



# Marra Mamba West (AR-13-11158) Native Vegetation Clearing Permit Report



Prepared for Rio Tinto Pty Ltd

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# Marra Mamba West NVCP Report

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# 1.0 Summary

Rio Tinto Pty Ltd (Rio Tinto) plans to undertake exploration and evaluation activities on its Marra Mamba West deposit (AR-13-11158), hereafter referred to as the study area. The study area is 324 ha in size and is located approximately 65 km west of Tom Price in the Pilbara region of Western Australia.

Biota Environmental Sciences was commissioned to conduct a biological assessment of the study area and an evaluation of the potential impacts of proposed activities within it to support a Native Vegetation Clearing Permit. A desktop review of biological information relevant to the study area was undertaken prior to a field survey being completed in September 2013. Eighteen relevés were sampled during the field survey, and data from two quadrats from a previous vegetation and flora survey that intersected the study area boundary were included in the assessment. The field survey also included searches for rare flora and fauna, and mapping of dominant vegetation types and fauna habitats found in the study area.

A total of 14 vegetation types were mapped in the study area. The vegetation types were associated with four broad landform categories: stony plains; creeklines and floodplains; stony hillslopes and crests; and rocky gorges. Most of the vegetation of the study area was in Very Good to Excellent condition, however the creekline and floodplain vegetation ranged from Good to Very Poor condition due to weed invasion and disturbance from cattle.

None of the vegetation types observed in the study area represent Threatened Ecological Communities or Priority Ecological Communities. Vegetation similar to that recorded for the study area is well represented in the locality.

A total of 245 native vascular flora taxa from 114 genera and 42 families have been recorded from the study area, along with eight introduced flora (weed) species.

No Threatened flora species are known from the study area or are likely to occur.

Three Priority flora taxa were encountered in the study area during the field survey:

- *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) (Priority 1): one individual was recorded from a rocky gorge;
- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3): this species is common in creekline habitats in the Brockman locality, and was recorded from nine locations in drainage lines in the study area, with an estimated population of 281 individuals; and
- *Goodenia nuda* (Priority 4): one individual was recorded from a floodplain.

Based on known locations and habitat preferences, one additional Priority 3 species (*Rostellularia adscendens* var. *latifolia*) may potentially occur in the study area. This species may not have been visible during the field survey due to the dry conditions.

The study area comprised four fauna habitats (functional landforms): stony plains; creeklines and floodplains; stony hillslopes and crests; and rocky gorges. The desktop review identified 10 conservation significant vertebrate fauna species as either likely to occur or having the potential to occur within the study area. These comprise:

- three Schedule 1 species; the Northern Quoll (*Dasyurus hallucatus*), Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) and Pilbara Olive Python (*Liasis olivaceus barroni*);
- two Schedule 3 (Migratory) species; the Fork-tailed Swift (*Apus pacificus*) and Rainbow Bee-eater (*Merops ornatus*); and
- five Priority 4 listed species: the Australian Bustard (*Ardeotis australis*), Bush Stone-curlew (*Burhinus grallarius*), Ghost Bat (*Macroderma gigas*), Western Pebble-mound Mouse (*Pseudomys chapmani*) and the skink *Notoscincus butleri*.

Four pebble-mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded during the field survey. None of the other fauna species of conservation significance would be restricted to or solely reliant on the habitats found in the study area.

The following recommendations are made to minimise the impacts to the vegetation, flora and fauna in and surrounding the study area:

1. Where possible, locations of Priority flora and fauna within the study area should be avoided during vegetation clearing.
2. Clearing of riparian vegetation (vegetation type C1) should be avoided or minimised where possible.
3. Weed hygiene protocols should be implemented during vegetation clearing and subsequent earthworks to minimise the spread or introduction of weeds to the study area.

## 2.0 Background to the Study

### 2.1 Project Background

Rio Tinto Pty Ltd (Rio Tinto) is looking to expand its drilling operations on its AR-13-11158 Marra Mamba West deposit (hereafter referred to as the study area) as part of the Brockman 4 operations. The study area is 324 ha in size and is located approximately 65 km west of Tom Price in the Pilbara region of Western Australia (WA) (Figure 2.1).

### 2.2 Scope and Objectives of the Study

Biota Environmental Sciences (Biota) was commissioned in July 2013 to conduct a biological assessment of the study area in order to provide the necessary information required to support a Native Vegetation Clearing Permit (NVCP). As part of this assessment, a systematic rare flora survey was conducted across the entire study area.

The objective of this study was to conduct a Level 1 vegetation, flora and fauna survey in accordance with the Environmental Protection Authority (EPA) Position Statement No. 3 (EPA 2002), Guidance Statement 51 (EPA 2004a), Guidance Statement 56 (EPA 2004b) and the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA and DEC 2010), with data collected according to the Rio Tinto 2013 data standards. As part of this study the following tasks were required to be completed:

- review and discuss existing information from the vicinity of the study area, including biogeographical context and literature describing previous surveys completed in the locality;
- review and discuss the results of relevant database searches to determine potential fauna, flora and vegetation communities of conservation significance that may occur in the study area;
- describe, photograph and map the dominant vegetation types of the study area (including description of dominant species, structure, vegetation condition and discussion of their representation in a regional context);
- identify vegetation types of particular conservation significance within the study area;
- record and photograph any species of particular conservation significance, including Threatened flora, Priority flora and other species of conservation interest;
- record any introduced (weed) species occurring in the study area;
- compile a list of vascular flora species recorded in the study area;
- describe, photograph and map fauna habitats (including a discussion of their representation in a regional context);
- record opportunistic fauna sightings and signs of fauna in the study area; and
- use the above information to prepare an assessment of clearing in the study area against the 10 Clearing Principles, as required for an NVCP application.

This report has been prepared using data collected during the field survey, together with data from the desktop review of existing biological information for the area. This included review of a number of previous biological surveys conducted in close proximity to the study area (see Section 3.1).

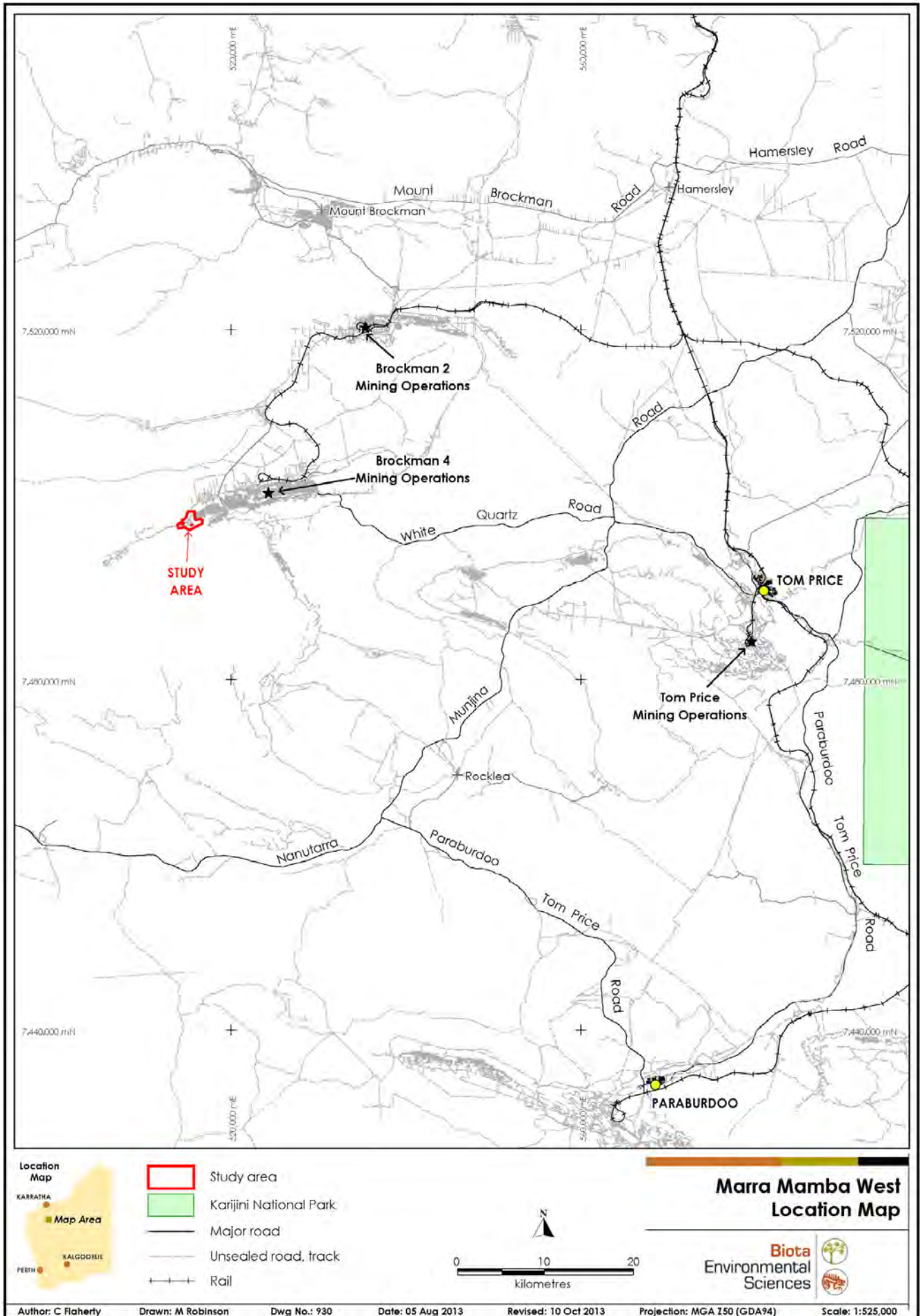


Figure 2.1: Location of the Marra Mamba West (AR-13-11158) study area.

## 3.0 Methodology

### 3.1 Desktop Review

Prior to the field survey, a desktop review was undertaken with the aim of identifying features of conservation significance known from the study area<sup>1</sup>.

#### 3.1.1 Literature Review

Published and unpublished reports relevant to the study area were reviewed. Several regional-scale reports and datasets were reviewed, including the summary of bioregional data (Kendrick 2003), land system mapping (Van Vreeswyk et al. 2004) and Beard's vegetation mapping (Beard 1975a, 1975b).

Additionally, a number of biological surveys that were undertaken in the vicinity of the study area were reviewed. The closest and most relevant previous surveys to the study area are:

- Brockman Syncline 4 Marra Mamba Targeted Fauna Survey (Biota 2013a);
- Brockman Syncline 4 Marra Mamba Vegetation and Flora Survey (Biota 2013b);
- Brockman 4 Camps Vegetation and Flora Survey (Biota 2012);
- Nammuldi Infill Fauna Survey (Biota 2010a);
- Brockman 2 Sustaining Tonnes Targeted Fauna Survey (Biota 2010b);
- Nammuldi Infill Areas Vegetation and Flora Survey (Biota 2010c);
- Brockman Syncline 2 Sustaining Tonnes Project and Pit 7 Land Bridge Vegetation and Flora Survey (Biota 2010d);
- Beasley River Limonites Fauna Survey (Biota 2009a);
- A Vegetation and Flora Survey of the White Quartz Road Corridor (Biota 2007a);
- Fauna Habitats and Fauna Assemblage of the Brockman No. 4 Project Area (Biota 2005a); and
- A Vegetation and Flora Survey of the Brockman Syncline 4 Project Area (Biota 2005b).

The findings of these surveys are summarised in Table 3.1, with the survey area locations shown in Figure 3.1 (fauna surveys) and Figure 3.2 (vegetation and flora surveys).

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<sup>1</sup> The framework for ranking the conservation significance of communities and species in Western Australia is summarised in Appendix 1.

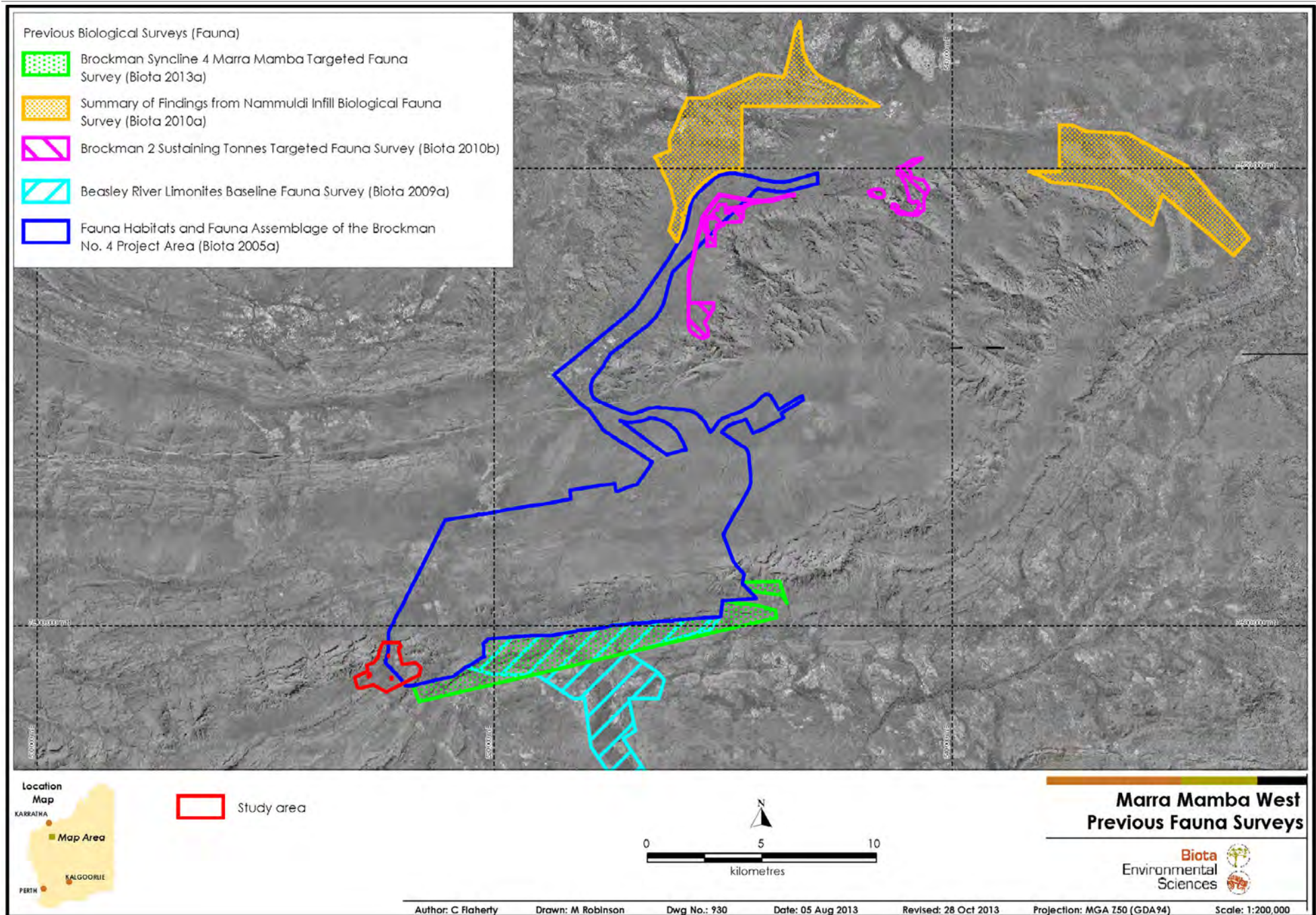


Figure 3.1: Previous fauna surveys conducted in the vicinity of the study area.

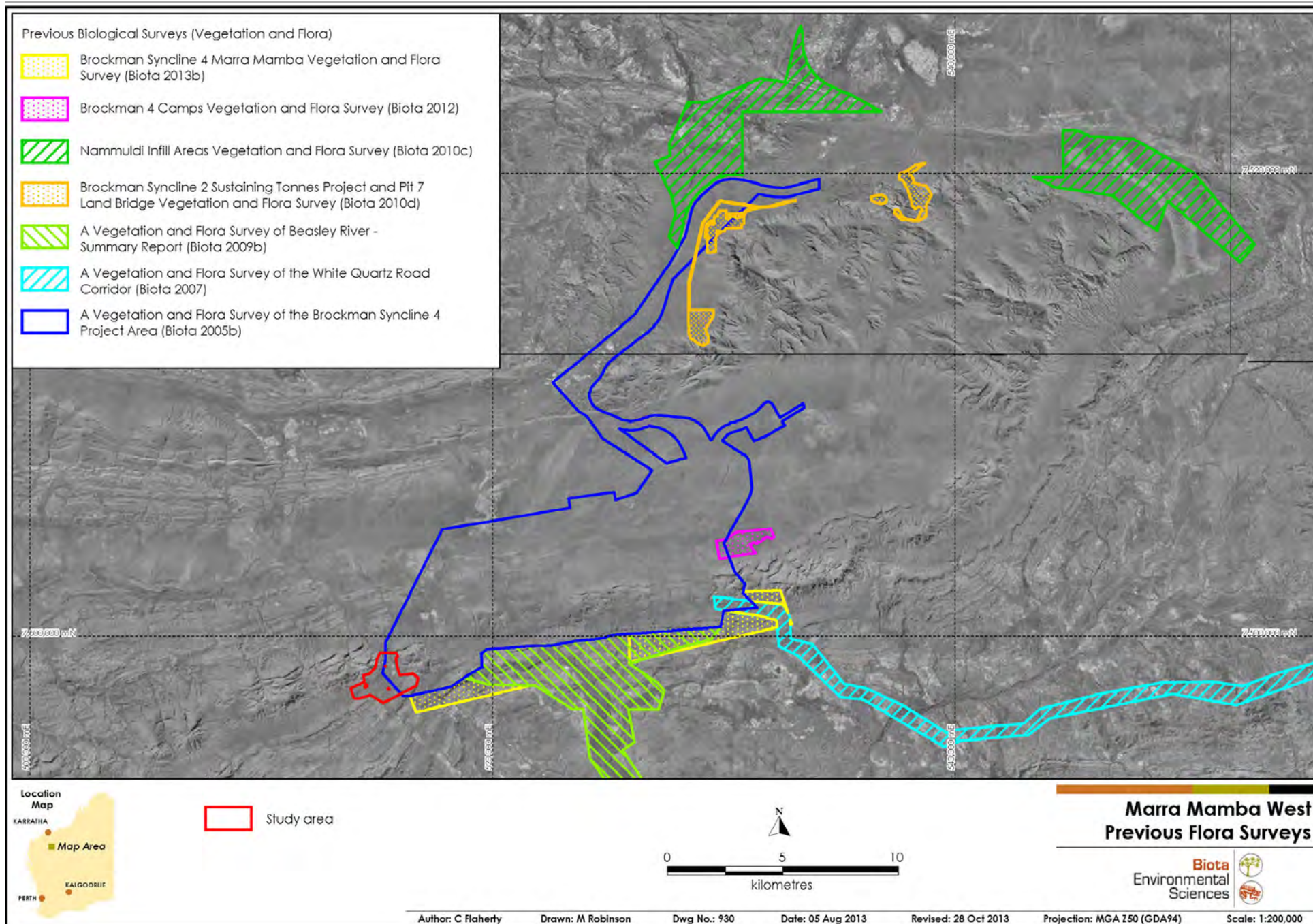


Figure 3.2: Previous vegetation and flora surveys conducted in the vicinity of the study area.

Table 3.1: A summary of relevant biological surveys completed in the Marra Mamba locality.

Project Area/Survey (Reference)	Date: Description	Size of Survey Area	Features of Conservation Significance
<b>Fauna Surveys</b>			
Brockman Syncline 4 Marra Mamba (Biota 2013a)	August-September 2012: targeted fauna survey.	1,921 ha	<ul style="list-style-type: none"> <li>No Schedule or Priority fauna recorded.</li> </ul>
Nammuldi Infill Areas (Biota 2010a)	November 2009: fauna survey.	3,997 ha	<ul style="list-style-type: none"> <li>Two vertebrate fauna species of conservation significance recorded:               <ul style="list-style-type: none"> <li>– one Schedule 3: Rainbow Bee-eater (<i>Merops ornatus</i>);</li> <li>– one Priority 4: Western Pebble-Mound Mouse (<i>Pseudomys chapmani</i>).</li> </ul> </li> </ul>
Brockman 2 Sustaining Tonnes (Biota 2010b)	April/May 2010: targeted fauna survey.	463 ha	<ul style="list-style-type: none"> <li>Two Priority 4 fauna species recorded: Ghost Bat (<i>Macroderma gigas</i>) and Western Pebble-Mound Mouse (<i>Pseudomys chapmani</i>).</li> </ul>
Beasley River Limonites (Biota 2009a)	May 2009: baseline fauna survey.	4,162 ha	<ul style="list-style-type: none"> <li>Four vertebrate fauna species of conservation significance recorded (gully systems in this area were much larger in scale than those in the current study area, and an area of cracking clay was present):               <ul style="list-style-type: none"> <li>– two Schedule 1: Orange Leaf-nosed Bat (<i>Rhinioncteris aurantius</i>), Pilbara Olive Python (<i>Liasis olivaceus barroni</i>);</li> <li>– one Schedule 3: Rainbow Bee-eater (<i>Merops ornatus</i>);</li> <li>– one Priority 4: Short-tailed Mouse (<i>Leggadina lakedownensis</i>).</li> </ul> </li> </ul>
Brockman No. 4 Project Area (Biota 2005a)	October 2004: baseline fauna survey.	11,796 ha	<ul style="list-style-type: none"> <li>Two Priority 4 fauna species recorded: Australian Bustard (<i>Ardeotis australis</i>) and <i>Notoscincus butleri</i>.</li> </ul>
<b>Vegetation and Flora Surveys</b>			
Brockman Syncline 4 Marra Mamba (Biota 2013b)	August-September 2012: single-phase vegetation and flora survey.	943 ha	<ul style="list-style-type: none"> <li>Two Priority flora species recorded:               <ul style="list-style-type: none"> <li>– one Priority 1: <i>Grevillea</i> sp. Turee (J. Bull &amp; G. Hopkinson ONS JJ 01.01);</li> <li>– one Priority 3: <i>Ptilotus subspinescens</i>.</li> </ul> </li> <li>Four weed species recorded: *<i>Cenchrus ciliaris</i>, *<i>Malvastrum americanum</i>, *<i>Setaria verticillata</i>, *<i>Vachellia farnesiana</i>.</li> </ul>
Brockman 4 Camps (Biota 2012)	July 2012: vegetation and flora survey.	97 ha	<ul style="list-style-type: none"> <li>One Priority 3 flora species recorded: <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301).</li> <li>Two weed species recorded: *<i>Cenchrus ciliaris</i>, *<i>Flaveria trinervia</i>.</li> </ul>
Nammuldi Infill Areas (Biota 2010c)	October 2009: single-phase vegetation and flora survey.	3,997 ha	<ul style="list-style-type: none"> <li>Three Priority 3 flora species recorded: <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301), <i>Ptilotus subspinescens</i>, <i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794).</li> <li>Six weed species recorded: *<i>Bidens bipinnata</i>, *<i>Cenchrus ciliaris</i>, *<i>Malvastrum americanum</i>, *<i>Portulaca oleracea</i>, *<i>Setaria verticillata</i>, *<i>Vachellia farnesiana</i>.</li> </ul>
Brockman 2 Sustaining Tonnes and Pit 7 Land Bridge (Biota 2010d)	April/May 2010: single-phase vegetation and flora survey.	463 ha	<ul style="list-style-type: none"> <li>Two Priority 3 flora species recorded: <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) and <i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642).</li> <li>One weed species recorded: *<i>Cenchrus ciliaris</i>.</li> </ul>
Beasley River (Biota 2009b)	May 2009 and September 2009: vegetation and flora survey.	4,162 ha	<ul style="list-style-type: none"> <li>Four Priority flora species recorded:               <ul style="list-style-type: none"> <li>– three Priority 3: <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301), <i>Oldenlandia</i> sp. Hamersley Station (A.A. Mitchell PRP 1479), <i>Ptilotus subspinescens</i>;</li> <li>– one Priority 4: <i>Ptilotus trichocephalus</i>.</li> </ul> </li> <li>Eleven weed species recorded: *<i>Aerva javanica</i>, *<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>, *<i>Bidens bipinnata</i>, *<i>Cenchrus ciliaris</i>, *<i>C. setiger</i>, *<i>Datura leichhardtii</i>, *<i>Malvastrum americanum</i>, *<i>Melochia pyramidata</i>, *<i>Portulaca oleracea</i>, *<i>Setaria verticillata</i>, *<i>Vachellia farnesiana</i>.</li> </ul>



Project Area/Survey (Reference)	Date: Description	Size of Survey Area	Features of Conservation Significance
White Quartz Road Corridor (Biota 2007a)	May 2005-June 2006: single-phase vegetation and flora survey.	2,303 ha	<ul style="list-style-type: none"> <li>• Two Priority 3 flora species recorded: <i>Ptilotus subspinescens</i>, <i>Rostellularia adscendens</i> var. <i>latifolia</i>.</li> <li>• Eight weed species recorded: *<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>, *<i>Bidens bipinnata</i>, *<i>Cenchrus ciliaris</i>, *<i>Cucumis melo</i> subsp. <i>agrestis</i>, *<i>Malvastrum americanum</i>, *<i>Melochia pyramidata</i>, *<i>Setaria verticillata</i>, *<i>Vachellia farnesiana</i>.</li> </ul>
Brockman Syncline 4, including Infrastructure Corridor (Biota 2005b)	March-June 2003: rare flora searches. October 2004: two-phase vegetation and flora survey.	11,796 ha	<ul style="list-style-type: none"> <li>• Two Priority species recorded: <ul style="list-style-type: none"> <li>– one Priority 3: <i>Ptilotus subspinescens</i>;</li> <li>– one Priority 4: <i>Eremophila magnifica</i> subsp. <i>magnifica</i>.</li> </ul> </li> <li>• Six weed species recorded: *<i>Acetosa vesicaria</i>, *<i>Bidens bipinnata</i>, *<i>Cenchrus ciliaris</i>, *<i>C. setiger</i>, *<i>Malvastrum americanum</i>, *<i>Setaria verticillata</i>.</li> </ul>

### 3.1.2 Database Searches

The following databases were searched to assist in the determination of the potential flora and fauna assemblages of the study area:

1. The NatureMap<sup>2</sup> database was searched to identify flora and fauna species that had previously been recorded in the locality.
2. A specific search of the DPaW Threatened and Priority Flora Database was also commissioned to confirm the Threatened and Priority flora species known from the area.
3. The Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters database was searched to identify flora and fauna species and other matters of national environmental significance that may occur in the locality.

The searches were centred on the point 22°37'31" S, 117°8'56" E (the central point of the study area) and requested the return of records from a 40 km radius (for flora searches) and a 25 km radius (for fauna searches). In addition, Priority flora records from the previous flora studies in the locality (see Section 3.1.1) and from other rare flora surveys undertaken by Rio Tinto botanists or on behalf of Rio Tinto were also reviewed.

All results from the literature review and database searches were then used to compile a list of conservation significant flora and fauna species that had previously been recorded from the broader locality. The likelihood that each species would occur in the study area was then assessed using the rankings and criteria provided in Table 3.2. Two rankings have been provided:

1. An initial assessment was made during the desktop review (see Sections 4.8 and 7.4; and Appendices 2 and 3). This was based on consideration of the overall distribution of the species, the proximity of the study area to known populations and, if the species was known to be linked to particular habitats, whether suitable habitat was present in the study area based on inspection of aerial photography and/or existing information. In the case of the current study area, creeklines, stony hills (including two small gorges), and plains (including two areas of calcrete) were apparent on aerial imagery.
2. The likelihood rankings were subsequently revised as necessary based on the findings of the field survey (see Sections 6.4 and 7.4; Appendices 2 and 3). Where the initial and final likelihood rankings were different, the reason was provided.

A review of Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) known from the locality was also conducted by requesting a search of the DPaW databases of these communities. The search area comprised the study area surrounded by a buffer of 40 km.

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<sup>2</sup> NatureMap is a joint project of the Department of Parks and Wildlife or DPaW (formerly the Department of Environment and Conservation (DEC)) and the WA Museum. It is the most comprehensive source of information on the distribution of WA's flora and fauna, and comprises records from the Fauna Survey Returns Database, the WA Threatened and Priority Flora Database, the WA Herbarium Specimen Database (all maintained by DPaW), the WA Museum Specimen Database, and BirdLife Australia's Atlas of Australian Birds. <http://naturemap.dec.wa.gov.au>

Table 3.2: Ranking system used to assign the likelihood that a species would occur in the study area.

Rank	Example Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely	1. There are existing records of the species in close proximity to the study area, or from the locality; and <ul style="list-style-type: none"> <li>• the species is strongly linked to a specific habitat, which is present in the study area; or</li> <li>• the species has more general habitat preferences, and suitable habitat is present.</li> </ul>
May potentially occur	1. There are existing records of the species from the locality, however <ul style="list-style-type: none"> <li>• the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or</li> <li>• the species has more general habitat preferences, but only some suitable habitat is present.</li> </ul> 2. There is suitable habitat in the study area, but the species is recorded infrequently in the region.
Unlikely	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present, however there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area, however the species is very infrequently recorded in the region.
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; and/or 2. The species' range is very restricted and would not include the study area.

## 3.2 Field Survey

### 3.2.1 Survey Team, Timing and Climatic Conditions

The field survey was undertaken by two botanists from Biota, Chloe Flaherty and Rachel Butler, between the 14<sup>th</sup> and 18<sup>th</sup> of September 2013. Both staff have experience with assessing landforms and vegetation (the key components of fauna habitat assessment), and recording the fauna of conservation significance (or habitats suitable for such) that are typically encountered during short-term Level 1 survey exercises (e.g. Australian Bustards, Rainbow Bee-eaters, mounds of the Western Pebble-mound Mouse, and caves suitable for bat nesting roots or Northern Quoll dens). Excluding travel days, a total of nine person days were spent on the field component of this study (a half day of sampling was completed on the 18<sup>th</sup> of September).

The weather conditions (particularly rainfall) leading up to a field survey are important factors influencing the number and type of flora species that are recorded from an area. The September 2013 survey was completed at a typically dry time of year for the Pilbara. To indicate rainfall leading up to this survey, monthly rainfall data from nearby Bureau of Meteorology (BoM) recording stations for the 12 months preceding the field survey are shown in Figure 3.3, compared to the long-term monthly averages for the area (BoM 2013). No single station had a complete set of monthly data for the required period<sup>3</sup>, so data were sourced from the Cheela Plains recording station for the months September 2012–June 2013 and Paraburdoo Airstrip recording station for the months July–August 2013. The long-term monthly average data were taken from the Hamersley recording station (5005), 65 km northeast, as this station had data available for the years 1912–2013.

<sup>3</sup> A complete monthly rainfall dataset for September 2012- August 2013 is not available for Cheela Plains (station number 5095), which is the closest recording station to the study area (39 km southwest). Data for the months of July and August 2013 were therefore taken from the Paraburdoo Airstrip recording station (station number 7185), which is 86 km southeast of the study area.

The data show that rainfall received during the 2012-2013 wet season (December 2012–March 2013) was slightly below average (213.0 mm compared to 272.1 mm for the long-term average), however this was followed by a wetter than average May–June 2013. No rainfall was received in July–August 2013, immediately preceding the survey. Rainfall in the Pilbara can be very localised and the Paraburdoo recording station is over 80 km from the study area, however it is expected that the study area would have similarly received no or very little rainfall in the two months immediately preceding the survey.

The survey timing was considered adequate for the collection of perennial flora. However, given the dry conditions in July and August 2013, some annual and cryptic perennial species may not have been present at the time of the survey.

