07-06	
Goodenia stobbsiana	0.1	30		
Gossypium robinsonii	0.1	180		
Hibiscus sturtii var. *campylochlamys*	0.1	35	MMF07-03	
Indigofera monophylla	0.1	40	MMF07-02	
Keraudrenia nephrosperma	0.1	60	MMF07-13	
Oldenlandia crouchiana	0.1	10		Dead
Paraneurachne muelleri	0.1	25		
Ptilotus calostachyus	0.1	50		
Ptilotus nobilis subsp. *nobilis*	0.1	10		
Schizachyrium fragile	0.1	2		
Solanum lasiophyllum	0.1	40		
Triodia melvillei	0.1	40	MMF07-11	
Triodia wiseana	11	70		

Marra Mamba Flora Site MMF08

Described	RPPS	Date	31/08/2012	Type	Quadrat 50 m x 50 m		
MGA	50	531756	mE	7500534	mN	117.308970 E	-22.601657 S

Habitat Undulating plain at base of large ridge.
Soil Red-brown sandy loam.
Rock Type Ironstone, continuous surface layer of gravel, pebbles, rocks.
Vegetation *Acacia citrinoviridis, A. pyrifolia* var. *pyrifolia* open shrubland over *Triodia epactia* open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Notes Elevation - 539 m.
Majority of *Acacia citrinoviridis* < 2 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon otocarpum (acute leaf form)	0.1	25		
Acacia ancistrocarpa	0.1	180		
Acacia citrinoviridis	1	200		
Acacia pyrifolia var. *pyrifolia*	1	100		
Acacia synchronicia	0.1	210		
Aristida contorta	0.1	15		
Bonamia rosea	0.1	30		
Cassia glutinosa	0.1	130	MMF08-07	
Cassia glutinosa x *'stricta'*	0.1	60	MMF08-06	
Cassia helmsii	0.1	50		
Cassia luerssenii	0.1	110		
Cassia oligophylla	0.1	85	MMF08-03	
Cleome viscosa	0.1	15		Dead
Enneapogon caerulescens	0.1	10		
Enneapogon polyphyllus	0.1	20		
Euphorbia sp. (site 1089)	0.1	5	MMF08-10	Determined by M. Trudgen
Gossypium australe (Burrup Peninsula form)	0.1	100		
Hakea lorea subsp. lorea	0.1	220		
Indigofera monophylla	0.1	50	MMF08-05	
Jasminum didymum subsp. *lineare*	0.1	130		
Maireana georgei	0.1	20	MMF08-04	
Maireana villosa	0.1	35	MMF08-11	
Paspalidium clementii	0.1	15	MMF08-12	
Pterocaulon sphacelatum	0.1	40	MMF08-08	
Ptilotus nobilis subsp. *nobilis*	0.1	30		
Scaevola spinescens (broad form)	0.1	70	MMF08-09	
Sida echinocarpa	0.1	35	MMF08-02	
Solanum lasiophyllum	0.1	20	=MM02-04	
Sporobolus australasicus	0.1	15		
Tribulus suberosus	0.1	100		
Triodia epactia	12	40	MMF08-01	

Marra Mamba Flora Site MMF09

Described	PLSW	Date	1/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	527446	mE	7499673	mN	117.267051 E	-22.609511 S

Habitat Minor floodplain, east of small drainage, west of low undulating hills.
Soil Light brown sandy clay.
Rock Type Generally bare, some parts with ironstone, mudstone 3-50 mm.
Vegetation *Acacia bivenosa* shrubland over *Triodia epactia* very open hummock grassland.
Veg Condition Good; some cattle scats and **Cenchrus ciliaris* present.
Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	15	190		
Acacia citrinoviridis	0.1	150		
Acacia citrinoviridis	0.1	130		
Acacia exilis	0.1	90		
Acacia inaequilatera	0.1	140		
Acacia kempeana	0.1	140	MMF09-02	
Acacia pyrifolia var. *pyrifolia*	0.1	80		
Acacia synchronicia	0.1	200		
Alternanthera nana	0.1	30		
Capparis lasiantha	0.1	180		
Cassia oligophylla	0.1	90	MMF09-03	
Cassia oligophylla x *helmsii*	0.1	60	MMF09-08	
**Cenchrus ciliaris*	0.1	40		x3
Chrysopogon fallax	0.1	30		
Eragrostis cumingii	0.1	10		
Eremophila longifolia	0.1	190		
Eucalyptus xerothermica	0.1	550		
Eulalia aurea	0.1	50		
Euphorbia tannensis subsp. *eremophila*	0.1	50		
Evolvulus alsinoides var. *villosicalyx*	0.1	10		
Goodenia forrestii	0.1	30	MMF09-10	
Gossypium australe (Burrup Peninsula form)	0.1	40		
Indigofera monophylla	0.1	50	MMF09-05	
Jasminum didymum subsp. *lineare*	0.1	130		
Petalostylis labicheoides	0.1	230		
Pterocaulon sphacelatum	0.1	35	MMF09-04	
Ptilotus nobilis subsp. *nobilis*	0.1	20		
Salsola australis	0.1	25		
Sida aff. *fibulifera* (oblong; MET 15 220)	0.1	25	MMF09-07	
Sida arsiniata	0.1	25	MMF09-06	
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90	0.1	90		
Sporobolus australasicus	0.1	15		
Streptoglossa bubakii	0.1	25	MMF09-09	
Stylobasium spathulatum	0.1	250		
Themeda triandra	0.1	45		
Triodia epactia	13	40	MMF09-01	

Marra Mamba Flora Site MMF10

Described	RB/PC	Date	1/09/2012		Type	Quadrat 50 m x 50 m		
MGA	50	530296	mE	7500388	mN	117.294768 E	-22.603003 S	

Habitat Very gently undulating stony plain at base of large ridge.

Soil Red-brown sandy clay.

Rock Type Ironstone continuous surface layer of gravel, pebbles, rocks.

Vegetation *Acacia xiphophylla* tall open shrubland over *Cassia luerssenii* scattered shrubs over *Triodia epactia, T. brizoides* scattered hummock grasses.

Veg Condition Very Good; signs of donkeys but no evidence of grazing.

Fire Age No sign of recent fire.

Note Elevation - 513 m.
No sign of recent fire, however approximately 1-2% of the mature *Acacia "aneura"* in quadrat is dead.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon aff. *lepidum* (1) (MET 15 352)	0.1	50	MMF10-19	
Acacia ? *incurvaneura*	0.1	90	MMF10-18	Juvenile
Acacia ? *incurvaneura*	0.1	110	MMF10-06	Juvenile
Acacia atkinsiana	0.1	130		
Acacia bivenosa	0.1	100		
Acacia synchronicia	0.1	30		
Acacia tenuissima	0.1	70	MMF10-15	
Acacia xiphophylla	2	230		
Aristida contorta	0.1	25		
Brachyachne prostrata	0.1	1		
Cassia glutinosa x *'stricta'*	0.1	40	MMF10-05	
Cassia luerssenii	1	120	MMF10-09	
Cassia oligophylla	0.1	110	MMF10-13	
Cassia oligophylla x *helmsii*	0.1	50	MMF10-23	
Cassia 'stricta'	0.1	100	MMF10-16	
Codonocarpus cotinifolius	0.1	120		
Corchorus crozophorifolius	0.1	60		
Duperreya commixta	0.1	200		
Enneapogon caerulescens	0.1	15		
Enneapogon polyphyllus	0.1	10		
Eremophila cuneifolia	0.1	25	MMF10-10	
Eremophila sp. (? hybrid)	0.1	30	MMF10-24	
Eriachne mucronata (typical form)	0.1	35		
Eriachne pulchella	0.1	15	MMF10-02	
Evolvulus alsinoides var. *villosicalyx*	0.1	20		
Goodenia forrestii	0.1	30	MMF10-14	
Goodenia microptera	0.1	35		
Hibiscus coatesii	0.1	8	MMF10-07	
Keraudrenia nephrosperma	0.1	45	MMF10-11	
Maireana georgei	0.1	35	MMF10-03	
Maireana melanocoma	0.1	25	MMF10-22	
Maireana thesioides	0.1	60	MMF10-17	
Paspalidium clementii	0.1	6	MMF10-21	
Ptilotus astrolasius	0.1	20		
Ptilotus nobilis subsp. *nobilis*	0.1	40		
Ptilotus schwartzii var. *schwartzii*	0.1	40	MMF10-04	
Sclerolaena eriacantha	0.1	10	MMF10-20	

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Sporobolus australasicus	0.1	25		
Tribulus suberosus	0.1	40		
Triodia brizoides	1	40	MMF10-12	
Triodia epactia	1	50	MMF10-01	
Triodia wiseana	0.1	25	MMF10-25	

Marra Mamba Flora Site MMF11

Described	PLSW	Date	1/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	530792	mE	7500492	m	117.299592 E	-22.602055 S

