

Vegetation and Flora Survey of Mesa A and Mesa G, near Pannawonica



Prepared for

Robe River Iron Associates

Prepared by

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1.0 Summary

1.1 Background

Robe River Iron Associates (Robe) currently produce pisolite ore from the Mesa J mine site, located approximately 15 km southwest of the town of Pannawonica. Current projections show that the Mesa J deposit will be mined to its maximum extent by the end of this decade. The Mesa A deposit, approximately 43 km west of Pannawonica, has been identified as the next logical deposit for development in the Robe Valley. In addition, exploration drilling is well underway at Mesa G, approximately 20 km southwest of Pannawonica. If sufficient reserves are identified at Mesa G, this area may also be developed in future.

Robe commissioned Biota Environmental Sciences to undertake a flora and vegetation survey of the Mesa A and Mesa G areas in May 2004. The study, which also included review of other botanical work conducted previously at Mesa A, was intended to provide baseline data for use in current and future environmental impact assessment.

1.2 Methods

The following visits were made to the study areas:

- Malcolm Trudgen (ME Trudgen and Associates) searched proposed exploration drill lines on Mesa A for rare flora between the 17th and 24th of August 2003;
- Brian Morgan (private consultant) recorded 22 flora quadrats on Mesa A between 17th and 24th of August 2003;
- Michi Maier (Biota) and Brian Morgan resampled the quadrats on Mesa A, established an additional quadrat, and took additional mapping notes between the 16th and 19th of May 2004;
- Kelli McCreery (Biota) and Raimond Orifici (Biota) traversed proposed exploration grid lines on Mesa G between the 13th and 16th of May 2004; and
- Michi Maier and Brian Morgan recorded 26 flora quadrats on Mesa G between the 10th and 15th May 2004.

The initial flora sampling on Mesa A was done following a prolonged dry period, and ephemeral flora were rare. The subsequent resampling in 2004 was done approximately six weeks after heavy rainfall in the area; although not abundant, numerous ephemeral flora taxa were collected.

1.3 Vegetation

A total of 23 vegetation types was defined for the Mesa A and Mesa G study areas (see , including:

- hummock grasslands of *Triodia wiseana* with a variable shrub overstorey of *Acacia* species (mainly *A. acradenia*, *A. atkinsiana* and/or *A. arida*) on mesa crests and low hills;
- *Triodia wiseana* hummock grasslands with an overstorey of *Acacia pruinocarpa* or Snakewood *A. xiphophylla* on steep mesa slopes;
- tall shrublands of *Acacia tumida*, usually with an overstorey of eucalypts, in creeklines on mesas;
- shrublands of *Acacia bivenosa* and *A. ancistrocarpa* over hummock grasslands of *Triodia wiseana*, sometimes with *T. epactia*, on baseplains around the mesas; and
- open forests of River Red Gum *Eucalyptus camaldulensis* and/or Coolibah *E. victrix* in the Robe River adjacent to Mesa G.

Only two of the vegetation types were shared by both of the study areas, despite their relatively close proximity (~20 km apart).

One vegetation type is considered to be of Very High conservation significance:

- S1 (vegetation of the sand dune and sand sheet adjacent to Mesa A) is considered likely to be restricted in distribution in both the local area and region, and supports species restricted to the deep sands of this particular habitat.

Two vegetation types are considered to be of High conservation significance;

- H16 (vegetation of rocky mesa edges including the undescribed *Triodia* sp. nov.) has a dominant species that is likely to be restricted in distribution in the region; this vegetation was only recorded from Mesa G; and
- C4 (riverine vegetation of the Robe River adjacent to Mesa G) occurs in the major drainage feature in the local area and supports numerous species restricted to this habitat.

The remainder of the vegetation types are considered to be of Moderate conservation significance.

1.4 Flora

A total of 257 taxa of native vascular flora from 111 genera belonging to 48 families was recorded from the Mesa A and Mesa G survey areas.

Neither of the Declared Rare Flora species that occur in the Pilbara (*Lepidium catapycnon* and *Thryptomene wittweri*) were located during the field survey, and neither would be expected to occur. On the basis of current knowledge, there are thus no flora of significance under the EPBC Act 1999 at Mesa A or Mesa G.

Two Priority flora were recorded during the field surveys, both of which have been previously recorded from the locality:

- *Abutilon trudgenii* ms. (Priority 3) was recorded numerous times from the crest of Mesa A; it was also abundant on the baseplain around Mesa G, and was recorded sporadically from the crest of this mesa;
- *Sida* sp. Wittenoom (WR Barker 1962) (Priority 3) was recorded from numerous locations on the crest of Mesa A, and was also recorded from 4 locations on a stony plain in the western section of the Mesa G study area.

Other flora of conservation interest included the undescribed spinifex species *Triodia* sp. nov., which is relatively common on rocky mesas in the Pannawonica area.

Eight species of introduced flora were recorded: Buffel Grass **Cenchrus ciliaris*, Awnless Barnyard Grass **Echinochloa colona*, Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca*, Spiked Malvastrum **Malvastrum americanum*, Colocynth **Citrullus colocynthis*, Asthma Plant **Euphorbia hirta*, Native Thornapple **Datura leichhardtii* and Beggar's Ticks **Bidens bipinnata*.

1.5 Management Recommendations

The following management measures are recommended to minimise disturbance to the vegetation and flora of Mesas A and G:

- Avoid disturbance to vegetation type S1, which occurs on the small sand dune on Mesa A, and the extensive sand sheet on the southern side of this mesa.
- Minimise disturbance to vegetation type H16, which is the main vegetation type containing the undescribed spinifex *Triodia* sp. nov.
- Minimise disturbance to vegetation type C4, which occurs in the Robe River.

- Include the data from Mesas A and G with data from additional sites from the Pannawonica area in another floristic analysis, and use the results to review the assessment of vegetation conservation significance and input to the mine planning process.
- Vegetation clearing should be kept to the minimum necessary for safe construction and operation of the project, particularly in areas adjacent to vegetation of higher conservation significance.
- Undertake an assessment of the likely impacts of groundwater drawdown on vegetation of the Robe River based on the results of hydrological studies.
- Although the majority of habitats on the mesas are not particularly susceptible to weed invasion, strict hygiene measures must be maintained to avoid the introduction and/or spread of weeds within Mesas A and G. A Weed Hygiene and Management Plan should be prepared in consultation with CALM prior to construction commencing.
- A Topsoil Management and Rehabilitation Plan should be prepared for all non-permanent cleared areas, in liaison with CALM, the Department of Environment and Department of Industry and Resources prior to the commencement of construction activities. This plan should include use of provenance collected native seed, characterisation and management of topsoil, and the respreading of cleared vegetative material. Recovery monitoring should also be carried out, with any rehabilitation failure subject to additional treatment to a suitable standard.
- As part of the environmental offsets package to be developed for the proposed projects, Robe River Iron Associates should consider contributing funding towards research into unresolved taxonomic issues in *Triodia*. Appropriate research topics would include a taxonomic revision of the genus and development of an electronic key for identification of the species.

2.0 Introduction

2.1 Background

2.1.1 Background to the Project and Location of the Study Area

Robe River Iron Associates (Robe) currently produce pisolite ore from the Mesa J mine site, located approximately 15 km southwest of the town of Pannawonica. Current projections show that the Mesa J deposit will be mined to its maximum extent by the end of this decade. Production from the Mesa J mine site is predicted to begin to decline in 2007/2008 as the quality of the available ore at Mesa J decreases. The Mesa A deposit has been identified, along with the Warramboos deposit, as the next logical deposit for development in the Robe Valley. Mesa A is located approximately 43 km west of Pannawonica. In addition, exploration drilling is well underway at Mesa G, approximately 20 km southwest of Pannawonica. If sufficient reserves are identified at Mesa G, this area may also be developed in future.

2.1.2 Purpose of this Report

The purpose of this report is to provide baseline vegetation and flora data for use in environmental impact assessment at Mesa A. The report also provides baseline data for Mesa G to assist with planning the exploration drilling program. The data for Mesa G may also be used in the future as part of an environmental impact assessment if sufficient reserves are identified at Mesa G.

The vegetation and flora surveys of the two study areas were planned and implemented as far as practicable according to the Environmental Protection Authority (EPA) Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

As such, the studies aimed to:

- provide detailed baseline information regarding vegetation and flora values of the Mesa A and Mesa G study areas (this incorporated a desktop review of available information, together with a field study, utilising techniques generally accepted as standard for the region, which addressed: description and mapping of vegetation types occurring in the study areas; identification of any vegetation types of particular conservation significance; cataloguing of the flora present within the study areas; and collation of information regarding any rare flora or other flora of conservation interest);
- place the information from the study areas in regional context by comparison with available data from other localities; and
- provide management recommendations to minimise impact to vegetation types and flora species of particular conservation significance within the study areas.

2.2 Geological and Physiographic Context of the Study Area

2.2.1 Geology

On the Geological Survey of Western Australia 1:250,000 scale mapsheet (Williams, Ryan and Halligan 1964), geological types within the Mesa A study area comprise:

- Tp (Robe Pisolite: pisolitic, oolitic, and massive limonite goethite hematite deposits containing fossil wood fragments; iron ore) on the mesa itself; and

- Qg (colluvium: unconsolidated to loosely consolidated piedmont deposits; scree, talus) associated with the baseplain surrounding the mesa, mainly in the southern section of the study area.

On the Geological Survey of Western Australia 1:500,000 scale mapsheet (Thorne and Trendall 2001), geological types within the Mesa G study area comprise:

- Czp (Robe Pisolite: pisolite limonite deposits; developed along palaeodrainage lines) on the mesa itself;
- PWd (Duck Creek Dolomite) towards the western end of the project area; and
- Qa (alluvium - unconsolidated silt, sand and gravel) and Qx (undivided Quaternary deposits) associated with the Robe River system, mainly on the southern side of the mesa.

2.2.2 Major Physiographic Units

Beard (1975) identified four major physiographic units within the Fortescue District. Mesa A and Mesa G lie towards the western end of the Hamersley Plateau, which comprises rounded hills and ranges, mainly of jaspilite and dolomite with some shale, siltstone and volcanics.

2.2.3 Land Systems (Rangelands)

Land System (Rangelands) mapping covering the project areas has been prepared to a draft stage by the Western Australian Department of Agriculture (2002) (see Figure 2.1). These are broad units that each consist of a series of "land units" that occur on characteristic physiographic types within the Land System.

One hundred and seven (107) Land Systems occur in the Pilbara bioregion. [This information was obtained by merging the Ashburton Land System mapping (Payne et al. 1988) and Pilbara Land System mapping (Department of Agriculture 2002) and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView 3.2.]

The Mesa A study area includes sections of the following Land Systems:

1. Robe Low limonite mesas and buttes supporting soft spinifex (and occasionally hard spinifex) grasslands; dominating the eastern portion of the mesa;
2. Peedamulla Stony and gravelly plains supporting hard spinifex grasslands and snakewood shrublands with patchy spinifex ground layer; dominating the western portion of Mesa A;
3. Capricorn Rugged sandstone hills and ridges; hard spinifex or stony short grass forb pasture; small area fringing the northwestern boundary of the mesa;
4. Nanutarra Low mesas and hills of sedimentary rocks supporting soft and hard spinifex grasslands; small areas fringing the southwestern boundary of the mesa; and
5. Stuart Undulating plains with snakewood; low hills with spinifex; stony chenopod and hard spinifex pastures; small areas fringing the southwestern boundary of the mesa.

The Mesa G study area includes sections of the following Land Systems:

1. Newman Rugged jaspilite plateaux, ridges and mountains supporting hard spinifex grasslands; dominating the main mesa;
2. Boolgeeda Stony lower slopes and plains below hill systems supporting hard and soft spinifex grasslands and mulga shrublands; small areas along the northeastern boundary of the main mesa;
3. Urandy Stony plains, alluvial plains and drainage lines supporting shrubby soft spinifex grasslands; a very small area along the northern boundary of the central section of the study area; and

4. Sherlock Stony alluvial plains supporting snakewood shrublands with patchy tussock grasses and spinifex grasslands; a small area along the northwestern boundary of the study area; and
5. River Active flood plains and major rivers supporting grassy eucalypt woodlands, tussock grasslands and soft spinifex grasslands; only along the Robe River, on the southern side of Mesa G.

With the exception of the Sherlock Land System, all of the Land Systems in the project area are relatively extensive in terms of their area within the Pilbara bioregion. The Sherlock Land System ranked 44th smallest out of the 107 Land Systems in terms of area, with a total area of 38,638 ha or approximately 0.2% of the Pilbara bioregion. Less than 1% of the total mapped area for the Pilbara bioregion for each Land System lies within the Mesa A and Mesa G study areas (see Table 2.1).

Table 2.1: Distribution of Land Systems within the Mesa A and Mesa G study areas and wider Pilbara bioregion (data from Payne et al. 1988 and Department of Agriculture 2002).

Land System	Total Area in the Pilbara Bioregion (Rank†)	Number of Mapping Polygons in the Pilbara Bioregion	General Distribution through the Pilbara Bioregion	Area within Mesa A Study Area		Area within Mesa G Study Area	
				Hectares	% of total in Pilbara bioregion	Hectares	% of total in Pilbara bioregion
Capricorn	698,531 ha (102 nd)	252	Widespread through the Hamersley and Chichester Range subregions; numerous occurrences	5.9	<0.01	-	
Nanutarra	77,384 ha (67 th)	52	Restricted to the western section of the Hamersley Range subregion; few occurrences	13.8	0.02	-	
Peedamulla	59,201 ha (57 th)	8	Restricted to a narrow band through the western section of the Hamersley Range subregion; very few occurrences	334.9	0.57	-	
Robe	128,859 ha (76 th)	251	Occurs within the central and western region of the Hamersley Range subregion, with a few occurrences in the Chichester Range subregion	704.4	0.55	-	
Stuart	276,685 ha (94 th)	53	Restricted to the western section of the Hamersley Range subregion; few occurrences	27.4	0.01	-	
Boolgeeda	961,634 ha (103 rd)	588	Widespread with a large number of occurrences, particularly through the Hamersley Range subregion	-		161.1	0.02
Newman	1,993,741 ha (106 th)	321	Relatively widespread through the Hamersley Range, also occurring as a band along the Chichester Range to the north of the Fortescue Marsh; numerous occurrences	-		1,560.4	0.08
River	482,175 ha (101 st)	126	Widespread in major river systems	-		427.5	0.09
Sherlock	38,638 ha (44 th)	39	Associated with river systems in the western sections of the Hamersley and Chichester Range subregions; few occurrences	-		26.8	0.07
Urandy	131,976 ha (78 th)	23	Occurs along the boundary of the Hamersley Range and Fortescue Plains subregions; also in the western section of the Hamersley Range subregion; few occurrences	-		13.4	0.01
Pilbara Total	17,800,478 ha	5636		1,086.5		2,189.2	

† Ranking of Land System in terms of area out of the 107 Land Systems in the Pilbara bioregion; ranked from least abundant in terms of area (1) to most abundant (107).

2.3 Biological Context of the Study Area

2.3.1 Pilbara IBRA Bioregion

The Interim Biogeographic Regionalisation for Australia (IBRA) recognises 85 bioregions (Environment Australia 2000). Mesa A and Mesa G lie within the Pilbara Bioregion, at the western end of the Hamersley Range subregion.

With increasing survey work in the Pilbara, it is becoming apparent that this region is one of the centers of biodiversity in the State. This appears to be related to the diversity of geological, altitudinal and climatic elements in the region, as well as a function of its location. The eastern portion of the Pilbara in particular is located in a transitional zone between the floras of the Eyrean (central desert) and southern Torresian (tropical) bioclimatic regions, and contains elements of both floras (see for example van Leeuwen and Bromilow (2002) for a detailed discussion of the significance of the Hamersley Range). In recognition of this high species diversity and the high levels of endemism in the region, the Pilbara has recently been nominated as one of 15 national biodiversity "hotspots" by the Minister for the Environment and Heritage (go to www.deh.gov.au/minister/env/2003/mr03oct03.html).

The Pilbara Bioregion is listed as a medium priority for funding for land purchase under the National Reserves System Co-operative Program due to the limited representation of the area in conservation reserves. Portions of various pastoral leases in the region have been nominated for exclusion for public purposes in 2015, when the leases come up for renewal. Many of the submissions are from the Department of Conservation and Land Management, with the intention of adding these areas to the existing conservation estate in order to provide a comprehensive, adequate and representative reserve system. None of these proposed exclusions are located in the vicinity of Mesa A or Mesa G.

2.3.2 Beard's Vegetation Mapping

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

The identity of Beard's mapping unit in the area of Mesa G is difficult to determine, but it appears that both the Mesa A and Mesa G study areas are mapped as:

- *Acacia pyrifolia* and/or *A. bivenosa* sparse shrubs over *Triodia basedowii* and/or *T. wiseana* hummock grasslands.

Given the broad nature of Beard's mapping, this unit is only broadly applicable to the vegetation occurring on site (see Section 4.0).

2.3.3 More Detailed Studies in the Region

Like much of the Pilbara region, the area surrounding and including the study area is relatively poorly known.

Various areas around Pannawonica have been surveyed as part of baseline vegetation and flora surveys for Robe River Iron Associates, including some work at Mesa A (see for example, Trudgen 2002, 2003a, 2003b, 2003c, Biota 2003).

As mentioned previously, the Department of Agriculture (2002) has carried out a broadscale survey of parts of the Pilbara. This will result in brief descriptions of the vegetation of the Land Systems (Rangelands), however these are not yet available. CALM has also sampled flora of numerous hilltops in the Hamersley Range (van Leeuwen and Bromilow 2002).

3.0 Study Methodology

3.1 Rare Flora Database Searches

A search of the CALM and WA Herbarium databases was done in February 2005 for DRF and Priority Flora recorded within an ~150 km² area surrounding the Mesa A and Mesa G study areas. The search area was bounded by the following coordinates:

- NW: 115° 30' E, 21° S;
- NE: 117° E, 21° S;
- SE: 117° E, 22° 30' S; and
- SW: 115° 30' E, 22° 30' S.

The search yielded 41 records of 19 Priority species (no Declared Rare Flora records were returned for this area). The locations of these records were investigated in ArcView to indicate populations in the vicinity of the study areas.

3.2 Botanical Team and Field Survey Timing

The following visits were made to the study areas:

- Malcolm Trudgen (ME Trudgen and Associates) searched proposed exploration drill lines on Mesa A for rare flora between the 17th and 24th of August 2003 (Trudgen 2003a);
- Brian Morgan (private consultant) recorded 22 flora quadrats on Mesa A between 17th and 24th of August 2003;
- Michi Maier (Biota) and Brian Morgan resampled the quadrats on Mesa A, established an additional quadrat, and took additional mapping notes between the 16th and 19th of May 2004;
- Kelli McCreery (Biota) and Raimond Orifici (Biota) traversed proposed exploration grid lines on Mesa G between the 13th and 16th of May 2004; and
- Michi Maier and Brian Morgan recorded 26 flora quadrats on Mesa G between the 10th and 15th May 2004.

The initial flora sampling on Mesa A was done following a prolonged dry period, and ephemeral flora were rare. The subsequent resampling in 2004 was done approximately six weeks after heavy rainfall in the area; although not abundant, numerous ephemeral flora taxa were collected.

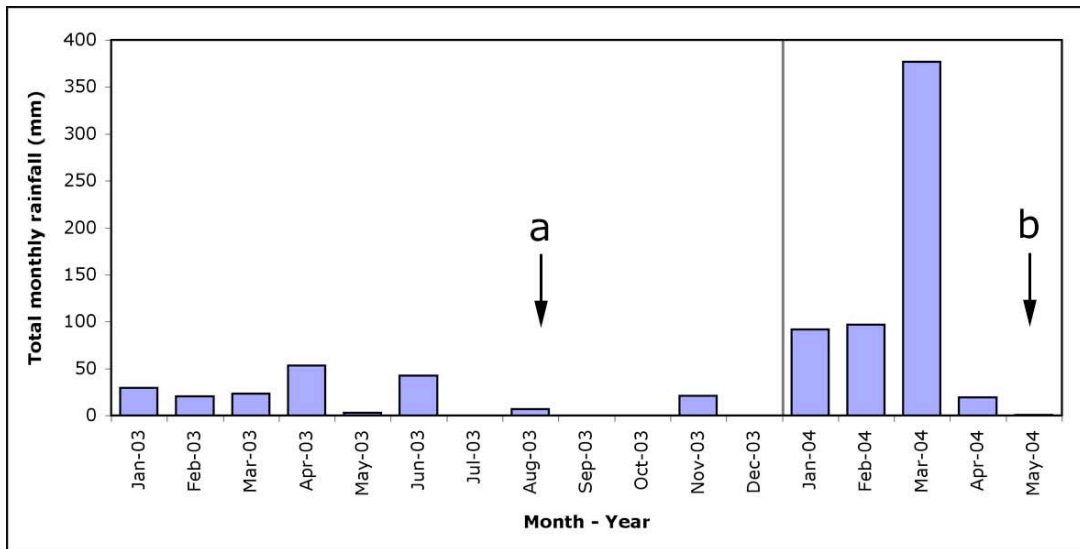


Figure 3.1: Monthly rainfall for Pannawonica from January 2003 to May 2004 (data supplied by Bureau of Meteorology) and timing of survey effort: a) Mesa A rare flora searches and initial recording of quadrats; b) Mesa G flora searches and recording of quadrats, and resampling of quadrats on Mesa A.

3.3 Vegetation Description and Mapping

In the current study, terrestrial vegetation descriptions were based on the height and estimated cover of dominant species using Aplin's (1979) modification of the vegetation classification of Specht (1970) to include a hummock grassland category (see Appendix 3). Descriptions were made at each of 49 floristic survey quadrats (see Section 3.4), and at a number of relevés (unbounded flora survey sites). Additional foot traverses were done to ground-truth the boundaries of vegetation types and to allow assessment of areas that were inaccessible by vehicle.

The vegetation descriptions were then grouped to arrive at vegetation units that were defined on the basis of a shared suite of perennial species with a similar range of cover values. These have been listed under the main landform/habitat types in which they were found to occur. Alternative approaches could utilise another framework, such as Land System (Rangelands) mapping or geology.

An arbitrary coding system was used for the vegetation types. This system incorporated:

- a letter designating the habitat / vegetation type: stony plains, hills and ridges (h); creeks and floodplains (c); sand drifts and dunes (s); and
- a number to further separate vegetation types within each habitat.

To gather the spatial information, the quadrat and relevé vegetation descriptions were used together with other mapping notes gathered in the field to prepare a draft map of vegetation, using rectified 1:20,000 scale colour digital photography as the background. Some of the vegetation units (mainly small flowlines) were frequently too small to show at the scale of mapping; only large occurrences of these were individually mapped.

The vegetation boundaries were subsequently digitised on-screen using the ArcView 3.2 package. The resulting shapefiles were "tagged" to provide each polygon with the vegetation unit code. Other point source datasets, such as locations of quadrats, weeds and priority flora, were generated into spatial data using ArcView. These datasets were subsequently saved as separate ArcView shapefiles.