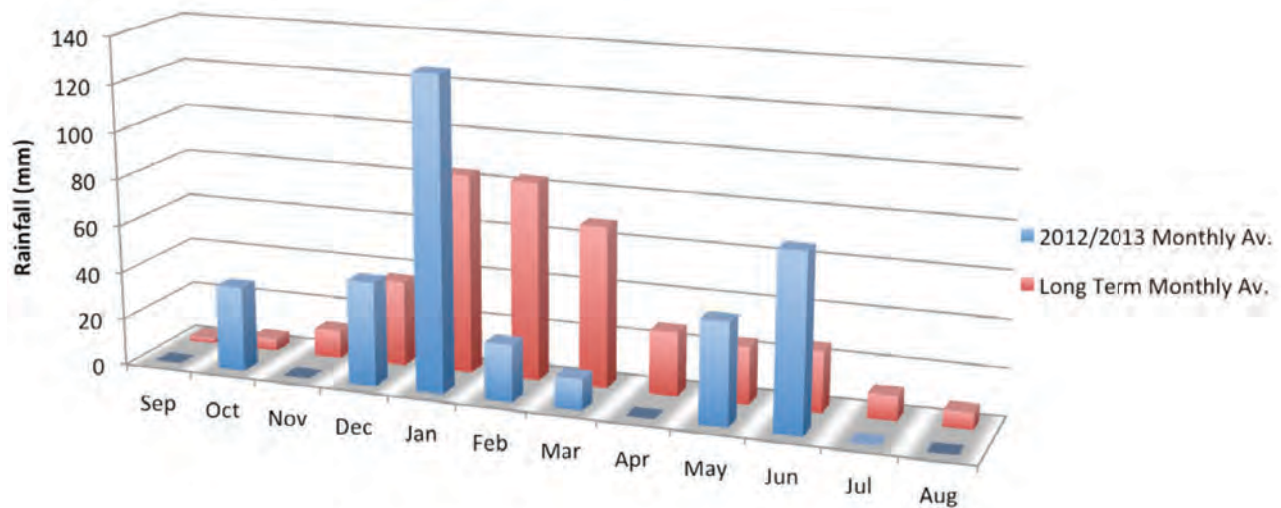


Figure 3.3: Monthly rainfall at Cheela Plains recording station for September 2012–June 2013 and Paraburdoo Airstrip recording station for July–August 2013, compared to the long-term monthly average for Hamersley recording station from 1912–2013 (BoM 2013).

### 3.2.2 Flora Sampling Sites

Two flora sampling quadrats (BRO21 and BRO22; both 50 x 50 m) from the Brockman Syncline 4 vegetation and flora survey (Biota 2005b) are situated within the study area. Flora species data from these quadrats were used to supplement the species list for the study area.

During the field survey, 18 relevés were sampled in the study area. A relevé is an unbounded flora sampling site, which is similar in area to a standard flora sampling quadrat (2,500 m<sup>2</sup>). Indicative relevé locations were selected prior to the field survey, based on the broad habitats and vegetation types apparent on aerial imagery. Once in the field, final locations were adjusted as necessary so that the relevés provided representative sampling of the range of landscapes and habitat types.

The following parameters were recorded for all relevés:

1. Location: AMG coordinates recorded in WGS84 datum (Zone 50) using a handheld Global Positioning System (GPS) for the central point of the relevé;
2. Vegetation Description: A broad description based on the height and estimated cover of dominant species after Aplin's (1979) modification of the vegetation classification system of Specht (1970) (see Appendix 4);
3. Habitat: A description of the landform and habitat;
4. Associated Species: A list of non-dominant species within the relevé area;
5. Fire History: An estimation of time since last fire;
6. Soil: A broad description of the soil surface and stony surface mantle;

7. Disturbance details: Vegetation condition was ranked according to the scale developed by Trudgen (1988) (see Appendix 4), considering evidence of grazing, physical disturbance, weed invasion etc.; and
8. Photograph: A representative photograph of the vegetation was taken.

In addition to relevés, a series of mapping notes were made in the study area during the field survey. Mapping notes are sampling sites conducted over a smaller scale than a relevé. 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.

Quadrat and relevé locations are shown on the vegetation map in Appendix 5. Vegetation condition mapping and weed locations are provided in Appendix 6. A summary of all quadrat and relevé data relevant to the study area is provided in Appendix 7.

### 3.2.3 Vegetation Description and Mapping

Vegetation types identified from aerial photography were ground-truthed during foot traverses in the study area. The boundaries of the study area were loaded onto hand-held GPS units to ensure that the correct areas were traversed. Vegetation descriptions for each vegetation type observed in the field were recorded at relevé points and in mapping notes (see Section 3.2.2), and were based on the height and estimated cover value of dominant species using Aplin's (1979) modification of the vegetation classification of Specht (1970).

The vegetation types were described at the sub-association level (level VI as per the National Vegetation Information System)<sup>4</sup>. The sub-association level includes information about the dominant growth form, height and cover for up to five species in all layers/sub-strata observed (e.g. *Eucalyptus xerothermica* scattered low trees over *Acacia citrinoviridis*, *Stylobasium spathulatum* tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered shrubs over *Themeda triandra*, *Chrysopogon fallax*, \**Cenchrus ciliaris* very open tussock grassland).

Similar vegetation descriptions 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. The vegetation mapping from Biota (2005b) partly overlaps the current study area. This mapping was used as a reference, and vegetation units from this study were extended wherever possible.

Two coding systems are presented in this report to refer to the individual vegetation types:

1. An alphabetic code that represents the dominant flora species from the tallest stratum to the lowest stratum. Each dominant species was given a unique code by using an abbreviation of the genus to capital letter(s) followed by an abbreviation of the species to lower case letter(s) (e.g. E1AprAmaTbrTe denotes a vegetation type dominated by *Eucalyptus leucophloia*, *Acacia pruinocarpa*, *A. marramamba*, *Triodia brizoides* and *T. epactia*). This coding enables vegetation types from different studies to be quickly compared, although it can sometimes result in long and unwieldy codes.
2. To aid interpretation, each vegetation type was also assigned an alpha-numeric code as a unique precursor to the species-driven code (e.g. H1: E1AprAmaTbrTe for a hillslope vegetation sub-association). This short code is used to refer more simply to the individual vegetation types.

Although some of the vegetation types were first drafted in the field, the majority of the vegetation mapping was completed in the office after the fieldwork had been completed. Field data and aerial imagery were studied to determine boundaries of vegetation types, which were then mapped at a maximum scale of 1:7,000. The maps were created and consolidated using GIS software (Quantum GIS 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).

<sup>4</sup> <http://www.environment.gov.au/erin/nvis/publications/avam/section-2-1.html>

### 3.2.4 Rare Flora Searches

Rare flora searches were systematically conducted during foot traverses over the entire study area, with observers spaced at approximately 50 m intervals (see Appendix 8 for track logs of the traverses). This intensity is generally considered adequate for most habitats in the region.

The locations of flora of conservation significance, flora of special interest, unknown flora and introduced (weed) species were recorded using a hand-held GPS (WGS84 datum, Zone 50). Where conservation significant flora species were encountered, estimates of density or numbers of individuals, habitats and associated flora were recorded.

A continuous list of vascular flora species was also recorded during the traverses, which contributed to the overall species list for the study area (see Appendix 9).

### 3.2.5 Flora Identification and Nomenclature

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 (Chloe Flaherty and Rachel Butler) identified most specimens, the majority of which were confirmed by Biota's principal botanist (Michi Maier). Andrew Perkins, a taxonomist with the WA Herbarium, provided confirmation of the *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) specimen.

Nomenclature was checked against the current listing of scientific names recognised by the WA Herbarium and updated as necessary. All data were entered into an Access database structure held by Biota.

### 3.2.6 Fauna Habitat Assessment and Opportunistic Fauna Sightings

The major fauna habitats within the study area were identified and mapped by Chloe Flaherty (Biota botanist; see Section 3.2.1), using a combination of landform type, aerial imagery, land systems mapping, vegetation mapping and information obtained during the field survey. All habitats were traversed systematically on foot (see Appendix 8). The fauna habitats were described and searched with a particular aim to identify habitat deemed suitable to support fauna species of conservation significance, particularly those species identified by the desktop review as being likely to or potentially occurring in the study area (see Section 7.4). Scott Werner and Nicola Watson (zoologists from Biota with experience in assessment of fauna habitats in the Pilbara region) provided confirmation of the fauna habitat mapping.

All opportunistic vertebrate fauna sightings (including mounds, scats and tracks) were recorded using a hand-held GPS (WGS84 datum; Zone 50) during the systematic foot traverses of the study area (see Section 3.2.4 and Appendix 8). Particular emphasis was placed on those species of conservation significance that are most likely to be encountered during short-term Level 1 fauna surveys (see Section 3.2.1).

### 3.2.7 Fauna Taxonomy and Nomenclature

As per the recommendations of EPA Guidance Statement 56 (2004b) and the Technical Guide to Fauna Surveys prepared by the EPA and DEC (2010), species nomenclature for reptiles and mammals follows that of the WA Museum fauna taxonomic checklist, last published in February 2012. Species nomenclature for birds follows that of Christidis and Boles (2008).

### 3.3 Limitations of the Study

Limitations of this study that should be considered comprise:

- The site visit was conducted during a typically dry time of the year in the Pilbara region and followed a two-month period of negligible rainfall for the area (Figure 3.3). As such, some ephemeral species such as short-lived annual herbs and grasses would not have been present at the time of the survey. This potentially includes one annual Priority flora species (Section 6.4.2.2).
- Wherever possible, foot traverses were spaced approximately 50 m apart. However, some areas of very steep slopes and sheer drops at the southeastern edge of the study area could not be traversed during the field survey for safety reasons.
- Fungi and non-vascular flora (algae, mosses and liverworts) were not sampled, which is consistent with the accepted level of effort for a survey of this type and scale.
- No qualified zoologists were present during the field survey, however the survey botanists have experience in fauna habitat assessment and detecting the species of conservation significance typically recorded by surveys of this scale (see Section 3.2.1). The assessments of fauna habitats and species provided in this report were co-authored with two zoologists, including confirmation of the habitat mapping and opportunistic observations made by the botanists during the field survey.
- No systematic sampling of fauna was required for this Level 1 assessment. This report should therefore not be treated as an exhaustive account of the fauna occurring in the study area.

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## 4.0 Existing Environment

### 4.1 IBRA Bioregion and Subregion

The study area lies within the Pilbara bioregion, one of 89 bioregions defined by the Interim Biogeographic Regionalisation for Australia (IBRA) (DoE 2013).

The Pilbara bioregion is divided into four subregions, and the study area lies in the Hamersley subregion, which is described as:

- 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 (*Eucalyptus leucophloia*) over *Triodia brizoides* on the skeletal sandy soils of the ranges (see Kendrick 2003).

### 4.2 Conservation Reserves in the Locality

The IBRA provides a national system for assessing the condition of native ecosystems and their level of protection in the National Reserve System (NRS). The NRS is Australia's network of protected areas, including national parks and other Government reserves, indigenous lands, and reserves run by non-profit conservation organisations. The Pilbara bioregion is considered to be under-represented by the NRS, with less than 10% of the bioregion protected. However, of the four subregions within the Pilbara bioregion, the Hamersley subregion has the highest percentage of area under some form of protection (Kendrick 2003).

Karijini National Park (Karijini) is the closest conservation reserve to the study area. The nearest boundary of Karijini to the study area is approximately 75 km to the east.

### 4.3 Land Systems

Western Australian Rangelands Surveys have been conducted for various parts of the State as part of a program of rangeland classification, mapping and resource evaluation (Waddell et al. 2010). These surveys have been conducted in Western Australia since the 1950s, when they were commenced by the Commonwealth Scientific and Industrial Research Organisation (Speck et al. 1960), and more recently have been conducted as a collaboration between the Department of Agriculture and Food WA and Landgate. The land system approach to mapping different country types has been used in all of the regional rangeland surveys in Western Australia.

The concept of land systems was first used by Christian and Stewart (1953). They define a land system as 'an area with a recurring pattern of topography, soils and vegetation'. These recurring patterns can be mapped using 1:50,000 scale aerial photography or other remotely sensed images (Waddell et al. 2010). It is assumed areas with a similar pattern represent the same land system. The land systems are then ground-truthed during field work.

A total of 105 land systems have been identified and mapped in the Pilbara bioregion<sup>5</sup>, with 63 land systems occurring in the Hamersley subregion. Land systems mapping covering the study area has been prepared by van Vreeswyk et al. (2004). The study area intersects two land systems, Newman and Rocklea, which are summarised in Table 4.1. Both of these land systems are widespread and extensive in terms of their area within the Pilbara bioregion. Their location in relation to the study area is shown in Figure 4.1.

<sup>5</sup> 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).

Table 4.1: Land systems intersected by the study area and their broader extent in the Hamersley subregion (Payne et al. 1988, van Vreeswyk et al. 2004).

Land System	Description (Van Vreeswyk et al. 2004)	Total Area of Land System in the Hamersley Subregion (ha)	Total Area of Land System within the Study Area (ha)	Proportion of Land System Mapped for the Subregion that Occurs in the Study Area (%)
Newman (RGENEW)	Rugged jaspillite 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%).	1,853,935	319.2	0.02
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%).	711,645	5.5	<0.01

## 4.4 Surface Geology

The study area encompasses eight geological units mapped by the Geological Survey of Western Australia (1984). These units are described in Table 4.2 and displayed in Figure 4.2.

Table 4.2: Geological units occurring within the study area (Geological Survey of Western Australia 1984).

Unit Code	Geological Description	Area (ha)
Czc	Colluvium: partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill deposits, locally derived.	68.2
Czr	Hematite: Goethite deposits on banded iron-formation and adjacent scree deposits.	62.1
AHm	Marra Mamba Iron Formation: chert, banded iron-formation, and pelite.	55.2
AHs	Mount McRae Shale and Mount Sylvia Formation: pelite, chert, and banded iron formation.	53.9
Qa	Alluvium: unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains.	52.5
PLHb	Brockman Iron Formation: Banded iron-formation, chert, and pelite.	26.2
AFj	Jeerinah Formation: pelite, metasandstone, chert, metabasaltic pillow lava and breccia, and metamorphosed felsic volcanic rock.	3.7
PLHt	Medium- to -coarse-grained metadolerite sills in the Hamersley Group.	2.9

## 4.5 Landforms, Surface Hydrology and Soils

The study area is situated in a broad, shallow valley, which divides a range of low hills. The valley is aligned in a north-south to a northeast-southwest orientation. A second low range of hills running northeast-southwest bisects the valley at the southern boundary of the study area, resulting in two narrow, shallow valleys.

A moderate-sized drainage line dissects the study area, draining from south to north; this drainage eventually joins into the Boolgeeda Creek system to the north. The drainage line is constrained to a single channel on the eastern side of the valley for most of its length in the study area, however there are several instances where the channel floods out during large flows. Numerous short, steep minor drainage lines flow off the sides of the valley and into the major drainage line.

Soils in the study area were generally described as red-brown loams, clay loams or sandy clay loams and were covered with a loose surface layer of stones and pebbles. Soils were more stony at the margins of the valley and on the associated footslopes. Heavier soils were found in the lower parts of the valley and in the flood-out areas.

## 4.6 Beard's Vegetation Mapping

Beard (1975a) 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.

Two of the vegetation units mapped by Beard (1975a) occur within the study area (see Figure 4.1):

- Hamersley 82: this unit comprises Snappy Gum (*Eucalyptus leucophloia*) low open woodland over Hard Spinifex (*Triodia wiseana*) hummock grassland; and
- 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, these units are only broadly applicable to the vegetation of the study area (see Section 5.2).

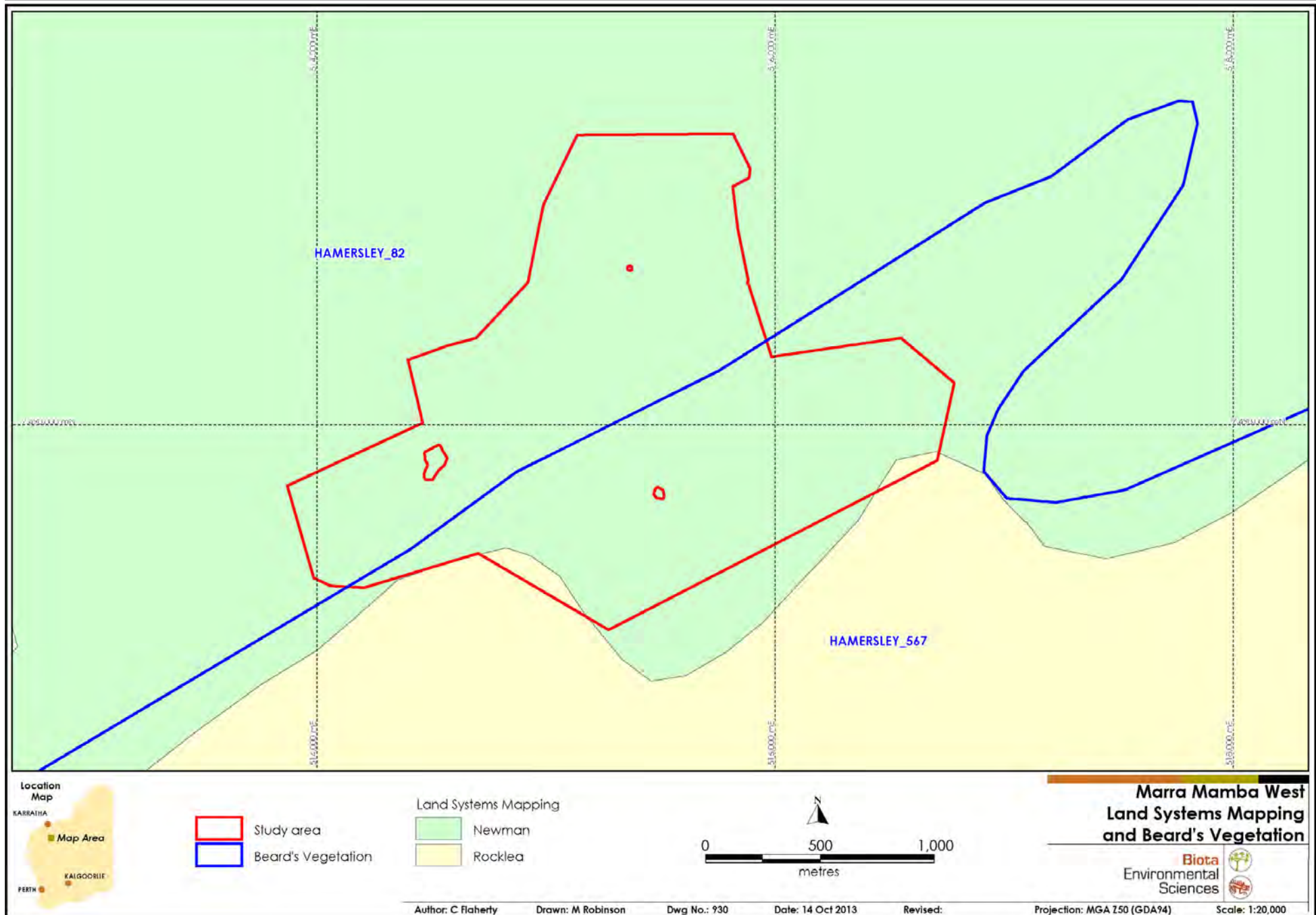


Figure 4.1: Land systems mapping (Van Vreeswyk et al. 2004) and Beard's (1975a) vegetation mapping in the locality of the study area.

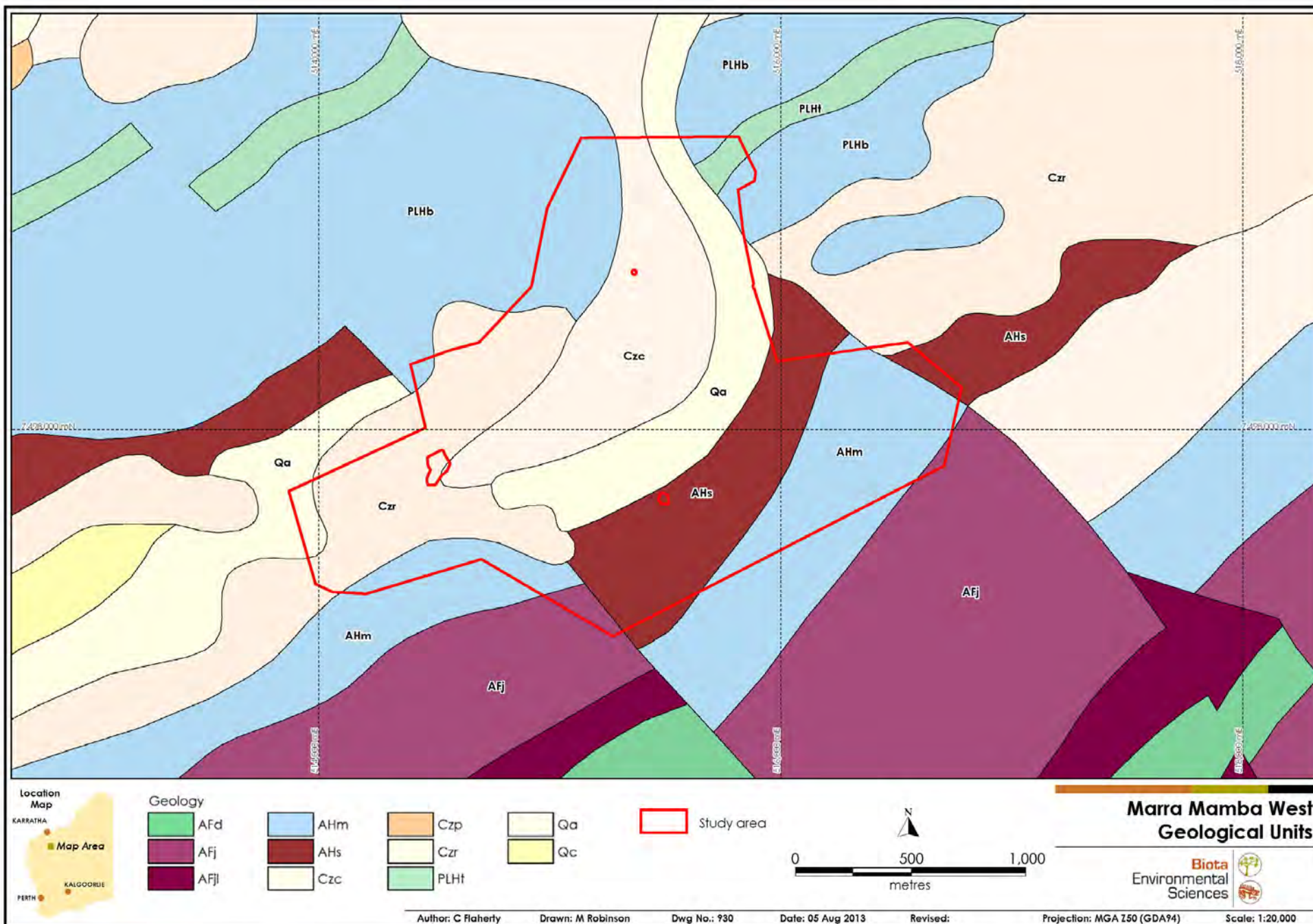


Figure 4.2: Geological units mapped in the vicinity of the study area (Geological Survey of Western Australia 1984).

## 4.7 Vegetation Communities of Conservation Significance Known from the Locality

The following section describes vegetation of conservation significance known from the locality, based on a search of the DPaW database of TECs and PECs (see Section 3.1). The framework for ranking communities of conservation significance in Western Australia is presented in Appendix 1.

### 4.7.1 Threatened Ecological Communities

TECs are described by DPaW as biological (flora or fauna) assemblages occurring in a particular habitat, which are under threat of modification or destruction from various processes (DEC 2010). TECs listed by DPaW are significant at the State level and are protected as Environmentally Sensitive Areas (ESAs) under the *Environmental Protection Act 1986 (WA)*. Two TECs are listed for the Pilbara bioregion: the 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' and the 'Ethel Gorge aquifer stygobiont community' (DEC 2013).

Twenty-three of the 69 TECs listed in Western Australia are also nationally recognised and listed under the Commonwealth *EPBC Act 1999*. These do not include either of the two TECs listed for the Pilbara bioregion.

The 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' TEC is known from within 40 km of the study area. The closest record of this TEC is approximately 38 km to the north-northeast of the study area. This TEC would not occur in the study area as there is no suitable habitat (clay plains).

### 4.7.2 Priority Ecological Communities

PECs include possible TECs that do not meet survey criteria or are not adequately defined. These are added to DPaW's PEC list under Priorities 1 (highest priority), 2 and 3. Ecological Communities that 1) are adequately known, 2) are rare but not threatened, or meet criteria for Near Threatened, or 3) have been recently removed from the threatened list, are placed in Priority 4. Conservation dependent ecological communities are placed in Priority 5.

Thirty PECs are listed for the Pilbara bioregion (DPaW 2013a). One PEC is known from the vicinity of the study area; the 'Brockman Iron cracking clay communities of the Hamersley Range'. This PEC is listed as Priority 1 and is described by DPaW (2013a) as a "tussock grassland dominated by *Astrebla lappacea* in the Hamersley range, on the Newman Land System". The nearest record of this PEC to the study area is approximately 35 km to the north-northeast of the study area. This PEC would not occur in the study area as there is no suitable habitat (areas of cracking clay).

## 4.8 Conservation Significant Flora Species Known from the Locality

### 4.8.1 Threatened Flora

Three Threatened flora species (*Aluta quadrata*, *Lepidium catapycnon* and *Thryptomene wittweri*) are known from the Pilbara bioregion. *Lepidium catapycnon* and *Thryptomene wittweri* are listed as Threatened flora under the Commonwealth EPBC Act 1999 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. Each species is described briefly below:

- *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. Given the lack of suitable habitat and the restricted distribution of this species, it would not occur in the study area.
- *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, particularly in association with the Newman land system (see Section 4.3). 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. The closest records of this species to the study area are approximately 30 km east-northeast. Although there is suitable habitat for this species in the study area, it has not been recorded previously in the Marra Mamba locality, despite intensive rare flora searches (see Appendix 2). This species was therefore considered unlikely to occur in the study area on the basis of the desktop review (see Appendix 3).
- *Thryptomene wittweri* (Mountain Thryptomene) 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. All Pilbara records are restricted to the Mt Bruce area. *Thryptomene wittweri* would not occur in the study area as suitable habitat is not present, and its distribution does not include the study area.

### 4.8.2 Priority Flora

Based on the results of the database searches and literature reviews conducted for this study, a total of 35 Priority flora taxa have been recorded within 40 km of the study area (Appendix 2). A brief description of these Priority flora taxa along with an assessment of the likelihood of occurrence of each taxon in the study area is provided in Appendix 2.

None of the existing Priority flora records were from within the study area boundary. Based on the known distributions of the Priority flora, and comparison of their habitat preferences with the habitats that appeared to be present in the study area, the following 12 Priority flora taxa were identified through the desktop review as being:

- Likely to occur:
  - one Priority 3 taxon: *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301).
- May potentially occur:
  - two Priority 1 taxa: *Hibiscus* sp. Brockman (E. Thoma ET 1354) and *Sida* sp. Hamersley Range (K. Newbey 10692);
  - five Priority 3 taxa: *Eremophila magnifica* subsp. *velutina*, *Gymnanthera cunninghamii*, *Ptilotus subspinescens*, *Rostellularia adscendens* var. *latifolia* and *Sida* sp. Barlee Range (S. van Leeuwen 1642); and

- four Priority 4 taxa: *Acacia bromilowiana*, *Eremophila magnifica* subsp. *magnifica*, *Goodenia nuda* and *Ptilotus mollis*.

These Priority flora taxa were the target species for the rare flora traverses in the study area.

With regards to the species considered likely to occur in the study area:

- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)  
This robust perennial shrub, which typically grows between 1 and 2 m tall, is known from drainage lines, floodplains and rocky gullies (DPaW 2013b). Recorded locations stretch over a range of approximately 208 km from the Bungaroo Valley in the northwest to West Turner in the southeast. The species has been recorded from numerous survey areas within 40 km of the current study area, including 5.7 km southwest of the study area at Vivash (e.g. Rio Tinto 2012), and 10.7 km southeast of the study area at Beasley River (Biota 2009b). Other locations within 40 km include Brockman Syncline 4 ((Biota 2005b, 2012)), Brockman 2 (Biota 2010d), Silvergrass (Biota 2010e), Pinarra (e.g. Rio Tinto 2011a), West Turner (Biota 2013c) and Mt Farquhar (e.g. Rio Tinto 2011b). Given the common occurrence of this species in creeklines in the locality, it was considered likely that it would occur in such habitats in the study area.

With regards to the species considered to have the potential to occur in the study area:

- *Hibiscus* sp. Brockman (E. Thoma ET 1354) (Priority 1)  
This taxon has only recently been allocated this phrase name, previously being included in the *Hibiscus* “haynaldii” complex. It is a robust shrub growing to 1.5 m tall, with large, ovate to lanceolate leaves, which are densely covered in stellate (star-shaped) hairs and have a uniformly toothed margin; uniformly and densely stellate-hairy stems; and large mauve to deep purple flowers with long, thin calyx lobes to about half the length of the petals (A. Perkins, WA Herbarium, pers. comm. 2012). Based on the current records, the distribution of *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354) extends over a radius of approximately 35 km around Brockman Syncline 4 (Biota 2013c), with records commonly being associated with gorges, gullies or other rocky habitats. As a small amount of suitable habitat (two small gorges) looked to be present in the study area on aerial imagery, it was considered that this species may potentially occur.
- *Sida* sp. Hamersley Range (K. Newbey 10692) (Priority 1)  
*Sida* sp. Hamersley Range (K. Newbey 10692) is a shrub that typically grows on rocky hill slopes and in gorges. This species is known from approximately 9.6 km southwest of the current study area at Vivash (Rio Tinto 2011c). Based on records held by Rio Tinto, this taxon has a range of 326 km east-west (from Hope Downs to Metawandy) and 100 km north-south, with most records occurring in the Brockman locality. Given the broad distribution of this species, and the presence of rocky hill slopes and some gorge habitat, it was considered that this species may potentially occur in the study area.
- *Eremophila magnifica* subsp. *velutina* (Priority 3)  
*Eremophila magnifica* subsp. *velutina* is a shrub to 1.5 m tall with blue-purple flowers between August and September (DPaW 2013b). This taxon occurs over a range of approximately 300 km east-west, from Newman to west of Brockman Syncline 4, and two populations are known from Karijini National Park. This species was recorded from several locations at Vivash, the closest of which is 5.7 km southwest of the study area (Rio Tinto 2012), with other populations known from Silvergrass West (Biota 2010e) and West Turner (Biota 2013c). Given the broad distribution of this species and the presence of hills in the study area, it was considered that this species may potentially occur.
- *Gymnanthera cunninghamii* (Priority 3)  
*Gymnanthera cunninghamii* is a shrub growing to 2 m tall with cream/yellow flowers year round, which is usually found growing along drainage lines (DPaW 2013b). This species is known from several locations scattered through the Pilbara, along with two records in the Carnarvon region and two records in the Great Sandy Desert region (DPaW 2013b). Although infrequently recorded in the locality, one individual of this species was recorded from a creekline at West Turner (Biota 2013c), and it was considered that this species may potentially occur in the study area.