Habitat Gently SE sloping plain at foothills amongst undulating plains/low hills.
Soil Red brown sandy clay (5% clay).
Rock Type Ironstone and calcrete gravel pebbles, cobbles with 1% outcropping.
Vegetation *Triodia epactia, T. wiseana, T. brizoides* scattered hummock grasses.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Note Elevation: 526 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon aff. *lepidum*	0.1	10	MMF11-10	
Acacia atkinsiana	0.1	70		
Acacia bivenosa	0.1	75		
Acacia exilis	0.1	80		
Acacia maitlandii	0.1	50		
Acacia pyrifolia var. *pyrifolia*	0.1	20		
Acacia synchronicia	0.1	20		
Aristida contorta	0.1	10		
Aristida holathera var. *holathera*	0.1	25		
Capparis lasiantha	0.1	100		
Cassia glutinosa	0.1	110		
Cassia helmsii	0.1	45		
Cassia luerssenii	0.1	100		
Cassia oligophylla	0.1	80	MMF11-11	
Cassia pruinosa	0.1	130		
Corchorus lasiocarpus subsp. *parvus*	0.1	80	MMF11-12	
Cymbopogon ambiguus	0.1	60	MMF11-08	
Enneapogon caerulescens	0.1	10		
Enneapogon polyphyllus	0.1	10		
Eremophila cuneifolia	0.1	50		
Eriachne aristidea	0.1	10		
Eriachne pulchella	0.1	15		
Goodenia microptera	0.1	25		
Goodenia stobbsiana	0.1	35		
Hibiscus sturtii var. *platychlamys*	0.1	20		
Iseilema dolichotrichum	0.1	10	MMF11-04	
Jasminum didymum subsp. *lineare*	0.1	60		
Maireana georgei	0.1	40		
Paraneurachne muelleri	0.1	50		
Ptilotus nobilis subsp. *nobilis*	0.1	80		
Salsola australis	0.1	40		
Schizachyrium fragile	0.1	15		
Sclerolaena eriacantha	0.1	15	MMF11-05	
Sclerolaena minuta	0.1	10	MMF11-07	Determined by P.Wilson
Sida arsiniata	0.1	30	=MMF09-06	
Sida echinocarpa	0.1	20	MMF11-09	
Sporobolus australasicus	0.1	10		
Tribulus suberosus	0.1	60		
Triodia angusta	0.1	45	MMF11-06	

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Triodia brizoides	0.5	65	MMF11-03	
Triodia epactia	1	70	MMF11-01	
Triodia wiseana	0.5	60	MMF11-02	

Marra Mamba Flora Site MMF12

Described	RB/PC	Date	1/09/2012	Type	Quadrat 20 m x 125 m		
MGA	50	530167	mE	7500136	mN	117.293518 E	-22.605282 S

Habitat Moderate-sized creek incised up to 3m.
Soil Bed: red-brown sand; Bank: red-brown sandy clay.
Rock Type Ironstone and some calcareous material. River stones.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Petalostylis labicheoides,* (*Acacia citrinoviridis, Gossypium robinsonii*) tall shrubland over *Androcalva luteiflora, Stylobasium spathulatum* scattered shrubs.
Veg Condition Good; scats of feral herbivores; **Cenchrus ciliaris* present.
Fire Age No sign of recent fire.
Note Elevation – 514 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon dioicum	0.1	100	MMF12-04	
Acacia atkinsiana	0.1	80		
Acacia bivenosa	0.1	200		
Acacia citrinoviridis	5	350		
Acacia maitlandii	0.1	60		
Acacia synchronicia	0.1	40		
Alternanthera nana	0.1	10	MMF12-12	
Androcalva luteiflora	1	170		
Capparis lasiantha	0.1	30		
Cassia glutinosa	0.1	140		
Cassia glutinosa x *'stricta'*	0.1	45	MMF12-14	
Cassia oligophylla	0.1	110	MMF12-03	
**Cenchrus ciliaris*	0.1	40		
Codonocarpus cotinifolius	0.1	150		
Cucumis variabilis	0.1	50		
Dodonaea lanceolata var. *lanceolata*	0.1	20	MMF12-13	
Duperreya commixta	0.1	200		
Eremophila longifolia	0.1	40		
Eriachne mucronata (typical form)	0.1	35		
Eriachne tenuiculmis	0.1	25		
Eucalyptus leucophloia subsp. *leucophloia*	1	500		
Euphorbia biconvexa	0.1	35	MMF12-15	
Euphorbia sp. (site 1089)	0.1	20	MMF12-06	Determined by M. Trudgen
Evolvulus alsinoides var. *villosicalyx*	0.1	25		
Goodenia stobbsiana	0.1	40		
Gossypium robinsonii	1	300		
Hibiscus sturtii var. *campylochlamys*	0.1	20	MMF12-09	
Hybanthus aurantiacus	0.1	30		
Indigofera monophylla	0.1	30	MMF12-02	
Jasminum didymum subsp. *lineare*	0.1	100		
Lepidium pedicellosum	0.1	50	MMF12-10	
Paraneurachne muelleri	0.1	40		
Paspalidium clementii	0.1	40		
Petalostylis labicheoides	25	300		
Pterocaulon sphacelatum	0.1	100	MMF12-05	
Ptilotus auriculifolius	0.1	30		
Ptilotus calostachyus	0.1	45		

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Ptilotus nobilis subsp. *nobilis*	0.1	80		
Rhynchosia minima	0.1	20		
Scaevola spinescens (broad form)	0.1	80	MMF12-08	
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90	0.1	3	MMF12-07	
Stylobasium spathulatum	4	130		
Tephrosia rosea var. *glabrior*	0.1	50	MMF12-11	
Themeda triandra	0.1	55		
Triodia angusta	0.1	70	MMF12-16	
Triodia epactia	0.1	50	MMF12-01	

Marra Mamba Flora Site MMF13
Described PLSW Date 1/09/2012 Type Quadrat 50 m x 50 m
MGA 50 531182 mE 7500135 mN 117.303393 E -22.605273 S
Habitat Low rise.
Soil Light brown to red sandy clay.
Rock Type Continuous rock layer - ironstone, mudrock, quartz (2-60 mm) with mudstone
Vegetation *Triodia brizoides, T. angusta* very open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia ancistrocarpa	0.1	90		
Acacia bivenosa	0.1	70		
Acacia kempeana	0.1	45	MMF13-12	
Acacia sibirica	0.1	70	MMF13-07	
Acacia synchronicia	0.1	20		
Aristida contorta	0.1	30		
Aristida holathera var. *holathera*	0.1	25		
Cassia glutinosa	0.1	120	MMF13-04	
Cassia luerssenii	0.1	150		
Cassia oligophylla	0.1	50	MMF13-11	
Cassia oligophylla x *helmsii*	0.1	40	MMF13-15	
Cassia pruinosa	0.1	100		
Codonocarpus cotinifolius	0.1	150		
Corchorus lasiocarpus subsp. *parvus*	0.1	40	MMF13-01	
Cymbopogon ambiguus	0.1	60	=MMF11-08	
Enneapogon caerulescens	0.1	25	MMF13-14	
Enneapogon polyphyllus	0.1	25		
Eremophila cuneifolia	0.1			
Eriachne pulchella	0.1	10		
Eucalyptus leucophloia subsp. *leucophloia*	0.1	400		
Gomphrena canescens	0.1	10	MMF13-03	
Gomphrena cunninghamii	0.1	10		
Goodenia forrestii	0.1	25		
Goodenia microptera	0.1	30		
Gossypium sturtianum	0.1	180	MMF13-10	
Hakea lorea subsp. *lorea*	0.1	160		
Jasminum didymum subsp. *lineare*	0.1	100		
Keraudrenia nephrosperma	0.1	40		
Lepidium pholidogynum	0.1	7	MMF13-08	
Maireana melanocoma	0.1	40	MMF13-09	
Paraneurachne muelleri	0.1	30		
Paspalidium clementii	0.1	10	MMF13-05	
Ptilotus nobilis subsp. *nobilis*	0.1	50		
Ptilotus obovatus	0.1	30		
Ptilotus rotundifolius	0.1	170		
Schizachyrium fragile	0.1	10		
Sclerolaena eriacantha	0.1	25	=MMF11-05	
Sclerolaena minuta	0.1	20	MMF13-06	Determined by P. Wilson
Sida echinocarpa	0.1	35	MMF13-13	
Sporobolus australasicus	0.1	150		

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Streptoglossa bubakii	0.1	15		
Tribulus suberosus	0.1	80		
Triodia angusta	3	30	=MMF11-06	
Triodia brizoides	0.1	30	=MMF11-03	
Triodia epactia	0.1	40	MMF13-02	
Triodia wiseana	0.1	20		

Marra Mamba Flora Site MMF14

Described	RB/PC	Date	1/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	529387 mE		7499901 mN	117.285933 E	-22.607418 S	
Habitat	Gently undulating plain, southerly aspect, between low hill and flowline.						
Soil	Red-brown silty loam.						
Rock Type	Ironstone, quartz, ?dolomite discontinuous surface layer of gravel, pebbles, rocks.						
Vegetation	*Triodia wiseana, T. epactia* very open hummock grassland.						
Veg Condition	Very Good.						
Fire Age	No sign of recent fire. *Acacia sibirica* are resprouting and *Corymbia hamersleyana* are only 250 cm tall, however hummocks of *Triodia* spp. are mature in size.						
Note	Elevation - 506 m. Within broader veg unit, *Acacia inaequilatera* is present as scattered tall shrubs; <1% in quadrat.						

