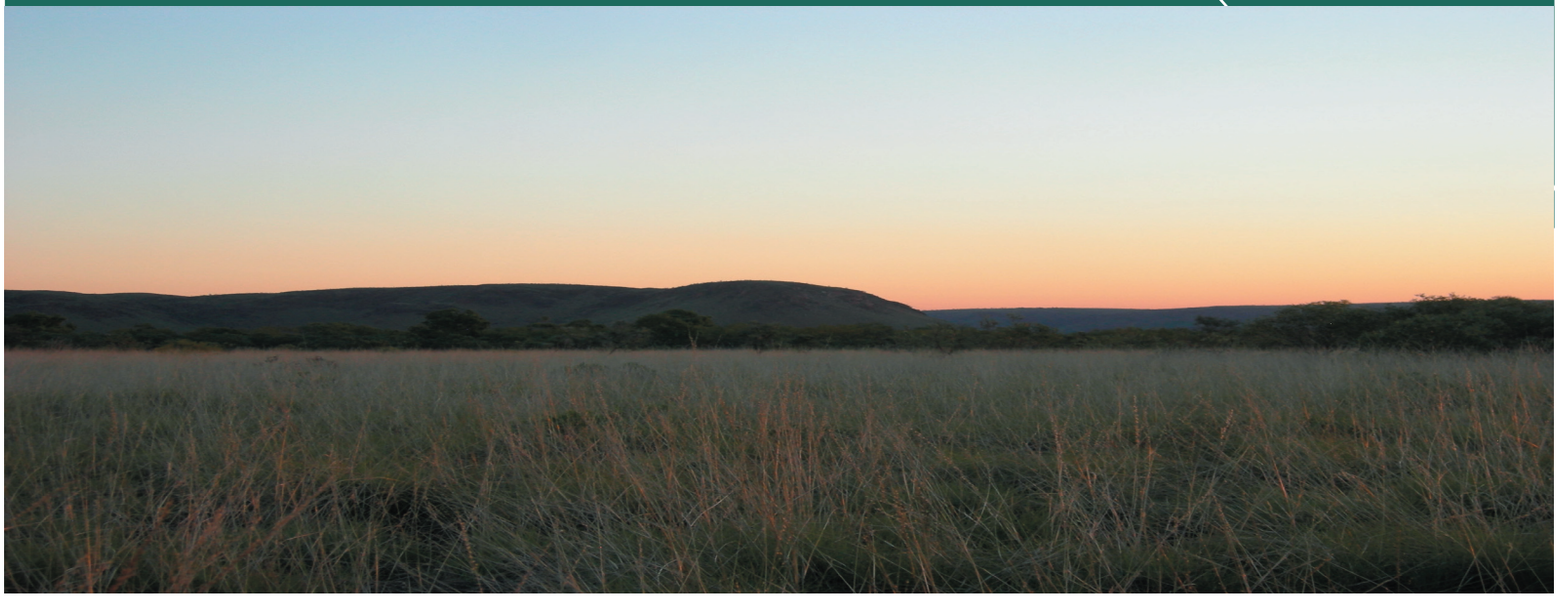
BHP Billiton Iron Ore



FLORA AND VEGETATION SURVEY

Callawa

May 2013

ONSHORE ENVIRONMENTAL

Document Status						
Rev No.	Authors	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	D.Brearley, E.Palmer	D.Brearley	29/06/12	D.Brearley	B.Menezies	08/10/12
2	D.Brearley	B.Menezies	05/11/12	D.Brearley	B.Menezies	14/11/12
3	D.Brearley	D.Brearley	01/05/13	D.Brearley	B.Menezies	02/05/13

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Executive Summary

In response to an invitation from BHP Billiton Iron Ore Pty Ltd (BHPBIO), Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned to undertake a single-season Level 2 flora and vegetation survey of the Callawa Deposit (the study area).

BHPBIO currently operates a number of open cut iron ore mines as part of the Goldsworthy Iron Ore Mining Operations, located approximately 200 kilometres (km) east of Port Hedland in the north-eastern Pilbara region of Western Australia. As part of the Goldsworthy Iron Ore Mining Operations, BHPBIO wishes to amend approvals for mining from that currently permitted at the Callawa Deposit; BHPBIO will be seeking approval for the expansion via a Section 45C application under the *Environmental Protection Act 1986*. The flora and vegetation survey provides additional information on the flora and vegetation of the area to support the application.

Onshore Environmental completed a single-season Level 2 flora and vegetation survey of the study area between the 11th and 20th June 2012. Results from the 2012 survey was combined with previous data collected from within the study area during two previous flora and vegetation surveys Ecologia Environment (2005a) and ENV Australia (2008). The combined datasets resulted in a total number of 249 plant taxa (including varieties and subspecies) from 49 families and 122 genera being recorded from the study area. Species representation was greatest among the Fabaceae, Poaceae, Malvaceae and Amaranthaceae families, which is typical for the Pilbara Bioregion.

None of the plant taxa recorded were gazetted as DRF pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act (1950)* (WC Act) or listed under the *Environment Protection and Biodiversity Conservation Act (1999)* (EPBC Act). There were two Priority flora taxa (as defined by the Department of Environment and Conservation (DEC)) recorded from the study area during the 2012 survey. *Fimbristylis* ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) (Priority 1) was recorded on a sandy loam plain with meandering sandy drainage lines in the north–west sector of the study area. It occurred with the Priority 3 flora species *Eragrostis crateriformis,* which was recorded at a second location along the central eastern border of the study area on a sandy scalded flood plain. Both taxa were minor components of the vegetation providing less than 1% ground coverage.

Another three plant taxa recorded along cliff faces and associated scree slopes in the southern sector of the study area were determined to be of interest; *Sida macropoda, Stemodia* sp. and *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05). A fifth plant species, *Cyperus microcephalus* subsp. *saxicola* showed a very large range extension of approximately 700 km south-west of the nearest recorded locations which occur in the Northern Botanical Province.

The Callawa population of *Sida macropoda* is determined to be significant due to its disjunct location approximately 700 km south-west of the main populations recorded in the northern Kimberley region of Western Australia. It is not listed as a Priority flora taxon.

Stemodia sp. Shay Gap has an unofficial phrase-name "sp. Shay Gap" that has been used in several previous reports but is not on the Western Australia Census. It is currently taxonomically undescribed beyond having the locality name, but appears to be locally

widespread on suitable cliff environments in the Goldsworthy area. It has previously been recorded at Callawa and the nearby Sunrise Hill, Shay Gap and Cundaline ridges. It is not currently listed as a Priority flora taxon.

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) was recorded for the first time during the current survey by Onshore Environmental and may be a new species or possibly a sub species (more material is required before this determination can be made) (Mr Steve Dillon *pers. comm.* 2012). This is a species of significant interest as nothing like it has previously been collected in Western Australia, or any other State/Territory based on the types viewed from Melbourne and Adelaide.

There were eight introduced (weed) flora recorded from the study area; **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris virgata* (Feathertop Rhodes Grass), **Cynodon dactylon* (Couch Grass), **Malvastrum americanum* (Spiked Malvastrum), **Passiflora foetida* var. *hispida* (Passionfruit Vine), **Portulaca oleracea* (Purslane) and **Vachellia farnesiana* (Mimosa Bush). None of these taxa are listed as Declared Weeds under the *Agriculture and Related Resources Protection Act (1976)* (ARRP Act).

A total of 20 vegetation associations were described and mapped from the study area. The vegetation associations were classified into ten Broad Floristic Formations on the basis of canopy structure. None of the vegetation associations recorded are currently listed Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs).

Vegetation condition across the study area ranged from Excellent to Degraded. Vegetation associations occurring in areas of increasing relief typically supported vegetation of better condition. The primary disturbances recorded were linked directly to grazing by domestic stock resulting in reduced native species richness, the introduction of weeds and surface soil instability. There were less obvious impacts from pastoral fencelines, as well as edge effects from mining infrastructure such as the rail line, exploration tracks and historical drill holes. The majority of the study area was long unburnt (5-10 years); however, there was evidence of recent fire in the north-east corner.

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1.0 Introduction

1.1 Preamble

The Callawa Deposit is part of what is collectively referred to as the BHPBIO Goldsworthy Iron Ore Mining Operations, which are located near Yarrie approximately 200 km east of Port Hedland in the north-eastern Pilbara region of Western Australia (Figure 1).

In the past BHPBIO has referred to the development of the existing lease areas near Yarrie and Nimingarra as the Goldsworthy Extension Project, which more specifically examined the potential development of several ore bodies including Yarrie, Cattle Gorge, Nimingarra and Sunrise Hill. Within close proximity to the Goldsworthy Extension Project, two other ore bodies that are stand-alone geological exploration projects and are not directly associated with the Goldsworthy Extension Project are Cundaline Ridge and Callawa Ridge.

Onshore Environmental was commissioned by BHPBIO to undertake a Level 2 flora and vegetation survey to provide additional information to support an amendment to current approvals for the mining at Callawa Ridge Deposit via a Section 45C application under the *Environmental Protection Act 1986*.

1.2 Previous Surveys

Previous flora and vegetation surveys completed within, or within the vicinity of, the Study area are listed below and are described in more detail in Appendix 1:

- Shay Gap Aerodrome, Yarrie Area A, Yarrie Area B Level 2 Flora and Vegetation Survey and Level 1 Fauna Survey (Onshore Environmental 2010);
- Yarrie Biological and Soil Survey (Ecologia Environment 1999);
- Cundaline Biological Assessment (Ecologia Environment 2005a);
- Callawa Biological Assessment (Ecologia Environment 2005b);
- Goldsworthy Extension Project Biological Assessment (Ecologia Environment 2005c);
- Cundaline and Callawa Mining Operations Flora and Vegetation Assessment (ENV Australia 2008); and
- Yarrie Mine Site Weed Survey and Mapping (Astron 2011).



SHAY GAP

YARRIE MINE CAMP

Goldsworthy Ltd Railway

Coonieena Creek

Eel Creek

Salt Well Creek

Yundinna Creek

Kookenyia Creek

De Grey River

MUCCAN SHAY GAP ROAD

Emu Creek

WARRAWAGINE ROAD

Miningarra Creek

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Projection: MGA Zone 51

CALLAWA

SURVEY AREA LOCATION

Legend

Study Area

Griffin Spatial & Mapping
2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213

1.3 Climate

The Study area is situated in the north-east Pilbara region of Western Australia, which experiences an arid-tropical climate characterised by two distinct seasons. The majority of annual rainfall is received during the hot summer months from October to April. Summer and autumn rainfall is typically associated with cyclone activity and thunderstorms, with falls being of higher intensity and shorter duration contributing to an erratic annual range. Annual evaporation exceeds rainfall by as much as 2,500 mm per year. However since Callawa is located in the north-eastern Pilbara and relatively close to the coast, the humidity is generally higher than in many other parts of the region. Surface water can be found in some pools and springs in the Pilbara all year round, although watercourses only flow briefly due to the short wet season. From May to September extensive cold fronts that develop off the south coast occasionally stray northwards into the Pilbara; these events are less frequent at Callawa than in southern areas of the Pilbara. Rainfall associated with these fronts is relatively low.

Annual average rainfall for the Pilbara ranges from 180 mm to over 400 mm (Beard 1975), with the long-term average for nearby Goldsworthy Weather Station being 327.2 mm occurring over 25.7 rain days. Most of the total annual precipitation occurs between the four months from December to March. The average maximum summer temperatures typically range between 38ºC and 40ºC, while winter maximum temperatures range from 28ºC to 30.5ºC.

Long term monthly rainfall at Yarrie was above average for January and March 2012, with the January 2012 total more than triple the long-term average (BOM 2012b) (Figure 2).

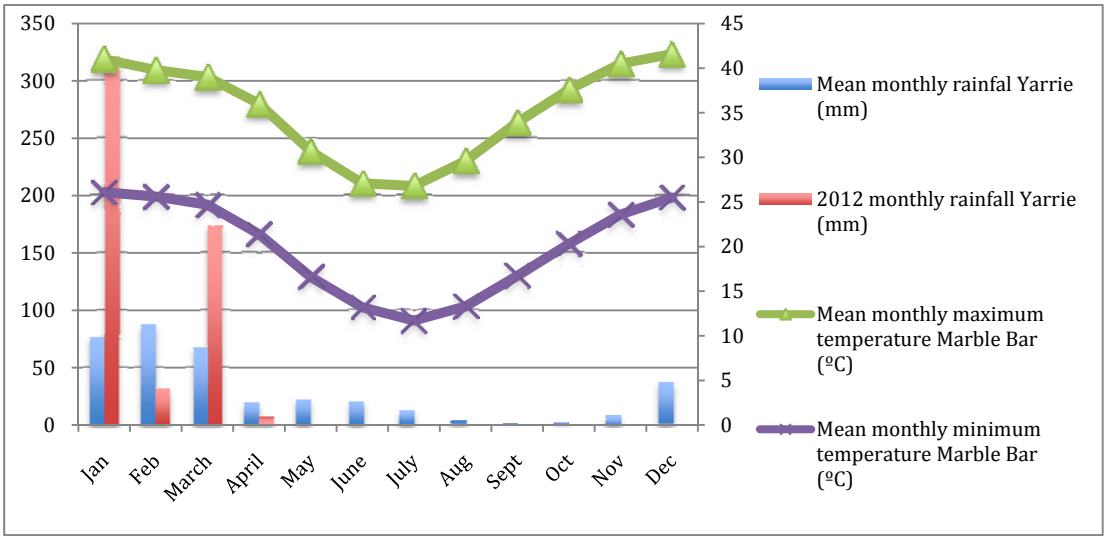


Figure 2 **Rainfall Data for Yarrie with mean maximum and minimum temperatures for Marble Bar (BOM 2012a and BOM 2012b).**

1.4 Biogeographic Regions

The Interim Biogeograhic Regionalisation for Australia (IBRA) describes a system of 85 'biogeographic regions' (bioregions) and 403 subregions covering the entire Australian continent (Thackway and Cresswell 1995). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna. The Study area is situated in close proximity to the boundary of the Chichester subregion (PIL1) and Roebourne subregion (PIL4) of the Pilbara bioregion (Thackway & Cresswell 1995, Kendrick & McKenzie 2001, Kendrick & Stanley 2001). The Great Sandy Desert bioregion also commences approximately 9 km north-east of the study area.

The PIL1 subregion is 9,044,560 hectares (ha) in size and is described as:
"Undulating Achaean granite and basalt plains (that) include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalytpus leucophloia* tree steppes occur on ranges. The climate is semi-desert-tropical and receives 300 mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock)."

The PIL4 subregion is 2,008,983 ha in size and covers the coastal fringe of the Pilbara bioregion also encompassing the off-shore islands of the Dampier Archipelago, islands between Cape Preston and Onslow and islands between Cape Lambert and Hedland, islands off Poissonnier Point and Bedout Island. The more inland landscape in which the Callawa Deposit Study area is located is described as:
"Quaternary alluvial and older colluvial coastal and subcoastal plains with a grass savannah of mixed bunch and hummock grasses and dwarf shrub steppe of *Acacia stellaticeps* or *A. pyrifolia* and *A. inaequilatera*. Uplands are dominated by *Triodia* hummock grasslands. Ephemeral drainage lines support *Eucalyptus victrix* or *Corymbia hamerslyana* woodlands."

The Great Sandy Desert bioregion (GSD) is characterised by Quarternary red longitudinal sand dune fields overlying Jurassic and Cretaceous sandstones of the Canning Basin, with some areas of gently undulating laterised uplands that support shrub steppe.

1.5 Existing Land Use

Land tenure in the Pilbara region and throughout the Chichester and Roebourne sub-regions consists of Aboriginal lands and leasehold reserves, national parks and reserves and Crown land which fall under a range of pastoral and mining leases. The dominant types of land use in the Pilbara are pastoralism (cattle grazing), mining, conservation (and associated tourism), unallocated Crown land, Crown reserves and urban areas (Kendrick and McKenzie 2001, Kendrick and Stanley 2001).

1.6 Soils

The soils of the Pilbara Region have been defined and mapped at a scale of 1:2,000,000 by Bettanay *et al.* (1967). The general Goldsworthy Project area lies within an area of soils that have been described as 'gradational soils within a neutral reaction trend through the profile' (Bettaney *et al.* (1967) as cited in Ecologia Environment (2005a)).

Due to sparse vegetation cover in the region and the erosive force of high summer rainfall much of the soil on the hill slopes tends to be transported to valleys and plains. Species and vegetation associations on hills and slopes therefore tend to be correlated with the geological conditions rather than particular soil type (Beard (1975) as cited in Ecologia Environment (2005a)).

Tille (2006) collated the most recent and detailed mapping of Western Australia's Rangelands and Arid interior into a hierarchy of soil-landscape mapping units. The Study area falls within the Fortescue Province, an area that occupies approximately 160,050 km^2 (6.3% of Western Australia) and includes the towns of Port Hedland, Karratha, Dampier, Roebourne, Newman, Tom Price, Paraburdoo, Pannawonica, Marble Bar, Nullagine and Jigalong. Soils and landform for the Fortescue Province are described as "Hills and ranges (with stoney plains and some alluvial plains and sandplains) on the volcanic, granitic and sedimentary rocks of the Pilbara Craton. Stony soils with red loamy earths and red shallow loams (and some red/brown non-cracking clays, red deep sandy duplexes and red deep sands)" (Tille 2006). The Fortescue Province is divided into ten soil-landscape zones:

- Nullagine Hills Zone;
- De Grey-Roebourne Lowlands Zone;
- Chichester Ranges Zone;
- Abydos Plains and Hills Zone;
- Fortescue Valley Zone;
- Hamersley Plateaux Zone;
- Karratha Coast Zone;
- Warrawagine Hills Zone;
- Jigalong Plains Zone; and
- Harding Hills and Plains Zone.

The Study area occurs within the De Grey-Roebourne Lowlands Zone and may include small sections of the Abydos Plains and Hills Zone. The dominant landform features within the De Grey-Roebourne Lowlands Zone are alluvial plains and sandplains (and some floodplains and stony plains) on alluvial and marine deposits over rocks of the northern Pilbara Craton (Tille 2006). Red deep sandy duplexes with red loamy earths and some red brown non-cracking clays, cracking clays, red sandy earths and red deep loamy duplexes also occur.

The dominant landform features of the Abydos Plains and Hills Zone include stony plains (with some hills) on granitic rocks of the Pilbara Craton (East Pilbara Terrane). Red deep sandy duplexes and red shallow loams with stony soils, red sandy earths and red loamy earths also occur. The majority of this zone is located in the northern Pilbara between Yandeyarra Community, Bamboo Springs Station and Marble Bar (Tille 2006).

1.7 Geology

The ancient continental Western Shield dominates the geology of Western Australia. The Pilbara region makes up a portion of the Western Shield and consists of pre-Cambrian, Proterozoic and Archaean rocks. The area contains some of the earth's oldest rock formations, thought to be around 3.5 billion years old (ANRA 2008). Important mineral reserves, including iron ore, which is prevalent in the Pilbara, are associated with these rock formations.

In *An inventory and condition survey of the Pilbara region, Western Australia*, van Vreeswyk *et al.* (2004) described the Hamersley and Chichester Ranges as the major topographic features of the Pilbara Bioregion that divide the two major river systems, the Fortescue and the De Grey Rivers. All rivers in the Pilbara are seasonal, which reflects the unreliability in rainfall and explains why they only flow after heavy rain. The rivers generally flow through distinct channels, but they often become poorly defined and begin to develop a network of braided tidal creeks and salt flats towards the coast. A gently sloping coastal plain exists in the north and west of the Pilbara Region, where the plain rises gradually from sea level to about 50 m AHD. It ranges from 20 to 60 km wide over most of the area. In the north, a broad alluvial plain linked to the De Grey, Coongan, Shaw and Oakover Rivers, merges with the coastal plain and continues about 120 km inland. An eolian sandplain exists in the north-east and signifies the westernmost extension of the Great Sandy Desert (Hickman 1983 as cited in van Vresswyk *et al.* 2004). The surface of the plain is characterised by east to south-east trending seif (longitudinal) dunes, uncommon rocky outcrops, and infrequent low breakaways where surface drainages are mostly absent.

The Pilbara Region has experienced a long geological history. The Pilbara Craton contains the oldest rocks in the Pilbara and is subdivided into the Achaen granite-greenstone terrane in the north. The greenstone sequences cover approximately 40% of the granite-greenstone terrane and consist of metasedimentary and volcanic rocks that have been intruded by granites. The granitic rocks contain many different deformed and metamorphosed stages. These rocks are more exposed in the eastern Pilbara and compared to the west (van Vresswyk *et al.* 2004).

The Canning Basin covers much of the area to the north-east of the Pilbara. The south-western part of the basin onlaps the north-eastern margin of the Pilbara Craton and extends into the Craton alon a narrowing valley about 140 km long that is associated with the Oakover River. The sequence of the Canning Basin is Late Carboniferous to Cretaceous in age, is over 700 m thick and consists of shale, mudstone, sandstone, conglomerate, siltstone and minor coal. A thin layer of Cainozoic deposits covers the sequence (van Vresswyk *et al.* 2004).

Rivers cross the coastal plains of the Pilbara region and in doing so have deposited layers of Quaternary age, alluvial material. On the coastal plain near Port Hedland Archaean basement rocks are covered by clay, silt, sand and gravel. It reaches over 50 m thick close to major drainages where it adds to colluvial material (van Vresswyk *et al.* 2004).

The geology of the Yarrie region has been mapped broadly by Wells (1959) (as cited in Ecologia Environment 1999). Ecologia Environment (1999) also commented on the geology of the Shay Gap area between Nimingarra and Yarrie using information from an internal BHP report from 1995. A summary of the general geology in relation to the landscape and vegetation for the Study area and surrounding Yarrie area is given below:

"The Archaen geology of the Shay Gap area comprises the exposed northern portions of the Muccan and Warragine batholiths flanked by the supracrustal rocks belonging to the Warrawoona and Gorge Creek Groups (BHP 1995, as cited in Ecologia Environment 1999). The Yarrie Mine Site is located in an area that consists of Archaen banded iron formations (BIF) belonging to the Gorge Creek Group, with shallow iron enrichment in the crustal deposits. The stratigraphy of the Yarrie plateau is dominated by an elevated block of Cleaverville Formation (BIF) that has undergone several stages of deformation overlying an intruded basement gratinoid. Horizontally bedded Cretaceous sandstone and siltstone of the Callawa formation and a thin cover of Tertiary to Recent sediments occur sporadically throughout

lowland areas. Dolerite dykes and sills are common but rarely have surface expression and are not anywhere extensive within the project area (BHP 1995, as cited in Ecologia Environment 1999)".

1.8 Flora & Vegetation

The Study area is located within the Fortescue Botanical District (Pilbara IBRA region) and close to the border of the Canning Botanical District (Great Sandy Desert IBRA region) which are both part of the Eremaean Province (Beard 1990), which is dominated by tree and shrub – steppe communities consisting mainly of *Eucalyptus* spp. and *Acacia* spp.; *Triodia pungens* and *Triodia wiseana* and some Mulga (*Acacia aneura*) occur within valley areas and short grass plains occur on alluvia.

The original vegetation mapping was undertaken by Beard (1975) and was refined by Shepherd *et al.* (2002), where two vegetation associations are described within the Study area (Figure 3). While the Pre-European extent for each vegetation association is 100%, less than ten percent of each association occurs within formal or informal reserves (Table 1).

Table 1 Pre-European Extent of Vegetation Associations occurring over the Study area (Shepherd *et al.* 2002).

Vegetation Sub-Association	Description	Pre-Euro. Extent Remaining	% remaining IUCN Class I-IV Reserves	% remaining Other Reserves	% remaining DEC Managed PL
George Ranges 171	Hummock grasslands, low tree steppe; snappy gum over soft spinifex & *T. brizoides*	200,150	0.0	0.0	4.5
Abydos Plain – Chichester 93	Hummock grasslands, shrub steppe; kanji over soft spinifex	3,376,354	0.4	0.0	1.7

A comprehensive and systematic field review of the entire Pilbara's regional flora, fauna and aquatic life and ecosystems is currently in preparation by the Department of Environmental and Conservation (DEC). The survey has included 800 study sites distributed across the entire Pilbara region between 2002 and 2007.

The resources boom in the Pilbara over the past decade has resulted in a significant number of site-specific biological surveys being completed as part of the formal environmental approvals process. A number of flora and vegetation assessments completed within sections of and in close proximity to the Study area (described in more detail in Appendix 1).

1.9 Land Systems

The Department of Agriculture has conducted inventory and condition surveys of the Pilbara (van Vreeswyk *et al.* 2004) using an integrated survey method involving the land system approach to rangeland description evaluation. The primary objective of the surveys was to provide comprehensive descriptions and mapping of the biophysical resources of the region as well as an evaluation on the condition of soils and vegetation. The mapping is based on patterns in topography, soils and vegetation.

A total of 102 land systems were defined in the Pilbara at scale of 1:250,000 (van Vreeswyk *et al.* 2004), with three land systems occurring within the Study area (Table 2, Figure 4). The land systems represented within the Study area are the Paradise, Boolgeeda and Capricorn Land Systems comprising the flood plain of Eel Creek to the west and associated stony clay alluvial plains and drainage system, as well as the ranges and ridges in the south of the Study area.

Table 2 Land Systems occurring within the Study area (descriptions from van Vreeswyk *et al.* 2004).

Land System Code	Land System	Representation in the Pilbara	Description
RGEPDS	Paradise	1,479 km^2 or 0.8 %	Flood plains with duplex soils (sometimes weakly saline) and clays. Alluvial plains supporting soft spinifex grasslands and tussock grasslands.
RGEBGD	Boolgeeda	7,748 km^2 or 4.3 %	Stony plains with hard spinifex grasslands or Mulga shrublands. The geology is quaternary colluvium. Stony lower slopes, level stony plains and narrow sub-parallel drainage floors, relief up to 20 m. A common system in shallow valleys below hill systems such as Newman and Rocklea.
RGECPN	Capricorn	5,296 km^2 or 2.9 %	Prominent strike ridges and ranges (relief up to 180 m) of sandstone and other sedimentary rocks with steep slopes and skeletal soils. Hills and ridges of sandstone and dolomite supporting shrubby hard and soft spinifex grasslands.

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GEORGE RANGES,171

GEORGE RANGES,171

GEORGE RANGES,171

GEORGE RANGES,171

GEORGE RANGES,171

GEORGE RANGES,171

MANDORA - WEST,101

ABYDOS PLAIN - CHICHESTER,93

ABYDOS PLAIN - CHICHESTER,93

ABYDOS PLAIN - CHICHESTER,197

ABYDOS PLAIN - CHICHESTER,197

ABYDOS PLAIN - CHICHESTER,197

ABYDOS PLAIN - CHICHESTER,619

ABYDOS PLAIN - CHICHESTER,93

ABYDOS PLAIN - CHICHESTER,11

ABYDOS PLAIN - CHICHESTER,171

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ABYDOS PLAIN - CHICHESTER,93

GEORGE RANGES,171



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CALLAWA

PRE - EUROPEAN VEGETATION (BEARD 1975)

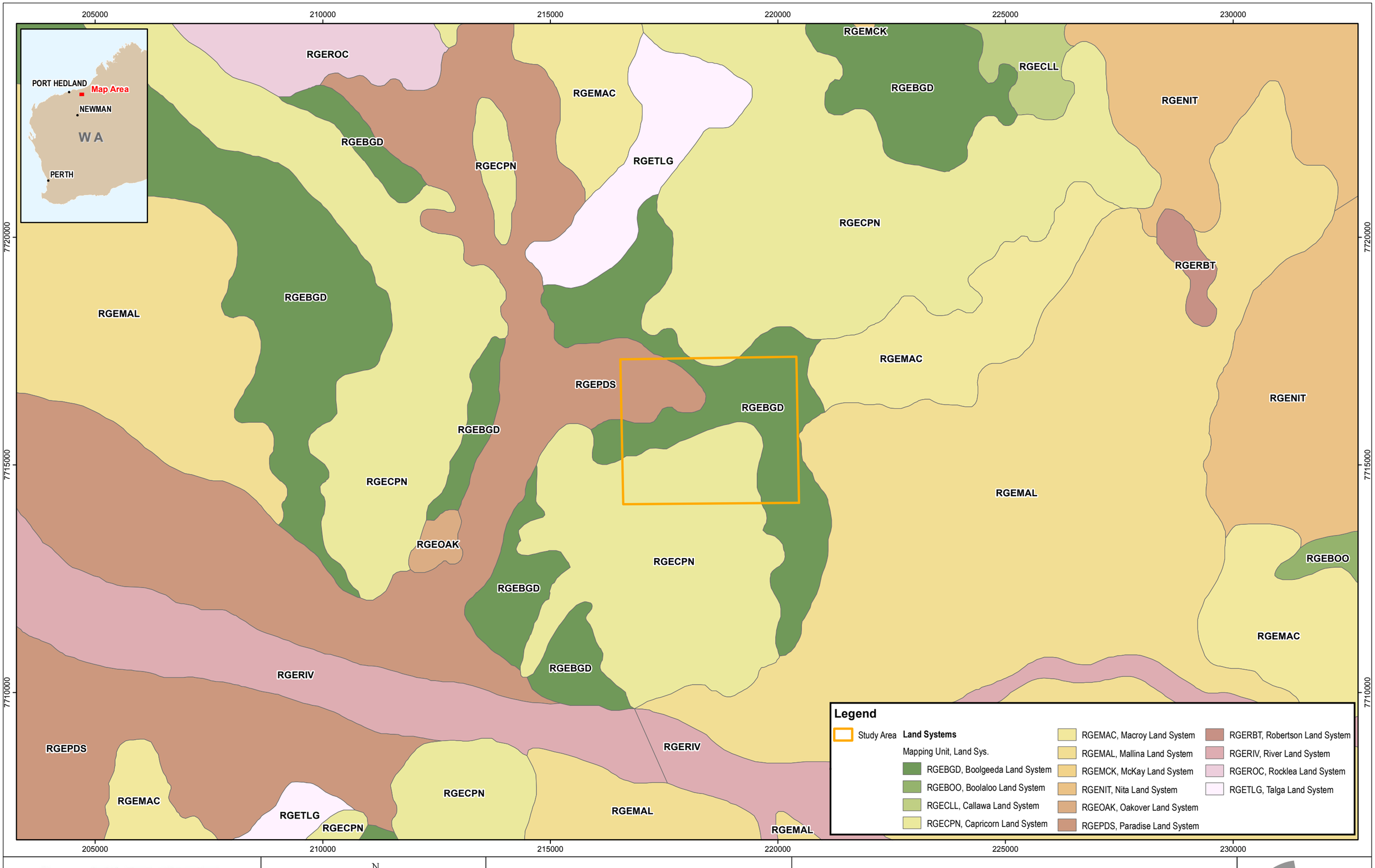
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Study Area

Pre-European Vegetation (Beard 1975)
SYSTEM, VEG_ASSOC

- ABYDOS PLAIN - CHICHESTER, 11
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- ABYDOS PLAIN - CHICHESTER, 175
- ABYDOS PLAIN - CHICHESTER, 197
- ABYDOS PLAIN - CHICHESTER, 619
- ABYDOS PLAIN - CHICHESTER, 93
- GEORGE RANGES, 171
- MANDORA - WEST, 101

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ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	03/05/2012
Sheet Size:	A3	Status: Final
Drawn by GSM	Requested by DB	GSM Reference Callawa Land Sys Map

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Kilometers
1:75,000

Datum: GDA94
Projection: MGA Zone 51

CALLAWA

LAND SYSTEMS

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2.0 Methodology

2.1 Background

2.1.1 Legislation and Guidance Statements

The flora and vegetation survey was carried out in a manner that was compliant with the following Environmental Protection Authority (EPA) requirements for the environmental surveying and reporting of flora and vegetation in Western Australia:

- Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No. 2 (EPA 2000);
- Terrestrial Biological Surveys as an Element of Environmental Protection. Position Statement No. 3 (EPA 2002); and
- EPA Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia No. 51 (EPA 2004).