- *Ptilotus subspinescens* (Priority 3)  
*Ptilotus subspinescens* is a compact shrub to 0.8 m tall, with distinctive spinescent and virtually leafless branchlets (DPaW 2013b). The distribution of this species is currently known to extend over a radius of approximately 35 km around Brockman Syncline 4, with all of the known records (approximately 500 locations in total) lying within 50 km of the current study area. The presence of *Ptilotus subspinescens* in the vicinity of the study area is well documented, including records as close as 2.7 km east (Biota 2013b). This species is strongly associated with plains that have a substrate of loose, calcareous silty-clay soil, with most records associated with hummock grasslands of *Triodia angusta* and/or *T. longiceps* (Biota 2007b). It was considered that this species may potentially occur in the study area, provided that suitable habitat was present (this could not be determined conclusively from aerial imagery).
- *Rostellularia adscendens* var. *latifolia* (Priority 3)  
*Rostellularia adscendens* var. *latifolia* is a small herb to low shrub that occurs in a variety of habitats (DPaW 2013b). This taxon has a broad distribution across the Pilbara (over 400 km, extending from the Brockman locality to the Oakover River), with five populations known from Karijini National Park. This taxon has been recorded from several localities within 40 km of the study area, with the closest known locations 26 km southeast at West Turner (Biota 2013c) and 31 km northwest along Caves Creek (Biota 2011). Given the broad distribution of this species and its wide range of habitats, it was considered that it may potentially occur in the study area.
- *Sida* sp. Barlee Range (*S. van Leeuwen* 1642) (Priority 3)  
*Sida* sp. Barlee Range (*S. van Leeuwen* 1642) is a spreading shrub, which grows to 0.5 m tall and typically occurs in pockets of red soil on steep rocky slopes and along the base of free rock faces (DPaW 2013b). This taxon has a broad distribution across 370 km east-west, extending from Barlee Range Nature Reserve to near Newman. Numerous records are known from the locality, including particularly large numbers from Brockman 2 (Biota 2010d, Rio Tinto 2010a, 2010b) and West Turner (Biota 2013c). It was considered that this species may potentially occur in the rocky gorge habitat in the northwestern section of the study area.
- *Acacia bromilowiana* (Priority 4)  
*Acacia bromilowiana* is a tree or large shrub that can grow up to 12 m tall. It has dark grey, fibrous bark, and produces yellow flowers in July and August (DPaW 2013b). This species has a broad distribution of approximately 400 km east-west in the southern Pilbara, and commonly occurs on skeletal stony loams on rocky hills, slopes, gorges or adjacent creek beds (DPaW 2013b). There are a small number of records of this species within 50 km of the study area, with the closest being 9.7 km southwest at Vivash (Rio Tinto 2012). It was considered that this species may potentially occur on hills in the study area.
- *Eremophila magnifica* subsp. *magnifica* (Priority 4)  
*Eremophila magnifica* subsp. *magnifica* is distinguished from *E. magnifica* subsp. *velutina* by the absence of hairs on its leaves. It occurs over the same broad range as subsp. *velutina*, with nine populations known from Karijini National Park. This subspecies is known from several different localities within 40 km of the study area; the closest records are on Mt West, only 420 m northeast of the study area (Biota 2005b), with additional populations known from areas further southwest, east and north (e.g. Vivash East (Rio Tinto 2011c), West Turner (Biota 2013c) and Silvergrass West (Pilbara Iron 2007) respectively). Given the proximity of the Mt West records and the presence of hills in the study area (although not of similar scale to Mt West), it was considered that this species may potentially occur.
- *Goodenia nuda* (Priority 4)  
*Goodenia nuda* is an erect to ascending, slender herb growing to 50 cm in height, with yellow flowers and narrow, pale green glaucous leaves (DPaW 2013b). This species is typically found growing near creeklines and in wet areas. It has a broad distribution; most records occur over a range of approximately 450 km through the Pilbara bioregion, with populations known from Karijini and Millstream-Chichester National Parks. There is also an outlying record from the Canning Stock Route in the Gascoyne bioregion. The species has not been frequently recorded within 40 km of the study area, with single records from 15.9 km northeast in the Brockman Syncline 4 infrastructure corridor (Biota 2007c) and 39.4 km north-northwest at Farquhar (Rio Tinto 2011b). Although there is suitable habitat in the study area for this species

(creeklines and floodplains), the likelihood ranking of “may potentially occur” reflects the limited number of records in the locality.

- *Ptilotus mollis* (Priority 4)  
*Ptilotus mollis* is a low shrub with leaves that are densely covered with soft white hairs. This species is typically found growing on stony hills, often where there is a shaly or rocky substrate (DPaW 2013b). *Ptilotus mollis* has a broad distribution through the Pilbara, occurring over a range of approximately 300 km north-south and 640 km east-west, from Rudall River to Cane River. One population is known from Karijini National Park. There are several records from three localities north-northwest, northeast and east-southeast of the study area, all of which are further than 25 km from the study area (Biota 2007b). Although there is suitable hills habitat in the study area, this species was designated as “may potentially occur” due to the lack of any existing records in close proximity.

## 5.0 Vegetation of the Study Area

### 5.1 Overview

A total of 14 vegetation types were mapped in the study area, and some cleared areas were also mapped as “Disturbed” (see Appendix 5).

The vegetation types defined for the study area are described in Section 5.2. The descriptions include information about associated species (those that, while not dominant, were frequently recorded from the vegetation unit and helped to define it) and vegetation condition.

The vegetation types were associated with four broad landform categories:

- stony plains;
- creeklines and floodplains;
- stony hillslopes and crests; and
- rocky gorges.

Table 5.1 outlines the area of each vegetation type in the study area, along with other study areas in the locality from which the vegetation type has been recorded.

Table 5.1: Area of each vegetation type in the study area and its occurrence in other study areas within the broader locality

Vegetation Type/Mapping Unit	Area (ha)	Percentage of the Study Area (%)	Other Study Areas from which Vegetation Type has been Recorded †
Disturbed	2.9	0.9	
Vegetation of Stony Plains			
P1: AaAbAsTe	86.7	26.7	BS4
P2: EsTw	6.5	2.0	BS4
Vegetation of Creeklines and Floodplains			
C1: EvGOOIPld	8.4	2.6	BS4
C2: ExAcISsPToTHtCHfCEc	32.9	10.1	-
C3: AcIVfCEc	4.3	1.3	-
Vegetation of Stony Hillslopes and Crests			
H1: EIAprAmaTbrTe	50.0	15.4	-
H2: ElHcAatTbrTw	21.7	6.7	-
H3: ElAmoAmTbrTe	43.9	13.5	-
H4: ElTe	57.6	17.8	BS4, WQ
H5: ElAatTw	4.2	1.3	BS4
H6: ElAbTbrTeTHmCYa	0.5	0.2	BS4
H7: ElAItw	2.1	0.6	BS4, MM
H8: AaTw	0.7	0.2	BS4
Vegetation of Rocky Gorges			
G1: CfDpAprTHmTe	2.3	0.7	-

† BS4 refers to the Brockman Syncline 4 survey (Biota 2005b), MM refers to the Marra Mamba survey (Biota 2013b) and WQ refers to the White Quartz Road survey (Biota 2007a).

## 5.2 Description of the Vegetation Types

### 5.2.1 Vegetation of Stony Plains

P1: AaAbAsTe *Acacia ancistrocarpa*, *A. bivenosa*, *A. synchronicia* open shrubland over *Triodia epactia* hummock grassland

Habitat	This vegetation type was recorded on plains through the central section of the study area (Plate 5.1).
Associated Species	<u>Trees</u> : <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> . <u>Tall Shrubs</u> : <i>Acacia pruinocarpa</i> . <u>Shrubs</u> : <i>Acacia atkinsiana</i> , <i>A. exilis</i> , <i>A. tetragonophylla</i> , <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> , <i>S. glutinosa</i> subsp. <i>pruinosa</i> . <u>Low Shrubs</u> : <i>Ptilotus astrolasius</i> , <i>Tribulus suberosus</i> . <u>Herbs and Grasses</u> : <i>Amphipogon sericeus</i> , <i>Aristida holathera</i> var. <i>holathera</i> , <i>Goodenia stobbsiana</i> , <i>Paraneurachne muelleri</i> .
Vegetation Condition	Very Good: no weeds; dissected by a few old vehicle tracks that have been rehabilitated and are now mostly regrown.
Flora Sampling Sites (within the current study area)	Relevés MMW-RCH and MMW-RCI; mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): mapping notes.
Notes	<ul style="list-style-type: none"> <li>This vegetation was patchily burnt ~4-5 years ago.</li> <li>Small patches of Mulga (too small to map) were present, often with a sparse understorey of <i>Eremophila forrestii</i> subsp. <i>forrestii</i> scattered shrubs.</li> <li>Minor creeklines (too small to map) dissected this vegetation type, consisting of <i>Gossypium robinsonii</i>, <i>Petalostylis labicheoides</i> tall shrubland over <i>Triodia epactia</i> hummock grassland.</li> </ul>

P2: EsTw *Eucalyptus socialis* subsp. *eucentrica* low open mallee woodland over *Triodia wiseana* open hummock grassland

Habitat	This vegetation type occurred in the northern part of the study area on two small areas of stony calcrete plain (Plate 5.2).
Associated Species	<u>Trees</u> : <i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> , <i>E. xerothermica</i> . <u>Tall Shrubs</u> : <i>Acacia citrinoviridis</i> , <i>A. inaequilatera</i> . <u>Shrubs</u> : <i>Acacia bivenosa</i> , <i>A. exilis</i> , <i>A. synchronicia</i> , <i>A. tetragonophylla</i> , <i>Ptilotus obovatus</i> var. <i>obovatus</i> . <u>Low Shrubs</u> : <i>Ptilotus astrolasius</i> , <i>Senna artemisioides</i> subsp. <i>helmsii</i> . <u>Herbs and Grasses</u> : <i>Amphipogon sericeus</i> , <i>Eragrostis eriopoda</i> , <i>Eriachne pulchella</i> , <i>Ptilotus clementii</i> , <i>P. nobilis</i> subsp. <i>nobilis</i> .
Vegetation Condition	Very Good: signs of cattle (scats); occasional weeds (* <i>Flaveria trinervia</i> ).
Flora Sampling Sites (within the current study area)	Relevé MMW-RRC, mapping notes (current study); quadrat BRO21 (Biota 2005b).
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): quadrat BRO24.

## 5.2.2 Vegetation of Creeklines and Floodplains

C1: EvGOOIPLd *Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland

Habitat	This vegetation was recorded in the bed of the moderate-sized creekline that flows through the central part of the study area, draining from south to north (this is a tributary of the Boolgeeda Creek system; Plate 5.3).
Associated Species	<u>Tall Shrubs</u> : * <i>Vachellia farnesiana</i> . <u>Herbs and Grasses</u> : * <i>Cenchrus ciliaris</i> , <i>Cyperus vaginatus</i> , <i>Eriachne tenuiculmis</i> , <i>Goodenia stobbsiana</i> , <i>Stemodia grossa</i> .
Vegetation Condition	Good: scattered weeds (* <i>Cenchrus ciliaris</i> , * <i>Vachellia farnesiana</i> ); evidence of cattle (grazing, scats, tracks).
Flora Sampling Sites (within the current study area)	Relevé MMW-RRE; mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): quadrats BRO09 and BRO49.

C2: ExAciSsPToTHtCHfCEc *Eucalyptus xerothermica* scattered low trees over *Acacia citrinoviridis*, *Stylobasium spathulatum* tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered shrubs over *Themeda triandra*, *Chrysopogon fallax*, \**Cenchrus ciliaris* very open tussock grassland

Habitat	This vegetation type dominated the floodplain associated with the moderate-sized creekline, fringing vegetation type C1 (Plate 5.4, Plate 5.5).
Associated Species	<u>Tall Shrubs</u> : <i>Acacia bivenosa</i> , <i>A. pyrifolia</i> var. <i>pyrifolia</i> , <i>Androcalva luteiflora</i> , <i>Eremophila longifolia</i> , <i>Gossypium robinsonii</i> , <i>Hakea lorea</i> subsp. <i>lorea</i> , * <i>Vachellia farnesiana</i> . <u>Shrubs</u> : <i>Acacia ancistrocarpa</i> , <i>Corchorus crozophorifolius</i> . <u>Low Shrubs</u> : <i>Gossypium australe</i> , <i>Hybanthus aurantiacus</i> , <i>Tephrosia rosea</i> var. <i>Fortescue</i> creeks (M.I.H. Brooker 2186), <i>Waltheria indica</i> . <u>Herbs and Grasses</u> : <i>Bothriochloa ewartiana</i> , <i>Dichanthium fecundum</i> , <i>Enneapogon polyphyllus</i> , <i>Enteropogon racemosus</i> , <i>Rhynchosia minima</i> , <i>Triodia epactia</i> .
Vegetation Condition	Good to Very Poor: presence of weeds (* <i>Cenchrus ciliaris</i> , * <i>Malvastrum americanum</i> , * <i>Setaria verticillata</i> , * <i>Vachellia farnesiana</i> ); damage from cattle (grazing, tracks, scats, and trampling causing some erosion on banks).
Flora Sampling Sites (within the current study area)	Relevés MMW-RCA, MMW-RCJ and MMW-RRD, and mapping notes (current study); quadrat BRO22 (Biota 2005b).
Notes	<ul style="list-style-type: none"> <li>*<i>Cenchrus ciliaris</i> was very prolific (almost continuous) along the creek banks, but was scattered or very open further into the floodplain.</li> </ul>

C3: AciVfCEc *Acacia citrinoviridis*, \**Vachellia farnesiana* tall open shrubland over \**Cenchrus ciliaris* closed tussock grassland

Habitat	This vegetation type occurred on one section of the floodplain, south of the calcrete area supporting vegetation type P2. It was more open than vegetation type C2, lacked the diverse shrub stratum and was mostly dominated by weed species (Plate 5.6).
Associated Species	<u>Trees:</u> <i>Eucalyptus xerothermica</i> . <u>Tall Shrubs:</u> <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> . <u>Herbs and Grasses:</u> <i>Pterocaulon sphacelatum</i> .
Vegetation Condition	Very Poor: high cover of weed species (* <i>Cenchrus ciliaris</i> , * <i>Vachellia farnesiana</i> ); few native species; damage from cattle (grazing).
Flora Sampling Sites (within the current study area)	Relevé MMW-RCK; mapping notes.
Notes	<ul style="list-style-type: none"> <li>• Few native species were associated with this vegetation type.</li> <li>• The prevalence of weed species may be due to more calcareous soils resulting from the location of this area near a patch of calcrete; such soils are frequently more susceptible to weed invasion.</li> </ul>

### 5.2.3 Vegetation of Stony Hillslopes and Crests

H1: ElAprAmaTbrTe *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia pruinocarpa*, *A. marramamba* open shrubland over *Triodia brizoides*, *T. epactia* open hummock grassland

Habitat	This vegetation type was recorded along the northwestern edge of the study area from the rocky east- and southeast-facing midslopes of a large hill (Plate 5.7).
Associated Species	<u>Tall Shrubs:</u> <i>Hakea chordophylla</i> . <u>Shrubs:</u> <i>Acacia exilis</i> , <i>Ptilotus calostachyus</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> . <u>Low Shrubs:</u> <i>Dampiera candicans</i> , <i>Tribulus suberosus</i> . <u>Herbs and Grasses:</u> <i>Goodenia cusackiana</i> , <i>Paraneurachne muelleri</i> , <i>Schizachyrium fragile</i> , <i>Triodia wiseana</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevés MMW-RCC and MMW-RCE; mapping notes.
Notes	<ul style="list-style-type: none"> <li>• Most of this vegetation type was dominated by <i>Triodia brizoides</i> (with scattered <i>T. epactia</i>), however some slopes were dominated by <i>T. epactia</i>.</li> </ul>

H2: EIHCaatTbrTw *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Hakea chordophylla* scattered tall shrubs over *Acacia atkinsiana* scattered shrubs over *Triodia brizoides*, *T. wiseana* open hummock grassland

Habitat	This vegetation type was recorded from the crest of a large hill in the east of the study area (Plate 5.8).
Associated Species	<u>Shrubs:</u> <i>Acacia maitlandii</i> , <i>A. marramamba</i> , <i>A. pruinocarpa</i> , <i>Keraudrenia nephrosperma</i> , <i>Senna glutinosa</i> subsp. <i>x luerssenii</i> , <i>S. glutinosa</i> subsp. <i>pruinosa</i> . <u>Low Shrubs:</u> <i>Ptilotus rotundifolius</i> , <i>Tribulus suberosus</i> . <u>Herbs and Grasses:</u> <i>Amphipogon sericeus</i> , <i>Goodenia cusackiana</i> , <i>Polycarphaea holtzei</i> , <i>Triodia epactia</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevé MMW-RCG; mapping notes.
Notes	<ul style="list-style-type: none"> <li>The dominant spinifex was mostly <i>Triodia brizoides</i>, however a few small areas within this vegetation type were dominated by <i>T. wiseana</i>.</li> </ul>

H3: EIAmoAmTbrTe *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia monticola*, *A. maitlandii* tall open shrubland over *Triodia brizoides*, *T. epactia* open tussock grassland

Habitat	This vegetation type occurred along the southern edge of the study area on north- and northwest-facing rocky midslopes and lower slopes (Plate 5.9).
Associated Species	<u>Trees:</u> <i>Hakea chordophylla</i> . <u>Tall Shrubs:</u> <i>Acacia citrinoviridis</i> , <i>A. inaequilatera</i> , <i>A. pruinocarpa</i> . <u>Shrubs:</u> <i>Senna glutinosa</i> subsp. <i>pruinosa</i> . <u>Low Shrubs:</u> <i>Dampiera candicans</i> , <i>Senna notabilis</i> , <i>Solanum lasiophyllum</i> . <u>Herbs and Grasses:</u> <i>Aristida holathera</i> var. <i>holathera</i> , <i>Eriachne mucronata</i> , <i>Goodenia stobbsiana</i> , <i>Triodia wiseana</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevé MMW-RCB, mapping notes.

H4: EITe *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia epactia* open hummock grassland to hummock grassland

Habitat	This vegetation type was recorded from the southern half of the study area, occurring on low hills in the far west and on the lower slopes of the hills in the east (Plate 5.10).
Associated Species	<u>Trees:</u> <i>Acacia aptaneura</i> . <u>Tall Shrubs:</u> <i>Acacia pruinocarpa</i> , <i>A. tetragonophylla</i> , <i>Grevillea berryana</i> . <u>Shrubs:</u> <i>Acacia atkinsiana</i> , <i>A. bivenosa</i> , <i>Codonocarpus cotinifolius</i> , <i>Senna artemisioides</i> subsp. <i>oligophylla</i> , <i>S. artemisioides</i> subsp. <i>oligophylla</i> x subsp. <i>helmsii</i> . <u>Low Shrubs:</u> <i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i> , <i>Ptilotus astrolasius</i> , <i>P. obovatus</i> var. <i>obovatus</i> , <i>Solanum lasiophyllum</i> . <u>Herbs and Grasses:</u> <i>Aristida contorta</i> , <i>Cymbopogon ambiguus</i> , <i>Goodenia cusackiana</i> , <i>Ptilotus nobilis</i> subsp. <i>nobilis</i> .
Vegetation Condition	Very Good.
Flora Sampling Sites (within the current study area)	Relevés MMW-RRA, MMW-RRB, MMW-RCF; mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): mapping notes. White Quartz Road survey (Biota 2007a): mapping notes.
Notes	<ul style="list-style-type: none"> <li>• Small patches of Mulga were present throughout this vegetation.</li> <li>• Patches of this vegetation type in the west of the study area had been burnt ~4-5 years ago.</li> </ul>

H5: EIAatTw *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia atkinsiana* open shrubland over *Triodia wiseana* hummock grassland

Habitat	This vegetation type occurred in a small area of stony hills in the northeast of the study area (Plate 5.11).
Associated Species	<u>Trees:</u> <i>Hakea chordophylla</i> . <u>Shrubs:</u> <i>Ptilotus calostachyus</i> , <i>Senna glutinosa</i> subsp. <i>glutinosa</i> . <u>Herbs and Grasses:</u> <i>Paraneurachne muelleri</i> , <i>Triodia epactia</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevé MMW-RRG; mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): relevés BRO-HA, BRO-MB, BRO-RA and mapping notes.



H6: EIAbTbrTeTHmCYa *Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia bivenosa* open shrubland over *Triodia brizoides*, *T. epactia* hummock grassland and *Themeda* sp. Mt. Barricade (M.E. Trudgen 2471), *Cymbopogon ambiguus* open tussock grassland

Habitat	This vegetation type was recorded from the slopes of a small, broad valley in the north of the study area (Plate 5.12). Only a small area of this vegetation type is intersected by the study area.
Associated Species	<u>Tall Shrubs:</u> <i>Gossypium robinsonii</i> , <i>Santalum lanceolatum</i> . <u>Shrubs:</u> <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3), <i>Ptilotus obovatus</i> var. <i>obovatus</i> , <i>Senna glutinosa</i> subsp. <i>pruinosa</i> . <u>Herbs and Grasses:</u> <i>Enneapogon robustissimus</i> , <i>Ptilotus auriculifolius</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): quadrat BRO26, relevé BRO-MH; mapping notes.

H7: EIAiTw *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland

Habitat	This vegetation type was recorded from two stony slopes leading down from a ridgeline in the south of the study area (Plate 5.13).
Associated Species	<u>Tall Shrubs:</u> <i>Acacia maitlandii</i> . <u>Shrubs:</u> <i>Ptilotus calostachyus</i> . <u>Herbs and Grasses:</u> <i>Amphipogon sericeus</i> , <i>Goodenia stobbsiana</i> , <i>Triodia epactia</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevé MMW-RRF; mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): quadrats BRO07, BRO24; mapping notes. Marra Mamba survey (Biota 2013b): quadrats MMF16, MMF18, MMF27, MMF29; mapping notes.

H8: AaTw *Acacia ancistrocarpa* open heath to tall open shrubland over *Triodia wiseana* hummock grassland to closed hummock grassland

Habitat	This vegetation was recorded from low stony hillslopes along the eastern boundary of the study area (Plate 5.14). Only a small area of this vegetation type is intersected by the study area.
Associated Species	<u>Shrubs:</u> <i>Acacia bivenosa</i> , <i>A. marramamba</i> , <i>A. pruinocarpa</i> , <i>A. synchronicia</i> , <i>Senna glutinosa</i> subsp. <i>pruinosa</i> . <u>Low Shrubs:</u> <i>Indigofera monophylla</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Mapping notes.
Also Described From (other surveys)	Brockman Syncline 4 survey (Biota 2005b): quadrat BRO20, relevé BRO-RB; mapping notes.

### 5.2.4 Vegetation of Rocky Gorges

G1: CfDpAprTHmTe *Corymbia ferriticola* open forest over *Dodonaea pachyneura*, *Acacia pruinocarpa* tall open shrubland to tall open scrub over *Themeda* sp. Mt Barricade (M.E. Trudgen 2471) very open tussock grassland and *Triodia epactia* very open hummock grassland

Habitat	This vegetation type was recorded from two narrow rocky gorges running through the hillslopes in the northwest of the study area (Plate 5.15).
Associated Species	<u>Trees:</u> <i>Acacia aptaneura</i> , <i>Brachychiton acuminatus</i> , <i>Ficus brachypoda</i> . <u>Tall Shrubs:</u> <i>Acacia hamersleyensis</i> , <i>A. rhodophloia</i> , <i>Clerodendrum floribundum</i> var. <i>angustifolium</i> , <i>Grevillea berryana</i> . <u>Shrubs:</u> <i>Astrotricha hamptonii</i> , <i>Ptilotus obovatus</i> var. <i>obovatus</i> . <u>Low Shrubs:</u> <i>Senna venusta</i> , <i>Tephrosia</i> sp. Fortescue (A.A. Mitchell 606), <i>Triumfetta maconochieana</i> . <u>Herbs and Grasses:</u> <i>Alternanthera nana</i> , <i>Aristida burbridgeae</i> , <i>Eriachne mucronata</i> , <i>Gomphrena cunninghamii</i> .
Vegetation Condition	Excellent.
Flora Sampling Sites (within the current study area)	Relevé MMW-RCD; mapping notes.



Plate 5.1: Vegetation type P1.



Plate 5.2: Vegetation type P2.



Plate 5.3: Vegetation type C1.



Plate 5.4: Vegetation type C2.  
(Low \**Cenchrus ciliaris* cover.)



Plate 5.5: Vegetation type C2.  
(High \**Cenchrus ciliaris* cover.)



Plate 5.6: Vegetation type C3.



Plate 5.7: Vegetation type H1.



Plate 5.8: Vegetation type H2.



Plate 5.9: Vegetation type H3.



Plate 5.10: Vegetation type H4.



Plate 5.11: Vegetation type H5 (from Brockman Syncline 4; Biota 2005b).



Plate 5.12: Vegetation type H6.



Plate 5.13: Vegetation type H7.



Plate 5.14: Vegetation type H8 (from Brockman Syncline 4; Biota 2005b).



Plate 5.15: Vegetation type G1.

## 5.3 Changes Made to Previous Vegetation Mapping

The eastern portion of the study area had been mapped previously for the Brockman Syncline 4 vegetation and flora survey (Biota 2005b). Where possible vegetation types and boundaries were kept consistent with the mapping presented in the Biota (2005b) report, however there were some vegetation types and vegetation boundaries that were amended for the current study. These differences in vegetation types observed over the same area reflect the different sizes of the two survey areas, with the Brockman Syncline 4 survey area approximately 36 times larger than the current study area (11,796 ha compared to 324 ha respectively). It is widely recognised that it is not practical to map very large areas at a similar level of detail to small areas, as reflected by statements such as the following: “(Vegetation) mapping at the population or community level is preferable. However, in larger areas this may not be feasible” (EPA 2004a).

Three vegetation types from the Brockman Syncline 4 survey vegetation mapping were changed for this report. These changes are explained in Table 5.2.

Table 5.2: Summary of changes made to vegetation mapping from Biota (2005b) for the area overlapping the current study area.

Vegetation Type Recorded by Brockman Syncline 4 Study (Biota 2005b)	Vegetation Type(s) Recorded in the Same Areas for the Current Study	Comments
P10: EExAbAexTan	P2: EsTw	<ul style="list-style-type: none"> <li>Dominant <i>Triodia</i> was identified to be <i>T. wiseana</i> (no <i>T. angusta</i> was observed). Vegetation thus more closely resembled P2: EsTw (which was also described from the Brockman Syncline 4 survey).</li> <li>Difference arising from the similarity of the aerial photo-signatures for units P10 and P2 (both occur on calcareous substrates).</li> </ul>
C3: ExAciSsPToThTCHf	C2: ExAciSsPToThTCHfCEc;  C3: AciVfCEc	<ul style="list-style-type: none"> <li>*<i>Cenchrus ciliaris</i> was found to be a dominant tussock grass species in this area. The level of infestation may have increased over time.</li> <li>Vegetation type C3 of the current study was mapped separately on an area of floodplain. Units of such small area would not have been able to be recognised for the baseline vegetation and flora survey of the 11,796 ha Brockman Syncline 4 study area.</li> </ul>
H14: EITw	H2: ElHcAatTbrTw; H3: ElAmoAmTbrTe	<ul style="list-style-type: none"> <li>The area mapped as H14 by Biota (2005b) was split into two separate units: H2 (hilltops) and H3 (slopes).</li> <li>Differences in mapping/vegetation types reflect the finer-scale mapping possible for the current 324 ha study area.</li> </ul>

## 5.4 Vegetation Condition

Vegetation condition mapping for the study area is presented in Appendix 6. 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 whole, given the impact of these disturbance factors. Appendix 4 presents the vegetation condition scale, developed by Trudgen (1988), that was used in determining the vegetation condition rankings.

Most of the vegetation of the study area was in Very Good to Excellent Condition. The main disturbance factor was weed invasion by *Cenchrus ciliaris* (Buffel Grass) and *Vachellia farnesiana* (Mimosa Bush) (see Section 6.5), however dense weed infestations were restricted to the creekline and floodplain vegetation types (C1, C2 and C3). Damage from livestock (cattle) was also evident in these vegetation types, and included grazing, tracks, trampled vegetation and scats (Plate 5.16). While most of the creekline and floodplain vegetation was rated as Good, some areas were rated as Very Poor due to high weed cover (>70% cover) and evidence of extensive grazing and trampling by cattle.

A further disturbance factor affecting the vegetation condition of some of the hills and plains of the study area was historical clearing. Old tracks and other areas of land that had been cleared were noted occasionally on the plains and low hills of the study area. These areas had been ripped and were observed to be in the later stages of regeneration, with the vegetation structure and flora assemblages not yet equivalent to those in the surrounding undisturbed vegetation. Most of these areas were small and were not mapped separately, however they contributed to the rating of the overall vegetation being reduced from Excellent to Very Good. Approximately 2.9 ha (0.9%) of the study area was mapped as Disturbed, which is equivalent to Completely Degraded in the vegetation condition scale (Appendix 4). This ranking was applied to tracks and to one large area of historical clearing, which was mostly cleared and still in an early stage of regeneration (Plate 5.17).



Plate 5.16: Grazing and trampling pressure from cattle in the creekline in the study area.



Plate 5.17: An area of historical clearing in the study area.

## 5.5 Conservation Significance of Vegetation

### 5.5.1 TECs and PECs

None of the vegetation types represent TECs listed either under the Commonwealth EPBC Act 1999 or the WA Environmental Protection Act 1986 (see Section 4.7.1), nor do they represent PECs listed by DPaW (see Section 4.7.2).

### 5.5.2 Ecosystems at Risk

While not listed as TECs or PECs, a number of ecosystems in each WA IBRA subregion are listed as being “at risk” from various threatening processes by regional ecologists in an audit of nature conservation issues of Western Australia’s Biogeographical subregions completed in 2002. Of those listed for the Hamersley subregion (Kendrick 2003), one is potentially of relevance to the study area:

- “All major ephemeral water courses” – described as NVIS Major Vegetation Sub-group 4, *Eucalyptus* forests with a shrubby understorey (Kendrick 2003). These communities are under threat from cattle grazing, feral animals (particularly donkeys, horses and cattle) and invasive weeds (particularly Buffel Grass (\**Cenchrus ciliaris*) and Ruby Dock (\**Acetosa vesicaria*) (Kendrick 2003).

Vegetation type C1 occurred in the moderate-sized creekline in the study area and supported riparian vegetation (specifically the Coolibah, *Eucalyptus victrix*). This vegetation type is not considered to represent the “major ephemeral water courses” ecosystem at risk, given that the tree overstorey comprises only an “open woodland” at its most dense. In addition, this vegetation is already subject to the threatening factors listed by Kendrick (2003), specifically the presence of Buffel Grass and grazing/trampling by cattle.

### 5.5.3 Other Conservation Values

All of the habitats in the study area are widespread in the locality, and none of the vegetation types are considered to be restricted in distribution.

Although not an ecosystem at risk, vegetation type C1 is still of some conservation value as it occurs in the major surface drainage feature for the area and supports riparian vegetation. Vegetation type C1 represented 2.6% of the study area (see Section 5.1).

The remaining 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 local area. 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 (DEWHA 2010).

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## 6.0 Flora of the Study Area

### 6.1 Overview

A total of 245 native vascular flora taxa from 114 genera belonging to 42 families have been recorded from the study area. This count includes taxa recorded from the 18 relevés, the two previously established quadrats (Biota 2005b), as well as opportunistic observations made during foot traverses of the study area.