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Abutilon trudgenii	0.1	7	MMF14-15	
Acacia atkinsiana	0.1	60		
Acacia bivenosa	0.1	30		
Acacia exilis	0.1	120	MMF14-14	
Acacia inaequilatera	0.1	250		
Acacia sibirica	0.1	40	MMF14-03	
Aristida contorta	0.1	25		
Boerhavia sp.	0.1	15		Inadequate material
Capparis lasiantha	0.1	100		
Cassia luerssenii	0.1	50		
Cassia oligophylla x *helmsii*	0.1	50	MMF14-04	
Cassia pruinosa	0.1	50		
Corchorus lasiocarpus subsp. *lasiocarpus*	0.1	45	MMF14-12	
Corymbia hamersleyana	0.1	250		
Enneapogon caerulescens	0.1	25		
Enneapogon polyphyllus	0.1	45		
Euphorbia biconvexa/alsiniflora	0.1	25	MMF14-13	
Euphorbia sp. (FMLMC-10)	0.1	6	MMF14-07	
Evolvulus alsinoides var. villosicalyx	0.1	10		
Goodenia forrestii	0.1	7		Dead
Heliotropium cunninghamii	0.1	10	MMF14-08	
Heliotropium inexplicitum	0.1	5	MMF14-06	
Hibiscus sturtii var. *campylochlamys*	0.1	5	MMF14-16	
Indigofera monophylla	0.1	30	MMF14-10	
Iseilema dolichotrichum	0.1	10	MMF14-18	
Jasminum didymum subsp. *lineare*	0.1	100		
Polycarpaea longiflora	0.1	10		
Ptilotus auriculifolius	0.1	30		
Ptilotus nobilis subsp. *nobilis*	0.1	3		
Ptilotus obovatus	0.1	40		
Salsola australis	0.1	35		
Sida aff. *fibulifera* (oblong; MET 15 220)	0.1	25	MMF14-19	
Sida echinocarpa	0.1	45	MMF14-11	
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)	0.1	100	MMF14-17	
Sporobolus australasicus	0.1	15		
Trachymene oleracea subsp. *oleracea*	0.1	35		Dead

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Triodia epactia	2	45	MMF14-02	
Triodia wiseana	8	35	MMF14-01	

Marra Mamba Flora Site MMF15

Described	PLSW	Date	1/09/2012	Type	Quadrat 50m x 50 m		
MGA	50	530726	mE	7500750	mN	117.298945 E	-22.599725 S

Habitat Crest of hill/mesa gently sloping northwest.
Soil Red-brown skeletal sandy clay.
Rock Type Continuous layer of outcropping and ironstone cobbles, rocks.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia exilis, A. maitlandii* scattered shrubs over *Triodia wiseana* open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Note Elevation: 575 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia atkinsiana	0.1	40		
Acacia exilis	1	160		
Acacia maitlandii	1	130		
Acacia marramamba	0.1	130	MMF15-01	
Amphipogon sericeus	0.1	20		Sterile
Aristida contorta	0.1	10		
Aristida holathera var. *holathera*	0.1	20		
Cassia glutinosa	0.1	150		
Cassia helmsii	0.1	40		
Cassia oligophylla	0.1	60	MMF15-06	
Cassia pruinosa	0.1	150		
Cassia pruinosa x ?	0.1	110	MMF15-05	
Eriachne mucronata (typical form)	0.1	20	MMF15-03	
Eucalyptus leucophloia subsp. *leucophloia*	1	600		
Fimbristylis simulans	0.1	10		
Goodenia stobbsiana	0.1	20		
Indigofera monophylla	0.1	40	MMF15-02	
Keraudrenia nephrosperma	0.1	45		
Oldenlandia crouchiana	0.1	10		Dead
Paraneurachne muelleri	0.1	40		
Ptilotus astrolasius	0.1	10	MMF15-04	
Ptilotus calostachyus	0.1	140		
Ptilotus nobilis subsp. *nobilis*	0.1	10		
Schizachyrium fragile	0.1	5		
Solanum lasiophyllum	0.1	40		
Tribulus suberosus	0.1	70		
Triodia wiseana	12	30		

Marra Mamba Flora Site MMF16

Described	RB/PC	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	517884	mE	7497166	mN	117.174041 E	-22.632286 S

Habitat Rolling foothills of range of hills situated to the north.
Soil Dark reddish-brown loam.
Rock Type Ironstone angled rocky outcropping in some areas. Grey brown rock other.
Vegetation *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland.
Veg Condition Very Good: tracks of feral herbivores evident.
Fire Age Very long unburnt.
Notes Elevation - 525 m.
Triodia epactia in depressions between higher ground.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia inaequilatera	1	300		
Acacia synchronicia	0.1	200		
Cassia oligophylla x *helmsii*	0.1	70	MMF16-02	
Cassia pruinosa	0.1	200		
Enneapogon caerulescens	0.1	30	MMF16-05	
Euphorbia sp. (FMLMC-10)	0.1	5	MMF16-06	
Oldenlandia crouchiana	0.1	20		Dead
Paraneurachne muelleri	0.1	25		
Ptilotus nobilis subsp. *nobilis*	0.1	45		Dead
Salsola australis	0.1	20		Dead
Sida echinocarpa	0.1	20	MMF16-03	
Sporobolus australasicus	0.1	15		
Trichodesma zeylanicum var. *zeylanicum*	0.1	80		Dead
Triodia epactia	0.1	70	MMF16-04	
Triodia wiseana	45	80	MMF16-01	

Marra Mamba Flora Site MMF17

Described	PLSW	Date	1/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	531509	mE	7500848	mN	117.306561 E	-22.598825 S

Habitat Hill top with south third sloping south.
Soil Red-brown sandy clay.
Rock Type Continuous ironstone (2-60mm) with outcropping.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia exilis* (*Cassia pruinosa*) open shrubland over *A. maitlandii* scattered low shrubs over *Triodia wiseana* open hummock grassland.
Veg Condition Excellent.
Fire Age Burnt 3-5 years ago.
Note Inactive *Pseudomys chapmani* mound in quadrat.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	60		
Acacia exilis	2	150		
Acacia kempeana	0.1	40	MMF17-07	
Acacia maitlandii	0.5	100		
Acacia monticola	0.1	90		
Acacia synchronicia	0.1	40		
Aristida holathera var. *holathera*	0.1	20		
Bonamia sp. Dampier (A.A. Mitchell PRP 217)	0.1	5		
Cassia glaucifolia x ?	0.1	80	MMF17-06	
Cassia glutinosa	0.1	120		
Cassia pruinosa	0.5	190		
Cassia pruinosa x ?	0.1	140	MMF17-01	x ?*glaucifolia*
Corchorus lasiocarpus subsp. *lasiocarpus*	0.1	50	MMF17-03	
Dampiera candicans	0.1	70		
Eremophila cuneifolia	0.1	30		
Eriachne mucronata (typical form)	0.1	50	MMF17-05	
Eriachne pulchella	0.1	10		
Eucalyptus leucophloia subsp. *leucophloia*	0.5	400		
Goodenia stobbsiana	0.1	30		
Gossypium australe (Burrup Peninsula form)	0.1	40		
Hakea chordophylla	0.1	230		
Hakea lorea subsp. *lorea*	0.1	130		
Indigofera monophylla	0.1	30	MMF17-02	
Keraudrenia nephrosperma	0.1	50		
Paraneurachne muelleri	0.1	45		
Ptilotus calostachyus	0.1	160		
Ptilotus nobilis subsp. *nobilis*	0.1	25		
Ptilotus rotundifolius	0.1	120		
Schizachyrium fragile	0.1	10		
Sida aff. *cardiophylla*	0.1	40	MMF17-04	Insufficient material for further determination.
Solanum lasiophyllum	0.1	40		
Tribulus suberosus	0.1	100		
Triodia wiseana	13	25		

Marra Mamba Flora Site MMF18

Described	RB/PC	Date	2/09/2012		Type	Quadrat 60 m x 40 m	
MGA	50	518123	mE	7497384	mN	117.176365 E	-22.630314 S

Habitat: Crest and slopes of very undulating plain at base of large ridge. Gentle south-southeasterly aspect.

Soil: Dark reddish brown clay loam.

Rock Type: Mostly ?dolomite/mudstone, some ironstone, quartz. Continuous surface layer of gravel, pebbles and rocks.

Vegetation: *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* (*T. angusta*) hummock grassland.

Veg Condition: Excellent.

Fire Age: Very long unburnt.

Note: Elevation - 521 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	300		
Acacia inaequilatera	1	350		
Acacia synchronicia	0.1	250		
Aristida contorta	0.1	5		
Cassia glutinosa	0.1	240	MMF18-05	
Cassia luerssenii	0.1	50		
Cassia oligophylla x *helmsii*	0.1	40	=MMF16-02	
Cassia pruinosa	0.1	110		Very poor condition
Enneapogon caerulescens	0.1	10		Dead
Maireana georgei	0.1	20	MMF18-03	
Ptilotus nobilis subsp. *nobilis*	0.1	45		Dead
Sida echinocarpa	0.1	25	MMF18-02	
Tribulus suberosus	0.1	70		
Trichodesma zeylanicum var. *zeylanicum*	0.1	50		Dead
Triodia angusta	1	80	MMF18-04	
Triodia wiseana	32	60	MMF18-01	

Marra Mamba Flora Site MMF19

Described	PLSW	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	516674	mE	7497222 mN	117.162266 E	-22.631793 S	

Habitat: Plain/shallow depression between undulating low hills.

Soil: Light-brown, very soft/aerated sandy clay loam with cracking clay. Very soft clay loam (easily depressed with weight).

Rock Type: Discontinuous layer of ironstone gravel, pebbles and cobbles with intermittent cracking clay (2%).

Vegetation: *Acacia xiphophylla* tall shrubland over *Cassia* aff. *oligophylla* (thinly sericeous), *Enchylaena tomentosa* var. *tomentosa* low open shrubland over *Triodia longiceps* scattered hummock grasses.

Veg Condition: Excellent.

Fire Age: Very long unburnt.