The survey was also conducted in accordance with BHP Billiton Iron Ore's Guidance for Flora and Vegetation Surveys in the Pilbara (BHP Billiton Iron Ore 2010).

2.2 Desktop Searches

Three desktop searches were undertaken for information relating to rare flora Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) previously collected or described within, or in close proximity to the Study area (Wildlife Conservation (Rare Flora) Notice 2012, TEC List 2012 and PEC List 2012). The database search was extended beyond the immediate survey limits to place flora values into a local and regional context. The search criteria used was a 50 km radius around the central point of the Study area: 218500 m E 7715750 m N (51K GDA94). The State database search investigated three DEC databases:

1. The DEC Threatened (Declared Rare) Flora Database;
2. The DEC Declared Rare and Priority Flora List; and
3. The Western Australian Herbarium Specimen Database for priority species opportunistically collected in the area of interest.

A search of the EPBC Act Protected Matters database was undertaken (DSEWPC 2012) within a 10 km buffer of the Study area (EPBC Act 1999 Protected Matters Tool 2012). No Threatened Flora species or TECs were found. A single "Invasive Flora species or species habitat likely occur within the Study area" was noted, that being **Cenchrus ciliaris* (Buffel Grass).

A search of the International Union for Conservation of Nature (IUCN) database was also conducted (IUCN 2012) where no threatened species were found to likely occur in the Study area.

2.3 Field Survey Methodology

2.3.1 Timing and Personnel

The study area has been surveyed on three separate occasions:

1. Ecologia Environment established 55 quadrats along the Callawa Ridge between the 9th and 17th June 2005 with follow-up vegetation mapping completed between the 12th and 14th September 2005; 33 of the quadrats that occur within the boundary of the study area;
2. ENV Australia established 22 quadrats within the study area between the 26th and 31st March 2008; and
3. Onshore Environmental established 22 quadrats within the study area between the 11th and 20th June 2012. Field work was undertaken by a Senior Botanist (Dr Jerome Bull) assisted by a Field Botanist (Mr Daniel Roberts).

2.3.2 Sampling of Study Sites

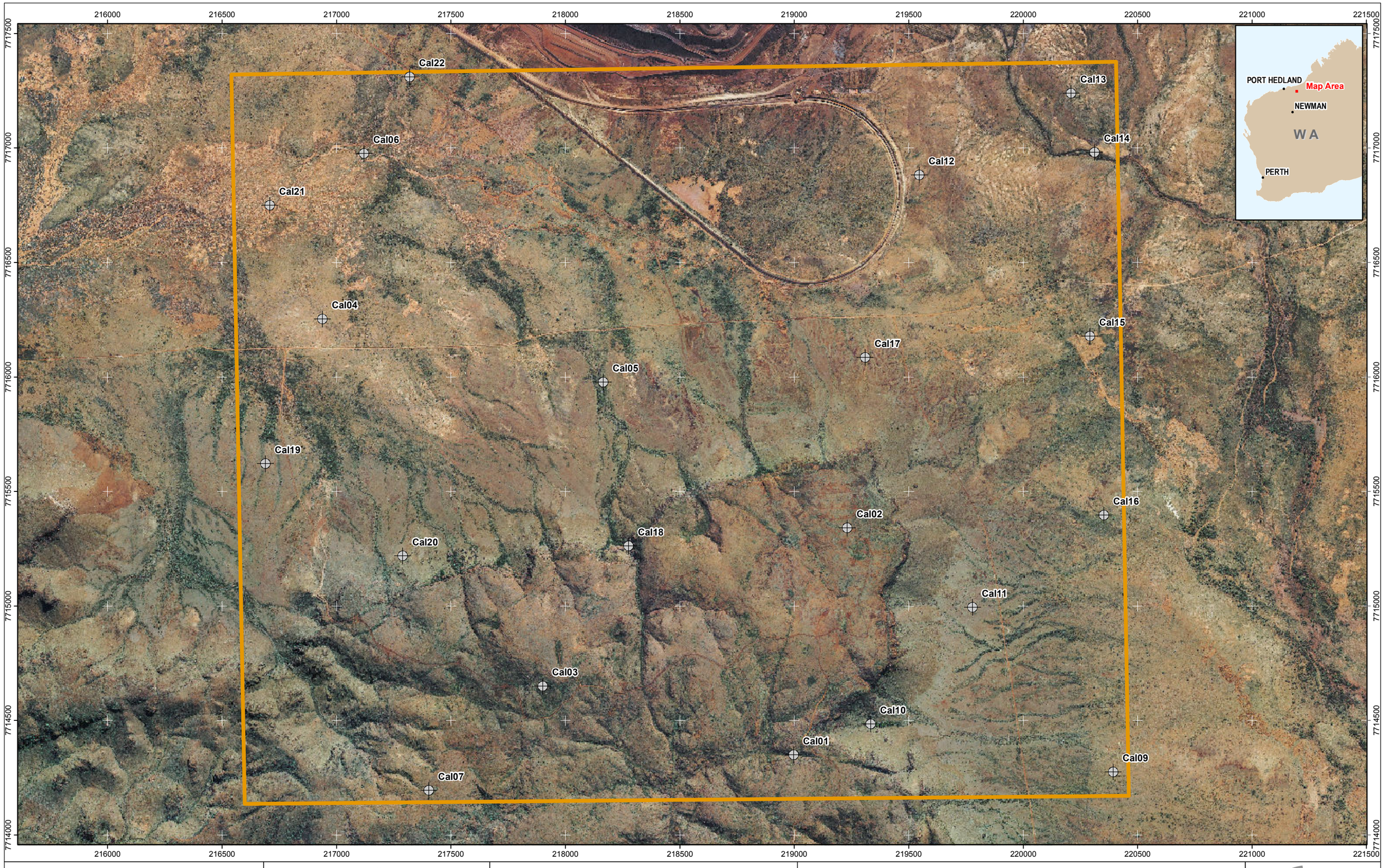
Previous surveys have involved systematic sampling using quadrats and transects (referred to as study sites). The study sites were generally 50 m by 50 m, or an equivalent area (2,500 m^2) along narrow associations such as minor drainage lines. The area sampled for each study site is standard for the Pilbara Bioregion.

The number of study sites sampled was determined by the size and heterogeneity of each Study area surveyed. A total of 22 quadrats were formally assessed within the Study area during the current survey (Figure 5). Data was simultaneously collected on a range of other environmental parameters including:

- Landform and habitat;
- Aspect;
- Soil colour and soil type;
- Rock type;
- Slope (angle);
- Percentage of bare ground, logs, twigs and leaves;
- Vegetation condition;
- Disturbance (caused by fire, clearing, grazing etc.);
- Age since fire;
- Broad floristic formation;
- Vegetation association description; and
- Height and percentage ground cover provided by individual plant taxa.

Other parameters recorded for each study site were:

- Study site number and date of assessment;
- Names of the botanists undertaking the assessment;
- Location description a waypoint – GPS coordinate (GDA94) using a handheld GPS; and
- Photograph number.



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	20/09/2012
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Meters

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Datum: GDA94

Projection: MGA Zone 51

CALLAWA

STUDY SITES LOCATIONS

Legend

- Study Site Location
- Study Area

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2.3.3 Targeted Surveys for Conservation Significant Species

The entire Study area was ground-truthed at 1 km intervals during the field assessment. This ground coverage provided the opportunity to record opportunistic locations for DRF and Priority Flora, and also undertake closer examination of specific landforms where Priority flora may be expected to occur. These landforms included medium and large drainage lines and cliff-lines.

2.3.4 Weed Survey and Mapping

A number of locations supporting introduced (weed) species had previously been identified within the Study area. These records were re-visited by botanists from Onshore Environmental to confirm their occurrence. Additional opportunistic records for weed species were made while moving around the Study area, and targeted weed searches were completed in high moisture habitats including medium and large drainage lines and flood plains.

2.3.5 Vegetation Association Mapping

The vegetation mapping utilised high-resolution aerial photography of the entire Study area at a scale of 1:20,000, with definition of vegetation polygons based on contrasting shading patterns. The location of 22 quadrats (50 m x 50 m or 2,500 m^2 in equivalent area) was overlaid on the aerial photography, and associated flora and vegetation data was used to provide vegetation association descriptions for the polygons defined. Ground-truthing of the Study area, formal assessment quadrats and numerous relevé vegetation descriptions were made within selected vegetation polygons to confirm dominant structural layers and associated plant taxa.

Description of vegetation structure follows the height, life form and density classes of Specht (1970) as modified by Alpin (1979) and Trudgen (2009) (see Appendix 2). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account. Vegetation condition for each of the sampling sites was determined using a recognised rating scale (based on Keighery 1994, see Appendix 3).

2.3.6 Vouchering

At least one voucher specimen was taken for each species collected to verify identification. Dr Eleanor Bennett confirmed specimen identifications with voucher specimens provided to a botanist at the Western Australian State Herbarium, Mr Steve Dillon. Use was made of the Western Australian State Herbarium for confirmation of species identification. Nomenclature follows Green (1985 and 1987), Paczkowska and Chapman (2000) and the Western Australian State Herbarium.

2.3.7 Field Survey Constraints

The EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004) list twelve potential constraints that field surveys may encounter. These constraints are addressed in Table 3.

Table 3 Relevance of constraints, as identified by EPA (2004), to the flora and vegetation survey.

Constraint	Relevance
Scope	The scope was established by BHP Billiton Iron Ore and is in compliance with relevant EPA Guidance Statements.
Proportion of flora collected and identified	It is likely that a large proportion of the flora occurring within the Study area has been collected, given that a previous biological survey (with a flora and vegetation component) and a Level 2 flora and vegetation survey have been completed within the Study area prior to the current work by Onshore Environmental.
Sources of information	As described above, a previous biological survey (with a flora and vegetation component) and a Level 2 flora and vegetation survey have been completed within the Study area. At least 5 additional surveys have been undertaken in close proximity since 1999, providing a large local database.
The proportion of the task achieved and further work which might be needed	There was a comprehensive desktop review of the previous survey work completed within, and in close proximity to the Study area, supported by an additional field trip to support this review. All allocated tasks were achieved during the investigation and no further work is needed at this site.
Timing / weather / season / cycle	Previous surveys completed at the site have occurred across a variety of seasons. The total flora species recorded in the Study area to date confirms that ephemeral and annual life forms anticipated during good seasons have been collected.
Disturbances, e.g. fire, flood	Disturbances within the Study area include fire (mosaic of burn ages recorded), grazing of lowland vegetation associations by domestic stock (cattle), introduction of weed species (particularly in riparian habitats), historical access tracks and exploration activities. None of these disturbances affected the ability to complete the survey.
Intensity	A total 33 quadrats were assessed within the study area by Ecologia Environment (2005), an additional 22 quadrats were assessed by ENV Australia (2008), and 22 quadrats and numerous releve plots were assessed in 2012 by Onshore Environmental. This represents an intensive flora and vegetation survey given the relatively small size of the study area.
Completeness	Relevant tasks related to assessing flora and vegetation values within the Study area were completed, including coverage of the entire survey area at one site per 1km^2, vegetation mapping, and targeted surveys for weeds and species of conservation significance.
Resources	Appropriate resources have been applied to surveying the Study area with two previous surveys completed within the Study area during 2005 and 2008.
Access problems	The entire Study area could be accessed by vehicle and on foot, noting that vegetation mapping was facilitated by high-resolution aerial photography.
Availability of contextual information	At least seven flora and vegetation surveys have been undertaken within a 50 km radius of the Study area, providing an extensive local database.
Experience levels	The two botanists working on the survey have over 25 years combined Pilbara experience between them. They have all completed numerous surveys at, and in close proximity to the Study area over recent years.

2.3.8 Assessment of Conservation Significance

The conservation significance of flora and ecological communities are classified on a Commonwealth, State and Local level on the basis of various Acts and Agreements (EPA Guidance Statement No. 51, EPA 2004), including:

Commonwealth Level:

- EPBC Act: The Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) lists Threatened Flora and Ecological Communities, which are determined by the Western Australian Threatened Species Scientific Committee according to criteria set out in the Act. The Act lists flora that are considered to be of conservation significance under one of six categories (Appendix 4).

State Level:

- WC Act: At a State level native flora species are protected under the WC Act – Wildlife Conservation (Rare Flora) Notice. A number of plant species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations. Species of the highest conservation significance are gazetted Declared Rare Flora (DRF) under subsection 2 of section 23F of the Act. It is an offence to take or damage DRF without Ministerial approval. Section 23F of the Act defines 'to take' as "to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means".
- DEC Priority list: DEC produces a list of Priority species and ecological communities (PECs) that have not been assigned statutory protection under the WC Act. Priority Flora are under consideration for declaration as 'Rare Flora', classified as in urgent need of further survey (Priority One to Three), require monitoring every 5-10 years (Priority Four) or require a specific conservation program to prevent the taxon becoming threatened within five years (Priority 5), see Appendix 5. The list of PECs identifies those that need further investigation before nomination for TEC status.

Local Level:

- Species may be considered of local conservation significance because of their patterns of distribution and abundance. Although not formally protected by legislation, such species are acknowledged to be in decline as a result of threatening processes, primarily habitat loss through land clearing.

2.3.9 Multivariate Statistical Analysis

An Agglomerative Hierarchical Fusion multivariate statistical cluster analysis of floristic quadrat data from the 22 study sites established within the Study area was completed to assist in understanding the vegetation-habitat relationships. Results and methods are presented as Appendix 6.

3.0 Results

3.1 Desktop Review

3.1.1 Significant Flora Database Searches

There were no records identified from a search of the EPBC Act Protected Matters Database (DSEWPaC 2012) or the IUCN database (IUCN 2012) for a 50 km radius surrounding the study area.

The DEC database search (DEC 2012) identified 17 Priority flora (Table 4). There were no DRF identified from the database searches.

Table 4 Significant flora species previously recorded from a 50 km search radius of the study area. SCC - State Conservation Code (WC Act).

Species	SCC
Acacia levata	3
Acacia sp. Marble Bar (J.G. & M.H. Simmons 3499)	1
Croton aridus	3
Desmodium pullenii	1
Eremophila maculata subsp. *filifolia*	1
Euphorbia clementii	2
Fimbristylis sp. Shay Gap (KR Newbey 10293)	1
Gomphrena leptophylla	3
Goodenia hartiana	2
Heliotropium murinum	3
Heliotropium parviantrum	1
Indigofera ammobia	3
Phyllanthus aridus	3
Pityrodia sp. Marble Bar (G. Woodman & D. Coultas GWDC Opp 4)	1
Ptilotus mollis	4
Rostellularia adscendens var. *latifolia*	3
Vigna sp. Central (M.E. Trudgen 1626)	2

3.1.2 Previous Flora and Vegetation Surveys within the Study Area

A biodiversity audit of Western Australia's 53 Biogeographical Subregions (Kendrick and McKenzie 2001 and Kendrick and Stanley 2001) defined Priority flora of the Chichester and Roebourne subregions (Tables 5 and 6). Locally significant flora in the Chichester Subregion includes *Sida macropoda* (previously known as *Sida* sp. Callawa and not currently on the Priority flora listing) and *Stemodia* sp. Shay Gap (under consideration for Priority listing). At the time of Kendrick and McKenzie's (2001) report *Livistona alfredii* was listed as a DRF, but is currently listed as a Priority 4 flora. According to Kendrick and McKenzie (2001) and Kendrick and Stanley (2001), no TECs were found to occur within the Chichester or Roebourne Subregions.

Table 5 Priority flora occurring in the Chichester Subregion as listed by Kendrick and McKenzie (2001) and the current conservation status (DEC 2012).

Species	Status 2001	Status 2012	Species record locations and proximity to Callawa Study Area
Acacia aphanoclada	P1	P1	Nearby
Acacia cyperophylla var. *omearana*	P1	P1	Nearby
Atriplex spinulosa	P1	P1	Nearby
Fimbristylis sp. Shay Gap (K. Newbey 1093)	P1	P1	Nearby
Goodenia sp. East Pilbara (previously *Goodenia omearana*)	P1	P3	>100 km
Lepidium amelum	P1	P1	Nearby
Dampiera atriplicina	P2	P3	Nearby
Euphorbia inappendiculata (previously *Euphorbia drummondii* subsp. Pilbara)	P2	P3	Nearby
Indigofera ixocarpa	P2	P2	>100 km
Ischaemum albovillosm	P2	No longer listed	Not relevant
Olearia fluvialis	P2	No longer listed	Not relevant
Olearia mucronata	P2	P3	>100 km
Paspilidium retiglume	P2	P2	>100 km
Ptilotus mollis	P2	P4	Nearby
Livistona alfredii	DRF	P4	>100 km
Stemodia sp. Shay Gap	Not recorded	New taxon	Nearby
Sida sp. Callawa (now known as *Sida macropoda*)	Not recorded	Not listed	Nearby

Table 6 Priority flora occurring in the Roebourne Subregion as listed by Kendrick and Stanley (2001), and the current conservation status (DEC FloraBase 2012).

Species	Status 2001	Status 2012	Species record locations and proximity to Callawa Study Area
Abutilon uncinatum R M Barker ms (previously *Abutilon* sp. Onslow (F Smith sn 10.9.1961)	P1	P1	>100 km
Goodenia sp. East Pilbara (previously *Goodenia omearana*)	P1	P3	>100 km
Helichrysum oligochaetum	P1	P1	>100 km
Ptilotus appendiculatus var. *minor*	P1	No longer listed	Not relevant
Ptilotus stipitatus	P1	No longer listed	Not relevant
Terminalia supranitifolia	P1	P3	>100 km
Fimbristylis aff. *microcarya*	P1	Not current	Not relevant
Carpobrotus sp. Thevenard Island (MR White 050)	P2	P2	>100 km
Euphorbia clementii	P2	P2	Nearby
Gomphrena cucullata	P2	P2	Nearby
Gomphrena pusilla	P2	P2	Nearby

There are two previous flora and vegetation surveys that have been completed over parts of the study area, and five additional surveys that have been completed in close proximity (Table 7). The seven previous surveys are summarized in Appendix 1.

Table 7 Summary of significant flora and environmental weeds recorded during previous flora and vegetation surveys within, or in close proximity to, the study area.

Report	Company	Field Survey Dates	Conservation Significant Flora Recorded	Introduced (Weed) Taxa Recorded
Surveys completed within the Study area				
Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations Flora and Vegetation Assessment	ENV Australia (2008)	26-31 March 2008 and 13-15 September 2008	*Euphorbia clementii* (Priority 2), *Goodenia nuda* (Priority 4)	**Cenchrus ciliaris* (Buffel Grass), **Echinochloa colona* (Awnless Barnyard Grass), **Chloris virgata* (Feathertop Rhodes Grass), **Portulaca oleracea* (Purselane), **Passiflora foetida* var. *hispida* (Passion flower) and **Cucumis melo* subsp. *agrestis* (Ulcardo Melon)
Callawa Biological Assessment Survey	Ecologia Environment (October 2005)	9-17 June 2005 (Flora & Vegetation Survey component 12-14 September (Vegetation Mapping Component)	*Sida* sp. Callawa (now known as *Sida macropoda*)	**Passiflora foetida* var. *hispida*
Surveys completed in close proximity to the Study area				
Yarrie Biological and Soil Survey	Ecologia Environment (1999)	3-9 June 1998	*Euphorbia clementii* (Priority 2), *Euphorbia drummondii* (Priority 2 at time of survey but no longer listed as Priority flora)	**Cenchrus ciliaris*, **Vachellia farnesiana* (Mimosa Bush), **Aerva javanica* (Kapok Bush) and **Chloris gayana* (Rhodes Grass)
Cundaline Biological Assessment Survey	Ecologia Environment (October 2005)	13-17 May 2005 (Flora and Vegetation component)	*Stemodia* sp. Shay Gap (currently being reviewed, under consideration as a Priority flora), *Sida* sp. Callawa (now known as *Sida macropoda*)	No weed species recorded
Goldsworthy Extension Project, Cattle Gorge Haul Road Biological Assessment Survey	Ecologia Environment (August 2005)	19-21 January and 11 May 2005 (Flora and Vegetation component)	*Acacia glaucocaesia* (Priority 3)	**Cenchrus ciliaris*, **Chloris virgata* and **Citrillus colocynthis*
Shay Gap Aerodrome and Yarrie Area A and Yarrie Area B Level 2 Flora and Vegetation Survey and Level 1 Fauna Survey	Onshore Environmental (2010)	9-15 September 2010	None recorded	**Aerva javanica*, **Cenchrus ciliaris*, **Chloris virgata*, **Cucumis melo* subsp. *agrestis* and **Portulaca oleracea*

Report	Company	Field Survey Dates	Conservation Significant Flora Recorded	Introduced (Weed) Taxa Recorded
Yarrie Mine Site Weed Survey and Mapping	Astron (2011)	31 August – 5 September 2011	None recorded	**Aerva javanica*, **Cenchrus ciliaris*, **Chloris virgata*, **Vachellia farnesiana*. *Cenchrus setiger* (Birdwood Grass), **Citrullus colocynthis*, **Conyza bonariensis* (Flaxleaf Fleabane), **Cucumis melo* subsp. *agrestis*, **Cynodon dactylon* (Couch), *Digitaria ciliaris (Summer Grass), **Echinochloa colona*, **Euphorbia hirta* (Asthma Plant), **Flaveria trinervia* (Speedy Weed), **Gomphrena celasiodes* (Gomphrena Weed), **Oxalis corniculata* (Yellow Wood Sorrel), **Polycarpon tetraphyllum* (Fourleaf Allseed), **Solanum nigrum* (Blackberry Nightshade), **Sonchus oleraceus* (Common Sowthistle), **Tridax procumbens*, potentially an unconfirmed species *Tribulus* sp. (possibly **Tribulus terrestris* (Caltrop)

3.2 Flora Species

Onshore Environmental completed a single-season Level 2 flora and vegetation survey of the study area between the 11th and 20th June 2012. Results from the 2012 survey was combined with previous data collected from within the study area during two previous flora and vegetation surveys Ecologia Environment (2005a) and ENV Australia (2008). The combined datasets resulted in a total number of 249 plant taxa (including varieties and subspecies) from 49 families and 122 genera being recorded from the study area (Table 8, Appendix 7). Species representation was greatest among the Fabaceae, Poaceae, Malvaceae, Cyperaceae and Amaranthaceae families, which is typical for the Pilbara Bioregion.

Table 8 Statistics for total flora recorded from the Study area.

Parameter	No.
No. Families	49
No. Genera	122
No. Species (incl. subspecies and varieties)	249
No. Native Species (incl. subspecies and varieties)	241
Priority Flora	2
Species of Interest	4
No. Introduced Species	8
Speciose Families	
FABACEAE	54
POACEAE	39
MALVACEAE	23
CYPERACEAE	15
AMARANTHACEAE	11
CONVOLVULACEAE	11
ASTERACEAE	8
SOLANACEAE	7
MYRTACEAE	6
CHENOPODIACEAE	5
EUPHORBIACEAE	5
Speciose Genera	
Acacia (Fabaceae)	14
Cyperus (Cyperaceae)	8
Eriachne (Poaceae)	7
Tephrosia (Fabaceae)	7
Ptilotus (Amaranthaceae)	7
Indigofera (Fabaceae)	6
Sida (Malvaceae)	6
Solanum (Solanaceae)	6
Introduced Flora	
**Aerva javanica* Kapok Bush (Amaranthaceae)	
**Cenchrus ciliaris* Buffel Grass (Poaceae)	
**Chloris virgata* Feathertop Rhodes Grass (Poaceae)	
**Cynodon dactylon* Couch Grass (Poaceae)	
**Malvastrum americanum* Spiked Malvastrum (Malvaceae)	
**Passiflora foetida* var. *hispida* Stinking Passionfruit (Passifloraceae)	
**Portulaca oleracea* Purslane (Portulacaceae)	
**Vachellia farnesiana* Mimosa Bush (Fabaceae)	

3.3 Conservation Significant Flora Species

3.3.1 Threatened Flora and Declared Rare Flora

Following intensive quadrat sampling and extensive grouth truthing of the study area none of the plant taxa recorded were gazetted as Threatened Flora - Declared Rare Flora (DRF) pursuant to subsection (2) of section 23F of the WC Act, or listed under the EPBC Act.

3.3.2 Priority Flora

There were two Priority flora taxa (as defined by the Department of Environment and Conservation (DEC)) recorded from the study area during the 2012 survey; *Fimbristylis* ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) (Priority 1) and *Eragrostis crateriformis* (Priority 3) (Figure 6).

Fimbristylis ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) (Priority 1)

Fimbristylis ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) (Priority 1) is a perennial sedge occurring to 0.3 m in height and flowering brown in July. It has previously been recorded from the Napier Range situated along the boundary of the Dampier and Fitzgerald Botanical Districts in the Kimberley region ofd Western Australia, approximately 250 km west south-west of Halls Creek. It also occurs in the Northern Territory and into Queensland.

The Callawa record represents the first collection made from the Goldsworthy area and is considered significant owing to the large distance from other known records at Napier Range, which are approximately 700 km to the north-east of Callawa.

BHPBIO consultant botanist Mr Steve Dillon confirmed that the Callawa specimen keys out to *Fimbristylis* sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722), but notes that all the collection material from the Western Australian Herbariun (WAH) is on loan (and has been since 1999). All other *Fimbristylis* taxa in the WAH have been checked against the Callawa specimen, and none are a match.

Fimbristylis ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) was recorded in brown sand on a sandy loam plain with meandering sandy drainage lines located in the north–west sector of the Study area (Figure 6). Vegetation was described as 'Hummock Grassland of *Triodia epactia* over Very Open Tussock Annual Grasses of *Sporobolus actinocladus, Eragrostis cumingii* and *Sporobolus australasicus* with Scattered Tall Shrubs of *Acacia colei* and *Sesbania cannabina* over Scattered Low Shrubs of *Pluchea tetranthera, Acacia stellaticeps* and *Pluchea rubelliflora'.* Vegetation condition was rated as Very Good, with disturbances including grazing by cattle and scattered weeds. The burn age was recorded as 'Old (5-10 years)'.

Eragrostis crateriformis (Priority 3)

Eragrostis crateriformis is an annual grass occurring from 0.1 m to 0.4 m in height, flowering from January to July, and occurring in clayey loam or clay soils along creek banks and in depressions. It has a relatively wide distribution occurring along the Pilbara coast from Nanutarra (east of Onslow) to Port Hedland, and east to Sturt Creek close to the Western Australian border.

Within the Study area it occurred as a scattered annual grass (Plate 1) with *Fimbristylis* ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) in brown sand on a sandy loam plain with meandering sandy drainage lines in the north–west sector of the Study area (Figure 6). It was recorded at a second location along the

central eastern border of the Study area on a sandy scalded flood plain, again providing <1% ground coverage. Vegetation at the second location was described as 'Annual Tussock Grassland of *Sporobolus australasicus, Dactyloctenium radulans* and **Chloris virgata* over Open Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia synchronicia*'. Vegetation condition at both sites was rated as Very Good with disturbances including grazing by cattle, weeds and surface erosion.



Plate 1 **Pressed specimen of** ***Eragrostis crateriformis*.**

3.3.3 Flora of Interest

There were three plant taxa collected from the study area that were determined to be of interest; *Sida macropoda, Stemodia* sp. Shay Gap and *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL01.05) (Appendices 8 and 9). These three plant taxa are discussed in more detail below.

Sida macropoda

Sida macropoda, previously called *Sida* sp. Callawa, is a low shrub growing to between 0.1 m and 0.3 m in height and occurring on steep rocky breakaway habitats (Plates 2 and 3). It has previously been recorded at Cundaline and Callawa (Ecologia Environment 2005a, 2005b).

The Callawa population is determined to be significant due to its disjunct location approximately 700 km south-west of the main populations recorded in the northern Kimberley region of Western Australia. Within the study area it was recorded along

cliff faces, scree slopes and mesa tops in the southern sector (Figure 6) generally occurring as scattered plants (approximating 1 plant per $10m^2$). Associated vegetation included:

- Open Scrub of *Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* over Very Open Hummock Grassland of *Triodia epacita* over Very Open Tussock Grassland of *Eriachne mucronata, Eriachne tenuiculmis* and *Cymbopogon ambiguus* in brown silty loam on scree slopes; and
- Hummock Grassland of *Triodia wiseana* with High Shrubland of *Grevillea wickhamii* subsp. *hispidula* and *Petalostylis labicheoides* over Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* in brown silty loam on mesa tops.



Plate 2 **Habit of** *Sida macropoda* **at Callawa.**



Plate 3 Close-up view of *Sida macropoda* leaves and fruits at Callawa.

Stemodia sp. Shay Gap

Stemodia sp. Shay Gap is a small herb that grows to 0.45 m in height, but is most often found between 0.15 m and 0.25 m high at maturity. It grows on vertical to overhanging banded iron formation (BIF) cliff environments, and while not entirely restricted by aspect populations with a northern aspect may occur at lower density (Plate 4). The distribution was influenced by the size of the cliff faces, taller being better, and occurrence of solid (and smooth) BIF that did not show any evidence of surface erosion or rockfall (was not crumbly) and appeared impervious to water (with the exception of narrow crevices in the cliff face).

The taxon has soft leaves that are in the range 10-40 mm long by 6-15 mm wide, lush green to dark green in colour and conspicuously serrated along the margins (Plate 5). The leaves occur in pairs that are usually openly arranged along the usually sparsely hairy stem. It has purple tubular flowers that appear to be present for at least the cooler half of the year. It appears to have a very specific habitat requirement for cliffs that are in cool positions or aspects that allow for near complete or total shade for most of the day, i.e. south-west to south-east facing cliff lines.

The unofficial phrase-name "sp. Shay Gap" has been used in several previous reports but not on the Western Australia Census. We are still awaiting confirmation from taxonomic specialist Mr W. Barker regarding the status of this entity, as he has a number of the *Stemodia* collections from Western Australia and wants to be certain that this entity does not fall within the variation of *Stemodia viscosa* and *Stemodia grossa* (and hybrids) before declaring it a new species (Mr Steve Dilon *pers. comm.* 2012). Mr Steve Dillon has noted that there are several collections from the eastern Kimberley in the *Stemodia* sp. folders that appear to match material collected from the study area, so the unofficial phrase-name "sp.

Shay Gap" may not be the most appropriate name. The situation is complicated by the *Stemodia viscosa* and *Stemodia grossa* collections containing a number of mis-identifications.