Three of these taxa are listed as Priority flora (see Section 6.4.2). Eight introduced flora (weed) species have been recorded in the study area (see Section 6.5). A list of all vascular flora taxa recorded in the study area is provided in Appendix 9.

### 6.2 Dominant Families and Genera

The dominant families and genera (native taxa only) recorded from the study area are presented in Table 6.1. These are typical of the most well represented families and genera for the Pilbara bioregion.

Table 6.1: Dominant plant families and genera in the study area

Family	No. of Native Taxa	Genus	No. of Native Taxa
Fabaceae	48	<i>Acacia</i>	22
Poaceae	46	<i>Senna</i>	13
Malvaceae	32	<i>Ptilotus</i>	10
Amaranthaceae	14	<i>Sida</i>	8
Goodeniaceae	9	<i>Eremophila</i>	6

### 6.3 Species Richness – Regional Context

Species richness tends to vary on a logarithmic scale with the size of the study area. When compared to other study areas that have been surveyed in the broader locality, the total number of native flora taxa recorded from the study area is slightly higher, but still within the range expected for a study area of this size in this locality (see Figure 6.1). This is likely to reflect the range of habitats present in the current study area (similar sized survey areas in the locality have usually contained fewer landforms).

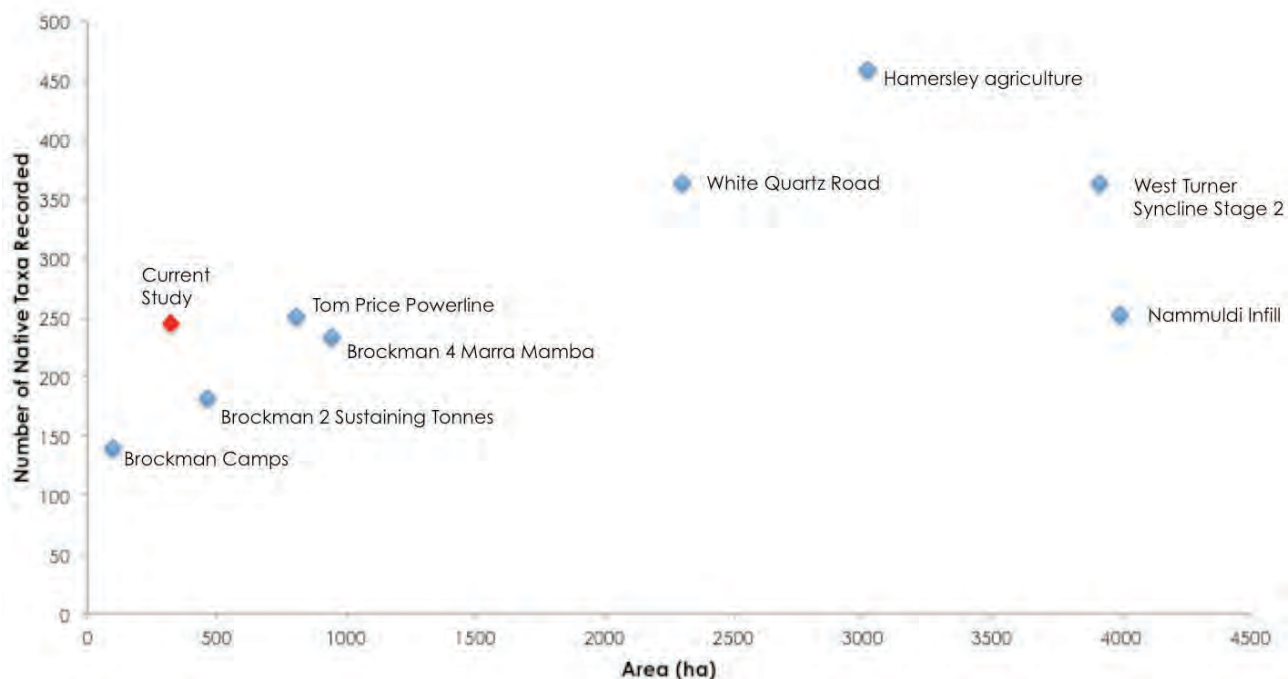


Figure 6.1: Number of native flora taxa recorded compared to other studies in the locality.

## 6.4 Flora of Conservation Significance

### 6.4.1 Threatened Flora

No Threatened flora listed under the Commonwealth EPBC Act 1999 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 lack of any recent records in close proximity or a distribution that does not overlap with this locality (see Section 4.8.1).

### 6.4.2 Priority Flora

#### 6.4.2.1 Priority Flora Recorded from the Study Area

Three Priority flora taxa were recorded in the study area during the field survey: *Hibiscus* sp. Mt Brockman (E. Thoma E.T. 1354) (Priority 1), *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3) and *Goodenia nuda* (Priority 4). The distribution of these taxa in the study area is presented on the vegetation mapping in Appendix 5 and coordinates are provided in Appendix 10. Threatened and Priority Flora Report Forms will be submitted to DPaW for each population of Priority flora recorded in the study area.

A description of these taxa has been provided in Section 4.8.2. Discussion of the populations in the study area is provided below:

- *Hibiscus* sp. Mt Brockman (E. Thoma E.T. 1354) (Priority 1)  
One individual of this taxon was recorded at relevé MMW-RCD in rocky gorge habitat (vegetation type G1) in the northwestern section of the study area. This location is approximately 29 km from the three other collection localities, which are northeast, east-southeast and south of the current study area. The current record does not substantially expand the known range of this species.
- *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3)  
*Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) was recorded nine times in the study area and was associated with minor creeklines through plains and low hills in the north of the study area (see Plate 6.1). The estimated population in the study area was 281 individuals. The records from the study area are within the known range of this species.
- *Goodenia nuda* (Priority 4)  
One individual of *Goodenia nuda* was recorded from a floodplain (vegetation type C2) in the study area (Plate 6.2). This record appears to be the most southern of the known locations in the central Pilbara.



Plate 6.1: *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3) in the study area.



Plate 6.2: *Goodenia nuda* (Priority 4) growing on a floodplain in the study area.

### 6.4.2.2 Other Priority Flora Potentially Occurring in the Study Area

Twelve Priority flora species were considered likely to occur in the study area, or to have the potential to occur (Section 4.8.2).

Three of these species were recorded during the field survey (Section 6.4.2.1).

Eight of the nine remaining species are now considered either unlikely to occur in the study area or do not occur, as all are shrubs that would have been visible during the field survey, if present. These species comprise *Acacia bromilowiana*, *Eremophila magnifica* subsp. *magnifica*, *E. magnifica* subsp. *velutina*, *Gymnanthera cunninghamii*, *Ptilotus mollis*, *P. subspinescens*, *Sida* sp. Barlee Range (S. van Leeuwen 1642) and *Sida* sp. Hamersley Range (K. Newbey 10692).

The remaining species, *Rostellularia adscendens* var. *latifolia* (Priority 3), may potentially occur in the study area; although not recorded during the field survey, this annual to weakly perennial species may not have been visible due to the dry conditions. Given the broad range of *Rostellularia adscendens* var. *latifolia*, its conservation status would not be affected by clearing within the study area, should the species occur there.

### 6.4.3 Unresolved Taxa

Numerous apparently undescribed taxa are regularly recorded from the Pilbara bioregion. In this report, only taxa that are formally recognised by the WA Herbarium have been presented, with one exception: an undescribed taxon of *Eulalia*, which is listed as *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133). This taxon is described briefly below:

- *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133)  
*Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133) differs from *Eulalia aurea* (the more common *Eulalia* species in the Pilbara) by its broader leaves, elongated rhizomes and the inflorescences remaining closed at maturity (Simon and Alfonso 2012). This *Eulalia* taxon was first collected in 2008 by Dr. Ken Tinley on Three Rivers Homestead (in the Gascoyne region of WA) and the phrase name *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133) was applied (Bryan Simon, Queensland Herbarium, pers. comm. 2012). This phrase name is not yet recognised on FloraBase or Australia's Virtual Herbarium. A formal description of *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133) is currently being progressed by the Pilbara bioregion flora expert Malcolm Trudgen (M.E Trudgen and Associates) and Rachel Butler (Biota), with expert advice from Bryan Simon (Queensland Herbarium).

Once recognised on FloraBase, it is possible that as a poorly known taxon, *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133) may be assigned a Priority status. However, given that a number of collections have been made throughout the Pilbara bioregion, it is unlikely that this taxon is truly rare. It is more probable that it has been under-collected due to its similarity to the common species *Eulalia aurea*.

### 6.4.4 Range Extensions and Poorly Vouchered Taxa

None of the taxa recorded from the study area represent substantial range extensions.

All of the taxa recorded in the study area have been adequately vouchered for the Pilbara bioregion, except for *Eulalia* sp. (Three Rivers Station B. Forsyth AQ6789133) (see Section 6.4.3). However, all specimens of this taxon were sterile and are therefore not suitable for lodgement with the WA Herbarium.

## 6.5 Introduced Flora (Weeds)

Eight introduced flora species have been recorded from the study area. Five of these species were recorded during the current field survey. Three additional annual weed species (\**Bidens bipinnata*, \**Portulaca oleracea* and \**Tribulus terrestris*) were recorded in the study area during the Brockman Syncline 4 survey (Biota 2005b), but were not evident during the current field survey. Weed locations are presented on the vegetation condition mapping in Appendix 6 and coordinates of all weed records are provided in Appendix 10.

None of the weeds recorded are listed as declared pests under the WA Biosecurity and Agriculture Management Act 2007, nor are any listed as Weeds of National Significance (Thorp and Lynch 2000)<sup>6</sup>. However, \**Cenchrus ciliaris* and \**Vachellia farnesiana* were ranked as weeds with High ecological impact according to DPaW's Invasive Plant Prioritisation Process (DEC 2012).

Each weed species recorded in the study area is discussed briefly below:

- \**Bidens bipinnata* (Bipinnate Beggartick) is a common weed associated with mulga vegetation and creeklines of the Pilbara. It has deeply lobed leaves and yellow flowers. This annual daisy may occur in very high densities within suitable habitats and given appropriate conditions, but on its own does not appear to cause exclusion of native flora species. This species was recorded from one location on a floodplain in the study area during the Brockman Syncline 4 survey (Biota 2005b). It was not recorded during the current survey.
- \**Cenchrus ciliaris* (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. \**Cenchrus ciliaris* grows to 1 m tall and flowers 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).  
  
\**Cenchrus ciliaris* was the most prolific weed in the study area, with 63 records predominantly from creekline and floodplain habitats. This species varied in abundance from scattered individuals to a closed tussock grassland. It was most dense along the creek banks, where it formed a near-continuous population through the study area. There were also several records of this species on the stony plains of the study area, however only scattered individuals were recorded in these habitats.
- \**Flaveria trinervia* (Speedy Weed) is an annual daisy that is common and widespread in various habitats throughout the north of Western Australia, from approximately Carnarvon through to the Kimberley (DPaW 2013b). This species was recorded three times within the study area, from calcrete plain and a floodplain during the Brockman Syncline 4 survey (Biota 2005b), and from the edge of a floodplain during the current survey.
- \**Malvastrum americanum* (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 13 times in the study area, predominantly from creekline or floodplain habitat.
- \**Portulaca oleracea* (Purslane) is a succulent, usually prostrate, annual herb, which grows throughout the State. While apparently common in the Pilbara, its status is currently unresolved, and some collections may represent the native species *P. intraterranea* or other taxa. \**Portulaca oleracea* prefers sandy or clay-loam soils and is often found at sites that have been previously disturbed, although it is also recorded in apparently intact native vegetation. Dense colonies can appear after rain. This species was recorded from floodplain habitat during the Brockman Syncline 4 survey (Biota 2005b). It was not recorded during the current survey.

<sup>6</sup> For the current listing of Weeds of National Significance, go to <http://www.weeds.org.au/WoNS/>

- \**Setaria verticillata* (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). This species was recorded from two locations within the study area, both in floodplain habitats.
- \**Tribulus terrestris* (Caltrop) is a prostrate annual herb with pinnate leaves, yellow flowers and spiny fruits (Hussey et al. 1997). This species is widely distributed across WA and is most commonly found on sandy, often disturbed soils. \**Tribulus terrestris* was recorded once in the study area from a floodplain during the Brockman Syncline 4 survey (Biota 2005b). It was not recorded again during the current survey.
- \**Vachellia farnesiana* (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). \**Vachellia farnesiana* was a very prolific weed of the study area and was a dominant component of the tall shrub stratum in some areas of floodplain habitat. It was recorded 33 times from creeklines and floodplains in the study area, with the number of individuals recorded at each location ranging from one to 50.

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## 7.0 Assessment of Fauna and Fauna Habitats

### 7.1 Background

When determining the significance of fauna species and habitats within a study area, the distribution and abundance of fauna within the bioregion are typically used to provide context. In the case of large-scale development proposals, fauna inventories are commonly compiled and compared to known inventories from the bioregion as a means of assessing their relative faunal diversity values. However, in the case of this relatively small-scale development proposal, and where no systematic fauna data were collected, two main elements were assessed:

- the fauna habitats represented within the study area (Section 7.2); and
- a review of the terrestrial vertebrate fauna of conservation significance recorded or likely to occur in the study area, based on the known distributions and habitat preferences of the species of interest, together with any opportunistic records (observations and secondary evidence) of vertebrate fauna made during the field survey (Sections 7.3 and 7.4).

### 7.2 Fauna Habitats

The study area intersects two land systems (Newman and Rocklea), with the vast majority (98.5%) of the study area occurring in the Newman land system (see Section 4.3). Based on Beard's (1975a) vegetation mapping, two vegetation units (Hamersley 82 and Hamersley 567) occur in the study area (see Section 4.6). Given the broad nature of the land systems and Beard's vegetation mapping, these units provide only indicative information about the habitat types and vegetation of the study area.

However, the vegetation types described for the study area in Section 5.2 are more detailed and, together with landform, constitute a single landscape comprising four functional landforms (fauna habitats). These four fauna habitats are mapped in Appendix 11 and described in Sections 7.2.1 to 7.2.4.

None of the habitats present in the study area represent TECs or PECs and all four are common and widespread in the Hamersley subregion (Kendrick 2003). The habitats in the study area are largely intact, with clearing limited to a few tracks and rehabilitation areas, and weeds present mainly in the creeklines and floodplains habitat. All of the habitats are contiguous with equivalent habitats in the surrounding areas, and all of the landforms have been previously documented in the Marra Mamba locality (Biota 2005a, 2013a).

#### 7.2.1 Creeklines and Floodplains

Creeklines and floodplains (Plate 5.3) occurred in association with the tributary of Boolgeeda Creek, draining from the southwestern and southern edges of the study area through to the northern boundary. This habitat supported vegetation equivalent to vegetation types C1, C2 and C3 (Section 5.2.2). Scattered low trees of *Eucalyptus victrix* occurred in the stony creek beds, which were otherwise bare or with an open herbland (Plate 5.3). *Eucalyptus xerothermica* was the dominant tree species on the creek banks and floodplains, which supported a variable tall shrub and shrub layer and an open tussock grassland (Plate 5.5). No areas of permanent water were present along the creek.

#### 7.2.2 Stony Plains

Stony plains were widespread through the central section of the study area. Most of these plains had a stony ironstone substrate (Plate 5.1), however small areas of stony calcrete plain also occurred in the study area Plate 5.2. The stony plains supported occasional low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over *Acacia* spp. shrubs over *Triodia* spp. hummock grasslands (equivalent to vegetation types P1 and P2; Section 5.2.1).

### 7.2.3 Stony Hillslopes and Crests

Stony hillslopes and crests dominated the ranges of hills along the northwestern and southeastern edges of the study area (Plate 5.7 to Plate 5.12). This habitat supported occasional scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* over *Acacia* spp. open shrubland and *Triodia* spp. open hummock grassland (equivalent to vegetation types H1 to H8; Section 5.2.3). The stony plains and stony hills of the study area comprise suitable habitat for the Western Pebble-mound Mouse (see Section 7.4.1.4).

### 7.2.4 Rocky Gorges

Two small rocky gorges were present in the northwestern section of the study area (Plate 7.1). These supported *Corymbia ferritcola* open forest over *Dodonaea pachyneura*, *Acacia pruinocarpa* tall open shrubland over *Themeda* sp. Mt Barricade (M.E. Trudgen 2471) very open tussock grassland and *Triodia epactia* very open hummock grassland (vegetation type G1; Section 5.2.4, Plate 5.15). No rock pools were present in either gorge.

The gorges in the study area were considerably smaller than the gorge systems observed in other nearby survey areas, which often also included sections of major creekline (e.g. at Beasley River; Plate 7.2). A number of conservation significant fauna species that would be considered likely to occur in these larger gorge/gully systems would not be expected to occur in the gorges of the current study area.



Plate 7.1: Gorge habitat in the study area.



Plate 7.2: Gorge and major creek habitats at Beasley River.



While a few shallow caves and overhangs were present amongst areas of rocky breakaways and slopes of the study area (Plate 7.3), foot traverses of the gorges and hill slopes did not reveal any caves, rock shelters or adits that appeared sufficiently deep to offer the microclimates required for roosting by the Schedule 1 Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) or Priority 4 Ghost Bat (*Macroderma gigas*) (Sections 7.4.1.2 and 7.4.1.3). While there is the potential that these small caves could be utilised by the Northern Quoll (*Dasyurus hallucatus*) for denning, these would represent sub-optimal habitat only (Section 7.4.1.1).



Plate 7.3: Shallow caves recorded in the study area would not provide suitable roosting habitat for Orange Leaf-nosed Bats or Ghost Bats, and would only provide sub-optimal denning habitat for Northern Quolls.

## 7.3 Fauna Recorded from the Study Area

Five mammal species, two reptile species and one invertebrate species were recorded from the study area during the field survey (Table 7.1). These species were recorded opportunistically and do not represent a comprehensive list of fauna that occur in the study area. One of these species, the Western Pebble-mound Mouse, is of conservation significance (see Section 7.4.1.4).

Table 7.1: Fauna species recorded in the study area.

Family	Species	Common Name	Notes
Mammals			
Bovidae	<i>Bos taurus</i> *	Cattle	Scats, tracks
Canidae	<i>Canis lupus familiaris</i>	Wild Dog	Scats
Equidae	<i>Equus caballus</i> *	Horse	Scats
Macropodidae	<i>Macropus rufus</i>	Red Kangaroo	Opportunistic sighting
Muridae	<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse	Mounds
Reptiles			
Agamidae	<i>Amphibolurus longirostris</i>	Long-nosed Dragon	Opportunistic sighting
Scincidae	<i>Ctenotus duricola</i>	Pilbara Ctenotus	Opportunistic sighting
Invertebrates			
Apidae	<i>Apis mellifera</i> *	European Honey Bee	Hive

\* indicates non-indigenous fauna species.

## 7.4 Vertebrate Fauna of Conservation Significance

A total of 17 vertebrate fauna species of listed conservation significance have been recorded within 25 km of the study area or have recognised distributions encompassing the locality (see Appendix 3). None of these conservation significant fauna were recorded from directly within the study area during previous surveys.

Taking into account the habitat preferences and known distributions of these species, together with the results of the field survey, a total of 10 conservation significant species have a medium to high probability of occurring within the study area (those listed as “recorded”, “likely” or “may potentially occur” in Appendix 3). These comprise the:

- Northern Quoll (*Dasyurus hallucatus*) (Schedule 1);
- Orange Leaf-nosed Bat (*Rhinioncteris aurantius*) (Schedule 1);
- Pilbara Olive Python (*Liasis olivaceus barroni*) (Schedule 1);
- Fork-tailed Swift (*Apus pacificus*) (Schedule 3, Migratory);
- Rainbow Bee-eater (*Merops ornatus*) (Schedule 3, Migratory);
- Australian Bustard (*Ardeotis australis*) (Priority 4);
- Bush Stone-curlew (*Burhinus grallarius*) (Priority 4);
- Ghost Bat (*Macroderma gigas*) (Priority 4);
- Western Pebble-mound Mouse (*Pseudomys chapmani*) (Priority 4); and
- the skink *Notoscincus butleri* (Priority 4).

Each of these species is discussed briefly in the following sections.

The remaining seven species would be considered unlikely to occur in the study area, or would not occur, based on the habitats present and information regarding their current range (see Appendix 3).

### 7.4.1 Mammals

#### 7.4.1.1 Northern Quoll (Schedule 1)

The Schedule 1 Northern Quoll (*Dasyurus hallucatus*) favours rocky gorges, breakaways, hills of high relief and drainage lines as denning and primary foraging habitat (DSEWPaC 2011). These core habitat types are commonly associated with the Rocklea, Macroy, Newman and Robe land systems in the Pilbara bioregion (Biota 2009c). The Northern Quoll has not been recorded by any previous surveys in the Marra Mamba locality, however there is suitable core habitat for this species in the broader area (large rocky gully systems in the Newman land system, and major creeklines). The closest recent record of the Northern Quoll is from the Marandoo project area, some 100 km to the east, and no evidence of a current population of this species was recorded during a targeted fauna survey east of the current study area (Biota 2013a; see Figure 3.2).

The majority of the study area comprised the Newman land system (Section 4.3), however only two minor gorges were present (Section 7.2.4). The few shallow caves in the study area were considered to represent sub-optimal habitat for denning (see Plate 7.3). It is considered that the appropriate likelihood ranking for this species is that it may potentially occur in the study area, rather than being likely to occur, and that it would be more likely to use the area for foraging rather than denning. Given the absence of core habitat in the study area and the lack of records from the locality, no significant impact would be expected to the Northern Quoll from clearing within the study area.

#### 7.4.1.2 Orange Leaf-nosed Bat (Schedule 1)

Calls of the Schedule 1 Orange Leaf-nosed Bat (*Rhinonicteris aurantius*) were recorded from a site in the Beasley River Limonites study area (Biota 2009a), 15.5 km southeast of the current study area. The Beasley River area contains much larger gorge systems than the two small gorges present in the study area (compare Plate 7.1 and Plate 7.2). In addition, foot traverses of the gorges and hill slopes in the study area did not reveal any caves, rock shelters or adits that appeared sufficiently deep to offer the microclimates required for roosting (Plate 7.3).

Given the lack of suitable roosting sites (i.e. deep, humid caves), the Orange Leaf-nosed Bat would only be expected to forage over the study area, should it occur. Clearing within the study area would therefore not be expected to impact upon this species to any significant extent.

#### 7.4.1.3 Ghost Bat (Priority 4)

The Priority 4 Ghost Bat (*Macroderma gigas*) has been recorded from Brockman 2 (Biota 2010b), 18.8 km northeast of the study area. As for the Orange Leaf-nosed Bat, the Ghost Bat is reliant on deep caves to roost (see Appendix 3), and no suitable roosting sites are present within the study area. Individuals may potentially forage over the study area, but given their mobile nature and nocturnal habits, clearing of vegetation within the study area would not have an impact on the conservation status of this species.

#### 7.4.1.4 Western Pebble-Mound Mouse (Priority 4)

The Pebble-mound Mouse (*Pseudomys chapmani*) is typically found on stony hillsides with hummock grasslands (Menkhorst and Knight 2011) and is common in suitable habitat within the Hamersley and Chichester subregions of the Pilbara bioregion. The desktop review indicated that this species was likely to occur in the study area, as suitable habitat was present and this widespread and commonly recorded species was known from surveys in the locality (see Appendix 3). Four pebble-mounds were subsequently recorded during the field survey from stony plains and hills in the study area (Table 7.2, Plate 7.4).

It is unlikely that there would be any significant regional scale impacts or changes to conservation status for this species as a result of the proposed clearing.

Table 7.2: Locations of pebble-mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) in the study area.

Species	Easting (mE)	Northing (mN)	Mound Status
Western Pebble-mound Mouse	515333	7497142	Active
Western Pebble-mound Mouse	515308	7498081	Active
Western Pebble-mound Mouse	515272	7498112	Active
Western Pebble-mound Mouse	516451	7497835	Old; inactive



Plate 7.4: Mound of the Western Pebble-mound Mouse (*Pseudomys chapmani*) in the study area.

## **7.4.2 Avifauna**

### **7.4.2.1 Migratory Avifauna – Fork-tailed Swift and Rainbow Bee-eater (Schedule 3)**

The Rainbow Bee-eater (*Merops ornatus*) is very common in the Pilbara and utilises a diverse array of habitats (Burbidge et al. 2010). The species favours generally well-watered and lightly wooded habitats with suitable sandy soil for nesting. It is a highly mobile species that would not be reliant on the habitats within the study area, however it is likely that it would fly through the study area or forage within it at times, particularly along the creekline and floodplain habitats.

The Fork-tailed Swift (*Apus pacificus*) is also a highly mobile species and nomadic in nature, as well as being almost exclusively aerial. Although potentially occurring within the study area at times, it would not be reliant on any of the habitats present (see Appendix 3).

Given the habitats observed within the study area and the nature of these two migratory species, it is unlikely that any significant population impacts on a local or regional scale would occur as a result of land clearing.

### **7.4.2.2 Australian Bustard (Priority 4)**

The Australian Bustard (*Ardeotis australis*) is typically nomadic and occupies large home ranges (Marchant and Higgins 1994) in open or lightly wooded grassland (Johnstone and Storr 1998). This species has been recorded from the nearby Brockman 4 survey area (Biota 2005a) and would be likely to occur in the study area at times, mainly in the stony plains or creeklines and floodplains habitats (see Appendix 3). This species is widespread and highly mobile (Simpson and Day 2004), and it is unlikely that there would be any significant population impacts on a local or regional scale to this species as a result of land clearing within the study area.

### **7.4.2.3 Bush Stone-curlew (Priority 4)**

The Priority 4 Bush Stone-curlew (*Burhinus grallarius*) is widely distributed through the Pilbara but is not commonly recorded, likely due to its secretive nature. It was not recorded by previous surveys in the locality, and has therefore been assigned a likelihood ranking of “may potentially occur” rather than “likely” for the study area. This species is highly mobile and would not be restricted to any habitats present (see Appendix 3). If present, it would most likely utilise the stony plains or creeklines and floodplains habitats. It is unlikely that there would be any significant population impacts on a local or regional scale to this species as a result of land clearing within the study area.

## **7.4.3 Herpetofauna**

### **7.4.3.1 Pilbara Olive Python (Schedule 1)**

The Schedule 1 Pilbara Olive Python (*Liasis olivaceus barroni*) is often associated with ephemeral or permanent water, but may also be recorded in rocky habitats some distance from these features. Some suitable habitat for this species is present in the study area, comprising the moderate-sized creekline and the two small gorge areas. However these areas are likely to represent suboptimal habitat for the species, as they were generally shallow, and lacking permanent water and rock pools. A sloughed skin of this species was collected from a site in the Beasley River Limonites study area, approximately 6 km east of the study area (Biota 2009a), and this species is also known from the West Turner Syncline Section 10 study area, 60 km east-southeast of the study area (Biota 2009d). Both areas are considerably more rugged than the current study area. Individuals of this species may potentially forage within the study area, given that suitable (albeit suboptimal) habitat is available and the species has been recorded previously from the locality. Clearing within the study area would be unlikely to affect the conservation status of the Pilbara Olive Python, should it occur.

#### **7.4.3.2      *Notoscincus butleri* (Priority 4)**

The Priority 4 skink *Notoscincus butleri* has a relatively broad range through the western Pilbara (over 210 km), extending from Dampier inland to the vicinity of the study area (NatureMap database). This species has been recorded previously in the vicinity of the study area from creekline habitat approximately 6 km northeast (Biota 2005a), and it was also recorded at West Turner (Biota 2009e) (Appendix 3). The creeklines and floodplains of the study area may offer suitable habitat for this species. Clearing in the study area would be unlikely to impact the conservation status of *Notoscincus butleri*, should it occur, given the broad occurrence of this species in the locality and the wider bioregion.

#### **7.4.4      Unresolved Taxa**

There are no unresolved vertebrate fauna taxa of conservation significance recorded from the vicinity (within 25 km) of the study area.

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## 8.0 Key Findings and Recommendations

### 8.1 Key Findings

Key findings of this study are as follows:

- Fourteen vegetation types were recorded from the study area, none of which are TECs or PECs.
- Vegetation type C1 (*Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland) is considered to be of somewhat elevated conservation significance due to its location in the major surface drainage feature for the area (a moderate-sized creekline, which is a tributary of Boolgeeda Creek).
- No Threatened flora have been recorded from the study area or are considered likely to occur.
- Three Priority flora species are known from the study area:
  - *Hibiscus* sp. Mt Brockman (E. Thoma E.T. 1354) (Priority 1) was recorded from a single location in a gorge in the northwestern section of the study area.
  - *Indigofera* sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3) was recorded from several locations in minor creeklines in the north of the study area.
  - *Goodenia nuda* (Priority 4) was recorded from one location on a floodplain in the southern section of the study area.
- One Priority 4 fauna species is known to occur in the study area: four mounds of the Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded from stony plains and low hills.
- All of the Priority flora and fauna species recorded are known from the locality surrounding the study area and all are widespread through the broader Pilbara bioregion. Clearing within the study area would not be expected to impact the conservation status of any of these species.
- Eight weed species have been recorded from the study area, the most prevalent of which is Buffel Grass (*\*Cenchrus ciliaris*), which was particularly widespread along the banks of the moderate-sized creekline through the centre of the study area.

### 8.2 Recommendations

The following recommendations are made to minimise the impacts to the vegetation, flora and fauna in and surrounding the study area:

1. Where possible, locations of Priority flora and fauna within the study area should be avoided during vegetation clearing.
2. Clearing of riparian vegetation (vegetation type C1) should be avoided or minimised where possible.
3. Weed hygiene protocols should be implemented during vegetation clearing and subsequent earthworks to minimise the spread or introduction of weeds to the study area.

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## 9.0 Assessment of the Ten Clearing Principles

### 9.1 Overview

Rio Tinto proposes to clear native vegetation within the Marra Mamba West (AR-13-11158) tenure. A general assessment of the biological values of the study area against each of the Ten Clearing Principles, as outlined in Schedule 5 of the *Environmental Protection Act 1986*, is provided below.

### 9.2 The Ten Clearing Principles

#### 9.2.1 Potential Impact on a High Level of Biological Diversity

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

A total of 14 vegetation types were described from the study area (see Section 5.0). This does not represent an unusual number of units, given the relatively fine-scale mapping of the study area and the different habitat types it contains. Vegetation similar to all of these communities has been recorded from other survey areas in the locality and is more widespread in the Pilbara bioregion (see Section 5.0).

None of the vegetation units described are PECs, and there are no PECs in the vicinity of the study area that are likely to be impacted by the proposed activities. The only vegetation type of elevated conservation significance is vegetation type C1, which supports riparian vegetation and occurs in the moderate-sized creekline that forms the major surface drainage feature for the area (see Section 5.5.2). This vegetation type represents 2.6% of the study area.

A total of 245 native vascular flora taxa from 114 genera belonging to 42 families have been recorded from the study area. The total number of native flora taxa recorded from the study area is at the upper end of the range expected for a study area of this size in this locality (see Section 6.3). Three Priority flora taxa have been recorded in the study area, all of which have been recorded previously in the locality (see Section 6.4.2).

The study area does not contain a high level of diversity, however clearing of vegetation type C1 and vegetation that supports populations of Priority flora taxa should be minimised as far as practicable. Provided this recommendation is followed, the proposal would not be at variance with this principle.

#### 9.2.2 Potential Impact to any Significant Habitat for Indigenous Fauna

(b) *Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.*

We are interpreting the intent of this principle to be:

- does the vegetation represent an unusual habitat for the locality?; and/or
- does the vegetation represent a core or primary habitat for fauna species of conservation significance?