Note: Elevation: 534 m.
"Crabholes" amongst cracking clay sections throughout quadrat.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia xiphophylla	16	310	MMF19-01	
Aristida latifolia	0.1	15	MMF19-03	
Cassia aff. *oligophylla* (thinly sericeous)	3	70	MMF19-10	
Cassia glutinosa x *luerssenii*	0.1	100	MMF19-04	
Cassia oligophylla x *helmsii*	0.1	60	MMF19-08	
Enchylaena tomentosa var. *tomentosa*	1	100	MMF19-06	
Eremophila cuneifolia	0.1	30		
Maireana georgei	0.1	25	MMF19-11	
Ptilotus obovatus	0.1	60		
Rhagodia eremaea	0.1	160		
Salsola australis	0.1	30		
Scaevola spinescens (narrow form)	0.1	160		
Sida aff. *fibulifera* (MET var. 'L')	0.1	20	MMF19-09	
Solanum lasiophyllum	0.1	25		
Streptoglossa bubakii	0.1	30	MMF19-05	
Triodia longiceps	1	110	MMF19-02	

Marra Mamba Flora Site MMF20

Described	RB/PC	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	517919	mE	7497648 mN	117.174377 E	-22.627932 S	

Habitat: Hilltop in range of low rolling hills.
Soil: Red-brown loamy sand.
Rock Type: Continuous surface layer of ironstone fine gravel, rocks and some outcropping.
Vegetation: *Triodia wiseana* open hummock grassland.
Veg Condition: Excellent.
Fire Age: No sign of recent fire.
Note: Elevation - 585 m.
Mixed *Acacia* and *Eucalyptus leucophloia* subsp. *leucophloia* scattered over hilltop vegetation in surrounds.
2 x *Pseudomys chapmani* mounds in quadrat.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia atkinsiana	0.1	40		
Acacia bivenosa	0.1	200		
Acacia pruinocarpa	0.1	250		
Acacia synchronicia	0.1	50		
Acacia tetragonophylla	0.1	50		
Amphipogon sericeus	0.1	20		Sterile
Aristida holathera var. *holathera*	0.1	10		
Cassia glutinosa	0.1	100	MMF20-05	
Cassia glutinosa x *luerssenii*	0.1	120	MMF20-04	
Cassia pruinosa	0.1	170		
Cymbopogon ambiguus	0.1	80	MMF20-06	
Dampiera candicans	0.1	30		Dead
Eriachne mucronata (typical form)	0.1	40		
Eucalyptus leucophloia subsp. *leucophloia*	0.1	500		
Goodenia stobbsiana	0.1	35		Dead
Oldenlandia crouchiana	0.1	10		
Paraneurachne muelleri	0.1	30		
Polycarpaea holtzei	0.1	8	MMF20-03	
Ptilotus calostachyus	0.1	70		
Ptilotus nobilis subsp. *nobilis*	0.1	30		
Ptilotus rotundifolius	0.1	90		
Schizachyrium fragile	0.1	3		
Solanum lasiophyllum	0.1	35		
Tribulus suberosus	0.1	45		
Triodia wiseana	15	40	MMF20-01	

Marra Mamba Flora Site MMF21

Described	PLSW	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	516721	mE	7496926 mN	117.162726 E	-22.634466 S	

Habitat Low rise.
Soil Light brown/pink sandy clay.
Rock Type Ironstone, shale, quartz, outcropping, continuous scree (10-100 mm stones).
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Triodia wiseana, T. angusta* (*T. longiceps*) open hummock grassland.
Veg Condition Excellent.
Fire Age Very long unburnt.
Note Elevation: 534 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia atkinsiana	0.1	30		Juvenile
Acacia bivenosa (wispy/weeping form)	0.1	260		
Acacia synchronicia	0.1	130		
Acacia tetragonophylla	0.1	100		
Cassia glutinosa	0.1	140		
Cassia oligophylla x *helmsii*	0.1	35	MMF21-03	
Cassia pruinosa	0.1	230		
Eriachne mucronata (typical form)	0.1	30	MMF21-04	
Eucalyptus leucophloia subsp. *leucophloia*	3	600		
Maireana georgei	0.1	30	=MMF19-11	
Maireana melanocoma	0.1	40	MMF21-02	
Polycarpaea corymbosa	0.1	20		Dead
Ptilotus nobilis subsp. *nobilis*	0.1	10		
Ptilotus obovatus	0.1	50		
Rhagodia eremaea	0.1	40		
Scaevola spinescens (narrow form)	0.1	50		
Sclerolaena ? minuta	0.1	10	MMF21-05	
Solanum lasiophyllum	0.1	40		
Triodia angusta	5	90	MMF21-06	
Triodia longiceps	1	80	MME18-2=	
Triodia wiseana	6	70	MMF21-01	

Marra Mamba Flora Site MMF22

Described	RB/PC	Date	3/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	519905	mE	7497555	mN	117.193704 E	-22.628750 S

Habitat Hillslope - northerly aspect, gentle slope.

Soil Red-brown silty clay loam.

Rock Type Continuous surface layer of gravel, pebbles, rocks dominated by calcrete, dolomite, quartz, ironstone.

Vegetation *Eucalyptus socialis* subsp. *eucentrica* scattered low mallees over *Melaleuca eleuterostachya* open shrubland over *Triodia angusta* open hummock grassland.

Veg Condition Excellent.

Fire Age Very long unburnt.

Note Elevation - 500 m.
Very minor rocky flowline running through quadrat, but no drainage specific species found.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa (wispy/weeping form)	0.1	230		
Cassytha capillaris	0.1	50		
Eucalyptus leucophloia subsp. *leucophloia*	0.1	250		
Eucalyptus socialis subsp. *eucentrica*	1	230	MMF22-01	
Melaleuca eleuterostachya	2	120	MMF22-02	
Ptilotus nobilis subsp. *nobilis*	0.1	25		
Sclerolaena ? minuta	0.1	5	MMF22-05	
Triodia angusta	20	65	MMF22-03	
Triodia wiseana	0.1	45	MMF22-04	

Marra Mamba Flora Site MMF23

Described	PLSW	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	517348	mE	7497202	mN	117.168825 E	-22.631967 S

Habitat Low ridge and NE-facing moderate rocky slope amongst undulating hills.
Soil Skeletal brown sandy loam.
Rock Type Continuous layer of shale pebbles, cobbles, rocks.
Vegetation *Acacia* ? *incurvaneura*, *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) tall shrubland over *A. marramamba* open shrubland over *Triodia epactia, T. longiceps* very open hummock grassland.
Veg Condition Excellent.
Fire Age Very long unburnt.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia ? *incurvaneura*	16	500	MMF23-01	
Acacia marramamba	3	150		
Aristida holathera var. *holathera*	0.1	15		
Cassia luerssenii	0.1	200		Dead
Eremophila forrestii subsp. *forrestii*	0.1	140		
Eriachne mucronata (typical form)	0.1	50	MMF23-04	
Eucalyptus leucophloia subsp. leucophloia	0.1	450		
Goodenia stobbsiana	0.1	15		
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ	2	300	MMF23-02	x20
Hibiscus burtonii	0.1	70		
Maireana georgei	0.1	40		
Scaevola acacioides	0.1	140	MMF23-05	
Schizachyrium fragile	0.1	10		
Solanum horridum	0.1	8		
Triodia epactia	2	90	MMF23-03	
Triodia longiceps	1	90		
Triodia wiseana	0.1	70		

Marra Mamba Flora Site MMF24

Described	RB/PC	Date	3/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	520256	mE	7497852	mN	117.197116 E	-22.626062 S

Habitat: Gentle, grading to moderate north-facing slope in a series of low rolling hills to undulating plains.

Soil: Dark reddish-brown silty clay loam.

Rock Type: Grey-brown coarse-grained rock; some outcropping rock.

Vegetation: *Acacia exilis,* (*A. bivenosa* (wispy/weeping form)) tall open shrubland over *Triodia wiseana* hummock grassland.

Veg Condition: Excellent.

Fire Age: Very long unburnt.

Note: Elevation - 505 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa (wispy/weeping form)	1	280		
Acacia exilis	3	220	MMF24-02	
Acacia maitlandii	0.1	110		
Acacia synchronicia	0.1	160		
Cassia luerssenii	0.1	35		
Cassia oligophylla x *helmsii*	0.1	50	MMF24-03	Juvenile
Cassia pruinosa	0.1	120		
Oldenlandia crouchiana	0.1	8		Dead
Ptilotus rotundifolius	0.1	50		
Swainsona maccullochiana	0.1	40	MMF24-04	
Triodia wiseana	60	90	=MMF22-0=	

Marra Mamba Flora Site MMF25

Described	PLSW	Date	2/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	518654	mE	7498073	mN	117.181524 E	-22.624084 S

Habitat Range top.
Soil Red brown sandy clay.
Rock Type Skeletal ironstone outcropping.
Vegetation *Acacia atkinsiana* scattered tall shrubs over *Triodia wiseana* hummock grassland.
Veg Condition Excellent.
Fire Age Very long unburnt.
Note Elevation - 584 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia ? incurvaneura	0.1	320	MMF25-05	
Acacia atkinsiana	1.5	350	MMF25-02	
Acacia exilis	0.1	130	MMF25-07	
Acacia marramamba	0.1	100	MMF25-06	
Acacia pruinocarpa	0.1	280		
Acacia sibirica	0.1	190	MMF25-12	
Acacia trudgeniana	0.1	230	MMF25-04	
Amyema fitzgeraldii	0.1	180	MMF25-13	
Cassia glutinosa	0.1	130		
Cassia helmsii	0.1	20		
Cassia pruinosa	0.1	170		
Cymbopogon ambiguus	0.1	80	MMF25-08	
Eriachne mucronata (typical form)	0.1	25	MMF25-03	
Eucalyptus leucophloia subsp. *leucophloia*	0.1	160		
Goodenia stobbsiana	0.1	10		
Hakea chordophylla	0.1	300		
Jasminum didymum subsp. *lineare*	0.1	60		
Pterocaulon sphacelatum	0.1	45	MMF25-10	
Ptilotus obovatus	0.1	80		
Ptilotus rotundifolius	0.1	40		
Themeda triandra	0.1	60	MMF25-11	
Tribulus suberosus	0.1	70		
Trichodesma zeylanicum var. *zeylanicum*	0.1	90		
Triodia wiseana	32	40	MMF25-01	