Stemodia sp. Shay Gap was first recorded in November 2004 at three locations along the Sunrise Hill and Shay Gap ridges as part of the Cundaline survey (Ecologia Environment 2005a). A total of 452 plants were previously recorded from 13 locations on the Callawa ridge (Ecologia Environment 2005a), and a further 32 plants were recorded from two locations on Cundaline Ridge (Ecologia Environment 2005a, 2005b). It has also recorded during an opportunistic survey at Cattle Gorge (Ecologia Environment 2005d). *Stemodia* sp. Shay Gap is currently taxonomically undescribed beyond having a locality name but appears to be locally widespread on suitable cliff environments at the Goldsworthy Iron Ore Mining Operations.

Within the study area *Stemodia* sp. Shay Gap occurred as scattered plants in narrow fissures along vertical cliff faces occurring up to 20 m in height and restricted to the south-east sector of the study area (Figure 6). It was formally recorded from five locations with approximately 60 plants counted from these locations. Associated vegetation was described as Low Open Woodland of *Terminalia canescens, Corymbia flavescens* and *Eucalyptus leucophloia* over High Open Shrubland of *Acacia tumida* over Open Tussock Grassland of *Eriachne mucronata* and *Cymbopogon ambiguus* in pockets of brown silty loam along cliff faces.



Plate 4 **Habit of *Stemodia* sp. Shay Gap growing out of fissures in steep cliff faces at Callawa.**



Plate 5 Close-up view of leaves and flower of *Stemodia* sp. Shay Gap at Callawa.

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

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) was recorded for the first time during the current survey and may be a new species or possibly a sub species (more material is required before this determination can be made) (Mr Steve Dillon *pers. comm.* 2012). This is a species of significant interest as nothing like it has previously been collected in Western Australia, or any other State/Territory based on the types viewed from Melbourne and Adelaide.

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) occurs as a low shrub between 0.5 m and 1.6 m in height (Plate 6), with smooth light coloured leaves and flowering yellow in June to October (Plate 7). It was recorded at 12 locations in the southern sector of the study area, restricted to scree slopes found below the base of steep cliff lines, where it provided up to 6% ground cover at densities ranging between 25 to 125 plants per quadrat (2,500 m^2). The distribution did extend into gullies and drainage lines on lower ground below the scree slopes, but only as scattered plants and providing <1% ground cover. The geology was BIF ironstone and soils were skeletal red brown silty loams.

Associated vegetation occurring on the cliff lines was described as Low Woodland of *Terminalia canescens, Atalaya hemiglauca* and *Ficus brachypoda* over High Shrubland of *Acacia tumida* var. *pilbarensis* and *Acacia pruinocarpa* over Very Open Tussock Grassland of *Eriachne mucronata, Cymbopogon ambiguous* and *Aristida burbidgeae*. This changed along minor drainage lines to Open Scrub of *Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* over Very Open Hummock Grassland of *Triodia epacita* over Very Open Tussock Grassland of *Eriachne mucronata, Eriachne tenuiculmis* and *Cymbopogon ambiguus,* and again changed along the major drainage lines to Low Woodland of *Eucalyptus camaldulensis* and *Corymbia flavescens* over High Shrubland of *Acacia colei* over Very Open Sedges of *Cyperus vaginatus.*



Plate 6 *Corchorus* **sp. Yarrie (J. Bull & D. Roberts CAL01.05) growing at the base of steep rocky cliffs at Callawa.**



Plate 7 **Flowering specimen and close-up view of** *Corchorus* **sp. Yarrie (J. Bull & D. Roberts CAL01.05).**

Cyperus microcephalus subsp. *saxicola*

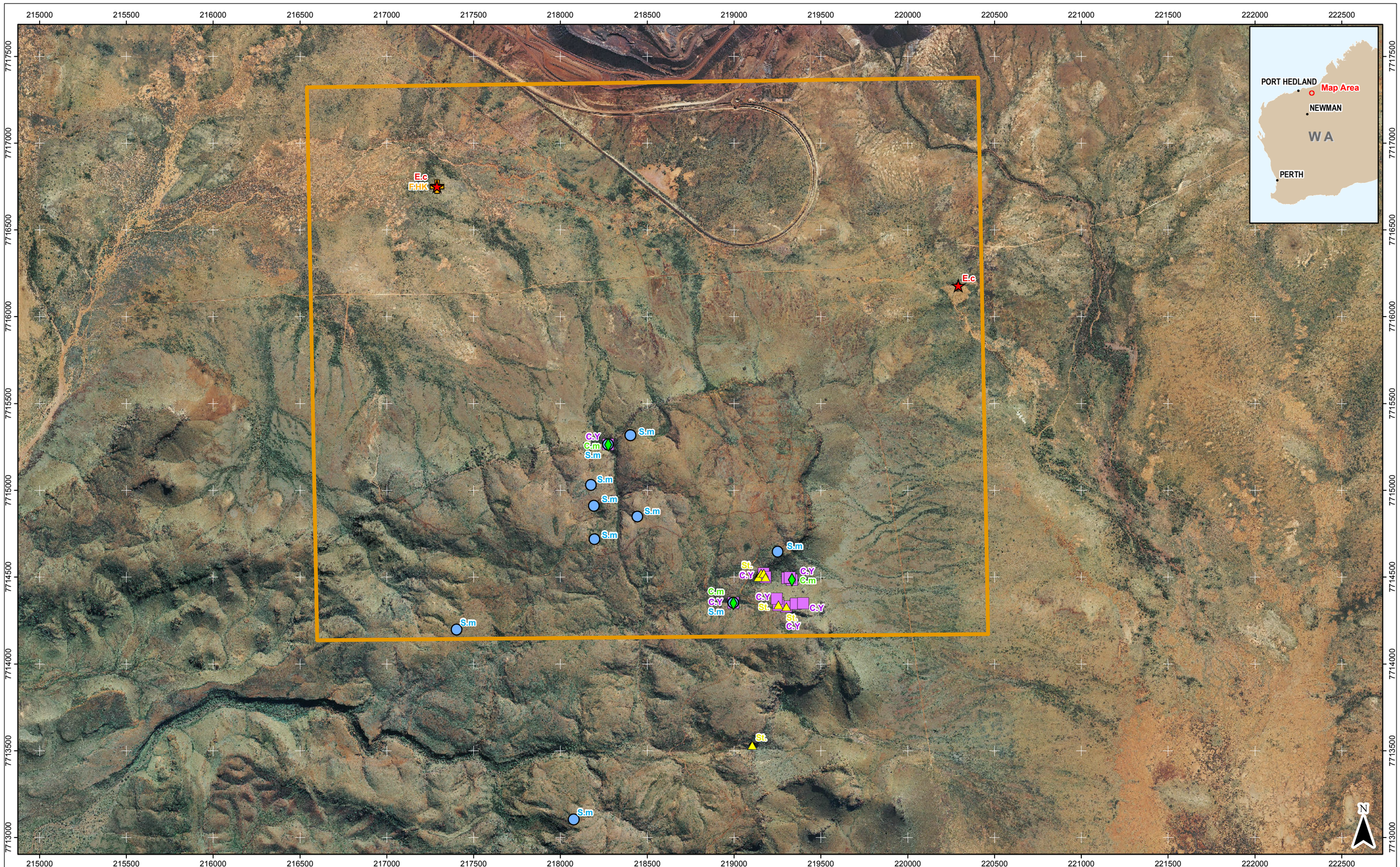
Cyperus microcephalus subsp. *saxicola* is an erect tufted perennial sedge occurring to between 0.2 m and 0.4 m in height, flowering yellow-brown from January to July, and typiclly growing on shallow pockets of sand within rock crevices on a variety of rock types. It is widespread in the northern half of the Kimberley, extending south to King Leopold Range and Halls Creek. It also occurs in the Northern Territory.

The Callawa record is determined to be significant due to its disjunct location approximately 700 km south-west of other known populations in the northern Kimberley region of Western Australia. It was recorded from one location in the

south-east sector of the study area (Figure 6) where it occurred as scattered plants (providing <1% ground cover) and to 0.3 m in height (Plate 8). It occurred in skeletal brown silty loam within a moderately inclined gully on an ironstone mesa with two other flora of interest; *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05) and *Sida* sp. Vegetation was described as 'Open Scrub of *Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* over Very Open Hummock Grassland of *Triodia epacita* over Very Open Tussock Grassland of *Eriachne mucronata, Eriachne tenuiculmis* and *Cymbopogon ambiguus*'.



Plate 8 Pressed specimen of *Cyperus microcephalus* subsp. *saxicola*.



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ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	4 May 2013
Sheet Size:	A3	Status:	Final
Drawn by GSM	Requested by DB	GSM Reference Callawa Sig Flora May 2013	

CALLAWA

SIGNIFICANT FLORA

0 200 400 600 800 1,000

Meters
1:20,000
Datum: GDA94 Projection: MGA Zone 51

Legend

Study Area

Priority Flora

Eragrostis crateriformis - Priority 3 (E.c)

Fimbristylis ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) - Priority 1 (F.HK)

Flora of Interest

Corchorus sp. Yarrie (J. Bull & D. Roberts CAL 01.05) (C.Y)

Cyperus microcephalus subsp. *saxicola*(C.m)

Sida macropoda (S.m)

Stemodia sp. (St.)

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3.4 Introduced Flora

There were eight introduced (weed) flora recorded from the Study area; **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris virgata* (Feathertop Rhodes Grass), **Cynodon dactylon* (Couch Grass), **Malvastrum americanum* (Spiked Malvastrum), **Passiflora foetida* var. *hispida* (Passionfruit Vine), **Portulaca oleracea* (Purslane) and **Vachellia farnesiana* (Mimosa Bush) (Figure 7, Appendix 10). None of these taxa are listed as Declared Weeds under the ARRP Act.

**Aerva javonica* (Kapok Bush, see Plate 7) is a short-lived soft-wooded perennial or diffuse herb, up to 1.6 m high, originating from Northern Africa and south-west Asia. It is widespread across Australia, occurring in Northern Territory, South Australia, Queensland and Western Australia. Kapok Bush was recorded as scattered plants from a single location along a drainage line in the north-east corner of the study area, occurring with four other weed species (Figure 7).

**Cenchrus ciliaris* (Buffel Grass, see Plate 8) is a tufted perennial grass introduced from the Middle East as a fodder species by pastoralists. It grows in dense tussocks up to 1 m tall and typically occurs in monospecific stands on loamy plains and creekline levee banks. It is an aggressive colonizing species that has become well established throughout the Pilbara, Gascoyne and Murchison regions and is continuing to spread in the south west (Hussey *et al.* 1997). **Cenchrus ciliaris* was recorded from six locations in the northern and eastern sectors of the study area associated with drainage lines and flood plains (Figure 7). It typically occurred as a prominent perennial grass providing between 2% and 20% ground cover.

**Chloris virgata* (Feathertop Rhodes Grass) is an annual grass up to 1 m in height and flowering between April and September (Plate 9). It was recorded from seven locations providing up to 10% ground cover in the northern one third of the study area, associated with a drainage lines and flood plains (Figure 7).

**Cynodon dactylon* (Couch Grass) is a rhizomatous (or stoloniferous), prostrate perennial grass occurring up to 0.3 m in height (Plate 10). It occurs on a variety of soils and flowers green to purple from June to February. **Cynodon dactylon* was recorded as 20 plants providing 2% ground cover from a single location along a drainage line in the north-east corner of the study area, where it occurred with four other weed species (Figure 7).

**Malvastrum americanum* (Spiked Malvastrum) is an erect perennial herb or shrub, ranging from 0.5 m to 1.3 m in height (Plate 11). It grows in a variety of soil types on stony ridges and hill sides, flood plains and along drainage lines. **Malvastrum americanum* was recorded from two locations in the north-east corner of the study area, both associated with drainage lines (Figure 7). Populations were recorded as scattered individuals providing <1% ground cover.

**Passiflora foetida* var. *hispida* (Wild Passionfruit, see Plate 12) is a woody climber / vine (with an unpleasent smell) growing to 9 m high. The flower colour ranges from cream to white to blue, with flowering occurring between February and November. It grows in disturbed native vegetation amongst medium sized trees, or less commonly in herblands and vine thickets. Its seeds are believed to be spread by birds. Wild Passionfruit occurs in a range of habitats including coastal dunes, river and creek banks, gorges, rocky slopes, hill slopes and valley plains. The preferred soil types range from rocky or stony soil, gravelly soil, sand, loam and

clay. **Passiflora foetida* var. *hispida* is native to the West Indies and South America. It has been introduced to Western Australia, Northern Territory, Queensland and New South Wales. It was recorded from five locations clustered along the 400 m length of a drainage line situated at the base of cliffs in the south-east corner of the study area (Figure 7). There was standing water evident at the time of assessment. Up to 200 plants were estimated to occur at the five locations, with ground cover ranging between 1% and 65%.

**Portulaca oleracea* (Purslane, see Plate 13) is a widespread succulent herb, distributed from the Kimberley to the south-west of Western Australia. It was recorded from three locations in the north-east corner of the study area, associated with stony plains and low rises. Plants were typically recorded as scattered individuals (27 plants in total) providing <1% cover.

**Vachellia farnesiana* (Mimosa Bush) is a tall spiny shrub which is widespread from the Kimberley to near Perth, typically occurring along drainage systems and in adjacent low-lying areas (Plate 14). It was recorded as three individuals from two locations in the noth-east corner of the study area, associated with drainage lines and flood plains.



Plate 7 **Aerva javanica*



Plate 8 **Cenchrus ciliaris*



Plate 9 **Chloris virgata*



Plate 10 **Cynodon dactylon*



Plate 11 **Malvastrum americanum*



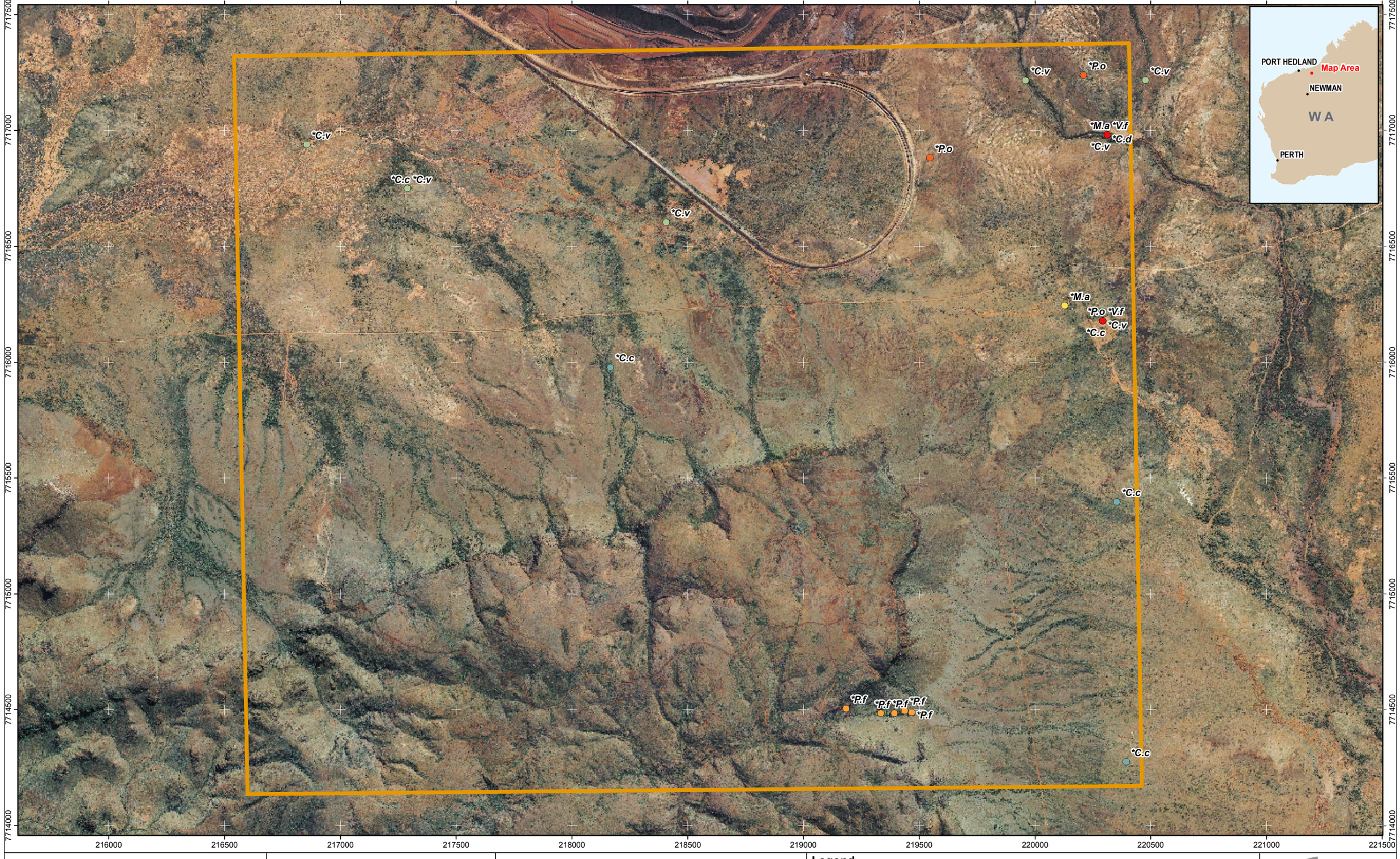
Plate 12 **Passiflora foetida* **var.** *hispida*



Plate 13 **Portulaca oleracea*



Plate 14 **Vachellia farnesiana*



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	13/09/2012
Sheet Size:	A3	Status: Final
Drawn by: GSM	Requested by: DB	GSM Reference: Callawa Intro Flora

N

0 100 200 300 400 500

Meters

1:15,000

Datum: GDA94

Projection: MGA Zone 51

CALLAWA

INTRODUCED FLORA

Legend

Study Area

Introduced Flora

- *Aerva javanica
- *Cenchrus ciliaris
- *Chloris virgata
- *Cynodon dactylon
- *Malvastrum americanum
- *Passiflora foetida
- *Portulaca oleracea
- *Vachellia farnesiana

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3.5 Threatened & Priority Ecological Communities

A vegetation association is considered a Threatened Ecological Community (TEC) if it is found to fit into one of the following categories:

- Presumed Totally Destroyed;
- Critically Endangered;
- Endangered; or
- Vulnerable.

Threatened species and ecological community conservation is coordinated by DEC's Nature Conservation Division, primarily through the Western Australian Threatened Species and Associations Unit (WATSCU). No State legislation deals specifically with TECs. However, TECs can be listed as nationally threatened and are protected under the EPBC Act.

A search of the EPBC database confirmed there were no TECs previously recorded within or adjacent to, the Study area. A search of the State database by DEC again confirmed there were no previous TEC records for a 50 km radius surrounding the Study area.

In addition to TECs, DEC has generated a list of Priority Ecological Communities (PECs) occurring in the Pilbara. The list identifies communities that require further investigation prior to nomination for TEC status. Field assessment confirmed that none of the PECs listed for the Pilbara region occurred within the Study area.

3.6 Vegetation

A total of 20 vegetation associations were described and mapped (Figure 8) within the Study area (Table 9). The vegetation associations were classified into ten Broad Floristic Formations on the basis of canopy structure. Raw data for the 22 study sites is provided as Appendix 11.

Table 9 Vegetation associations described and mapped from the Study area by Onshore Environmental.

Broad Floristic Formation		Vegetation Association
Terminalia Low Open Forest	1	Low Open Forest of *Terminalia canescens* and *Corymbia flavescens* over High Shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* over Open Tussock Grassland of *Eriachne tenuiculmis* and *Cymbopogon ambiguus* in red brown sandy loam along medium drainage lines
Eucalyptus Low Woodland	2	Low Woodland of *Eucalyptus camaldulensis* subsp. *refulgens, Corymbia flavescens* and *Corymbia hamersleyana* over High Open Shrubland of *Acacia colei* and *Acacia monticola* with Climbers of **Passiflora foetida* var. *hispida* and *Ipomoea muelleri* in brown sandy loam along medium drainage lines
Terminalia Low Open Woodland	3	Low Open Woodland of *Terminalia canescens, Ficus brachypoda* and *Atalaya hemiglauca* over High Open Shrubland *of Acacia pruinocarpa, Acacia tumida* var. *pilbarensis* and *Phyllanthus reticulatus* over Very Open Tussock Grassland of *Eriachne mucronata, Cymbopogon ambiguus* and *Aristida burbidgeae* in red silty loam along cliff lines
Acacia Closed Scrub	4	Closed Scrub of *Acacia tumida* var. *pilbarensis* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Hummock Grassland of *Triodia epactia* in brown loamy sand on drainage lines and drainage flats
Acacia Open Scrub	5a	Open Scrub of *Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* and *Grevillea wickhamii* over Open Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Terminalia canescens, Corymbia flavescens* and *Ficus brachypoda* in brown silty loam along minor drainage lines
Acacia Open Scrub	5b	Open Scrub of *Acacia tumida* var. *pilbarensis* and *Acacia colei* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Sedges of *Typha domingensis* and *Cyperus vaginatus* in brown loamy sand on medium drainage lines
Acacia Low Open Heath	6a	Low Open Heath of *Acacia spondylophylla* and *Acacia ptychophylla* over Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with High Shrubland of *Grevillea wickhamii, Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* in brown silty loam on south facing mesa slopes
Acacia Low Open Heath	6b	Low Open Heath of *Acacia ptychophylla* over Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Grevillea pyramidalis, Acacia inaequilatera* and *Acacia colei* in red sand on sandplains
Triodia Closed Hummock Grassland	7a	Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia colei, Grevillea pyramidalis* and *Acacia inaequilatera* over Scattered Low Shrubs of *Pluchea tetranthera* in orange brown loamy sand on plains
Triodia Closed Hummock Grassland	7b	Closed Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia hamersleyana* over High Open Shrubland of *Acacia ancistrocarpa, Acacia elachantha* and *Acacia inaequilatera* in brown sandy loam on sand plains

Broad Floristic Formation		Vegetation Association
Triodia Closed Hummock Grassland	7c	Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* over Scattered Low Shrubs of *Acacia ptychophylla* in orange red brown silty sandy loam on footslopes
Triodia Closed Hummock Grassland	7d	Closed Hummock Grassland of *Triodia wiseana* with Scattered High Shrubs of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* in brown silty loam on scree slopes
Triodia Closed Hummock Grassland	7e	Closed Hummock Grassland of *Triodia epactia* over Low Shrubland of *Acacia stellaticeps* and High Open Shrubland of *Acacia tumida* var. *pilbarensis, Acacia colei* and *Acacia inaequilatera* in orange brown loam on sand plains
Triodia Hummock Grassland	8a	Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* and High Open Shrubland of *Grevillea wickhamii* and *Petalostylis labicheoides* in red brown silty/sandy loam on mesa hill crests and plateaux
Triodia Hummock Grassland	8b	Hummock Grassland of *Triodia epactia* and *Triodia wiseana* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* and Low Open Shrubland of *Acacia ptychophylla* in brown sandy loam on footslopes and stony rises
Triodia Hummock Grassland	8c	Hummock Grassland of *Triodia epactia* with Low Open Shrubland of *Pluchea tetranthera, Acacia stellaticeps* and *Pluchea rubelliflora* over Very Open Bunch Grassland of *Sporobolus actinocladus, Sporobolus australasicus* and *Eragrostis cumingii* in brown sand along drainage lines and floodplains
Triodia Hummock Grassland	8d	Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia flavescens* over Low Shrubland *of Tephrosia rosea* var. *glabrior, Cullen martinii* and *Crotalaria ramosissima* in orange sand along minor drainage lines and on sand plains
Triodia Hummock Grassland	8e	Hummock Grassland of *Triodia epactia* over Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* with Scattered High Shrubs of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* and *Acacia inaequilatera* in red brown sandy loam along minor drainage lines and on footslopes
Triodia Open Hummock Grassland	9	Open Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Acacia synchronicia, Acacia inaequilatera* and *Acacia colei* and Scattered Low Shrubs of *Pluchea tetranthera* in silty loam on plains
Cyperus Sedges	10	Sedges of *Cyperus vaginatus* with Low Open Woodland of *Terminalia canescens* and High Open Shrubland of *Acacia tumida* var. *pilbarensis*, *Flueggea virosa* subsp. *melanthesoides* and *Phyllanthus reticulatus* in elevated marsh/soak

Broad Floristic Formation	1. *Terminalia* Low Open Forest
Vegetation Association	Low Open Forest of *Terminalia canescens* and *Corymbia flavescens* over High Shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* over Open Tussock Grassland of *Eriachne tenuiculmis* and *Cymbopogon ambiguus* in red brown sandy loam along medium drainage lines



Area Mapped	0.52 ha
Quadrats Sampled	CJ54
Location	Occurs along one section of a drainage line in the south east of the Study area
Leaf Litter Cover (%)	70
Bare Ground (%)	20-30
Soils and Geology	Brown loam and sandy loam soils with ironstone cobbles and pebbles
Land System	Capricorn
Land Form	Medium drainage line with cliff sections
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Passiflora foetida* var. *hispidula*
Vegetation Condition	Good
Disturbances	Introduced species
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Terminalia canescens, Corymbia flavescens*
Tall Shrubs >2m	*Acacia tumida* var. *pilbaraensis, Grevillea wickhamii*
Hummock Grasses	*Triodia epactia*
Tussock Grasses	*Eriachne tenuiculmis, Cymbopogon ambiguus*

Broad Floristic Formation	2. *Eucalyptus* Low Woodland
Vegetation Association	Low Woodland of *Eucalyptus camaldulensis* subsp. *refulgens, Corymbia flavescens* and *Corymbia hamersleyana* over High Open Shrubland of *Acacia colei* and *Acacia monticola* with Climbers of **Passiflora foetida* var. *hispida* and *Ipomoea muelleri* in brown sandy loam along medium drainage line



Area Mapped	0.55 ha
Quadrats Sampled	CAL10, CJ15, CJ16
Location	Small area in the south-east of the Study area
Leaf Litter Cover (%)	70
Bare Ground (%)	3-43
Soils and Geology	Brown soil with ironstone cobbles and pebbles
Land System	Boolgeeda
Land Form	Medium drainage line with soak
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Passiflora foetida* var. *hispidula*
Vegetation Condition	Good
Disturbances	Introduced species
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Eucalyptus camaldulensis* subsp. *refulgens, Corymbia flavescens, Corymbia hamersleyana, Melaleuca argentea*
Tall Shrubs >2m	*Acacia colei, Acacia monticola, Ficus brachypoda*
Shrubs <1m	*Cajanus cinereus*
Hummock Grasses	*Triodia wiseana*
Climbers	**Passiflora foetida* var. *hispidula, Ipomoea muelleri*
Sedges	*Cyperus vaginatus*

Broad Floristic Formation	3. *Terminalia* Low Open Woodland
Vegetation Association	Low Open Woodland of *Terminalia canescens, Ficus brachypoda* and *Atalaya hemiglauca* over High Open Shrubland *of Acacia pruinocarpa, Acacia tumida* var. *pilbarensis* and *Phyllanthus reticulatus* over Very Open Tussock Grassland of *Eriachne mucronata, Cymbopogon ambiguus* and *Aristida burbidgeae* in red silty loam along cliff lines



Area Mapped	27.28 ha
Quadrats Sampled	CAL18, CJ46, CJ47
Location	Situated along a cliff line running through the south of the Study area.
Leaf Litter Cover (%)	6
Bare Ground (%)	50
Soils and Geology	Red silty loam with ironstone cliffs and boulders
Land System	Boundary between Capricorn and Boolgeeda
Land Form	Cliff lines and steep rocky edges
Priority Ecological Community	None
Rare Flora	*Stemodia* sp. Shay Gap (new species of interest)
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	None evident
Average Fire Age	Very Old
Vegetation Structure & Floristics	
Trees >10m	*Terminalia canescens, Ficus brachypoda*, *Atalaya hemiglauca, Ficus virens*
Tall Shrubs >2m	*Acacia pruinocarpa, Acacia tumida* var. *pilbarensis*, *Phyllanthus reticulatus,*
Shrubs 1-2 m	*Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Shrubs <1m	*Sida macropoda*
Tussock Grasses	*Eriachne mucronata, Cymbopogon ambiguus*, *Aristida burbidgeae*
Sedges	*Cyperus cunninghamii*

Broad Floristic Formation	4. *Acacia* Closed Scrub
Vegetation Association	Closed Scrub of *Acacia tumida* var. *pilbarensis* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Hummock Grassland of *Triodia epactia* in brown loamy sand on drainage lines and drainage flats



Area Mapped	120.45 ha
Quadrats Sampled	CAL5, CJ58, CJ59, CJ60, CJ61
Location	Drainage lines and flats throughout the Study area.
Leaf Litter Cover (%)	7
Bare ground (%)	2
Soils and Geology	Brown loamy sand with ironstone pebbles, cobbles and outcrops
Land System	Paradise, Boolgeeda
Land Form	Drainage lines and drainage flats on plains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Cenchrus ciliaris*
Vegetation Condition	Very Good
Disturbances	Introduced species, access track, livestock
Average Fire Age	Very Old
Vegetation Structure & Floristics	
Trees >10m	*Corymbia flavescens*, *Corymbia hamersleyana*
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis*, *Phyllanthus reticulatus*
Shrubs 1-2 m	*Cajanus cinereus*
Shrubs <1m	*Acacia spondylophyla, Acacia ptychosperma*
Hummock Grasses	*Triodia epactia*
Tussock Grasses	*Eriachne tenuiculmis, *Cenchrus ciliaris, Eragrostis cummingii*

Broad Floristic Formation	5a. *Acacia* Open Scrub
Vegetation Association	Open Scrub of *Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* and *Grevillea wickhamii* over Open Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Terminalia canescens, Corymbia flavescens* and *Ficus brachypoda* in brown silty loam along minor drainage lines



Area Mapped	22.91 ha
Quadrats Sampled	CAL1, CJ3, CJ8, CJ41, CJ50, CJ52
Location	Drainage lines on mesa crests / plateau in the south of the Study area.
Leaf Litter Cover (%)	2
Bare Ground (%)	10
Soils and Geology	Brown silty loam, ironstone pebbles, cobbles outcropping
Land System	Capricorn
Land Form	Minor drainage line/ rocky gullies
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	Access tracks
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Terminalia canescens, Corymbia flavescens* and *Ficus brachypoda*
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis, Petalostylis labicheoides Grevillea wickhamii, Acacia monticola*
Shrubs <1m	*Corchrus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05), *Acacia spondylophylla*
Herbs	*Trachymene oleracea*
Hummock Grasses	*Triodia epactia, Triodia wiseana*
Tussock Grasses	*Eriachne mucronata, Eriachne tenuiculmis*

Broad Floristic Formation	5b. *Acacia* Open Scrub
Vegetation Association	Open Scrub of *Acacia tumida* var. *pilbarensis* and *Acacia colei* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Sedges of *Typha domingensis* and *Cyperus vaginatus* in brown loamy sand along medium drainage lines