Four functional landforms (fauna habitats) have been described within the study area, all of which have been previously documented in the Marra Mamba locality and are common and widespread in the broader Hamersley subregion (see Section 7.0). None of the landforms encountered in the study area are unusual for the location or are considered to be core or primary habitat for fauna species of conservation significance.

Four pebble-mounds of the Priority 4 Western Pebble-mound Mouse (*Pseudomys chapmani*) were recorded in the study area. Accounting for habitat preferences and known distributions, nine other conservation significant vertebrate fauna species are considered likely to occur or may potentially occur in the study area. Extensive foot traverses through the study area did not identify any individuals or secondary evidence of these species, nor any habitat that might support significant numbers of individuals (e.g. no breeding roosts for bats). It is unlikely that the proposed activity would have any impact on the conservation status of any conservation significant fauna species that may utilise the study area (see Section 7.4), however the locations of the pebble-mounds should not be cleared, if possible.

The proposal is not at variance with this principle.

### **9.2.3 Potential Impact to any Rare Flora**

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

No Threatened flora species were recorded from the study area (see Section 6.4.1).

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 4.7.1).

The proposal is not at variance with this principle.

### **9.2.4 Potential Impact on any Threatened Ecological Communities**

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

No TECs occur within the study area. The closest TEC to the study area is the 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)', located approximately 38 km north-northeast of the study area. The proposed activity would not be expected to directly or indirectly affect this community.

The proposal is not at variance with this principle.

### **9.2.5 Potential Impact on any Native Vegetation Remnant in an Area that has been Extensively Cleared**

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

Much of the Pilbara bioregion has never been cleared, however a combination of weed invasions, hot frequent bushfires, feral predators and grazing by exotic herbivores is causing a loss of soil fertility and vegetation cover through some pastoral areas.

The vegetation types identified within the study area are typical for the locality. Historical clearing in the study area is minimal, and mainly comprises vehicle tracks. The vegetation units identified in the study area are therefore not representative of remnant stands of extensively cleared vegetation.

The proposal is not at variance with this principle.

## 9.2.6 Potential Impact on any Watercourse and/or Wetland

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

There are no permanent surface water sources or wetlands in the study area, however a moderate-sized creekline (vegetation unit C1; Section 5.0) occurs in the study area. This watercourse would flow intermittently following periods of intense rainfall. This riparian vegetation represented 2.6% of the study area and is widespread in the broader locality, with areas mapped some 25 km northeast of the study area along the Brockman Syncline 4 rail corridor (Biota 2005b).

Clearing of this vegetation unit may be at variance with this principle.

## 9.2.7 Potential to Cause Appreciable Land Degradation

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

The study area intersects the Newman and Rocklea land systems (see Section 4.3), which are not particularly prone to degradation or erosion (Van Vreeswyk et al. 2004).

While the majority of the study area was in Very Good to Excellent condition, some areas associated with creeklines and floodplains (vegetation types C1, C2 and C3) were in Very Poor condition, being impacted by cattle grazing, trampling and weed invasion. Trampling was also causing minor erosion along the creek banks in places. These areas would be susceptible to continued weed invasion and spread, and to further erosion caused by cattle.

Eight weed species have been recorded from the study area. Provided that strict weed hygiene measures are implemented, clearing within the study area would not be expected to contribute significantly to land degradation. The proposal is therefore not at variance with this principle.

## 9.2.8 Potential Impact on Adjacent or Nearby Conservation Areas

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

There are no conservation areas in close proximity to the study area. Karijini National Park is the closest conservation reserve at 75 km to the east. The proposal is therefore not at variance with this principle.

## 9.2.9 Potential Deterioration in Water Quality

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

There are no sources of permanent surface water in the study area. Provided that clearing within creeklines is minimised, there is no reason to expect that clearing of vegetation in this area should affect the quality of surface or underground water. The proposal is not at variance with this principle.

## 9.2.10 Potential to Cause or Exacerbate Flooding

(j) Native vegetation should not be cleared if clearing of the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

The moderate-sized ephemeral creekline (vegetation type C1) would flow intermittently following periods of intense rainfall. Clearing within the study area would not be expected to cause or increase the frequency or intensity of flooding. The proposal is not at variance with this principle.

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## 10.0 Glossary and Acronyms

*	Used prior to a species name to denote a weed species.
Adit	A horizontal or near-horizontal entrance to an underground mine.
Alluvial	Loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which have been eroded, reshaped by water in some form, and redeposited in a non-marine setting.
Annual (plant)	A plant that lives for only one year.
Colluvial	Loose, unconsolidated (not cemented together into a solid rock) deposits of rock debris accumulated through the action of gravity at the base of a slope or cliff.
Conservation Significant	A plant that is recognised to be rare, unusual, new or poorly sampled; may have a formally assigned conservation ranking (see Appendix 1 for more on the WA conservation framework).
Cryptic	Plants that die back to a perennial rootstock under dry conditions; considered cryptic (meaning hidden) because although they are consistently present, it is difficult to tell unless suitable conditions prevail.
DPaW	WA Department of Parks and Wildlife (formerly the Department of Environment and Conservation (DEC)).
EPA	Environmental Protection Authority of Western Australia.
EPBC Act 1999	The Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
Ephemeral	A plant that lives a very short time; less than one year, usually less than six months.
Flora keys	Botanical publications containing a series of questions regarding the characteristics of plants, aiding in the identification of different taxa.
GIS	Geographic Information Systems.
IBRA	Interim Biogeographic Regionalisation for Australia.
NRS	Natural Reserve System.
NVCP	Native Vegetation Clearing Permit.
Opportunistic	A plant or animal species collected or recorded outside a formal sampling site (e.g. flora quadrats or relevés, or fauna trapping sites). Opportunistic collections are usually made during foot traverses and when travelling between sites.
PEC	Priority Ecological Community (see Appendix 1 for more on the WA conservation framework).
Perennial	A plant that lives for more than two growing seasons.
Priority flora	Flora listed by DPaW as requiring additional information to properly evaluate their conservation significance; see Appendix 1 for more on the WA conservation framework.
Stratum (plural: strata)	A horizontal level of vegetation defined by growth habit (and sometimes height); e.g. low trees, tall trees, tussock grasses, hummock grasses.
subsp.	Abbreviation of subspecies.
Taxon (plural: taxa)	A taxonomic distinction at species level or below.
TEC	Threatened Ecological Community (see Appendix 1 for more on the WA conservation framework).

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Threatened flora	Flora protected by legislation, either listed under the Commonwealth EPBC Act 1999 or the State <i>Wildlife Conservation Act 1950</i> (species formerly known as Declared Rare Flora); see Appendix 1 for more on the WA conservation framework.
var.	Abbreviation of variety.

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# 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 biological 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 DPaW'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.



## B. Threatened Flora Statutory Framework

In Western Australia, all native flora species are protected under the *Wildlife Conservation Act 1950-1979*, 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.

Species of the highest conservation significance are designated Threatened, either extant or presumed extinct:

- X: Presumed Extinct (Threatened Flora - Presumed Extinct): taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee;
- T: Threatened Flora (Threatened 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, following approval by the Minister for the Environment, after recommendation by the State's Endangered Flora Consultative Committee (Atkins 2008). (= Threatened Flora = Endangered + Vulnerable)

Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of four Priority flora categories:

- P1: Priority One - Poorly Known: taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- P2: Priority Two - Poorly Known: taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
- P3: Priority Three - Poorly Known: taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.
- P4: Priority Four - Rare: taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.
- P5: Priority Five – Conservation Dependent: taxa that 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' has statutory standing. The Priority Flora classifications are employed by DPaw 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 1950-1979* in addition to the requirements of the *Environmental Protection (Native Vegetation Clearing) Regulations 2004*.

Note also that some of the Threatened flora species listed for WA are also listed under the Commonwealth EPBC Act 1999.

## C. Threatened Fauna Statutory Framework

Native fauna species that are rare, threatened with extinction, or have high conservation value are specially protected by law under the WA *Wildlife Conservation Act 1950-1979*. In addition, many of these species are listed under the Commonwealth *EPBC Act 1999*.

### C1. Commonwealth EPBC Act 1999

Fauna species of national conservation significance are listed under the *EPBC Act 1999*, and have been classified as 'critically endangered', 'endangered', 'vulnerable' or 'conservation dependent' (broadly consistent with International Union for Conservation of Nature (IUCN) categories: ([http://jr.iucnredlist.org/documents/redlist\\_cats\\_crit\\_en.pdf](http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf)).

Migratory wader species are also protected under the *EPBC Act 1999*. The national List of Migratory Species consists of those species listed under the following International Conventions:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

### C2. Western Australian Wildlife Conservation Act 1950-1979

Classification of rare and endangered fauna under the *Wildlife Conservation (Specially Protected Fauna) Notice 2010* recognises four distinct schedules of taxa:

Schedule 1 - taxa are fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection;

Schedule 2 - taxa are fauna which are presumed to be extinct and are declared to be fauna in need of special protection;

Schedule 3 - taxa are birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, which are declared to be fauna in need of special protection; and

Schedule 4 - taxa are fauna that are in need of special protection, otherwise than for the reasons mentioned in paragraphs (1), (2) and (3).

In addition to the above, fauna are also classified under five different Priority codes:

- |                |  |
|----------------|--|
| Priority One   | Taxa with few, poorly known populations on threatened lands.<br>Taxa which are known from a few specimens or sight records from one or a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.   |
| Priority Two   | Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands.<br>Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna. |
| Priority Three | Taxa with several, poorly known populations, some on conservation lands.<br>Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.   |
| Priority Four  | Taxa in need of monitoring.<br>Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which 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. Taxa which are declining significantly but are not yet threatened.  |
| Priority Five  | Taxa in need of monitoring.<br>Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within 5 years.   |

## Appendix 2

# Results of Flora Desktop Review: Summary of Conservation Significant Flora Species Recorded within 40 km of the Study Area





Species	Description and Habitat Preference	Source of Record					Likelihood of Occurrence in the Study Area	
		Nature Map	TPFL †	WA Herb	Biota ¥	Rio Tinto	Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
Threatened								
<i>Lepidium catapycnon</i>	Perennial low shrub: apparently a short-lived colonising species; occurs on skeletal soils of hill slopes and crests.	✓	✓			✓	Unlikely; some suitable habitat (stony hills) in the study area, however this species has not previously been recorded in the Marra Mamba locality despite intensive rare flora searches; nearest known populations are approximately 30 km east-northeast.	Unlikely; not recorded during the field survey.
Priority 1								
<i>Brachyscome</i> sp. Wanna Munna Flats (S. van Leeuwen 4662)	Annual herb: occurs on clayey plains, usually in mulga woodland.	✓		✓			Would not occur; no suitable habitat.	Would not occur.
<i>Calotis squamigera</i>	Annual daisy: occurs on pebbly loam, usually in mulga woodland.					✓	Unlikely; no suitable habitat.	Unlikely.
<i>Goodenia pedicellata</i>	Single-stemmed perennial herb: occurs on rocky slopes and crests of small calcrete hills.			✓		✓	Unlikely; small areas of calcrete low hills in the study area could provide suitable habitat, however closest records are 37 km southeast at West Turner.	Unlikely.
<i>Hibiscus</i> sp. Brockman (E. Thoma ET 1354)	Erect shrub: occurs in gullies and on range crests and slopes.	✓		✓			May potentially occur; a small amount of suitable habitat (hill slopes and gullies) is present.	Recorded from one location in gully habitat in the northern section of the study area.
<i>Sida</i> sp. Hamersley Range (K. Newbey 10692)	Low shrub: occurs on skeletal stony soil, rocky hills and breakaways.	✓	✓	✓		✓	May potentially occur; rocky hills, slopes and breakaways in the study area may provide suitable habitat.	Unlikely; this shrub species would have been expected to be recorded during the field survey, if present.
Priority 2								
<i>Euphorbia australis</i> var. <i>glabra</i>	Annual herb: known from only a few locations in the Hamersley Range including banks of semi-permanent pools and alluvial clay flats.					✓	Unlikely; no semi-permanent pools or particularly suitable habitat in the study area.	Unlikely.

Species	Description and Habitat Preference	Source of Record					Likelihood of Occurrence in the Study Area	
		Nature Map	TPFL †	WA Herb	Biota ¥	Rio Tinto	Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
<i>Grevillea</i> sp. Turee (J. Bull & G. Hopkinson ONS JJ 01.01)	Small tree or shrub: occurs on steep, rocky hill slopes, usually with Mulga.	✓		✓	✓	✓	Unlikely; this species has been recorded approximately 1 km southeast, however there do not appear to be any suitable areas of Mulga vegetation in the study area.	Would not occur; no suitable habitat and this tall shrub would have been recorded during the field survey, if present.
<i>Oxalis</i> sp. Pilbara (M.E. Trudgen 12725)	Herb: Usually found in shaded gullies, sometimes along major creeklines.					✓	Unlikely; small areas of suitable habitat, however this species has not been recorded by any of the numerous previous surveys in the locality; the closest record is 30 km north.	Unlikely.
<i>Spartothamnella puberula</i>	Spindly shrub: occurs on rocky loam, sandy or skeletal soils, usually in gullies.	✓	✓	✓		✓	Unlikely; only a small amount of suitable habitat is present in the study area and the closest records are approximately 10 km southwest.	Unlikely.
Priority 3								
<i>Astrebla lappacea</i>	Tufted perennial grass: occurs on clay to clay-loam on plains.	✓		✓		✓	Would not occur; no suitable habitat.	Would not occur.
<i>Dampiera anonyma</i>	Low perennial shrub: occurs on skeletal soils over banded ironstone; hill summits and slopes (above 1,000 m).	✓		✓		✓	Would not occur; no suitable habitat.	Would not occur.
<i>Eragrostis surreyana</i>	Small tussock grass: occurs in creeklines and soaks with permanently wet soils					✓	Would not occur; no suitable habitat.	Would not occur.
<i>Eremophila magnifica</i> subsp. <i>velutina</i>	Shrub: occurs on skeletal soils over ironstone on tall hills and breakaways.	✓	✓	✓		✓	May potentially occur; some suitable habitat (hill slopes) is present in the study area.	Would not occur; this shrub would have been recorded during the field survey, if present.
<i>Glycine falcata</i>	Mat-forming perennial herb: occurs on crabhole plains		✓				Would not occur; no suitable habitat.	Would not occur.

Species	Description and Habitat Preference	Source of Record					Likelihood of Occurrence in the Study Area	
		Nature Map	TPFL †	WA Herb	Biota ¥	Rio Tinto	Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
<i>Goodenia</i> sp. East Pilbara (A.A. Mitchell PRP 727)	Herb: occurs on calcrete plains.					✓	Unlikely; small area of calcrete plain in the study area could provide suitable habitat, however the closest records from the locality are 37km east-southeast at West Turner, and it is now considered that these represent a taxon with affinities to <i>Goodenia pedicellata</i> .	Unlikely.
<i>Gymnanthera cunninghamii</i>	Erect shrub: occurs in creeklines on sandy soils.					✓	May potentially occur; drainage lines in the study area could provide suitable habitat, however this species is recorded very infrequently in the Pilbara.	Would not occur; this tall shrub would have been recorded during the field survey, if present.
<i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301)	Low to medium shrub: occurs in drainage lines.	✓		✓	✓	✓	Likely; drainage lines in the study area would comprise suitable habitat, and this species is commonly encountered in such habitat in the locality.	Recorded during the field survey from several locations in minor flowlines through the plains in the northern section of the study area.
<i>Indigofera</i> sp. Gilesii (M.E. Trudgen 15869)	Spindly shrub; occurs in a variety of habitats including creeklines, hilltops and slopes, and gullies.					✓	Unlikely; a small amount of suitable habitat is present, however the closest records are over 30 km northeast.	Unlikely; this species was not recorded during the field survey.
<i>Iotasperma sessilifolium</i>	Herb: occurs on cracking clay plains and on the edges of waterholes.	✓		✓			Would not occur: no suitable habitat.	Would not occur.
<i>Nicotiana umbratica</i>	Erect, short-lived annual/perennial: occurs in shallow soils; gullies, rocky outcrops and riverbeds.	✓		✓		✓	Unlikely; gullies and drainage lines in the study area may comprise suitable habitat, however the closest records are over 30 km northeast.	Unlikely.
<i>Oldenlandia</i> sp. Hamersley Station (A.A. Mitchell PRP 1479)	Spreading annual herb: occurs on cracking clay plains.				✓	✓	Would not occur: no suitable habitat.	Would not occur.

Species	Description and Habitat Preference	Source of Record					Likelihood of Occurrence in the Study Area	
		Nature Map	TPFL †	WA Herb	Biota ¥	Rio Tinto	Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
<i>Ptilotus subspinescens</i>	Low shrub: occurs mainly on stony plains with a calcareous loamy substrate, occasionally extending up onto and adjacent gentle stony scree slopes; semi-saline colluvial plains.	✓	✓	✓	✓	✓	May potentially occur: species is common in the locality but restricted to a particular habitat with a calcareous loamy substrate; a small amount of this habitat may be present in the southern part of the study area.	Would not occur; habitat in southern part of study area is not suitable (stony plain without a loamy substrate); this species would have been expected to be recorded during the field survey, if present.
<i>Rostellularia adscendens</i> var. <i>latifolia</i>	Herb or shrub: various habitats including creeks and rocky hills.				✓	✓	May potentially occur; no records within 30 km, however this species has a broad distribution and a wide range of habitat preferences; drainage lines in particular may comprise suitable habitat.	May potentially occur.
<i>Rhagodia</i> sp. Hamersley (M. Trudgen 17794)	Shrub: occurs under mulga, usually on clay plains.	✓		✓	✓	✓	Unlikely; no suitable habitat.	Would not occur; this shrub would have been expected to be recorded during the field survey, if present.
<i>Sida</i> sp. Barlee Range (S. van Leeuwen 1642)	Low spreading shrub: occurs on skeletal soils on steep slopes.	✓		✓	✓	✓	May potentially occur: only a small amount of suitable habitat (gullies and slopes), and there are no records closer than 18 km from the study area.	Unlikely; this shrub would have been expected to be recorded during the field survey, if present.
<i>Swainsona thompsoniana</i>	Prostrate annual, herb: occurs on crab-holed clay plains.	✓		✓		✓	Would not occur; no suitable habitat.	Would not occur.
<i>Themeda</i> sp. Hamersley Station (M.E. Trudgen 11431)	Annual tussock grass: occurs mainly on clay plains.	✓		✓		✓	Would not occur; no suitable habitat.	Would not occur.
<i>Triodia</i> sp. Robe River (M.E. Trudgen 11431)	Hummock grass: occurs in drainage lines and on rocky hillslopes and mesa-tops.			✓		✓	Would not occur; main distribution is in the western Pilbara, and the closest records are more than 30 km west of the study area.	Would not occur.
Priority 4								



Species	Description and Habitat Preference	Source of Record					Likelihood of Occurrence in the Study Area	
		Nature Map	TPFL †	WA Herb	Biota ¥	Rio Tinto	Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
<i>Acacia bromilowiana</i>	Tree or shrub: occurs on skeletal loam soils on rocky hills, breakaways, scree slopes, gorges and creek beds.	✓		✓		✓	May potentially occur; hills in the study area may comprise suitable habitat.	Would not occur; this tall shrub would have been recorded during the field survey, if present.
<i>Eremophila magnifica</i> subsp. <i>magnifica</i>	Shrub: occurs on rocky hillslopes and breakaways	✓		✓	✓	✓	May potentially occur; hills and slopes in the study area may comprise suitable habitat.	Would not occur; this shrub would have been recorded during the field survey, if present.
<i>Goodenia nuda</i>	Herb: occurs mainly along creeklines and on floodplains.	✓	✓	✓		✓	May potentially occur; suitable habitat in the study area and species has been recorded from the locality.	Recorded during the field survey from one location on floodplain in the southern section of the study area.
<i>Livistona alfredii</i>	Palm: occurs on edges of permanent pools.			✓		✓	Would not occur; no suitable habitat.	Would not occur.
<i>Ptilotus mollis</i>	Low shrub: occurs on stony hills and screes.	✓		✓		✓	May potentially occur; hills and slopes in the study area may provide suitable habitat.	Would not occur; this shrub species would have been expected to be recorded during the field survey, if present.
<i>Ptilotus trichocephalus</i>	Prostrate, spreading perennial herb: occurs on colluvial plains consisting of hard-packed clay with a stony surface.			✓	✓	✓	Unlikely; no suitable habitat; nearest records are over 17 km southeast.	Unlikely.
<i>Rhynchosia bungarensis</i>	Compact, prostrate shrub: occurs in drainage lines and on coarse sand amongst boulders.					✓	Unlikely; moderate-sized creekline may provide suitable habitat, however no records from nearby surveys; closest record is 20.5 km southwest.	Unlikely.

† DPaW Threatened and Priority Flora List.

¥ Various surveys (Biota 2005b, 2007a, 2009b, 2010c, 2010d, 2012, 2013b).



## Appendix 3

### Results of Fauna Desktop Review: Summary of Conservation Significant Fauna Species Recorded within 25 km of the Study Area





Common Name	Species	Conservation Status		NatureMap (<25km)	EPBC Act Protected Matters (<25 km)	Brockman 4 (Biota 2005a)	Marra Mamba (Biota 2013a)	Beasley River Limonites (Biota 2009a)	Brockman 2 Sustaining Tonnes (Biota 2010b)	Nammuldi Infill (Biota 2010a)	Preferred Habitat	Likelihood of Occurrence	
		State	Federal									Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
Northern Quoll	<i>Dasyurus hallucatus</i>	S1	EN		✓						Rocky gorges, rocky free faces and hills; secondarily along drainage lines.	May potentially occur; although not previously recorded near Marra Mamba, suitable core habitat is present in the locality; may be suitable habitat for denning or foraging in the study area.	May potentially occur (primarily for foraging); some small areas of rocky gorge habitat, which may be suitable for denning, however no large caves were found.
Northern Marsupial Mole	<i>Notoryctes caurinus</i>	S1	EN		✓						Underground, primarily in sand dunes and sandy soils along river flats.	Would not occur; no suitable habitat and the study area is beyond the recently documented distribution for this species.	Would not occur
Bilby	<i>Macrotis lagotis</i>	S1	VU		✓						Spinifex grasslands and Acacia shrublands. Requires soft substrate for burrowing.	Would not occur; no suitable habitat and the study area is beyond the recently documented distribution for this species.	Would not occur

Common Name	Species	Conservation Status		NatureMap (<25km)	EPBC Act Protected Matters (<25 km)	Brockman 4 (Biota 2005a)	Marra Mamba (Biota 2013a)	Beasley River Limonites (Biota 2009a)	Brockman 2 Sustaining Tonnes (Biota 2010b)	Nammuldi Infill (Biota 2010a)	Preferred Habitat	Likelihood of Occurrence	
		State	Federal									Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
Orange Leaf-nosed Bat	<i>Rhinonictoris aurantius</i>	S1	VU	✓	✓			✓			Breakaways adjacent to large drainage lines.	May potentially occur; species has been recorded in the Marra Mamba locality and may forage over the area at times; unlikely to be any caves suitable for roosting.	May potentially occur (foraging only); no suitable habitat for roosting, as only shallow caves recorded within the study area.
Pilbara Olive Python	<i>Liasis olivaceus barroni</i>	S1	VU	✓	✓			✓			Rocky habitats, particularly those near water or containing rock pools.	May potentially occur; only suboptimal habitat present, and species has not been recorded previously near Brockman 4	May potentially occur.
Great Egret	<i>Ardea modesta</i>	S3, IA	M		✓						Shallow standing freshwater.	Unlikely; no suitable habitat.	Unlikely.
Cattle Egret	<i>Ardea ibis</i>	S3, IA	M		✓						Grasslands, woodlands and wetlands.	Unlikely; no suitable habitat.	Unlikely.
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	S3, IA	M		✓						Coastal areas or inland wetlands.	Would not occur; no suitable habitat and few records from the inland Pilbara.	Would not occur.
Fork-tailed Swift	<i>Apus pacificus</i>	S3, IA	M		✓						Almost exclusively aerial.	May potentially occur; would not rely on terrestrial habitats in the study area, but may overfly on occasion.	May potentially occur.

Common Name	Species	Conservation Status		NatureMap (<25km)	EPBC Act Protected Matters (<25 km)	Brockman 4 (Biota 2005a)	Marra Mamba (Biota 2013a)	Beasley River Limonites (Biota 2009a)	Brockman 2 Sustaining Tonnes (Biota 2010b)	Nammuldi Infill (Biota 2010a)	Preferred Habitat	Likelihood of Occurrence	
		State	Federal									Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
Oriental Plover	<i>Charadrius veredus</i>	S3, IA	M		✓						Sparsely vegetated plains.	Unlikely; no records from the vicinity and only sub-optimal habitat present.	Unlikely.
Rainbow Bee-eater	<i>Merops ornatus</i>	S3, IA	M	✓	✓			✓		✓	Lightly wooded vegetation.	Likely; suitable habitat available and recorded during other surveys in the locality.	Likely.
Australian Bustard	<i>Ardeotis australis</i>	P4	-	✓		✓					Open to lightly wooded grasslands including <i>Triodia</i> sandplains and flats.	Likely; suitable habitat available and recorded during nearby survey of Brockman 4.	Likely.
Bush Stone-curlew	<i>Burhinus grallarius</i>	P4	-	✓							Sparsely grassed, lightly timbered forest or woodland.	May potentially occur; suitable habitat available but not recorded by other surveys in the locality.	May potentially occur.
Ghost Bat	<i>Macroderma gigas</i>	P4	-	✓					✓		Rocky areas with suitable roosting caves, often near drainage lines along which they can forage.	May potentially occur; species has not been recorded in the Marra Mamba locality but has been recorded at Brockman 2; unlikely to be any caves suitable for roosting but may forage over the area at times.	May potentially occur (foraging only); no suitable habitat for roosting, as only shallow caves recorded within the study area.

Common Name	Species	Conservation Status		NatureMap (<25km)	EPBC Act Protected Matters (<25 km)	Brockman 4 (Biota 2005a)	Marra Mamba (Biota 2013a)	Beasley River Limonites (Biota 2009a)	Brockman 2 Sustaining Tonnes (Biota 2010b)	Nammuldi Infill (Biota 2010a)	Preferred Habitat	Likelihood of Occurrence	
		State	Federal									Initial Ranking Based on Desktop Review	Final Ranking Including Results of Field Survey
Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>	P4	-	✓					✓	✓	Scree slopes and stony plains.	Likely to occur; suitable habitat available and recorded from surveys in the locality.	Recorded; four mounds noted in the study area.
Short-tailed Mouse	<i>Leggadina lakedownensis</i>	P4	-	✓				✓			Cracking clay and surrounding habitat.	Would not occur; no suitable habitat	Would not occur.
-	<i>Notoscincus butleri</i>	P4	-	✓		✓					Spinifex-dominated areas near creek and river margins.	May potentially occur; some suitable habitat and recorded from surveys in the locality.	May potentially occur.



## Appendix 4

# 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 for use on Pilbara surveys\*

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 * <i>Ursinia anthemoides</i> or * <i>Briza</i> 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 * <i>Ehrharta</i> 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 * <i>Ehrharta</i> 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.



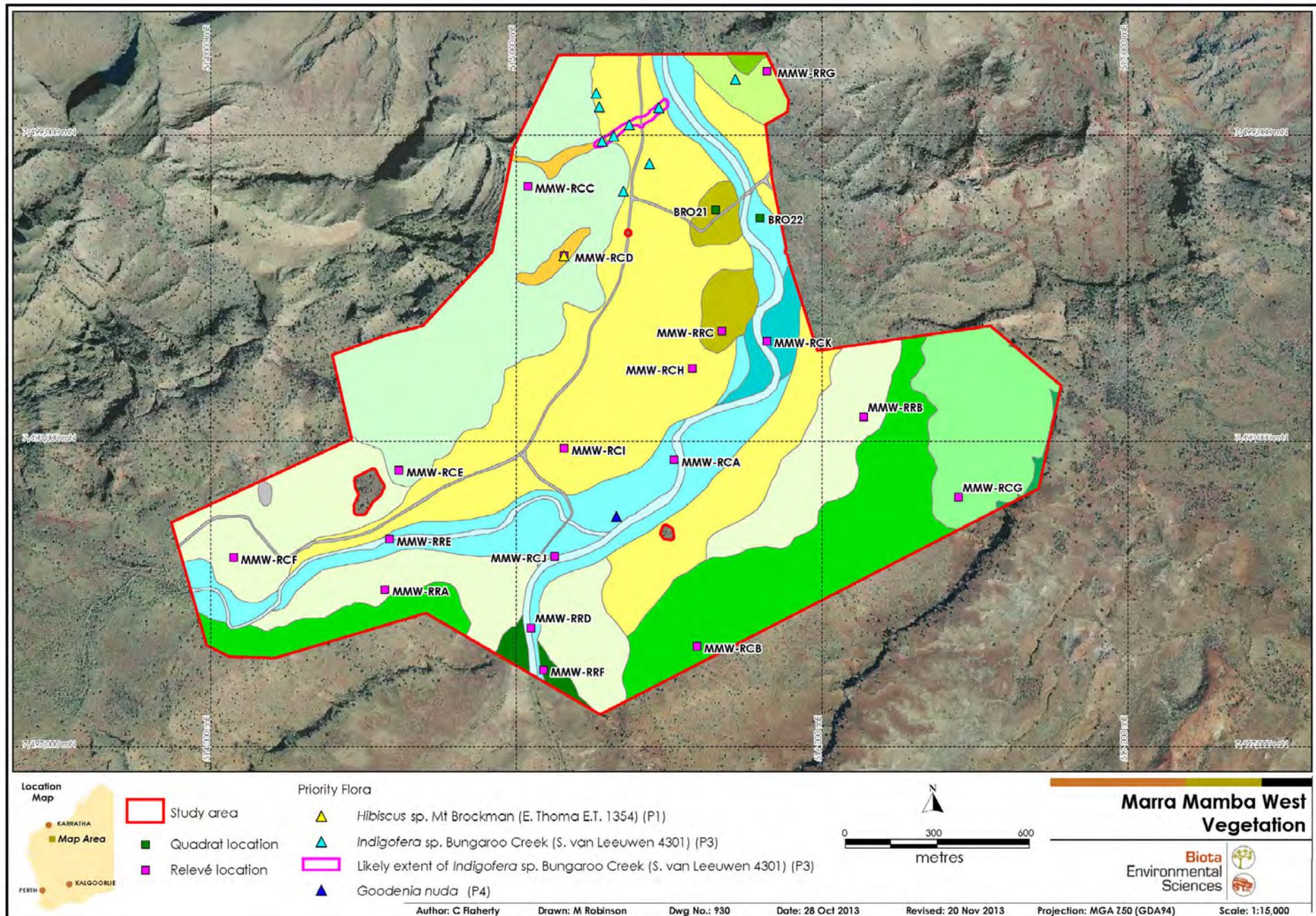
## Appendix 5

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# Vegetation Mapping and Priority Flora Locations







## Vegetation of Marra Mamba West

### Vegetation of Stony Plains



**P1: AaAbAsTe**

*Acacia ancistrocarpa*, *A. bivenosa*, *A. synchronicia* open shrubland over *Triodia epactia* hummock grassland.



**P2: EsTw**

*Eucalyptus socialis* subsp. *eucentrica* low open mallee woodland over *Triodia wiseana* open hummock grassland.

### Vegetation of Creeklines and Floodplains



**C1: EvGOOIPld**

*Eucalyptus victrix* scattered low trees to open woodland over *Goodenia lamprosperma*, *Pluchea dentex* very open herbland.