Marra Mamba Flora Site MMF26

Described	RB/PC	Date	3/09/2012	Type	Quadrat 50 m x 50 m
MGA 50	521192 mE		7497834 mN	117.206225 E	-22.626214 S

Habitat Undulating plain at base of low hills. Gentle slope, easterly aspect.
Soil Red-brown loam.
Rock Type Ironstone, calcrete, quartz continuous surface layer of gravel, pebbles, rocks.
Vegetation *Melaleuca eleuterostachya* open shrubland over *Triodia angusta, T. wiseana* open hummock grassland.
Veg Condition Very Good; cattle tracks present.
Fire Age Very long unburnt.
Note Elevation - 496 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	220		
Aristida contorta	0.1	25		
Cassia luerssenii	0.1	150		
Cassia oligophylla x *helmsii*	0.1	40	MMF26-06	
Cassia pruinosa	0.1	30		
Enneapogon caerulescens	0.1	20		
Eriachne pulchella	0.1	5	MMF26-05	
Eucalyptus leucophloia subsp. *leucophloia*	0.1	500		
Heliotropium chrysocarpum	0.1	30	MMF26-03	
Iseilema dolichotrichum	0.1	4	MMF26-04	
Melaleuca eleuterostachya	2	120		
Oldenlandia crouchiana	0.1	3		Dead
Paraneurachne muelleri	0.1	35		
Ptilotus nobilis subsp. *nobilis*	0.1	4		
Sclerolaena eriacantha	0.1	5	MMF26-07	
Solanum lasiophyllum	0.1	160		
Sporobolus australasicus	0.1	15		
Triodia angusta	15	80	MMF26-02	
Triodia wiseana	10	45	MMF26-01	

Marra Mamba Flora Site MMF27

Described	PLSW	Date	3/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	519228	mE	7497507	mN	117.187117 E	-22.629191 S

Habitat: Crest and moderate to gentle sloping midslope and footslope. South-southwest aspect.

Soil: Brown sandy loam; 10YR 5/3.

Rock Type: Sandstone/dolomite conglomerate gravel, pebbles, cobbles and scattered outcropping (2-5%).

Vegetation: *Acacia inaequilatera* tall open shrubland over *Triodia wiseana,* (*T. epactia*) open hummock grassland.

Veg Condition: Excellent.

Fire Age: No sign of recent fire.

Note: Elevation: 510 m.

Corymbia hamersleyana sub-adult (250 cm, 0.5%) present in quadrat but represents intruder from nearby drainage. *Triodia epactia* confined to SW-SE border on lower slope nearest drainage (not represented in broader veg unit on undulating hills/crests).

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia inaequilatera	3	220		
Aristida contorta	0.1	20		
Cassia glutinosa	0.1	140		
Cassia oligophylla x *helmsii*	0.1	70	MMF27-02	
Corchorus aff. *parviflorus*	0.1	60	MMF27-06	
Corymbia hamersleyana	0.1	250		
Cymbopogon ambiguus	0.1	60	MMF27-04	
Enneapogon caerulescens	0.1	35		
Enneapogon polyphyllus	0.1	10		
Paraneurachne muelleri	0.1	30		
Rhynchosia minima	0.1	15		
Salsola australis	0.1	20		
Sida echinocarpa	0.1	15	MMF27-08	
Solanum horridum	0.1	20	MMF27-07	
Triodia epactia	2	70	MMF27-05	
Triodia wiseana	16	40	MMF27-01	

Marra Mamba Flora Site MMF28

Described	RPPS	Date	3/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	531755	mE	7501661	mN	117.308938 E	-22.591476 S

Habitat Moderate south-facing slope of hill.
Soil Red-brown clay loam.
Rock Type Ironstone outcropping rock throughout.
Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia exilis* open shrubland over *Triodia wiseana, T. epactia* very open hummock grassland.
Veg Excellent.
Fire Age No sign of recent fire.
Note Elevation - 596 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia exilis	2	140	MMF28-01	
Acacia maitlandii	0.1	160		
Amphipogon sericeus	0.1	35	MMF28-09	
Aristida holathera var. *holathera*	0.1	25		
Cassia glutinosa	0.1	150	MMF28-05	
Cassia pruinosa	0.1	150		
Cassia pruinosa x *oligophylla*	0.1	100	MMF28-12	
Cassia 'stricta'	0.1	45	MMF28-08	
Corchorus lasiocarpus subsp. *parvus*	0.1	40	MMF28-06	
Dampiera candicans	0.1	50		
Eriachne mucronata (typical form)	0.1	35		
Eriachne pulchella	0.1	15	MMF28-10	
Eucalyptus leucophloia subsp. *leucophloia*	1	300		
Goodenia microptera	0.1	30		Dead
Goodenia stobbsiana	0.1	10		
Hakea chordophylla	0.1	280		
Hibiscus sturtii var. *campylochlamys*	0.1	30	MMF28-11	
Indigofera monophylla	0.1	25	MMF28-04	
Keraudrenia nephrosperma	0.1	110	MMF28-07	
Oldenlandia crouchiana	0.1	10		Dead
Paraneurachne muelleri	0.1	50		
Ptilotus astrolasius	0.1	30		
Ptilotus calostachyus	0.1	120		
Triodia epactia	6	35	MMF28-02	
Triodia wiseana	6	35	MMF28-03	

Marra Mamba Flora Site MMF29

Described	PLSW	Date	3/09/2012	Type	Quadrat 50 m x 50 m		
MGA	50	519018	mE	7497536	mN	117.185073 E	-22.628931 S

Habitat South sloping hillside, moderate slope.
Soil Light brown sandy-clay; 7.5YR 6/3.
Rock Type Ironstone outcropping, mudrock, some quartz and calcrete. Most fragments 10-100 mm.
Vegetation *Acacia bivenosa* (wispy/weeping form) tall open shrubland over *Triodia wiseana* hummock grassland.
Veg Condition Excellent.
Fire Age Very long unburnt.
Note Elevation: 519 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa (wispy/weeping form)	3	300		
Acacia exilis	0.1	140	MMF29-02	
Acacia inaequilatera	0.1	260		
Acacia maitlandii	0.1	140		
Acacia sibirica	0.1	100	MMF29-03	
Acacia synchronicia	0.1	200		
Acacia tenuissima	0.1	200	MMF29-04	
Capparis umbonata	0.1	100		
Cassia glutinosa	0.1	150		
Cassia oligophylla x *helmsii*	0.1	30	MMF29-01	
Eucalyptus leucophloia subsp. *leucophloia*	0.1	420		
Hakea lorea subsp. *lorea*	0.1	25		
Solanum lasiophyllum	0.1	25		
Trichodesma zeylanicum var. *zeylanicum*	0.1	60		
Triodia wiseana	40	80	=MMF27-01	

Marra Mamba Flora Site MMF31

Described	PLSW	Date	3/09/2012		Type	Quadrat 50 m x 50 m	
MGA	50	519075	mE	7497960	mN	117.185622 E	-22.625100 S

Habitat Very gentle undulating plain amongst broader undulating/rolling hills.
Soil Reddish-brown sandy-clay. 2.5YR 4/3.
Rock Type Continuous layer of 10-20mm ironstone and quartz with occasional 100mm rock.
Vegetation *Acacia sibirica* scattered tall shrubs over *Triodia longiceps* open hummock grassland.
Veg Condition Excellent.
Fire Age No sign of recent fire.
Note Elevation: 504 m.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa (wispy/weeping form)	0.1	230		
Acacia sibirica	1	210	MMF31-01	
Acacia synchronicia	0.1	270		
Aristida holathera var. *holathera*	0.1	15		
Cassia glutinosa	0.1	200		
Cassia luerssenii	0.1	220		
Cassia luerssenii	0.1	190		
Cassia oligophylla	0.1	70	MMF31-05	
Corchorus lasiocarpus subsp. *parvus*	0.1	40	MMF31-04	
Eremophila cuneifolia	0.1	80		
Eriachne pulchella	0.1	5		
Evolvulus alsinoides var. *villosicalyx*	0.1	15		
Hakea lorea subsp. *lorea*	0.1	170		
Heliotropium heteranthum	0.1	1	MMF31-03	
Hibiscus sturtii var. *platychlamys*	0.1	20		
Maireana melanocoma	0.1	100		
Sporobolus australasicus	0.1	5		
Trichodesma zeylanicum var. *zeylanicum*	0.1	40		
Triodia brizoides	0.1	40	MMF31-02	
Triodia longiceps	16	60		