These datasets, in conjunction with other data supplied from other organisations, were used in the production of the vegetation maps (Figures 4.1 and 4.2) contained in this report. All maps were produced using the ArcView package.

3.4 Assessment of Floristic Quadrats

The locations of the 49 detailed flora recording quadrats were chosen to represent the range of terrestrial vegetation types occurring within the survey area.

Quadrats were typically 50 m x 50 m, as this size gives a good sample of flora presence in the Pilbara. It also gives a good indication of the shrub and grass layer vegetation structure for most vegetation types in the Pilbara that occur in 'uniform' habitats (eg. plains and hillslopes, where vegetation stands are typically greater than this quadrat size). Quadrat shape and/or size were adjusted as necessary to fit smaller or oddly shaped habitats (eg. flowlines and breakaways).

Each quadrat was permanently marked using a steel fence dropper at one corner of the quadrat (usually the northwest corner). Quadrats were uniquely numbered, from MEA01 to MEA23 on Mesa A, and from MESG01 to MESG27 on Mesa G (MESG26 was not used). A small number of relevés was also sampled; these were labelled MEA-MA, MESG-MC etc.

The following parameters were recorded for each quadrat:

- | | |
|----------------------------|---|
| 1. Location | AMG coordinates recorded in WGS84 datum (very similar to GDA94) using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m; readings usually taken for all four corners of the quadrat; |
| 2. Vegetation Description | 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 3); |
| 3. Habitat | Description of landform and habitat; |
| 4. Soil | Broad description of soil type and stony surface mantle; |
| 5. Disturbance Details | Evidence of grazing, mining exploration activities, weed invasion, frequent fires etc. Note that fire effects are only considered as a negative impact if they are caused by repeated burning (such as that done for pastoral purposes). Fire is a natural and frequent process in the Pilbara to which the vegetation has adapted, and to class areas as being in poor condition simply because they have been recently burnt is misleading; and |
| 6. Percentage Foliar Cover | Cover was estimated visually for each species. Estimates were made to the nearest percent where possible, or a range (eg. 5-10%) was used. '+' was used where only occasional individuals were present, with a cover of less than 1%. |

Colour photographs of the vegetation at each site were taken using a digital camera.

Additional foot traverses were done to allow assessment of areas that were inaccessible by vehicle. Opportunistic flora collections were made on these traverses to supplement the list of species recorded from the flora survey sites. Particular attention was paid to searching habitats likely to support flora species with sporadic distributions (eg. creeklines, rockpiles and gorges).

In recognition that the Mesa A quadrats had been initially sampled in August 2003 following a prolonged dry period, these quadrats were resampled in May 2004.

3.5 Rare Flora Searches

A total of eight person days was spent searching each of the Mesa A and Mesa G areas specifically for rare flora (see Section 3.2). Locations of Priority flora recorded by Trudgen

(2003a) were only recorded in reference to proposed drill holes; location coordinates for these records were subsequently generated from a hard-copy map. Locations of Priority flora or other flora of interest noted during the vegetation and flora survey in 2004 were recorded using a hand-held GPS in WGS84 datum (equivalent to GDA94 datum). All records of Priority flora are displayed on the vegetation mapping in Figures 4.1 and 4.2.

Estimates were made of population size, and other details such as habitat and associated flora species were also noted. Voucher specimens were also collected for lodgement with the Western Australian Herbarium. Rare Flora Report Forms will be completed and lodged with CALM.

3.6 Flora Identification and Data Entry

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and assigned a unique number to facilitate tracking of data. These were pressed in the field, and dried in a drying oven.

These vouchers were then identified by keying out, reference to appropriate publications, use of reference collections and comparison to the collections held at the Western Australian Herbarium. Most specimens were identified by Michi Maier and Kelli McCreery, with assistance from Malcolm Trudgen. Some specimens of difficult taxa were identified by relevant specialists (see Section 7.0). Specimens will be lodged with the Western Australian Herbarium and Karratha Regional Herbarium for all taxa for which suitable material is available.

Nomenclature was checked against the current listing of scientific names recognised by the Western Australian Herbarium and updated as necessary. The only outdated nomenclature retained was that relating to *Cassia*. This genus is currently recognised as *Senna* (see Randell 1989), however the older *Cassia* classification (Symon 1966) was perceived to be a more realistic level of separation of the taxa (eg. with taxa such as '*glutinosa*' and '*pruinosa*' recognised at specific rather than subspecific level). A more detailed discussion is contained in Trudgen and Casson (1998), while a comparison of the nomenclature under the two classifications is presented in Appendix 2.

All raw site data was entered into an Access database, with species names entered following identification of the specimens.

3.7 PATN Analysis of the Mesa A and Mesa G Floristic Data

To provide an understanding of the floristic composition of vegetation of the survey areas in relation to the surrounding region, a pattern analysis was carried out using a numeric classification procedure within the PATN software package (Belbin 1987). The analysis was run by Mr Ted Griffin (private consultant), with assistance from Mr Malcolm Trudgen (ME Trudgen and Associates) to ensure that datasets were rationalised. The flexible UPGMA classification strategy was used, together with the Bray-Curtis site similarity measure. All other PATN settings were set to the default options, consistent with use of this software by CALM to analyse data from the Swan Coastal Plain (Gibson et al. 1994).

The analysis compared the floristic composition of the 50 by 50m quadrats (and some relevés) recorded in the Mesa A and Mesa G study areas with quadrats and relevés recorded in a series of survey areas from both nearby and some distance away in the Hamersley and Chichester Ranges. The dataset comprised some 789 sites (standard 50m by 50m floristic survey quadrats, or well-recorded relevés), including 55 sites from the current study of the Mesa A and Mesa G areas, together with 734 sites from nine other survey areas in the Pilbara:

- 119 sites from Cape Preston, west of Dampier (Biota and Trudgen 2001); ~90 km north of Pannawonica;

- 12 sites from the Mesa J Extension (Biota 2003); ~15 km southwest of Pannawonica;
- 102 sites from the West Angelas Millstream Rail Segment, extending from the Fortescue Slopes study area along the lower slopes of the Chichester Range parallel to the existing Hamersley Iron rail line, then to Barowanna Hill; ~80 km east of Pannawonica;
- 66 sites from the Brockman Syncline 4 study area, near Tom Price (Biota 2005a); ~140 km southeast of Pannawonica;
- 46 sites from a rail corridor in the Four Corners Bore area on Hamersley Station (Trudgen and Casson 1998); ~160 km east-southeast of Pannawonica;
- 2 sites from near Eight Mile Well on Hamersley Station (Trudgen and Casson 1998); ~160 km east-southeast of Pannawonica;
- 305 sites from the core area surveyed for Robe River Iron Associates' West Angelas mine (Trudgen and Casson 1998); ~310 km southeast of Pannawonica;
- 45 sites from Hamersley Iron's Yandi Expansion area (Biota 2004a); ~320 km east-southeast of Pannawonica; and
- 37 sites from the Mindy Mindy area (Biota 2004b); ~340 km east-southeast of Pannawonica.

The dataset included presence/absence data (rather than estimated percent cover) for each species present at each site, as it has been shown that when undertaking analysis of large regional datasets, floristic differences between areas tend to over-ride variation arising from the inclusion of more detailed quantitative data (M. Trudgen, ME Trudgen and Associates, pers. comm.). Incompletely recorded floristic survey quadrats were excluded from the analysis, and relevés (unbounded floristic survey sites) were included where the list of species recorded was believed to be a good sample of the available flora.

The combined species list from the 10 projects was reviewed for errors and inconsistencies in nomenclature. Where there were multiple taxa that were considered likely to represent the same species, these were all referred to a single taxon identification code and thus treated as a single entity in the analysis (eg. records of *Convolvulus "angustissimus"* and *C. "clementii"* were treated as belonging to the same taxon, as were records of *Triodia epactia* and *Triodia pungens*). Where a taxon name could potentially refer to more than one entity across different projects (eg. *Euphorbia* sp., *Tephrosia* sp.), it was excluded from the analysis.

3.8 Limitations of this Study

A number of limitations of the field survey and subsequent conservation assessments are discussed in the following section. These are factors that must be considered when reviewing and applying the results of this study. Despite these limitations, the field study and the subsequent analyses are believed to give a reasonable representation of the flora and vegetation values of the Mesa A and Mesa G study areas.

The main limitations of this study are as follows:

- Fungi and nonvascular flora (eg. algae, mosses and liverworts) were not specifically sampled.
- Although the 2004 field work was done at an appropriate time for detecting most ephemeral flora, some species (eg. annual daisies that would germinate mostly after late winter rains) would not have been present or identifiable at the time of survey.
- As the sites at Mesa G were only sampled once, additional species might be recorded if the sites were revisited. The species lists should therefore be taken as indicative rather than exhaustive.
- The vegetation units for this study were defined based on interpretation of aerial photography signatures combined with the site data recorded during the field survey. As it was not possible to map areas outside the study area in this way, the distribution of these units outside the study area can only be inferred by their correlation with the Land Systems mapping prepared by the Department of Agriculture. This means that there is a level of

uncertainty regarding the assessment of distribution of these vegetation types outside the current study area.

- The PATN floristic analysis is limited by a lack of comparable sites in the vicinity. The Mesa A / Mesa G data should be included in an additional floristic analysis as more data becomes available from the Pannawonica area.
- There would be some level of error associated with the species identifications contained in the combined dataset utilised for the PATN floristic analysis. Although most of the species identifications were done using comparison with a single reference set, some of the data comes from field identifications. The degree of such errors in this dataset is not believed to be of an order that would affect the outcomes. In addition, the various projects were done over a substantial timeframe (several years), and some taxa that were differentiated relatively recently (eg. *Triodia epactia*) would not have been distinguished in earlier surveys. The latter issue was dealt with by treating suspect taxa as a single entity (see above).
- The combined dataset used for the floristic analysis includes relevé as well as quadrat data. Some of the relevés in the datasets would have been less well sampled than others due to time / access restrictions. Any noted to be incomplete (or to sample mixed habitats) were excluded from the analysis, however some incomplete sites or sites representing mosaics may have been left in the dataset. As such sites would not be likely to group with well recorded sites, this was not considered to be a significant problem in the analysis, which was intended to see if variation in the current study area was replicated in the other survey areas.
- As the proposed layouts of the Mesa A and Mesa G projects have not yet been finalised, the discussion of management measures is limited to generic strategies typically associated with projects of similar scale in the Pilbara region.

4.0 Terrestrial Vegetation

A total of 23 vegetation types was defined for the Mesa A and Mesa G study areas (see , including:

- hummock grasslands of *Triodia wiseana* with a variable shrub overstorey of *Acacia* species (mainly *A. acradenia*, *A. atkinsiana* and/or *A. arida*) on mesa crests and low hills;
- *Triodia wiseana* hummock grasslands with an overstorey of *Acacia pruinocarpa* or Snakewood *A. xiphophylla* on steep mesa slopes;
- tall shrublands of *Acacia tumida*, usually with an overstorey of eucalypts, in creeklines on mesas;
- shrublands of *Acacia bivenosa* and *A. ancistrocarpa* over hummock grasslands of *Triodia wiseana*, sometimes with *T. epactia*, on baseplains around the mesas; and
- open forests of River Red Gum *Eucalyptus camaldulensis* and/or Coolibah *E. victrix* in the Robe River adjacent to Mesa G.

Only two of the vegetation types were shared by both of the study areas, despite their relatively close proximity (~20 km apart). This is not unexpected, given the different Land Systems mapped for the areas (see Figure 2.1). One immediately apparent difference between the two study areas was the prevalence of *Acacia arida* and *A. atkinsiana* at Mesa A, and *Acacia acradenia* at Mesa G.

A description of each terrestrial vegetation type is given below, grouped under the habitat type in which they were mainly found to occur. Maps of the distribution of the vegetation types are presented in Figures 4.1 and 4.2. The raw data from the individual detailed flora survey sites is contained in Appendix 3. Note that an asterisk (*) preceding a scientific name denotes that the species is introduced (not native). Note also that *Cassia* has been retained in preference to *Senna* in this document (see Section 3.5).

It is important to understand the broad nature of these vegetation types, each of which incorporates a range of structural and floristic variants. The units described are considered to range from at, to somewhat higher than, the vegetation association level, although they are not strictly defined as vegetation associations. The structural and floristic variation they include undoubtedly covers a large number of vegetation communities. The broad nature of the units defined needs to be taken into account when using them for assessing conservation value of the vegetation.

4.1 Vegetation Types at Mesa A

4.1.1 Vegetation of Stony Hills and Plains

H1 *Eucalyptus leucophloia* scattered low trees over *Acacia arida* shrubland to tall shrubland over *Triodia wiseana* mid-dense hummock grassland

This vegetation occurred over the crest of Mesa A, particularly close to the edges of the mesa. Other associated species: *Acacia tumida* var. *pillbarensis*, *Bonamia media* var. *villosa*, *Cassia glutinosa*, *C. notabilis*, *Grevillea wickhamii*, *Ptilotus calostachyus* var. *calostachyus*, *Solanum horridum*, *Trichodesma zeylanicum* var. *zeylanicum*. Sites MEA11, MEA17.

H2 *Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana* (*A. arida*) open shrubland to tall shrubland over *Triodia wiseana* mid-dense hummock grassland

This vegetation occurred broadly over the crest of Mesa A. The shrub overstorey was dominated by *Acacia atkinsiana*, with a variable amount of *A. arida*. Other associated species: *Acacia pruinocarpa*, *Cassia notabilis*, *Corchorus sideoides* subsp. *sideoides*, *Ptilotus calostachyus* var. *calostachyus*, *Solanum diversiflorum*, *Triumfetta clementii*. Sites MEA01, MEA02, MEA07, MEA09, MEA12, MEA13, MEA16, MEA18, MEA20, MEA22.

- H3 *Eucalyptus leucophloia* scattered low trees over *Acacia pruinocarpa*, *A. atkinsiana* tall open shrubland over *Triodia wiseana* open hummock grassland**
This vegetation occurred in narrow bands towards the edges of the crest of Mesa A. Other associated species: *Acacia arida*, *Cassia glutinosa*, *Grevillea wickhamii*, *Sarcostemma viminalis* subsp. *australe*. Site MEA03.
- H4 *Acacia atkinsiana*, *A. inaequilatera* (*A. arida*) tall open shrubland over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland**
This vegetation occurred in broad swathes on the crest of Mesa A. Other associated species: *Acacia ancistrocarpa*, *Cassia notabilis*, *Corchorus sidoides* subsp. *sidoides*, *Hakea chordophylla*, *Indigofera monophylla*, *Solanum horridum*, *S. sturtianum*, *Tephrosia uniovulata*. Sites MEA10, MEA21, MEA23.
- H5 *Acacia pruinocarpa*, *Eucalyptus leucophloia* scattered low trees to low open woodland over scattered mixed tall shrubs over *Triodia wiseana* hummock grassland**
This vegetation occurred on steep slopes and breakaways along the edge of Mesa A. Other associated species: *Acacia arida*, *A. tumida* var. *pilbarensis*, *Cassia venusta*, *Cheilanthes sieberi* subsp. *sieberi*, *Clerodendrum floribundum* var. *angustifolium*, *Corymbia candida*, *Cymbopogon ambiguus*, *Eriachne mucronata*, *Eucalyptus leucophloia* subsp. *leucophloia*, *Ficus brachypoda*, *Solanum gabrielae*, *S. horridum*. Sites MEA04, MEA06.
- H6 *Eucalyptus leucophloia* scattered low trees over *Acacia tumida* var. *pilbarensis* tall open shrubland to open scrub over *Triodia wiseana* hummock grassland**
This vegetation occurred on steep slopes and breakaways along the edge of Mesa A. Other associated species: *Dodonaea coriacea*, *Eriachne helmsii*, *Petalostylis labicheoides*. Relevé MEA-MD.
- H7 *Acacia xiphophylla* low woodland to tall shrubland over *Triodia wiseana* hummock grassland**
This vegetation occurred on stony plains at the base of the northern edge of Mesa A and around the northern and southern edges of Mesa G. The site at Mesa A was located on a more stony, dry substrate and had a considerably lower species richness than the site at Mesa G. Other associated species: *Acacia bivenosa*, *A. farnesiana*, *A. synchronicia*, *Alternanthera nana*, *Boerhavia coccinea*, *Cassia glutinosa*, *C. notabilis*, *C. pruinosa*, *Eriachne mucronata*, *Euphorbia* spp., *Lysiana casuarinae*, *Ptilotus axillaris*, *P. fusiformis* var. *fusiformis*, *Salsola tragus*, *Solanum horridum*, *Trianthema triquetra*, *Tribulus* spp., *Trichodesma zeylanicum* var. *zeylanicum*, *Triodia epactia*. Site MEA08 at Mesa A; site MESG13 at Mesa G.
- H8 *Acacia ancistrocarpa*, *A. bivenosa* shrubland over *Triodia wiseana* hummock grassland**
This vegetation occurred on the stony baseplains around Mesa A, and was also recorded from Mesa G. Other associated species: *Acacia acradenia*, *A. citrinoviridis*, *A. inaequilatera*, *Corchorus sidoides* subsp. *sidoides*, *Corymbia hamersleyana*, *Indigofera monophylla* (grey/green leaflet form), *Ipomoea muelleri*, *Ptilotus astrolasius* var. *astrolasius*, *Trichodesma zeylanicum* var. *zeylanicum*, *Triodia epactia*. No sites from Mesa A; site MESG15 from Mesa G.

4.1.2 Vegetation of Creeklines and Floodplains

- C1 *Eucalyptus leucophloia* scattered low trees over *Acacia pruinocarpa* scattered tall shrubs over *Acacia atkinsiana*, *A. arida* shrubland over *Triodia wiseana* open hummock grassland**
This vegetation occurred in flowlines and small gullies on the crest of Mesa A. Other associated species: *Cassia notabilis*, *Eriachne mucronata*, *Mollugo molluginis*. No sites from this study.
- C2 *Acacia tumida* var. *pilbarensis*, *A. pruinocarpa*, *Grevillea wickhamii* tall open shrubland to open scrub over *Acacia atkinsiana*, *A. arida* open shrubland to tall open shrubland over *Triodia wiseana* open hummock grassland and *Eriachne mucronata* scattered tussock grasses**
This vegetation occurred on the crest and slopes of Mesa A in larger gullies than those supporting vegetation type C1. Other associated species: *Cheilanthes sieberi* subsp. *sieberi*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Eucalyptus leucophloia* subsp. *leucophloia*, *Ficus brachypoda*, *Petalostylis labicheoides*, *Tephrosia uniovulata*. Sites MEA05, MEA15, MEA19 and relevé MEA-MB.
- C3 *Corymbia hamersleyana*, *C. candida* scattered low trees to low open woodland over *Acacia atkinsiana*, *A. ancistrocarpa* scattered tall shrubs over *Triodia epactia* hummock grassland**
This vegetation type occurred only in a broad shallow flow area in the south-western section of the Mesa A study area. Other associated species: *Acacia trachycarpa*, *Chrysopogon fallax*, *Grevillea wickhamii*, *Mollugo molluginis*. Relevés MEA-MF, MEA-MY.

4.1.3 Vegetation of Sand Dunes and Sand Sheets

- S1** *Corymbia zygomphylla* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Grevillea eriostachya* high shrubland over *Triodia schinzii* hummock grassland
- This vegetation occurred only on the small red sand dune on Mesa A and extensive sand sheet adjacent to the eastern edge of this mesa. Other associated species: *Cleome uncifera*, *Heliotropium transforme*, *Indigofera boviparda* subsp. *boviparda*, *Ptilotus arthrolasius*. Although much of this sandy habitat had been recently burnt, and some of the sand dune had been removed for fill, most of this vegetation was in excellent condition with no weeds evident and no other disturbance noted. This vegetation is different to that sampled on dunes in both the eastern Hamersley Range (see Biota and Trudgen 2002) and closer to the coast near the Exmouth Gulf (Biota, unpublished data). The conservation significance of the intact sand dune and sand sheet vegetation is high, particularly given the small size and fragile nature of the habitat. Site MEA14 and relevé MEA-ME.

4.2 Vegetation Types at Mesa G

4.2.1 Vegetation of Stony Hills and Plains

- H7** *Acacia xiphophylla* low woodland to tall shrubland over *Triodia wiseana* hummock grassland
- This vegetation occurred on stony plains and slopes around the northern and southern edges of Mesa G and at the base of the northern edge of Mesa A. The site at Mesa G was located on a more clayey substrate and had a considerably higher species richness than the site at Mesa A. Other associated species: *Acacia bivenosa*, *A. farnesiana*, *A. synchronicia*, *Alternanthera nana*, *Boerhavia coccinea*, *Cassia glutinosa*, *C. notabilis*, *C. pruinosa*, *Eriachne mucronata*, *Euphorbia* spp., *Lysiana casuarinae*, *Ptilotus axillaris*, *P. fusiformis* var. *fusiformis*, *Salsola tragus*, *Solanum horridum*, *Trianthema triquetra*, *Tribulus* spp., *Trichodesma zeylanicum* var. *zeylanicum*, *Triodia epactia*. Site MESG13 at Mesa G; site MEA08 at Mesa A.
- H8** *Acacia ancistrocarpa*, *A. bivenosa* shrubland over *Triodia wiseana* hummock grassland
- This vegetation occurred on the stony baseplains around Mesa G, and was also recorded from Mesa A. Other associated species: *Acacia acradenia*, *A. citrinoviridis*, *A. inaequilatera*, *Corchorus sidoides* subsp. *sidoides*, *Corymbia hamersleyana*, *Indigofera monophylla* (grey/green leaflet form), *Ipomoea muelleri*, *Ptilotus astrolasius* var. *astrolasius*, *Trichodesma zeylanicum* var. *zeylanicum*, *Triodia epactia*. Site MESG15.
- H9** *Acacia bivenosa*, *A. inaequilatera* open shrubland over *Triodia wiseana* mid-dense hummock grassland
- This vegetation occurred on stony baseplains around Mesa G. It was similar to vegetation type H8 however *Acacia ancistrocarpa* was present only as scattered individuals. Other associated species: *Acacia ancistrocarpa*, *A. synchronicia*, *Cassia glutinosa*, *C. notabilis*, *C. oligophylla*, *C. pruinosa*, *Corchorus sidoides* subsp. *sidoides*, *Corymbia hamersleyana*, *Goodenia stobbsiana*, *Hakea chordophylla*, *Ptilotus astrolasius* var. *astrolasius*, *P. fusiformis* var. *fusiformis*, *Sida echinocarpa*, *Triumfetta clementii*. Sites MESG14, MESG18.
- H10** *Acacia atkinsiana* (*A. bivenosa*) open shrubland over *Triodia epactia*, *T. wiseana* mid-dense hummock grassland
- This vegetation occurred on baseplains around Mesa G. Other associated species: *Acacia synchronicia*, *A. tumida* var. *pilbarensis*, *Cassia notabilis*, *C. oligophylla*, *Corchorus sidoides* subsp. *sidoides*, *Euphorbia* spp., *Gossypium australe* (Burrup Peninsula form), *Hakea lorea* subsp. *lorea*, *Paspalidium clementii*, *Ptilotus astrolasius* var. *astrolasius*, *Sida* aff. *cardiophylla* (site 1215), *Sida echinocarpa*, *Solanum horridum*, *Triumfetta clementii*. Site MESG06.
- H11** *Acacia synchronicia* scattered tall shrubs to tall open shrubland over *Triodia wiseana* mid-dense hummock grassland
- This vegetation occurred on low spurs and stony baseplains around Mesa G. Other associated species: *Acacia inaequilatera*, *Cassytha capillaris*, *Corchorus sidoides* subsp. *sidoides*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Sida* aff. *cardiophylla* (site 1215). Sites MESG05, MESG07.
- H12** *Acacia atkinsiana*, *A. inaequilatera*, *Petalostylis labicheoides* tall shrubland over *Tephrosia uniovulata* open shrubland over *Triodia wiseana* mid-dense hummock grassland
- This vegetation occurred on the flattened crest of the mesa within the Mesa G study area. Other associated species: *Cassia notabilis*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Eriachne pulchella* subsp. *dominii*, *Eucalyptus leucophloia* subsp. *leucophloia*, *Goodenia stobbsiana*, *Indigofera boviparda* subsp. *boviparda*, *Trachymene oleracea* subsp. *oleracea*. Sites MESG01, MESG16.