**C2: ExAciSsPToTHtCHfCEc**

*Eucalyptus xerothermica* scattered low trees over *Acacia citrinoviridis*, *Stylobasium spathulatum* tall shrubland over *Ptilotus obovatus* var. *obovatus* scattered shrubs over *Themeda triandra*, *Chrysopogon fallax*, *\*Cenchrus ciliaris* open tussock grassland.



**C3: AciVfCEc**

*Acacia citrinoviridis*, *\*Vachellia farnesiana* tall open shrubland over *\*Cenchrus ciliaris* closed tussock grassland.

### Vegetation of Stony Hillslopes and Crests



**H1: EIAprAmaTbrTe**

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia pruinocarpa*, *A. marramamba* open shrubland over *Triodia brizoides*, *T. epactia* open hummock grassland.



**H2: EIhcAatTbrTw**

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Hakea chordophylla* scattered tall shrubs over *Acacia atkinsiana* scattered shrubs over *Triodia brizoides*, *T. wiseana* open hummock grassland.

Vegetation Type Descriptions for the  
Marra Mamba West Study Area Vegetation Map

Legend Sheet 1



## Vegetation of Marra Mamba West

### Vegetation of Stony Hillslopes and Crests



H3: EIAmoAmTbrTe

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia monticola*, *A. maitlandii* tall open shrubland over *Triodia brizoides*, *T. epactia* open tussock grassland.



H4: EITe

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia epactia* open hummock grassland to hummock grassland.



H5: EIAatTw

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia atkinsiana* open shrubland over *Triodia wiseana* hummock grassland.



H6: EIAbTbrTeTHmCYa

*Eucalyptus leucophloia* subsp. *leucophloia* low open woodland over *Acacia bivenosa* open shrubland over *Triodia brizoides*, *T. epactia* hummock grassland and *Themeda* sp. Mt. Barricade, *Cymbopogon ambiguus* open tussock grassland.



H7: EIAiTw

*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland.



H8: AaTw

*Acacia ancistrocarpa* open heath to tall open shrubland over *Triodia wiseana* hummock grassland to closed hummock grassland.

### Vegetation of Rocky Gorges



G1: CfDpAprTHmTe

*Corymbia ferritcola* open forest over *Dodonaea pachyneura*, *Acacia pruinocarpa* tall open shrubland to tall open scrub over *Themeda* sp. Mt. Barricade very open tussock grassland and *Triodia epactia* very open hummock grassland.

Other



Disturbed

Cleared areas.

Vegetation Type Descriptions for the  
Marra Mamba West Study Area Vegetation Map

Legend Sheet 2

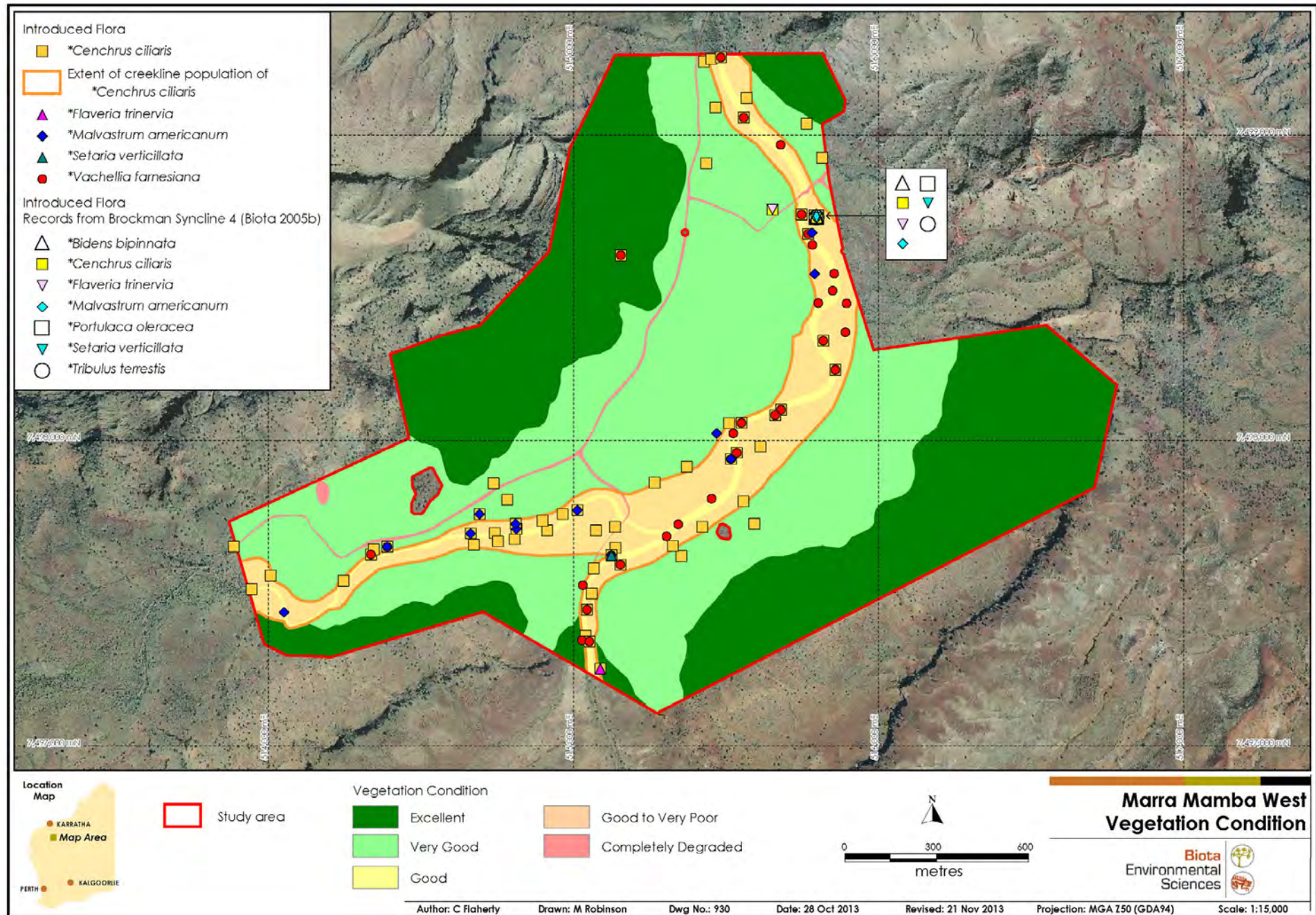


## Appendix 6

# Vegetation Condition Mapping and Weed Locations









# Appendix 7



## Raw Site Data







Marra Mamba West Site	MMW-RCA
Described by CEF	Date 14-Sep-13
Type Relevé	
MGA Zone 50	515511 mE, 7497966 mN
Habitat	Broad banks and floodplain of a moderate-sized creekline.
Vegetation	<i>Eucalyptus xerothermica</i> scattered low trees over <i>Acacia citrinoviridis</i> , <i>A. bivenosa</i> , <i>Stylobasium spathulatum</i> tall open scrub over * <i>Cenchrus ciliaris</i> , <i>Themeda triandra</i> , <i>Chrysopogon fallax</i> tussock grassland to closed tussock grassland and <i>Triodia epactia</i> very open hummock grassland.
Veg Condition	Poor-Very Poor (High cover of * <i>Cenchrus ciliaris</i> ; also * <i>Malvastrum americanum</i> , * <i>Vachellia farnesiana</i> ; evidence of grazing, horse and cow scats).
Fire Age	No sign of recent fire
Notes	Relevé search area was approximately 50 x 50 m on the banks on the western side of the creek bed. * <i>Cenchrus ciliaris</i> cover ranges from approximately 35% to 75%, with generally higher cover closer to the creekbed. Where * <i>C. ciliaris</i> cover is lower, the other native grasses ( <i>Themeda triandra</i> , <i>Chrysopogon fallax</i> , <i>Triodia epactia</i> ) are more abundant.

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia bivenosa</i>	1	250 cm		
<i>Acacia citrinoviridis</i>	40	300 cm		
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	0.1	180 cm	MMW-RCA15	
<i>Acacia synchronicia</i>	0.1	45 cm	=MMW-CEF04	
<i>Alternanthera nana</i>	0.1	15 cm	MMW-RCA03	
<i>Androcalva luteiflora</i>	0.1	140 cm		
<i>Aristida contorta</i>	0.1	25 cm		
<i>Bonamia erecta</i>	0.1	20 cm		
* <i>Cenchrus ciliaris</i>	75	70 cm		
<i>Chrysopogon fallax</i>	2	90 cm		
<i>Corchorus crozophorifolius</i>	0.1	55 cm		
<i>Cymbopogon procerus</i>	0.1	60 cm		
<i>Dicladanthera forrestii</i>	0.1	40 cm	MMW-RCA05	
<i>Dipteracanthus australasicus</i> subsp. <i>australasicus</i>	0.1	30 cm	MMW-RCA02	
<i>Duperreya commixta</i>	0.1	160 cm		
<i>Enneapogon polyphyllus</i>	0.1	15 cm		
<i>Eragrostis eriopoda</i>	0.1	20 cm	MMW-RCA11	
<i>Eriachne mucronata</i>	0.1	35 cm	MMW-RCA08	
<i>Eucalyptus xerothermica</i>	1	420 cm		
<i>Eulalia</i> sp. (Three Rivers Station, B.Forsyth AQ6789133)	0.1	40 cm	MMW-RCA10	
<i>Euphorbia australis</i> var. <i>hispidula</i>	0.1	3 cm	MMW-RCA13	
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	0.1	15 cm		
<i>Gossypium australe</i>	0.1	40 cm		
<i>Gossypium robinsonii</i>	0.1	160 cm		
<i>Gossypium sturtianum</i>	0.1	80 cm		
<i>Hakea lorea</i> subsp. <i>lorea</i>	0.1	60 cm		Juvenile
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	0.1	40 cm	MMW-RCA09	
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	120 cm		
* <i>Malvastrum americanum</i>	0.1	15 cm		9 plants
<i>Pterocaulon sphacelatum</i>	0.1	20 cm	MMW-RCA01, 04	
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	45 cm		
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1	60 cm		
<i>Rhynchosia minima</i>	0.1	20 cm		
<i>Senna artemisioides</i> subsp. <i>helmsii</i>	0.1	35 cm		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	60 cm	MMW-RCA07, 12	
<i>Sida fibulifera</i>	0.1	15 cm	MMW-RCA14	
<i>Stylobasium spathulatum</i>	1	200 cm		
<i>Tephrosia rosea</i> var. <i>Fortescue</i> creeks (M.I.H. Brooker	0.1	40 cm	MMW-RCA06	

Species	Cover (%)	Height	Specimen Number	Notes
2186)				
<i>Themeda triandra</i>	5	60 cm		
<i>Triodia epactia</i>	3	50 cm		
* <i>Vachellia farnesiana</i>	0.1	250 cm		7 plants



Marra Mamba West Site		MMW-RCB
Described by	CEF	Date 14-Sep-13
Type	Relevé	
MGA Zone 50	515590 mE, 7497330 mN	
Habitat	Rocky northwest-facing slope.	
Soil	Skeletal red-brown sandy loam.	
Rock Type	Ironstone with rocks and pebbles on surface and some outcropping.	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Acacia monticola</i> , <i>A. maitlandii</i> tall open shrubland over <i>Triodia wiseana</i> , <i>T. brizoides</i> hummock grassland.	
Veg Condition	Excellent	
Fire Age	No sign of recent fire	

Species	Cover (%)	Height	Specimen Number
<i>Abutilon</i> sp. <i>Dioicum</i> (A.A. Mitchell PRP 1618)	0.1	95 cm	MMW-RCB09
<i>Acacia citrinoviridis</i>	0.1	100 cm	
<i>Acacia exilis</i>	0.1	60 cm	MMW-RCB02
<i>Acacia inaequilatera</i>	0.1	130 cm	
<i>Acacia maitlandii</i>	1	250cm	
<i>Acacia marramamba</i>	0.1	85 cm	
<i>Acacia monticola</i>	6	200 cm	
<i>Acacia pruinocarpa</i>	0.1	140 cm	
<i>Acacia synchronicia</i>	0.1	45 cm	
<i>Amphipogon sericeus</i>	0.1	25 cm	MMW-RCB06
<i>Aristida holathera</i> var. <i>holathera</i>	0.1	20 cm	
<i>Bulbostylis barbata</i>	0.1	7 cm	
<i>Cleome viscosa</i>	0.1	40 cm	
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	20 cm	=MMW-CEF02
<i>Cucumis variabilis</i>	0.1	60 cm	
<i>Cymbopogon ambiguus</i>	0.1	120 cm	MMW-RCB03
<i>Dampiera candicans</i>	0.1	40 cm	
<i>Duperreya commixta</i>	0.1	100 cm	
<i>Eriachne mucronata</i>	0.1	35 cm	MMW-RCB04
<i>Eriachne pulchella</i>	0.1	10 cm	MMW-RCB05
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	320 cm	
<i>Goodenia stobbsiana</i>	0.1	20 cm	
<i>Gossypium robinsonii</i>	0.1	180 cm	
<i>Hakea chordophylla</i>	0.1	180 cm	
<i>Hybanthus aurantiacus</i>	0.1	25 cm	
<i>Indigofera monophylla</i>	0.1	35 cm	MMW-RCB08
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	50 cm	
<i>Oldenlandia crouchiana</i>	0.1	10 cm	
<i>Polycarpaea longiflora</i>	0.1	20 cm	
<i>Ptilotus calostachyus</i>	0.1	60 cm	
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	30 cm	
<i>Schizachyrium fragile</i>	0.1	10 cm	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	40 cm	=MMW-RCA07
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	80 cm	MMW-RCB01
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	80 cm	
<i>Senna notabilis</i>	0.1	25 cm	
<i>Solanum diversiflorum</i>	0.1	15 cm	
<i>Solanum horridum</i>	0.1	20 cm	MMW-RCB07
<i>Tephrosia</i> sp. <i>Fortescue</i> (A.A. Mitchell 606)	0.1	25 cm	=MMW-CEF14
<i>Themeda triandra</i>	0.1	70 cm	
<i>Tribulus suberosus</i>	0.1	40 cm	
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	0.1	35 cm	
<i>Triodia brizoides</i>	15	50 cm	
<i>Triodia epactia</i>	0.1	40 cm	
<i>Triodia wiseana</i>	25	60 cm	

Species	Cover (%)	Height	Specimen Number
<i>Triumfetta maconochieana</i>	0.1	30 cm	=MMW-CEF13



Marra Mamba West Site		MMW-RCC
Described by	CEF	Date 15-Sep-13
Type	Relevé	
MGA Zone 50	515009 mE, 7498841 mN	
Habitat	Rocky, east-facing mid-slope of a large hill.	
Soil	Skeletal red-brown sandy loam.	
Rock Type	Ironstone	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Acacia pruinocarpa</i> tall open shrubland over <i>Triodia brizoides</i> , <i>T. epactia</i> , <i>T. wiseana</i> hummock grassland.	
Veg Condition	Excellent	
Fire Age	No sign of recent fire	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia citrinoviridis</i>	0.1	120 cm		
<i>Acacia exilis</i>	0.1	120 cm		
<i>Acacia marramamba</i>	0.1	50 cm		
<i>Acacia pruinocarpa</i>	3	210 cm		
<i>Acacia synchronicia</i>	0.1	50 cm	=MMW-CEF04	
<i>Acacia tetragonophylla</i>	0.1	150 cm		
<i>Amphipogon sericeus</i>	0.1	35 cm	=MMW-RCB06	
<i>Corchorus ? tectus</i>	0.1	40 cm	=MMW-CEF34	
<i>Cucumis variabilis</i>	0.1	60 cm		
<i>Cymbopogon ambiguus</i>	0.1	90 cm	=MMW-RCB03	
<i>Dampiera candicans</i>	0.1	30 cm		
<i>Eriachne mucronata</i>	0.1	40 cm	=MMW-RCB04	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	400 cm		
<i>Gomphrena cunninghamii</i>	0.1	10 cm		
<i>Goodenia cusackiana</i>	0.1	20 cm		
<i>Hakea chordophylla</i>	0.1	180 cm		
<i>Hakea lorea</i> subsp. <i>lorea</i>	0.1	60 cm		Juvenile
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	50 cm		
<i>Paraneurachne muelleri</i>	0.1	20 cm		
<i>Ptilotus calostachyus</i>	0.1	70 cm		
<i>Schizachyrium fragile</i>	0.1	10 cm		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.1	60 cm	MMW-RCC01	
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	120 cm		
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	100 cm		
<i>Senna notabilis</i>	0.1	15 cm		
<i>Solanum horridum</i>	0.1	15 cm		
<i>Solanum lasiophyllum</i>	0.1	30 cm	MMW-RCC04	
<i>Tribulus suberosus</i>	0.1	45 cm		
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	0.1	20 cm		
<i>Triodia brizoides</i>	25	40 cm	MMW-RCC05	
<i>Triodia epactia</i>	15	40 cm	MMW-RCC02	
<i>Triodia wiseana</i>	4	40 cm		



Marra Mamba West Site		MMW-RCD
Described by	CEF	Date 15-Sep-13
Type	Relevé	
MGA Zone 50	515110 mE, 7498559 mN	
Habitat	Incised, rocky gully in in east-facing slope.	
Soil	Skeletal soil	
Rock Type	Ironstone; exposed boulders and rocks and outcropping.	
Vegetation	<i>Corymbia ferriticola</i> , <i>Acacia aptaneura</i> low woodland over <i>Acacia pruinocarpa</i> , <i>Dodonaea pachyneura</i> tall open shrubland over <i>Themeda</i> sp. Mt Barricade (M.E. Trudgen 2471), <i>Cymbopogon procerus</i> open tussock grassland over <i>Triodia epactia</i> very open hummock grassland.	
Veg Condition	Excellent	
Fire Age	No sign of recent fire	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Abutilon</i> sp. <i>Dioicum</i> (A.A. Mitchell PRP 1618)	0.1	130 cm	=MMW-RCB09	
<i>Acacia aptaneura</i>	5	600 cm	MMW-RCD09	
<i>Acacia hamersleyensis</i>	1	350 cm		
<i>Acacia rhodophloia</i>	0.1	250 cm		
<i>Acacia tetragonophylla</i>	0.1	120 cm		
<i>Acacia trudgeniana</i>	0.1	160 cm	MMW-RCD17	
<i>Alternanthera nana</i>	0.1	10 cm		
<i>Amaranthus undulatus</i>	0.1	30 cm	MMW-RCD14	
<i>Aristida burbridgeae</i>	0.1	110 cm	MMW-RCD05	
<i>Brachychiton acuminatus</i>	0.1	450 cm	MMW-RCD04	
<i>Capparis lasiantha</i>	0.1	50 cm		
<i>Cleome viscosa</i>	0.1	35 cm		
<i>Clerodendrum floribundum</i> var. <i>angustifolium</i>	0.1	260 cm		
<i>Corchorus crozophorifolius</i>	0.1	40 cm		
<i>Corymbia ferriticola</i>	6	550 cm		
<i>Cucumis variabilis</i>	0.1	40 cm		
<i>Cymbopogon procerus</i>	0.1	120 cm		
<i>Dodonaea pachyneura</i>	1	250 cm	MMW-RCD01	
<i>Duperreya commixta</i>	0.1	400 cm		
<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	0.1	60 cm	MMW-RCD10	
<i>Eriachne mucronata</i>	0.1	30 cm		
<i>Euphorbia trigonosperma</i>	0.1	40 cm	MMW-RCD03	
<i>Ficus brachypoda</i>	0.1	350 cm	MMW-RCD06	
<i>Gomphrena cunninghamii</i>	0.1	10 cm		
<i>Grevillea berryana</i>	0.1	110 cm		Juvenile
<i>Hibiscus</i> sp. Mt Brockman (E. Thoma ET 1354)	0.1	10 cm	MMW-RCD08	Priority 1
<i>Hybanthus aurantiacus</i>	0.1	35 cm		
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	30 cm		
<i>Paspalidium clementii</i>	0.1	20 cm	MMW-RCD12	
<i>Polycarpaea longiflora</i>	0.1	30 cm		
<i>Pterocaulon sphacelatum</i>	0.1	30 cm	MMW-RCD13	
<i>Ptilotus calostachyus</i>	0.1	120 cm		
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1	50 cm		
<i>Rhynchosia minima</i>	0.1	20 cm		
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	120 cm		
<i>Senna venusta</i>	0.1	100 cm		
<i>Sida</i> sp. Shovelanna Hill (S. van Leeuwen 3842)	0.1	20 cm		
<i>Solanum horridum</i>	0.1	20 cm		
<i>Tephrosia</i> sp. Fortescue (A.A. Mitchell 606)	0.1	40 cm	MMW-RCD02	
<i>Themeda</i> sp. Mt Barricade (M.E. Trudgen 2471)	10	30 cm	MMW-RCD07	
<i>Tinospora smilacina</i>	0.1	20 cm	MMW-RCD16	
<i>Triodia epactia</i>	8	30 cm		
<i>Triodia wiseana</i>	0.1	40 cm	MMW-RCD11	
<i>Triumfetta maconochieana</i>	0.1	25 cm	=MMW-CEF13	



Marra Mamba West Site		MMW-RCE
Described by	CEF	Date 15-Sep-13
Type	Relevé	
MGA Zone 50	514634 mE, 7497944 mN	
Habitat	Rocky lower footslopes of a medium-sized, south-facing hill	
Soil	Red-brown loam	
Rock Type	Ironstone; Surface layer of small ironstone pebbles and gravel.	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Acacia pruinocarpa</i> , <i>A. marramamba</i> open shrubland over <i>Triodia epactia</i> open hummock grassland and <i>Amphipogon sericeus</i> very open tussock grassland.	
Veg Condition	Very Good; No weeds, small area of ripped, rehabilitated old track.	
Fire Age	~5 years	
Notes	Standing dead (burnt) trunks persistent in landscape.	

Species	Cover (%)	Height	Specimen Number
<i>Acacia ancistrocarpa</i>	0.1		
<i>Acacia atkinsiana</i>	0.1		MMW-RCE01
<i>Acacia bivenosa</i>	0.1		
<i>Acacia citrinoviridis</i>	0.1		
<i>Acacia maitlandii</i>	0.1		
<i>Acacia marramamba</i>	2		
<i>Acacia pruinocarpa</i>	3		
<i>Acacia tetragonophylla</i>	0.1		
<i>Amphipogon sericeus</i>	3		
<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>	0.1		MMW-RCE04
<i>Corchorus</i> ? <i>tectus</i>	0.1		=MMW-CEF34
<i>Cucumis variabilis</i>	0.1		
<i>Cymbopogon ambiguus</i>	0.1		MMW-RCE05
<i>Dampiera candicans</i>	0.1		
<i>Duperreya commixta</i>	0.1		
<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	0.1		=MMW- RCD10
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1		
<i>Goodenia cusackiana</i>	0.1		
<i>Goodenia microptera</i>	0.1		
<i>Goodenia stobbsiana</i>	0.1		
<i>Grevillea berryana</i>	0.1		
<i>Indigofera monophylla</i>	0.1		MMW-RCE02
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1		
<i>Pterocaulon sphacelatum</i>	0.1		MMW-RCE07
<i>Ptilotus astrolasius</i>	0.1		
<i>Ptilotus calostachyus</i>	0.1		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1		
<i>Senna artemisioides</i> subsp. <i>helmsii</i>	0.1		MMW-RCE06
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.1		=MMW-RCC01
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1		
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1		
<i>Sida</i> sp. Pilbara (A.A. Mitchell PRP 1543)	0.1		MMW-RCE03
<i>Solanum lasiophyllum</i>	0.1		=MMW-RCC04
<i>Tephrosia</i> sp. Fortescue (A.A. Mitchell 606)	0.1		=MMW- RCD02
<i>Triodia epactia</i>	25		





Marra Mamba West Site MMW-RCF  
 Described by CEF Date 16-Sep-13  
 Type Relevé  
 MGA Zone 50 514075 mE, 7497620 mN  
 Habitat Low rocky rise (slightly sloping to the northeast).  
 Soil Red-brown sandy loam  
 Rock Type Ironstone; loose pebble matrix on the surface, some outcropping.  
 Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia pruinocarpa* open shrubland over *Triodia epactia* open hummock grassland over *Goodenia cusackiana* scattered herbs.  
 Veg Condition Excellent  
 Fire Age ~4 years (patchily)

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia aptaneura</i>	0.1	170 cm	MMW-RCF07	Juvenile
<i>Acacia atkinsiana</i>	0.1	90 cm		
<i>Acacia bivenosa</i>	0.1	60 cm		
<i>Acacia maitlandii</i>	0.1	120 cm		
<i>Acacia pruinocarpa</i>	2	140 cm		
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	0.1	90 cm	MMW-RCF16	
<i>Acacia tetragonophylla</i>	0.1	70 cm		
<i>Amphipogon sericeus</i>	0.1	30 cm		
<i>Aristida contorta</i>	0.1	15 cm		
<i>Capparis lasiantha</i>	0.1	50 cm		
<i>Codonocarpus cotinifolius</i>	0.1	40 cm		Resprouting
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	35 cm	MMW-RCF09	
<i>Cymbopogon ambiguus</i>	0.1	100 cm	MMW-RCF15	
<i>Dampiera candicans</i>	0.1	35 cm		
<i>Duperreya commixta</i>	0.1	100 cm		
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	0.1	40 cm	MMW-RCF06	
<i>Eremophila longifolia</i>	0.1	50 cm		
<i>Eriachne mucronata</i>	0.1	35 cm		
<i>Eriachne pulchella</i>	0.1	30 cm	MMW-RCF13	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	500 cm		
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	0.1	20 cm		
<i>Goodenia cusackiana</i>	1	15 cm		
<i>Grevillea berryana</i>	0.1	70 cm		
<i>Hibiscus coatesii</i>	0.1	30 cm	MMW-RCF11	
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	50 cm		
<i>Keraudrenia nephrosperma</i>	0.1	30 cm	MMW-RCF10	
<i>Pterocaulon sphacelatum</i>	0.1	40 cm	MMW-RCF05	
<i>Ptilotus astrolasius</i>	0.1	25 cm		
<i>Ptilotus calostachyus</i>	0.1	80 cm		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	30 cm		
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1	60 cm		
<i>Senna artemisioides</i> subsp. <i>helmsii</i>	0.1	50 cm	MMW-RCF08	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	60 cm	MMW-RCF04	
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	100 cm		
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>Senna stricta</i>	0.1	120 cm	MMW-RCF03	
<i>Sida</i> sp. Pillbara (A.A. Mitchell PRP 1543)	0.1	20 cm	MMW-RCF02	
<i>Solanum lasiophyllum</i>	0.1	30 cm	MMW-RCF01	
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	0.1	70 cm		
<i>Triodia brizoides</i>	0.1	30 cm	MMW-RCF12	
<i>Triodia epactia</i>	25	30 cm		



Marra Mamba West Site		MMW-RCG
Described by	CEF	Date 17-Sep-13
Type	Relevé	
MGA Zone 50	516446 mE, 7497817 mN	
Habitat	Flat to slightly northwest-sloping crest of a large hill.	
Soil	Skeletal red-brown loam.	
Rock Type	Continuous cover of ironstone rock	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Hakea chordophylla</i> scattered tall shrubs over <i>Acacia atkinsiana</i> open shrubland over <i>Triodia brizoides</i> open hummock grassland.	
Veg Condition	Excellent	
Fire Age	No sign of recent fire	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia atkinsiana</i>	3	160 cm		
<i>Acacia maitlandii</i>	0.1	90 cm		
<i>Acacia marramamba</i>	0.1	60 cm		
<i>Acacia pruinocarpa</i>	0.1	120 cm		
<i>Amphipogon sericeus</i>	0.1	40 cm		
<i>Aristida holathera</i> var. <i>holathera</i>	0.1	20 cm		
<i>Dampiera candicans</i>	0.1	30 cm		
<i>Dodonaea coriacea</i>	0.1	80 cm	MMW-RCG02	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	450 cm		
<i>Goodenia cusackiana</i>	0.1	20 cm		
<i>Goodenia stobbsiana</i>	0.1	30 cm		
<i>Goodenia stobbsiana</i>	0.1	30 cm		
<i>Hakea chordophylla</i>	1	350 cm		
<i>Keraudrenia nephrosperma</i>	0.1	30 cm	MMW-RCG04	
<i>Paraneurachne muelleri</i>	0.1	30 cm		
<i>Polycarpaea holtzei</i>	0.1	5 cm		
<i>Ptilotus calostachyus</i>	0.1	90 cm		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	20 cm		
<i>Ptilotus rotundifolius</i>	0.1	45 cm		
<i>Schizachyrium fragile</i>	0.1	20 cm		
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	100 cm		
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>Senna stricta</i>	0.1	100 cm	MMW-RCG01	
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	100 cm		
<i>Solanum elatius</i>	0.1	60 cm	=MMW-RB18	
<i>Solanum lasiophyllum</i>	0.1	20 cm	MMW-RCG03	
<i>Tribulus suberosus</i>	0.1	90 cm		
<i>Triodia brizoides</i>	28	30 cm		
<i>Triodia epactia</i>	0.1	20 cm		Sterile
<i>Triumfetta maconochieana</i>	0.1	25 cm	=MMW-CEF13	



Marra Mamba West Site		MMW-RCH	
Described by	CEF	Date	17-Sep-13
Type	Relevé		
MGA Zone 50	515575 mE, 7498238 mN		
Habitat	Undulating rocky plain		
Rock Type	Ironstone; small pebbles and larger rocks continuous on surface.		
Vegetation	Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia pruinocarpa tall open shrubland over A. bivenosa scattered shrubs over Triodia epactia hummock grassland.		
Veg Condition	Very Good (some old tracks that have been ripped and rehabilitated)		
Fire Age	~4 years		
Notes	Standing dead (burnt) trees persist in landscape. Some Acacia aptaneura and Acacia atkinsiana are resprouting.		