Area Mapped	2.12 ha
Quadrats Sampled	CAL14, CJ21, CJ24
Location	Medium drainage lines in the far north eastern corner of the Study area
Leaf Litter Cover (%)	5
Bare Ground (%)	7
Soils and Geology	Brown loamy sand with granite/quartz scattered cobbles
Land System	Boolgeeda
Land Form	Medium drainage lines
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Malvastrum americanum, *Cenchrus ciliaris, *Vachellia farnesiana, *Chloris virgata, *Cynodon dactylon, *Aerva javanica*
Vegetation Condition	Degraded
Disturbances	Fire, introduced species, livestock
Average Fire Age	Recent
Vegetation Structure & Floristics	
Trees >10m	*Corymbia flavescens, Corymbia hamersleyana*
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis, Acacia colei*
Shrubs <1m	*Pluchea rubeliflora, Sida rohlenae* subsp. *rohlenae, Stemodia viscosa*
Hummock Grasses	*Triodia epactia*
Tussock Grasses	*Eragrostis cummingii, *Cynodon dactylon, *Chloris virgata, *Cenchrus ciliaris*
Sedges	*Typha domingensis, Cyperus vaginatus*

Broad Floristic Formation	6a. *Acacia* Low Open Heath
Vegetation Association	Low Open Heath of *Acacia spondylophylla* and *Acacia ptychophylla* over Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with High Shrubland of *Grevillea wickhamii, Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* in brown silty loam on south facing mesa slopes



Area Mapped	44.54 ha
Quadrats Sampled	CAL3
Location	South facing slopes of the mesa in the south of the Study area
Leaf Litter Cover (%)	0.5
Bare Ground (%)	10
Soils and Geology	Brown silty loam with ironstone pebbles and cobbles
Land System	Capricorn
Land Form	South facing mesa slopes
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	Access track
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Corymbia hamersleyana, Eucalyptus leucophloia*
Tall Shrubs >2m	*Grevillea wickhamii, Acacia tumida* var. *pilbarensis, Petalostylis labicheoides*
Shrubs <1m	*Acacia spondylophylla, Acacia ptychophylla, Indigofera monophylla*
Hummock Grasses	*Triodia wiseana, Triodia epactia*

Broad Floristic Formation	6b. *Acacia* Low Open Heath
Vegetation Association	Low Open Heath of *Acacia ptychophylla* over Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Grevillea pyramidalis, Acacia inaequilatera* and *Acacia colei* in red sand on sandplains



Area Mapped	11.73 ha
Quadrats Sampled	East of CAL9, CAL12
Location	Far south eastern corner of the Study area
Leaf Litter Cover (%)	10%
Bare Ground (%)	20-30%
Soils and Geology	Sand
Land System	Boolgeeda
Land Form	Sandplains with minor drainage depressions
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	None evident
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Grevillea pyramidalis, Acacia inaequilatera, Acacia colei*
Shrubs <1m	*Acacia ptychophylla*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	7a. *Triodia* Closed Hummock Grassland
Vegetation Association	Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia colei, Grevillea pyramidalis* and *Acacia inaequilatera* over Scattered Low Shrubs of *Pluchea tetranthera* in orange brown loamy sand on plains



Area Mapped	149.37 ha
Quadrats Sampled	CAL4, CAL6, CJ65, CJ17
Location	Loamy sandplains across the northern parts of the Study area.
Leaf Litter Cover (%)	<1
Bare Ground (%)	10-25
Soils and Geology	Orange brown loamy sand
Land System	Paradise, Boolgeeda
Land Form	Loamy sand plains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Very Good
Disturbances	Fence, access track, rail line, livestock
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia colei, Grevillea pyramidalis, Acacia inaequilatera*
Shrubs <1m	*Pluchea tetranthera*
Hummock Grasses	*Triodia epactia, Triodia wiseana*

Broad Floristic Formation	7b. *Triodia* Closed Hummock Grassland
Vegetation Association	Closed Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia hamersleyana* over High Open Shrubland of *Acacia ancistrocarpa, Acacia elachantha* and *Acacia inaequilatera* in brown sandy loam on sand plains



Area Mapped	38.16 ha
Quadrats Sampled	CAL9, CJ29
Location	Sand plains in the central and north eastern parts of the Study area
Leaf Litter Cover (%)	<1
Bare Ground (%)	15
Soils and Geology	Brown sandy loam
Land System	Boolgeeda
Land Form	Sandplain
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Cenchrus ciliaris*
Vegetation Condition	Very Good
Disturbances	Access track, introduced species
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Corymbia hamersleyana*
Tall Shrubs >2m	*Acacia ancistrocarpa, Acacia elachantha, Acacia inaequilatera, Acacia tumida* var. *pilbarensis*
Shrubs 1-2 m	*Acacia sphaerostachya, Acacia ptychophylla,*
Shrubs <1 m	*Acacia stellaticeps, Acacia ptychophylla*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	7c. *Triodia* Closed Hummock Grassland
Vegetation Association	Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* over Scattered Low Shrubs of *Acacia ptychophylla* in orange red brown silty sandy loam on footslopes



Area Mapped	136.50 ha
Quadrats Sampled	CAL11, CAL19, CJ12, CJ38
Location	Footslopes around the mesa through the central and south eastern parts of the Study area.
Leaf Litter Cover (%)	0.5
Bare Ground (%)	20-25
Soils and Geology	Orange red brown silty sandy loam with ironstone cobbles and pebbles
Land System	Boolgeeda, Paradise
Land Form	Footslopes
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Very Good - Excellent
Disturbances	Access tracks
Average Fire Age	Moderate - Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia inaequilatera, Grevillea pyramidalis, Grevillea wickhamii, Acacia tumida* var. *pilbarensis*
Shrubs <1m	*Acacia ptychophylla*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	7d. *Triodia* Closed Hummock Grassland
Vegetation Association	Closed Hummock Grassland of *Triodia wiseana* with Scattered High Shrubs of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* in brown silty loam on scree slopes



Area Mapped	81.45 ha
Quadrats Sampled	CAL20, CJ11, CJ57
Location	Scree slopes around the mesa thorugh the central ad south eastern parts of the Study area
Leaf Litter Cover (%)	<1
Bare Ground (%)	10
Soils and Geology	Brown silty loam
Land System	Boolgeeda
Land Form	Scree slopes
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	Access tracks
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia inaequilatera, Grevillea pyramidalis, Grevillea wickhamii*
Shrubs <1m	*Acacia spondylophylla*
Hummock Grasses	*Triodia wiseana*

Broad Floristic Formation	7e. *Triodia* Closed Hummock Grassland
Vegetation Association	Closed Hummock Grassland of *Triodia epactia* over Low Shrubland of *Acacia stellaticeps* and High Open Shrubland of *Acacia tumida* var. *pilbarensis, Acacia colei* and *Acacia inaequilatera* in orange brown loam on sand plains
	
Area Mapped	38.44 ha
Quadrats Sampled	CAL22, CJ65, CJ67, CJ32
Location	Sand plains in the north east of the Study area
Leaf Litter Cover (%)	6
Bare Ground (%)	8
Soils and Geology	Orange brown loamy sand
Land System	Paradise
Land Form	Sand plains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Very Good
Disturbances	Access track, livestock
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis, Acacia colei, Acacia inaequilatera*
Shrubs <1m	*Acacia stellaticeps*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	8a. *Triodia* Hummock Grassland
Vegetation Association	Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* and High Open Shrubland of *Grevillea wickhamii* and *Petalostylis labicheoides* in red brown silty/sandy loam on mesa hill crests and plateaux
	
Area Mapped	225.37 ha
Quadrats Sampled	CAL2, CAL7, CAL8
Location	Mesa/plateau in the south western part of the Study area.
Leaf Litter Cover (%)	<1
Bare Ground (%)	20-43
Soils and Geology	Red brown silty/sandy loam with ironstone cliffs, outcrops, boulders and cobbles
Land System	Capricorn
Land Form	Mesa crest/plateau
Priority Ecological Community	No
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Very Good - Excellent
Disturbances	Access track, drill pads,
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Corymbia hamersleyana, Eucalyptus leucophloia*
Tall Shrubs >2m	*Grevillea wickhamii, Petalostylis labichioides*
Shrubs 1-2 m	*Senna glutinosa* subsp. *glutinosa*
Shrubs <1m	*Acacia spondylophylla, Acacia ptychophylla*
Hummock Grasses	*Triodia wiseana, Triodia epactia*
Tussock Grasses	*Eriachne mucronata*
Herbs	*Trachymene oleracea*

Broad Floristic Formation	8b. *Triodia* Hummock Grassland
Vegetation Association	Hummock Grassland of *Triodia epactia* and *Triodia wiseana* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* and Low Open Shrubland of *Acacia ptychophylla* in brown sandy loam on footslopes and stony rises





Area Mapped	145.00 ha
Quadrats Sampled	CAL12, CAL13, CAL17, CJ37, CJ33, CJ18, CJ27
Location	Footslopes through the central and central eastern parts of the Study area
Leaf Litter Cover (%)	<1
Bare Ground (%)	20-70
Soils and Geology	Brown sandy loam with granite, quartz, calcrete, ironstone cobbles, pebbles, and scattered outcrops
Land System	Boolgeeda
Land Form	Footslopes and stony rises
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Portulaca oleracea*
Vegetation Condition	Very Good - Excellent
Disturbances	Rail line, fence line, mine site, access track, introduced species, fire, soil disturbance
Average Fire Age	Recent - Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia inaequilatera, Grevillea pyramidalis, Grevillea wickhamii*
Shrubs <1m	*Acacia ptychophylla, Senna notabilis, Corchorus elachocarpus, Swainsona formosa, Ptilotus auriculiformis, Solanum diversiflorum*
Hummock Grasses	*Triodia epactia, Triodia wiseana*
Tussock Grasses	*Eriachne pulchella* subsp. *dominii*
Herbs	*Heliotropium cunninghamii, Cleome viscosa*

Broad Floristic Formation	8c. *Triodia* Hummock Grassland
Vegetation Association	Hummock Grassland of *Triodia epactia* with Low Open Shrubland of *Pluchea tetranthera, Acacia stellaticeps* and *Pluchea rubelliflora* over Very Open Bunch Grassland of *Sporobolus actinocladus, Sporobolus australasicus* and *Eragrostis cumingii* in brown sand along drainage lines and on floodplains



Area Mapped	68.22 ha
Quadrats Sampled	CAL15, CAL21, CJ69
Location	Floodplains and drainage lines throughout the north of the Study area.
Leaf Litter Cover (%)	<1
Bare Ground (%)	30-43
Soils and Geology	Orange brown sand with blue ironstone and granite medium gravels and pebbles
Land System	Paradise, Boolgeeda
Land Form	Drainage lines and floodplains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Chloris virgata, *Cenchrus ciliaris*
Vegetation Condition	Very Good
Disturbances	Livestock, introduced species, erosion
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia synchronicia, Acacia colei*
Shrubs <1m	*Pluchea tetranthera, Acacia stellaticeps* and *Pluchea rubelliflora, Solanum cleistogamum*
Hummock Grasses	*Triodia epactia*
Tussock Grasses	*Sporobolus actinocladus, Sporobolus australasicus* and *Eragrostis cumingii, *Chloris virgata, Dactyloctenium radulans*

Broad Floristic Formation	8d. *Triodia* Hummock Grassland
Vegetation Association	Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia flavescens* over Low Shrubland *of Tephrosia rosea* var. *glabrior, Cullen martinii* and *Crotalaria ramosissima* in orange sand along minor drainage lines and on sand plains



Area Mapped	7.38 ha
Quadrats Sampled	CAL16, CJ34
Location	Small area of sand plains in the central east of the Study area
Leaf Litter Cover (%)	0.5%
Bare Ground (%)	4%
Soils and Geology	Orange sand
Land System	Boolgeeda
Land Form	Minor drainage lines and sand plains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	**Cenchrus ciliaris*
Vegetation Condition	Very Good
Disturbances	Introduced species, livestock
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Corymbia flavescens*
Tall Shrubs >2m	*Acacia inaequilatera, Acacia colei, Grevillea pyramidalis* var. *leucadendron*
Shrubs <1m	*Tephrosia rosea* var. *glabrior, Cullen martini, Crotalaria ramosissima, Hibiscus leptocladus, Corchorus elachocarpus,*
Hummock Grasses	*Triodia epactia*
Tussock Grasses	**Cenchrus ciliaris, Eragrostis cummingii, Eriachne aff. obtusa, Aristida holathera* var. *holathera*

Broad Floristic Formation	8e. *Triodia* Hummock Grassland
Vegetation Association	Hummock Grassland of *Triodia epactia* over Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* with Scattered High Shrubs of *Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii* and *Acacia inaequilatera* in red brown sandy loam along minor drainage lines and on footslopes



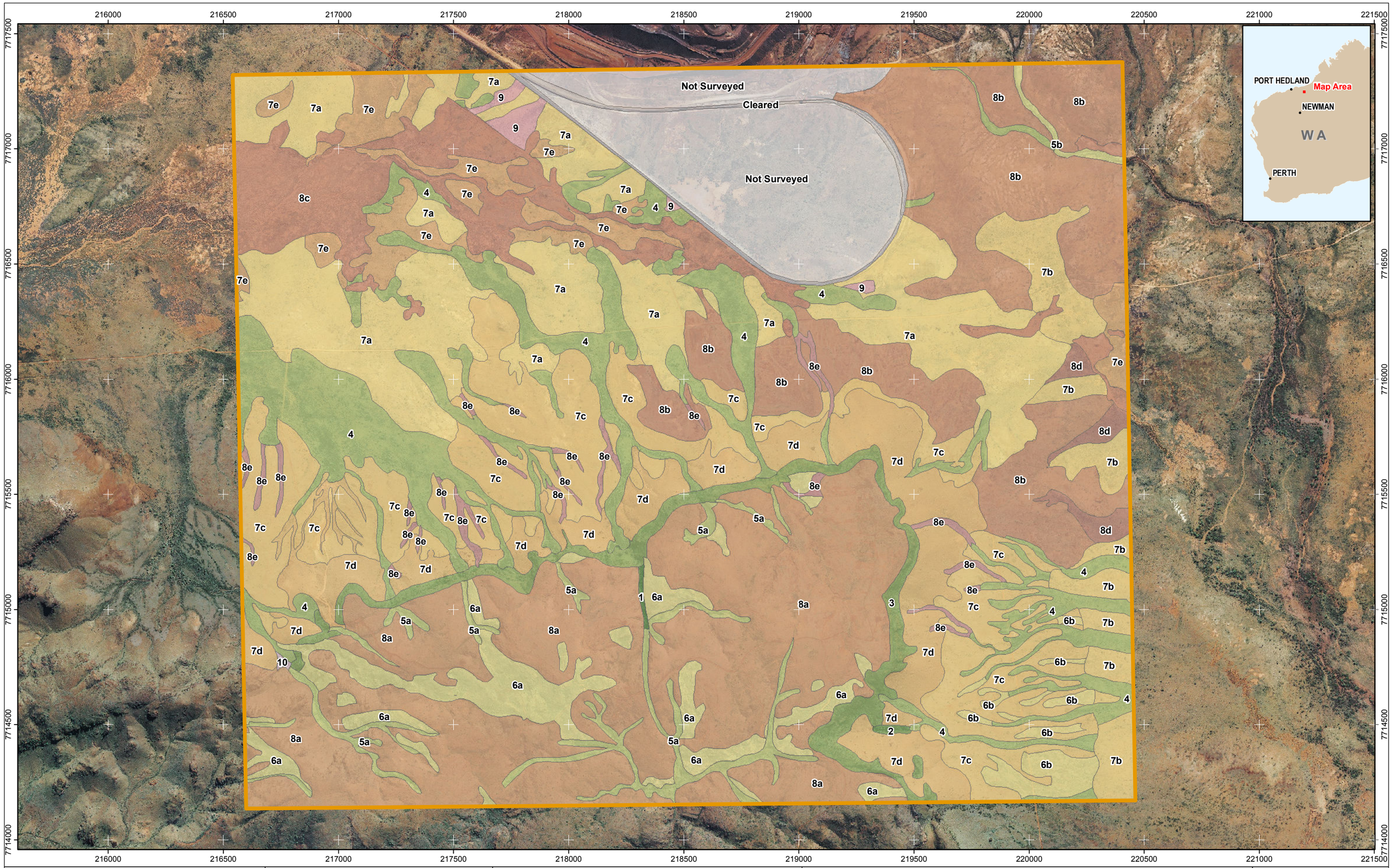
Area Mapped	11.37 ha
Quadrats Sampled	Adjacent to CAL19
Location	Minor drainage lines on footslopes surrounding mesa crest/plateau
Leaf Litter Cover (%)	10%
Bare Ground (%)	35%
Soils and Geology	Red brown sandy loam
Land System	Boolgeeda
Land Form	Minor drainage lines and footslopes
Priority Ecological Community	No
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	None
Average Fire Age	Old
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis*, *Grevillea wickhamii*, *Acacia inaequilatera*
Shrubs <1m	*Acacia spondylophylla*, *Acacia ptychophylla*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	9. *Triodia* Open Hummock Grassland
Vegetation Association	Open Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Acacia synchronicia,* Acacia i*naequilatera* and *Acacia colei* and Scattered Low Shrubs of *Pluchea tetranthera* in silty loam on plains
	
Area Mapped	4.51 ha
Quadrats Sampled	CJ66
Location	Small areas in the northern parts of the Study area
Leaf Litter Cover (%)	<1%
Bare Ground (%)	60-70%
Soils and Geology	Silty loam on plains
Land System	Paradise, Boolgeeda
Land Form	Degraded silty plains
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Good
Disturbances	Fire, siltation
Average Fire Age	Young
Vegetation Structure & Floristics	
Tall Shrubs >2m	*Acacia synchronicia,* Acacia i*naequilatera, Acacia colei*
Shrubs <1m	*Pluchea tetranthera*
Hummock Grasses	*Triodia epactia*

Broad Floristic Formation	10. *Cyperus* Sedges
Vegetation Association	Sedges of *Cyperus vaginatus* with Low Open Woodland of *Terminalia canescens* and High Open Shrubland of *Acacia tumida* var. *pilbarensis*, *Flueggea virosa* subsp. *melanthesoides* and *Phyllanthus reticulatus* in elevated marsh/soak



Area Mapped	0.27 ha
Quadrats Sampled	CJ9
Location	Permanent spring in the south west of the Study area at the base of the mesa
Leaf Litter Cover (%)	<1%
Bare Ground (%)	30%
Soils and Geology	Marsh / soak
Land System	Capricorn
Land Form	Elevated marsh/soak
Priority Ecological Community	None
Rare Flora	None
Introduced (Weed) Species	None
Vegetation Condition	Excellent
Disturbances	None
Average Fire Age	Old
Vegetation Structure & Floristics	
Trees >10m	*Terminalia canescens, Eucalyptus camaldulensis,*
Tall Shrubs >2m	*Acacia tumida* var. *pilbarensis*, *Flueggea virosa* subsp. *melanthesoides, Phyllanthus reticulatus*
Shrubs <1m	*Stemodia grossa*
Tussock Grasses	*Eriachne tenuiculmis*
Hummock Grasses	*Triodia wiseana*
Sedges	*Cyperus vaginatus*



ONSHORE ENVIRONMENTAL			
ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	13/09/2012
Sheet Size:	A3	Status:	Final
Drawn by: GSM	Requested by: DB	GSM Reference: Callawa Veg Types Map	

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Meters

1:15,000

Datum: GDA94

Projection: MGA Zone 51

CALLAWA

VEGETATION TYPES

Legend

Study Area

Griffin Spatial & Mapping

2 Spacris Elbow Pelican Point

Bunbury WA 6230

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Legend

Vegetation Types

Terminalia Low Open Forest

1 — Low Open Forest of *Terminalia canescens* and *Corymbia flavescens* over High Shrubland of *Acacia tumida* var. *pilbarensis* and *Grevillea wickhamii* over Open Tussock Grassland of *Eriachne tenuiculmis* and *Cymbopogon ambiguus* in red brown sandy loam along medium drainage lines

Eucalyptus Low Woodland

2 — Low Woodland of *Eucalyptus camaldulensis* subsp. *refulgens, Corymbia flavescens* and *Corymbia hamersleyana* over High Open Shrubland of *Acacia colei* and *Acacia monticola* with Climbers of *Passiflora foetida* ssp. *hispida* and *Ipomoea muelleri* in brown sandy loam along medium drainage lines

Terminalia Low Open Woodland

3 — Low Open Woodland of *Terminalia canescens, Ficus brachypoda* and *Atalaya hemiglauca* over High Open Shrubland of *Acacia pruinocarpa, Acacia tumida* var. *pilbarensis* and *Phyllanthus reticulatus* over Very Open Tussock Grassland of *Eriachne mucronata, Cymbopogon ambiguus* and *Aristida burbidgeae* in red silty loam along cliff lines

Acacia Closed Scrub

4 — Closed Scrub of *Acacia tumida* var. *pilbarensis* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Hummock Grassland of *Triodia epactia* in brown loamy sand on drainage lines and drainage flats

Acacia Open Scrub

5a — Open Scrub of *Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* and *Grevillea wickhamii* over Open Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Terminalia canescens, Corymbia flavescens* and *Ficus brachypoda* in brown silty loam along minor drainage lines

5b — Open Scrub of *Acacia tumida* var. *pilbarensis* and *Acacia colei* with Low Open Woodland of *Corymbia flavescens* and *Corymbia hamersleyana* and Open Sedges of *Typha domingensis* and *Cyperus vaginatus* in brown loamy sand on medium drainage lines

Acacia Low Open Heath

6a — Low Open Heath of *Acacia spondylophylla* and *Acacia ptychophylla* over Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with High Shrubland of *Grevillea wickhamii, Acacia tumida* var. *pilbarensis* and *Petalostylis labicheoides* in brown silty loam on south facing mesa slopes

6b — Low Open Heath of *Acacia ptychophylla* over Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Grevillea pyramidalis, Acacia inaequilatera* and *Acacia colei* in red sand on sandplains

Triodia Closed Hummock Grassland

7a — Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia colei, Grevillea pyramidalis* and *Acacia inaequilatera* over Scattered Low Shrubs of *Pluchea tetranthera* in orange brown loamy sand on plains

7b — Closed Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia hamersleyana* over High Open Shrubland of *Acacia ancistrocarpa, Acacia elachantha* and *Acacia inaequilatera* in brown sandy loam on sand plains

7c — Closed Hummock Grassland of *Triodia epactia* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* over Scattered Low Shrubs of *Acacia ptychophylla* in orange red brown silty sandy loam on footslopes

7d — Closed Hummock Grassland of *Triodia wiseana* with Scattered High Shrubs of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* in brown silty loam on scree slopes

7e — Closed Hummock Grassland of *Triodia epactia* with over Low Shrubland of *Acacia stellaticeps* and High Open Shrubland of *Acacia tumida* var. *pilbarensis, Acacia colei* and *Acacia inaequilatera* in orange brown loam on sand plains

Triodia Hummock Grassland

8a — Hummock Grassland of *Triodia wiseana* and *Triodia epactia* with Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* and High Open Shrubland of *Grevillea wickhamii* and *Petalostylis labicheoides* in red brown silty sandy loam on mesa hill crests and plateaux

8b — Hummock Grassland of *Triodia epactia* and *Triodia wiseana* with High Open Shrubland of *Acacia inaequilatera, Grevillea pyramidalis* and *Grevillea wickhamii* and Low Open Shrubland of *Acacia ptychophylla* in brown sandy loam on footslopes and stony rises

8c — Hummock Grassland of *Triodia epactia* with Low Open Shrubland of *Pluchea tetranthera, Acacia stellaticeps* and *Pluchea rubelliflora* over Very Open Bunch Grassland of *Sporobolus actinocladus, Sporobolus australasicus* and *Eragrostis cumingii* in brown sand along drainage lines and floodplains

8d — Hummock Grassland of *Triodia epactia* with Low Open Woodland of *Corymbia flavescens* over Low Shrubland of *Tephrosia rosea* var. *glabrior, Cullen martinii* and *Crotalaria ramosissima* in orange sand along minor drainage lines and sand plains

8e — Hummock Grassland of *Triodia epactia* over Low Shrubland of *Acacia spondylophylla* and *Acacia ptychophylla* with Scattered High Shrubs of *Acacia tumida* var. *pilbarensis, Grevillea wickhamii* and *Acacia inaequilatera* in red brown sandy loam along minor drainage lines and footslopes

Triodia Open Hummock Grassland

9 — Open Hummock Grassland of *Triodia epactia* with Scattered Tall Shrubs of *Acacia synchronicia, Acacia inaequilatera* and *Acacia colei* and Scattered Low Shrubs of *Pluchea tetranthera* in silty loam on plains

Cyperus Sedges

10 — Sedges of *Cyperus vaginatus* with Low Open Woodland of *Terminalia canescens* and High Open Shrubland of *Acacia tumida* var. *pilbarensis, Flueggea virosa* ssp. *melanthoides* and *Phyllanthus reticulatus* in elevated marsh/soak

Other

Cleared

Not Surveyed

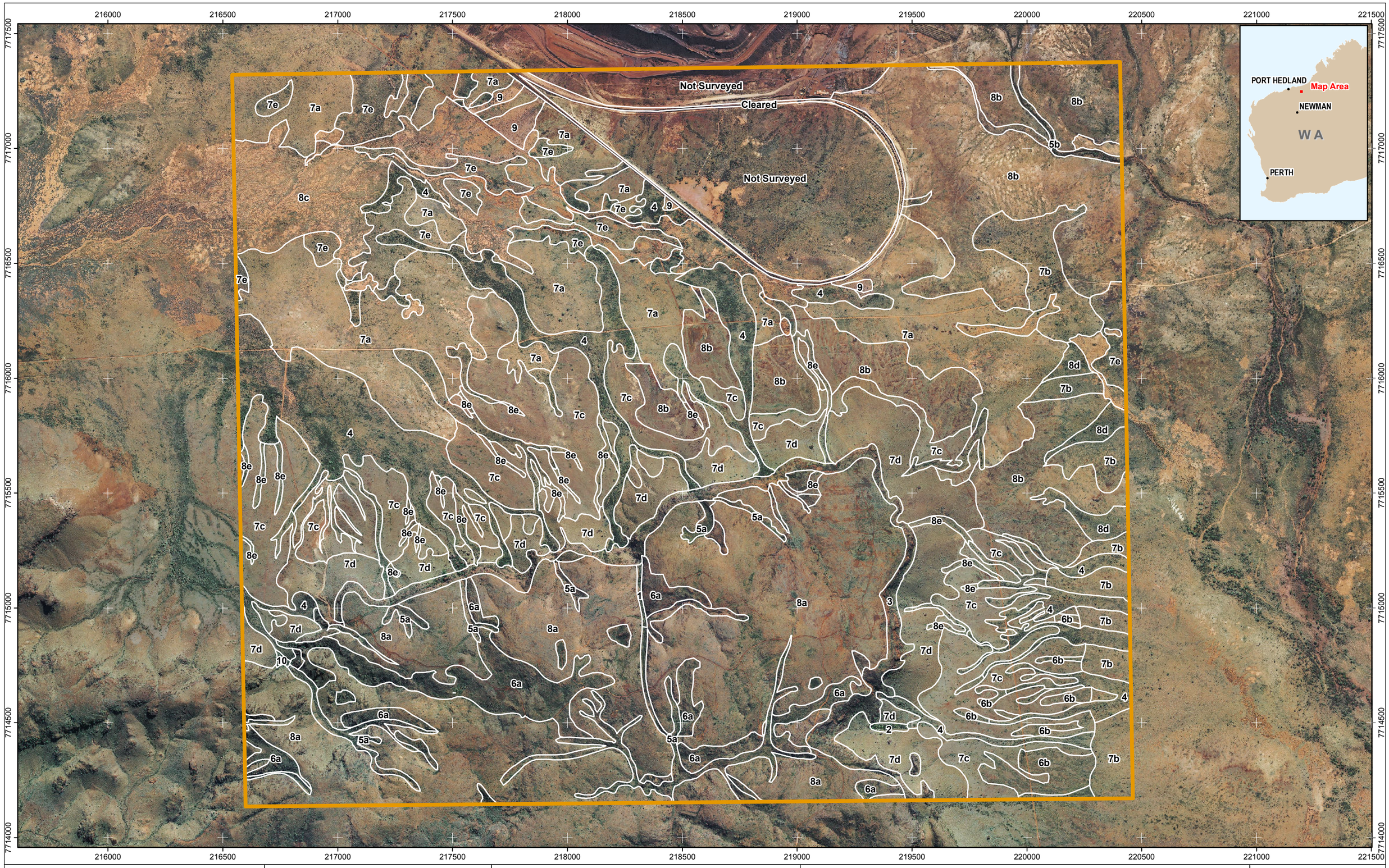
ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	13/09/2012
Sheet Size:	A3	Status:	Final
Drawn by: GSM	Requested by: DB	GSM Reference: Callawa Veg Types Legend	

CALLAWA

VEGETATION TYPE LEGEND

Griffin Spatial & Mapping
2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3213



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS		Date:	13/09/2012
Sheet Size:	A3	Status:	Final
Drawn by: GSM	Requested by: DB	GSM Reference: Callawa Veg Types Map	

Griffin Spatial & Mapping
2 Epacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
+61 (0) 8 9725 3813

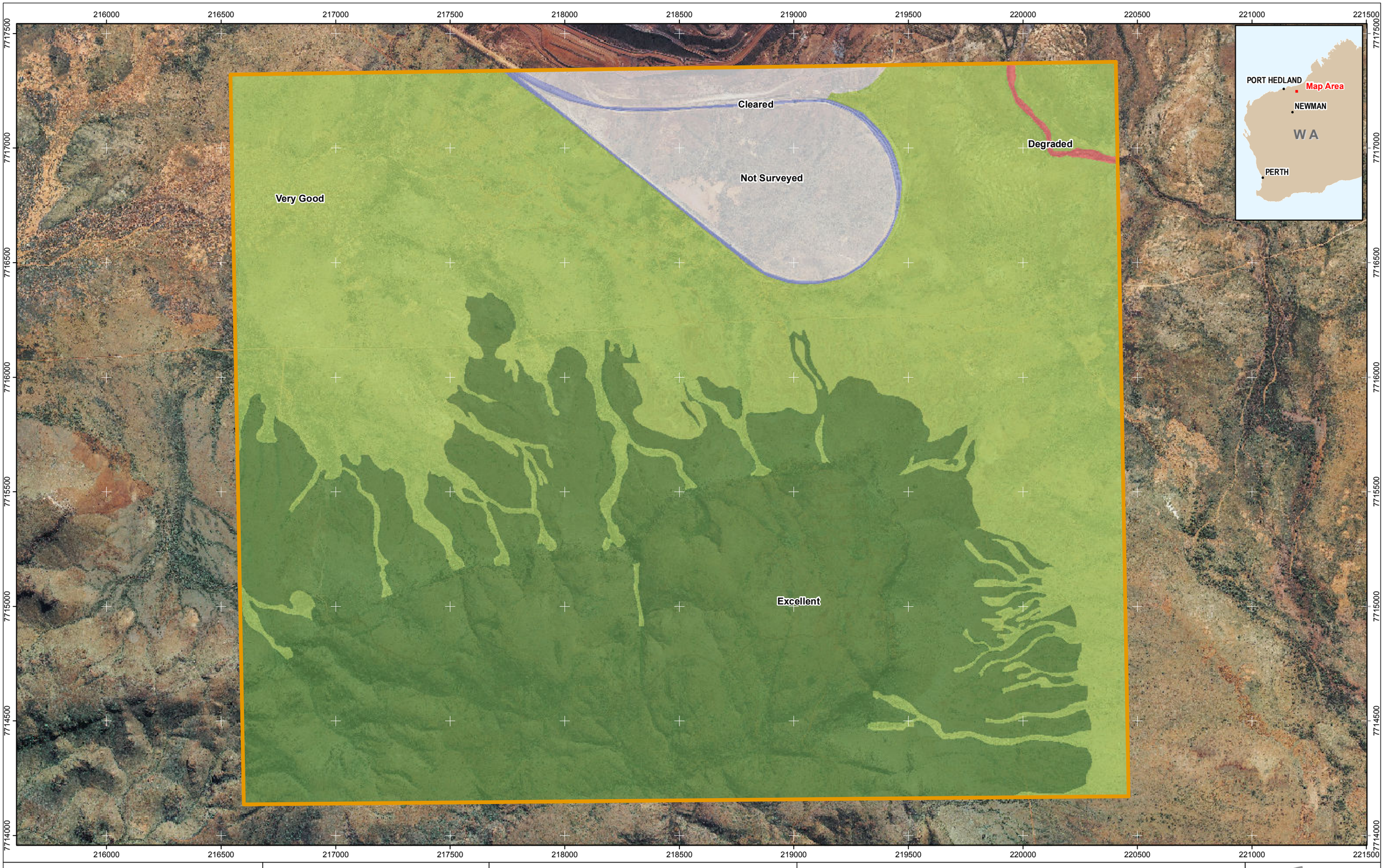
3.7 Vegetation Condition

Vegetation condition across the study area ranged from Excellent to Degraded. Vegetation condition for nine of the 20 vegetation associations was rated as Excellent, seven were rated as Very Good, three were rated as Good and one was rated as Degraded.