- H13 Acacia acradenia open heath over *Triodia wiseana* hummock grassland**
This vegetation occurred broadly on low hills and over the flattened crest and slopes of the mesa within the Mesa G study area. Low trees of *Eucalyptus leucophloia* were common on mesa slopes. Other associated species: *Acacia ancistrocarpa*, *A. inaequilatera*, *A. maitlandii*, *Goodenia stobbsiana*, *Petalostylis labicheoides*, *Trichodesma zeylanicum* var. *zeylanicum*. Sites MESG04, MESG10.
- H14 *Grevillea wickhamii* tall shrubland over *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland**
Other areas of the flattened mesa crest at Mesa G with a more rocky substrate, or close to the mesa edges, had similar vegetation to H13 but with an open tall shrub overstorey dominated by *Grevillea wickhamii* subsp. *hispidula*. Other associated species: *Acacia inaequilatera*, *Corchorus sidoides* subsp. *sidoides*, *Dampiera candicans*, *Keraudrenia nephrosperma*, *Trichodesma zeylanicum* var. *zeylanicum*. Site MESG22.
- H15 *Acacia acradenia* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland**
This vegetation occurred on hills and on the slopes of broad gullies in the Mesa G study area. Scattered low trees of *Eucalyptus leucophloia* subsp. *leucophloia* were sometimes present, mainly around gully areas. Steep rocky areas supported species largely restricted to such habitats, including *Cyperus cunninghamii* subsp. *cunninghamii*, *Ficus brachypoda* and *Rhodanthe margarethae*. Other associated species: *Acacia ancistrocarpa*, *A. inaequilatera*, *Bonamia media* var. *villosa*, *Cassia glutinosa*, *C. notabilis*, *Cassytha capillaris*, *Eriachne pulchella* subsp. *dominii*, *Goodenia stobbsiana*, *Hakea chordophylla*, *Ptilotus calostachyus* var. *calostachyus*, *Solanum horridum*, *Trachymene oleracea* subsp. *oleracea*, *Trichodesma zeylanicum* var. *zeylanicum*, *Triumfetta clementii*. Sites MESG03, MESG08, MESG11, MESG12, MESG17, MESG24, MESG25, MESG27.
- H16 *Acacia tumida* var. *pilbarensis* (*Petalostylis labicheoides*) tall closed scrub over *Acacia acradenia* low open shrubland over *Triodia wiseana* (*Triodia* sp. nov.) very open hummock grassland**
This vegetation occurred in a usually narrow band (~10-20 m wide) around the rocky edge of the flattened mesa crest in the Mesa G study area. It was not recorded from Mesa A. This was the main vegetation type from which the undescribed spinifex species *Triodia* sp. nov. was recorded (see Section 5.3.1). Other associated species: *Acacia atkinsiana*, *A. inaequilatera*, *Eriachne mucronata*, *Goodenia stobbsiana*, *Grevillea wickhamii* subsp. *hispidula*, *Lysiana casuarinae*, *Ptilotus calostachyus* var. *calostachyus*. Site MESG19.

4.2.2 Vegetation of Creeklines and Floodplains

- C4 *Eucalyptus camaldulensis* woodland over *Eucalyptus victrix* low woodland over *Acacia trachycarpa*, *A. pyrifolia*, *Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* open hummock grassland**
This vegetation type occurred in the Robe River south of Mesa G. The broad gravelly, cobbly bed of the river supported River Red Gum *Eucalyptus camaldulensis* woodland over an open cover of herbs, while the slightly higher banks supported Coolibah *Eucalyptus victrix* low woodland over an open cover of tall shrubs dominated by *Acacia trachycarpa* and an open hummock grassland of *Triodia wiseana*. Several weed species were recorded from this drainage system, generally in low densities (see Section 5.4). Other associated species: *Amaranthus pallidiflorus*, *Cleome viscosa*, *Cyperus vaginatus*, *Flueggea virosa* subsp. *melanthesoides*, *Goodenia lamprosperma*, *Gossypium robinsonii*, *Grevillea wickhamii*, *Leptopus decaisnei* var. *decaisnei*, *Waltheria indica*. Site MESG21 and relevés MESG-MA and MESG-MB.
- C5 *Eucalyptus leucophloia*, *Corymbia hamersleyana* scattered low trees to low open woodland over *Petalostylis labicheoides*, *Grevillea wickhamii* subsp. *hispidula* tall open shrubland over *Acacia acradenia* open heath over *Triodia wiseana* mid-dense hummock grassland**
This vegetation occurred in gullies in the Mesa G area. Small amounts of the undescribed spinifex species *Triodia* sp. nov. were often present. Other associated species: *Acacia ancistrocarpa*, *A. bivenosa*, *A. tumida* var. *pilbarensis*, *Cassia glutinosa*, *Dodonaea coriacea*, *Eriachne mucronata*. Sites MESG02, MESG23.
- C6 *Corymbia hamersleyana*, *Eucalyptus leucophloia* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Petalostylis labicheoides* tall open scrub over *Triodia wiseana* open hummock grassland**
This vegetation occurred in rocky creeks at Mesa G, particularly through gorges. Other associated species: *Acacia acradenia*, *A. inaequilatera*, *Cassia glutinosa*, *Cassytha capillaris*, *Clerodendrum floribundum* var. *angustifolium*, *Corchorus sidoides* subsp. *sidoides*, *Goodenia stobbsiana*, *Grevillea wickhamii*, *Sida* aff. *cardiophylla* (site 1215), *Solanum* spp., *Trichodesma zeylanicum* var. *zeylanicum*. Sites MESG09 and MESG20 and relevé MESG-MC.

C7 *Corymbia hamersleyana* scattered low trees over *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland

This vegetation occurred in gullies at Mesa G. Other associated species: *Acacia inaequilatera*, *Cassytha capillaris*, *Grevillea wickhamii*, *Hybanthus aurantiacus*, *Jasminum didymium* subsp. *lineare*, *Petalostylis labicheoides*. No sites from this study.

4.3 Results of the PATN Floristic Analysis

The primary output of the PATN analysis was a dendrogram indicating relationships between sites on the basis of floristic composition, with sites with similar species clustering out together. Given the size of the dataset analysed, the entire dendrogram has not been reproduced here, however it is available for inspection if required.

Following generation of the dendrogram by PATN, arbitrary cut-off points were selected to generate three levels of grouping within the resultant site clusters; a 20-group level (ie. the level dividing the 789 sites into 20 groups, based on floristic composition), a 50-group level (the level dividing the 789 sites into 50 groups) and a 100-group level (the level dividing the 789 sites into 100 groups). These groups, and the vegetation types and sites from the Mesa A and Mesa G study areas within each group, are indicated in the table in Appendix 1.

A summary of the groups at the 20-group level that contained sites from the Mesa A and Mesa G study areas is presented in Table 4.1. None of these groups was restricted to either the Mesa A or Mesa G study area.

Table 4.1: Summary of vegetation* and broad habitat types for the floristic groups defined at the 20-group level of the PATN analysis that contained sites within the Mesa A and Mesa G study areas (*based on vegetation descriptions for the component sites).

20-group	Description of dominant vegetation types and habitats
Group 2	Predominantly <i>Triodia wiseana</i> hummock grasslands on stony hills and plains, usually with a sparse to open shrub overstorey of <i>Acacia bivenosa</i> and/or <i>A. pyrifolia</i> , sometimes with <i>A. xiphophylla</i> or <i>A. synchronicia</i> ; also some creekline vegetation; groups 9-20 at the 100-group level.
Group 3	Riverine vegetation (River Red Gum <i>Eucalyptus camaldulensis</i> and Coolibah <i>Eucalyptus victrix</i> woodlands) and vegetation of smaller creeks and floodplains (particularly including <i>Eucalyptus xerothermica</i> , <i>Acacia pyrifolia</i> , <i>Triodia epactia</i> and perennial tussock grasses); groups 21-29 at the 100-group level.
Group 4	Mainly shrublands of <i>Acacia tumida</i> and/or <i>A. pyrifolia</i> over <i>Triodia epactia</i> / <i>T. pungens</i> and/or <i>T. wiseana</i> hummock grasslands, usually in drainage areas; also unusual sandplain vegetation; groups 30-33 at the 100-group level.
Group 14	Mainly stony hills with <i>Triodia wiseana</i> hummock grasslands with scattered trees of Snappy Gum <i>Eucalyptus leucophloia</i> and open shrublands of <i>Acacia atkinsiana</i> , sometimes with <i>A. bivenosa</i> or <i>A. maitlandii</i> ; groups 61-67 at the 100-group level.
Group 16	Mainly <i>Acacia atkinsiana</i> , <i>A. arida</i> and/or <i>A. inaequilatera</i> open shrublands over <i>Triodia wiseana</i> hummock grasslands on mesa crests and in gullies; groups 71-76 at the 100-group level.

In contrast, three of the groups at the 50-group level contain only sites from the Mesa A and Mesa G study area:

- group 15 comprised the vegetation of the sand dune and sand sheet at Mesa A; the floristic composition of these sites is clearly distinct at a relatively high level from the other sites within the same 20-group cluster (Figure 4.1);
- group 37 comprised *Triodia wiseana* and/or *T. epactia* hummock grasslands with open shrublands of *Acacia atkinsiana*, often with *A. arida*, *A. bivenosa* and/or *A. inaequilatera*, on mesa crests and stony baseplains; sites from both Mesa A and Mesa G were included in this grouping. It appears that this group is largely distinguished by the presence of *Acacia atkinsiana*, a species largely absent from sites in the other datasets used for comparison (see Figure 4.2);
- group 38 comprised four sites from gullies (or creeklines through gullies) at Mesa A (Figure 4.2). It is not clear which species distinguish these sites from others assessed in gully habitats in the other study areas included in the analysis.

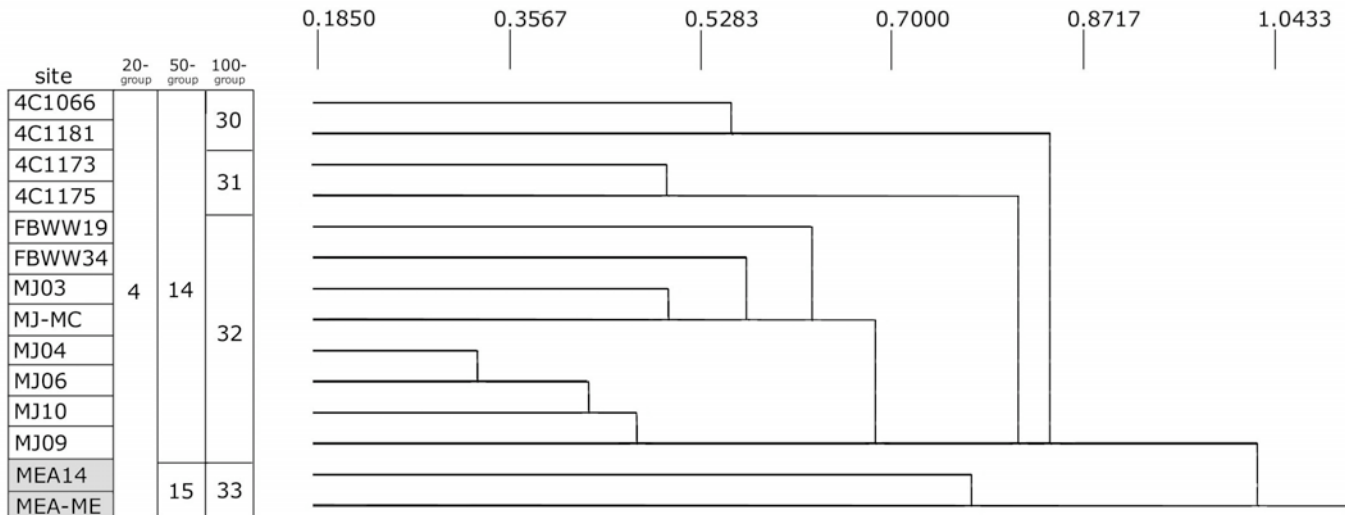


Figure 4.1: Similarity of sites within groups 14 and 15 of the 50-group level of the PATN analysis.

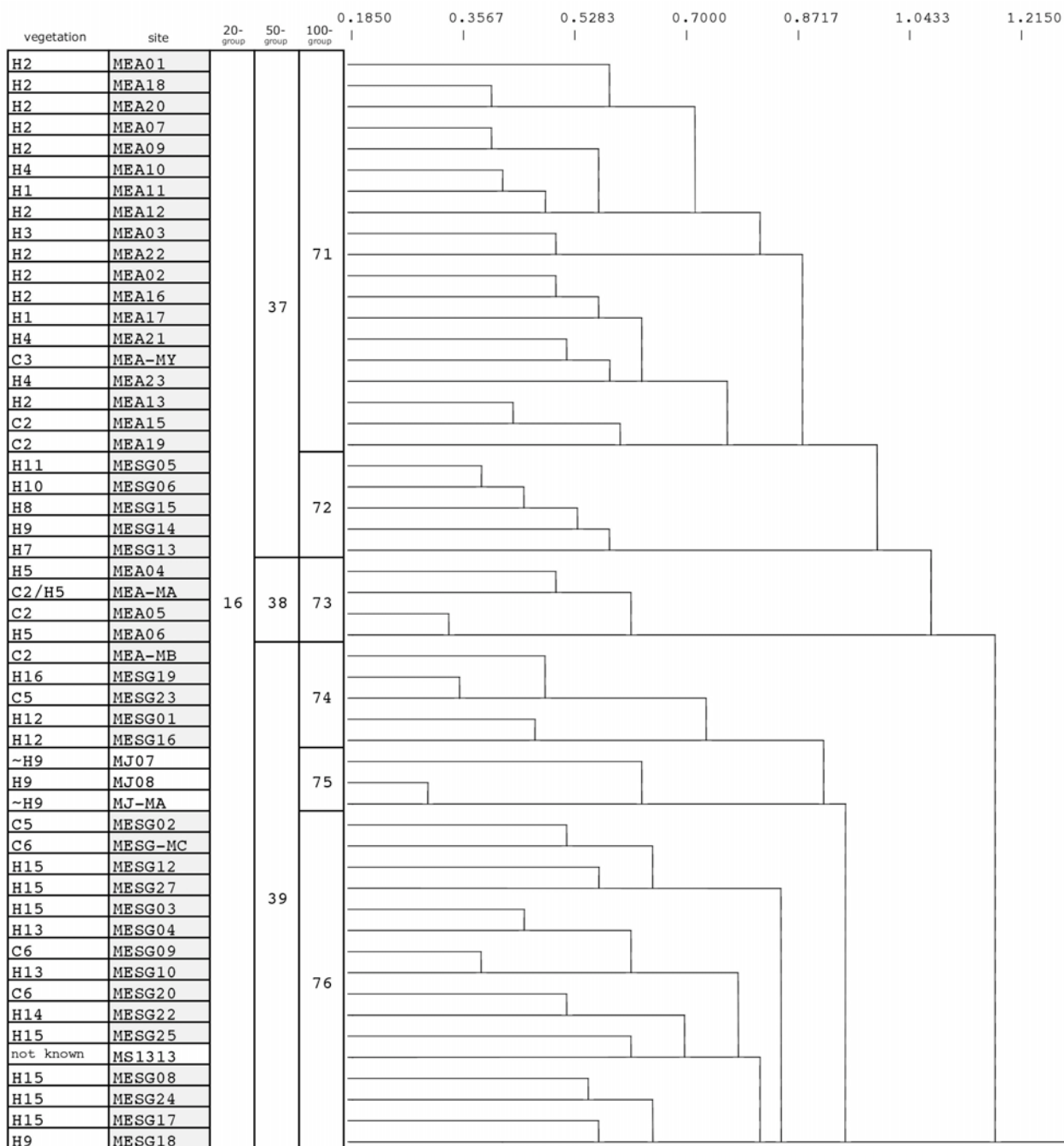


Figure 4.2: Similarity of sites within groups 37, 38 and 39 of the 50-group level of the PATN analysis.

At the 100-group level, five groups contain only sites from the Mesa A and/or Mesa G study areas:

- group 33 comprised the two sites assessed on the sand dune and sand sheet at Mesa A (see Figure 4.1);
- group 71 comprised mainly the open shrublands of *Acacia atkinsiana* and *A. arida* over *Triodia wiseana* hummock grasslands from Mesa A (Figure 4.2);
- group 72 comprised similar vegetation of open shrublands of *Acacia atkinsiana*, *A. bivenosa* and *A. inaequilatera* over *Triodia wiseana* hummock grasslands from Mesa G (Figure 4.2);
- group 73 comprised gully vegetation from Mesa A (Figure 4.2); and
- group 74 comprised shrublands of *Acacia atkinsiana* and *A. acradenia* over *Triodia wiseana* hummock grasslands, mainly from Mesa G (Figure 4.2).

Group 33 is considered to be a floristic group that is genuinely poorly represented in the region, since this habitat is rare in the western Pilbara and the species assemblage recorded is unusual. Most of the flora species recorded from the sites in groups 71-74 at the 100-group level are not uncommon for the region, however they are not well represented in the dataset utilised for the analysis. Although additional data from the region would be required to confirm this, it is considered that the latter floristic groups are unlikely to be restricted in the western Pilbara. An additional floristic analysis should be conducted as extra data becomes available for the Pannawonica area (ie. from recent or proposed surveys at Bungaroo Creek, Warramboos and the Mesa A transport corridor).

4.4 Vegetation Conservation Significance Assessment

4.4.1 Vegetation Condition

The vegetation of the Mesa A and Mesa G areas was generally in very good to excellent condition. The main disturbance comprised numerous exploration tracks, particularly on the mesa crests. There were no major weed infestations, and the small number of weed species are all common and widespread species in the Pilbara. In particular, there were no significant stands of Buffel Grass **Cenchrus ciliaris*, even along the Robe River adjacent to Mesa G and on the sand dune and sand sheet at Mesa A, both of which would represent ideal habitat.

4.4.2 Probable Distribution of Vegetation Types Based on Correspondence with Land Systems

The main vegetation types identified by this study as occurring within each Land System are indicated in Table 4.2.

Given the different scales of the two mapping exercises, an element of discretion has been used to generate the association between vegetation type and Land System to avoid spurious associations. Without some interpretation of the two mapping schemes, vegetation types could be wrongly associated with other Land Systems. For example, an area of the vegetation type H9 defined by this study falls within the River Land System, however it should clearly be associated with a Land System that comprises stony plains supporting spinifex (eg. Boolgeeda).

On the whole, the vegetation types identified within the study areas are compatible with the broad descriptions of their associated Land System/s. The exception is the sand sheet vegetation type S1, which does not appear to correspond with the descriptions of either the Nanutarra or Stuart Land Systems (see Section 2.2.3). It is possible that this sandplain is an outlier of the Uaroo Land System (broad sandy plains supporting shrubby hard and soft spinifex grasslands), which is broadly distributed along the westernmost edge of the Pilbara bioregion, however without some comparable data it is difficult to be sure. In any case, it appears to be an unusual land unit within the local area.

The vegetation types H8 and H9 that were associated with the Land System with the smallest area of representation (Sherlock; see Table 2.1) were both also recorded from other Land Systems (Capricorn and Boolgeeda), and are therefore unlikely to be restricted in distribution.

Table 4.2: Association between vegetation types identified at Mesa A and Mesa G and the Land Systems mapped within the study areas.

Land System	Mesa A Vegetation Types	Mesa G Vegetation Types
Capricorn	H8	-
Nanutarra	S1	-
Peedamulla	H1, H2, H4	-
Robe	H1, H2, H3, H4, H5, H6, H7; C1, C2, C3	-
Stuart	S1	-
Boolgeeda	-	H7, H9, H10, H11
Newman	-	H10, H11, H12, H13, H14, H15, H16; C5, C6, C7
River	-	C4
Sherlock	-	H8, H9
Urandy	-	H10

4.4.3 Assessment at the Level of the Vegetation Types Defined by this Study

Based on the results of the PATN analysis and the author's knowledge of the local area and selected other areas in the region, the majority of the vegetation types are not considered to be restricted in distribution (see Table 4.3). The notable exceptions are vegetation type S1 (restricted to sand sheet / sand dune habitat, which is uncommon in the area) and vegetation type H16 (which contains an undescribed *Triodia* species that is likely to have a restricted distribution in the region).

One vegetation type is considered to be of Very High conservation significance:

- S1 (vegetation of the sand dune and sand sheet adjacent to Mesa A) is considered likely to be restricted in distribution in both the local area and region, and supports species restricted to the deep sands of this particular habitat.