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia ancistrocarpa</i>	0.1	60 cm		
<i>Acacia aptaneura</i>	0.1	50 cm	MMW-RCH08	Juvenile
<i>Acacia atkinsiana</i>	0.1	90 cm		
<i>Acacia bivenosa</i>	1	130 cm		
<i>Acacia citrinoviridis</i>	0.1	130 cm		
<i>Acacia exilis</i>	0.1	50 cm		
<i>Acacia inaequilatera</i>	0.1	110 cm		
<i>Acacia maitlandii</i>	0.1	60 cm		
<i>Acacia pruinocarpa</i>	4	200 cm		
<i>Amphipogon sericeus</i>	0.1	40 cm		
<i>Aristida holathera</i> var. <i>holathera</i>	0.1	30 cm		
<i>Capparis lasiantha</i>	0.1	45 cm		
<i>Codonocarpus cotinifolius</i>	0.1	130 cm		
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	40 cm	MMW-RCH02	
<i>Cucumis variabilis</i>	0.1	50 cm		
<i>Dampiera candicans</i>	0.1	30 cm		
<i>Dodonaea coriacea</i>	0.1	20 cm		
<i>Duperreya commixta</i>	0.1	60 cm		
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	0.1	50 cm	MMW-RCH07	
<i>Eriachne mucronata</i>	0.1	35 cm	MMW-RCH05	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	450 cm		
<i>Goodenia cusackiana</i>	0.1	15 cm		
<i>Goodenia microptera</i>	0.1	20 cm		
<i>Goodenia stobbsiana</i>	0.1	20 cm		
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	35 cm		
<i>Keraudrenia nephrosperma</i>	0.1	30 cm	=MMW-RCG04	
<i>Pluchea dentex</i>	0.1	35 cm	MMW-RCH09	
<i>Ptilotus astrolasius</i>	0.1	25 cm		
<i>Ptilotus calostachyus</i>	0.1	70 cm		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	30 cm		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	35 cm	MMW-RCH04	
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>Senna stricta</i>	0.1	80 cm	MMW-RCH06	
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	90 cm		
<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	0.1	70 cm		
<i>Sida</i> sp. <i>Pilbara</i> (A.A. Mitchell PRP 1543)	0.1	20 cm	MMW-RCH03	
<i>Solanum lasiophyllum</i>	0.1	30 cm	MMW-RCH01	
<i>Triodia epactia</i>	35	45 cm		



Marra Mamba West Site		MMW-RCI	
Described by	CEF	Date	17-Sep-13
Type	Relevé		
MGA Zone 50	515156 mE, 7497975 mN		
Habitat	Stony plain		
Soil	Red-brown clay loam.		
Rock Type	Ironstone rocks and pebbles continuous on the soil surface.		
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Acacia ancistrocarpa</i> , ( <i>A. pruinocarpa</i> ) tall open shrubland over <i>Triodia epactia</i> open hummock grassland.		
Veg Condition	Very Good (Rehabilitated old tracks)		
Fire Age	~4 years		

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia ancistrocarpa</i>	9	200 cm		
<i>Acacia aptaneura</i>	0.1	70 cm	MMW-RCI08	Juvenile
<i>Acacia atkinsiana</i>	0.1	90 cm		
<i>Acacia bivenosa</i>	0.1	110 cm		
<i>Acacia citrinoviridis</i>	0.1	120 cm		
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	0.1	120 cm		
<i>Acacia synchronicia</i>	0.1	70 cm		
<i>Acacia tetragonophylla</i>	0.1	140 cm		
<i>Amphipogon sericeus</i>	0.1	45 cm		
<i>Aristida contorta</i>	0.1	25 cm		
<i>Aristida holathera</i> var. <i>holathera</i>	0.1	20 cm		
<i>Capparis lasiantha</i>	0.1	50 cm		
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	35 cm	=MMW- RCH02	
<i>Duperreya commixta</i>	0.1	110 cm		
<i>Enneapogon caeruleus</i>	0.1	15 cm	MMW-RCI03	
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>	0.1	60 cm		
<i>Eriachne pulchella</i>	0.1	20 cm	MMW-RCI06	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	400 cm		
<i>Goodenia microptera</i>	0.1	15 cm	MMW-RCI07	
<i>Gossypium australe</i>	0.1	90 cm	=MMW-RCJ13	
<i>Hakea lorea</i> subsp. <i>lorea</i>	0.1	120 cm		
<i>Indigofera monophylla</i>	0.1	20 cm	MMW-RCI05	
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	70 cm		
<i>Keraudrenia nephrosperma</i>	0.1	40 cm	=MMW- RCG04	
<i>Paraneurachne muelleri</i>	0.1	30 cm		
<i>Ptilotus astrolasius</i>	0.1	30 cm		
<i>Ptilotus calostachyus</i>	0.1	100 cm		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	20 cm		
<i>Senna artemisioides</i> subsp. <i>helmsii</i>	0.1	50 cm	MMW-RCI04	
<i>Senna glutinosa</i> subsp. <i>luerssenii</i> x <i>Senna stricta</i>	0.1	60 cm	=MMW- RCH06	
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	90 cm		
<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	0.1	90 cm		
<i>Solanum elatius</i>	0.1	40 cm	=MMW-RB18	
<i>Solanum lasiophyllum</i>	0.1	30 cm	MMW-RCI02	
<i>Themeda triandra</i>	0.1	40 cm		
<i>Tribulus suberosus</i>	0.1	70 cm		
<i>Triodia epactia</i>	15	45 cm	MMW-RCI09	





Marra Mamba West Site		MMW-RCJ
Described by	CEF	Date 18-Sep-13
Type	Relevé	
MGA Zone 50	50, 515157 mE, 7497636 mN	
Habitat	Banks of a creekline.	
Soil	Red-brown loamy sand	
Rock Type	Ironstone- a few rocks scattered on the surface	
Vegetation	Eucalyptus victrix scattered trees over E. xerothermica scattered low trees over Acacia citrinoviridis tall shrubland over Eremophila longifolia, Ptilotus obovatus var. obovatus open shrubland over *Cenchrus ciliaris, Dichanthium fecundum, Themeda triandra, (Chrysopogon fallax) closed tussock grassland and Triodia epactia very open hummock grassland.	
Veg Condition	Very Poor (high *Cenchrus ciliaris cover; also *Vachellia farnesiana, *Malvastrum americanum, *Setaria verticillata, cattle scats, grazing and tracks).	
Fire Age	No sign of recent fire.	

Species	Cover (%)	Specimen Number	Notes
<i>Abutilon fraseri</i> subsp. <i>fraseri</i>	0.1	MMW-RCJ10	
<i>Acacia ancistrocarpa</i>	0.1		
<i>Acacia bivenosa</i>	0.1		
<i>Acacia citrinoviridis</i>	35		
<i>Acacia pyrifolia</i> var. <i>morrisonii</i>	0.1	MMW-RCJ05	
<i>Acacia tetragonophylla</i>	0.1		
<i>Aristida contorta</i>	0.1		
<i>Bothriochloa ewartiana</i>	0.1	MMW-RCJ01	
<i>Capparis lasiantha</i>	0.1		
<i>Capparis umbonata</i>	0.1	MMW-RCJ08	
* <i>Cenchrus ciliaris</i>	75		
<i>Chrysopogon fallax</i>	1		
<i>Cleome viscosa</i>	0.1		
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	=MMW-RB07	
<i>Cymbopogon ambiguus</i>	0.1	MMW-RCJ14	
<i>Dichanthium fecundum</i>	5	MMW-RCJ02	
<i>Dipteracanthus australasicus</i> subsp. <i>australasicus</i>	0.1	MMW-RCJ06	
<i>Duperreya commixta</i>	0.1		
<i>Enneapogon caerulescens</i>	0.1	MMW-RCJ09	
<i>Enneapogon polyphyllus</i>	0.1		
<i>Eremophila longifolia</i>	5		
<i>Eremophila longifolia</i>	0.1		
<i>Eriachne mucronata</i>	0.1		
<i>Eucalyptus victrix</i>	0.5		
<i>Eucalyptus xerothermica</i>	0.5		
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	0.1		
<i>Goodenia muelleriana</i>	0.1		
<i>Gossypium australe</i>	0.1	MMW-RCJ13	
<i>Gossypium sturtianum</i>	0.1		
<i>Hibiscus sturtii</i> var. <i>platyclamys</i>	0.1	MMW-RCJ16	
<i>Hybanthus aurantiacus</i>	0.1		
<i>Isotropis atropurpurea</i>	0.1	MMW-RCJ12	
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1		
* <i>Malvastrum americanum</i>	0.1		2 plants
<i>Melhania oblongifolia</i>	0.1		
<i>Paraneurachne muelleri</i>	0.1		
<i>Pluchea rubelliflora</i>	0.1		
<i>Polycarpaea longiflora</i>	0.1		
<i>Pterocaulon sphacelatum</i>	0.1	MMW-RCJ03	
<i>Ptilotus astrolasius</i>	0.1		
<i>Ptilotus helipteroides</i>	0.1		

Species	Cover (%)	Specimen Number	Notes
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1		
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	5		
<i>Rhynchosia minima</i>	0.1		
<i>Salsola australis</i>	0.1		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.1	MMW-RCJ04	
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1		
<i>Senna notabilis</i>	0.1		
* <i>Setaria verticillata</i>	0.1		1 plant
<i>Sida echinocarpa</i>	0.1	MMW-RCJ15	
<i>Sida fibulifera</i>	0.1	MMW-RCJ07	
<i>Sida fibulifera</i>	0.1	MMW-RCJ11	
<i>Solanum lasiophyllum</i>	0.1	=MMW-RCI02	
<i>Stemodia grossa</i>	0.1		
<i>Stylobasium spathulatum</i>	0.1		
<i>Tephrosia rosea</i> var. <i>Fortescue</i> creeks (M.I.H. Brooker 2186)	0.1	=MMW- RCA06	
<i>Themeda triandra</i>	5		
<i>Triodia epactia</i>	8		
* <i>Vachellia farnesiana</i>	0.1		
<i>Waltheria indica</i>	0.1		

NB. Heights not recorded.



Marra Mamba West Site		MMW-RCK
Described by	CEF	Date 16-Sep-13
Type	Relevé	
MGA Zone	50 515819 mE, 7498327 mN	
Habitat	Floodplain of creekline	
Soil	Red-brown sandy loam	
Rock Type	N/A	
Vegetation	Acacia citrinoviridis, *Vachellia farnesiana tall open shrubland over *Cenchrus ciliaris closed tussock grassland.	
Veg Condition	Very Poor; (*Cenchrus ciliaris, *Vachellia farnesiana, low native species diversity, evidence of grazing from cattle).	
Fire Age	No sign of recent fire	
Notes	Relevé MMW-RCK equivalent to CF MN114.	

Species	Cover (%)
<i>Acacia bivenosa</i>	0.1
<i>Acacia citrinoviridis</i>	6
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	0.1
<i>Acacia synchronicia</i>	0.1
* <i>Cenchrus ciliaris</i>	85
<i>Eremophila longifolia</i>	0.1
<i>Eucalyptus victrix</i>	0.1
<i>Eucalyptus xerothermica</i>	<1
<i>Vachellia farnesiana</i>	<2

NB. Heights not recorded.



Marra Mamba West Site	MMW-RRA
Described by RB	Date 16-Sep-13
Type	Relevé
MGA Zone 50	514551mE, 7497488 mN
Habitat	Lower/mid-slope of stony moderate hill.
Soil	Skeletal red-brown clay-loam
Rock Type	Ironstone. Continuous surface layer of gravel, pebbles, rocks and some outcropping.
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> low open woodland over <i>Acacia pruinocarpa</i> scattered tall shrubs over <i>Triodia epactia</i> open hummock grassland.
Veg Condition	Excellent
Fire Age	No sign of recent fire

Species	Cover (%)	Height	Specimen Number
<i>Acacia aptaneura</i>	0.1	250 cm	MMW-RRA06
<i>Acacia atkinsiana</i>	0.1	130 cm	
<i>Acacia bivenosa</i>	0.1	120 cm	
<i>Acacia citrinoviridis</i>	1	150 cm	
<i>Acacia pruinocarpa</i>	2	200 cm	
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	0.1	130 cm	
<i>Acacia trudgeniana</i>	0.1	170 cm	MMW-RRA05
<i>Alternanthera nana</i>	0.1	5 cm	
<i>Amphipogon sericeus</i>	0.1	20 cm	MMW-RRA09
<i>Aristida contorta</i>	0.1	25 cm	
<i>Aristida holathera</i> var. <i>holathera</i>	0.1	25 cm	
<i>Bonamia</i> sp. Dampier (A.A. Mitchell PRP 217)	0.1	1 cm	MMW-RRA03
<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>	0.1	50 cm	MMW-RRA07
<i>Cymbopogon ambiguus</i>	0.1	50 cm	
<i>Dampiera candicans</i>	0.1	40 cm	
<i>Enneapogon polyphyllus</i>	0.1	15 cm	
<i>Eremophila latrobei</i> subsp. <i>latrobei</i>	0.1	90 cm	MMW-RRA08
<i>Eriachne mucronata</i>	0.1	25 cm	
<i>Eriachne pulchella</i>	0.1	10 cm	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	3	700 cm	
<i>Goodenia cusackiana</i>	0.1	15 cm	
<i>Gossypium australe</i>	0.1	120 cm	
<i>Gossypium robinsonii</i>	0.1	220 cm	
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	0.1	20 cm	MMW-RRA10
<i>Indigofera monophylla</i>	0.1	35 cm	MMW-RRA04
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	40cm	
<i>Paraneurachne muelleri</i>	0.1	40 cm	
<i>Polycarpaea longiflora</i>	0.1	15 cm	
<i>Ptilotus astrolasius</i>	0.1	35 cm	
<i>Ptilotus calostachyus</i>	0.1	100 cm	
<i>Ptilotus clementii</i>	0.1	40 cm	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	100cm	MMW-RRA12
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	130 cm	MMW-RRA02
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	120 cm	
<i>Senna notabilis</i>	0.1	50 cm	
<i>Sida</i> sp. Pilbara (A.A. Mitchell PRP 1543)	0.1	30 cm	MMW-RRA11
<i>Solanum lasiophyllum</i>	0.1	40 cm	
<i>Tribulus suberosus</i>	0.1	80 cm	
<i>Triodia brizoides</i>	0.1	40cm	
<i>Triodia epactia</i>	15	50 cm	MMW-RRA01



Marra Mamba West Site		MMW-RRB
Described by	RB	Date 17-Sep-13
Type	Relevé	
MGA Zone 50	516123 mE, 7498049 mN	
Habitat	Lower slope (north west facing) of large hill.	
Soil	Skeletal red-brown clay-loam.	
Rock Type	Ironstone. Continuous surface layer of gravel, pebbles, rocks.	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Triodia epactia</i> open hummock grassland.	
Veg Condition	Excellent.	
Fire Age	No sign of recent fire.	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia atkinsiana</i>	0.1	200 cm		
<i>Acacia bivenosa</i>	0.1	50 cm		
<i>Acacia exilis</i>	0.1	150 cm	MMW-RRB03	
<i>Acacia inaequilatera</i>	0.1	300 cm		
<i>Acacia maitlandii</i>	0.1	60 cm		
<i>Acacia marramamba</i>	0.1	100 cm		
<i>Acacia monticola</i>	0.1	180 cm		
<i>Acacia pruinocarpa</i>	0.1	300 cm		
<i>Acacia synchronicia</i>	0.1	120 cm		
<i>Amphipogon sericeus</i>	0.1	30 cm	=MMW- RRA09	
<i>Cymbopogon ambiguus</i>	0.1	120 cm		
<i>Dampiera candidans</i>	0.1	50 cm		
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	2	700 cm		
<i>Goodenia cusackiana</i>	0.1	20 cm		
<i>Hakea lorea</i> subsp. <i>lorea</i>	0.1	200 cm		
<i>Indigofera monophylla</i>	0.1	40 cm	MMW-RRB04	
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	100 cm		
<i>Paraneurachne muelleri</i>	0.1	30 cm		
<i>Ptilotus astrolasius</i>	0.1	35 cm		
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1	40 cm		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.1	40 cm		
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1	130 cm	MMW-RRB01	
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	100 cm		
<i>Sida</i> sp. Pilbara (A.A. Mitchell PRP 1543)	0.1	40 cm	MMW-RRB05	
<i>Solanum lasiophyllum</i>	0.1	30 cm		
<i>Themeda triandra</i>	0.1	45 cm		
<i>Tribulus suberosus</i>	0.1	60 cm		
<i>Triodia epactia</i>	12	40 cm	MMW-RRB02	Sterile



Marra Mamba West Site		MMW-RRC
Described by	RB	Date 17-Sep-13
Type	Relevé	
MGA Zone 50	515668 mE, 7498333 mN	
Habitat	Low stony hill	
Soil	Red-brown clay-loam.	
Rock Type	Ironstone, calcrete. Continuous surface layer of gravel, pebbles and some rocks.	
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>E. socialis</i> subsp. <i>eucentrica</i> low open mallee woodland over <i>Triodia wiseana</i> open hummock grassland.	
Veg Condition	Very Good; signs of cattle (1 scat).	
Fire Age	No sign of recent fire.	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia citrinoviridis</i>	0.1	180 cm		
<i>Acacia exilis</i>	0.1	120 cm	MMW-RRC02	
<i>Acacia ? kempeana</i>	0.1	130 cm	MMW-RRC04	Sterile
<i>Acacia synchronicia</i>	0.1	30 cm		
<i>Acacia tetragonophylla</i>	0.1	80 cm		
<i>Amphipogon sericeus</i>	0.1	40 cm	MMW-RRC05	
<i>Bulbostylis barbata</i>	0.1	10 cm	MMW-RRC09	
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1	30 cm	MMW-RRC07	
<i>Eriachne mucronata</i>	0.1	30 cm		
<i>Eriachne pulchella</i>	0.1	7 cm	MMW-RRC08	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1	700 cm		
<i>Eucalyptus socialis</i> subsp. <i>eucentrica</i>	2	220 cm	MMW-RRC06	
<i>Ptilotus astrolasius</i>	0.1	35 cm		
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	35 cm		
<i>Salsola australis</i>	0.1	30 cm		
<i>Senna artemisioides</i> subsp. <i>helmsii</i>	0.1	50 cm	MMW-RRC10	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	80 cm	MMW-RRC03	
<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	0.1	90 cm		
<i>Triodia wiseana</i>	20	30 cm	MMW-RRC01	



Marra Mamba West Site		MMW-RRD
Described by	RB	Date 18-Sep-13
Type	Relevé	
MGA Zone 50	515044 mE, 7497499 mN	
Habitat	Banks of moderate-sized creekline.	
Soil	Red-brown clay-loam.	
Rock Type	Ironstone. Surface scattering of gravel, pebbles.	
Vegetation	Eucalyptus xerothermica low open woodland over Acacia citrinoviridis, (Gossypium sturtianum) tall open shrubland over *Cenchrus ciliaris, (Eulalia sp. (Three Rivers Station, B.Forsyth AQ6789133), Themeda triandra) closed tussock grassland.	
Veg Condition	Poor; closed tussock grassland of *Cenchrus ciliaris, scattered shrubs of *Vachellia farnesiana and signs of cattle.	
Fire Age	No sign of recent fire.	

Species	Cover (%)	Height	Specimen Number	Notes
<i>Acacia bivenosa</i>	0.1	250 cm		
<i>Acacia citrinoviridis</i>	5	400 cm		
<i>Acacia inaequilatera</i>	0.1	250 cm		
<i>Acacia tetragonophylla</i>	0.1	40 cm		
<i>Androcalva luteiflora</i>	0.1	160 cm		
<i>Bothriochloa ewartiana</i>	0.1	120 cm	MMW-RRD05	
<i>Capparis lasiantha</i>	0.1	100 cm		
<i>Capparis umbonata</i>	0.1	160 cm	MMW-RRD11	
* <i>Cenchrus ciliaris</i>	70	70 cm		
<i>Crotalaria medicaginea</i> var. <i>neglecta</i>	0.1	30 cm		Dead
<i>Enteropogon ramosus</i>	0.1	120 cm		
<i>Eremophila longifolia</i>	0.1	140 cm		
<i>Eucalyptus xerothermica</i>	2	700 cm		
<i>Eulalia aurea</i>	0.1	100 cm	MMW-RRD12	
<i>Eulalia</i> sp. (Three Rivers Station, B.Forsyth AQ6789133)	3	30 cm	MMW-RRD07	
<i>Gossypium australe</i>	0.1	80 cm		
<i>Gossypium sturtianum</i>	1	300 cm	MMW-RRD01	
<i>Hakea lorea</i> subsp. <i>lorea</i>	0.1	100 cm		
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	130 cm		
<i>Pterocaulon sphacelatum</i>	0.1	100 cm	MMW-RRD03	
<i>Rhynchosia minima</i>	0.1	100 cm		
<i>Santalum lanceolatum</i>	0.1	200 cm	MMW-RRD08	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i>	0.1	100 cm	MMW-RRD04	
<i>Stylobasium spathulatum</i>	0.1	200 cm		
<i>Tephrosia rosea</i> var. <i>Fortescue</i> creeks (M.I.H. Brooker 2186)	0.1	100 cm	MMW-RRD06	
<i>Themeda triandra</i>	2	120 cm		
<i>Triodia epactia</i>	0.1	60 cm	MMW-RRD09	
<i>Triodia wiseana</i>	0.1	40 cm	MMW-RRD02	
* <i>Vachellia farnesiana</i>	0.1	230 cm	MMW-RRD10	





Marra Mamba West Site		MMW-RRE
Described by	RB	Date 14-Sep-13
Type	Relevé	
MGA Zone	50 514585 mE, 7497679 mN	
Habitat	Major creek.	
Soil	Skeletal red-brown riversand	
Rock Type	Riverstone	
Vegetation	Eucalyptus victrix scattered trees over Acacia citrinoviridis, A. pyrifolia var. pyrifolia, Stylobasium spathulatum tall shrubland over Tephrosia rosea var. Fortescue creeks (M.I.H. Brooker 2186) low open shrubland over Themeda triandra, (Eriachne tenuiculmis) very open tussock grassland.	
Veg Condition	Good; *Cenchrus ciliaris along banks.	
Fire Age	No sign of recent fire.	
Notes	Relevé MMW-RRE equivalent to RB MN02.	

Species	Cover (%)
<i>Acacia citrinoviridis</i>	15
<i>Acacia pyrifolia</i> var. <i>pyrifolia</i>	5
<i>Androcalva luteiflora</i>	0.1
* <i>Cenchrus ciliaris</i>	<1
<i>Corchorus crozophorifolius</i>	0.1
<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>	0.1
<i>Cymbopogon ambiguus</i>	0.1
<i>Digitaria brownii</i>	0.1
<i>Dipteracanthus australasicus</i> subsp. <i>australasicus</i>	0.1
<i>Eriachne tenuiculmis</i>	1
<i>Eucalyptus victrix</i>	<2
<i>Gomphrena cunninghamii</i>	0.1
<i>Heliotropium cunninghamii</i>	0.1
<i>Hybanthus aurantiacus</i>	0.1
<i>Pluchea rubelliflora</i>	0.1
<i>Polycarphaea longiflora</i>	0.1
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1
<i>Sida</i> sp. spiciform panicles (E. Leyland s.n. 14/8/90)	0.1
<i>Sporobolus australasicus</i>	0.1
<i>Stemodia grossa</i>	0.1
<i>Stylobasium spathulatum</i>	5
<i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186)	2
<i>Themeda triandra</i>	5

NB. Heights not recorded.



Marra Mamba West Site		MMW-RRF	
Described by	RB	Date	14-Sep-13
Type	Relevé		
MGA Zone	50 515088 mE, 7497252 mN		
Habitat	Mid slope of moderate hill.		
Soil	Red-brown clay loam.		
Rock Type	Ironstone; continuous surface layer of gravel, pebbles, rocks.		
Vegetation	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i> scattered low trees over <i>Acacia inaequilatera</i> scattered tall shrubs over <i>Triodia wiseana</i> hummock grassland.		
Veg Condition	Very Good; presence of individuals of <i>*Cenchrus ciliaris</i> and <i>*Flaveria trinervia</i> .		
Fire Age	No sign of recent fire.		
Notes	Relevé MMW-RRF equivalent to RB MN32.		

Species	Cover (%)
<i>Acacia atkinsiana</i>	0.1
<i>Acacia bivenosa</i>	0.1
<i>Acacia inaequilatera</i>	<1
<i>Acacia synchronicia</i>	0.1
<i>*Cenchrus ciliaris</i>	0.1
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	<1
<i>*Flaveria trinervia</i>	0.1
<i>Triodia wiseana</i>	40

NB. Heights not recorded.



Marra Mamba West Site MMW-RRG  
 Described by RB Date 16-Sep-13  
 Type Relevé  
 MGA Zone 50 515819 mE, 7499210 mN  
 Habitat Crest of spur/upper slope of large hill.  
 Soil Red-brown clay loam.  
 Rock Type Ironstone; continuous surface layer of gravel, pebbles, rocks and some outcropping.  
 Vegetation *Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Acacia pruinocarpa* scattered shrubs over *Triodia brizoides*, (*T. epactia*) open hummock grassland.  
 Veg Condition Excellent.  
 Fire Age No sign of recent fire.  
 Notes Relevé equivalent to RB MN60.

Species	Cover (%)
<i>Acacia exilis</i>	0.1
<i>Acacia pruinocarpa</i>	<1
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	<1
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	0.1
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1
<i>Triodia brizoides</i>	15
<i>Triodia epactia</i>	2
<i>Triodia wiseana</i>	0.1

NB. Heights not recorded.

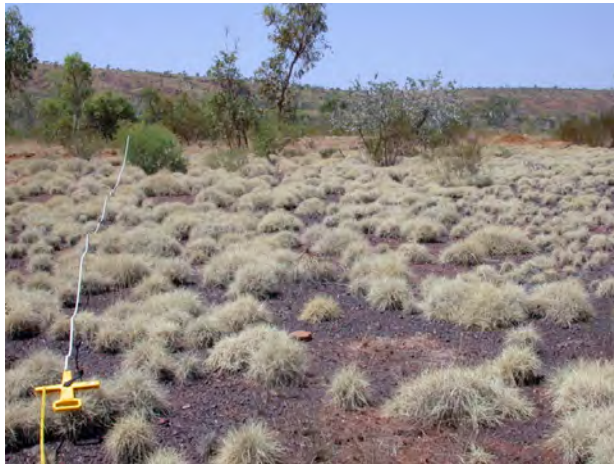


Brockman Syncline 4 Site BRO21  
 Described by Raimond Orifici Quadrat size 50 x 50 m  
 Date Phase 1: 10/10/2004 Phase 2: 30/05/2006  
 AMG Zone 50 515668mE, 7498792mN 515690mE, 7498762mN  
 515637mE, 7498722mN 515614mE, 7498749mN  
 Habitat Stony undulating plain  
 Soil Red clay-loam (alluvial deposited?)  
 Rock Type Ironstone, quartzitic rock and calcrete  
 Vegetation *Eucalyptus leucophloia* subsp. *leucophloia*, *E. xerothermica* scattered low trees over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland  
 Veg. Condition Very good; very occasional weed individuals present  
 Fire Possibly burnt in the last 3-5 years

Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Abutilon lepidum</i>	0.1	1.3 m	BRO21-04			
<i>Acacia bivenosa</i>	2.5	1.5-2 m	BRO21-02	2.5	1.5-2 m	BRO21-02
<i>Acacia exilis</i>	1	to 1.8 m		1	to 1.8 m	
<i>Acacia inaequilatera</i>	1	2.5-3 m	BRO21-09	1	2.5-3 m	BRO21-09
<i>Acacia maitlandii</i>				0.1		
<i>Acacia synchronicia</i>	1.5	1 m	BRO21-05	1.5	1 m	BRO21-05
<i>Acacia tetragonophylla</i>	0.1	1.2 m		0.1	1.2 m	
<i>Capparis umbonata</i>	0.1	1.3-1.4 m	BRO21-15	0.1	1.3-1.4 m	BRO21-15
* <i>Cenchrus ciliaris</i>	0.1	40 cm		0.1	40 cm	
<i>Cleome viscosa</i>				0.1		
<i>Codonocarpus cotinifolius</i>	0.1	1.8 m		0.1	1.8 m	
<i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i>	0.1		BRO21-25	0.1		BRO21-25
<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>	0.1	30-40 cm	BRO21-13	0.1	30-40 cm	BRO21-13
<i>Cucumis variabilis</i>				0.1		
<i>Cymbopogon ambiguus</i>	0.1	1.1 m	BRO21-18	0.1	1.1 m	BRO21-18
<i>Duperreya commixta</i>	0.1			0.1		
<i>Enneapogon caerulescens</i>	0.1	10-12 cm		0.1	10-12 cm	
<i>Enneapogon polyphyllus</i>	0.1					
<i>Eragrostis eriopoda</i>	0.1	50 cm		0.1	50 cm	
<i>Eremophila longifolia</i>	0.1					
<i>Eriachne pulchella</i>	0.1	15 cm		0.1	15 cm	
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	0.1	3-4 m		0.1	3-4 m	
<i>Eucalyptus xerothermica</i>	0.1	to 7 m	BRO21-10	0.1	to 7 m	BRO21-10
<i>Euphorbia</i> sp.	0.1	5-8 cm	BRO21-12	0.1	5-8 cm	BRO21-12

Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>	0.1		BROS21-03	0.1		BROS21-03
* <i>Flaveria trinervia</i>	0.1	20-35 cm		0.1	20-35 cm	
<i>Goodenia forrestii</i>				0.1		
<i>Goodenia microptera</i>	0.1	35-45 cm	BRO21-21	0.1	35-45 cm	BRO21-21
<i>Goodenia stobbsiana</i>	0.1	15 cm		0.1	15 cm	
<i>Gossypium australe</i>	1	1.2 m		1	1.2 m	
<i>Indigofera monophylla</i>	0.1					
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	25-30 cm		0.1	25-30 cm	
<i>Notoleptopus decaisnei</i> var. <i>decaisnei</i>				0.1		
<i>Oldenlandia crouchiana</i>				0.1		
<i>Paraneurachne muelleri</i>	0.1	60 cm		0.1	60 cm	
<i>Paspalidium clementii</i>				0.1		
<i>Pterocaulon sphacelatum</i>	0.1	25-30 cm	BRO21-20	0.1	25-30 cm	BRO21-20
<i>Ptilotus astrolasius</i>	0.1	30-40 cm	BRO21-11	0.1	30-40 cm	BRO21-11
<i>Ptilotus auriculifolius</i>				0.1		
<i>Ptilotus calostachyus</i>	0.1	40-50 cm		0.1	40-50 cm	
<i>Ptilotus clementii</i>	0.1	50-60 cm		0.1	50-60 cm	
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	60 cm		0.1	60 cm	
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	0.1	40-50 cm	BRO21-17	0.1	40-50 cm	BRO21-17
<i>Rhagodia eremaea</i>	0.1	to 1.2 m	BRO21-14	0.1	to 1.2 m	BRO21-14
<i>Salsola australis</i>	0.1	50 cm		0.1	50 cm	
<i>Senna artemisioides</i> subsp. <i>helmsii</i>				0.1		
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	1.5	50 cm	BRO21-03	1.5	50 cm	BRO21-03, BRO21-04
<i>Senna glutinosa</i> subsp. <i>glutinosa</i> x subsp. x <i>luerssenii</i>	0.1	to 60 cm	BRO21-06	0.1	to 60 cm	BRO21-06
<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>	1	60 cm				
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>	0.1	40-50 cm		0.1	40-50 cm	
<i>Sida arsinata</i>				0.1		
<i>Solanum diversiflorum</i>	0.1	35 cm	BRO21-23			
<i>Solanum lasiophyllum</i>	1.5	40-50 cm	BRO21-07	1.5	40-50 cm	BRO21-07
<i>Sporobolus australasicus</i>	0.1	5-7 cm		0.1	5-7 cm	
<i>Stackhousia intermedia</i>	0.1	20-25 cm	BRO21-19	0.1	20-25 cm	BRO21-19
<i>Stylobasium spathulatum</i>				0.1		
<i>Swainsona maccullochiana</i>	0.1	25 cm	BRO21-X	0.1	25 cm	BRO21-22
<i>Tephrosia clementii</i>				0.1		BROS21-01
<i>Themeda triandra</i>	1	to 1 m	BRO21-16	1	to 1 m	BRO21-16
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>				0.1		
<i>Tribulus hirsutus</i>				0.1		
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	0.1	to 1.2 m		0.1	to 1.2 m	
<i>Triodia epactia</i>	1.5	40 cm	BRO21-24	1.5	40 cm	BRO21-24
<i>Triodia wiseana</i>	65	to 40-60 cm	BRO21-01	65	to 40-60 cm	BRO21-01

Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Zygophyllum eichleri</i>				0.1	10-15 cm	BRO21-08