Vegetation associations occurring in areas of increasing relief typically supported vegetation of better condition (Figure 9). This included steep cliff lines, the crests, plateau, scree slopes, hill slopes, and footslopes of mesa hills, as well as rocky drainage lines amongst mesa slopes and minor drainage lines amongst footslopes. There was also an elevated permanent marsh recorded in the south-east that was rated as being in Excellent condition.

Vegetation condition along drainage lines and on plains typically ranged from Very Good to Good, with the exceptions being Vegetation association 6b (sandplains with minor depressions rated as Excellent) and Vegetation association 5b (medium drainage line and adjacent floodplain rated as Degraded). The variation in vegetation condition was largely in response to historical grazing pressure.

The primary disturbance impact was linked directly to grazing by domestic stock resulting in reduced native species richness, the introduction of weeds and surface soil instability. There were less obvious impacts from pastoral fencelines, as well as edge effects from mining infrastructure such as the rail line and exploration tracks and historical drill holes. The majority of the study area was long unburnt; however, there was evidence of recent fire in the north-east corner encompassing study sites Cal13 and Cal14.



ONSHORE ENVIRONMENTAL

ON SHORE ENVIRONMENTAL CONSULTANTS	Date:	11/10/2012
Sheet Size:	A3	Status: Final
Drawn by: GSM	Requested by: DB	GSM Reference: Callawa Veg Condition Map

N

0 100 200 300 400 500

Meters
1:15,000

Datum: GDA94
Projection: MGA Zone 51

CALLAWA

VEGETATION CONDITION

Legend

Study Area

Vegetation Condition

- Excellent
- Very Good
- Degraded
- Cleared
- Not Surveyed

Griffin Spatial & Mapping
2 Spacris Elbow Pelican Point
Bunbury WA 6230
griffinspatial@bigpond.com
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4.0 Summary

Onshore Environmental completed a single-season Level 2 flora and vegetation survey of the study area between the 11th and 20th June 2012. Results from the 2012 survey was combined with previous data collected from within the study area during two previous flora and vegetation surveys Ecologia Environment (2005a) and ENV Australia (2008). The combined datasets resulted in a total number of 249 plant taxa (including varieties and subspecies) from 49 families and 122 genera being recorded from the study area. Species representation was greatest among the Fabaceae, Poaceae, Malvaceae and Amaranthaceae families, which is typical for the Pilbara Bioregion.

None of the plant taxa recorded were gazetted as DRF pursuant to subsection (2) of section 23F of the WC Act or listed under the EPBC Act. There were two Priority flora taxa recorded from the Study area during the 2012 survey; *Fimbristylis* ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722) (Priority 1) and *Eragrostis crateriformis* (Priority 3). Another three plant taxa recorded along cliff faces and associated scree slopes in the southern sector of the study area were determined to be of interest; *Sida macropoda, Stemodia* sp. and *Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL 01.05). A fifth plant species, *Cyperus microcephalus* subsp. *saxicola* showed a very large range extension of approximately 700 km south-west of the nearest recorded locations which occur in the Northern Botanical Province.

There were eight introduced (weed) flora recorded from the study area; **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris virgata* (Feathertop Rhodes Grass), **Cynodon dactylon* (Couch Grass), **Malvastrum americanum* (Spiked Malvastrum), **Passiflora foetida* var. *hispida* (Passionfruit Vine), **Portulaca oleracea* (Purslane) and **Vachellia farnesiana* (Mimosa Bush). None of these taxa are listed as Declared Weeds under the ARRP Act.

A total of 20 vegetation associations were described and mapped from the study area. The vegetation associations were classified into ten Broad Floristic Formations on the basis of canopy structure. None of the vegetation associations recorded are currently listed TECs or PECs.

Vegetation condition across the study area ranged from Excellent to Degraded. Vegetation associations occurring in areas of increasing relief typically supported vegetation of better condition. The primary disturbances recorded were linked directly to grazing by domestic stock resulting in reduced native species richness, the introduction of weeds and surface soil instability. There were less obvious impacts from pastoral fencelines, as well as edge effects from mining infrastructure such as the rail line and exploration tracks and historical drill holes. The majority of the study area was long unburnt; however, there was evidence of recent fire in the north-east corner.

5.0 Study Team

The Level 2 flora survey and vegetation survey was planned, coordinated and executed by the following personnel:

Onshore Environmental Consultants P/L
ABN 41 095 837 120
PO Box 227
YALLINGUP WA 6282
pf 08 9756 6206 m 0427 339 842
email onshoreenv@westnet.com.au

Project Staff

Dr Darren Brearley	PhD	Project Manager
Dr Jerome Bull	PhD	Senior Botanist
Mr Daniel Roberts	BSc	Botanist
Ms Jessica Waters	BSc	Botanist
Ms Ellen Palmer	BSc	Botanist
Mrs Kerry Keenan		Data Analyst
Mr Todd Griffin		GIS Specialist

Licences

The field survey was conducted under the authorization of the following licences issued by the Department of Environment & Conservation:

- Jerome Bull, Onshore Environmental Consultants 'Licence to take flora for scientific & other prescribed purposes' Licence No. SL009579
- Daniel Roberts, Onshore Environmental Consultants 'Licence to take flora for scientific & other prescribed purposes' Licence No. SL009561

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Wildlife Conservation (Rare Flora) Notice 2012.

APPENDIX 1

Summary of previous flora and vegetation surveys in and adjacent to the Study area.

Yarrie Biological and Soil Survey (Ecologia Environmental 1999)

In accordance with the BHP Iron Ore environmental management plan a survey of existing biota and soils of the Yarrie project area was conducted by Ecologia Environment during 3-9 June 1998. A baseline biological (flora and fauna) and soil survey of the project area was carried out where soil profiles were described and samples taken at each major vegetation type to assess the distribution and relative value of soils for rehabilitation.

There was a relatively low number of species recorded. This was attributed to a combination of factors such as the timing of the survey following an unusually dry summer and the area being somewhat homogenous, with relatively few vegetation types. The flora and vegetation component of the survey included 39 quadrats, each measuring 100 m x 100 m or equivalent area. There were 209 plant taxa recorded from 47 families and 105 genera, 67 of which were represented by a single taxon. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the project area. Two Priority Flora species were recorded in the project area being *Euphorbia clementii* (Priority 2) and *Euphorbia drummondii* (Priority 2 at time of survey but no longer listed as a Priority flora). Four weed taxon being **Cenchrus ciliaris* (Buffel Grass), **Acacia* (*Vachellia*) *farnesiana* (Mimosa Bush), **Aerva javanica* (Kapok Bush) and **Chloris gayana* (Rhodes Grass) were recorded within the project area, none of which were gazetted within the current schedule published by the Agricultural Protection Board at the time. A total of 12 vegetation associations (or community types) were identified in the project area.

Cundaline Biological Assessment Survey (Ecologia 2005a)

As part of BHPBIO's proposal to extend mining activity in Yarrie and Nimingarra in the north-eastern Pilbara two ore bodies associated with the Cundaline and Callawa Ridges were to be investigated for further development. During May 2005 Ecologia Environment was commissioned to conduct a biological assessment of the Cundaline project area.

The seasonal conditions during the survey were not optimal as rainfall for the 2 months preceding the survey was recorded at less than 2 mm for the nearby centres of Port Hedland and Marble Bar. Hence the full complement of annuals and small perennials that may occur in the area may not have been recorded. However, soil conditions during the survey were observed as partially moist and several flora species were recorded flowering widespread over the area, suggesting that conditions were at least partially favourable to some annuals. The flora and vegetation component of the survey included 35 quadrats measuring 50 m x 50 m or equivalent area. There were 91 plant taxa recorded from 28 families and 48 genera. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the project area. There was no Priority flora recorded, however the locally significant species, *Stemodia* sp. Shay Gap was found at two locations. The species was discovered in November 2004 at Sunrise Hill/Shay Gap Ridges and was taxonomically un-described at time of report. The report also suggests that it may become a Priority 1 flora species in WA when it is recognised by the WA Herbarium. A current FloraBase search showed no result for a species of that name (FloraBase 2012). *Sida* sp. Callawa (now known as *Sida macropoda*) was also recorded at one site within the Cundaline Project area and is known to occur within the adjacent Callawa Project area. At the time of the report specimens of the species had not

been matched with reference material at the WA Herbarium and may represent a new or un-described taxon. The species *Sida macropoda* is not listed as a declared rare or priority flora. Two other species of interest included *Corchorus pumilio* and *Solanum beaugleholei*, which recognised possible range extensions from their previously known distribution in the Kimberley region. Both taxa have since been collected more widely in the Pilbara. No weed species were recorded during the survey. A total of eight vegetation associations were identified.

Callawa Biological Assessment Survey (Ecologia 2005b)

As part of BHPBIO's proposal to extend mining activity in the Yarrie and Goldsworthy areas in the north-eastern Pilbara two ore bodies associated with the Cundaline and Callawa Ridges were to be investigated for further development. During June and September 2005 Ecologia Environment conducted a baseline biological assessment of the Callawa Project area.

The flora and vegetation survey was conducted from 9-17 June 2005, while mapping of the vegetation occurred from 12-14 September 2005. In the two months prior to the survey less than 8 mm of rainfall had been recorded for areas surrounding the Callawa Project area (Marble Bar and Port Hedland) suggesting that the seasonal conditions were not ideal. Therefore it is possible that the full complement of annuals and semi-perennials in the area may not have been recorded during the survey. However, additional searching was conducted during the vegetation mapping phase, which followed a period of favourable rainfall. A total number of 55 quadrats measuring 50 m x 50 m or equivalent area were assessed. The survey recorded 96 total plant taxa from 35 families and 61 genera, 17 families were represented by a single taxon. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the project area. There was no Priority flora recorded with the exception of *Stemodia* sp. Shay Gap being recorded at two locations. Five flora species of interest were recorded during the survey, including two grass species that were thought to be endemic to the Pilbara region at the time of the 2005 survey but have since been more widely collected; *Enneapogon lindleyanus* and *Eriachne tenuiculmis*. *Phyllanthus exilis* and *Solanum beaugleholei* were recognized as having possible range extensions from their known Kimberley distributions; both taxa have since been more widely collected in the Pilbara. *Sida* sp. Callawa (now known as *Sida macropoda*) was also recorded at eight locations (it is also known to occur at adjacent Cundaline Ridge Project area). At the time of the report specimens had not been matched with reference material at the WA Herbarium so they were thought to potentially represent a new or un-described taxon. The species *Sida macropoda* is not currently listed as a declared rare or priority flora. One weed taxon was recorded; **Passiflora foetida* var. *hispida* of which is not listed as a declared plant under the ARRP Act.

Goldsworthy Extension Project Cattle Gorge Haul Road Biological Assessment Survey (Ecologia 2005c)

As part of BHPBIO's proposal to extend mining activity in the north-eastern Pilbara, the Goldsworthy Extension Project was initiated. Development of different ore bodies within the Goldsworthy area, such as Cattle Gorge, was being considered. If the Cattle Gorge area was to begin operation it was to be serviced by the Yarrie Mining Operations and would require a haul road to be constructed between the two areas. During Octorber 2005 Ecologia Environment was commissioned to conduct a biological assessment of the proposed haul road corridor.

The seasonal conditions during the flora and vegetation component of the survey were satisfactory as some annuals and semi-perennials were recorded in addition to perennial plant species. The flora and vegetation component of the survey was conducted from 19-21 January 2005. An extra survey day on 11 May 2005 was added for targeted searches of priority flora. The survey included 10 quadrats, each measuring 50 m x 50 m or equivalent area. There were 102 plant taxa recorded from 26 families and 57 genera. This included a total of 90 flora species, 29 subspecies, varieties and forms determined from the flora recorded in the area. Nine plant families were represented by a single taxon. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the project area. One Priority Flora species being *Acacia glaucocaesia* (Priority 3) was recorded in the Project area and from the follow up targeted survey up to six sub-populations were located within close proximity to each other and in near vicinity of the proposed haul road corridor. Three weed species were recorded; **Cenchrus ciliaris*, **Chloris virgata* and **Citrillus colocynthis* and a total of eight vegetation associations were identified within the Project area. None of the above weeds are declared plants under the ARRP Act.

Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations Flora and Vegetation Assessment (ENV 2008)

Ecologia Environment completed the original flora and survey work on the Callawa and Cundaline ridges in 2005, on behalf of the Goldsworthy Iron Ore Mining Operations (Ecologia 2005a, 2005b). ENV (2008) completed a supplementary flora survey in March 2008.

A total of 147 plant taxa were recorded in the Callawa survey area and 193 plant taxa were recorded from the Cundaline survey area. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the Callawa and Cundaline Study areas or are considered likely to occur. Two Priority Flora species were recorded within the Cundaline Project area, namely *Euphorbia clementii* (Priority 2) and *Goodenia nuda* (Priority 3 at the time of the survey, now a Priority 4 species). One Priority Flora species was recorded in the Callawa Project area, *Euphorbia inappendiculata* (Priority 3); it is noted that the three records were situated north of the current study area. Six introduced species were recorded; **Cenchrus ciliaris*, **Echinochloa colona* (Awnless Barnyard Grass), **Chloris virgata* (Feathertop Rhodes Grass), **Portulaca oleracea* and **Passiflora foetida* var. *hispida* (Passion flower) occurred within the Callawa Study area, and **Cenchrus ciliaris*, **Portulaca olearacea*, **Chloris virgata* and **Cucumis melo* subsp. *agrestis* (Ulcardo Melon) were recorded within the Cundaline Study area. A total of 14 vegetation associations were identified in the Callawa Study area and 21 vegetation associations were recorded in the Cundaline Study area. Both Study areas comprised mainly woodlands and shrubands. No vegetation communities recorded are listed as Threatened Ecological Communities, Priority Ecological Communities or are considered to be of regional significance.

Shay Gap Aerodrome and Yarrie Area A and Yarrie Area B Level 2 Flora and Vegetation Survey and Level 1 Fauna Survey (Onshore Environmental 2010)

Onshore Environmental was commissioned to undertake a one-season Level 2 Flora and Vegetation Survey at 3 relatively small survey areas at the Mt. Goldsworthy Mining Operations from 9-15 September 2010. The survey information was required to support a Native Vegetation Clearing Permit (NVCP) application to disturb areas required for the expansion of the existing Shay Gap Aerodrome and two options for the development of a crushing area to replace the existing facility at Cattle Gorge.

The seasonal conditions of the survey were satisfactory during September 2010. Rainfall at Yarrie between January and October 2010 was below average, totaling 218.8 mm. Good summer rainfall occurred during the months of December 2009 (212.6 mm) and January 2010 (99.4 mm) with above average winter rainfall received during the months of July 2010 (64.4 mm) and September (32.4 mm). The flora and vegetation component of the survey was conducted from 9-15 September 2010 where 48 quadrats measuring 50 m x 50 m or equivalent area were assessed. There were 165 plant taxa (including varieties and subspecies) recorded from 37 families and 93 genera. No Endangered or Vulnerable species listed under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* or DRF species listed under the *Western Australian Wildlife Conservation Act 1950* were recorded from the survey areas. There was no Priority flora recorded at any of the three areas. Five weed species were recorded across the three survey areas; **Aerva javanica*, **Cenchrus ciliaris*, **Chloris virgata*, **Cucumis melo* subsp. *agrestis* and **Portulaca oleracea*. None of the above weeds are declared plants under the ARRP Act.

Yarrie Mine Site Weed Survey and Mapping (Astron 2011)

Astron was commissioned by BHPBIO to undertake a weed survey and mapping field visit at the Yarrie Mine Site during August and September 2011 aiming to conduct a targeted survey for all weed species including details on the distribution of all weed species identified within the survey areas. A total of three targeted survey areas within the Yarrie Mine Site were identified by BHPBIO, the survey occurred between 31 August and 5 September 2011.

The seasonal conditions during the survey were less than ideal as the total rainfall in the two months prior to the visit was 9.8 mm, which is below average for the area. Astron used their own Weed Survey Mapping Methodology along with BHPBIO WAIO Weed Mapping Procedure to capture data. Astron's methodology uses a series of Weed Record Points (WRPs) described as 5 m x 5 m single GPS references points, assessed for a series of attributes for a single species at a single day or time. They are captured at set intervals throughout the survey area. As the survey targeted weeds, no total taxa, Declared Rare Flora, Priority Flora or Vegetation Associations were recorded.

A total of 20 weed species were recorded during the survey, 16 of which had not been previously recorded in prior surveys. Weeds previously recorded in prior surveys were **Aerva javanica*, **Cenchrus ciliaris*, **Chloris virgata, *Portulaca oleracea* (Purslane) and **Vachellia farnesiana*. The weeds not previously recorded were **Cenchrus setiger* (Birdwood Grass), **Citrullus colocynthis*, **Conyza bonariensis* (Flaxleaf Fleabane), **Cucumis melo* subsp. *agrestis*, **Cynodon dactylon* (Couch), **Digitaria ciliaris* (Summer Grass), **Echinochloa colona*, **Euphorbia hirta* (Asthma Plant), **Flaveria trinervia* (Speedy Weed), **Gomphrena celosioides* (Gomphrena Weed), **Oxalis corniculata* (Yellow Wood Sorrel), **Polycarpon*

tetraphyllum (Fourleaf Allseed), **Solanum nigrum* (Blackberry Nightshade), **Sonchus oleraceus* (Common Sowthistle), **Tridax procumbens*, potentially an unconfirmed species *Tribulus* sp. (possibly **Tribulus terrestris* (Caltrop)). None of the above weeds are declared plants under the ARRP Act.

APPENDIX 2

Vegetation Classifications for the Pilbara based on Specht (1970), as modified by Aplin (1979) and Trudgen (2009).

Height Class	Canopy Cover				
	100 - 70%	70 - 30%	30 - 10%	10 - 2%	< 2%
Trees > 30 m	High Closed Forest	High Open Forest	High Woodland	High Open Woodland	Scattered Tall Trees
Trees 10-30 m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees < 10 m	Low Closed Woodland	Low Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Mallee	Closed Mallee	Mallee	Open Mallee	Very Open Mallee	Scattered Mallees
Shrubs > 2 m	Closed Scrub	Open Scrub	High Shrubland	High Open Shrubland	Scattered Tall Shrubs
Shrubs 1-2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs < 1 m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Low Scattered Shrubs
Hummock Grass	Closed Hummock Grassland	Hummock Grassland	Open Hummock Grassland	Very Open Hummock Grassland	Scattered Hummock Grass
Tussock Grass	Closed Tussock Grassland	Tussock Grassland	Open Tussock Grassland	Very Open Tussock Grassland	Scattered Tussock Grass
Bunch Grass	Closed Bunch Grassland	Bunch Grassland	Open Bunch Grassland	Very Open Bunch Grassland	Scattered Bunch Grass
Sedges	Closed Sedges	Sedges	Open Sedges	Very Open Sedges	Scattered Sedges
Herbs	Closed Herbs	Herbs	Open Herbs	Very Open Herbs	Scattered Herbs

Source: S. Van Leeuwen (DEC)

APPENDIX 3

Vegetation condition scale
(as developed by Keighery 1994)

CONDITION	CODE	DESCRIPTION
Pristine	1	Pristine or nearly so, no obvious signs of disturbance.
Excellent	2	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	3	Vegetation structure altered; obvious signs of disturbance.
Good	4	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
Degraded	5	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching Very Good condition without intensive management.
Completely Degraded	6	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

APPENDIX 4

Conservation categories for flora described under the EPBC Act.

CATEGORY	DESCRIPTION
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the Wild	A species is categorised as extinct in the wild if it is only known to survive in cultivations, in captivity, or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild and in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival, or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX 5

Conservation Codes for Western Australian Flora.

R: Declared Rare Flora - Extant Taxa

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

1: Priority One - Poorly Known Taxa

Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.

2: Priority Two - Poorly Known Taxa

Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.

3: Priority Three - Poorly Known Taxa

Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

4: Priority Four - Rare, Near Threatened and other taxa in need of monitoring

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

5: Priority Five - Conservation Dependent taxa

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

APPENDIX 6

Multivariate statistical analysis for floristic data collected from study sites within the Study area

1. Project Background and Objectives

This project involved a multivariate analysis of 22 floristic quadrats from the Callawa Study Area in the northern Pilbara, The aim of the project was to compare the quadrat groups derived from Agglomerative Hierarchical Fusion of the quadrats with mapping units derived from species dominance and structure of the vegetation.

2. Methods

2.1. Data Preparation

The original data consisted of a 218 taxon by 22 quadrat matrix. Ninety taxa included in the original matrix had less than two occurrences and were removed from the modified dataset. This resulted in a final dataset comprised of a 128 taxon by 22 quadrat matrix that was the subject of the analysis.

2.2. Clustering and Ordination

A two-way classification (Agglomerative Hierarchical Fusion) of the presence/absence quadrat data was carried out on the 128 taxon by 22 quadrat dataset using the program PATN (Belbin 2003). The flexible UPGMA classification strategy was used (β = -0.1), together with the Bray-Curtis site similarity measure. The number of groups to be determined was set at five. A number of preliminary analyses showed that this number produced a good balance of group number and group size. The primary output of the classification was in the form of dendrograms and a two-way table of taxa and quadrats.

3. Results and Discussion

Table A6.1 shows the Vegetation associations described and mapped in the field in comparison with the Quadrat Sub-groups derived from the multivariate analysis. Broadly speaking the analysis separated quadrats originating from upland areas (Quadrat Group 1a, 1b) from those placed on downslope or water-gaining areas (Quadrat Sub-groups 2a, 2b, 3) (Figures A6.1 and A6.2). Within Quadrat Group 1, sub-group 1b (quadrats CAL10 and CAL 20) appear to be situated lower in the landscape than the other quadrats in this group.

There is only a limited agreement between the broad floristic formation descriptions and the quadrat grouping output from the multivariate analysis.

VEG CODE	Sites, releves	Quadrat Group	JBs Landform	BFF
3a	CAL18, cj46, cj47	1a	Cliff lines steep rocky ledges	Terminalia Low Open Woodland
5a	CAL1, cj3, cj8,cj41,cj50, cj52	1a	Minor Drainage Line/ Rocky Gully	Acacia Open Scrub
6a	CAL3	1a	Mesa hill slopes/ south facing slopes	Acacia Low Open Heath
8a	CAL2, CAL7, CAL8.	1a	Mesa hill crest/ plateau/ slopes	Triodia Hummock Grassland
2a	CAL10, cj15, cj16	1b	Medium Drainage Line with Soak	Eucalyptus Low Woodland
7d	CAL20, cj11, cj57	1b	Scree slopes	Triodia Closed Hummock Grassland
4a	CAL5, cj58, cj59, cj60, cj61	2a	Drainage Lines/ Drainage Flats on Plains	Acacia Closed Scrub
7a	CAL4, CAL6, cj65, cj17	2a	Loamy sandplains	Triodia Closed Hummock Grassland
7b	CAL9, cj29	2a	Sandplains with drainage zones	Triodia Closed Hummock Grassland
7e	CAL22, cj65, cj67, cj32	2a	Loamy sandplains	Triodia Closed Hummock Grassland
8d	CAL16, cj34	2a	Minor Drainage Zone with Undulating sandplain	Triodia Hummock Grassland
7c	CAL11, CAL19, cj12, cj38	2b	Footslopes of Mesa hills	Triodia Closed Hummock Grassland
8b	CAL12, CAL13, CAL17, cj37, cj33, cj18, cj27	2b (2a)	Footslopes, Undulating stony rises and stony plains	Triodia Hummock Grassland
5b	CAL14, cj21, cj24	3	Medium Drainage Line and associated floodplain	Acacia Open Scrub
8c	CAL15, CAL21, cj69	3	Sandy drainage lines with floodplains and wind scalds	Triodia Hummock Grassland
1a	cj54	n/a	Medium Drainage Line with Cliff sections	Terminalia Low Open Forest
6b	notes	n/a	Sandplains with minor drainage depressions	Acacia Low Open Heath
8e	notes	n/a	Minor drainage line on footslopes	Triodia Hummock Grassland
9a	cj66	n/a	Degraded silty plains	Triodia Open Hummock Grassland
10a	cj09	n/a	Elevated Marsh, Permanent Soak	Cyperus Sedges

Table A6.1. Comparison of vegetation mapping units with Quadrat Group for each of the Callawa quadrats.

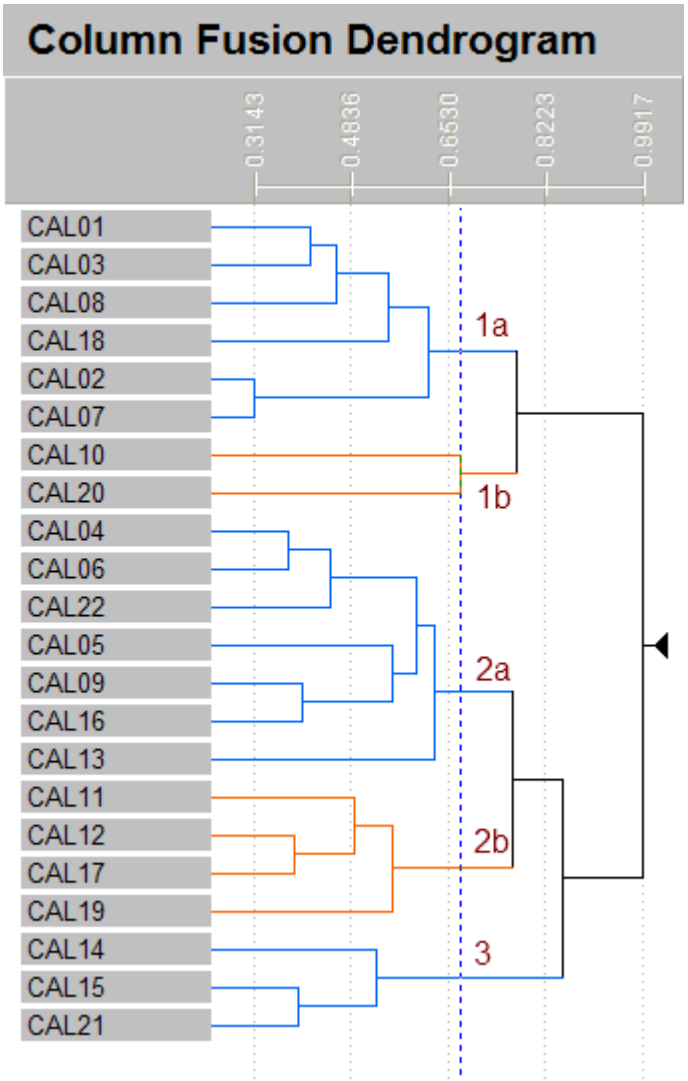


Figure A6.1. Output from clustering with dendrogram showing quadrat similarity and groups.

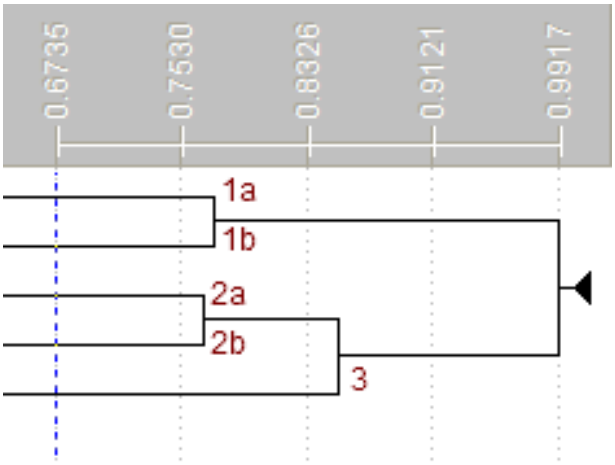


Figure A6.2. Similarity of Quadrat Groups after clustering.