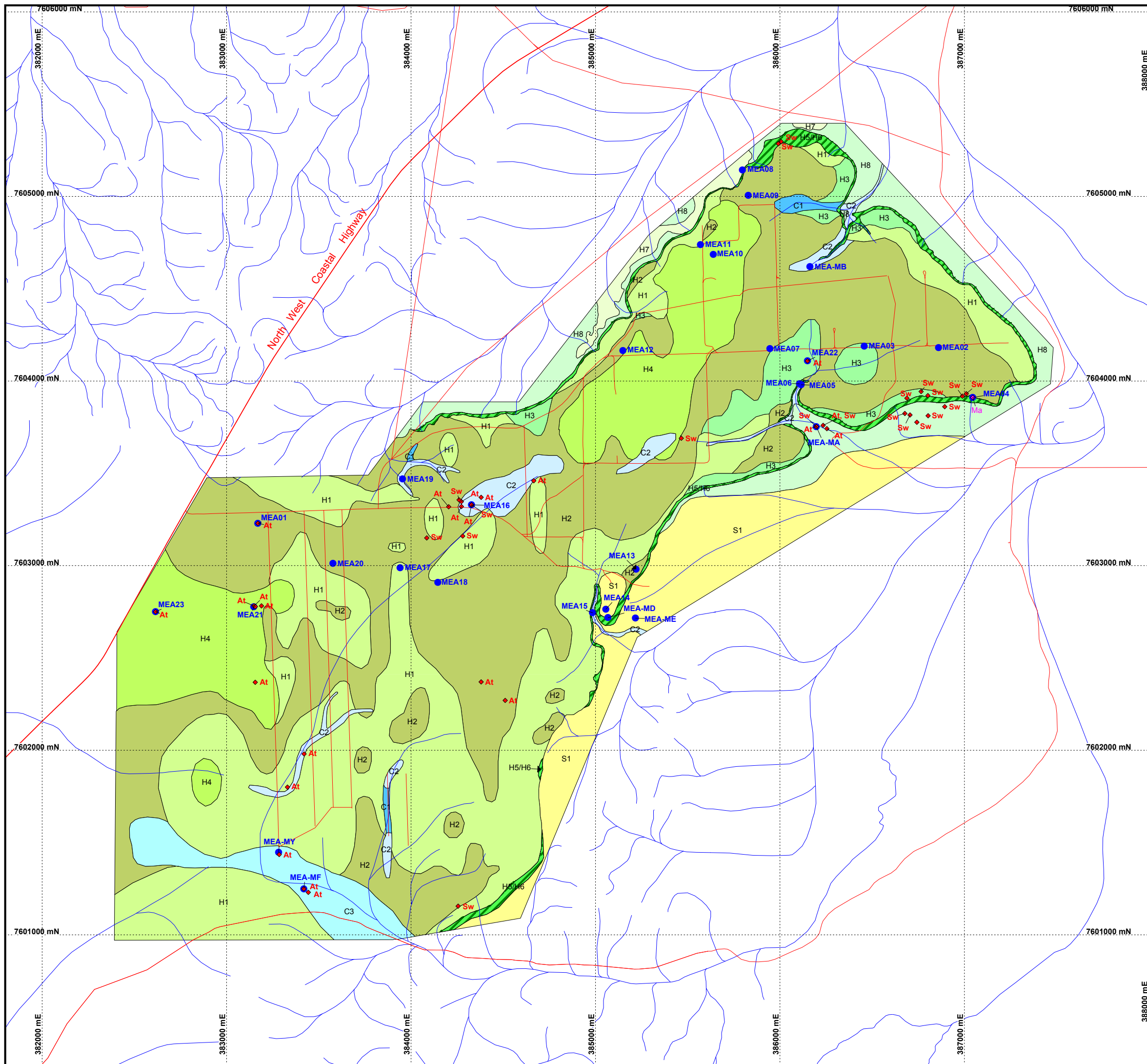
Two vegetation types are considered to be of High conservation significance;

- H16 (vegetation of rocky mesa edges including the undescribed *Triodia* sp. nov.) has a dominant species that is likely to be restricted in distribution in the region; this vegetation was only recorded from Mesa G; and
- C4 (riverine vegetation of the Robe River adjacent to Mesa G) occurs in the major drainage feature in the local area and supports numerous species restricted to this habitat.

The remainder of the vegetation types are considered to be of Moderate conservation significance.

Table 4.3: Probable distribution and representation of vegetation types in the Mesa A and Mesa G study areas in the local area and in the broader Pilbara region.

Vegetation Type	Probable Distribution and Representation	Conservation Significance
Vegetation of mesas, stony hills and plains		
H1 – H4, and H8	Common in the Mesa A / Warramboos area	Moderate
H5 and H6	Likely to occur in suitable habitats (breakaways) in the area	Moderate
H7	Widespread in the Mesa A / Mesa G area	Moderate
H9 – H15	Common in the Mesa G area	Moderate
H16	Occurs over various mesas in the Mesa G area, typically restricted to rocky edges; likely to be uncommon in the region	High
Vegetation of sand dunes and sand sheets		
S1	Restricted in the local area; likely to be uncommon in the region	Very High
Vegetation of creeklines		
C1 and C2	Likely to be common in the area	Moderate
C3	Possibly not abundant in the area	Moderate
C4	Restricted to the Robe River in the local area; similar riverine vegetation occurs in major creeklines in the region	High
C5 – C7	Likely to be common in the area, but not abundant in terms of area due to restriction to gully habitats	Moderate



Location Map

LEGEND

- Major Road
- Roads
- Drainage

Vegetation Sites

- MEA02 -Veg Site Identification Number

Priority Flora Species

- ◆ Priority Flora Location
- At *Abutilon trudgenii*
- Sw *Sida* sp. Wittenoom

Weed Species

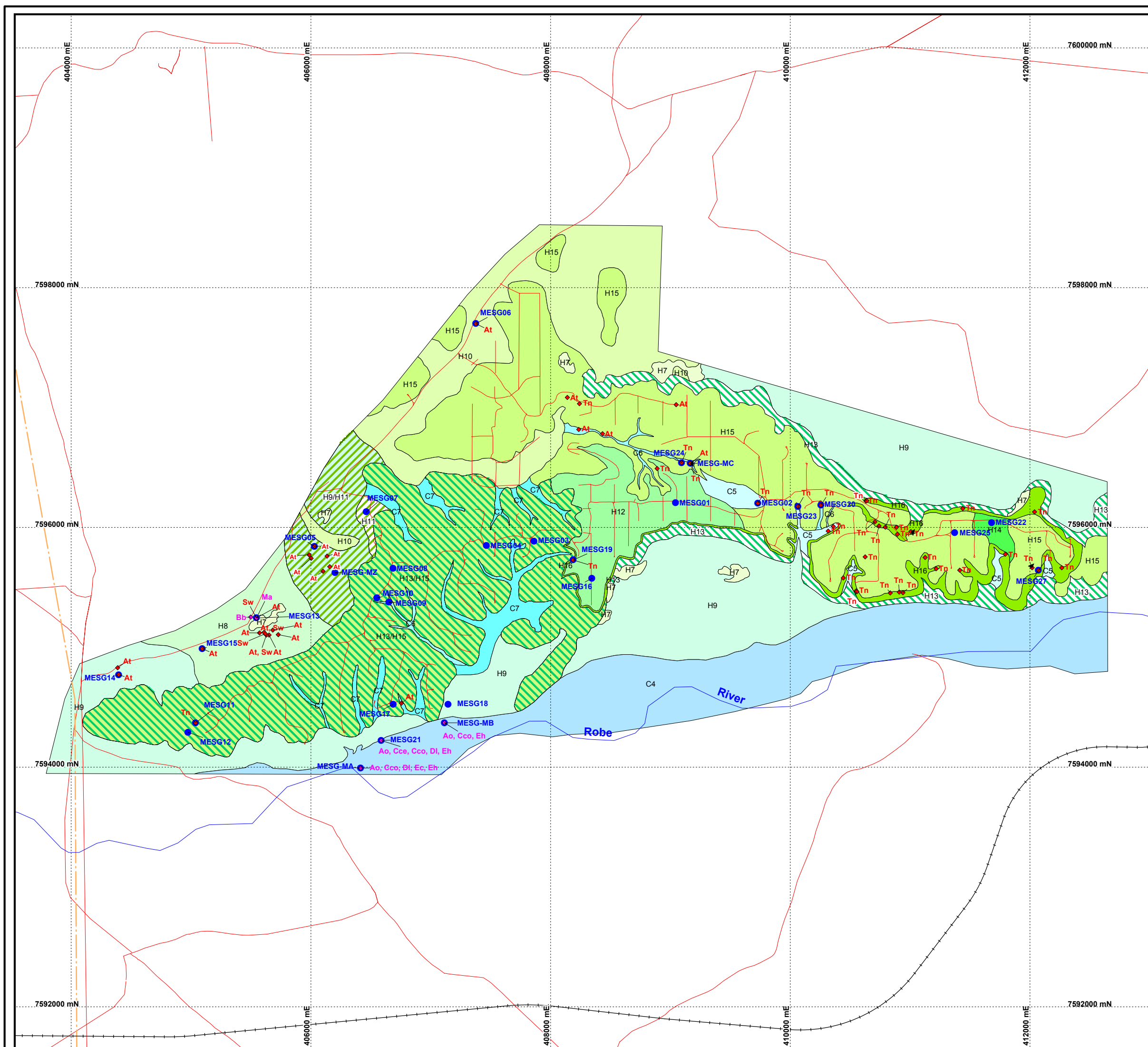
- ◆ Weed Location
- Ma *Malvastrum americanum*

Vegetation Communities

C1	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia pruinocarpa</i> scattered tall shrubs over <i>Acacia atkinsiana</i> , <i>A. arida</i> shrubland over <i>Triodia wiseana</i> open hummock grassland
C2	<i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>A. pruinocarpa</i> , <i>Grevillea wickhamii</i> tall open shrubland to open scrub over <i>Acacia atkinsiana</i> , <i>A. arida</i> open shrubland to tall open shrubland over <i>Triodia wiseana</i> open hummock grassland and <i>Eriachne mucronata</i> scattered tussock grasses
C3	<i>Corymbia hamersleyana</i> , <i>C. candida</i> scattered low trees to low open woodland over <i>Acacia atkinsiana</i> , <i>A. ancistrocarpa</i> scattered tall shrubs over <i>Triodia opactia</i> hummock grassland
H1	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia arida</i> shrubland to tall shrubland over <i>Triodia wiseana</i> mid-dense hummock grassland
H2	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia atkinsiana</i> (<i>A. arida</i>) open shrubland to tall shrubland over <i>Triodia wiseana</i> mid-dense hummock grassland
H3	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia pruinocarpa</i> , <i>A. atkinsiana</i> tall open shrubland over <i>Triodia wiseana</i> open hummock grassland
H4	<i>Acacia atkinsiana</i> , <i>A. inaequilatera</i> (<i>A. arida</i>) tall open shrubland over <i>Acacia bivenosa</i> open shrubland over <i>Triodia wiseana</i> hummock grassland
H5	<i>Acacia pruinocarpa</i> , <i>Eucalyptus leucophloia</i> scattered low trees to low open woodland over scattered mixed tall shrubs over <i>Triodia wiseana</i> hummock grassland
H6	<i>Eucalyptus leucophloia</i> scattered low trees over <i>Acacia tumida</i> var. <i>pilbarensis</i> tall open shrubland to open scrub over <i>Triodia wiseana</i> hummock grassland
H7	<i>Acacia xiphophylla</i> low woodland to tall shrubland over <i>Triodia wiseana</i> hummock grassland
H8	<i>Acacia ancistrocarpa</i> , <i>A. bivenosa</i> shrubland over <i>Triodia wiseana</i> hummock grassland
S1	<i>Corymbia zygomphyla</i> scattered low trees over <i>Acacia tumida</i> var. <i>pilbarensis</i> , <i>Grevillea eristachya</i> high shrubland over <i>Triodia schinzii</i> hummock grassland

Vegetation of Mesa A

Author: M Maier	Date: 07/04/05
Drawn: P Sawers	Revised:
Job No.: 232	WS No. WS 01005
Projection: MGA Zone 50	Scale: 1:20,000



LEGEND

- Roads
- Gas Pipeline
- Railway

Vegetation Sites

- MESHG - Veg Site Identification No.

Flora of Conservation Significance

- Flora Location
- At *Abutilon trudgenii*
- Sw *Sida* sp. Wittenoom
- Tn *Triodia* sp. nov.

Weed Species

- Weed Location
- Bb *Bidens bipinnata*
- Ma *Malvastrum americanum*
- Ao *Argemone ochroleuca* subsp. *ochroleuca*
- Cco *Citrullus colocynthis*
- DI *Datura leichhardtii*
- Eh *Euphorbia hirta*

Vegetation Communities

- C4 *Eucalyptus camaldulensis* woodland over *Eucalyptus victrix* low woodland over *Acacia trachycarpa*, *A. pyrifolia*, *Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* open hummock grassland
- C5 *Eucalyptus leucophloia*, *Corymbia hamersleyana* scattered low trees to low open woodland over *Petalostylis labicheoides*, *Grevillea wickhamii* subsp. *hispidula* tall open shrubland over *Acacia acradenia* open heath over *Triodia wiseana* mid dense hummock grassland
- C6 *Corymbia hamersleyana*, *Eucalyptus leucophloia* scattered low trees over *Acacia tumida* var. *pilbarensis*, *Petalostylis labicheoides* tall open scrub over *Triodia wiseana* open hummock grassland
- C7 *Corymbia hamersleyana* scattered low trees over *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland
- H7 *Acacia xiphophylla* low woodland to tall shrubland over *Triodia wiseana* hummock grassland
- H8 *Acacia ancistrocarpa*, *A. bivenosa* shrubland over *Triodia wiseana* hummock grassland
- H9 *Acacia bivenosa*, *A. inaequilatera* open shrubland over *Triodia wiseana* mid-dense hummock grassland
- H10 *Acacia atkinsiana* (*A. bivenosa*) open sheubland over *Triodia epactia*, *T. wiseana* mid-dense hummock grassland
- H11 *Acacia synchronicia* scattered tall shrubs to tall open shrubland over *Triodia wiseana* mid-dense hummock grassland
- H12 *Acacia atkinsiana*, *A. inaequilatera*, *Petalostylis labicheoides* tall shrubland over *Tephrosia uniovulata* open shrubland over *Triodia wiseana* mid-dense hummock grassland
- H13 *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland
- H14 *Grevillea wickhamii* tall shrubland over *Acacia acradenia* open heath over *Triodia wiseana* hummock grassland
- H15 *Acacia acradenia* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
- H16 *Acacia tumida* var. *pilbarensis* (*Petalostylis labicheoides*) tall closed scrub over *Acacia acradenia* low open shrubland over *Triodia wiseana* (*Triodia* sp. nov.) very open hummock grassland

Location Map

KARRATHA
Map Area
PERTH
KALGOORLIE

0 1 2
kilometres

BIOTA | Biota Environmenta Sciences

Vegetation of Mesa G

Author: M Maier	Date: 08/04/05
Drawn: P Sawers	Revised:
Job No.: 232	WS No. WS 01105
Projection: MGA Zone 50	Scale: 1:30,000

5.0 Terrestrial Flora

5.1 General

5.1.1 Species Richness of the Study Areas

A total of 257 taxa of native vascular flora from 111 genera belonging to 48 families was recorded from the survey area (see Appendix 2). In addition, eight species of introduced flora were recorded (see Section 5.4). Nonvascular flora were not specifically sampled, however a bracket fungus was noted on dead wood at Mesa A, and a spherical fungus was noted at Mesa G.

Species richness per quadrat (detailed flora recording site) ranged from 6 to 62 native taxa, with an average of 23 taxa. Sites with the highest native species richness were mostly located in gorges or creeklines, however some were on mesic plains; eg. MESA21 (Robe River: 62 taxa), MEA04 (rocky gully: 50 taxa), MEA15 (creek in gorge: 45 taxa), MESA15 (stony plain: 43 taxa), MESA13 (clayey plain: 41 taxa) and MEA06 (gorge: 41 taxa). Sites with the lowest native species richness were all located on the stony crests of the mesas; eg. MEA07 (6 taxa), MEA18 (8 taxa), MEA12 (9 taxa), MESA22 (9 taxa), MESA01 (10 taxa) and MESA16 (10 taxa). The main factor driving differences in the number of species recorded in different quadrats thus seems to be habitat type. Habitats with generally good conditions (deep, well-drained soils; more readily available water) typically had more species than habitats with shallow, less favourable soils.

The Mesa A and Mesa G areas are relatively species poor in comparison to areas further east in the Hamersley Range, reflecting a number of factors:

- the relatively low and inconsistent rainfall received by the area;
- the low relief of the mesas in comparison to areas further east (altitude has been shown to be a significant contributor to species diversity; see van Leeuwen and Bromilow 2002);
- the relatively small size of the study areas, and limited number of habitats present;
- the recent prolonged dry period experienced at Pannawonica.

5.1.2 Effects of Survey Timing on Recorded Species Richness

Sampling of quadrats at Mesa A over two years provides some cautionary data regarding the adequacy of sampling following extended dry periods. With the exception of MEA16, which could not be relocated, all of the quadrats initially established at Mesa A in August 2003 were resampled in May 2004. GPS readings were used to relocate the sites, and in most cases the fence droppers marking the corner points were able to be relocated, giving additional confidence that the same area was being resampled.

The number of additional taxa recorded from the quadrats during the resampling event in May 2004 ranged between 0 and 27 (Table 5.1). A small number of these records were of perennial shrub species such as *Grevillea* and *Corchorus*. These were presumably either included following a slight alteration in the area sampled in the second year (particularly where the quadrats were not uniformly square; eg. in gullies), or were simply overlooked during the first sampling exercise. However, the vast majority of the additional flora recorded were ephemeral species such as *Alternanthera nana*, *Amaranthus* spp., *Bulbostylis barbata*, *Cleome viscosa*, *Dysphania rhadinostachya* subsp. *rhadinostachya*, *Eriachne pulchella* var. *dominii*, *Euphorbia* spp., *Evolvulus alsinoides* var. *villosicalyx*, *Gomphrena* spp., *Leptopus decaisnei* var. *decaisnei*, *Mollugo molluginis*, *Mukia maderaspatana*, *Paspalidium clementii*, *Phyllanthus erwinii* and *Portulaca oleracea*.

The proportion of the total number of taxa (ie. the combined total from the August 2003 and May 2004 sampling events) in each quadrat that was recorded during the initial sampling event ranged from 26% to 100%, with an average of 71% (Table 5.1). Sites from which large

numbers of additional species were recorded were generally in, or very close to, habitats that retain water following rainfall and typically support numerous ephemeral flora at such times (eg. creeklines: MEA15; gorges and gullies: MEA04, MEA05 and MEA06; scree slopes: MEA08; and a mesa crest location adjacent to a creekline and gorge: MEA22). Sites from which no or only a small number of new flora were recorded were typically located in habitats that do not tend to hold water effectively following rainfall (eg. mesa crests: MEA01, MEA07, MEA12, MEA13, MEA18 and MEA20; and the sand dune: MEA14).

Table 5.1: Number of taxa initially recorded from the Mesa A quadrats in August 2003, and the number of additional taxa recorded during resampling in May 2004.

Site	Number of taxa recorded in August 2003	Additional taxa recorded in May 2004	Percent of total taxa recorded by initial survey
MEA01	15	3	83 %
MEA02	14	6	70 %
MEA03	8	7	53 %
MEA04	23	27	46 %
MEA05	26	12	68 %
MEA06	26	15	63 %
MEA07	5	1	83 %
MEA08	11	9	55 %
MEA09	7	4	64 %
MEA10	7	4	64 %
MEA11	10	8	56 %
MEA12	9	0	100 %
MEA13	29	1	97 %
MEA14	18	2	90 %
MEA15	34	10	77 %
MEA17	15	7	68 %
MEA18	8	0	100 %
MEA19	20	5	80 %
MEA20	11	0	100 %
MEA21	14	21	40 %
MEA22	6 (+3 unidentifiable seedlings)	17	26 %

NB: MEA16 could not be relocated and was therefore not resampled; MEA23 was established in May 2004.

For most sites resampled during 2004, only those species that were considered unlikely to have been present during the first exercise were recorded, however for seven sites, the entire flora within the quadrat was resampled. For these latter sites, it is possible to calculate the proportion of the total taxa at each site that was recorded by the May 2004 survey alone (see Table 5.2). On average, 93% of the taxa recorded from the quadrats over the two sampling events were recorded by the single sampling exercise in May 2004, which is a marked improvement on the average of 71% recorded by the sampling exercise in August 2003.

Table 5.2: Number of flora taxa recorded from seven of the Mesa A quadrats during May 2004, and the proportion that this represents of the total species richness known for those sites.

Site	Number of taxa recorded in May 2004	Percent of total taxa recorded by May 2004 survey
MEA02	16	80 %
MEA03	15	100 %
MEA04	49	98 %
MEA07	6	100 %
MEA08	17	85 %
MEA14	17	85 %
MEA22	23	100 %

Although based on only a small number of samples, these results clearly highlight the importance of conducting surveys following adequate rainfall wherever possible, and the necessity for seasonal sampling when an initial sampling event follows a period of low rainfall.

5.1.3 Dominant Species

The families and genera with the greatest number of taxa are shown in Table 5.3 and Table 5.4. These families and genera are those that are predominant in the vegetation of the Pilbara, and that usually have most representatives on flora lists from this region, due to their prominence in the Eremaean flora. Some of the families (eg. the Amaranthaceae, Malvaceae and Poaceae) are more species rich in the Northern flora and poorer in the Southern flora, while others (such as the Mimosaceae) are abundant in all three provinces.

In contrast to these families and genera that have many representatives, 16 families and 67 genera recorded during the survey were represented by only one taxon. These included *Codonocarpus* (Gyrostemonaceae), *Corynotheca* (Anthericaceae), *Haloragis* (Haloragaceae) and *Clerodendrum* (Lamiaceae). Some of the genera are widespread in the State (eg. *Codonocarpus* and *Corynotheca*). Others have predominantly northern or southern affinities (eg. *Clerodendrum* and *Haloragis* respectively).

The most frequently recorded species were *Triodia wiseana*, *Acacia atkinsiana*, *Cassia notabilis*, *Corchorus sidoides* subsp. *sidoides*, *Dysphania rhadinostachya* subsp. *rhadinostachya* and *Mollugo molluginis*. Some of these species are commonly dominant in the vegetation of the area (eg. *Triodia wiseana*), or at least frequently contribute to its structure (eg. *Acacia atkinsiana*). Others are species with wide environmental tolerance, but usually with low abundance (eg. *Cassia notabilis* and *Mollugo molluginis*).

Families under-represented in the flora compared to areas further east were the Chenopodiaceae (saltbush, bluebush etc) and Goodeniaceae (fan-flowers).

Table 5.3: Most species rich families within the project area.

Family	No. of Native Taxa (No. of Introduced Taxa)
Malvaceae (Hibiscus family)	25 (1)
Poaceae (grass family)	23 (2)
Euphorbiaceae (spurge family)	13 (1)
Papilionaceae (pea family)	20 (0)
Mimosaceae (wattle family)	18 (0)
Amaranthaceae (mulla-mulla family)	15 (0)
Caesalpinaceae (Cassia family)	13 (0)
Cyperaceae (sedge family)	10 (0)
Asteraceae (daisy family)	10 (1)

Table 5.4: Most species rich genera within the project area.

Genus	No. of Native Taxa
<i>Acacia</i> (wattle family)	18
<i>Cassia</i> (cassia family)	12
<i>Hibiscus</i> (hibiscus family)	11
<i>Euphorbia</i> (spurge family)	9
<i>Ptilotus</i> (mulla-mulla family)	9
<i>Tephrosia</i> (pea family)	7
<i>Abutilon</i> (hibiscus family)	6
<i>Cyperus</i> (sedge family)	6
<i>Grevillea</i> (grevillea, hakea family)	6
<i>Indigofera</i> (pea family)	6
<i>Sida</i> (hibiscus family)	6
<i>Solanum</i> (native tomato family)	6

5.2 Declared Rare and Priority Flora

5.2.1 Legislative and Administrative Levels of Conservation Protection

While all native flora are protected under the *Wildlife Conservation Act 1950-1979*, a number of plant species are assigned an additional level of conservation significance based on the

limited number of known populations and the perceived threats to these populations (Table 5.5). Species of the highest conservation significance are designated Declared Rare Flora (DRF), either extant or presumed extinct. 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.