Marra Mamba Flora Site MMF33

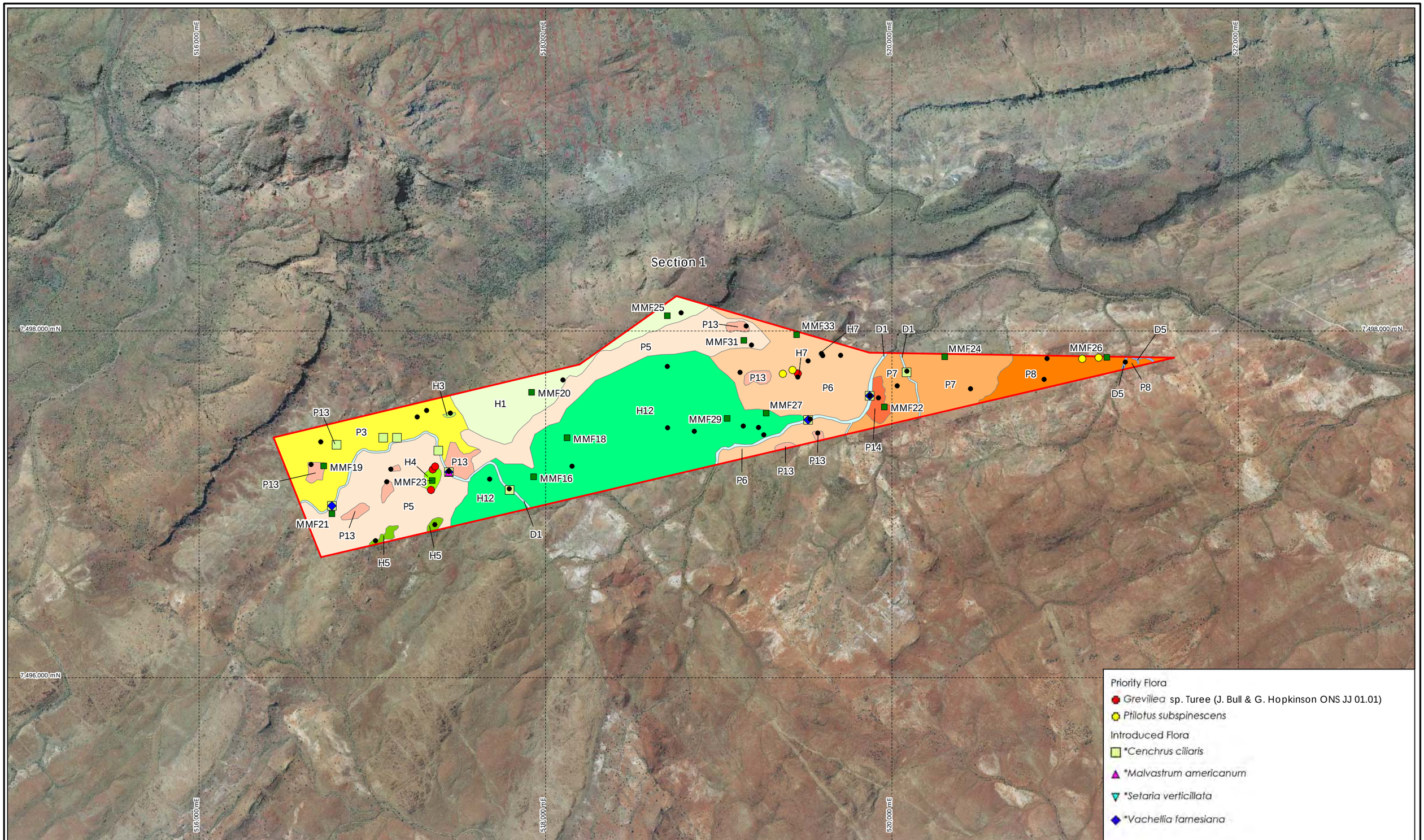
Described	PLSW	Date	3/09/2012		Type	Quadrat 50 m x 50 m	
MGA	50	519401	mE	7497980	mN	117.188794 E	-22.624916 S

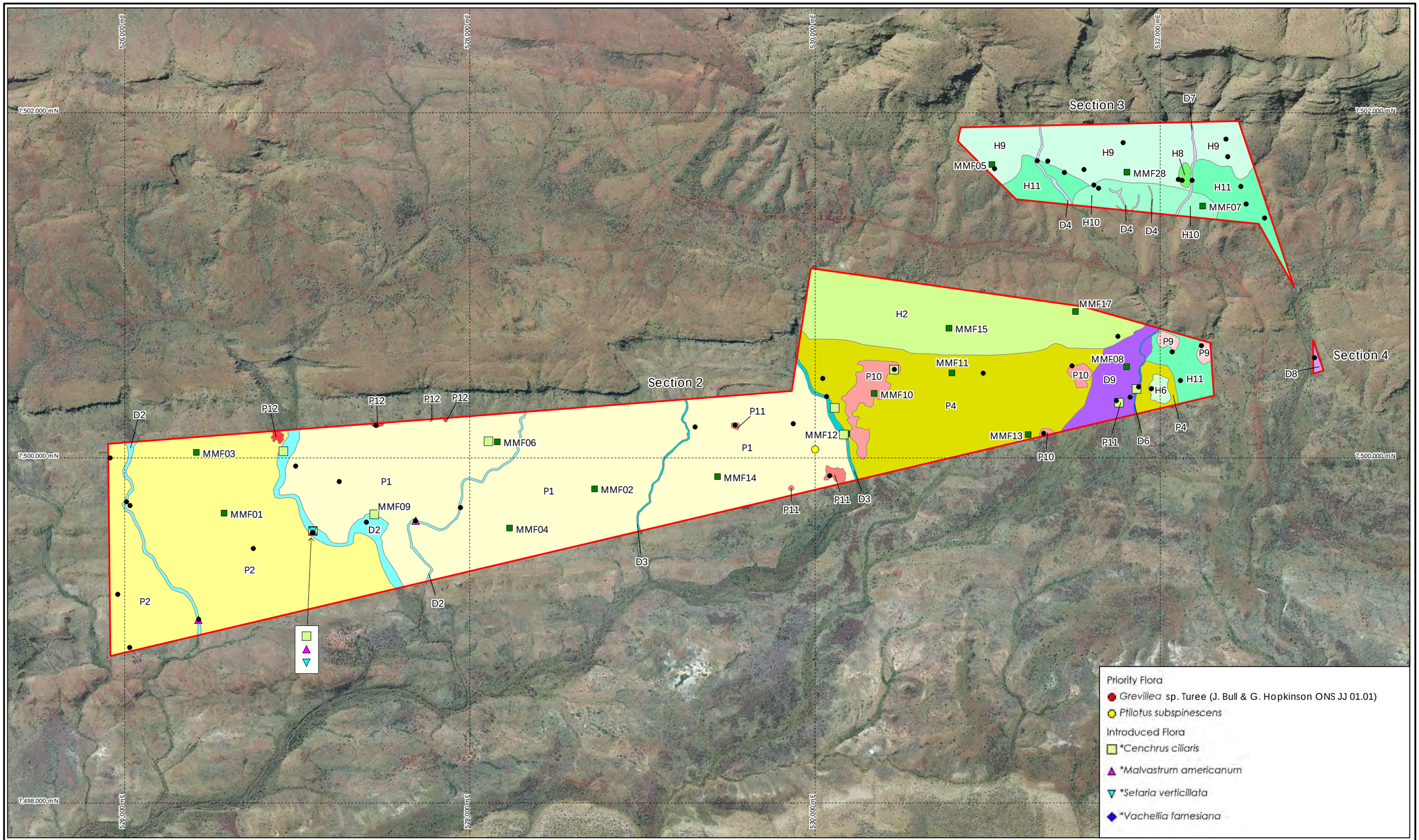
Habitat Gently SE-sloping valley situated between three low ridges.
Soil Reddish-brown sandy clay. 5YR 4/4.
Rock Type Ironstone and quartz continuous scree mostly 10-30mm. Some ironstone and mudrock outcropping.
Vegetation *Triodia longiceps*, *T. angusta* open hummock grassland.
Veg Condition Excellent.
Fire Age Very long unburnt.

Species	Cover (%)	Height (cm)	Specimen No.	Notes
Acacia bivenosa	0.1	100		
Acacia exilis	0.1	90		
Acacia synchronicia	0.1	230		
Capparis lasiantha	0.1	70		
Cassia luerssenii	0.1	130		
Cassia oligophylla x *helmsii*	0.1	50	MMF33-01	
Cassia pruinosa	0.1	130		
Corymbia hamersleyana	0.1	650		
Eucalyptus leucophloia subsp. *leucophloia*	0.1	450		
Maireana georgei	0.1	70		
Maireana melanocoma	0.1	90		
Triodia angusta	3	50		
Triodia longiceps	10	80		

Appendix 4

Vegetation Maps and Legend for the Marra Mamba Study Area


Section 1
516,000 mE
518,000 mE
520,000 mE
522,000 mE
7,498,000 m N
7,496,000 mN
MMF25
P13
MMF33
H7
D1
D1
D5
MMF31
P5
H7
MMF24
MMF26
P13
P7
P8
P7
P8
D5
H3
MMF20
H1
P6
H12
MMF27
MMF22
P13
MMF29
P3
MMF18
P14
MMF19
H4
P13
P13
P13
MMF23
MMF16
P6
P13
P5
H12
MMF21
D1
P13
H5
H5
Priority Flora
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)
Ptilotus subspinescens
Introduced Flora
*Cenchrus ciliaris
*Malvastrum americanum
*Setaria verticillata
*Vachellia farnesiana
Location Map
KARRATHA
Map Area
PERTH
KALGOORLIE
Survey area
Quadrat location
Mapping note location
N
0
500
1,000
metres
Marra Mamba Vegetation Map 1
Biota Environmental Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 811
Date: 26 Nov 2012
Revised: 19 Mar 2013
Projection: MGA Z50 (GDA94)
Scale: 1:20,000