APPENDIX 7

Total flora list from the Study area

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
AIZOACEAE	*Trianthema*	*triquetra*		*	*	
AMARANTHACEAE	*Aerva	*javanica*		*		
AMARANTHACEAE	*Alternanthera*	*nana*		*	*	
AMARANTHACEAE	*Amaranthus*	*undulatus*		*		
AMARANTHACEAE	*Gomphrena*	*cunninghamii*		*		
AMARANTHACEAE	*Ptilotus*	*auriculiformis*		*		
AMARANTHACEAE	*Ptilotus*	*axillaris*		*		
AMARANTHACEAE	*Ptilotus*	*calostachyus*		*	*	*
AMARANTHACEAE	*Ptilotus*	*fusiformis*		*	*	*
AMARANTHACEAE	*Ptilotus*	*gomphrenoides*		*		
AMARANTHACEAE	*Ptilotus*	*incanus*				*
AMARANTHACEAE	*Ptilotus*	*obovatus*		*		*
APOYCNACEAE	*Carrisa*	*lanceolata*		*	*	
ARALIACEAE	*Trachymene*	*oleracea*		*	*	*
ASTERACEAE	*Blumea*	*tenella*				*
ASTERACEAE	*Centipeda*	*minima*	subsp. *macrocephala*	*		*
ASTERACEAE	*Pluchea*	*dentex*		*		*
ASTERACEAE	*Pluchea*	*ferdinandi-muelleri*		*	*	
ASTERACEAE	*Pluchea*	*rubelliflora*		*		*
ASTERACEAE	*Pluchea*	*tetranthera*		*	*	*
ASTERACEAE	*Pterocaulon*	*sphaeranthoides*		*	*	
ASTERACEAE	*Streptoglossa*	*decurrens*		*		
BIGNONIACEAE	*Dolichandrone*	*heterophylla*			*	
BORAGINACEAE	*Heliotropium*	*cunninghamii*		*	*	
BORAGINACEAE	*Heliotropium*	*heteranthum*		*		
BORAGINACEAE	*Trichodesma*	*zeylanicum*		*	*	*

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
CAMPANULACEAE	*Wahlenbergia*	*tumidifructa*		*		
CAPPARACEAE	*Capparis*	*spinosa*	var. *nummularia*			*
CARYOPHYLLACEAE	*Polycarpaea*	*corymbosa*		*		
CARYOPHYLLACEAE	*Polycarpaea*	*holtzei*		*		
CHENOPODIACEAE	*Dysphania*	*plantaginella*		*		
CHENOPODIACEAE	*Dysphania*	*rhadinostachya*		*		
CHENOPODIACEAE	*Salsola*	*australis*		*	*	
CHENOPODIACEAE	*Sclerolaena*	*costata*		*	*	
CHENOPODIACEAE	*Sclerolaena*	*hostilis*		*		
CLEOMACEAE	*Cleome*	*uncifera*		*	*	
CLEOMACEAE	*Cleome*	*viscosa*		*	*	*
COMBRETACEAE	*Terminalia*	*canescens*		*		*
CONVOLVULACEAE	*Bonamia*	*linearis*		*	*	
CONVOLVULACEAE	*Bonamia*	*media*	var. *villosa*		*	
CONVOLVULACEAE	*Bonamia*	*pannosa*		*		
CONVOLVULACEAE	*Bonamia*	*rosea*		*	*	
CONVOLVULACEAE	*Bonamia*	*sp. Dampier (A. A. Mitchell PRP 217)*		*		
CONVOLVULACEAE	*Convolvulus*	*cf. clementii*		*		
CONVOLVULACEAE	*Evolvulus*	*alsinoides*	var. *decumbens*	*	*	
CONVOLVULACEAE	*Evolvulus*	*alsinoides*	var. *villosicaylx*	*	*	
CONVOLVULACEAE	*Ipomoea*	*muelleri*		*	*	*
CONVOLVULACEAE	*Polymeria*	*ambigua*		*		
CONVOLVULACEAE	*Polymeria*	*calycina*			*	
CUCURBITACEAE	*Cucumis*	*maderaspatanus*		*	*	*
CUCURBITACEAE	*Trichosanthes*	*cucumerina*		*		

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
CYPERACEAE	*Bulbostylis*	*barbata*		*	*	*
CYPERACEAE	*Cyperus*	*cunninghamii*	subsp. *cunninghamii*		*	
CYPERACEAE	*Cyperus*	*hesperius*		*		*
CYPERACEAE	*Cyperus*	*iria*		*	*	
CYPERACEAE	*Cyperus*	*ixiocarpus*		*		
CYPERACEAE	*Cyperus*	*microcephalus*	subsp. *saxicola*	*		
CYPERACEAE	*Cyperus*	*pulchellus*				*
CYPERACEAE	*Cyperus*	*squarrous*		*		
CYPERACEAE	*Cyperus*	*vaginatus*		*	*	*
CYPERACEAE	*Fimbristylis*	*dichotoma*		*		
CYPERACEAE	*Fimbristylis*	*depauperata*		*		
CYPERACEAE	*Fimbristylis*	*microcarya*				*
CYPERACEAE	*Fimbristylis*	*simulans*			*	
CYPERACEAE	*Fimbristylis*	*? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722)*		*		
CYPERACEAE	*Lipocarpha*	*microcephala*		*		*
ELATINACEAE	*Bergia*	*pedicellaris*				*
EUPHORBIACEAE	*Euphorbia*	*alsiniflora*			*	
EUPHORBIACEAE	*Euphorbia*	*australis*		*		
EUPHORBIACEAE	*Euphorbia*	*careyi*		*		
EUPHORBIACEAE	*Euphorbia*	*tannensis*	subsp. *eremophila*	*		
EUPHORBIACEAE	*Euphorbia*	*wheeleri*			*	*
FABACEAE	**Vachellia*	*farnesiana*		*		
FABACEAE	*Acacia*	*ancistrocarpa*		*	*	
FABACEAE	*Acacia*	*colei*	var. *colei*	*	*	
FABACEAE	*Acacia*	*elachantha*		*	*	

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
FABACEAE	*Acacia*	*inaequilatera*		*	*	*
FABACEAE	*Acacia*	*monticola*		*		*
FABACEAE	*Acacia*	*pruinocarpa*		*		*
FABACEAE	*Acacia*	*ptychophylla*		*	*	*
FABACEAE	*Acacia*	*robeorum*		*		
FABACEAE	*Acacia*	*sphaerostachya*		*		
FABACEAE	*Acacia*	*spondylophylla*		*	*	*
FABACEAE	*Acacia*	*stellaticeps*		*	*	
FABACEAE	*Acacia*	*synchronicia*		*	*	
FABACEAE	*Acacia*	*trachycarpa*		*	*	
FABACEAE	*Acacia*	*tumida*	var. *pilbarensis*	*	*	*
FABACEAE	*Alysicarpus*	*muelleri*		*	*	
FABACEAE	*Cajanus*	*cinereus*		*	*	*
FABACEAE	*Cajanus*	*marmoratus*			*	
FABACEAE	*Crotalaria*	*medicaginea*		*		
FABACEAE	*Crotalaria*	*ramosissima*		*	*	
FABACEAE	*Cullen*	*lachnostachys*		*		
FABACEAE	*Cullen*	*leucanthum*		*		
FABACEAE	*Cullen*	*martinii*		*		
FABACEAE	*Cullen*	*pogonocarpum*		*		
FABACEAE	*Cullen*	*stipulaceum*		*	*	*
FABACEAE	*Desmodium*	*filiforme*		*	*	
FABACEAE	*Glycine*	*canescens*		*		
FABACEAE	*Indigofera*	*colutea*		*	*	
FABACEAE	*Indigofera*	*linifolia*		*		
FABACEAE	*Indigofera*	*linnaei*		*	*	

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
FABACEAE	*Indigofera*	*monophylla*		*	*	*
FABACEAE	*Indigofera*	*trita*			*	
FABACEAE	*Indigofera*	*atropurpurea*			*	
FABACEAE	*Neptunia*	*dimorphantha*		*		
FABACEAE	*Petalostylis*	*labicheoides*		*	*	*
FABACEAE	*Rhynchosia*	*australis*		*	*	*
FABACEAE	*Senna*	*glutinosa*	subsp. *glutinosa*	*	*	*
FABACEAE	*Senna*	*glutinosa*	subsp. *luerssenii*		*	
FABACEAE	*Senna*	*glutinosa*	subsp. *pruinosa*	*		
FABACEAE	*Senna*	*notabilis*		*	*	*
FABACEAE	*Senna*	*venusta*		*		*
FABACEAE	*Sesbania*	*cannabina*		*		
FABACEAE	*Swainsona*	*formosa*		*		
FABACEAE	*Templetonia*	*hookeri*		*		*
FABACEAE	*Tephrosia*	*rosea*	var. *clementii*	*	*	
FABACEAE	*Tephrosia*	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		*	*	
FABACEAE	*Tephrosia*	*sp. D Kimberley Flora (R.D.Royce 1848)*		*		
FABACEAE	*Tephrosia*	*sp. Pilbara (A.L. Payne PRP 1393)*		*		
FABACEAE	*Tephrosia*	*spechtii*			*	*
FABACEAE	*Tephrosia*	*supina*		*	*	
FABACEAE	*Tephrosia*	*virens*		*		
FABACEAE	*Vigna*	*sp. Hamersley Clay (A.A. Mitchell PRP 113)*		*		
FABACEAE	*Zornia*	*albiflora*		*		
FABACEAE	*Zornia*	*muelleriana*	subsp. *congesta*		*	

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
GOODENIACEAE	*Dampiera*	*candicans*		*	*	*
GOODENIACEAE	*Goodenia*	*microptera*		*	*	
GOODENIACEAE	*Goodenia*	*meulleriana*			*	
GOODENIACEAE	*Goodenia*	*stobbsiana*		*	*	*
HALORAGACEAE	*Haloragis*	*gossei*		*		
LAMIACEAE	*Clerodendrum*	*floribundum*	var. *angustifolium*			*
LAMIACEAE	*Clerodendrum*	*tomentosum*		*		
LAURACEAE	*Cassytha*	*capillaris*		*		*
LOGANIACEAE	*Mitrasacme*	*connata*		*		
LYTHRACEAE	*Ammannia*	*baccifera*		*		*
LYTHRACEAE	*Rotala*	*diandra*				*
MALVACEAE	**Malvastrum*	*americanum*		*		
MALVACEAE	*Abutilon*	*leptocladus*		*		
MALVACEAE	*Abutilon*	*otocarpum*		*		
MALVACEAE	*Corchorus*	*elachocarpus*		*	*	
MALVACEAE	*Corchorus*	*parviflorus*		*	*	*
MALVACEAE	*Corchorus*	*sp. Yarrie (J. Bull & D. Roberts CAL01.05)*		*		
MALVACEAE	*Corchorus*	*tridens*		*		
MALVACEAE	*Gossypium*	*australe*				*
MALVACEAE	*Hibiscus*	*coatesii*		*		
MALVACEAE	*Hibiscus*	*goldsworthii*				*
MALVACEAE	*Hibiscus*	*leptocladus*		*	*	
MALVACEAE	*Hibiscus*	*sturtii*	var. *campylochlamis*		*	
MALVACEAE	*Sida*	*clementii*		*		
MALVACEAE	*Sida*	*fibulifera*		*		

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
MALVACEAE	*Sida*	*macropoda*		*		*
MALVACEAE	*Sida*	*rohlenae*	subsp. *rohlenae*	*	*	*
MALVACEAE	*Sida*	*sp. A Kimberley Flora (P.A. Fryxell & L.A. Craven 3900)*				*
MALVACEAE	*Sida*	*sp. Pilbara (A.A. Mitchell PRP1543)*		*	*	
MALVACEAE	*Triumfetta*	*johnstonii*		*	*	*
MALVACEAE	*Triumfetta*	*maconochieana*		*		
MALVACEAE	*Triumfetta*	*propinqua*		*	*	*
MALVACEAE	*Triumfetta*	*triquetra*		*		
MALVACEAE	*Waltheria*	*indica*			*	
MARSILEACEAE	*Marselia*	*hirsuta*				*
MENISPERMACEAE	*Tinospora*	*smilacina*		*	*	*
MOLLUGINACEAE	*Mollugo*	*molluginea*		*	*	
MORACEAE	*Ficus*	*aculeata*	var. *indecora*			*
MORACEAE	*Ficus*	*brachypoda*		*		*
MORACEAE	*Ficus*	*virens*		*		
MYRTACEAE	*Corymbia*	*flavescens*		*	*	*
MYRTACEAE	*Corymbia*	*hamersleyana*		*	*	*
MYRTACEAE	*Corymbia*	*opaca*			*	
MYRTACEAE	*Eucalyptus*	*camaldulensis*	var. *obtusa*	*		*
MYRTACEAE	*Eucalyptus*	*leucophloia*	subsp. *leucophloia*	*		*
MYRTACEAE	*Melaleuca*	*argentea*		*		
NYCTAGINACEAE	*Boehavia*	*coccinea*		*	*	
NYCTAGINACEAE	*Boehavia*	*gardneri*			*	
OPHIOGLOSSACEAE	*Ophioglossum*	*lusitanicum*				*
OROBANCHACEAE	*Striga*	*squamigera*		*		

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
PASSIFLORACEAE	*Passiflora	foetida	var. hispida	*		*
PHYLLANTHACEAE	Flueggea	virosa	subsp. melanthesoides			*
PHYLLANTHACEAE	Notoleptopus	decaisnei		*		
PHYLLANTHACEAE	Phyllanthus	exilis				*
PHYLLANTHACEAE	Phyllanthus	maderaspatensis		*	*	
PHYLLANTHACEAE	Phyllanthus	reticulatus		*		
PLANTAGINACEAE	Stemodia	grossa		*	*	*
PLANTAGINACEAE	Stemodia	sp.		*		*
PLANTAGINACEAE	Stemodia	viscosa		*		*
POACEAE	*Cenchrus	ciliaris		*	*	
POACEAE	*Chloris	virgata		*	*	
POACEAE	*Cynodon	dactylon		*		
POACEAE	Aristida	burbidgeae		*		*
POACEAE	Aristida	contorta		*	*	
POACEAE	Aristida	holathera	var. holathera	*	*	
POACEAE	Chloris	pumilio			*	
POACEAE	Chrysopogon	fallax		*	*	
POACEAE	Cymbopogon	ambiguus		*	*	*
POACEAE	Cymbopogon	procerus			*	*
POACEAE	Dactyloctenium	radulans		*	*	
POACEAE	Enneapogon	lindleyanus				*
POACEAE	Eragrostis	cumingii		*	*	
POACEAE	Eragrostis	eriopoda		*	*	
POACEAE	Eragrostis	pergracilis		*		
POACEAE	Eragrostis	tenellula		*		*
POACEAE	Eriachne	aristidea		*	*	

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
POACEAE	*Eriachne*	*ciliata*		*		*
POACEAE	*Eriachne*	*lanata*		*		*
POACEAE	*Eriachne*	*mucronanta*		*	*	*
POACEAE	*Eriachne*	*aff. obtusa*		*	*	
POACEAE	*Eriachne*	*pulchella*	subsp. *dominii*	*	*	
POACEAE	*Eriachne*	*tenuiculmis*		*	*	*
POACEAE	*Eulalia*	*aurea*		*	*	
POACEAE	*Heteropogon*	*contortus*		*		
POACEAE	*Paraneurachne*	*muelleri*			*	
POACEAE	*Paspalidium*	*rarum*		*		
POACEAE	*Paspalidium*	*tabulatum*		*	*	
POACEAE	*Perotis*	*rara*			*	
POACEAE	*Schizachyrium*	*fragile*		*		
POACEAE	*Sporobolus*	*actinocladus*		*		
POACEAE	*Sporobolus*	*australasicus*		*	*	
POACEAE	*Themeda*	*triandra*			*	
POACEAE	*Triodia*	*angusta*			*	
POACEAE	*Triodia*	*epactia*		*	*	*
POACEAE	*Triodia*	*longiceps*		*		
POACEAE	*Triodia*	*wiseana*		*	*	*
POACEAE	*Xerochloa*	*barbata*		*		
POACEAE	*Yakirra*	*australiensis*		*	*	
POLYGALACEAE	*Polygala*	*glaucifolia*		*		
POLYGALACEAE	*Polygala*	*isingii*		*		
PORTULACACEAE	**Portulaca*	*oleracea*		*	*	
PORTULACACEAE	*Portulaca*	*pilosa*		*		

FAMILY	GENUS	SPECIES	SUBSP. / VAR.	Onshore 2012	ENV 2008	Ecologia 2005a
PROTEACEAE	*Grevillea*	*pyramidalis*	var. *leucadendron*	*	*	*
PROTEACEAE	*Grevillea*	*wickhamii*	subsp. *hispidula*	*	*	*
PROTEACEAE	*Hakea*	*lorea*	subsp. *lorea*	*	*	
PTERIDACEAE	*Cheilanthes*	*brownii*		*		
RUBIACEAE	*Oldenlandia*	*crouchiana*		*		*
RUBIACEAE	*Synaptantha*	*tillaeacea*		*	*	
SANTALACEAE	*Santalum*	*lanceolatum*		*		
SAPINDACEAE	*Atalaya*	*hemiglauca*		*		*
SOLANACEAE	*Nicotiana*	*benthamiana*		*		
SOLANACEAE	*Solanum*	*beaugleholei*			*	*
SOLANACEAE	*Solanum*	*dioicum*		*	*	*
SOLANACEAE	*Solanum*	*diversiflorum*		*	*	
SOLANACEAE	*Solanum*	*cleistogamum*		*		*
SOLANACEAE	*Solanum*	*lasiophyllum*		*		
SOLANACEAE	*Solanum*	*phlomoides*		*	*	
TYPHACEAE	*Typha*	*domingensis*		*		*
VIOLACEAE	*Hybanthus*	*aurantiacus*		*	*	
ZYGOPHYLLACEAE	*Tribulus*	*hirsutus*		*	*	
ZYGOPHYLLACEAE	*Tribulus*	*macrocarpus*		*		
ZYGOPHYLLACEAE	*Tribulus*	*platypterus*		*	*	
ZYGOPHYLLACEAE	*Tribulus*	*suberosus*		*		*

APPENDIX 8

Chain of Custody Form

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CJ01.01	cliff line leading down to scree and foot slopes	Open Scrub of Acacia tumida var. pilbarensis, Petalostylis labicheoides over Very Open Hummock Grassland of Triodia epactia over Very Open Tussock Grassland of Eriachne mucronata, Eriachne tenuiculmis, Cymbopogon ambiguus	*Sida macropoda*	N.B. Code on bag looks like CA 01.10 Part of a complex, awaiting revision from R. Barker	2038.787,S	12018.342,E
CAL01.05	gully, minor drainage line on mesa, skeletal brown silty loam, ironstone, NW aspect, 10% bare ground	Open Scrub of Acacia tumida var. pilbarensis, Petalostylis labicheoides over Very Open Hummock Grassland of Triodia epacita over Very Open Tussock Grassland of Eriachne mucronata, Eriachne tenuiculmis, Cymbopogon ambiguus	*Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL01.05)	New species (or maybe subspecies, need more material before I make that decision). This is a species of significant interest - nothing quite like it in WA (or any other Stae/Territory going by the types I have seen from Melbourne & Adelaide). Already vouchered.	218997	7714351
CAL07.01	gully	Hummock Grassland of Triodia wiseana with High Shrubland of Grevillea wickhamii ssp hispidula, Petalostylis labicheoides over Low Shrubland of Acacia spondylophylla, Acacia ptychophylla	*Sida macropoda*	Part of a complex, awaiting revision from R. Barker	217403	7714196
CAL10.02	medium drainage line at base of mesa hills, 3% bare ground	Low Woodland of Eucalyptus camaldulensis, Corymbia flavescens over High Shrubland of Acacia colei over Very Open Sedges of Cyperus vaginatus	*Corchorus* sp. Yarrie (J. Bull & D. Roberts CAL01.05)	New species (or maybe subspecies, need more material before I make that decision). This is a species of significant interest - nothing quite like it in WA (or any other Stae/Territory going by the types I have seen from Melbourne & Adelaide). Already vouchered.	219334	7714485

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL13.05	stony rise, undulating plains, brown sandy loam	Low Shrubland of Acacia ptychophylla, Corchorus elachocarpus, Senna notabilis over Very Open Hummock Grassland of Triodia wiseana, Triodia epacita with Scattered Tall Shrubs of Grevillea pyramidalis var. leucadendron, Acacia inaequilatera, Acacia tumida var. pilbarensis	*Tephrosia supina*	At this stage of the *Tephrosia* revision it would appear that the taxa we have been referring to as *T. supina* in WA is probably something else. If this is confirmed then this specimen will fit the concept of a yet to be raised phrase name "NW Eremaean"	220209	7717240
CAL14.06	medium drainage line on small floodplain	Open Scrub of Acacia tumida var. pilbarensis, Acacia colei over Tussock Grassland of *Cenchrus ciliaris, *Chloris virgata, Eragrostis cumingii with Open Sedges of Typha domingensis, Cyperus vaginatus with Low Open Woodland of Corymbia flavescens	*Tephrosia* sp. Pilbara (A.L. Payne PRP 1393)		220312	7716981
CAL15.03	sandy floodplain / scalds, orange sand	Tussock Annual Grassland of Sporobolus australasicus, Dactyloctenium radulans, *Chloris virgata over Open Hummock Grassland of Triodia epacita with High Open Shrubland of Acacia synchronicia	*Tephrosia* sp. Pilbara (A.L. Payne PRP 1393)		220292	7716179
CAL18.02	cliff line and steep rocky ledges	Low Woodland of Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda over High Shrubland of Acacia tumida var. pilbarensis, Acacia pruinocarpa over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae	*Nicotiana benthamiana*	Lacks the distinct elliptic-headed glandular hairs & extremely long petioles of *N. umbratica*	218275	7715263

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL18.05	cliff line and steep rocky ledges	Low Woodland of Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda over High Shrubland of Acacia tumida var. pilbarensis, Acacia pruinocarpa over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae	*Sida macropoda*	Part of a complex, awaiting revision from R. Barker, Voucher	218275	7715263
CAL22.01	compacted loamy sandplain	Closed Hummock Grassland of Triodia epactia with High Shrubland of Acacia tumida var. pilbarensis over Low Shrubland of Acacia stellaticeps	*Tephrosia* sp. D Kimberley Flora (R.D.Royce 1848)		217319	7717311
CJ01.03	cliff line leading down to scree and foot slopes	Open Low Woodland of Eucalyptus leucophloia, Acacia pruinocarpa, Atalaya hemiglauca, Ficus brachypoda	*Sida macropoda*	Part of a complex, awaiting revision from R. Barker	2038.787,S	12018.342,E
CJ18.06	stony hill slopes	Burnt recently	*Tephrosia* sp. Pilbara (A.L. Payne PRP 1393)		2037.502,S	12018.612,E
CJ24.02	minor drainage line supporting permanent water flow	Open Scrub of Acacia tumida var. pilbarensis	*Lipocarpha microcephala*		2037.391,S	12019.075,E
CJ30.03	loamy sand plains	Open Low Woodland of Corymbia hamersleyana over Open Scrub of Acacia ancistrocarpa	*Vigna* ? sp. Hamersley Clay (A.A. Mitchell PRP 113)	There are few mature (& intact) leaves present on this specimen so it is difficult to be certain of the ID as *V. lanceolata* can also have broad leaves, usually on younger growth.	2037.849,S	12018.781,E

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CJ39.01	cliff faces (25m high), vertical, massive ironstone	Open Low Woodland of Terminalia canescens, Corymbia flavescens over High Shrubland of Acacia tumida var. pilbarensis over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus	*Stemodia* sp.	Still awaiting confirmation from W. Barker regarding the status of this entity as he has a number of the WA *Stemodia* collections and wants to be certain that this entity doesn't fall within the varitaion of *S. viscosa* & *S. grossa* (and hybrids) before declaring it a new species. I did find several collections from the eastern Kimberley in the *Stemodia* sp. folders that appear to match this material so the unofficial phrase-name "sp. Shay Gap" (used in several reports but not on the WA Census) may not be a good name to use. The situation is not helped by the *S. viscosa* & *S. grossa* collections containing a number of mis-identifications. Voucher.	2039.392,S	12018.246,E
CJ39.02	cliff faces (25m high), vertical, massive ironstone	Open Low Woodland of Terminalia canescens, Corymbia flavescens over High Shrubland of Acacia tumida var. pilbarensis over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus	*Stemodia* sp.	See note above.	2039.392,S	12018.246,E
CJ03.01	steep gully	Low Woodland of Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda over High Shrubland of Acacia tumida var. pilbarensis, Acacia pruinocarpa over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae	*Nicotiana benthamiana*	Lacks the distinct elliptic-headed glandular hairs & extremely long petioles of *N. umbratica*	2038.971,S	12017.151,E

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL01.08	Gully/ minor drainage line on mesa; Fire - old 5-10 yrs, brown silty loam	Open Scrub of Acacia tumida var. pilbarensis, Petalostylis labicheoides over Very Open Hummock Grassland of Triodia epacita over Very Open Tussock Grassland of Eriachne mucronata, Eriachne tenuiculmis, Cymbopogon ambiguus	*Solanum cleistogamum*		218997	7714351
CAL01.09	Gully/ minor drainage line on mesa; Fire - old 5-10 yrs, brown silty loam	Open Scrub of Acacia tumida var. pilbarensis, Petalostylis labicheoides over Very Open Hummock Grassland of Triodia epacita over Very Open Tussock Grassland of Eriachne mucronata, Eriachne tenuiculmis, Cymbopogon ambiguus	*Cyperus microcephalus* subsp. *saxicola*	Worth lodging. Good match for this, insane range-extension though.	218997	7714351
CAL02.01			*Polygala glaucifolia*	There is an element of doubt re the ID as ahe few seeds present on this specimen do not have an aril - possibly immature or eaten by an invertabrate.	219231	7715342
CAL05.03	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Zornia muelleriana* subsp. *congesta*	Worth lodging.	218165	7715978

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL05.11	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Cajanus cinereus*	After examining just the specimens det'd or cited by van der Maesen I must admit I'm struggling to see what the key differences are myself. The key & treatment doesn't quantify some of the important characters (broad vs narrow pods - how broad is broad?) and many of the others overlap (e.g. petiolules 3-5 mm vs 2-4 mm). Someone (else) needs to re-assess the WA collections of these two species.	218165	7715978
CAL05.13	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Euphorbia australis* (see comments)	Actually this is *E. vaccaria* but this name has yet to be added to the WA Census so it can't be used. There are two varieties of *E. vaccaria* but most of the specimens cited in the paper by Halford are still on loan so I haven't been able to get my head around the differences.	218165	7715978
CAL05.14	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Convolvulus* cf. *clementii*	See above.	218165	7715978

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL05.15	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Triumfetta propinqua*		218165	7715978
CAL05.17	Minor/ medium drainage line/zone; Fire - very old >10yrs, brown loamy sand	Closed Scrub of Acacia tumida var. pilbarensis over Low Shrubland of Acacia spondylophylla over Open Hummock Grassland of Triodia epacita over Open Tussock Grassland of *Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii with Low Open Woodland of Corymbia hamersleyana, Corymbia flavescens	*Corchorus tridens*	Although the fruits are quite short (very few are intact) the setae at the base of the leaf and the scabrid hairs on the fruit are a better match for this than *C. fasicularis*. There are a number of collections in the Pilbara that match this (but there are also a number of *C. trilocularis* in the *C. tridens* folders). The specimen of *C. fasicularis* in the Ref. Herb. doesn't match the sheet in the main collection, I'll follow this up. When I get back to *Corchorus* I'll investigate this group (fasicularis, tridens, trilocularis) further.	218165	7715978

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL06.02	Gently incline plain, ornage sandy loam	Closed Hummock Grassland of Triodia epactia, Triodia wiseana with Scattered Tall Shrubs of Acacia colei, Grevillea wickhamii ssp hispidula, Acacia tumida var. pilbarensis over Scattered Low Shrubs of Pluchea tetranthera	*Convolvulus* cf. *clementii*	Closest match in *Convolvulus* is *C. clementii* but material is insufficient to be certain. Actually having some doubts about the genus but can't find anything else in the family that works either. Has very narrow sepals for *Convovulus* & bracts are very low on the pedicel but this family is renowned for variation. Would need better material (especially fruit) to take the ID any further.	217119	7716976
CAL08.01	Very steep hill slope, red silty loam	Hummock Grassland of Triodia wiseana with Low Open Shrubland of Acacia spondylophylla, Indigofera monophylla with Scattered Shrubs of Senna glutinosa subsp. glutinosa	*Euphorbia careyi*		218100	7714450
CAL10.07	Drainage line, brown silty loam, Fire - old 5-10 yrs	Low Woodland of Eucalyptus camaldulensis, Corymbia flavescens over High Shrubland of Acacia colei over *Passiflora foetida var. hispida, Ipomoea muelleri over Very Open Sedges of Cyperus vaginatus	*Glycine tomentella*	Worth lodging. For bigger specimens it is worth taking them out of the paper bag and spreading them out when pressing - just fold the edges of the newspaper over if you're worried about losing bits.	219334	7714485
CAL10.09	Drainage line, brown silty loam, Fire - old 5-10 yrs	Low Woodland of Eucalyptus camaldulensis, Corymbia flavescens over High Shrubland of Acacia colei over *Passiflora foetida var. hispida, Ipomoea muelleri over Very Open Sedges of Cyperus vaginatus	*Sida* sp. Articulation below (A.A. Mitchell PRP 1605)	All fruiting specimens of this taxon have raised fruits (including those det'd by Robyn Barker). I only found 1 specimen which had flowers clustered in the axils - guess it's a "draft" key for a reason.	219334	7714485

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL13.03	stony rise, undulating plains, brown sandy loam	Low Shrubland of Acacia ptychophylla, Corchorus elachocarpus, Senna notabilis over Very Open Hummock Grassland of Triodia wiseana, Triodia epacita with Scattered Tall Shrubs of Grevillea pyramidalis var. leucadendron, Acacia inaequilatera, Acacia tumida var. pilbarensis	*Haloragis gossei* var. *gossei*		220209	7717240
CAL13.07	stony rise, undulating plains, brown sandy loam	Low Shrubland of Acacia ptychophylla, Corchorus elachocarpus, Senna notabilis over Very Open Hummock Grassland of Triodia wiseana, Triodia epacita with Scattered Tall Shrubs of Grevillea pyramidalis var. leucadendron, Acacia inaequilatera, Acacia tumida var. pilbarensis	*Euphorbia alsiniflora* (see comments)	Actually this is *E. trigonosperma* but this name has yet to be added to the WA Census so it can't be used. *E. alsiniflora* has been synonymised with a species that doesn't occur in WA. Most of the WA material under this name will be either *E. trigonosperma* or *E. coghlanii*	220209	7717240
CAL14.03	medium drainage line on small floodplain	Open Scrub of Acacia tumida var. pilbarensis, Acacia colei over Tussock Grassland of *Cenchrus ciliaris, *Chloris virgata, Eragrostis cumingii with Open Sedges of Typha domingensis, Cyperus vaginatus with Low Open Woodland of Corymbia flavescens	*Ptilotus murrayi*		220312	7716981
CAL15.01	Sandy floodplain with scalds; Fire - old 5-10 yrs, orange sand, cattle/weeds/erosion	Tussock Annual Grassland of Sporobolus australasicus, Dactyloctenium radulans, *Chloris virgata over Open Hummock Grassland of Triodia epacita with High Open Shrubland of Acacia synchronicia	*Xerochloa barabata*		220292	7716179

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL15.06	Sandy floodplain with scalds; Fire - old 5-10 yrs, orange sand, cattle/weeds/erosion	Tussock Annual Grassland of Sporobolus australasicus, Dactyloctenium radulans, *Chloris virgata over Open Hummock Grassland of Triodia epacita with High Open Shrubland of Acacia synchronicia	*Eriachne* aff. *obtusa*	This specimen doesn't key out to any known *Eriachne*. It appears to be a perennial, the glumes are 7 nerved & 2-2.5 mm long, the inflorescence is distinctly pulvianate, the callus is densely hairy and the lemma has tufts of hair at the apex. There are several collections that match this in the *E. obtusa* folders, investigations are continuing...	220292	7716179
CAL15.07	Sandy floodplain with scalds; Fire - old 5-10 yrs, orange sand, cattle/weeds/erosion	Tussock Annual Grassland of Sporobolus australasicus, Dactyloctenium radulans, *Chloris virgata over Open Hummock Grassland of Triodia epacita with High Open Shrubland of Acacia synchronicia	*Eragrostis crateriformis*		220292	7716179
CAL18.01	Cliffline & steep rocky ledges; Fire - very old >10 yrs, red silty loam, massive ironstone	Low Woodland of Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda over High Shrubland of Acacia tumida var. pilbarensis, Acacia pruinocarpa over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae	*Cheilanthes brownii*		218275	7715263
CAL18.07	Cliffline & steep rocky ledges; Fire - very old >10 yrs, red silty loam, massive ironstone	Low Woodland of Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda over High Shrubland of Acacia tumida var. pilbarensis, Acacia pruinocarpa over Very Open Tussock Grassland of Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae	*Ficu virens*	Worth lodging.	218275	7715263
CAL20.01	Very steep screeslope; Fire - old 5-10 yrs, brown silty loam	Closed Hummock Grassland of Triodia wiseana with Scattered Tall Shrubs of Acacia inaequilatera	*Triumfetta propinqua*		217289	7715220