In addition, the presence of some flora species means that it may be necessary to refer proposals to the Federal Minister for the Environment under the *Environment Protection and Biodiversity Conservation Act 1999*. In the Pilbara, only the two Declared Rare Flora species (*Lepidium catapycnon* and *Thryptomene wittweri*) are currently listed under the EPBC Act.

Table 5.5: Categories of conservation significance for flora species (Atkins 2005).

Declared Rare Flora - Extant Taxa. Taxa that 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.
Declared Rare 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.
Priority 1 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
Priority 2 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
Priority 3 - Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat.
Priority 4 - Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

5.2.2 Flora of Conservation Significance Previously Recorded from the Pannawonica Area

Neither *Lepidium catapycnon* nor *Thryptomene wittweri* have been recorded from the Pannawonica area. Priority flora that have been previously recorded at or near Pannawonica include:

- *Dicladanthera glabra* (Priority 2): A single record from the Robe River, 4 km northeast of Mesa A (WA Herbarium database);
- *Abutilon trudgenii* (Priority 3): Recorded from Mesa A by Trudgen (2003a);
- *Rhynchosia bungarensis* (Priority 3): Five WA Herbarium records from the Robe River, from 5 km east of Mesa A, 8 km east of Mesa A, 8 km northwest of Mesa G and 6 km east of Mesa G (2 locations); one WA Herbarium record from a minor drainage in the Mesa J Extension (Biota 2003), 7 km east of Mesa G; also recorded from Bungaroo Creek by Trudgen (2003c) and Biota (2005b); and
- *Sida* sp. Wittenoom (Priority 3): Recorded from Mesa A by Trudgen (2003a).

5.2.3 Priority Flora Recorded from Mesas A and G

Neither of the Declared Rare Flora species that occur in the Pilbara (*Lepidium catapycnon* and *Thryptomene wittweri*) were located during the field survey, and neither would be expected to occur. On the basis of current knowledge, there are thus no flora of significance under the EPBC Act 1999 at Mesa A or Mesa G.

Two Priority flora were recorded during the field surveys, both of which have been previously recorded from the locality. Each of these species is discussed below. A summary of the distribution of each species is given in tables in the relevant sections, and locations are also shown in Figures 4.1 and 4.2.

- ***Abutilon trudgenii* ms.**

Priority 3

This short-lived (1 to 2 years) species is stimulated by fire and is consequently typically recorded from recently burnt areas, particularly on clayey to stony plains. Specimens of *A. trudgenii* are lodged at the WA Herbarium from the Cane River, Hillside Station, Goldsworthy and Tom Price. However, according to the Priority Flora List this species is also known from other locations including Marillana, Warralong, Woodstock, Point Sampson, Karratha and Pannawonica (Atkins 2005). *A. trudgenii* ms. was recorded 23 times by Trudgen and Casson (1998) during the West Angelas surveys, and has also been recorded west of Dampier (Halpern Glick Maunsell 2000), from south-south-east of Port Hedland (Trudgen et al. 2002), and seven times during the survey of the greater Hope Downs Rail Corridor (see Biota and Trudgen 2002). Recent locations from which this species has been recorded in the Pannawonica area include Bungaroo Creek (Trudgen 2003c, Biota 2005b), the Mesa J Extension (1 record; Biota 2005c) and Mesa L Minor (7 records; Biota 2005d). *A. trudgenii* is thus not genuinely rare, but rather poorly collected because of its straggly, open appearance and inconspicuous flowers (see Plate 5.1 and Plate 5.2).



Plate 5.1: Young plant of *Abutilon trudgenii*.



Plate 5.2: Pendant fruit of *Abutilon trudgenii*.

Abutilon trudgenii was recorded numerous times from recently cleared exploration tracks on Mesa A during the survey work in 2004, particularly in association with *Acacia bivenosa* and *Triodia wiseana*. Eight individuals were also recorded from seven locations on the mesa top by Trudgen (2003a). This species was also abundant on the baseplain around Mesa G, and was recorded sporadically from burnt areas on top of this mesa. It is likely to be widespread within both study areas.

Table 5.6: Locations of *Abutilon trudgenii* ms. at Mesa A and Mesa G.

Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)
Mesa A		Mesa G	
382615	7602750	404388	7594829
383149	7602782	404396	7594771
383155	7602368	405094	7594988
383156	7602778	405546	7595244
383170	7603229	405571	7595120
383189	7602782	405651	7595102
383285	7601435	405682	7595143
383330†*	7601800†*	405728	7595105
383419	7601249	405985	7595771
383420†*	7601980†*	406002	7595742
383443	7601230	406030	7595842
384204	7603319	406101	7595634
384273	7603347	406135	7595760
384273	7603320	406157	7595672

Table 5.6: continued.

Easting (mE)	Northing (mN)
Mesa A	
384328†	7603329†
384380†*	7602370†*
384380†*	7603370†*
384510†*	7602270†*
384665†*	7603460†*
386149	7604109
386197	7603753
386254	7603742
386234	7603760

Easting (mE)	Northing (mN)
Mesa G	
406756	7594534
407377	7597699
408140	7597084
408235	7596817
408433	7596781
409048	7597024
409167	7596535
405609	7595124
405629	7595102

† Recorded by Trudgen (2003a).

* Coordinates not recorded with a GPS, but determined from the description of their locations in relation to proposed boreholes (as indicated on a hard-copy map provided by M. Trudgen).

• ***Sida* sp. Wittenuom (WR Barker 1962) Priority 3**

This medium-height, spreading shrub (see Plate 5.3 and Plate 5.4) is known from numerous populations. Specimens are lodged with the WA Herbarium from both the western and eastern Pilbara, and this species is also known from Wittenuom and Roy Hill in the central Pilbara. Specific records include two locations in the Hope Downs rail corridor (Biota 2004c), nine locations in the FMG Stage A rail corridor (Biota 2004a), two locations in the FMG Stage B rail corridor (Biota 2004b), 5 locations in the Mesa J Extension (Biota 2005c), 1 location at Mesa L Minor (Biota 2005d) and 95 locations within the Bungaroo Creek transport corridor (Biota 2005b).



Plate 5.3: Growth form of *Sida* sp. Wittenuom.



Plate 5.4: Fruit of *Sida* sp. Wittenuom.

Six plants of *Sida* sp. Wittenuom were recorded from five locations on top of Mesa A by Trudgen (2003a). This species was recorded from numerous additional locations within the Mesa A study area during the survey work in 2004, particularly in recently burnt or otherwise disturbed areas. *Sida* sp. Wittenuom was also recorded from four locations at Mesa G, all from a stony plain in the westernmost section of the study area (see Table 5.3).

Table 5.7: Locations of *Sida* sp. Wittenoom at Mesa A and Mesa G.

Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)
Mesa A		Mesa G	
384085†*	7603150†*	405546	7595244
384255†*	7601155†*	405609	7595124
384260	7603356	405619	7595112
384280†*	7603160†*	405629	7595102
384328†	7603329†		
385465†*	7603690†*		
385991	7605286		
386197	7603753		
386006	7605297		
386234	7603760		
386677	7603824		
386688	7603907		
386705	7603816		
386742	7603777		
386765	7603943		
386802	7603921		
386803	7603812		
386893	7603861		
386989	7603918		
387010	7603931		

† Recorded by Trudgen (2003a).

* Coordinates not recorded with a GPS, but determined from the description of their locations in relation to proposed boreholes (as indicated on a hard-copy map provided by M. Trudgen).

5.3 Other Flora of Conservation Interest

In addition to the DRF and Priority Flora categories, some other 'Flora of Conservation Interest' have been identified. These are flora species that are not listed as DRF or Priority species by CALM, but which are poorly known and/or could not be identified to species level for reasons other than poor condition of specimens.

Details of these flora are given below.

5.3.1 Apparently Undescribed Taxa

- ***Triodia* sp. nov.**

Trudgen (2002) recorded an undescribed spinifex (*Triodia*) species from mesas in the Robe Valley, mainly along the rocky upper edges of the mesas but also occasionally on the rocky crests. This taxon has subsequently been recorded in the Mesa J Extension study area (Biota 2003), on Mesa L Minor (Biota 2005d) and on hills near Bungaroo Creek (Biota 2005b).

Triodia sp. nov. was recorded in narrow bands around the edge of the flat-topped mesa at the eastern end of the Mesa G study area (see Plate 5.5 and Plate 5.6). Numerous individual records were made (see Table 5.8), however the populations are essentially continuous.

Specimens could not be matched with any of the species currently distinguished by the WA Herbarium, hence this taxon appears to be a new entity. Trudgen (2002) describes this *Triodia* as quite common on mesas in the Robe Valley, but moderately geographically restricted and also habitat restricted.

Plate 5.5: Growth form of *Triodia* sp. nov.Plate 5.6: Florets of *Triodia* sp. nov.Table 5.8: Locations of *Triodia* sp. nov. at Mesa G.

Easting (mE)	Northing (mN)	Easting (mE)	Northing (mN)
405038	7594369	410740	7596012
408188	7595728	410793	7596002
408241	7597032	410834	7595453
408889	7596491	410886	7596001
409093	7596540	410894	7595943
409165	7596534	410909	7595460
409729	7596202	410940	7595455
410064	7596174	411006	7595965
410255	7596186	411125	7595749
410316	7595969	411217	7595655
410359	7596007	411414	7595643
410442	7595578	411439	7596158
410550	7595470	411794	7595776
410556	7595463	412018	7595663
410625	7595754	412038	7596129
410631	7596220	412071	7595642
410639	7596222	412265	7595663
410706	7596046		

- **Amaranthus species**

A number of undescribed *Amaranthus* taxa are believed to occur in the Pilbara. The two taxa recorded from the Mesa A and Mesa G study areas (*Amaranthus* aff. *interruptus* (MET 16,114) and *Amaranthus* aff. *pallidiflorus* (D89)) have been recorded during other surveys in the region and are considered widespread.

- **Cassia (Senna) species**

Numerous undescribed *Cassia* (*Senna*) taxa occur in the Pilbara, including various hybrids between recognised "species". The taxa recorded from the current study areas have been recorded during other surveys in the region and do not appear to be geographically restricted.

- **Euphorbia species**

Similar to the previous two genera, there is a large number of undescribed *Euphorbia* taxa in the Pilbara, many of which are poorly collected. The undescribed *Euphorbia* taxa recorded from Mesa A and Mesa G have been recorded during other surveys in the region, and are not considered to be geographically restricted.

- **Malvaceae species (*Abutilon*, *Hibiscus* and *Sida*)**

The Malvaceae family has a high species diversity in the Pilbara bioregion, with a large number of undescribed taxa. The taxa recorded from Mesa A and Mesa G have been recorded in other survey areas (particularly at Hope Downs), and are considered poorly collected rather than rare, and not restricted in distribution.

- **Papilionaceae (*Indigofera* and *Tephrosia* species)**

The genus *Indigofera* in the Pilbara contains a number of distinct taxa that are currently undescribed, particularly within *Indigofera* "*monophylla*". The *Indigofera* taxa collected from the study area have all been previously recorded elsewhere in the region (M. Trudgen pers. comm.).

The genus *Tephrosia* similarly contains numerous distinct taxa in the Pilbara, particularly within *T.* "*clementii*", *T.* "*densa*", *T.* "*rosea*" and *T.* "*supina*". All of the apparently undescribed taxa recorded from the current study area have been recorded from other survey areas in the region and appear to be widespread.

5.3.2 Range Extensions

Most of the species recorded from the Mesa A and Mesa G study areas are well within their known ranges (based on voucher specimens lodged with the WA Herbarium). However the record of *Mukia* sp. D Flora of Australia (A.A. Mitchell PRP 1121) is a small western extension for this species.

5.4 Introduced Flora

On the whole, the study areas were relatively weed free; of the more than 50 quadrats and relevés sampled, only five contained introduced flora. Three of these locations (site MESG21, relevé MESG-MA and relevé MESG-MB) were located within the Robe River, south of Mesa G. Creeklines are particularly susceptible to weed invasion, and these three sites together contributed the majority of weed records.

One and eight species of introduced flora were recorded from Mesa A and Mesa G respectively (see Table 5.9). None of these are listed as Declared Plants for the East Pilbara under the *Agriculture and Related Resources Protection Act 1976* (see Section 5.4.1).

The weed species recorded are common and widespread species in the Pilbara region:

- Buffel Grass **Cenchrus ciliaris* was introduced as a fodder species by pastoralists. This species forms dense grasslands along creeklines, on floodplains, coastal sands and rockpiles in the Pilbara. Within the study areas, **C. ciliaris* was not widespread, occurring only in isolated patches along the banks of the Robe River adjacent to Mesa G;
- Awnless Barnyard Grass **Echinochloa colona* was recorded from the Robe River adjacent to Mesa G;
- Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca* typically occurs along the gravelly beds of creeklines, and was recorded from the Robe River adjacent to Mesa G (Plate 5.7 and Plate 5.8);



Plate 5.7: Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca*.



Plate 5.8: Scattered Mexican Poppy plants in the Robe River.

- Spiked Malvastrum **Malvastrum americanum* was recorded as scattered individuals from a single site at Mesa A and two sites at Mesa G, including the Robe River. This species can be abundant in some habitats, particularly in good seasons;
- The introduced cucurbit creeper Colocynth **Citrullus colocynthis* was collected from the Robe River adjacent to Mesa G. This species is a frequent weed of creeklines but is rarely abundant;
- Asthma Plant **Euphorbia hirta* was recorded from three locations, all in the Robe River adjacent to Mesa G. Although no specimens have been lodged with the WA Herbarium previously from the Pilbara, this species was recorded from the Hope Downs rail alignment between Port Hedland and Newman (Biota and Trudgen 2002) and has also been seen at Karratha townsite (Michi Maier, Biota, pers. obs.);
- Scattered individuals of Native Thornapple **Datura leichhardtii* were recorded from the Robe River, adjacent to Mesa G. This species is a common weed of creeklines in the Pilbara but is rarely abundant;
- Beggar's Ticks **Bidens bipinnata* were recorded within the Mesa G study area, along the access track near MESH13. This weed can be very dense after good rains, especially in shaded areas, and can crowd out native flora species, but was not abundant at Mesa G during the current study.

Table 5.9: Distribution of introduced flora within the survey area.

Introduced Flora	No. of Records (Location)
Poaceae * <i>Cenchrus ciliaris</i> (Buffel Grass) * <i>Echinochloa colona</i> (Awnless Barnyard Grass)	1 (Mesa G – Robe River: site MESH21) 1 (Mesa G – Robe River: relevé MESHMA)
Papaveraceae * <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i> (Mexican Poppy)	3 (Mesa G – Robe River: site MESH21, relevés MESH-MA and MESH-MB)
Malvaceae * <i>Malvastrum americanum</i> (Spiked Malvastrum)	3 (Mesa A: site MEA04; Mesa G: sites MESH13 and MESH21 (latter in the Robe River))
Cucurbitaceae * <i>Citrullus colocynthis</i> (Colocynth)	3 (Mesa G – Robe River: site MESH21, relevés MESH-MA and MESH-MB)
Euphorbiaceae * <i>Euphorbia hirta</i> (Asthma Plant)	3 (Mesa G – Robe River: site MESH21, relevés MESH-MA and MESH-MB)
Solanaceae * <i>Datura leichhardtii</i> (Native Thornapple)	2 (Mesa G – Robe River: site MESH21 and relevé MESH-MA)
Asteraceae * <i>Bidens bipinnata</i> (Beggar's Ticks)	1 (Mesa G: 405498 mE, 7595252 mN)

5.4.1 Declared Plants

Declared weeds under the *Agriculture and Related Resources Protection Act 1976* are assigned to one of five control categories (see Table 5.10). None of the weed species recorded are Declared Plants for the East Pilbara, however the Native Thornapple **Datura leichhardtii* and Mexican Poppy **Argemone ochroleuca* subsp. *ochroleuca* are listed for other areas of the State. Native Thornapple is a Priority 1 Declared Plant for most areas of the State except the Kimberley, Ashburton and Pilbara regions, which means that this species cannot be spread, and is Priority 3 or Priority 4 for a number of agricultural areas, which means that the existing populations in these areas must be either reduced or prevented from spreading (Table 5.10). Mexican Poppy is listed as Priority 1 for the Pilbara region, except the East Pilbara, and Priority 3 or Priority 4 for a number of agricultural areas.

While Buffel Grass **Cenchrus ciliaris* is highly invasive and has demonstrated allelopathic capacities (whereby it releases chemicals that inhibit growth of other species), it is not listed

as a Declared Weed due to its importance to the pastoral industry. Nonetheless, it is considered to be a serious environmental weed by CALM, and a key threatening factor for some ecosystems, particularly seasonal watercourses.

Table 5.10: Control Categories for Declared Plants.

Priority	Requirements
P1	Prohibits movement. The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2	Aim is to eradicate infestation. Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3	Aims to control infestation by reducing area and/or density of infestation. The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.
P4	Aims to prevent infestation spreading beyond existing boundaries of infestation. The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.
P5	Infestations on public lands must be controlled.

5.5 Flora Conservation Significance Assessment

The combined number of taxa recorded from the study areas is relatively low compared to areas further east, mainly reflecting low rainfall and subdued topography.

No Declared Rare Flora have been recorded from Mesa A and Mesa G, hence there are also no flora listed under the *EPBC Act 1999* within the study areas. Two Priority flora (*Abutilon trudgenii* and *Sida* sp. Wittenoom) have been recorded from the study areas, both of which have been previously recorded from the local area. Both species are poorly collected rather than rare, and are considered to warrant removal from the Priority listing.

The remaining flora recorded from the Mesa A and Mesa G study areas are largely widespread and typical of the Hamersley Range subregion, with the exception of the undescribed species of spinifex *Triodia* sp. nov, which is apparently restricted to the Robe Valley.

Given that the Mesa A and Mesa G study areas support a relatively low number of species, the majority of which are widespread and typical of the region, these areas are considered to have low conservation value for overall flora. However specific areas, such as the sand sheet at Mesa A and the Robe River near Mesa G, have higher conservation value as they support flora restricted to these habitats.

6.0 Discussion and Recommendations

6.1 Features of Particular Conservation Significance

6.1.1 Vegetation Types

The small sand dune at site MEA14 on Mesa A represents an extension of a large sand sheet lower in the valley on the southern side of the mesa. These sandy habitats support a different suite of flora (and consequently different vegetation) to the remainder of the habitats present on the mesas, and would not be widespread in the region. These sandy habitats would also be particularly susceptible to erosion and weed invasion following physical disturbance. Part of the sand dune has already been removed, apparently to use as fill for disused winzes.

Vegetation of the Robe River (ie. vegetation type C4, which is dominated by River Red Gums *Eucalyptus camaldulensis* and Coolibahs *Eucalyptus victrix*) would be susceptible to a reduction in the groundwater level, which could arise if mining of the adjacent Mesa G deposit occurs below the water table and therefore requires dewatering. Hydrological studies should indicate whether groundwater drawdown is a likely result of the proposed development.

Most of the vegetation at Mesas A and G is in excellent or very good condition, and there are currently no major weed infestations in the study areas. A small number of weed species has been recorded, all of which are common and widespread species in the Pilbara. In particular, there are no significant stands of Buffel Grass *Cenchrus ciliaris*, even along the Robe River adjacent to Mesa G or on the sand sheet habitat adjacent to Mesa A, both of which would represent ideal habitat. Further earthworks in the area, particularly establishment of tracks and infrastructure on the baseplains surrounding the mesas, have the potential to introduce additional weed species and/or spread existing populations within the study areas.

6.1.2 Flora

The two Priority flora recorded from the study areas (*Abutilon trudgenii* and *Sida* sp. Wittenoom) are poorly collected rather than rare, and are considered to warrant removal from the Priority listing. The only species of particular conservation significance within the study areas is therefore the undescribed spinifex *Triodia* sp. nov, which was recorded from Mesa G.

6.2 Recommendations

As the mine planning process has not been finalised (details of pit and infrastructure locations are not yet known), the following recommendations are necessarily largely generic strategies that are typical for projects of similar scale in the Pilbara.

The following management measures are recommended to minimise disturbance to the vegetation and flora of Mesas A and G:

- Avoid disturbance to vegetation type S1, which occurs on the small sand dune on Mesa A, and the extensive sand sheet on the southern side of this mesa.
- Minimise disturbance to vegetation type H16, which is the main vegetation type containing the undescribed spinifex *Triodia* sp. nov.
- Minimise disturbance to vegetation type C4, which occurs in the Robe River.
- Include the data from Mesas A and G with data from additional sites from the Pannawonica area in another floristic analysis, and use the results to review the assessment of vegetation conservation significance and input to the mine planning process.

- Vegetation clearing should be kept to the minimum necessary for safe construction and operation of the project, particularly in areas adjacent to vegetation of higher conservation significance.
- Undertake an assessment of the likely impacts of groundwater drawdown on vegetation of the Robe River based on the results of hydrological studies.
- Although the majority of habitats on the mesas are not particularly susceptible to weed invasion, strict hygiene measures must be maintained to avoid the introduction and/or spread of weeds within Mesas A and G. A Weed Hygiene and Management Plan should be prepared in consultation with CALM prior to construction commencing.
- A Topsoil Management and Rehabilitation Plan should be prepared for all non-permanent cleared areas, in liaison with CALM, the Department of Environment and Department of Industry and Resources prior to the commencement of construction activities. This plan should include use of provenance collected native seed, characterisation and management of topsoil, and the respreading of cleared vegetative material. Recovery monitoring should also be carried out, with any rehabilitation failure subject to additional treatment to a suitable standard.
- As part of the environmental offsets package to be developed for the proposed projects, Robe River Iron Associates should consider contributing funding towards research into unresolved taxonomic issues in *Triodia*. Appropriate research topics would include a taxonomic revision of the genus and development of an electronic key for identification of the species.

7.0 Acknowledgements

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- Dr Stephen van Leeuwen (CALM Karratha) provided some comments on the regional distribution and conservation significance of the sand sheet habitat near Mesa A.