528,000 mE
529,000 mE
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Section 2
Section 3
Section 4
MMF01
MMF02
MMF03
MMF04
MMF05
MMF06
MMF07
MMF08
MMF09
MMF10
MMF11
MMF12
MMF13
MMF14
MMF15
MMF17
MMF28
P1
P2
P4
D2
D3
D4
D6
D7
D8
D9
H2
H6
H8
H9
H10
H11
P9
P10
P11
P12
Priority Flora
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)
Ptilotus subspinescens
Introduced Flora
*Cenchrus ciliaris
*Malvastrum americanum
*Setaria verticillata
*Vachellia farnesiana
Location Map
KARRATHA
Map Area
KALGOORLIE
PERTH
Survey area
Quadrat location
Mapping note location
N
0
500
1,000
metres
Marra Mamba Vegetation Map 2
Biota Environmental Sciences
Author: Shadila
Drawn: M Robinson
Dwg No.: 811
Date: 26 Nov 2012
Revised: 19 Mar 2013
Projection: MGA Z50 (GDA94)
Scale: 1:20,000

Vegetation of Marra Mamba

Drainage and Floodplains

D1: ExAciAbPlTHtCEc — *Eucalyptus xerothermica*, *Acacia citrinoviridis* scattered low trees over *A. bivenosa*, *Petalostylis labicheoides* tall open shrubland over *Themeda triandra*, **Cenchrus ciliaris* open tussock grassland

D2: ExAciPlAbTHtTe — *Eucalyptus xerothermica*, *Acacia citrinoviridis* low open woodland over *Petalostylis labicheoides* scattered tall shrubs over *Acacia bivenosa* open shrubland over *Triodia epactia* very open hummock grassland over *Themeda triandra* scattered tussock grasses

D3: ElAciPlSsGOrTe — *Eucalyptus leucophloia*, *Acacia citrinoviridis* scattered low trees over *Petalostylis labicheoides*, *Stylobasium spathulatum*, *Gossypium robinsonii* tall shrubland over *Triodia epactia* very open hummock grassland

D4: ElAmoGOrTe — *Eucalyptus leucophloia* scattered low trees over *Acacia monticola*, *Gossypium robinsonii* tall open shrubland over *Triodia epactia* scattered hummock grasses

D5: AciAbTHtCEc — *Acacia citrinoviridis*, *A. bivenosa* tall open shrubland over *Themeda triandra*, **Cenchrus ciliaris* open tussock grassland

D6: AciPlGOrApyTe — *Acacia citrinoviridis* scattered low trees over *Petalostylis labicheoides*, *Gossypium robinsonii*, *A. pyrifolia* tall open shrubland over *Triodia epactia* very open hummock grassland

D7: PlAmoTe — *Petalostylis labicheoides*, *Acacia monticola* tall open shrubland over *Triodia epactia* very open hummock grassland

D8: AtuPlApyAbTe — *Acacia tumida*, *Petalostylis labicheoides*, *A. pyrifolia*, *A. bivenosa* tall shrubland over *Triodia epactia* very open hummock grassland

D9: ElAbTe — *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered shrubs over *Triodia epactia* hummock grassland

Hills and Low Hills

H1: ElAprAatTw — *Eucalyptus leucophloia* scattered low trees over *Acacia pyrifolia*, *A. atkinsiana* tall open shrubland over *Triodia wiseana* hummock grassland

H2: ElAexAprTw — *Eucalyptus leucophloia* scattered low trees over *Acacia exilis*, *A. pruinocarpa* open shrubland over Triodia wiseana open hummock grassland

H3: AanAprTe — *Acacia 'aneura'* woodland over *A. pyrifolia* scattered tall shrubs over *Triodia epactia* open hummock grassland

H4: AanGtTbrTlo — *Acacia 'aneura'*, *Grevillea* sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) low open woodland over *Triodia brizoides*, *T. longiceps* very open hummock grassland

H5: AanTbrTe — *Acacia 'aneura'* low open woodland over *Triodia brizoides*, *T. epactia* scattered hummock grasses

H6: AanTaTe — *Acacia 'aneura'* woodland over *Triodia angusta*, *T. epactia* scattered hummock grasses

H7: AanTbr — *Acacia 'aneura'* woodland over *Triodia brizoides* very open hummock grassland

Vegetation of Marra Mamba

Hills and Low Hills (cont.)

H8: ElAanAciGbTe — *Eucalyptus leucophloia*, *Acacia 'aneura'*, *A. citrinoviridis*, *Grevillea berryana* woodland over *Triodia epactia* very open hummock grassland

H9: ElAmAexTw — *Eucalyptus leucophloia* scattered low trees over *Acacia maitlandii*, *A. exilis* open shrubland over *Triodia wiseana* hummock grassland

H10: ElAmTwTm — *Eucalyptus leucophloia* scattered low trees over *Acacia maitlandii* open shrubland over *Triodia wiseana*, *T. melvillei* hummock grassland

H11: ElTw — *Eucalyptus leucophloia* scattered low trees over *Triodia wiseana* hummock grassland

H12: ElAiTw — *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland

Plains and Undulating Plains

P1: ElAiTwTeTbrTaTlo — *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana*, *T. epactia*, *T. brizoides*, *T. angusta*, *T. longiceps* open hummock grassland

P2: ElAiTwTbrTloTa — *Eucalyptus leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana*, *T. brizoides*, *T. longiceps*, *T. angusta* open hummock grassland

P3: ElTloTaTe(Tw) — *Eucalyptus leucophloia* scattered low trees over *Triodia longiceps*, *T. angusta*, *T. epactia*, (*T. wiseana*) hummock grassland

P4: ElTeTwTaTlo — *Eucalyptus leucophloia* scattered low trees over *Triodia epactia*, *T. wiseana*, *T. angusta*, *T. longiceps* very open hummock grassland

P5: ElTwTloTa — *Eucalyptus leucophloia* scattered low trees over *Triodia wiseana*, *T. longiceps*, *T. angusta* open hummock grassland

P6: ElAexTloTbrTw — *Eucalyptus leucophloia* scattered low trees over *Acacia exilis* scattered shrubs over *Triodia longiceps*, *T. brizoides*, *T. wiseana* hummock grassland

P7: ElAbAexTaTw — *Eucalyptus leucophloia* scattered low trees over *Acacia bivenosa* scattered tall shrubs over *A. exilis* open shrubland over *Triodia angusta*, *T. wiseana* open hummock grassland

P8: ElMeTaTw — *Eucalyptus leucophloia* scattered low trees over *Melaleuca eleuterostachya* open shrubland over *Triodia angusta*, *T. wiseana* open hummock grassland

P9: AanAxTeTw — *Acacia 'aneura'*, *A. xiphophylla* low open woodland over *Triodia epactia*, *T. wiseana* very open hummock grassland

P10: AxAanTaTe — *Acacia xiphophylla*, *A. 'aneura'* low open woodland over *Triodia angusta*, *T. epactia* scattered hummock grasses

Vegetation of Marra Mamba

Plains and Undulating Plains (cont.)

	P11: AxTaTe	*Acacia xiphophylla* low open woodland over *Triodia angusta*, *T. epactia* scattered hummock grasses
	P12: AxTbr	*Acacia xiphophylla* low woodland over *Triodia brizoides* scattered hummock grasses
	P13: AxTlo	*Acacia xiphophylla* low woodland over *Triodia longiceps* scattered hummock grasses
	P14: EsMeTaTw	*Eucalyptus socialis* low open mallee woodland over *Melaleuca eleuterostachya* low open shrubland over *Triodia angusta*, *T. wiseana* hummock grassland

Appendix 5

List of Vascular Flora Recorded from the Marra Mamba Study Area

NB.

As discussed in the main report, this species list should be regarded as comprehensive but not exhaustive.

* denotes introduced weed species

Most nomenclature reflects current scientific names accepted by the WA Herbarium. The use of the genus *Cassia* has been retained in favour of *Senna*, as it is felt to reflect a more realistic separation of taxa. Correspondence of *Cassia* / *Senna* nomenclature is given below:

Cassia ferraria	=	*Senna ferraria*
Cassia '*glaucifolia*'	=	*Senna glaucifolia*
Cassia '*glaucifolia*' x ?	=	*Cassia* '*glaucifolia*' hybrid with unknown species
Cassia glutinosa	=	*Senna glutinosa* subsp. *glutinosa*
Cassia glutinosa x *luerssenii*	=	*Senna glutinosa* subsp. *glutinosa* x *Senna glutinosa* subsp. *x luerssenii*
Cassia glutinosa x '*stricta*'	=	*Senna glutinosa* subsp. *glutinosa* x *Senna stricta*
Cassia helmsii	=	*Senna artemisioides* subsp. *helmsii*
Cassia helmsii x	=	*Senna artemisioides* subsp. *helmsii* hybrid with unknown species
Cassia luerssenii	=	*Senna glutinosa* subsp. *x luerssenii*
Cassia notabilis	=	*Senna notabilis*
Cassia oligophylla	=	*Senna artemisioides* subsp. *oligophylla*
Cassia oligophylla x *helmsii*	=	*Senna artemisioides* subsp. *oligophylla* x *Senna artemisioides* subsp. *helmsii*
Cassia aff. *oligophylla*	=	*Senna artemisioides* aff. subsp. *oligophylla*
Cassia aff. *oligophylla* (thinly sericeous)	=	*Senna artemisioides* aff. subsp. *oligophylla* (thinly sericeous)
Cassia pruinosa	=	*Senna glutinosa* subsp. *pruinosa*
Cassia pruinosa x ?	=	*Senna glutinosa* subsp. *pruinosa* hybrid with unknown species
Cassia pruinosa x *oligophylla*	=	*Senna glutinosa* subsp. *pruinosa* x *Senna artemisioides* subsp. *oligophylla*
Cassia '*stricta*'	=	*Senna stricta*