Brockman Syncline 4 Site	BRO22	
Described by	Michi Maier	Quadrat size 50 x 50 m
Date	Phase 1: 10/10/2004	Phase 2: 30/05/2006
AMG Zone 50	515772mE, 7498756mN	515822mE, 7498753mN
	515821mE, 7498706mN	515772mE, 7498706mN
Habitat	Floodplain	
Soil	Red-brown clay-loam; mainly bare clay with scattered pebbles on surface	
Rock Type	Ironstone	
Vegetation	Eucalyptus xerothermica scattered low trees over Acacia citrinoviridis, Stylobasium spathulatum tall shrubland over Ptilotus obovatus var. obovatus scattered low shrubs over Themeda triandra, Chrysopogon fallax very open tussock grassland	
Veg. Condition	Good; signs of cattle and a number of weed species (though not much cover overall)	
Fire	Burnt in the last 3-4 years	

Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Abutilon fraseri</i> subsp. <i>fraseri</i>				0.1	40cm	BROS22-06
<i>Abutilon otocarpum</i>				0.1	20cm	
<i>Abutilon oxycarpum</i> subsp. Prostrate (A.A. Mitchell PRP 1266)	0.1	5 cm	BRO22-07	0.1	5 cm	BRO22-07
<i>Acacia bivenosa</i>	1	1.8 m		2	1.8 m	
<i>Acacia citrinoviridis</i>	30	1.5-2.5 m		30	1.5-2.5 m	
<i>Acacia synchronicia</i>	0.1	1.3 m		0.1	1.3 m	
<i>Acacia tetragonophylla</i>	0.1	1 m		0.1	1 m	
<i>Alternanthera nana</i>	0.1	20 cm		0.1	20 cm	
<i>Amaranthus cuspidifolius</i>				0.1	40 cm	BROS22-02
<i>Amaranthus undulatus</i>	0.1	40 cm	BRO22-20			
<i>Androcalva luteiflora</i>				0.1	1.6 m	
<i>Aristida contorta</i>	0.1	35 cm		0.1	35 cm	
* <i>Bidens bipinnata</i>	0.1	20 cm		0.1	20 cm	
<i>Boerhavia coccinea</i>	0.1	20 cm	BRO22-04	0.1	20 cm	BRO22-04
<i>Boerhavia repleta</i>				0.1	5 cm	
<i>Capparis lasiantha</i>				0.1	90 cm	
* <i>Cenchrus ciliaris</i>	1.5	50 cm		1.5	50 cm	
<i>Chrysopogon fallax</i>	2	80 cm		2	80 cm	
<i>Cleome viscosa</i>	1	40-70 cm		1	40-70 cm	
<i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i>	0.1	BRO22-19		0.1	BRO22-19	
<i>Corchorus tridens</i>	0.1	15 cm		0.1	15 cm	
<i>Cucumis variabilis</i>	0.1					
<i>Cymbopogon ambiguus</i>	0.1	90 cm	BRO22-23	0.1	90 cm	BRO22-23
<i>Dactyloctenium radulans</i>				0.1	5cm	

Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Dichanthium sericeum</i> subsp. <i>humilius</i>	0.1	40cm				
<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>				0.1	1.2m	BROS22-07
<i>Dicladantha forrestii</i>	0.1	40 cm		0.1	40 cm	
<i>Digitaria brownii</i>	0.1	60 cm		0.1	60 cm	
<i>Digitaria ctenantha</i>				0.1	20cm	
<i>Dipteracanthus australasicus</i> subsp. <i>australasicus</i>	0.1	60 cm	BRO22-11	0.1	60 cm	BRO22-11
<i>Duperreya commixta</i>	0.1			0.1		
<i>Dysphania melanocarpa</i>				0.1	35cm	
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>	0.1	25 cm		0.1	25 cm	
<i>Enneapogon caerulescens</i>	0.1	15 cm		1	15 cm	
<i>Enneapogon lindleyanus</i>	0.1	60cm		0.1	60cm	BROS22-05
<i>Enneapogon polyphyllus</i>				0.1	40cm	
<i>Eragrostis cumingii</i>	0.1	3-4 cm		0.1	3-4 cm	
<i>Eragrostis eriopoda</i>				0.1	45cm	
<i>Eremophila longifolia</i>				0.1	1.8m	
<i>Eriachne aristidea</i>				0.1	30cm	
<i>Eucalyptus xerothermica</i>	0.1	2.5 m		0.1	2.5 m	
<i>Eulalia aurea</i>				3	50cm	BROS22-17
<i>Euphorbia australis</i> var. <i>subtomentosa</i>	0.1	5 cm	BRO22-10	0.1	5cm	BROS22-04
<i>Euphorbia biconvexa</i>	0.1	15 cm	BRO22-05	0.1	15 cm	BROS22-03
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>	0.1	35 cm	BRO22-22	0.1	35 cm	BRO22-22
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>				0.1	20cm	
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	0.1	15 cm		0.1	15 cm	
* <i>Flaveria trinervia</i>	0.1	30cm		0.1	30cm	
<i>Glycine canescens</i>	0.1			0.1		
<i>Gomphrena cunninghamii</i>	0.1	10 cm				
<i>Goodenia forrestii</i>	0.1	40 cm		0.1	40 cm	
<i>Gossypium australe</i>	0.1	70 cm		0.1	70 cm	
<i>Gossypium sturtianum</i>	0.1	2 m		0.1	2 m	
<i>Hakea lorea</i> subsp. <i>lorea</i>				0.1	2.2m	
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	0.1	30 cm	BRO22-08	0.1	30 cm	BRO22-08
<i>Ipomoea plebeia</i>				0.1	40cm	BROS22-16
<i>Ipomoea polymorpha</i>				0.1	5cm	BROS22-01
<i>Iseilema eremaeum</i>				0.1	15cm	BROS22-13
<i>Jasminum didymum</i> subsp. <i>lineare</i>	0.1	1 m		0.1	1 m	
<i>Lepidium phlebopetalum</i>				0.1	20cm	BROS22-14
<i>Lepidium platypetalum</i>	0.1	20 cm	BRO22-17			
* <i>Malvastrum americanum</i>	0.1	25 cm		0.1	25 cm	
<i>Melhania oblongifolia</i>				0.1	40cm	BROS22-08
<i>Neptunia dimorphantha</i>				0.1	30cm	BROS22-15



Species	Phase 1			Phase 2		
	Cover (%)	Height	Specimen Number	Cover (%)	Height	Specimen Number
<i>Notoleptopus decaisnei</i> var. <i>decaisnei</i>	0.1	20 cm	BRO22-02	0.1	20 cm	BRO22-02
<i>Paraneurachne muelleri</i>				0.1	40cm	
<i>Paspalidium clementii</i>	0.1	30 cm	BRO22-12	0.1	30 cm	BRO22-12
<i>Paspalidium rarum</i>				0.1	20cm	BROS22-10
<i>Perotis rara</i>				0.1	20cm	
<i>Phyllanthus erwinii</i>				0.1	35cm	
<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i>				0.1	20cm	
<i>Polycarpaea longiflora</i>				0.1	30cm	
<i>Polymeria ambigua</i>	0.1	10 cm	BRO22-14	0.1	10 cm	BRO22-14
<i>Portulaca oleracea</i>				0.1	2cm	
<i>Pterocaulon sphacelatum</i>	0.1	40 cm	BRO22-13	0.1	40 cm	BRO22-13
<i>Ptilotus auriculifolius</i>				0.1	20cm	
<i>Ptilotus clementii</i>	0.1	10 cm				
<i>Ptilotus helipteroides</i>	0.1	30 cm		0.1	30 cm	
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	0.1	70 cm - 1 m		0.1	70 cm - 1 m	
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	1.5	50 cm - 1 m	1-2	1.5	50 cm - 1 m	
<i>Rhagodia eremaea</i>	0.1	1.5 m		0.1	1.5 m	
<i>Rhodanthe floribunda</i>	0.1	20 cm	BRO22-21			
<i>Rhynchosia minima</i>	0.1		BRO22-18	0.1	BRO22-18	
<i>Salsola australis</i>	0.1	45 cm		0.1	45 cm	
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>	0.1	1.3 m	BRO22-06	0.1	1.3 m	BRO22-06
<i>Senna notabilis</i>				0.1	4cm	
<i>Setaria dielsii</i>	0.1	40 cm	BRO22-03			
<i>Setaria verticillata</i>	0.1	30 cm		0.1	30 cm	
<i>Sida fibulifera</i>	0.1	15 cm	BRO22-01	0.1	15 cm	BRO22-01, BROS22-09, BROS22-12
<i>Sida arsinata</i>				0.1	50cm	
<i>Sida echinocarpa</i>				0.1	70cm	
<i>Solanum lasiophyllum</i>	0.1	70 cm				
<i>Sporobolus australasicus</i>	0.1	20 cm		0.1	20 cm	
<i>Streptoglossa bubakii</i>				0.1	25cm	BROS22-11
<i>Streptoglossa tenuiflora</i>	0.1	30 cm	BRO22-15			
<i>Stylobasium spathulatum</i>	10	1.5-2 m		10	1.5-2 m	
<i>Swainsona maccullochiana</i>	0.1	45 cm	BRO22-16	0.1	45 cm	BRO22-16
<i>Themeda triandra</i>	4.5	80 cm		4.5	80 cm	
<i>Tragus australianus</i>	0.1	15 cm		0.1	15 cm	
* <i>Tribulus terrestris</i>	0.1	3-4 cm	BRO22-09	0.1	3-4 cm	BRO22-09
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>	0.1	40 cm		0.1	40 cm	
<i>Triodia epactia</i>	0.1	50-60 cm		5	50-60 cm	
<i>Triraphis mollis</i>				0.1	50cm	

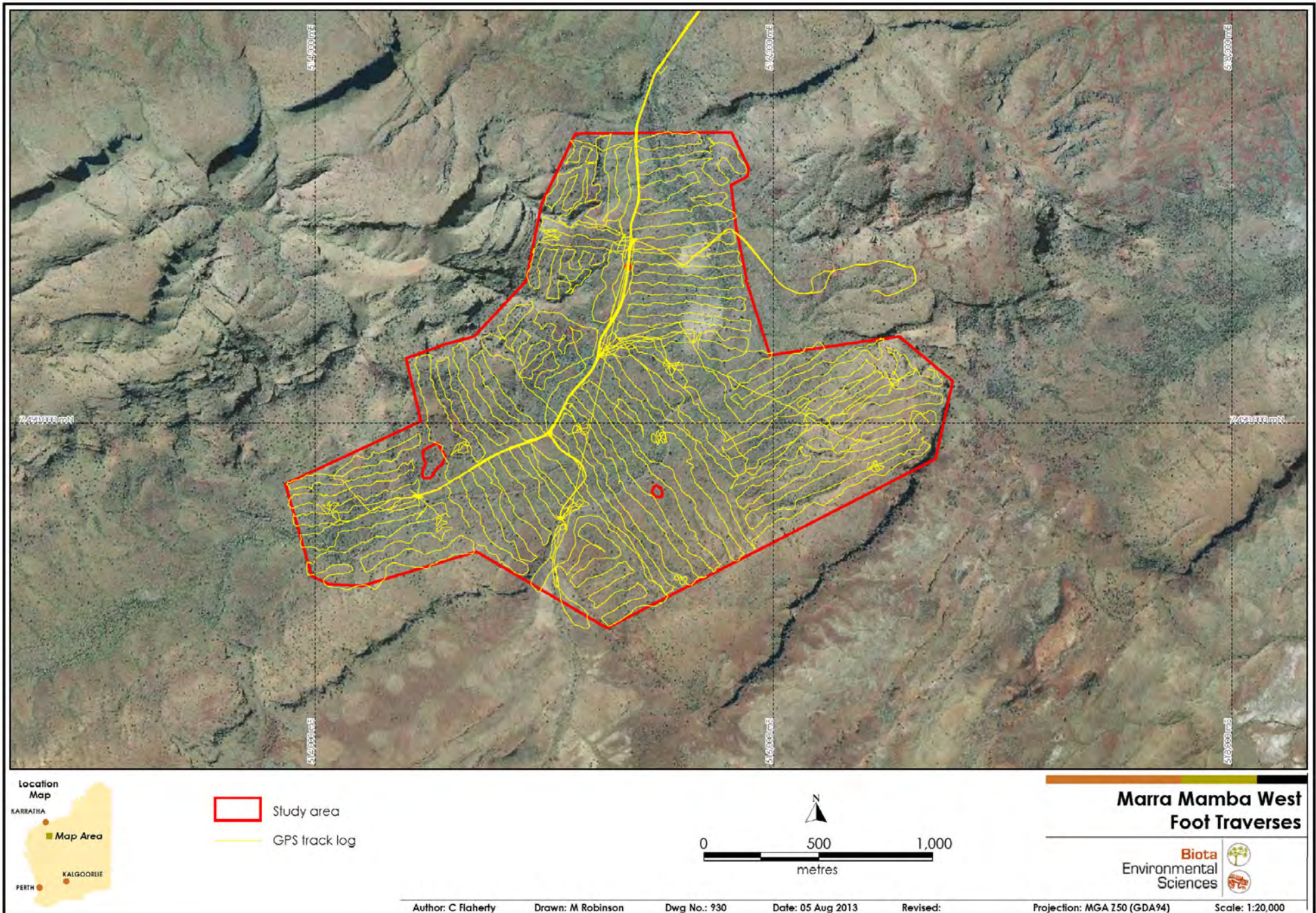


## Appendix 8

### Survey Effort – Map of Foot Traverses in the Study Area









## Appendix 9

### List of Vascular Flora Taxa Recorded in the Study Area







Family	Species
Acanthaceae	<i>Dicladantha forrestii</i> <i>Dipteracanthus australasicus</i> subsp. <i>australasicus</i>
Amaranthaceae	<i>Alternanthera nana</i> <i>Amaranthus cuspidifolius</i> <i>Amaranthus undulatus</i> <i>Gomphrena cunninghamii</i> <i>Ptilotus astrolasius</i> <i>Ptilotus auriculifolius</i> <i>Ptilotus calostachyus</i> <i>Ptilotus clementii</i> <i>Ptilotus fusiformis</i> <i>Ptilotus gaudichaudii</i> <i>Ptilotus helipteroides</i> <i>Ptilotus nobilis</i> subsp. <i>nobilis</i> <i>Ptilotus obovatus</i> var. <i>obovatus</i> <i>Ptilotus rotundifolius</i>
Apocynaceae	<i>Sarcostemma viminale</i> subsp. <i>australe</i>
Araliaceae	<i>Astrotricha hamptonii</i> <i>Trachymene oleracea</i> subsp. <i>oleracea</i>
Asteraceae	* <i>Bidens bipinnata</i> <i>Centipeda minima</i> <i>Chrysocephalum apiculatum</i> * <i>Flaveria trinervia</i> <i>Pluchea dentex</i> <i>Pluchea rubelliflora</i> <i>Pterocaulon sphacelatum</i> <i>Rhodanthe floribunda</i> <i>Streptoglossa bubakii</i> <i>Streptoglossa tenuiflora</i>
Boraginaceae	<i>Heliotropium cunninghamii</i> <i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>
Brassicaceae	<i>Lepidium pedicellosum</i> <i>Lepidium phlebopetalum</i> <i>Lepidium platypetalum</i>
Campanulaceae	<i>Lobelia heterophylla</i> subsp. <i>pilbarensis</i>
Capparaceae	<i>Capparis lasiantha</i> <i>Capparis umbonata</i>
Caryophyllaceae	<i>Polycarpaea corymbosa</i> var. <i>corymbosa</i> <i>Polycarpaea holtzei</i> <i>Polycarpaea longiflora</i>

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Family	Species
Celastraceae	<i>Stackhousia intermedia</i>
Chenopodiaceae	<i>Dysphania melanocarpa</i> <i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i> <i>Maireana georgei</i> <i>Maireana planifolia</i> <i>Rhagodia eremaea</i> <i>Salsola australis</i>
Cleomaceae	<i>Cleome viscosa</i>
Convolvulaceae	<i>Bonamia erecta</i> <i>Bonamia</i> sp. Dampier (A.A. Mitchell PRP 217) <i>Convolvulus angustissimus</i> subsp. <i>angustissimus</i> <i>Duperreya commixta</i> <i>Evolvulus alsinoides</i> var. <i>decumbens</i> <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> <i>Ipomoea plebeia</i> <i>Ipomoea polymorpha</i> <i>Polymeria ambigua</i>
Cucurbitaceae	<i>Cucumis variabilis</i>
Cyperaceae	<i>Bulbostylis barbata</i> <i>Cyperus vaginatus</i> <i>Fimbristylis simulans</i>
Euphorbiaceae	<i>Euphorbia australis</i> var. <i>hispidula</i> <i>Euphorbia australis</i> var. <i>subtomentosa</i> <i>Euphorbia biconvexa</i> <i>Euphorbia tannensis</i> subsp. <i>eremophila</i> <i>Euphorbia trigonosperma</i> <i>Euphorbia</i> sp. (inadequate material for further determination)
Fabaceae	<i>Acacia ancistrocarpa</i> <i>Acacia aptaneura</i> <i>Acacia atkinsiana</i> <i>Acacia ayersiana</i> <i>Acacia bivenosa</i> <i>Acacia citrinoviridis</i> <i>Acacia exilis</i> <i>Acacia hamersleyensis</i> <i>Acacia inaequilatera</i> <i>Acacia incurvaneura</i> <i>Acacia ? kempeana</i> <i>Acacia maitlandii</i> <i>Acacia marramamba</i> <i>Acacia monticola</i> <i>Acacia pruinocarpa</i>

Family	Species
Fabaceae (cont.)	<i>Acacia pyrifolia</i> var. <i>morrisonii</i> <i>Acacia pyrifolia</i> var. <i>pyrifolia</i> <i>Acacia rhodophloia</i> <i>Acacia sibirica</i> <i>Acacia synchronicia</i> <i>Acacia tetragonophylla</i> <i>Acacia trudgeniana</i> <i>Crotalaria medicaginea</i> var. <i>neglecta</i> <i>Glycine canescens</i> <i>Indigofera colutea</i> <i>Indigofera monophylla</i> <i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301) (Priority 3) <i>Isotropis atropurpurea</i> <i>Neptunia dimorphantha</i> <i>Petalostylis labicheoides</i> <i>Rhynchosia minima</i> <i>Senna artemisioides</i> subsp. <i>helmsii</i> <i>Senna artemisioides</i> subsp. <i>oligophylla</i> <i>Senna artemisioides</i> subsp. <i>oligophylla</i> x <i>helmsii</i> <i>Senna ferraria</i> <i>Senna glutinosa</i> subsp. <i>glutinosa</i> <i>Senna glutinosa</i> subsp. <i>glutinosa</i> x <i>Senna stricta</i> <i>Senna glutinosa</i> subsp. <i>glutinosa</i> x subsp. x <i>luerssenii</i> <i>Senna glutinosa</i> subsp. x <i>luerssenii</i> <i>Senna glutinosa</i> subsp. x <i>luerssenii</i> x <i>Senna stricta</i> <i>Senna glutinosa</i> subsp. <i>pruinosa</i> <i>Senna notabilis</i> <i>Senna stricta</i> <i>Senna venusta</i> <i>Swainsona maccullochiana</i> <i>Tephrosia clementii</i> <i>Tephrosia rosea</i> var. Fortescue creeks (M.I.H. Brooker 2186) <i>Tephrosia</i> sp. Fortescue (A.A. Mitchell 606) <i>*Vachellia farnesiana</i>
Goodeniaceae	<i>Dampiera candidans</i> <i>Goodenia cusackiana</i> <i>Goodenia forrestii</i> <i>Goodenia microptera</i> <i>Goodenia muelleriana</i> <i>Goodenia nuda</i> (Priority 4) <i>Goodenia stobbsiana</i> <i>Scaevola amblyanthera</i> var. <i>amblyanthera</i> <i>Scaevola spinescens</i>
Gyrostemonaceae	<i>Codonocarpus cotinifolius</i>
Lamiaceae	<i>Clerodendrum floribundum</i> var. <i>angustifolium</i>

Family	Species
Lauraceae	
	<i>Cassytha capillaris</i>
Loranthaceae	
	<i>Amyema fitzgeraldii</i>
Malvaceae	
	<i>Abutilon fraseri</i> subsp. <i>fraseri</i>
	<i>Abutilon lepidum</i>
	<i>Abutilon otocarpum</i>
	<i>Abutilon oxycarpum</i> subsp. <i>Prostrate</i> (A.A. Mitchell PRP 1266)
	<i>Abutilon</i> sp. <i>Dioicum</i> (A.A. Mitchell PRP 1618)
	<i>Androcalva luteiflora</i>
	<i>Brachychiton acuminatus</i>
	<i>Corchorus crozophorifolius</i>
	<i>Corchorus lasiocarpus</i> subsp. <i>lasiocarpus</i>
	<i>Corchorus lasiocarpus</i> subsp. <i>parvus</i>
	<i>Corchorus</i> ? <i>tectus</i>
	<i>Corchorus tridens</i>
	<i>Gossypium australe</i>
	<i>Gossypium robinsonii</i>
	<i>Gossypium sturtianum</i>
	<i>Hibiscus coatesii</i>
	<i>Hibiscus</i> sp. <i>Mt Brockman</i> (E. Thoma ET 1354) (Priority 1)
	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>
	<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>
	<i>Hibiscus sturtii</i> var. <i>platychlamys</i>
	<i>Keraudrenia nephrosperma</i>
	* <i>Malvastrum americanum</i>
	<i>Melhania oblongifolia</i>
	<i>Sida arsiniata</i>
	<i>Sida echinocarpa</i>
	<i>Sida fibulifera</i>
	<i>Sida</i> sp. <i>Excedentifolia</i> (J.L. Egan 1925)
	<i>Sida</i> sp. <i>Pilbara</i> (A.A. Mitchell PRP 1543)
	<i>Sida</i> sp. <i>Shovelanna Hill</i> (S. van Leeuwen 3842)
	<i>Sida</i> sp. <i>spiciform panicles</i> (E. Leyland s.n. 14/8/90)
	<i>Sida</i> sp. <i>verrucose glands</i> (F.H. Mollemans 2423)
	<i>Triumfetta maconochieana</i>
	<i>Waltheria indica</i>
Menispermaceae	
	<i>Tinospora smilacina</i>
Moraceae	
	<i>Ficus brachypoda</i>
Myrtaceae	
	<i>Corymbia ferriticola</i>
	<i>Corymbia hamersleyana</i>
	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>
	<i>Eucalyptus socialis</i> subsp. <i>eucentrica</i>
	<i>Eucalyptus victrix</i>
	<i>Eucalyptus xerothermica</i>

Family	Species
Nyctaginaceae	<i>Boerhavia coccinea</i>
	<i>Boerhavia repleta</i>
Oleaceae	<i>Jasminum didymum</i> subsp. <i>lineare</i>
Phyllanthaceae	<i>Notoleptopus decaisnei</i> var. <i>decaisnei</i>
	<i>Phyllanthus erwinii</i>
	<i>Phyllanthus maderaspatensis</i>
Plantaginaceae	<i>Stemodia grossa</i>
Poaceae	<i>Amphipogon sericeus</i>
	<i>Aristida burbidgeae</i>
	<i>Aristida contorta</i>
	<i>Aristida holathera</i> var. <i>holathera</i>
	<i>Bothriochloa ewartiana</i>
	* <i>Cenchrus ciliaris</i>
	<i>Chrysopogon fallax</i>
	<i>Cymbopogon ambiguus</i>
	<i>Cymbopogon obtectus</i>
	<i>Cymbopogon procerus</i>
	<i>Dactyloctenium radulans</i>
	<i>Dichanthium fecundum</i>
	<i>Dichanthium sericeum</i> subsp. <i>humilius</i>
	<i>Dichanthium sericeum</i> subsp. <i>sericeum</i>
	<i>Digitaria brownii</i>
	<i>Digitaria ctenantha</i>
	<i>Enneapogon caerulescens</i>
	<i>Enneapogon lindleyanus</i>
	<i>Enneapogon polyphyllus</i>
	<i>Enneapogon robustissimus</i>
	<i>Enteropogon ramosus</i>
	<i>Eragrostis cumingii</i>
	<i>Eragrostis eriopoda</i>
	<i>Eragrostis tenellula</i>
	<i>Eriachne aristidea</i>
	<i>Eriachne mucronata</i>
	<i>Eriachne pulchella</i>
	<i>Eriachne tenuiculmis</i>
	<i>Eulalia aurea</i>
	<i>Eulalia</i> sp. (Three Rivers Station, B.Forsyth AQ6789133)
	<i>Iseilema dolichotrichum</i>
	<i>Iseilema eremaeum</i>
<i>Paraneurachne muelleri</i>	
<i>Paspalidium clementii</i>	
<i>Paspalidium rarum</i>	
<i>Perotis rara</i>	
<i>Schizachyrium fragile</i>	
<i>Setaria dielsii</i>	

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Family	Species
Poaceae (cont.)	* <i>Setaria verticillata</i> <i>Sporobolus australasicus</i> <i>Themeda triandra</i> <i>Themeda</i> sp. Mt Barricade (M.E. Trudgen 2471) <i>Tragus australianus</i> <i>Triodia angusta</i> <i>Triodia brizoides</i> <i>Triodia epactia</i> <i>Triodia wiseana</i> <i>Triraphis mollis</i>
Portulacaceae	* <i>Portulaca oleracea</i>
Proteaceae	<i>Grevillea berryana</i> <i>Hakea chordophylla</i> <i>Hakea lorea</i> subsp. <i>lorea</i>
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>
Rubiaceae	<i>Oldenlandia crouchiana</i>
Santalaceae	<i>Santalum lanceolatum</i>
Sapindaceae	<i>Alectryon oleifolius</i> subsp. <i>oleifolius</i> <i>Dodonaea coriacea</i> <i>Dodonaea pachyneura</i>
Scrophulariaceae	<i>Eremophila cuneifolia</i> <i>Eremophila exilifolia</i> <i>Eremophila forrestii</i> subsp. <i>forrestii</i> <i>Eremophila latrobei</i> subsp. <i>glabra</i> <i>Eremophila latrobei</i> subsp. <i>latrobei</i> <i>Eremophila longifolia</i>
Solanaceae	<i>Nicotiana benthamiana</i> <i>Solanum diversiflorum</i> <i>Solanum elatius</i> <i>Solanum horridum</i> <i>Solanum lasiophyllum</i>
Surianaceae	<i>Stylobasium spathulatum</i>
Violaceae	<i>Hybanthus aurantiacus</i>
Zygophyllaceae	<i>Tribulus hirsutus</i> <i>Tribulus suberosus</i> * <i>Tribulus terrestris</i> <i>Zygophyllum eichleri</i>

# Appendix 10

## Locations of Priority Flora and Weeds







## Priority flora species

Family	Species	Conservation Status	Easting	Northing	Population Estimate
Malvaceae	<i>Hibiscus</i> sp. Mt Brockman (E. Thoma E.T. 1354)	Priority 1	515156	7498606	1
Fabaceae	<i>Indigofera</i> sp. Bungaroo Creek (S. van Leeuwen 4301)	Priority 3	515261	7499138	30
			515271	7499093	30
			515280	7498981	40
			515318	7498997	20
			515350	7498817	6
			515369	7499035	15
			515435	7498907	20
			515466	7499091	100
	515717	7499183	20		
Goodeniaceae	<i>Goodenia nuda</i>	Priority 4	515328	7497753	1

## Weed species

Family	Species	Common Name	Easting	Northing	Population Estimate†
Asteraceae	* <i>Bidens bipinnata</i>	Bipinnate Beggartick	515797	7498730	NR (scattered)
	* <i>Flaveria trinervia</i>	Speedy Weed	515088	7497252	1
			515652	7498756	NR (scattered)
			515797	7498730	NR (scattered)
Fabaceae	* <i>Vachellia farnesiana</i>	Mimosa Bush	514337	7497626	1
			514390	7497651	1
			515028	7497345	20
			515029	7447414	8
			515031	7497525	1
			515045	7497446	1
			515053	7497341	30
			515125	7497624	1
			515154	7497593	20
			515156	7498606	1
			515305	7497686	10
			515344	7497725	15
			515453	7497809	20
			515483	7499254	1
			515516	7497939	7
			515524	7498023	3
	515535	7497959	1		

Family	Species	Common Name	Easting	Northing	Population Estimate†
Fabaceae (cont.)	* <i>Vachellia farnesiana</i> (cont.)	Mimosa Bush	515551	7498057	11
			515558	7499057	5
			515626	7490932	1
			515662	7498082	5
			515679	7498969	10
			515680	7498100	20
			515748	7498739	1
			515770	7498676	6
			515784	7498641	6
			515803	7498450	2
			515819	7498327	50
			515849	7498490	4
			515855	7498546	2
			515859	7498231	20
			515891	7498355	15
515895	7498448	8			
Malvaceae	* <i>Malvastrum americanum</i>	Spiked Malvastrum	514052	7497436	1
			514390	7497651	1
			514663	7497695	5
			514693	7497758	5
			514811	7497727	10
			514814	7497710	5
			515013	7497771	5
			515125	7497624	2
			515470	7498022	1
			515516	7497939	9
			515782	7498680	1
			515791	7498545	10
			515797	7498730	NR (scattered)
Poaceae	* <i>Cenchrus ciliaris</i>	Buffel Grass	513887	7497652	2
			513945	7497513	1,000
			514008	7497557	10
			514247	7497541	100
			514337	7497626	10
			514346	7497642	500
			514390	7497651	10

Family	Species	Common Name	Easting	Northing	Population Estimate†
Poaceae (cont.)	* <i>Cenchrus ciliaris</i> (cont.)	Buffel Grass	514663	7497695	10
			514674	7497658	60
			514693	7497758	15
			514739	7497858	20
			514743	7497696	1
			514753	7497669	500
			514783	7497805	200
			514807	7497675	500
			514811	7497727	500
			514814	7497710	500
			514899	7497737	100
			514914	7497705	50
			514965	7497758	1,000
			515013	7497771	1,000
			515040	7497360	1,000
			515045	7497446	1,000
			515053	7497341	1,000
			515060	7497499	20
			515066	7497581	1,000
			515074	7497705	1,000
			515088	7497252	10
			515125	7497624	1,000
			515136	7497716	1,000
			515138	7497647	1,000
			515154	7497593	1,000
			515156	7498606	1,000
			515266	7497861	1,000
			515326	7497654	200
			515354	7497621	1
			515372	7497913	1,000
			515423	7497716	1,000
			515427	7499240	400
			515435	7498907	1,000
			515452	7499249	1,000
			515466	7499091	1,000
			515483	7499254	1,000

Family	Species	Common Name	Easting	Northing	Population Estimate†
Poaceae (cont.)	* <i>Cenchrus ciliaris</i> (cont.)	Buffel Grass	515510	7498056	1,000
			515516	7497939	1,000
			515535	7497959	1
			515551	7498057	1,000
			515557	7497800	1,000
			515558	7499057	1,000
			515568	7499121	1,000
			515593	7497726	1
			515613	7497979	1,000
			515626	7490932	1,000
			515652	7498756	NR (scattered)
			515662	7498082	1,000
			515680	7498100	1,000
			515748	7498739	1,000
			515764	7499037	50
			515770	7498676	1,000
			515797	7498730	NR (scattered)
			515815	7498925	1,000
			515819	7498327	1,000
			515859	7498231	1,000
	* <i>Setaria verticillata</i>	Whorled Pigeon Grass	515125	7497624	1
			515797	7498730	NR (scattered)
Portulacaceae	* <i>Portulaca oleracea</i>	Purslane	515797	7498730	NR (scattered)
Zygophyllaceae	* <i>Tribulus terrestris</i>	Caltrop	515797	7498730	NR (scattered)

† NR = number of individuals not recorded.

# Appendix 11

## Fauna Habitat Mapping and Mound Locations of the Western Pebble-mound Mouse