8.0 References

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Appendix 1

Summary Data from the Mesa A and Mesa G Floristic Analysis

Summary table showing the 20-group, 50-group and 100-group levels defined for the current PATN analysis, and the vegetation types and sites from the Mesa A and G study areas within each group.

group 20	group 50	group 100	Cape Preston	Mesa A / Mesa G	Mesa J Extension	MILL	Brockman	WAEIMIWE	WAFCBOR	WASA	Yandi Expansion	Mindy Mindy	Biota Vegetation Mapping Types (and Associated Sites / Reliefs) from the Mesa A and G Study (see Section 4.0 for explanation of vegetation codes)
1	1	1							2	14			
		2								13			
		3								8			
	2	4								4			
		5								2			
	3	6							16				
		7							2	3			
	4	8								5			
9									2				
2	5	10							5			1	
		11							2			1	
		12							1	1			
	6	13						1	1	1			
		14			1	1				1			H7 (MEA08)
	8	15						3		1			
		16						8			1		
		17	1					3			2		
		18									2		
	9	19								17			
20									3				
3	10	21				1			1				
		22									7	1	
		23			1	2							C4 (MESG21)
	12	24				6							
		25									4		
	13	26						9					
27							1				9	4	
28	28										7	2	
	29												
4	14	30							2				
		31							2				
	32				6							2	
5	15	33		2									S1 (MEA14, MEA-ME)
		34									1	10	
6	17	35				2			2				
		36				4							
		37				5							
		38				5							
7	20	39	4										
		40	6										
		41	2										
		42	4										
		43	1										
21	44	1											
	45												
8	22	45	4										
		46											
9	23	47	15										
		48	18										
		49	13										
		50	10										
		51	2										
10	26	52				2				1			
		53				1							
		54				10							
11	29	55								7			
		56								2			
		57	10										
12	31	58									2		
		59	3										
13	32	60	1										
		61							2				H11 (MESG07), H15 (MESG11)
14	33	62				4				1		1	
		63				18							
		64				5							
		65				12							
		66				20							
		67				5							
		68								2		15	13
15	36	69					12						
		70						18					
16	37	71		19									H1 (MEA11, MEA17), H2 (MEA01, MEA02, MEA07, MEA09, MEA12, MEA13, MEA16, MEA18, MEA20, MEA22), H3 (MEA03), H4 (MEA10, MEA21, MEA23), C2 (MEA15, MEA19), C3 (MEA-MY)
		72		5									H8 (MESG15), H9 (MESG14), H10 (MESG06), H11 (MESG05), H7 (MESG13)
		73		4									H5 (MEA04, MEA06), C2 (MEA05), C2/H5 (MEA-NA)
		74		5									H12 (MESG01, MESG16), H16 (MESG19), C2 (MEA-MB), C5 (MESG23)
		75				3							
		76		15		1							
17	40	77					1			13			
		78								1		1	
		79									10		
		80									18		
		81						7					
18	43	82								9			
		83				1							
		84									5		
		85									2		
		86									1		
		87									1		
		88									2		
45	89	89								2			
		90								2			
		91									2		
19	46	92					1			29			
		93								22			
		94									10		
		95									28		
		96									18		
20	48	97								7			
		98								32			
		99									7		
		100									2		
		100									4		

EXPLANATION OF PROJECT CODES
 Cape Preston Cape Preston mine area, west of Dampier (Biota and Trudgen 1998)
 Mesa A / Mesa G Mesa A and Mesa G mine areas (this study)
 Mesa J Extension Mesa J Extension mine area (Biota 2003)
 MILL West Angelas Millstream Roll Segment (Trudgen)
 Brockman Brockman 4 survey area (Biota 2005a)
 WAEIMIWE West Angelas Eight Mile Well survey (Trudgen and Casson 1998)
 WAFCBOR West Angelas Four Corners Bare rail corridor (Trudgen and Casson 1998)
 WASA West Angelas mine area (Trudgen and Casson 1998)
 Yandi Expansion Hamersley Iron Yandi Expansion area (Biota 2004a)
 Mindy Mindy Mindy mine area surveyed as part of FMG Stage 8 rail corridor and mines survey (Biota 2004b)

Colour-coding as follows: **story hills and plains**; gorges and breakaways; **Snakewood** vegetation; **crestlines**; **sand sheets**.



Appendix 2

List of Vascular Flora Recorded
from the Mesa A and Mesa G
Study Areas

Note:

* denotes introduced (weed) species.

Correspondence of *Cassia* / *Senna* nomenclature:

<i>Cassia glutinosa</i>	-	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
<i>Cassia helmsii</i>	-	<i>Senna artemisioides</i> subsp. <i>helmsii</i>
<i>Cassia luerssenii</i>	-	<i>Senna glutinosa</i> subsp. x <i>luerssenii</i>
<i>Cassia notabilis</i>	-	<i>Senna notabilis</i>
<i>Cassia oligophylla</i>	-	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>
<i>Cassia pruinosa</i>	-	<i>Senna glutinosa</i> subsp. <i>pruinosa</i>
<i>Cassia 'stricta'</i>	-	<i>Senna stricta</i>
<i>Cassia venusta</i>	-	<i>Senna venusta</i>

ADIANTACEAE (7)

Cheilanthes brownii

Cheilanthes sieberi subsp. *sieberi*

AIZOACEAE (110)

Trianthema triquetra

AMARANTHACEAE (106)

Alternanthera nana

Amaranthus aff. *interruptus* (MET 16,114)

Amaranthus pallidiflorus

Amaranthus aff. *pallidiflorus* (D89)

Gomphrena affinis subsp. *pilbarensis*

Gomphrena cunninghamii

Ptilotus appendiculatus var. *appendiculatus*

Ptilotus arthrolasius

Ptilotus astrolasius var. *astrolasius*

Ptilotus auriculifolius

Ptilotus axillaris

Ptilotus calostachyus var. *calostachyus*

Ptilotus exaltatus var. *exaltatus*

Ptilotus fusiformis var. *fusiformis*

Ptilotus incanus var. *incanus*

ANTHERICACEAE (54F)

Corynotheca pungens

APIACEAE (281)

Trachymene oleracea subsp. *oleracea*

ASCLEPIADACEAE (305)

Cynanchum floribundum

Sarcostemma viminale subsp. *australe*

ASTERACEAE (345)

**Bidens bipinnata*

Centipeda minima

Flaveria australasica

Pentalepis trichodesmoides

Pluchea dentex

Pluchea rubelliflora

Pluchea tetranthera

Pterocaulon sphaeranthoides

Pterocaulon sphaeranthoides

Rhodanthe margarethae

Streptoglossa bubakii

BORAGINACEAE (310)

Heliotropium cunninghamii

Heliotropium heteranthum

Heliotropium tenuifolium

Heliotropium transforme

Trichodesma zeylanicum var. *zeylanicum*

CAESALPINIACEAE (164)

Cassia glutinosa

Cassia glutinosa x *luerssenii*

Cassia luerssenii

Cassia luerssenii x '*stricta*'

Cassia notabilis

Cassia oligophylla

Cassia aff. *oligophylla* (thinly sericeous)

Cassia oligophylla x *helmsii*

Cassia ? *oligophylla* x

Cassia pruinosa

Cassia pruinosa x *luerssenii*

Cassia venusta

Petalostylis labicheoides

CAPPARACEAE (137A)

Capparis spinosa var. *nummularia*

Cleome uncifera

Cleome viscosa

CARYOPHYLLACEAE (113)

Polycarpaea corymbosa var. *corymbosa*

Polycarpaea longiflora

CHENOPODIACEAE (105)

Chenopodium melanocarpum

Dysphania glomulifera subsp. *eremaea*

Dysphania rhadinostachya subsp. *rhadinostachya*

Rhagodia eremaea

Salsola tragus

CONVOLVULACEAE (307)

Bonamia linearis

Bonamia media var. *villosa*

Bonamia pannosa

Bonamia rosea

Evolvulus alsinoides var. *decumbens*

Evolvulus alsinoides var. *villosicalyx*

Ipomoea muelleri

Porana commixta

CUCURBITACEAE (337)

**Citrullus colocynthis*

Cucumis melo subsp. *agrestis*

Mukia maderaspatana

Mukia sp. D Flora of Australia (A.A.Mitchell PRP 1121)

CYPERACEAE (32)

Bulbostylis barbata

Cyperus bifax

Cyperus cunninghamii subsp. *cunninghamii*

Cyperus difformis

Cyperus hesperius

Cyperus squarrosus

Cyperus vaginatus

Eleocharis atropurpurea

Fimbristylis dichotoma

Fimbristylis microcarpa

ELATINACEAE (235)

Bergia pedicellaris

EUPHORBIACEAE (185)

Euphorbia aff. *australis* (B191)

Euphorbia australis (mid-green form)

Euphorbia biconvexa

Euphorbia boophthona (Large seed form)

Euphorbia careyi

Euphorbia coghlanii

**Euphorbia hirta*

Euphorbia sp. (BPBS10-50)

Euphorbia sp. (MJB-05)

Euphorbia tannensis subsp. *eremophila*
(Hamersley form)

Flueggea virosa subsp. *melanthesoides*

Leptopus decaisnei var. *decaisnei*

Phyllanthus erwinii

Phyllanthus maderaspatensis

GOODENIACEAE (341)

Dampiera candidans

Goodenia forrestii

Goodenia lamprosperma

Goodenia microptera

Goodenia stobbsiana

Scaevola spinescens (broad form)

Velleia connata

GYROSTEMONACEAE (108)

Codonocarpus cotinifolius

HALORAGACEAE (276)

Haloragis gossei

LAMIACEAE (311)

Clerodendrum floribundum var. *angustifolium*

LAURACEAE (131)

Cassytha capillaris

LOBELIACEAE (340)

Lobelia quadrangularis

LORANTHACEAE (97)

Amyema preissii

Diplatia grandibractea

Lysiana casuarinae

LYTHRACEAE (265)

Ammannia baccifera

Ammannia multiflora

MALVACEAE (221)

Abutilon aff. *dioicum* (HD195)

Abutilon aff. *dioicum* (HD72-14)

Abutilon fraseri

Abutilon otocarpum

Abutilon trudgenii

Abutilon sp.

Gossypium australe (Burrup Peninsula form)

Gossypium robinsonii

Hibiscus brachychlaenus

Hibiscus burtonii

Hibiscus coatesii

Hibiscus aff. *coatesii*

Hibiscus leptocladus

Hibiscus platychlamys

Hibiscus aff. *platychlamys* (FMG88-08)

Hibiscus aff. *platychlamys* (site 1139)

Hibiscus sturtii var. aff. *grandiflorus*

Hibiscus sturtii var. *campylochlamys*

Hibiscus aff. *sturtii*

**Malvastrum americanum*

Sida aff. *cardiophylla* (site 1215)

Sida aff. *clementii* (site 664)

Sida echinocarpa

Sida aff. *fibulifera*

Sida rohlena subsp. *rohlena*

Sida sp. Wittenoom (W.R.Barker 1962)

MARSILEACEAE (13)

Marsilea sp.

MIMOSACEAE (163)

Acacia acradenia

Acacia ancistrocarpa

Acacia arida

Acacia atkinsiana

Acacia bivenosa

Acacia citrinoviridis

Acacia colei var. *colei*

Acacia coriacea subsp. *sericophylla*

Acacia elachantha

Acacia farnesiana

Acacia inaequilatera

Acacia maitlandii

Acacia pruinocarpa

Acacia pyrifolia

Acacia synchronicia

Acacia trachycarpa

Acacia tumida var. *pilbarensis*

Acacia xiphophylla

MOLLUGINACEAE (110A)

Mollugo molluginis

MORACEAE (87)

Ficus brachypoda

Ficus opposita var. *indecora*

MYOPORACEAE (326)

Eremophila forrestii subsp. *forrestii*

Eremophila longifolia

MYRTACEAE (273)

Corymbia candida

Corymbia ferritcola subsp. *ferritcola*

Corymbia hamersleyana

Corymbia zygophylla

Eucalyptus camaldulensis

Eucalyptus leucophloia subsp. *leucophloia*

Eucalyptus victrix

NAJADACEAE (24)

Najas sp.

NYCTAGINACEAE (107)

Boerhavia burbridgeana

Boerhavia coccinea

OLEACEAE (301)

Jasminum didymum subsp. *lineare*

PAPAVERACEAE (135)

**Argemone ochroleuca* subsp. *ochroleuca*

PAPILIONACEAE (165)

Crotalaria medicaginea

Cullen lachnostachys

Erythrina vespertilio

Indigofera boviperda subsp. *boviperda*

Indigofera colutea

Indigofera monophylla (grey/green leaflet form)

Indigofera monophylla (small calyx form)

Indigofera monophylla (small leaflet form)

Indigofera sp. (HD19)

Isotropis atropurpurea

Rhynchosia minima var. *australis*

Sesbania cannabina

Swainsona formosa

Tephrosia aff. *rosea* (CH3-47)

Tephrosia densa

Tephrosia rosea var. *glabrior*

Tephrosia sp. B Kimberley Flora (C.A.Gardner 7300)

Tephrosia sp. Bungaroo Creek (M.E.Trudgen 11601)

Tephrosia spechtii

Tephrosia uniovulata

POACEAE (31)

Aristida holathera var. *holathera*

**Cenchrus ciliaris*

Chrysopogon fallax

Cymbopogon ambiguus

**Echinochloa colona*

Enneapogon caerulescens var. *caerulescens*

Eragrostis cumingii

Eragrostis eriopoda

Eragrostis tenellula

Eriachne aristidea

Eriachne helmsii

Eriachne mucronata

Eriachne pulchella subsp. *dominii*

Eriachne tenuiculmis

Eulalia aurea

Paraneurachne muelleri

Paspalidium clementii

Paspalidium rarum

Sporobolus australasicus

Themeda triandra

Triodia epactia

Triodia schinzii

Triodia wiseana

Triodia sp. nov.

Tripogon loliiformis

POLYGALACEAE (183)

Polygala aff. *isingii*

PORTULACACEAE (111)

Calandrinia sp.

Portulaca oleracea

PROTEACEAE (90)

Grevillea eriostachya

Grevillea pyramidalis

Grevillea wickhamii (sterile / form not recorded)

Grevillea wickhamii subsp. *aprica*

Grevillea wickhamii subsp. *hispidula*

Grevillea wickhamii subsp. *macrodonata*

Hakea chordophylla

Hakea lorea subsp. *lorea*

RUBIACEAE (331)

Oldenlandia crouchiana

Oldenlandia galioides

Synaptantha tillaeacea var. *tillaeacea*

SAPINDACEAE (207)

Dodonaea coriacea

SCROPHULARIACEAE (316)

Mimulus gracilis

Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)

Stemodia grossa

SOLANACEAE (315)

**Datura leichhardtii*

Nicotiana benthamiana

Nicotiana occidentalis subsp. *occidentalis*

Nicotiana sp.

Solanum cleistogamum

Solanum diversiflorum

Solanum gabrielae

Solanum horridum

Solanum phlomoides

Solanum sturtianum

STERCULIACEAE (223)

Keraudrenia nephrosperma

Waltheria indica

TILIACEAE (220)

Corchorus incanus

Corchorus sidoides subsp. *sidoides*

Corchorus tridens

Triumfetta chaetocarpa

Triumfetta clementii

Triumfetta johnstonii

Triumfetta maconochieana

VIOLACEAE (243)

Hybanthus aurantiacus

ZYGOPHYLLACEAE (173)

Tribulus astrocarpus

Tribulus hirsutus

Tribulus macrocarpus

Tribulus platypterus

Tribulus suberosus

Appendix 3

Site Data from Quadrats and Relevés Assessed in the Mesa A and Mesa G Study Areas

Vegetation Structural Classification and Condition Scale used for the current survey

Vegetation Structural Classes*

Stratum	70-100% cover	30-70% cover	10-30% cover	2-10% cover	<2% cover
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 / sedgeland / herbland	Tussock grassland / sedgeland / herbland	Open tussock grassland / sedgeland / herbland	Very open tussock grassland / sedgeland / herbland	Scattered tussock grasses / sedges / herbs

* Based on 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; Specht R.L. (1970). Vegetation. In The Australian Environment. 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale*

E = Excellent (=Pristine of BushForever) Pristine or nearly so; no obvious signs of damage caused by the activities of European man.
VG = Very Good (= Excellent of BushForever) Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as * <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.

NB: All coordinates in WGS84 datum, zone 50.

Mesa A Site MEA01

Described by Brian Morgan **Survey date/s** 16/04/03 18/05/04 **Quadrat size** 50x50 m
AMG Zone 50 383170mE, 7603229mN 383168mE, 7603280mN 383124mE, 7603279mN
Habitat Mesa crest - very gently sloping, west facing
Soil Bright orange-brown loam with some fine gravel, a black coarse sand to gravelly surface, and some pebbles
Rock Type Nearby mesa capped with Robe Piezolite
Vegetation *Acacia atkinsiana*, *A. inaequilatera*, *Grevillea wickhamii* tall shrubland over *Triodia wiseana* hummock grassland
Veg Condition Very Good; would be excellent if not burnt repeatedly
Fire Age Last fire >5 years ago; patchy
Notes Some disturbance (earthmoving) along north boundary of plot

Mesa A Site MEA02

Described by Michi Maier **Survey date/s** 17/04/03 17/05/04 **Quadrat size** 40m x 60m
AMG Zone 50 386860mE, 7604181mN 386898mE, 7604175mN 386898mE, 7604115mN 386859mE, 7604120mN
Habitat Mesa crest (very gently sloping, east facing slope, sloping down to eastern edge of Mesa A)
Soil Red-brown fine clay loam with continuous surface layer of ironstone gravel and stones
Rock Type Ironstone
Vegetation *Acacia atkinsiana* open scrub over *Triodia wiseana* hummock grassland
Veg Condition Very good; large part recently burnt
Fire Age Most unburnt for >10 years; SW corner burnt 1-2 years ago
Notes Quadrat shape adjusted to fit between drill lines

Mesa A Site MEA03

Described by Brian Morgan **Survey date/s** 18/04/03 17/05/04 **Quadrat size** 50x50 m
AMG Zone 50 386457mE, 7604189mN 386458mE, 7604239mN 386410mE, 7604239mN 386410mE, 7604185mN
Habitat Mesa crest (very gently undulating to flat surface of Mesa A; gentle slope; SE facing)
Soil Red-brown gravelly, pebbly and cobbly loam
Rock Type Ironstone
Vegetation *Acacia pruinocarpa* scattered low trees to low open woodland over *Acacia atkinsiana*, *A. arida* tall open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent
Fire Age Burnt >7-10 years ago

Mesa A Site MEA04

Described by Brian Morgan **Survey date/s** 18/04/03 17/05/04 **Quadrat size** 50x50 m
AMG Zone 50 387045mE, 7603911mN 387004mE, 7603908mN
Habitat Steep S-facing rocky gully slope below laterite breakaway
Soil Gravelly red loam matrix amongst laterite boulders and rocks on slopes below breakaway
Rock Type Laterite boulders, rocks
Vegetation *Eucalyptus leucophloia* low woodland over *Acacia pruinocarpa* tall open shrubland over *Eriachne mucronata*, *Cymbopogon ambiguus*, *Triodia wiseana* open tussock / hummock grassland
Veg Condition Very good; burnt in recent years
Fire Age Burnt 3 years ago (*Acacia pruinocarpa* re-sprouting)
Notes Breakaway indents to N mid-plot; sampled up to and along base of breakaway and downslope.

Mesa A Site MEA05

Described by Brian Morgan **Survey date/s** 18/04/03 16/05/04 **Quadrat size** 50x50 m
AMG Zone 50 386115mE, 7603980mN 386081mE, 7603911mN
Habitat Bouldery rocky creekline running east-west in narrow gorge with 30-40 m cliff walls, about 10 m wide transect
Soil Bouldery, rocky, cobbly, gravelly red sand
Vegetation *Corymbia candida* scattered low trees to low open woodland over *Acacia tumida* tall open scrub over *Cymbopogon ambiguus*, *Themeda triandra* very open tussock grassland
Veg Condition Very Good to Excellent
Fire Age <2-3 years ago (*Acacia tumida* regenerating ~2m)

Mesa A Site MEA06

Described by Brian Morgan **Survey date/s** 18/04/03 16/05/04 **Quadrat size** 50x50 m
AMG Zone 50 386106mE, 7603985mN
Habitat Scree boulder slopes of deep gorge; adjacent to creekline
Vegetation *Acacia pruinocarpa*, *A. tumida* var. *pilbarensis* low open woodland over *Abutilon* sp. tall open shrubland over *Cassia venusta*, *Triumfetta maconochieana* low open shrubland over *Themeda*

Veg Condition *triandra* open grassland
Fire Age Very Good to Excellent
 Burnt <3-4 years ago

Mesa A Site MEA07

Described by Brian Morgan **Survey date/s** 18/04/03 16/05/04 **Quadrat size** 50x50 m
AMG Zone 385946mE, 7604176mN 385905mE, 7604177mN 385899mE, 7604235mN
Habitat Mesa crest (very gently sloping, SE-facing slope)
Soil Red-brown loam with some small gravel and a surface covered by black coarse sand to gravel, pebbles and some cobbles
Vegetation *Acacia atkinsiana*, *A. arida* tall open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent
Fire Age Burnt >7 years ago

Mesa A Site MEA08

Described by Brian Morgan **Survey date/s** 19/04/03 18/05/04 **Quadrat size** 50x50 m
AMG Zone 50 385797mE, 7605144mN 385777mE, 7605162mN
Habitat Steep north-facing scree slope, below breakaway
Soil Gravelly, pebbly, cobbly brown sandy loam with considerable shale base rock at surface (5-10 %)
Rock Type Shale?
Vegetation *Acacia xiphophylla* low woodland over *Triodia wiseana* hummock grassland
Veg Condition Excellent
Fire Age Burnt >7-10 years ago

Mesa A Site MEA09

Described by Michi Maier **Survey date/s** 19/04/03 18/05/04 **Quadrat size** 50 x 50m
AMG Zone 50 385829mE, 7605005mN 385826mE, 7605065mN 385864mE, 7605058mN 385862mE, 7605002mN
Habitat Mesa crest; flat to very gently sloping (NW)
Soil Red-brown sandy loam with some small gravel and a layer of black coarse sand to gravel on surface
Vegetation *Acacia atkinsiana*, *A. arida* open scrub over *Triodia wiseana* hummock grassland
Veg Condition Very good.
Fire Age Burnt >7 years ago
Notes Some variation with some quite open areas (same species)

Mesa A Site MEA10

Described by Brian Morgan **Survey date/s** 19/04/03 18/05/04 **Quadrat size** 35x65 m
AMG Zone 50 385639mE, 7604686mN 385633mE, 7604744mN 385675mE, 7604746mN 385683mE, 7604690mN
Habitat Mesa crest (flat area)
Soil Red-brown loam with some small gravel with surface covered by black coarse sand to gravel with some cobbles
Vegetation *Acacia atkinsiana*, *A. inaequilatera* scattered tall shrubs over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Very good to Excellent between gridlines
Fire Age Burnt >7 years ago

Mesa A Site MEA11

Described by Brian Morgan **Survey date/s** 20/04/03 18/05/04 **Quadrat size** 35x65 m
AMG Zone 385569mE, 7604740mN 385567mE, 7604806mN 385532mE, 7604803mN
Habitat Mesa crest (flat to very gently NW sloping)
Soil Red-brown gravelly sand with a surface covered by layer of black coarse sand to gravel
Vegetation *Acacia arida* (*A. atkinsiana*) open scrub over *Triodia wiseana* hummock grassland
Veg Condition Very Good; some areas of disturbance adjacent to old drill line
Fire Age Burnt >7-10 years ago
Notes Some old disturbed areas (revegetating) at SE corner of plot adjacent to old drill site

Mesa A Site MEA12

Described by Brian Morgan **Survey date/s** 20/04/03 18/05/04 **Quadrat size** 50x50 m
AMG Zone 50 385149mE, 7604165mN 385101mE, 7604165mN 3851015mE, 7604220mN
Habitat Mesa crest (flat)
Soil Red-brown loam with some gravel, and black coarse sand to gravel layer on surface
Vegetation *Acacia atkinsiana* open scrub over *Triodia wiseana* hummock grassland
Notes Revisit: new gridline installed, no fence dropper found at original coordinates for peg 1; adjacent area surveyed.