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CAL21.06	Sandy loam plains with meandering sandy drainage lines; Fire old 5=10 yrs, brown sand, cattle, weeds	Hummock Grassland of Triodia epacita over Very Open Tussock Annual Grasses of Sporobolus actinocladus, Eragrostis cummingii, Sporobolus australasicus with Scattered Tall Shrubs of Acacia colei, Sesbbania cannabina over Scattered Low Shrubs of Pluchea tetranthera, Acacia stellata, Pluchea rubelliflora	*Fimbristylis* ? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722)	Worth lodging. The specimen keys out to this (which it also keys to in the 1990 P.K.Latz treatment as sp. F) but all the WA material is on loan (has been since 1999). I will have to see who has borrowed it & ask them if they will confirm this ID. I checked every *Fimbristylis* taxa we have and this specimen doesn't match any of them. Could also be something new.	216708	7716750
CAL21.08	Sandy loam plains with meandering sandy drainage lines; Fire old 5=10 yrs, brown sand, cattle, weeds	Hummock Grassland of Triodia epactia over Very Open Tussock Annual Grasses of Sporobolus actinocladus, Eragrostis cummingii, Sporobolus australasicus with Scattered Tall Shrubs of Acacia colei, Sesbbania cannabina over Scattered Low Shrubs of Pluchea tetranthera, Acacia stellata, Pluchea rubelliflora	*Eragrostis crateriformis*	Not great material, I'll check with the curation manager & see if either can be lodged.	216708	7716750
CJ18.04	NOT RECORDED	NOT RECORDED	*Bonamia* sp. Dampier (A. A. Mitchell PRP 217)	Worth lodging. *B. media* has cordate leaf bases & smooth seeds (cf. wavy margins on the seeds for *B.* sp. Dampier)	20°37.502'S	120°18.612'E
CJ18.08	NOT RECORDED	NOT RECORDED	*Euphorbia australis* (see comments)	Actually this is *E. vaccaria* but this name has yet to be added to the WA Census so it can't be used. There are two varieties of *E. vaccaria* but most of the specimens cited in the paper by Halford are still on loan so I haven't been able to get my head around the differences.	20°37.502'S	120°18.612'E
CJ21.02	Minor drainage line	Open Scrub of Acacia tumida over Open Hummock Grassland of Triodia epactia with Scattered Low Trees of Corymbia hamersleyana and Corymbia flavescens	*Stemodia viscosa*		20°37.404'S	120°18.773'E

Specimen Code	Habitat (including landscape form & soil)	Vegetation	BHP Sponsored Botanist ID	BHP Sponsored Botanist Comments	Eastings GDA94	Northings GDA94
CJ24.01	Minor drainage line	Open Scrub of Acacia tumida over Open Hummock Grassland of Triodia epactia with Scattered Low Trees of Corymbia hamersleyana and Corymbia flavescens	*Fimbristylis depauperata*		20°37.391'S	120°19.075'E
CJ64.01	Plains, sandy loam	Hummock Grassland of Triodia epactia over with Scatetred Shrubs of Acacia colei and Sesbannia cannabina with Low Scatetred Shrubs of Pluchea tetranthera and Acacia stellaticeps	*Cullen lachnostachys*		20°37.526'S	120°19.075'E
CJ69.02	NOT RECORDED	NOT RECORDED	*Blumea tenella*		20°37.707'S	120°16.984'E

APPENDIX 9

Records of conservation significant flora from the Study area

Sample Method	Waypoint	Easting	Northing	Genus	Species
Onshore Environmental (2012) Records					
Quadrat	Cal-01	218997	7714351	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Quadrat	Cal-10	219334	7714485	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Quadrat	Cal-18	218275	7715263	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	CJ46	2038.857	12018.292	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	CJ47	2038.865	12018.301	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc107	219321	7714497	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc108	219307	7714495	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc109	219245	7714374	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc110	219256	7714339	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc111	219301	7714331	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc112	219355	7714346	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Targeted searching	jc113	219398	7714349	*Corchorus*	sp. Yarrie (J. Bull & D. Roberts CAL 01.05)
Quadrat	Cal-01	218997	7714351	*Cyperus*	*microcephalus* subsp. *saxicola*
Quadrat	Cal-10	219334	7714485	*Cyperus*	*microcephalus* subsp. *saxicola*
Quadrat	Cal-18	218275	7715263	*Cyperus*	*microcephalus* subsp. *saxicola*
Quadrat	Cal-15	220292	7716179	*Eragrostis*	*crateriformis*
Quadrat	Cal-21	217289	7716750	*Eragrostis*	*crateriformis*
Quadrat	Cal-21	217289	7716750	*Fimbristylis*	? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722)
Quadrat	Cal-01	218997	7714351	*Sida*	*macropoda*
Quadrat	Cal-07	217403	7714196	*Sida*	*macropoda*
Quadrat	Cal-18	218275	7715263	*Sida*	*macropoda*
Targeted searching		2038.787	12018.342	*Sida*	*macropoda*
Targeted searching	CJ39	2039.392	12018.246	*Stemodia*	sp.
Targeted searching	CJ44	2038.866	12018.277	*Stemodia*	sp.
Targeted searching	CJ45	2038.856	12018.285	*Stemodia*	sp.

Sample Method	Waypoint	Easting	Northing	Genus	Species
Targeted searching	CJ46	2038.857	12018.292	*Stemodia*	sp.
Targeted searching	CJ47	2038.865	12018.301	*Stemodia*	sp.
Targeted searching	jc110	219256	7714339	*Stemodia*	sp.
Targeted searching	jc111	219301	7714331	*Stemodia*	sp.
Ecologia Environment (2005) Records					
Quadrat	21.03	218197	7714717	*Sida*	*macropoda*
Quadrat	25.04A	218177	7715030	*Sida*	*macropoda*
Quadrat	26.06	218194	7714909	*Sida*	*macropoda*
Quadrat	27.08	218445	7714847	*Sida*	*macropoda*
Quadrat	29.09	218403	7715316	*Sida*	*macropoda*
Quadrat	32.17	218077	7713102	*Sida*	*macropoda*

APPENDIX 10

Records for introduced weed species recorded from the Study area

Waypoint	Easting (GDA 94)	Northing (GDA 94)	Genus	Species	Subsp/Var
Cal-14	220312	7716981	*Aerva	*javanica*	
Cal05	218165	7715978	*Cenchrus	*ciliaris*	
Cal-09	220393	7714275	*Cenchrus	*ciliaris*	
Cal-14	220312	7716981	*Cenchrus	*ciliaris*	
Cal-15	220292	7716179	*Cenchrus	*ciliaris*	
Cal-16	220353	7715398	*Cenchrus	*ciliaris*	
Cal-21	217289	7716750	*Cenchrus	*ciliaris*	
CJ21	2037.404	12018.773	*Chloris	*virgata*	
CJ25	2037.408	12019.071	*Chloris	*virgata*	
CJ64	2037.526	12016.984	*Chloris	*virgata*	
CJ68	2037.722	12017.874	*Chloris	*virgata*	
Cal-15	220292	7716179	*Chloris	*virgata*	
Cal-21	217289	7716750	*Chloris	*virgata*	
Cal-14	220312	7716981	*Chloris	*virgata*	
Cal-14	220312	7716981	*Cynodon	*dactylon*	
Cal-14	220312	7716981	*Malvastrum	*americanum*	
CJ31	2037.932	12018.861	*Malvastrum	*americanum*	
CJ16	2038.877	12018.464	*Passiflora	*foetida*	var. *hispida*
CJ14	2038.872	12018.447	*Passiflora	*foetida*	var. *hispida*
CJ15	2038.878	12018.421	*Passiflora	*foetida*	var. *hispida*
CJ47	2038.865	12018.301	*Passiflora	*foetida*	var. *hispida*
Cal-10	219334	7714485	*Passiflora	*foetida*	var. *hispida*
Cal-12	219546	7716883	*Portulaca	*oleracea*	
Cal-13	220209	7717240	*Portulaca	*oleracea*	
Cal-15	220292	7716179	*Portulaca	*oleracea*	
Cal-14	220312	7716981	*Vachellia	*farnesiana*	
Cal-15	220292	7716179	*Vachellia	*farnesiana*	

APPENDIX 11

Site sheets summarizing raw data for quadrats within the Study area

Site	Callawa - Site CAL 01
Date	16/06/2012
Recorder	JB/DR
Photo	9764
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	218997
Northing	7714351
Habitat	Gully (GUL)
Aspect	320°
Slope	Moderately Inclined (MO) (5°46' to 18°)
Soil	Silty Loam – brown
Rock Type	Ironstone (pebbles, cobbles, outcrops)
% Leaves:Logs	2:3
Vegetation Condition	Excellent
Disturbance Type	Access Tracks on top of MESA
Fire Age	Old – 5-10 yrs
Vegetation	Open Scrub of *Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* over Very Open Hummock Grassland of *Triodia epacita* over Very Open Tussock Grassland of *Eriachne mucronata, Eriachne tenuiculmis, Cymbopogon ambiguus*

Species			% Cover	Height
Eucalyptus	*leucophloia*	subsp. *leucophloia*	<1	5
Petalostylis	*labicheoides*		3	1-2
Acacia	*tumida*	var. *pilbarensis*	65	2-5
Solanum	*cleistogamum*		<1	0.15
Triodia	*epactia*		7.5	0.5-1.7
Corchorus	*sp. Callawa*		2	0.7
Solanum	*dioicum*		<1	0.3
Indigofera	*monophylla*		<1	0.5
Corymbia	*hamersleyana*		<1	3
Acacia	*spondylophylla*		1.5	0.6
Acacia	*monticola*		1.5	2-3
Senna	*glutinosa*	subsp. *glutinosa*	<1	1-1.5
Bulbostylis	*barbata*		<1	0.1
Templetonia	*hookeri*		<1	1-1.5
Hybanthus	*aurantiacus*		<1	0.1
Trachymene	*oleracea*		2	0.3-0.8
Eriachne	*tenuiculmis*		1	0.5
Eriachne	*mucronata*		2	0.4
Triumfetta	*maconochieana*		<1	0.5
Terminalia	*canescens*		0.5	3-5
Cyperus	*microcephalus*	subsp. *saxicola*	<1	0.4
Cyperus	*hesperius*		<1	0.3
Paspalidium	*tabulatum*		<1	0.45
Cymbopogon	*ambiguus*		<1	0.8
Oldenlandia	*crouchiana*		<1	0.1
Sida	*rohlenae*	subsp. *rohlenae*	<1	0.2

Species			% Cover	Height
Grevillea	*wickhamii*	subsp. *hispidula*	<1	1.2-3
Acacia	*ptychophylla*		<1	0.5
Cheilanthes	*brownii*		<1	0.1
Corymbia	*flavescens*		5-7	1
Fimbristylis	*depauperata*		<1	0.15
Eriachne	*ciliata*		0.5	0.15
Triodia	*wiseana*		1.5	0.5-1.3
Sida	*clementii*		<1	0.6
Sida	*macrocarpa*		<1	0.15

Site	Callawa - Site CAL 02
Date	16/06/2012
Recorder	JB/DR
Photo	9765
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	219231
Northing	7715342
Habitat	Hillcrest (HCR)
Aspect	300°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Silty Loam – brown
Rock Type	Ironstone (pebbles, cobbles, outcrops)
% Leaves:Logs	0.5:<1
Vegetation Condition	Very Good
Disturbance Type	Access Tracks; Drill Pads; Soil Disturbance
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita, Triodia wiseana* with Low Shrubland of *Acacia spondylophylla, Acacia ptychophylla* with Scattered Tall Shrubs of *Acacia inaequilatera, Grevillea wickhamii* subsp *hispidula*

Species			% Cover	Height
Triodia	*epactia*		65	0.4-1.2
Grevillea	*wickhamii*	subsp. *hispidula*	0.5	2-3
Eriachne	*ciliata*		<1	0.2
Bulbostylis	*barbata*		<1	0.1
Acacia	*spondylophylla*		20	0.5
Trachymene	*oleracea*		0.5	0.1-0.5
Polygala	*isingii*		<1	0.05
Fimbristylis	*dichotoma*		<1	0.1
Grevillea	*pyramidalis*		<1	3
Polycarpaea	*holtzei*		<1	0.05
Acacia	*inaequilatera*		0.5	2-3
Acacia	*ptychophylla*		2.5	0.5
Triodia	*wiseana*		7	0.5-1.3
Petalostylis	*labicheoides*		<1	1-2
Tinospora	*smilacina*		<1	Cl
Goodenia	*stobbsiana*		<1	0.2
Eriachne	*pulchella*	subsp. *dominii*	<1	0.1
Oldenlandia	*crouchiana*		<1	0.1
Santalum	*lanceolatum*		<1	2
Solanum	*cleistogamum*		<1	0.1
Dysphania	*rhadinostachya*		<1	0.05
Pluchea	*tetranthera*		<1	0.4
Dampiera	*candicans*		<1	0.5
Corymbia	*flavescens*		0.5	2-3
Corymbia	*hamersleyana*		-	6

Site	Callawa - Site CAL 03
Date	16/06/2012
Recorder	JB/DR
Photo	DSC00635
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	217901
Northing	7714651
Habitat	Hillslope (HSL)
Aspect	160°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Silty Loam – brown
Rock Type	Ironstone (pebbles, cobbles, outcrops)
% Leaves:Logs	0.5:<1
Vegetation Condition	Excellent
Disturbance Type	Access Track
Fire Age	Old – 5-10 yrs
Vegetation	Low Open Heath of *Acacia spondylophylla, Acacia ptychophylla, Indigofera monophylla* over Hummock Grassland of *Triodia wiseana* with High Shrubland of *Grevillea wickhamii* subsp *hispidula, Acacia tumida* var. *pilbarensis, Petalostylis labicheoides* with Scattered Low Trees of *Corymbia hamersleyana*

Species			% Cover	Height
Corymbia	*hamersleyana*		3	3-5
Grevillea	*wickhamii*	subsp. *hispidula*	7	2-3
Acacia	*ptychophylla*		20	0.5
Acacia	*spondylophylla*		25	0.5
Triodia	*wiseana*		40	0.5-1.3
Bulbostylis	*barbata*		<1	0.3
Eriachne	*pulchella*	subsp. *dominii*	<1	0.1
Corchorus	*parviflorus*		<1	0.4
Oldenlandia	*crouchiana*		<1	0.1
Cassytha	*capillaris*		<1	Cl
Petalostylis	*labicheoides*		4	2.5
Trachymene	*oleracea*		<1	0.2
Acacia	*monticola*		<1	1-2.5
Indigofera	*monophylla*		2	0.5-1
Goodenia	*stobbsiana*		<1	0.3
Acacia	*tumida*	var. *pilbarensis*	6	4
Ptilotus	*calostachyus*		<1	1
Polycarpaea	*holtzei*		<1	0.05
Triodia	*epactia*		1	1.4
Hybanthus	*aurantiacus*		<1	0.8
Eriachne	*mucronata*		<1	0.5

Site	Callawa - Site CAL 04
Date	16/06/2012
Recorder	JB/DR
Photo	9766
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	216938
Northing	7716254
Habitat	Plain (PLA)
Aspect	80°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Loamy Sand – orange
Rock Type	Quartz; Ironstone (cobbles, pebbles)
% Leaves:Logs	<1:0
Vegetation Condition	Very Good
Disturbance Type	Access track nearby; Cattle
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita* with Scattered Tall Shrubs of *Grevillea pyramidalis* subsp. *leucadendron, Acacia colei, Acacia inaequilatera* over Scattered Shrubs of *Acacia colei*

Species			% Cover	Height
Triodia	*epactia*		70	0.5-1.3
Acacia	*colei*		1.5	1.5-3
Grevillea	*pyramidalis*	var. *leucadendron*	1	2-4
Acacia	*inaequilatera*		0.5	2-3
Bonamia	*linearis*		<1	Cr
Triodia	*wiseana*		7	0.5-1.3
Trianthema	*triquetra*		0.5	0.15
Sporobolus	*australasicus*		0.5	0.3
Pluchea	*tetranthera*		1	0.5
Eriachne	*pulchella*	subsp. *dominii*	0.5	0.1
Indigofera	*colutea*		<1	0.2
Cleome	*uncifera*		<1	0.3
Tephrosia	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		<1	0.
Mollugo	*molluginea*		<1	0.1
Bulbostylis	*barbata*		<1	0.1
Fimbristylis	*dichotoma*		<1	0.2
Polycarpaea	*corymbosa*		<1	0.15
Hakea	*lorea*	subsp. *lorea*	<1	0.5
Grevillea	*wickhamii*	subsp. *hispidula*	<1	2
Eragrostis	*cumingii*		<1	0.15
Eriachne	*aristidea*		<1	0.2
Solanum	*phlomoides*		<1	0.4
Eulalia	*aurea*		<1	0.3
Yakirra	*australiensis*		<1	0.1
Mitrasacme	*connata*		<1	0.25
Corchorus	*elachocarpus*		<1	0.4

Site	Callawa - Site CAL 05
Date	16/06/2012
Recorder	DB/JB
Photo	Missing
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	218165
Northing	7715978
Habitat	Drainage Depression (DDE)
Aspect	350°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Loamy Sand – brown
Rock Type	Ironstone (cobbles, pebbles, outcrops)
% Leaves:Logs	2:7
Vegetation Condition	Very Good
Disturbance Type	Access track; Cattle; Weeds
Fire Age	Very old >10 yrs
Vegetation	Closed Scrub of *Acacia tumida* var. *pilbarensis* over Low Shrubland of *Acacia spondylophylla* over Open Hummock Grassland of *Triodia epacita* over Open Tussock Grassland of **Cenchrus ciliaris, Eriachne tenuiculmis, Eragrostis cumingii* with Low Open Woodland of *Corymbia hamersleyana, Corymbia flavescens*

Species			% Cover	Height
Eriachne	*tenuiculmis*		2	0.4
Acacia	*spondylophylla*		10	0.5-1
Acacia	*tumida*	var. *pilbarensis*	70	2-4
Triodia	*epactia*		26	0.5-1.4
Corymbia	*hamersleyana*		3.5	5-7
Cleome	*viscosa*		2	0.45
Eragrostis	*cumingii*		4	0.3
Trachymene	*oleracea*		2	0.5-1.5
Evolvulus	*alsinoides*	var. *decumbens*	<1	0.2
Bulbostylis	*barbata*		0.5	0.15
Cymbopogon	*ambiguus*		0.5	0.6
Cajanus	*cinereus*		2	0.5-1
Mollugo	*molluginea*		0.5	0.12
Indigofera	*colutea*		<1	0.2
**Cenchrus*	*ciliaris*		20	0.5
Goodenia	*microptera*		<1	0.5
Pluchea	*rubelliflora*		<1	0.2
Hybanthus	*aurantiacus*		<1	0.2
Pterocaulon	*sphaeranthoides*		0.5	0.3
Boehavia	*sp. indet*		<1	0.15
Eragrostis	*tenellula*		0.5	0.2
Solanum	*dioicum*		<1	0.45
Sida	*rohlenae*	subsp. *rohlenae*	0.5	0.3
Corymbia	*flavescens*		1.5	0.5
Dysphania	*rhadinostachya*		<1	0.2
Ptilotus	*fusiformis*		<1	0.5

Species			% Cover	Height
Ipomoea	*muelleri*		<1	Cl
Pluchea	*tetranthera*		<1	0.4
Senna	*notabilis*		<1	0.1
Synaptantha	*tilliacea*		<1	0.05
Grevillea	*pyramidalis*	var. *leucadendron*	<1	1-2
Tephrosia	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		<1	0.2
Sida	*clementii*		<1	0.5
Grevillea	*wickhamii*	subsp. *hispidula*	<1	2-3
Triumfetta	*propinqua*		<1	0.45
Petalostylis	*labicheoides*		2	2-3
Stemodia	*grossa*		<1	0.15
Corchorus	*parviflorus*		<1	0.3
Corchorus	*tridens*		<1	0.2
Triodia	*wiseana*		1	0.5-1
Amaranthus	*undulatus*		<1	0.2
Crotalaria	*medicaginea*		<1	0.3
Zornia	*albiflora*		<1	0.15
Acacia	*colei*		<1	-
Convulvulus	*cf. clementii*		<1	Cr
Desmodium	*filiforme*		<1	0.2
Acacia	*robeorum*		<1	2

Site	Callawa - Site CAL 06
Date	16/06/2012
Recorder	DR/JB
Photo	9769
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	217119
Northing	7716976
Habitat	Plain (PLA)
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Loamy Sand – orange
Rock Type	Granite (derived soils, scattered pebbles)
% Leaves:Logs	<1:<1
Vegetation Condition	Very Good
Disturbance Type	Fence; Access track; Rail
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita, Triodia wiseana* with Scattered Tall Shrubs of *Acacia colei, Grevillea wickhamii subsp hispidula, Acacia tumida* var. *pilbarensis* over Scattered Low Shrubs of *Pluchea tetranthera*

Species			% Cover	Height
Yakirra	*australiensis*		<1	0.2
Bulbostylis	*barbata*		<1	0.1
Acacia	*colei*		1.5	2-3
Sporobolus	*australasicus*		<1	0.2
Grevillea	*wickhamii*	subsp. *hispidula*	<1	2
Senna	*notabilis*		<1	0.1
Tephrosia	*virens*		<1	0.5
Triumfetta	*triquetra*		<1	0.1
Hakea	*lorea*		<1	2.5
Eriachne	*aristidea*		<1	0.2
Grevillea	*pyramidalis*	var. *leucadendron*	0.5	2-3
Eragrostis	*pergracilis*		<1	0.1
Polycarpaea	*corymbosa*		<1	0.15
Mollugo	*molluginea*		<1	0.1
Cucumis	*maderaspatanus*		<1	Cl
Solanum	*phlomoides*		<1	0.4
Bonamia	*pannosa*		<1	Cr
Acacia	*tumida*	var. *pilbarensis*	0.5	2-4
Acacia	*inaequilatera*		0.25	2-3
Pluchea	*tetranthera*		1.5	0.5
Convulvulus	*cf. clementii*		<1	Cr
Corymbia	*hamersleyana*		<1	1.2
Acacia	*ptychophylla*		<1	1
Triodia	*wiseana*		3	0.5-1.4
Triodia	*epactia*		80	0.5-1.4
Desmodium	*filiforme*		<1	0.1
Bonamia	*linearis*		<1	Cr
Indigofera	*colutea*		<1	0.2

Site	Callawa - Site CAL 07
Date	17/06/2012
Recorder	DR/JB
Photo	9772
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	217403
Northing	7714196
Habitat	Hillcrest (HCR)
Aspect	210°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Silty Loam – brown
Rock Type	Ironstone (cobbles, pebbles, outcrops)
% Leaves:Logs	<1:<1
Vegetation Condition	Excellent
Disturbance Type	None evident
Fire Age	Old – 5-10 yrs
Vegetation	Hummock Grassland of *Triodia wiseana* with High Shrubland of *Grevillea wickhamii subsp hispidula*, *Petalostylis labicheoides* over Low Shrubland of *Acacia spondylophylla, Acacia ptychophylla*

Species			% Cover	Height
Acacia	*ptychophylla*		4	0.5-1
Acacia	*spondylophylla*		10	0.5-1
Triodia	*wiseana*		45	0.5-1
Petalostylis	*labicheoides*		1.5	1-2.5
Grevillea	*wickhamii*	subsp. *hispidula*	8	1-3
Bulbostylis	*barbata*		<1	0.05
Polycarpaea	*holtzei*		<1	0.01
Eriachne	*pulchella*		<1	0.05
Goodenia	*stobbsiana*		<1	0.3
Eriachne	*ciliata*		<1	0.1
Polygala	*isingii*		<1	0.03
Fimbristylis	*dichotoma*		<1	0.1
Eriachne	*lanata*		<1	0.2
Triodia	*epactia*		20	0.5-1
Sida	*macropoda*		-	-

Site	Callawa - Site CAL 08
Date	17/06/2012
Recorder	DR/JB
Photo	9783
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	Missing
Northing	Missing
Habitat	Hillslope (HSL)
Aspect	320°
Slope	Very Steep (VS) (30°1' to 45°)
Soil	Silty Loam – red
Rock Type	Ironstone (siliceous) (boulders, cobbles, pebbles)
% Leaves:Logs	<1:0
Vegetation Condition	Excellent
Disturbance Type	None evident
Fire Age	Old – 5-10 yrs
Vegetation	Hummock Grassland of *Triodia wiseana* with Low Open Shrubland of *Acacia spondylophylla, Indigofera monophylla* with Scattered Shrubs of *Senna glutinosa subsp. glutinosa*

Species			% Cover	Height
Triodia	*wiseana*		50	0.5-1
Petalostylis	*labicheoides*		<1	1-2
Senna	*glutinosa*	subsp. *glutinosa*	1.5	1-1.5
Trachymene	*oleracea*		2	0.5-1
Eriachne	*mucronata*		1	0.35
Cypreus	*iria*		<1	0.3
Gomphrena	*cunninghamii*		<1	0.2
Nicotiana	*benthamiana*		<1	0.6
Triumfetta	*maconochieana*		<1	0.2
Cymbopogon	*ambiguus*		<1	0.5
Cleome	*viscosa*		0.5	0.5
Pterocaulon	*sphaeranthoides*		<1	0.2
Tribulus	*suberosus*		<1	0.3
Oldenlandia	*crouchiana*		<1	0.1
Indigofera	*monophylla*		1	0.2-0.5
Corchorus	*parviflorus*		<1	0.2
Eriachne	*ciliata*		<1	0.2
Ptilotus	*obovatus*		<1	0.4
Acacia	*spondylophylla*		5	0.6
Bulbostylis	*barbata*		<1	0.15
Solanum	*cleistogamum*		<1	0.1
Atalaya	*hemiglauca*		<1	1-2
Eucalyptus	*leucophloia*	subsp. *leucophloia*	<1	2-4
Euphorbia	*careyi*		<1	0.1
Polycarpaea	*holtzei*		<1	0.05

Site	Callawa - Site CAL 09
Date	17/06/2012
Recorder	DR/JB
Photo	9788
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	220393
Northing	7714275
Habitat	Plain (PLA)
Aspect	100°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Sandy Loam – brown
Rock Type	None evident
% Leaves:Logs	<1:<1
Vegetation Condition	Very Good
Disturbance Type	Access tracks; Weeds
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita* with Open Shrubland of *Acacia ptychophylla, Acacia ancistrocarpa, Acacia sphaerostachya, Acacia inaequilatera* with Scattered Low Trees of *Corymbia hamersleyana*

Species			% Cover	Height
Triodia	*epactia*		80	1-1.5
Acacia	*ptychophylla*		7	1
Acacia	*inaequilatera*		1.5	1-2
Acacia	*elachantha*		2	1-2
Solanum	*diversiflorum*		<1	0.4
Desmodium	*filiforme*		<1	0.3
Crotalaria	*medicaginea*		<1	0.3
**Cenchrus*	*ciliaris*		<1	0.4
Cucumis	*maderaspatanus*		<1	Cl
Rhynchosia	*australis*		0.5	Cr
Crotalaria	*ramosissima*		<1	0.25
Senna	*notabilis*		<1	0.2
Eriachne	*aristidea*		<1	0.5
Zornia	*albiflora*		<1	0.1
Solanum	*dioicum*		<1	0.35
Acacia	*colei*		<1	2-3
Acacia	*sphaerostachya*		2	1-2
Corchorus	*elachocarpus*		<1	0.4
Bonamia	*pannosa*		<1	0.2
Bonamia	*rosea*		<1	0.3
Corymbia	*hamersleyana*		1.5	4-6
Acacia	*tumida*	var. *pilbarensis*	2	2-3
Acacia	*ancistrocarpa*		45	2
Indigofera	*monophylla*	round leaf'	0.5	0.5
Bulbostylis	*barbata*		<1	0.1
Goodenia	*microptera*		<1	0.3
Polycarpaea	*corymbosa*		<1	0.1
Grevillea	*pyramidalis*	var. *leucadendron*	0.5	2-2.5

Species			% Cover	Height
Synaptantha	*tillaeacea*		<1	0.05
Euphorbia	*australis*		<1	0.03
Euphorbia	*tannensis*	subsp. *eremophila*	<1	0.2
Mollugo	*molluginea*		<1	0.01
Grevillea	*wickhamii*	subsp. *hispidula*	<1	1-2
Dampiera	*candicans*		<1	0.4
Cymbopogon	*ambiguus*		<1	1.5

Site	Callawa - Site CAL 10
Date	17/06/2012
Recorder	DR/JB
Photo	9791
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	219334
Northing	7714485
Habitat	Drainage Depression (DDE)
Aspect	50°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Brown
Rock Type	Ironstone (pebbles, cobbles, outcrops)
% Leaves:Logs	70:5
Vegetation Condition	Good
Disturbance Type	Weeds common
Fire Age	Old 5-10 yrs
Vegetation	Low Woodland of *Eucalyptus camaldulensis, Corymbia flavescens* over High Shrubland of *Acacia colei* over **Passiflora foetida* var. *hispida, Ipomoea muelleri* over Very Open Sedges of *Cyperus vaginatus*

Species			% Cover	Height
**Passiflora*	*foetida*	var. *hispida*	60	Cl
Eucalyptus	*camaldulensis*		17	5-12
Melaleuca	*argentea*		1	6
Ipomoea	*muelleri*		2	Cr
Acacia	*colei*		4	2-3.5
Cyperus	*vaginatus*		5	1.2
Triodia	*wiseana*		5	0.5-1.1
Indigofera	*monophylla*	round'	1	0.5-0.8
Ammania	*baccifera*		<1	0.35
Corymbia	*flavescens*		1.5	6
Cajanus	*cinereus*		6	1-2
Solanum	*cleistogamum*		<1	0.2
Senna	*venusta*		0.5	0.3-1.5
Triumfetta	*propinqua*		<1	0.3
Typha	*domingensis*		<1	1-2
Paspalidium	*tabulatum*		<1	0.5
Ficus	*brachypoda*		1.5	2-4
Cymbopogon	*ambiguus*		0.5	1
Atalaya	*hemiglauca*		<1	2
Eriachne	*mucronata*		<1	0.35
Corchorus	*sp. Callawa*		<1	0.4
Eriachne	*tenuiculmis*		<1	0.5
Cyperus	*microcephalus*	subsp. *saxicola*	<1	0.2
Cleome	*viscosa*		<1	0.3
Sida	*rohlenae*	var. *rohlenae*	<1	0.2
Tephrosia	*virens*		0.5	1-1.5
Triumfetta	*maconochieana*		<1	0.2
Solanum	*phlomoides*		<1	0.5