Species (ordered alphabetically by family)
Family: Acanthaceae
Dipteracanthus australasicus subsp. *australasicus*
Harnieria kempeana subsp. *muelleri*
Family: Amaranthaceae
Alternanthera nana
Amaranthus cuspidifolius
Amaranthus undulatus
Gomphrena canescens
Gomphrena cunninghamii
Ptilotus aervoides
Ptilotus astrolasius
Ptilotus auriculifolius
Ptilotus calostachyus
Ptilotus clementii
Ptilotus helipteroides
Ptilotus nobilis subsp. *nobilis*
Ptilotus obovatus
Ptilotus rotundifolius
Ptilotus schwartzii var. *schwartzii*
Ptilotus subspinescens (Priority 3)

Species (ordered alphabetically by family)
Family: Araliaceae
Trachymene oleracea subsp. *oleracea*
Family: Asteraceae
Peripleura virgata
Pluchea dentex
Pluchea rubelliflora
Pterocaulon serrulatum var. *velutinum*
Pterocaulon sphacelatum
Pterocaulon sphaeranthoides
Streptoglossa bubakii
Family: Boraginaceae
Heliotropium chrysocarpum
Heliotropium cunninghamii
Heliotropium heteranthum
Heliotropium inexplicitum
Trichodesma zeylanicum var. *zeylanicum*
Family: Brassicaceae
Lepidium pedicellosum
Lepidium pholidogynum
Family: Capparaceae
Capparis lasiantha
Capparis umbonata
Family: Caryophyllaceae
Polycarpaea corymbosa
Polycarpaea holtzei
Polycarpaea longiflora
Family: Celastraceae
Stackhousia muricata
Family: Chenopodiaceae
Atriplex codoncarpa
Dysphania rhadinostachya subsp. *rhadinostachya*
Enchylaena tomentosa var. tomentosa
Maireana carnosa
Maireana georgei
Maireana melanocoma
Maireana thesioides
Maireana villosa
Rhagodia eremaea
Salsola australis
Sclerolaena eriacantha
Tecticornia disarticulata
Sclerolaena minuta
Sclerolaena ? *minuta* (pending further determination by P. Wilson, WA Herbarium)
Family: Cleomaceae
Cleome viscosa
Family: Convolvulaceae
Bonamia rosea
Bonamia sp. Dampier (A.A. Mitchell PRP 217)

Species (ordered alphabetically by family)
Duperreya commixta
Evolvulus alsinoides var. *villosicalyx*
Polymeria ambigua
Family: Cucurbitaceae
Cucumis variabilis
Family: Cyperaceae
Fimbristylis simulans
Family: Euphorbiaceae
Euphorbia alsiniflora
Euphorbia biconvexa
Euphorbia biconvexa/alsiniflora (sterile)
Euphorbia boophthona
Euphorbia tannensis subsp. *eremophila*
Euphorbia sp. (FMLMC-10)
Euphorbia sp. (site 1089)
Family: Fabaceae
Acacia ancistrocarpa
Acacia ? *aptaneura*
Acacia atkinsiana
Acacia bivenosa
Acacia bivenosa (wispy/weeping form)
Acacia citrinoviridis
Acacia elachantha
Acacia exilis
Acacia inaequilatera
Acacia ? *incurvaneura*
Acacia kempeana
Acacia maitlandii
Acacia marramamba
Acacia monticola
Acacia pruinocarpa
Acacia ? *pteraneura*
Acacia pyrifolia var. *morrisonii*
Acacia pyrifolia var. *pyrifolia*
Acacia sibirica
Acacia synchronicia
Acacia tenuissima
Acacia tetragonophylla
Acacia trudgeniana
Acacia tumida var. *pilbarensis*
Acacia xiphophylla
Cassia ferraria
Cassia 'glaucifolia'
Cassia glaucifolia x ?
Cassia glutinosa
Cassia glutinosa x *luerssenii*
Cassia glutinosa x *'stricta'*
Cassia helmsii

Species (ordered alphabetically by family)
Cassia luerssenii
Cassia notabilis
Cassia oligophylla
Cassia oligophylla x *helmsii*
Cassia aff. *oligophylla*
Cassia aff. *oligophylla* (thinly sericeous)
Cassia pruinosa
Cassia pruinosa x *oligophylla*
Cassia pruinosa x ?
Cassia 'stricta'
Cassia sp. (inadequate material for further determination)
Crotalaria medicaginea var. *neglecta*
Cullen leucochaites
Indigofera monophylla
Indigofera rugosa
Petalostylis labicheoides
Rhynchosia minima
Swainsona maccullochiana
Templetonia egena
Tephrosia aff. *clementii*
Tephrosia rosea var. *glabrior*
**Vachellia farnesiana*
Family: Goodeniaceae
Dampiera candicans
Goodenia cusackiana
Goodenia forrestii
Goodenia microptera
Goodenia stobbsiana
Scaevola acacioides
Scaevola spinescens (form not determined)
Scaevola spinescens (broad form)
Scaevola spinescens (narrow form)
Family: Gyrostemonaceae
Codonocarpus cotinifolius
Family: Lamiaceae
Clerodendrum floribundum var. *angustifolium*
Family: Lauraceae
Cassytha capillaris
Family: Loranthaceae
Amyema fitzgeraldii
Lysiana casuarinae
Family: Malvaceae
Abutilon dioicum
Abutilon lepidum
Abutilon aff. *lepidum* (1) (MET 15 352)
Abutilon aff. *lepidum* (insufficient material for further determination)
Abutilon otocarpum (acute leaf form)
Abutilon trudgenii

Species (ordered alphabetically by family)
Androcalva luteiflora
Corchorus crozophorifolius
Corchorus lasiocarpus (subsp. not determined)
Corchorus lasiocarpus subsp. *lasiocarpus*
Corchorus lasiocarpus subsp. *parvus*
Corchorus aff. *parviflorus*
Gossypium australe (Burrup Peninsula form)
Gossypium australe (Whim Creek form)
Gossypium robinsonii
Gossypium sturtianum
Hibiscus burtonii

Hibiscus coatesii

Hibiscus gardneri
Hibiscus sturtii var. *campylochlamys*
Hibiscus sturtii var. *platychlamys*
Keraudrenia nephrosperma
**Malvastrum americanum*
Melhania oblongifolia
Sida arsiniata
Sida aff. *cardiophylla*
Sida echinocarpa
Sida aff. *fibulifera* (MET var. 'L')
Sida aff. *fibulifera* (oblong; MET 15 220)
Sida sp. Pilbara (A.A. Mitchell PRP 1543)
Sida sp. Shovelanna Hill (S. van Leeuwen 3842)
Sida sp. spiciform panicles (E. Leyland s.n. 14/8/90)
Waltheria indica
Family: Moraceae
Ficus brachypoda
Family: Myrtaceae
Corymbia deserticola subsp. *deserticola*
Corymbia ferriticola
Corymbia hamersleyana
Eucalyptus leucophloia subsp. *leucophloia*
Eucalyptus socialis subsp. *eucentrica*
Eucalyptus xerothermica
Melaleuca eleuterostachya
Family: Nyctaginaceae
Boerhavia coccinea
Boerhavia sp. (inadequate material for further determination)
Family: Oleaceae
Jasminum didymum subsp. *lineare*
Family: Phyllanthaceae
Phyllanthus maderaspatensis
Family: Plantaginaceae
Stemodia grossa

Species (ordered alphabetically by family)
Family: Poaceae
Amphipogon sericeus
Aristida contorta
Aristida holathera var. *holathera*
Aristida latifolia
Brachyachne prostrata
**Cenchrus ciliaris*
Chrysopogon fallax
Cymbopogon ambiguus
Cymbopogon procerus
Enneapogon caerulescens
Enneapogon lindleyanus
Enneapogon polyphyllus
Eragrostis cumingii
Eragrostis eriopoda
Eriachne aristidea
Eriachne mucronata (arid form) (MET 12 736)
Eriachne mucronata (typical form)
Eriachne pulchella (subsp. not determined)
Eriachne tenuiculmis
Eulalia aurea
Iseilema dolichotrichum
Paraneurachne muelleri
Paspalidium clementii
Paspalidium constrictum
Schizachyrium fragile
**Setaria verticillata*
Sporobolus australasicus
Themeda triandra
Themeda sp. Mt Barricade (M.E. Trudgen 2471)
Triodia angusta
Triodia brizoides
Triodia epactia
Triodia longiceps
Triodia melvillei
Triodia wiseana
Family: Proteaceae
Grevillea berryana
Grevillea sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01) (Priority 1)
Hakea chordophylla
Hakea lorea subsp. *lorea*
Family: Pteridaceae
Cheilanthes contigua
Cheilanthes sieberi subsp. *sieberi*
Family: Rubiaceae
Oldenlandia crouchiana
Family: Santalaceae
Santalum lanceolatum

Species (ordered alphabetically by family)
Family: Sapindaceae
Dodonaea coriacea
Dodonaea lanceolata var. *lanceolata*
Dodonaea pachyneura
Family: Scrophulariaceae
Eremophila cuneifolia
Eremophila forrestii subsp. *forrestii*
Eremophila fraseri subsp. *fraseri*
Eremophila latrobei subsp. *latrobei*
Eremophila longifolia
Eremophila sp. (Inadequate material for further determination)
Family: Solanaceae
Solanum horridum
Solanum lasiophyllum
Solanum phlomoides
Family: Surianaceae
Stylobasium spathulatum
Family: Violaceae
Hybanthus aurantiacus
Family: Zygophyllaceae
Tribulus suberosus