Mesa A Site MEA13

Described by Brian Morgan **Survey date/s** 20/04/03 17/05/04 **Quadrat size** 15x100 m
AMG Zone 50 385220mE, 7602981mN 385243mE, 7603070mN 385207mE, 7603991mN

Habitat Mesa crest (very gentle S-facing slope, immediately adjacent to breakaway)
Soil Red-brown sand with some gravel with exposed base rock (laterite / iron conglomerate) and surface layer of black coarse sand to gravel and cobbles
Rock Type Laterite / Iron Conglomerate
Vegetation *Eucalyptus leucophloia* scattered low trees over *Acacia atkinsiana*, *A. arida*, *Grevillea wickhamii* open scrub over *Triodia wiseana* hummock grassland
Veg Condition Very Good to Excellent; recently burnt
Fire Age Burnt 2-3 years ago
Notes Some superficial old disturbance near NE corner of plot (peg P3)

Mesa A Site MEA14

Described by Michi Maier **Survey date/s** 21/04/03 17/05/04 **Quadrat size** 25m x 100m
AMG Zone 50 385056mE, 7602764mN 385067mE, 7602824mN 385094mE, 7602825mN 385086mE, 7602762mN
Habitat Crest and upper slopes of small red sand dune (oriented N-S and about 5 m high)
Soil Red sand with thin layer of black sand on surface in places
Vegetation *Acacia tumida* var. *pilbarensis* (*Grevillea wickhamii*) open scrub over *Indigofera boviparda* subsp. *boviparda* low open shrubland over *Triodia schinzii* mid-dense hummock grassland
Veg Condition Very good; some sand removed from dune near parking area; recently burnt and indications of frequent periodic fires in past eg. no very mature *Acacia tumida*.
Fire Age Burnt ~4-5 years ago
Notes Quadrat shape modified to fit crest of dune. Sand dune sits above breakaways to the south (Mesa breakaway) and west (breakaway over deep, steep gully). 50 m of dune already mined from north side. Full dune length is about 100-150 m long and 60 m wide. South end of sand dune has lots of *Tephrosia* sp. B.

Mesa A Site MEA15

Described by Brian Morgan **Survey date/s** 21/04/03 17/05/04 **Quadrat size** 100x25 m
AMG Zone 50 384984mE, 7602744mN 385031mE, 7602658mN
Habitat Banks of creek in a gorge
Soil Deep red sand to loamy sand (80 cm to 1.2 m deep)
Vegetation *Corymbia hamersleyana* (*Eucalyptus leucophloia*) scattered low trees over *Acacia tumida* var. *pilbarensis* (*Grevillea wickhamii*) tall scrub over *Petalostylis labicheoides* open shrubland over *Aristida holathera* var. *holathera*, *Paraneurachne muelleri*, *Triodia wiseana*, *T. epactia* scattered tussock / hummock grasses
Veg Condition Very Good to Excellent; frequent burning
Fire Age Burnt <2-3 years ago
Notes Plot shape modified to fit creekline. Only recorded vegetation on immediate creek banks (quite steep, high banks - about 80 cm to 1.2 m high); did not include flood plain.

Mesa A Site MEA16

Described by Brian Morgan **Survey date/s** 22/04/03 **Quadrat size** 50 x 50m
AMG Zone 50 384328mE, 7603329mN 384354mE, 7603332mN 384366mE, 7603393mN
Habitat Mesa crest (flat area)
Soil Red-brown sand with some small gravel and a layer of black coarse sand (some gravel) on surface
Vegetation *Corymbia hamersleyana* low scattered trees over *Acacia atkinsiana* (*A. inaequilatera*) tall shrubland to open scrub over *Tephrosia uniovulata*, *Corchorus sidioides* subsp. *sidioides* low open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Very good
Fire Age Burnt <3 years ago

Mesa A Site MEA17

Described by Brian Morgan **Survey date/s** 22/04/03 18/05/04 **Quadrat size** 50x50
AMG Zone 50 383941mE, 7602987mN 383944mE, 7602927mN 383981mE, 7602923mN 383976mE, 7602990mN
Habitat Mesa crest (flat area)
Soil Red-brown loam with some gravel and a layer of black coarse sand to fine gravel with areas of scattered gravel and occasional cobbles
Vegetation *Acacia arida* tall shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent; some disturbance in adjacent areas (ie. old grid lines)
Fire Age Burnt >5-7 years ago
Notes Revisit: new grid line through middle of plot (peg 3); not surveyed as part of revisit by BM)

Mesa A Site MEA18

Described by Brian Morgan **Survey date/s** 22/04/03 18/05/04 **Quadrat size** 50x50 m
AMG Zone 50 384146mE, 7602910mN 384145mE, 7602850mN 384186mE, 7602853mN 384189mE, 7602912mN
Habitat Mesa crest (flat to sloping very gently WNW)
Soil Red-brown sand with some gravel and a surface layer of black coarse sand to gravel with some cobbles

Vegetation *Acacia atkinsiana*, *A. arida* tall shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent
Fire Age Mostly burnt >7 years ago
Notes Small area at SW corner was burnt 2-3 years ago. *Corchorus sidioides* subsp. *sidioides* only seen in burnt area.

Mesa A Site MEA19

Described by Brian Morgan **Survey date/s** 24/04/03 18/05/04 **Quadrat size** 100x25 m
AMG Zone 50 383954mE, 7603469mN 383880mE, 7603535mN
Habitat Flowline (sandy gravelly creek bed ~5 m wide in a broad gully, gently sloping down to north)
Soil Red-brown sand amongst rock and baserock
Vegetation *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* closed scrub over *Acacia atkinsiana* open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Very Good to Excellent
Fire Age Burnt <2-3 years ago
Notes Plot shape modified to fit creek.

Mesa A Site MEA20

Described by Brian Morgan **Survey date/s** 23/04/03 18/05/04 **Quadrat size** 50x50 m
AMG Zone 50 383577mE, 7603012mN 383545mE, 7603011mN 383545mE, 7602943mN 383578mE, 7602946mN
Habitat Mesa crest (flat to very gently sloping SW)
Soil Red-brown gravelly sand with a thin layer of black coarse sand to gravel pebbles and few cobbles on surface
Vegetation *Acacia inaequilatera* scattered tall shrubs over *Acacia atkinsiana*, *A. arida* tall shrubland over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; disturbance (old grid) along west boundary of plot
Fire Age Burnt >7-10 years ago
Notes New gridline now goes through where peg 1 was; this peg now on ground by side of new gridline.

Mesa A Site MEA21

Described by Brian Morgan **Survey date/s** 24/04/03 18/05/04 **Quadrat size** 33x67 m
AMG Zone 50 383148mE, 7602776mN 383185mE, 7602778mN 383189mE, 7602709mN 383154mE, 7602709mN
Habitat Mesa crest (flat area with very gentle slope to W or a very slight depression (difficult to pick))
Soil Red-brown loam with surface layer of black coarse sand to gravel
Vegetation *Corymbia zygophylla* scattered low trees over *Acacia atkinsiana*, *A. ancistrocarpa*, *Grevillea wickhamii* tall shrubland over *Acacia bivenosa* open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Very Good to Excellent
Fire Age Burnt 3-4 years ago.

Mesa A Site MEA22

Described by Brian Morgan **Survey date/s** 25/04/03 16/05/04 **Quadrat size** 55x45 m
AMG Zone 50 386149mE, 7604109mN 386148mE, 7604053mN 386104mE, 7604049mN 386105mE, 7604104mN
Habitat Mesa crest (gentle slope SE)
Soil Red-brown gravelly, pebbly, cobbly loam
Rock Type Ironstone
Vegetation *Acacia pruinocarpa* low open woodland over *Acacia atkinsiana* scattered tall shrubs over *Triodia wiseana* hummock grassland
Veg Condition Excellent (some disturbance along edges)
Fire Age Burnt >10 years ago.
Notes Adjacent to creekline at head of main gorge / gully.

Mesa A Site MEA23

Described by Michi Maier **Survey date/s** 16/05/04 **Quadrat size** 50m x 50m
AMG Zone 50 382615mE, 7602750mN
Habitat Mesa crest
Soil Red-brown fine sandy clay loam with continuous surface layer of buckshot gravel and hardset surface
Vegetation *Acacia atkinsiana* tall shrubland over *Acacia bivenosa* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age No sign of recent fire; long unburnt
Notes Fauna trapping site

Mesa A Site MEA-MA

Described by Michi Maier **Survey date/s** **Quadrat size** Relevé
AMG Zone 50 386197mE, 7603753mN
Habitat Gorge
Vegetation As per MEA05 and MEA06

Mesa A Site MEA-MB

Described by Michi Maier **Survey date/s** 17/05/04 **Quadrat size** Relevé
AMG Zone 50 386163mE, 7604619mN 386303mE, 7604725mN
Habitat Very small gully
Vegetation *Eucalyptus leucophloia* low open woodland over *Acacia atkinsiana* shrubland over *Acacia arida* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland

Mesa A Site MEA-MD

Described by Michi Maier **Survey date/s** **Quadrat size** Relevé
AMG Zone 50 385068mE, 7602718mN
Habitat Rocky edge of hill
Vegetation *Acacia arida*, *A. tumida* tall shrubland over *Triodia wiseana* hummock grassland
Notes Collections around the rocky edge of a hill

Mesa A Site MEA-ME

Described by Michi Maier **Survey date/s** **Quadrat size** Relevé
AMG Zone 50 385217mE, 7602715mN
Habitat Extensive sand drift at base of hill
Soil Red sand
Vegetation *Corymbia zygophylla* scattered low trees over *Grevillea eriostachya* scrub over *Triodia schinzii* hummock grassland
Veg Condition Excellent

Mesa A Site MEA-MF

Described by Michi Maier **Survey date/s** 18/05/04 **Quadrat size** Relevé
AMG Zone 50 383419mE, 7601249mN
Habitat Drainage line through mesa crest
Vegetation *Corymbia hamersleyana* low open woodland over *Acacia trachycarpa* open heath over *Triodia epactia* mid-dense hummock grassland

Mesa A Site MEA-MY

Described by Michi Maier **Survey date/s** 18/05/04 **Quadrat size** Relevé
AMG Zone 50 383282mE, 7601447mN
Habitat Bowl-shaped depression; ~drainage area
Vegetation *Corymbia hamersleyana* low open woodland over *Acacia arida* shrubland over *Triodia epactia* (*T. wiseana*) mid-dense hummock grassland

Mesa G Site MESG01

Described by Brian Morgan **Survey date/s** 10/05/04 **Quadrat size** 50x50 m
AMG Zone 50 409043mE, 7596205mN 409034mE, 7596156mN 409083mE, 7596148mN 409091mE, 7596197mN
Habitat Mesa crest
Soil Red-brown clayey loam with piezolite on surface
Rock Type Ironstone
Vegetation *Acacia atkinsiana*, *A. inaequilatera*, *Petalostylis labicheoides* tall shrubland over *Tephrosia uniovulata* open shrubland over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt <4-5 years ago; still a lot of burnt stems.

Mesa G Site MESG02

Described by Michi Maier **Survey date/s** 10/05/04 **Quadrat size** 100x25 m
AMG Zone 50 409729mE, 7596202mN 409643mE, 7596251mN 409648mE, 7596276mN 409742mE, 7596224mN
Habitat Broad gully
Soil Red-brown clay loam with continuous surface layer of ironstone pebbles and stones
Vegetation *Corymbia hamersleyana* scattered low trees over *Petalostylis labicheoides*, *Grevillea wickhamii* subsp. *hispidula* tall open shrubland over *Acacia acradenia* open heath over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no signs of disturbance.
Fire Age Burnt 4-5 years ago
Notes Single large termite mound in plot.

Mesa G Site MESG03

Described by Brian Morgan **Survey date/s** 10/05/04 **Quadrat size** 25 x 85 m
AMG Zone 50 407862mE, 7595886mN 407889mE, 7595887mN 407922mE, 7595814mN 407908mE, 7595793mN
Habitat Narrow gully
Soil Red-brown sandy loam
Rock Type Ironstone
Vegetation *Corymbia hamersleyana* scattered low trees over *Acacia acradenia* open heath over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no weeds
Fire Age Burnt 5-6 years ago; 40-45 cm high hummocks

Mesa G Site MESG04

Described by Michi Maier **Survey date/s** 10/05/04 **Quadrat size** 100x25 m
AMG Zone 50 407464mE, 7595850mN 407461mE, 7595874mN 407541mE, 7595920mN 407551mE, 7595897mN
Habitat Mesa crest
Soil Red-brown fine sandy loam with continuous surface layer of ironstone gravel and occasional stones
Vegetation *Acacia acradenia* open heath to low open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent to Very Good; only disturbance is frequent exploration tracks in area; no weeds.
Fire Age Burnt 4-5 years ago
Notes Occasional large termite mound on mesa crest.
Notes Quadrat shape adjusted to try to avoid tracks, but still contains short stretch of track at eastern end.

Mesa G Site MESG05

Described by Brian Morgan **Survey date/s** 11/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 406030mE, 7595842mN 406075mE, 7595817mN 406050mE, 7595773mN 406007mE, 7595798mN
Habitat Stony plain fringing hill
Soil Red-brown loamy sand
Rock Type Ironstone
Vegetation *Acacia synchronicia* tall open shrubland over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Unburnt for at least 10 years

Mesa G Site MESG06

Described by Michi Maier **Survey date/s** 11/05/04 **Quadrat size** 50 x 50m
AMG Zone 50 407377mE, 7597699mN 407424mE, 7597679mN 407408mE, 7597630mN 407361mE, 7597652mN
Habitat Plain
Soil Red-brown clay loam with hard-set surface and scatters of buckshot and ironstone pebbles on surface
Rock Type Ironstone
Vegetation *Acacia atkinsiana* (*A. bivenosa*) open shrubland over *Triodia epactia*, *T. wiseana* mid-dense hummock grassland
Veg Condition Excellent; cattle dung, but no obvious signs of grazing.
Fire Age Burnt ~5 years ago

Mesa G Site MESH07

Described by Brian Morgan **Survey date/s** 11/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 406462mE, 7596130mN 406432mE, 7596165mN 406397mE, 7596130mN 406431mE, 7596093mN
Habitat Rocky slope of low rise (N-facing)
Soil Red-brown sandy loam
Rock Type Ironstone
Vegetation *Acacia synchronicia*, *A. inaequilatera* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no weeds or disturbance.
Fire Age Burnt <3-4 years ago

Mesa G Site MESH08

Described by Michi Maier **Survey date/s** 11/05/04 **Quadrat size**
AMG Zone 50 406686mE, 7595658mN 406666mE, 7595561mN 406690mE, 7595551mN 406710mE, 7595650mN
Habitat Upper slope and crest of rocky hill (spur)
Soil Red-brown sandy loam with continuous surface layer of ironstone gravel, stones and rocks
Rock Type Ironstone
Vegetation *Acacia inaequilatera* scattered tall shrubs over *Acacia ancistrocarpa*, *A. acradenia* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; occasional track is only disturbance. No weeds.
Fire Age Burnt ~3 years ago

Mesa G Site MESH09

Described by Brian Morgan **Survey date/s** 11/05/04 **Quadrat size** 10 x 200 m
AMG Zone 50 406651mE, 7595377mN 406660mE, 7595380mN 406775mE, 7595229mN 406774mE, 7595219mN
Habitat Narrow rocky creek bed
Rock Type Ironstone
Vegetation *Corymbia hamersleyana* scattered low trees over *Acacia tumida* var. *pilbarensis* (*Petalostylis labicheoides*) tall open scrub over *Acacia acradenia* open shrubland over *Triodia wiseana* open hummock grassland
Fire Age Burnt <7-10 years ago
Notes Quadrat shape adjusted to fit creek.

Mesa G Site MESH10

Described by Michi Maier **Survey date/s** 11/05/04 **Quadrat size** 50x50 m
AMG Zone 50 406551mE, 7595411mN 406600mE, 7595404mN 406592mE, 7595355mN 406543mE, 7595361mN
Habitat Upper reaches of gully and surrounding hillslopes
Soil Red-brown fine sandy loam with continuous surface layer of ironstone gravel stones and rocks
Rock Type Ironstone
Vegetation *Acacia acradenia* open heath over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt ?3 years ago

Mesa G Site MESH11

Described by Brian Morgan **Survey date/s** 11/05/04 **Quadrat size** 35x50 m
AMG Zone 50 405038mE, 7594369mN 405010mE, 7594346mN 405000mE, 7594395mN 405025mE, 7594418mN
Habitat Low ridge on edge of mesa
Soil Red-brown sandy loam
Rock Type Ironstone
Vegetation *Eucalyptus leucophloia* scattered low trees over *Acacia acradenia*, *Cassia pruinosa* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt >4-5 years ago
Notes *Acacia acradenia* on creek lines and lower to mid slopes only; *Eucalyptus leucophloia* mainly on slopes of gullies, not ridge tops.

Mesa G Site MESH12

Described by Michi Maier **Survey date/s** 11/05/04 **Quadrat size** 50x50 m
AMG Zone 50 404974mE, 7594291mN 405015mE, 7594263mN 404990mE, 7594221mN 404947mE, 7594249mN
Habitat Slope of broad gully
Soil Red-brown fine sandy loam with continuous surface layer of ironstone pebbles, stones and rocks
Rock Type Ironstone
Vegetation *Eucalyptus leucophloia* low open woodland over *Acacia acradenia* scattered shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt ?5+ years ago

Mesa G Site MESH13

Described by Brian Morgan **Survey date/s** 12/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 405546mE, 7595244mN 405588mE, 7595217mN 405618mE, 7595259mN 405574mE, 7595286mN
Habitat Flat plain (very gentle NW slope)
Soil Red-brown gravelly loamy clay
Rock Type Ironstone
Vegetation *Acacia xiphophylla* tall open shrubland (to open scrub in places) over *Triodia wiseana*, *T. epactia* mid-dense hummock grassland
Veg Condition Excellent; no weeds or disturbance.
Fire Age Burnt >7-10 years ago

Mesa G Site MESH14

Described by Michi Maier **Survey date/s** 12/05/04 **Quadrat size** 50x50 m
AMG Zone 50 404396mE, 7594771mN 404440mE, 7594795mN 404464mE, 7594751mN 404420mE, 7594727mN
Habitat Low stony plain (very gradually sloping footslopes of range of hills to south of plot)
Soil Red-brown fine sandy loam with continuous surface layer of ironstone gravel
Rock Type Ironstone
Vegetation *Acacia bivenosa*, *A. inaequilatera* open shrubland over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt >5 years ago
Notes Scattered low trees of *Corymbia hamersleyana* outside plot.

Mesa G Site MESH15

Described by Brian Morgan **Survey date/s** 12/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 405094mE, 7594988mN 405143mE, 7594997mN 405152mE, 7594948mN 405103mE, 7594939mN
Habitat Plains at base of mesa (very gentle NW slope)
Soil Red-brown loam
Vegetation *Acacia citrinoviridis* scattered tall shrubs over *Acacia bivenosa*, *A. ancistrocarpa* tall shrubland over *Triodia wiseana* (*T. epactia*) mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt <4-5 years ago

Mesa G Site MESH16

Described by Michi Maier **Survey date/s** 12/05/04 **Quadrat size** 30x83 m
AMG Zone 50 408345mE, 7595575mN 408375mE, 7595574mN 408374mE, 7595491mN 408343mE, 7595491mN
Habitat Mesa crest
Soil Red-brown skeletal fine sandy loam with continuous surface layer of ironstone gravel and occasional stones
Rock Type Ironstone
Vegetation *Acacia atkinsiana* tall open scrub over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no signs of disturbance apart from tracks.
Fire Age Burnt >5 years ago
Notes Quadrat shape adjusted to fit between grid line and edge of mesa.

Mesa G Site MESH17

Described by Brian Morgan **Survey date/s** 12/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 406687mE, 7594525mN 406638mE, 7594519mN 406644mE, 7594469mN 406693mE, 7594475mN
Habitat Crest of low spur (gentle slope to S)
Soil Red-brown gravelly, sandy loam
Rock Type Ironstone
Vegetation *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no weeds or disturbance.
Fire Age Burnt >4-5 years ago

Mesa G Site MESH18

Described by Michi Maier **Survey date/s** 13/05/04 **Quadrat size** 50x50 m
AMG Zone 50 407145mE, 7594524mN 407189mE, 7594545mN 407212mE, 7594503mN 407168mE, 7594478mN
Habitat Low stony plain (very gradually sloping footslopes of range of hills to north)
Soil Red-brown fine sandy clay loam with continuous surface layer of ironstone pebbles and stones
Rock Type Ironstone
Vegetation *Acacia inaequilatera* scattered tall shrubs over *Acacia bivenosa*, *A. acradenia* open shrubland over *Triodia wiseana* hummock grassland
Veg Condition Excellent
Fire Age Burnt ?3-4 years ago
Notes Scattered low trees of *Corymbia hamersleyana* outside plot.

Mesa G Site MESH19

Described by Brian Morgan **Survey date/s** 12/05/04 **Quadrat size**
AMG Zone 50 408188mE, 7595728mN 408117mE, 7595590mN
Habitat Mesa crest (very gentle NW slope; adjacent to breakaway)
Soil Red-brown gravelly loam amongst exposed sheet rock (rock ~60-70% surface cover)
Rock Type Ironstone
Vegetation *Acacia tumida* var. *pillbarensis* (*Petalostylis labicheoides*) tall closed scrub over *Acacia acradenia*
low open shrubland over *Triodia wiseana* (*Triodia* sp. nov.) very open hummock grassland
Veg Condition Excellent
Fire Age Burnt <5-7 years ago.
Notes Less *Acacia tumida* at southern end of plot. *Triodia* sp. nov. occurs in scattered intermittent patches; more around southern end (peg 2).

Mesa G Site MESH20

Described by Michi Maier **Survey date/s** 13/05/04 **Quadrat size** 20x130 m
AMG Zone 50 410255mE, 7596186mN 410257mE, 7596052mN 410243mE, 7596057mN 410238mE, 7596201mN
Habitat Flowline through stony footslope
Soil Red-brown shallow fine sandy loam with occasional ironstone rocks
Rock Type Ironstone
Vegetation *Eucalyptus leucophloia*, *Corymbia hamersleyana* low open woodland over *Acacia tumida* var. *pillbarensis* tall closed scrub over *Triodia wiseana*, *Triodia* sp. nov. hummock grassland
Veg Condition Excellent
Fire Age Burnt >5 years ago.
Notes Quadrat shape adjusted to fit flowline. Further south, get into a more rocky, deeper gully with more *Eucalyptus leucophloia*, less *Acacia tumida* and some *Acacia acradenia* over *Triodia wiseana* etc.