Species			% Cover	Height
Boehavia	*coccinea*		<1	Cr
Eriachne	*aff. obtusa*		<1	0.35
Tephrosia	*rosea*	var. *clementii*	<1	1
Solanum	*dioicum*		<1	0.4
Tinospora	*smilacina*		<1	Cl
Trichosanthes	*cucumerina*		<1	Cl
Sida	*clementii*		<1	1-2
Amaranthus	*undulatus*		<1	0.2
Cheilanthes	*brownii*		<1	0.05
Glycine	*canescens*		<1	Cl
Triumfetta	*johnstonii*		<1	0.4
Stemodia	*grossa*		<1	0.3
Grevillea	*wickhamii*	subsp. *hispidula*	<1	1-2
Tephrosia	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		-	-

Site	Callawa - Site CAL 11
Date	17/06/2012
Recorder	DR/JB
Photo	9793
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	219778
Northing	7714995
Habitat	Footslope (FOO)
Aspect	60°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Silty Loam – brown
Rock Type	Ironstone (pebbles, cobbles)
% Leaves:Logs	<1:<1
Vegetation Condition	Very Good
Disturbance Type	Access Tracks
Fire Age	Old 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita* with High Open Shrubland of *Grevillea wickhamii subsp hispidula, Acacia inaequilatera, Acacia tumida* over Open Shrubland of *Acacia inaequilatera*

Species			% Cover	Height
Triodia	*epactia*		83	1
Acacia	*inaequilatera*		3	1-2.5
Acacia	*tumida*	var. *pilbarensis*	1	2-4
Grevillea	*pyramidalis*	var. *leucadendron*	0.5	2-3
Grevillea	*wickhamii*	subsp. *hispidula*	1	2-3
Acacia	*colei*		<1	1-2
Acacia	*spondylophylla*		<1	0.5
Acacia	*ptychophylla*		0.5	0.6
Solanum	*phlomoides*		<1	0.7
Sida	*sp. Pilbara (A.A. Mitchell PRP1543)*		<1	0.3

Site	Callawa - Site CAL 12
Date	18/06/2012
Recorder	DR/JB
Photo	9799
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	219546
Northing	7716883
Habitat	Riseslope (RES)
Aspect	200°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sandy Loam - brown
Rock Type	Black silicious Ironstone; Granite; Quartz (cobbles, pebbles, scattered outcrops)
% Leaves:Logs	<1:0
Vegetation Condition	Very Good
Disturbance Type	Rail line; Fenceline; Minesite; Access tracks; Weeds
Fire Age	Old 5-10 yrs
Vegetation	Hummock Grassland of *Triodia epacita* with Low Shrubland of *Acacia ptychophylla* with Scattered Tall shrubs of *Grevillea pyramidalis var. hispida, Acacia inaequilatera, Grevillea wickhamii*

Species			% Cover	Height
Acacia	*ptychophylla*		25	0.5-1
Grevillea	*pyramidalis*	var. *leucadendron*	1	2-2.5
Triodia	*epactia*		63	0.5-1
Senna	*glutinosa*	subsp. *glutinosa*	<1	1
Eriachne	*pulchella*	subsp. *dominii*	4	0.1
Goodenia	*microptera*		<1	0.2
Acacia	*inaequilatera*		1.5	1-2.5
Grevillea	*wickhamii*		0.5	1-2
**Portulaca*	*oleracea*		<1	0.1
Polycarpaea	*corymbosa*		<1	0.1
Sporobolus	*australasicus*		0.5	0.1
Acacia	*synchronicia*		<1	0.5-1.5
Ptilotus	*calostachyus*		<1	0.8
Bulbostylis	*barbata*		<1	0.05
Polygala	*isingii*		<1	0.01
Solanum	*phlomoides*		<1	0.5
Senna	*glutinosa*	subsp. *pruinosa*	<1	1-2
Aristida	*contorta*		<1	0.15
Acacia	*sphaerostachya*		<1	1-2
Acacia	*colei*		<1	1-2
Salsola	*australis*		<1	0.1
Indigofera	*monophylla*		<1	0.4
Pluchea	*tetranthera*		<1	0.5
Corymbia	*hamersleyana*		<1	2-3
Brachypoda	*prostrata*		<1	0.03
Heliotropium	*heteranthum*		<1	0.01
Trianthema	*triquetra*		<1	0.1

Species			% Cover	Height
Acacia	*ancistrocarpa*		<1	2
Tribulus	*hirsutus*		<1	0.05
Polycarpaea	*holtzei*		<1	0.05
Bulbostylis	*barbata*		<1	0.1

Site	Callawa - Site CAL 13
Date	18/06/2012
Recorder	DR/JB
Photo	9803
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	220209
Northing	7717240
Habitat	Riseslope (RES)
Aspect	150°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sandy Loam – brown
Rock Type	Quartzite, Calcrete, Granite, Silicious Ironstone (pebbles, occasional outcrops)
% Leaves:Logs	<1:<1
Vegetation Condition	Excellent
Disturbance Type	Fire; Minesite; Access tracks
Fire Age	Recent <1 yr
Vegetation	Low Shrubland of *Acacia ptychophylla, Corchorus elachocarpus, Senna notabilis* over Very Open Hummock Grassland of *Triodia wiseana, Triodia epacita* with Scattered Tall Shrubs of *Grevillea pyramidalis* var. *leucadendron, Acacia inaequilatera, Acacia tumida* var. *pilbarensis*

Species			% Cover	Height
Tribulus	*macrocarpus*		1	Cr
Senna	*notabilis*		5.5	0.2
Heliotropium	*cunninghamii*		1.5	0.15
Cleome	*viscosa*		4	0.5-1
Triumfetta	*propinqua*		<1	0.35
Haloragis	*gossei*		0.5	0.3
Corchorus	*elachocarpus*		5	0.35
Triodia	*wiseana*		4	0.2
Trachymene	*oleracea*		<1	0.5
Corymbia	*hamersleyana*		1	1-6
Bulbostylis	*barbata*		<1	0.1
Solanum	*dioicum*		0.5	0.4
Acacia	*ptychophylla*		6	0.1-0.5
Swainsona	*formosa*		1.5	0.15
Oldenlandia	*crouchiana*		0.5	0.2
Hibiscus	*coatesii*		<1	0.2-0.5
Eriachne	*mucronata*		<1	0.4
Solanum	*phlomoides*		<1	0.3
Ptilotus	*auriculiformis*		1	0.4
Goodenia	*stobbsiana*		<1	0.2
Acacia	*inaequilatera*		1.5	0.5-3
Senna	*glutinosa*	subsp. *glutinosa*	<1	0.5
Ptilotus	*axillaris*		0.5	Cr
Grevillea	*pyramidalis*	var. *leucadendron*	0.5	0.2-4
Tribulus	*platypterus*		<1	0.4

Species			% Cover	Height
Tephrosia	*sp. Pilbara (A.L. Payne PRP 1393)*		<1	0.1
Eriachne	*aristidea*		<1	0.25
Sida	*sp. Pilbara (A.A. Mitchell PRP1543)*		<1	0.25
Eriachne	*pulchella*	subsp. *dominii*	6	0.2
Solanum	*diversiflorum*		1	0.3
Cleome	*uncifera*		1.5	0.4
Hibiscus	*leptocladus*		0.5	0.25
Goodenia	*microptera*		0.5	0.4
Ptilotus	*calostachyus*		<1	0.4
Goodenia	*microptera*		1.5	0.4
Evolvulus	*alsinoides*	var. *villosicaylx*	<1	0.1
Mollugo	*molluginea*		0.5	0.1
Streptoglossa	*decurrens*		<1	0.4
Yakirra	*australiensis*		<1	0.1
Bonamia	*pannosa*		0.5	0.2
Solanum	*cleistogamum*		<1	0.1
Notoleptopus	*decaisnei*		<1	0.3
Ptilotus	*fusiformis*		<1	0.4
Eriachne	*aff. obtusa*		<1	0.4
Tephrosia	*sp. Pilbara (A.L. Payne PRP 1393)*		<1	0.25
Triodia	*epactia*		1.5	0.25
Dysphania	*plantaginella*		<1	0.1
Acacia	*stellaticeps*		<1	0.2
Heliotropium	*cunninghamii*		<1	0.2
Polycarpaea	*holtzei*		<1	0.1
Tephrosia	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		<1	0.2
Euphorbia	*alsiniflora*		<1	0.2
**Portulaca*	*oleracea*		<1	0.1
Acacia	*tumida*	var. *pilbarensis*	1	0.3-4
Solanum	*lasiophyllum*		<1	0.5

Site	Callawa - Site CAL 14
Date	18/06/2012
Recorder	DR/JB
Photo	9806
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	220312
Northing	7716981
Habitat	Drainage Depression (DDE)
Aspect	100°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Loamy Sand - brown
Rock Type	Granite; Quartz (scattered cobbles
% Leaves:Logs	5:4
Vegetation Condition	Degraded
Disturbance Type	Fire; Weeds; Cattle
Fire Age	Very old >10yrs
Vegetation	Open Scrub of *Acacia tumida* var. *pilbarensis, Acacia colei* over Tussock Grassland of **Cenchrus ciliaris, *Chloris virgata, Eragrostis cumingii* with Open Sedges of *Typha domingensis, Cyperus vaginatus* with Low Open Woodland of *Corymbia flavescens*

Species			% Cover	Height
**Vachellia*	*farnesiana*		<1	0.5-1
**Cenchrus*	*ciliaris*		21	0.55
Ipomoea	*muelleri*		1	Cr
**Chloris*	*virgata*		10	0.5-1.2
Carrisa	*lanceolata*		0.5	2.5
Corymbia	*flavescens*		5	2-12
Acacia	*tumida*	var. *pilbarensis*	22	2-4
Ammania	*baccifera*		0.5	0.5
Sida	*rohlenae*	var. *rohlenae*	2	0.45
Typha	*domingensis*		6.5	1-2
Cyperus	*vaginatus*		10	1
Acacia	*colei*		5	2-4
**Cynodon*	*dactylon*		2	0.15
Acacia	*stellaticeps*		1	0.5-1
Eragrostis	*cumingii*		8	0.2
Stemodia	*viscosa*		1	0.5
Pluchea	*rubelliflora*		5	0.3
Senna	*notabilis*		0.5	0.3
Sporobolus	*australasicus*		0.5	0.2
Eriachne	*tenuiculmis*		1	0.6
**Malvastrum*	*americanum*		<1	0.6
Trianthema	*triquetra*		<1	0.1
Centipeda	*minima*	subsp. *macrocephala*	<1	0.1
Sesbania	*cannabina*		<1	0.2
Atalaya	*hemiglauca*		1	3-5
Ptilotus	*gomphrenoides*		<1	0.1
Chrysopogon	*fallax*		<1	0.5-1

Species			% Cover	Height
Dampiera	*candicans*		<1	0.2
Triodia	*epactia*		5	0.2-1
Paspalidium	*rarum*		<1	0.15
Cleome	*uncifera*		<1	0.4
Sida	*sp. Pilbara (A.A. Mitchell PRP1543)*		<1	0.3
Grevillea	*pyramidalis*	var. *leucadendron*	<1	0.5-1
Pluchea	*tetranthera*		<1	0.4
Dysphania	*rhadinostachya*		<1	0.2
Grevillea	*wickhamii*	subsp. *hispidula*	<1	3
Trachymene	*oleracea*		<1	0.4
Bonamia	*pannosa*		<1	0.2
Pterocaulon	*sphaeranthoides*		<1	0.4
Alternanthera	*nana*		<1	0.1
Acacia	*synchronicia*		1	1.5-3
Acacia	*ptychophylla*		<1	0.5-1
Pluchea	*dentex*		<1	0.4
Euphorbia	*alsiniflora*		<1	0.25
Bulbostylis	*barbata*		<1	0.1
**Aerva*	*javanica*		<1	0.2
Portulaca	*pilosa*		<1	0.1
Abutilon	*otocarpum*		<1	0.4
Trichodesma	*zeylanicum*		<1	0.5
Sporobolus	*australasicus*		<1	0.15
Triumfetta	*propinqua*		<1	0.3
Tephrosia	*sp. Pilbara (A.L. Payne PRP 1393)*		<1	0.2
Indigofera	*colutea*		<1	0.1
Euphorbia	*careyi*		<1	0.1
Evolvulus	*alsinoides*	var. *decumbens*	<1	0.1
Corchorus	*elachocarpus*		<1	0.2
Cullen	*stipulaceum*		<1	0.4
Sclerolaena	*hostilis*		-	-

Site	Callawa - Site CAL 15
Date	18/06/2012
Recorder	DR/JB
Photo	9817
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	220292
Northing	7716179
Habitat	Flood-out (FLD)
Aspect	60°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Sand – orange
Rock Type	Blue Ironstone- Granite derived (medium gravels, pebbles)
% Leaves:Logs	0.5:<1
Vegetation Condition	Very Good
Disturbance Type	Cattle; Weeds; Erosion
Fire Age	Old 5-10 yrs
Vegetation	Tussock Annual Grassland of *Sporobolus australasicus, Dactyloctenium radulans, *Chloris virgata* over Open Hummock Grassland of *Triodia epacita* with High Open Shrubland of *Acacia synchronicia*

Species			% Cover	Height
Acacia	*inaequilatera*		<1	2-3.5
Sclerolaena	*cleistogamum*		3	0.3-1.2
Sporobolus	*australasicus*		15	0.2
**Cenchrus*	*ciliaris*		2.5	0.4
Eragrostis	*crateriformis*		6	0.25
Dactyloctenium	*radulans*		7	0.1
Eragrostis	*pergracilis*		1	0.1
Xerochloa	*barbata*		1	0.3
Triodia	*epactia*		11	0.5-1.2
Sporobolus	*actinocladus*		1.5	0.3
Pluchea	*ferdinandi-muelleri*		<1	0.5
Indigofera	*colutea*		<1	0.2
Triumfetta	*triquetra*		<1	0.15
Tephrosia	*sp. Pilbara (A.L. Payne PRP 1393)*		<1	0.25
Pluchea	*tetranthera*		0.5	0.5
Acacia	*synchronicia*		2.5	2-4.5
Sclerolaena	*costata*		<1	0.25
Sida	*fibulifera*		<1	0.25
Pluchea	*rubelliflora*		2	0.25
Acacia	*stellaticeps*		2	0.5-1
**Chloris*	*virgata*		3	0.5
Cypreus	*ixiocarpus*		<1	0.2
Centipeda	*minima*	subsp. *macrocephala*	<1	0.1
Ptilotus	*gomphrenoides*		<1	0.1
Eriachne	*aristidea*		<1	0.32
**Vachellia*	*farnesiana*		<1	0.3
Solanum	*diversiflorum*		<1	0.5

Species			% Cover	Height
Pterocaulon	*sphaeranthoides*		<1	0.4
Senna	*notabilis*		<1	0.3
Sida	*rohlenae*	var. *rohlenae*	<1	0.3
Cleome	*viscosa*		<1	0.5
Cullen	*pogonocarpum*		<1	0.4
Abutilon	*leptocladus*		<1	0.5
Acacia	*colei*		<1	2-3
Grevillea	*wickhamii*	subsp. *hispidula*	<1	2-3
Ipomoea	*muelleri*		<1	Cr
Eriachne	*aff. obtusa*		<1	0.25
**Portulaca*	*oleracea*		<1	0.05
Fimbristylis	*depauperata*		<1	0.1
Eragrostis	*tenellula*		<1	0.3
Solanum	*dioicum*		<1	0.5

Site	Callawa - Site CAL 16
Date	18/06/2012
Recorder	DR/JB
Photo	9818
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	220353
Northing	7715398
Habitat	Plain (PLA)
Aspect	120°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Sand – orange
Rock Type	None evident
% Leaves:Logs	10:0.5
Vegetation Condition	Very Good
Disturbance Type	Weeds; Cattle
Fire Age	Old 5-10 yrs
Vegetation	Hummock Grassland of *Triodia epacita* with Low Shrubland of *Tephrosia rosea* var. *clementii, Cullen martinii, Corchorus elachocarpus* with High Open Shrubland of *Acacia inaequilatera, Acacia colei, Grevillea pyramidalis* var. *leucadendron with Scattered* Low Trees of *Corymbia flavescens*

Species			% Cover	Height
Indigofera	*linifolia*		<1	0.2
Hibiscus	*leptocladus*		1	0.5
Corymbia	*hamersleyana*		<1	2-4
Acacia	*inaequilatera*		2	2-3
Sida	*sp. Pilbara (A.A. Mitchell PRP1543)*		<1	0.6
Corchorus	*elachocarpus*		3.5	0.5
Triodia	*epactia*		70	0.4-1.2
Senna	*notabilis*		<1	0.6
**Cenchrus*	*ciliaris*		2	0.4
Acacia	*colei*		2.5	2-3
Acacia	*colei*		<1	2
Tephrosia	*rosea*	var. *clementii*	6	0.5-1
Zornia	*albiflora*		0.5	0.1
Solanum	*diversiflorum*		<1	0.4
Crotalaria	*ramosissima*		2.5	0.25
Solanum	*dioicum*		<1	0.35
Eragrostis	*cumingii*		1.5	0.15
Mollugo	*molluginea*		0.5	0.1
Bonamia	*pannosa*		<1	0.2
Acacia	*ancistrocarpa*		<1	2
Cucumis	*maderaspatanus*		<1	Cl
Eriachne	*aristidea*		<1	0.2
Pterocaulon	*sphaeranthoides*		0.5	0.3
Cullen	*martinii*		2	0.5
Schizachyrium	*fragile*		0.5	0.25

Species			% Cover	Height
Convulvulus	*cf. clementii*		<1	Cr
Bulbostylis	*barbata*		<1	0.1
Alysicarpus	*muelleri*		<1	0.3
Cullen	*pogonocarpum*		<1	0.3
Polycarpaea	*corymbosa*		0.5	0.15
Pluchea	*tetranthera*		0.5	0.5
Grevillea	*pyramidalis*	var. *leucadendron*	1	1.5-3
Euphorbia	*australis*		<1	0.1
Tephrosia	*sp. Bungaroo Creek (M.E. Trudgen 11601)*		<1	0.35
Aristida	*holathera*	var. *holathera*	<1	0.35
Indigofera	*linnaei*		<1	0.15
Desmodium	*filiforme*		<1	0.1
Goodenia	*microptera*		<1	0.3
Indigofera	*monophylla*		<1	0.4
Synaptantha	*tillaeacea*		<1	0.1
Sida	*rohlenae*	var. *rohlenae*	<1	0.4
Bonamia	*rosea*		<1	0.35
Indigofera	*colutea*		<1	0.2
Rhynchosia	*australis*		<1	Cr
Corymbia	*flavescens*		2	10
Cajanus	*cinereus*		<1	0.5
Heteropogon	*contortus*		<1	0.5
Ptilotus	*fusiformis*		<1	0.4
Stemodia	*grossa*		<1	0.3
Heliotropium	*cunninghamii*		<1	0.1
Yakirra	*australiensis*			
Eriachne	*aff. obtusa*		2	0.5
Eragrostis	*eriopoda*			
Polymeria	*sp. indet*		<1	Cr
Grevillea	*wickhamii*	subsp. *hispidula*	<1	2-2.5
Chrysopogon	*fallax*		<1	0.5

Site	Callawa - Site CAL 17
Date	18/06/2012
Recorder	DR/JB
Photo	9819
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	219310
Northing	7716086
Habitat	Footslope (FOO)
Aspect	0°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sandy Loam – brown
Rock Type	Silicious Ironstone; Quartzite (cobbles, pebbles)
% Leaves:Logs	<1:0
Vegetation Condition	Very Good
Disturbance Type	Soil Disturbance; Access tracks
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita, Triodia wiseana* with Low Shrubland of *Acacia ptychophylla* with Scattered Tall Shrubs of *Acacia inaequilatera, Grevillea wickhamii subsp hispidula*, *Grevillea pyramidalis* var. *leucadendron*

Species			% Cover	Height
Acacia	*ptychophylla*		11	0.6
Triodia	*epactia*		50	0.4-1
Grevillea	*wickhamii*	subsp. *hispidula*	0.5	2-3
Grevillea	*pyramidalis*	var. *leucadendron*	<1	2-3
Acacia	*inaequilatera*		1	2-4
Senna	*glutinosa*	subsp. *glutinosa*	<1	1-2
Eriachne	*pulchella*	subsp. *dominii*	3.5	0.1
Bulbostylis	*barbata*		<1	0.1
Triodia	*wiseana*		25	0.5-1
Acacia	*spondylophylla*		1	0.4
Acacia	*sphaerostachya*		<1	1-1.5
Solanum	*phlomoides*		<1	0.4-1
Acacia	*ancistrocarpa*		<1	1-2
Mollugo	*molluginea*		<1	0.1
Acacia	*colei*		<1	2
Pluchea	*tetranthera*		<1	0.5

Site	Callawa - Site CAL 18
Date	19/06/2012
Recorder	DR/JB
Photo	9843/9844
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	218275
Northing	7715263
Habitat	Cliff (CLI)
Aspect	310°
Slope	Cliffed (CL) (72°1' plus)
Soil	Silty Loam- red
Rock Type	Ironstone (massive cliffs & boulders)
% Leaves:Logs	6:3
Vegetation Condition	Excellent
Disturbance Type	None evident
Fire Age	Very old > 10yrs
Vegetation	Low Woodland of *Terminalia canescens, Atalaya hemiglauca, Ficus brachypoda* over High Shrubland of *Acacia tumida* var*. pilbarensis*, *Acacia pruinocarpa* over Very Open Tussock Grassland of *Eriachne mucronata, Cymbopogon ambiguus, Aristida burbidgeae*

Species			% Cover	Height
Cheilanthes	*brownii*		<1	0.1
Eriachne	*mucronanta*		2.5	0.4
Phyllanthus	*reticulatus*		1	1-2
Terminalia	*canescens*		6	3-8
Acacia	*tumida*	var. *pilbarensis*	15	3-6
Atalaya	*hemiglauca*		6	3-8
Cyperus	*microcephalus*	subsp. *saxicola*	1.5	0.4
Hybanthus	*aurantiacus*		<1	0.4
Eriachne	*tenuiculmis*		1	0.5
Corchorus	*sp. Callawa*		4	0.5-1.3
Eriachne	*ciliata*		<1	0.2
Triodia	*wiseana*		2	1
Trachymene	*oleracea*		<1	0.5
Acacia	*pruinocarpa*		5	3-4.5
Ficus	*brachypoda*		5	2-4
Bulbostylis	*barbata*		<1	0.1
Convulvulus	*cf. clementii*		0.5	1.5
Acacia	*spondylophylla*		<1	0.5-1
Nicotiana	*umbratica*		0.5	0.4
Aristida	*burbidgeae*		1	0.6
Solanum	*cleistogamum*		<1	0.1
Sida	*sp. Indet*		<1	0.35
Sida	*rohlenae*	var*. rohlenae*	<1	0.4
Trichosanthes	*cucumerina*		<1	Cl
Amaranthus	*undulatus*		<1	0.1
Cleome	*viscosa*		<1	0.4
Triodia	*epactia*		5	0.5-1

Species			% Cover	Height
Cymbopogon	*ambiguus*		2	0.5-1
Ficus	*virens*		1.5	5
Glycine	*canescens*		<1	Cr
Clerodenrum	*tomentosum*		<1	0.5

Site	Callawa - Site CAL 19
Date	19/06/2012
Recorder	DR/JB
Photo	9848
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	216689
Northing	7715622
Habitat	Footslope (FOO)
Aspect	350°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sandy loam – orange
Rock Type	Ironstone: Quartz 9cobbles, pebbles)
% Leaves:Logs	<1:0
Vegetation Condition	Excellent
Disturbance Type	Access Tracks
Fire Age	Old 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epacita* with High Open Shrubland of *Grevillea wickhamii subsp hispidula, Acacia inaequilatera* over Scattered Low Shrubs of *Acacia spondylophylla*

Species			% Cover	Height
Triodia	*epactia*		75	1.1
Grevillea	*wickhamii*	subsp. *hispidula*	3.5	1-3
Acacia	*inaequilatera*		1.5	2-4
Bulbostylis	*barbata*		<1	0.1
Acacia	*spondylophylla*		<1	0.5
Grevillea	*pyramidalis*	var. *leucadendron*	<1	1-2.5
Eriachne	*pulchella*	subsp. *dominii*	0.5	0.15
Corymbia	*hamersleyana*		<1	1-2
Triodia	*wiseana*		<1	0.5-1.2
Dampiera	*candicans*		<1	0.4
Euphorbia	*australis*		<1	0.1
Cleome	*uncifera*		<1	0.2
Tephrosia	*sp. Pilbara (A.L. Payne PRP 1393)*		<1	0.1

Site	Callawa - Site CAL 20
Date	19/06/2012
Recorder	DR/JB
Photo	9850
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	217289
Northing	7715220
Habitat	Cliff (CLI)
Aspect	340°
Slope	Very Steep (VS) (30°1' to 45°)
Soil	Silty Loam - brown
Rock Type	Ironstone (pebbles, cobbles, outcrops)
% Leaves:Logs	<1:<1
Vegetation Condition	Excellent
Disturbance Type	Access track
Fire Age	Old 5 – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia wiseana* with Scattered Tall Shrubs of *Acacia inaequilatera*

Species			% Cover	Height
Acacia	*inaequilatera*		1.5	2-3
Triodia	*wiseana*		80	0.5-1.5
Bulbostylis	*barbata*		<1	0.05
Solanum	*cleistogamum*		<1	0.1
Eriachne	*ciliata*		<1	0.1
Triumfetta	*propinqua*		<1	0.3
Solanum	*dioicum*		<1	0.3
Eriachne	*mucronata*		<1	0.3
Acacia	*tumida*	var. *pilbarensis*	<1	2-4
Cleome	*viscosa*		<1	0.5
Corchorus	*parviflorus*		<1	0.5
Solanum	*phlomoides*		<1	0.4
Acacia	*spondylophylla*		<1	0.5-1
Tephrosia	*virens*		<1	1-1.5

Site	Callawa - Site CAL 21
Date	19/06/2012
Recorder	DR/JB
Photo	9851
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	216708
Northing	7716750
Habitat	Plain (PLA)
Aspect	
Slope	Gently Inclined (GE) (1˚46' to 5˚45')
Soil	Sand – brown
Rock Type	None evident
% Leaves:Logs	<1:<1
Vegetation Condition	Very Good
Disturbance Type	Weeds; Cattle
Fire Age	Old – 5-10 yrs
Vegetation	Hummock Grassland of *Triodia epacita* over Very Open Tussock Annual Grasses of *Sporobolus actinocladus, Eragrostis cummingii, Sporobolus australasicus* with Scattered Tall Shrubs of *Acacia colei, Sesbbania cannabina* over Scattered Low Shrubs of *Pluchea tetranthera, Acacia stellata, Pluchea rubelliflora*

Species			% Cover	Height
Sesbania	*cannabina*		0.5	1-2
Triodia	*epactia*		67	0.5-1.5
Cyperus	*ixiocarpus*		<1	0.5-1
Pluchea	*tetranthera*		1.5	0.5
Eragrostis	*cumingii*		3	0.25
Sporobolus	*australasicus*		1	0.15
Fimbristylis	? sp. H Kimberley Flora (Carr 3944 & Beauglehole 47722)		<1	0.15
Eriachne	*aristidea*		<1	0.25
Sporobolus	*actinocladus*		2	0.35
Euphorbia	*australis*		<1	0.15
Acacia	*colei*		0.5	2-2.5
Centipedea	*minima*	subsp. *macrocephala*	<1	0.1
Cyperus	*squarrous*		<1	0.1
**Chloris*	*virgata*		<1	0.5
Stemodia	*grossa*		<1	0.2
Ipomoea	*muelleri*		0.5	Cr
**Cenchrus*	*ciliaris*		<1	0.2
Phyllanthus	*maderaspatensis*		<1	0.4
Wahlenbergia	*tumidifructa*		<1	0.3
Paspalidium	*rarum*		<1	0.15
Desmodium	*filiforme*		<1	0.2
Trianthema	*triquetra*		<1	0.1
Euphorbia	*alsiniflora*		<1	0.1
Dactyloctenium	*radulans*		0.5	0.1
Pterocaulon	*sphaeranthoides*		<1	0.2

Species			% Cover	Height
Striga	*squamigera*		<1	0.3
Eragrostis	*pergracilis*		0.5	0.1
**Chloris*	*virgata*		<1	0.35
Eragrostis	*tenellula*		<1	0.3
Sida	*fibulifera*		<1	0.2
Pluchea	*ferdinandi-muelleri*		<1	0.6
Acacia	*trachycarpa*		<1	2
Corchorus	*elachocarpus*		<1	0.3
Neptunia	*dimorphantha*		<1	0.15
Crotalaria	*medicaginea*		<1	0.3
Acacia	*stellaticeps*		<1	0.5-1
Indigofera	*colutea*		<1	0.15
Bulbostylis	*barbata*		<1	0.1
Eragrostis	*crateriformis*		<1	0.35
Cullen	*leucanthum*		<1	0.4
Pluchea	*rubelliflora*		1	0.4
Triodia	*longiceps*		-	-

Site	Callawa - Site CAL 22
Date	19/06/2012
Recorder	DR/JB
Photo	9853
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	217319
Northing	7717311
Habitat	Plain (PLA)
Aspect	200°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Loamy sand – brown
Rock Type	(scattered pebbles)
% Leaves:Logs	0:6
Vegetation Condition	Very Good
Disturbance Type	Access Track, Livestock
Fire Age	Old – 5-10 yrs
Vegetation	Closed Hummock Grassland of *Triodia epactia* with High Shrubland of *Acacia tumida* var. *pilbarensis* over Low Shrubland of *Acacia stellaticeps*

Species			% Cover	Height
Acacia	*stellaticeps*		14	0.5-1.4
Triodia	*epactia*		90	0.4-1.1
Acacia	*tumida*	var. *pilbarensis*	15	2-4
Hakea	*lorea*	subsp. *lorea*	0.5	5.5
Bulbostylis	*barbata*		0.5	0.1
Mollugo	*molluginea*		<1	0.1
Polycarpaea	*corymbosa*		<1	0.1
Eragrostis	*eriopoda*		<1	0.4
Goodenia	*microptera*		<1	0.2
Convulvulus	*cf. clementii*		<1	Cr
Yakirra	*australiensis*		<1	0.1
Synaptantha	*tillaeacea*		<1	0.1
Eriachne	*aristidea*		0.5	0.2
Bonamia	*linearis*		0.5	Cr
Bonamia	*pannosa*		<1	0.2
Polymeria	*ambigua*		<1	Cr
Euphorbia	*australis*		<1	0.1
Desmodium	*filiforme*		<1	0.2
Pluchea	*tetranthera*		<1	0.5-1
Heliotropium	*small skeletal'*		<1	0.3
Indigofera	*colutea*		<1	0.2
Senna	*notabilis*		<1	0.1
Aristida	*holathera*	var. *holathera*	<1	0.5
Acacia	*ptychophylla*		<1	1-1.4
Crotalaria	*medicaginea*		<1	0.3
Acacia	*inaequilatera*		<1	2-3
Indigofera	*linnaei*		<1	0.1
Tephrosia	*sp. Thin*		<1	0.25
Indigofera	*linifolia*		<1	0.2

Species			% Cover	Height
Grevillea	*pyramidalis*	var. *leucadendron*	<1	0.5
Eragrostis	*cumingii*		<1	0.15
Acacia	*stellaticeps*		14	0.5-1.4