Mesa G Site MESH21

Described by Brian Morgan **Survey date/s** 13/05/04 **Quadrat size** 160 x 15 m
AMG Zone 50 406587mE, 7594222mN 406738mE, 7594278mN
Habitat Banks of wide river (Robe River)
Soil Red-brown clayey loam
Vegetation *Eucalyptus camaldulensis* woodland over *Eucalyptus victrix* low woodland over *Acacia trachycarpa*, *A. pyrifolia*, *Petalostylis labicheoides* tall open shrubland over mixed open herbland and *Triodia wiseana* open hummock grassland
Veg Condition Very Good; a few weeds
Fire Age Probably burnt >7-10 years ago

Mesa G Site MESH22

Described by Michi Maier **Survey date/s** 13/05/04 **Quadrat size** 50x50 m
AMG Zone 50 411680mE, 7596039mN 411727mE, 7596026mN 411713mE, 7595982mN 411667mE, 7595996mN
Habitat Mesa crest
Soil Red-brown fine sandy loam with continuous surface layer of ironstone pebbles and stones
Rock Type Ironstone
Vegetation *Grevillea wickhamii* tall shrubland over *Acacia acradenia* open heath over *Triodia wiseana*
hummock grassland
Veg Condition Excellent; occasional track
Fire Age Burnt >5-7 years ago

Mesa G Site MESH23

Described by Brian Morgan **Survey date/s** 13/05/04 **Quadrat size** 10 x 140 m
AMG Zone 50 410064mE, 7596174mN 410053mE, 7596174mN 410090mE, 7590041mN 410072mE, 7596042mN
Habitat Lower slopes of gully and creek bed in base
Soil Red-brown gravelly, cobbly bouldery sand
Rock Type Ironstone
Vegetation *Eucalyptus leucophloia* low woodland over *Petalostylis labicheoides*, *Grevillea wickhamii*
scattered tall shrubs over *Acacia acradenia* open heath over *Triodia wiseana* (*Triodia* sp. nov.)
mid-dense hummock grassland
Veg Condition Excellent; no weeds
Fire Age Burnt 5-6 years ago

Mesa G Site MESH24

Described by Brian Morgan **Survey date/s** 15/05/04 **Quadrat size**
AMG Zone 50 409093mE, 7596540mN 409188mE, 7596506mN 409171mE, 7596487mN 409093mE, 7596514mN
Habitat Lower to mid-slope of colluvial spur (moderate slope, N-facing)
Soil Red-brown gravelly, pebbly, cobbly, loam amongst exposed ironstone sheet rock
Rock Type Ironstone
Vegetation *Acacia acradenia* scattered tall shrubs over *Triodia wiseana* hummock grassland

Veg Condition Excellent
Fire Age Burnt 7-10 years ago
Notes Most of the valley burnt <1.5 years ago., but this small area of lower-midslope not recently burnt.

Mesa G Site MESH25

Described by Brian Morgan **Survey date/s** 13/05/04 **Quadrat size** 50 x 50 m
AMG Zone 50 411372mE, 7595955mN 411423mE, 7595965mN 411435mE, 7595916mN 411385mE, 7595906mN
Habitat Lower slope of a low rise
Soil Red-brown gravelly loam
Rock Type Ironstone
Vegetation *Acacia inaequilatera*, *Hakea chordophylla* scattered tall shrubs over *Acacia acradenia* scattered low shrubs over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent
Fire Age Burnt <5-6 years ago

Mesa G Site MESH27

Described by Brian Morgan **Survey date/s** 15/05/04 **Quadrat size** 120 x 20
AMG Zone 50 412071mE, 7595642mN 412089mE, 7595632mN 412022mE, 7595538mN 412008mE, 7595538mN
Habitat Steep upper slope of gully (includes E-facing breakaway and area below)
Soil Red-brown pebbly, cobbly bouldery loam
Rock Type Ironstone
Vegetation *Eucalyptus leucophloia* scattered low trees over *Acacia acradenia* open shrubland over *Triodia wiseana* mid-dense hummock grassland
Veg Condition Excellent; no weeds or disturbance.
Fire Age Burnt at least 5-6 years ago
Notes *Ficus brachypoda* growing on upslope edge of breakaway. *Triodia* sp. nov. often at base of breakaway and along steep creeklines flowing down with the deep gully. *Eriachne mucronata* at base of rocky breakaway.

Mesa G Site MESH-MA

Described by Michi Maier **Survey date/s** 13/05/04 **Quadrat size** Relevé
AMG Zone 50 406414mE, 7593992mN
Habitat River (Robe River)
Soil Coarse sand; wet in places
Vegetation *Eucalyptus camaldulensis* woodland over patches of sedges and herbs, with *Eucalyptus victrix* woodland on raised areas

Mesa G Site MESH-MB

Described by Michi Maier **Survey date/s** 13/05/04 **Quadrat size** Relevé
AMG Zone 50 407114mE, 7594370mN 406587mE, 7594222mN
Habitat River (Robe River)
Soil Red-brown clay loam on banks; coarse sand in bed
Vegetation *Eucalyptus victrix* woodland over *Triodia wiseana* hummock grassland on banks; *Eucalyptus camaldulensis* woodland over herbs in bed

Mesa G Site MESH-MC

Described by Michi Maier **Survey date/s** 15/05/04 **Quadrat size** Relevé
AMG Zone 50 409165mE, 7596534mN 409032mE, 7596568mN 408606mE, 7596694mN
Habitat Creekline in base of gorge
Vegetation *Corymbia hamersleyana*, *Eucalyptus leucophloia* low woodland over patches of *Petalostylis labicheoides*, *Acacia tumida* (*A. atkinsiana*) tall open scrub over *Triodia wiseana* open hummock grassland

Mesa G Site MESH-MZ

Described by Michi Maier **Survey date/s** 05/04 **Quadrat size** Relevé
AMG Zone 50 406202mE, 7595622mN
Habitat Rocky outcrop
Vegetation *Acacia bivenosa* scattered shrubs over *Triodia wiseana* open hummock grassland and *Eriachne mucronata* scattered tussock grasses

Species	Mesa A Sites																													
	MEA 01	MEA 02	MEA 03	MEA 04	MEA 05	MEA 06	MEA 07	MEA 08	MEA 09	MEA 10	MEA 11	MEA 12	MEA 13	MEA 14	MEA 15	MEA 16	MEA 17	MEA 18	MEA 19	MEA 20	MEA 21	MEA 22	MEA 23	MEA-MA	MEA-MB	MEA-MD	MEA-ME	MEA-MF	MEA-MY	MEA-OPP
<i>Codonocarpus cotinifolius</i>	0																													
<i>Corchorus incanus</i>																														1
<i>Corchorus sidoides</i> subsp. <i>sidoides</i>	0	0		0	0	0				1	1	0	0		0	0	0	0					1	1				1	1	1
<i>Corchorus tridens</i>																														
<i>Corymbia candida</i>					0																								1	1
<i>Corymbia ferritcola</i> subsp. <i>ferritcola</i>																														1
<i>Corymbia hamersleyana</i>														0	0	0								1					1	1
<i>Corymbia zygophylla</i>																					0						1			
<i>Corynotheca pungens</i>														0																
<i>Crotalaria medicaginea</i>																														
<i>Cucumis melo</i> subsp. <i>agrestis</i>				1																										
<i>Cullen lachnostachys</i>																														1
<i>Cymbopogon ambiguus</i>				0	0	1																		1						
<i>Cynanchum floribundum</i>																														
<i>Cyperus bifax</i>																														
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>																														
<i>Cyperus difformis</i>																														
<i>Cyperus hesperius</i>						0																								
<i>Cyperus squarrosus</i>																														
<i>Cyperus vaginatus</i>																														
<i>Dampiera candidans</i>													0	0	0						0								1	1
* <i>Datura leichhardtii</i>																														
<i>Diplatia grandibractea</i>																														
<i>Dodonaea coriacea</i>	0												0							0	0						1			
<i>Dysphania glomulifera</i> subsp. <i>eremaea</i>																														
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>		0		1			1		1	0	1		0		0	0	0				1	0	1	1					1	
* <i>Echinochloa colona</i>																														
<i>Eleocharis atropurpurea</i>																														
<i>Enneapogon caeruleus</i> var. <i>caeruleus</i>																														
<i>Eragrostis cumingii</i>																														
<i>Eragrostis eriopoda</i>														0	0														1	1
<i>Eragrostis tenellula</i>																														
<i>Eremophila forrestii</i> subsp. <i>forrestii</i>																														1
<i>Eremophila longifolia</i>																								1						
<i>Eriachne aristidea</i>																						1								
<i>Eriachne helmsii</i>																0											1		1	1
<i>Eriachne mucronata</i>				0	1	0		0					0	0							0			1						
<i>Eriachne pulchella</i> subsp. <i>dominii</i>		1	1						1	1												1							1	1
<i>Eriachne tenuiculmis</i>																								1						
<i>Erythrina vespertilio</i>																														
<i>Eucalyptus camaldulensis</i>																														
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>				0	0							0	0							0				1	1					
<i>Eucalyptus victrix</i>																														
<i>Eulalia aurea</i>																														1
<i>Euphorbia australis</i> (mid-green form)		1			1					1	0				0					1		1			1				1	
<i>Euphorbia</i> aff. <i>australis</i> (B191)																														1
<i>Euphorbia biconvexa</i>																														
<i>Euphorbia boophthona</i> (Large seed form)				1							0						0				1	1	1	1				1		
<i>Euphorbia careyi</i>																														
<i>Euphorbia coghlanii</i>															1															
* <i>Euphorbia hirta</i>																														
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i> (Hamersley form)				1																										
<i>Euphorbia</i> sp. (BPBS10-50)									1																					
<i>Euphorbia</i> sp. (MJB-05)																														
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>																														
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>				1	1	1									0															1
<i>Ficus brachypoda</i>						0																								1
<i>Ficus opposita</i> var. <i>indecora</i>					1	1																								
<i>Fimbristylis dichotoma</i>																							1							
<i>Fimbristylis microcarya</i>																														
<i>Flaveria australasica</i>																														
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>																														
<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>					1	1																								
<i>Gomphrena cunninghamii</i>						1																		1						1
<i>Goodenia forrestii</i>																														1
<i>Goodenia lamprosperma</i>																														
<i>Goodenia microptera</i>				1											0						0	1		1					1	1

Species	Mesa A Sites																														
	MEA 01	MEA 02	MEA 03	MEA 04	MEA 05	MEA 06	MEA 07	MEA 08	MEA 09	MEA 10	MEA 11	MEA 12	MEA 13	MEA 14	MEA 15	MEA 16	MEA 17	MEA 18	MEA 19	MEA 20	MEA 21	MEA 22	MEA 23	MEA-MA	MEA-MB	MEA-MD	MEA-ME	MEA-MF	MEA-MY	MEA-OPP	
<i>Porana commixta</i>				1	0	0																		1							
<i>Portulaca oleracea</i>									1								1					1		1							
<i>Pterocaulon sphacelatum</i>																															
<i>Pterocaulon sphaeranthoides</i>																															
<i>Ptilotus appendiculatus</i> var. <i>appendiculatus</i>																															
<i>Ptilotus arthrolasius</i>														0														1		1	
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>				1									1			0						1		1					1		
<i>Ptilotus auriculifolius</i>																															
<i>Ptilotus axillaris</i>									1																						
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>		0											0		0	0	0		1		1								1	1	
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>																								1							
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>															0	0	0						1							1	
<i>Ptilotus incanus</i> var. <i>incanus</i>												0																			
<i>Rhagodia eremaea</i>				0																											
<i>Rhodanthe margarethae</i>				0	0	0																									
<i>Rhynchosia minima</i> var. <i>australis</i>																												1		1	
<i>Salsola tragus</i>									1																						
<i>Sarcostemma viminalis</i> subsp. <i>australe</i>				0																											
<i>Scaevola spinescens</i> (broad form)																								1						1	
<i>Sesbania cannabina</i>																															
<i>Sida</i> aff. <i>cardiophylla</i> (site 1215)	0	0			1								0		0	0		0	0	0									1	1	1
<i>Sida</i> aff. <i>clementii</i> (site 664)																														1	
<i>Sida echinocarpa</i>																0								1						1	1
<i>Sida</i> aff. <i>fibulifera</i>				0	1	0									0									1						1	1
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>					0	0							0		0									1						1	1
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)																0								1						1	1
<i>Solanum cleistogamum</i>																															
<i>Solanum diversiflorum</i>													0																		
<i>Solanum gabrielae</i>				1		0																		1							1
<i>Solanum horridum</i>					0	0		0					0		0				0												
<i>Solanum phlomoides</i>													0	1	1														1		1
<i>Solanum sturtianum</i>																0	0				0		1	1						1	1
<i>Sporobolus australasicus</i>		1		1				1														1									1
<i>Stemodia grossa</i>																															
<i>Streptoglossa bubakii</i>		0		1								1				0	0						1								
<i>Swainsona formosa</i>																															
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>																															1
<i>Tephrosia densa</i>																															
<i>Tephrosia rosea</i> var. <i>glabrior</i>																															
<i>Tephrosia</i> aff. <i>rosea</i> (CH3-47)																															
<i>Tephrosia spechtii</i>																															
<i>Tephrosia</i> sp. B Kimberley Flora (C.A. Gardner 7300)														0	0																1
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)																															1
<i>Tephrosia uniovulata</i>	0	0											0		0	0	0		0			0									1
<i>Themeda triandra</i>				0	0	0																									1
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>				1								1												1							
<i>Trianthema triquetra</i>								1																							
<i>Tribulus astrocarpus</i>																		1						1						1	
<i>Tribulus hirsutus</i>																															
<i>Tribulus macrocarpus</i>																1															1
<i>Tribulus platypterus</i>																															
<i>Tribulus suberosus</i>									0																						1
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>		0		0	0			1					0		0	0						1	1	1							
<i>Triodia epactia</i>																						0								1	1
<i>Triodia schinzii</i>														0	1														1		1
<i>Triodia wiseana</i>	0	0	0	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1				1	
<i>Triodia</i> sp. nov.																															
<i>Tripogon loliiformis</i>				1																											
<i>Triumfetta chaetocarpa</i>													0		0		1					1									1
<i>Triumfetta clementii</i>	1			1		1					1											1		1	1						
<i>Triumfetta johnstonii</i>																								1							1
<i>Triumfetta maconochieana</i>					0	0																									1
<i>Velleia connata</i>																															1
<i>Waltheria indica</i>													0		0									1							1

0 = recorded in August 2003; 1 = recorded in May 2004

Species	Mesa G Sites																														
	MESG 01	MESG 02	MESG 03	MESG 04	MESG 05	MESG 06	MESG 07	MESG 08	MESG 09	MESG 10	MESG 11	MESG 12	MESG 13	MESG 14	MESG 15	MESG 16	MESG 17	MESG 18	MESG 19	MESG 20	MESG 21	MESG 22	MESG 23	MESG 24	MESG 25	MESG 27	MESG-MA	MESG-MB	MESG-MC	MESG-MZ	MESG-OPP
<i>Abutilon</i> aff. <i>dioicum</i> (HD195)																					1								1		
<i>Abutilon</i> aff. <i>dioicum</i> (HD72-14)																															1
<i>Abutilon fraseri</i>																															
<i>Abutilon otocarpum</i>																															
<i>Abutilon trudgenii</i> ms.					1	1							1	1	1																
<i>Abutilon</i> sp.																															
<i>Acacia acradenia</i>		1	1	1				1	1	1	1	1			1		1	1	1	1		1	1	1	1	1			1		
<i>Acacia ancistrocarpa</i>		1		1				1			1	1	1	1	1																
<i>Acacia arida</i>																															
<i>Acacia atkinsiana</i>	1	1			1	1										1			1										1		
<i>Acacia bivenosa</i>					1	1		1		1		1	1	1	1			1					1				1			1	
<i>Acacia citrinoviridis</i>															1																
<i>Acacia colei</i> var. <i>colei</i>													1									1									
<i>Acacia coriacea</i> subsp. <i>sericophylla</i>																															
<i>Acacia elachantha</i>																															
<i>Acacia farnesiana</i>													1									1							1		
<i>Acacia inaequilatera</i>	1	1			1		1	1	1	1				1	1	1		1	1	1		1	1	1	1						
<i>Acacia maitlandii</i>				1																											1
<i>Acacia pruinocarpa</i>																															1
<i>Acacia pyrifolia</i>																						1							1		
<i>Acacia synchronicia</i>					1	1	1				1		1	1	1															1	
<i>Acacia trachycarpa</i>									1													1							1		1
<i>Acacia tumida</i> var. <i>pilbarensis</i>		1	1		1	1			1											1	1			1	1				1		
<i>Acacia xiphophylla</i>													1																		
<i>Alternanthera nana</i>													1		1	1						1						1	1		
<i>Amaranthus</i> aff. <i>interruptus</i> (MET 16,114)					1	1									1							1							1		
<i>Amaranthus pallidiflorus</i>																						1							1	1	
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (D89)		1									1																1	1		1	
<i>Ammannia baccifera</i>																															1
<i>Ammannia multiflora</i>																															1
<i>Amyema preissii</i>																							1			1					
* <i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>																						1						1	1		
<i>Aristida holathera</i> var. <i>holathera</i>																															
<i>Bergia pedicellaris</i>																														1	
* <i>Bidens bipinnata</i>																															1
<i>Boerhavia burbridgeana</i>																						1							1		
<i>Boerhavia coccinea</i>					1								1																		
<i>Bonamia linearis</i>																															
<i>Bonamia media</i> var. <i>villosa</i>		1					1			1	1	1														1			1		
<i>Bonamia pannosa</i>															1																
<i>Bonamia rosea</i>																													1		1
<i>Bulbostylis barbata</i>					1	1								1	1													1			
<i>Calandrinia</i> sp.																															
<i>Capparis spinosa</i> var. <i>nummularia</i>																															1
<i>Cassia glutinosa</i>		1							1		1	1		1										1	1		1			1	
<i>Cassia glutinosa</i> x <i>luerssenii</i>																															
<i>Cassia luerssenii</i>									1																					1	
<i>Cassia luerssenii</i> x ' <i>stricta</i> '																															
<i>Cassia notabilis</i>	1	1			1	1		1					1	1	1			1	1			1			1	1			1		
<i>Cassia oligophylla</i>		1			1	1				1				1																	
<i>Cassia</i> aff. <i>oligophylla</i> (thinly sericeous)																															
<i>Cassia oligophylla</i> x <i>helmsii</i>									1																						
<i>Cassia</i> ? <i>oligophylla</i> x																															
<i>Cassia pruinosa</i>									1			1			1																
<i>Cassia pruinosa</i> x <i>luerssenii</i>																															
<i>Cassia venusta</i>																															
<i>Cassytha capillaris</i>		1	1		1		1	1	1	1	1	1						1	1						1				1		
* <i>Cenchrus ciliaris</i>																						1									
<i>Centipeda minima</i>																						1							1		
<i>Cheilanthes brownii</i>																															
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>																															
<i>Chenopodium melanocarpum</i>																						1							1		
<i>Chrysopogon fallax</i>																															
* <i>Citrullus colocynthis</i>																						1							1	1	
<i>Cleome uncifera</i>																															
<i>Cleome viscosa</i>		1			1	1						1	1	1	1			1								1	1	1	1	1	
<i>Clerodendrum floribundum</i> var. <i>angustifolium</i>									1	1																	1			1	

Species	Mesa G Sites																													
	MESG 01	MESG 02	MESG 03	MESG 04	MESG 05	MESG 06	MESG 07	MESG 08	MESG 09	MESG 10	MESG 11	MESG 12	MESG 13	MESG 14	MESG 15	MESG 16	MESG 17	MESG 18	MESG 19	MESG 20	MESG 21	MESG 22	MESG 23	MESG 24	MESG 25	MESG 27	MESG-MA	MESG-MB	MESG-MC	MESG-MZ
<i>Porana commixta</i>																														1
<i>Portulaca oleracea</i>						1							1		1															
<i>Pterocaulon sphacelatum</i>																													1	
<i>Pterocaulon sphaeranthoides</i>																						1						1	1	
<i>Ptilotus appendiculatus</i> var. <i>appendiculatus</i>													1																	
<i>Ptilotus arthrolasius</i>																														
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>					1	1								1	1														1	
<i>Ptilotus auriculifolius</i>																														1
<i>Ptilotus axillaris</i>						1								1															1	
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>											1						1	1	1						1	1				
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>																														
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>					1								1	1																1
<i>Ptilotus incanus</i> var. <i>incanus</i>									1		1																	1		
<i>Rhagodia eremaea</i>																														
<i>Rhodanthe margarethae</i>																														1
<i>Rhynchosia minima</i> var. <i>australis</i>													1		1															
<i>Salsola tragus</i>																														
<i>Sarcostemma viminale</i> subsp. <i>australe</i>																														
<i>Scaevola spinescens</i> (broad form)																														
<i>Sesbania cannabina</i>																													1	
<i>Sida</i> aff. <i>cardiophylla</i> (site 1215)					1	1	1					1					1	1			1								1	
<i>Sida</i> aff. <i>clementii</i> (site 664)																														1
<i>Sida echinocarpa</i>						1								1																
<i>Sida</i> aff. <i>fibulifera</i>													1																	
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>																														
<i>Sida</i> sp. Wittenoom (W.R. Barker 1962)													1																	
<i>Solanum cleistogamum</i>													1																	
<i>Solanum diversiflorum</i>					1									1	1		1									1				1
<i>Solanum gabrielae</i>																													1	1
<i>Solanum horridum</i>				1		1	1	1				1	1				1							1		1	1	1	1	
<i>Solanum phlomoides</i>																														
<i>Solanum sturtianum</i>				1																										1
<i>Sporobolus australasicus</i>																						1								
<i>Stemodia grossa</i>																												1	1	
<i>Streptoglossa bubakii</i>					1	1							1	1	1		1										1			
<i>Swainsona formosa</i>																													1	
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>															1															
<i>Tephrosia densa</i>														1																
<i>Tephrosia rosea</i> var. <i>glabrior</i>																													1	
<i>Tephrosia</i> aff. <i>rosea</i> (CH3-47)																														1
<i>Tephrosia spechtii</i>																														1
<i>Tephrosia</i> sp. B Kimberley Flora (C.A. Gardner 7300)																														
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)																														
<i>Tephrosia uniovulata</i>	1	1	1													1													1	1
<i>Themeda triandra</i>																													1	
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>				1								1		1	1	1	1	1									1	1	1	
<i>Trianthema triquetra</i>																													1	
<i>Tribulus astrocarpus</i>					1	1							1		1															
<i>Tribulus hirsutus</i>													1																	
<i>Tribulus macrocarpus</i>					1	1							1	1	1															
<i>Tribulus platypterus</i>																														1
<i>Tribulus suberosus</i>																														
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>				1	1			1		1	1			1		1					1	1	1			1		1	1	
<i>Triodia epactia</i>					1	1							1		1														1	
<i>Triodia schinzii</i>																														
<i>Triodia wiseana</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
<i>Triodia</i> sp. nov.		1									1								1	1				1	1			1		
<i>Tripogon loliiformis</i>																														
<i>Triumfetta chaetocarpa</i>															1															
<i>Triumfetta clementii</i>						1		1				1	1	1	1		1								1	1				
<i>Triumfetta johnstonii</i>																														
<i>Triumfetta maconochieana</i>																														
<i>Velleia connata</i>																														
<i>Waltheria indica</i>													1																	

0 = recorded in August 2003; 1 = recorded in May 2004