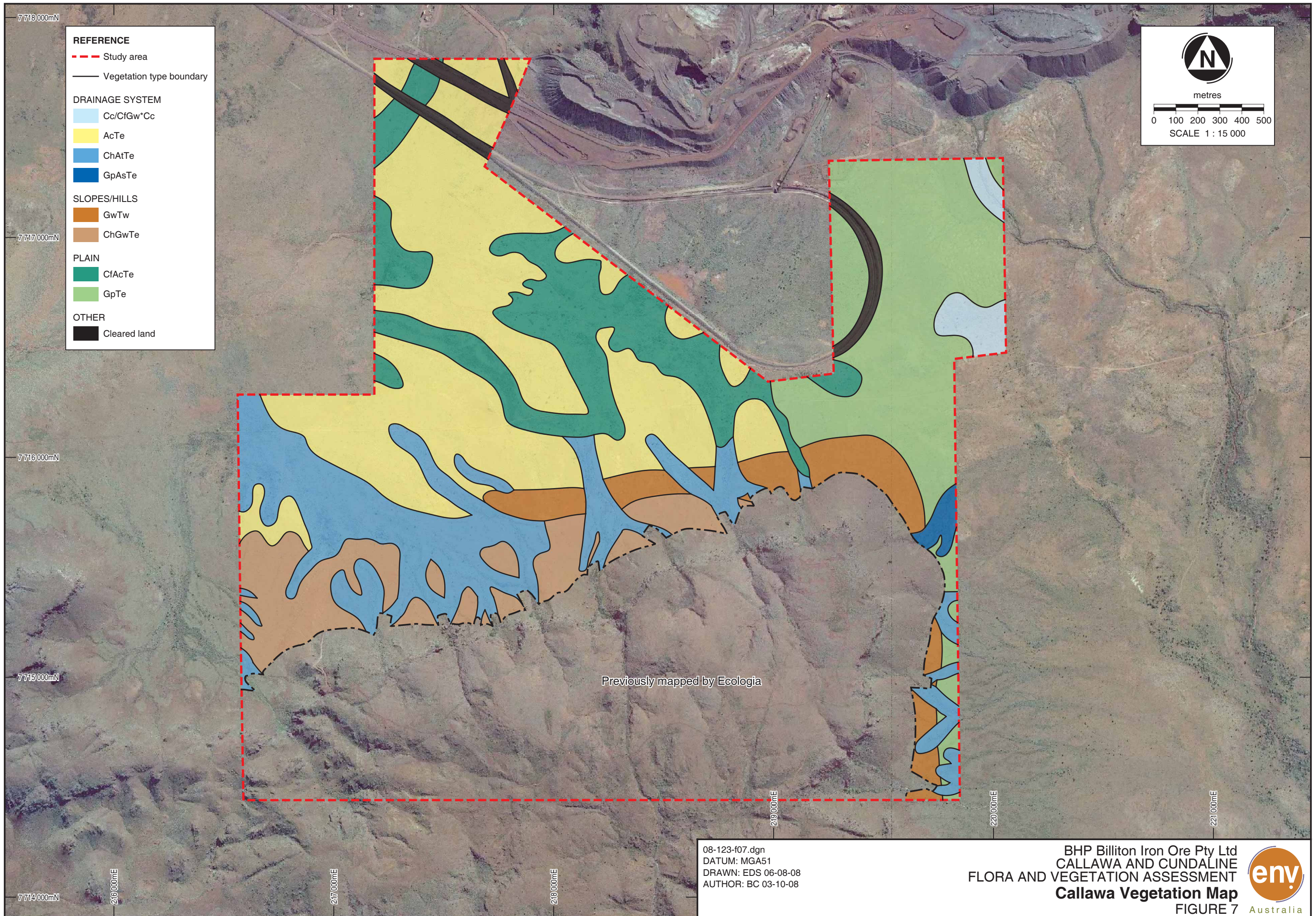
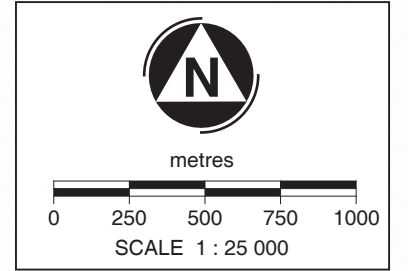


- REFERENCE**
- Study area
  - Vegetation type boundary
- DRAINAGE SYSTEM**
- ChAcCf
  - ChAtTe
  - AiTe
  - ChTe
  - GwTe
- SLOPES/HILLS**
- EIAiTw
  - Ch/EIGwTe
  - Gp/GwTe
  - ChGwTe
  - AoTe
- PLAIN**
- ChApTe
  - ChAbTw
- GORGES/GULLYS/BREAKAWAYS**
- Ch/EIAtEm
- OTHER**
- Cleared land





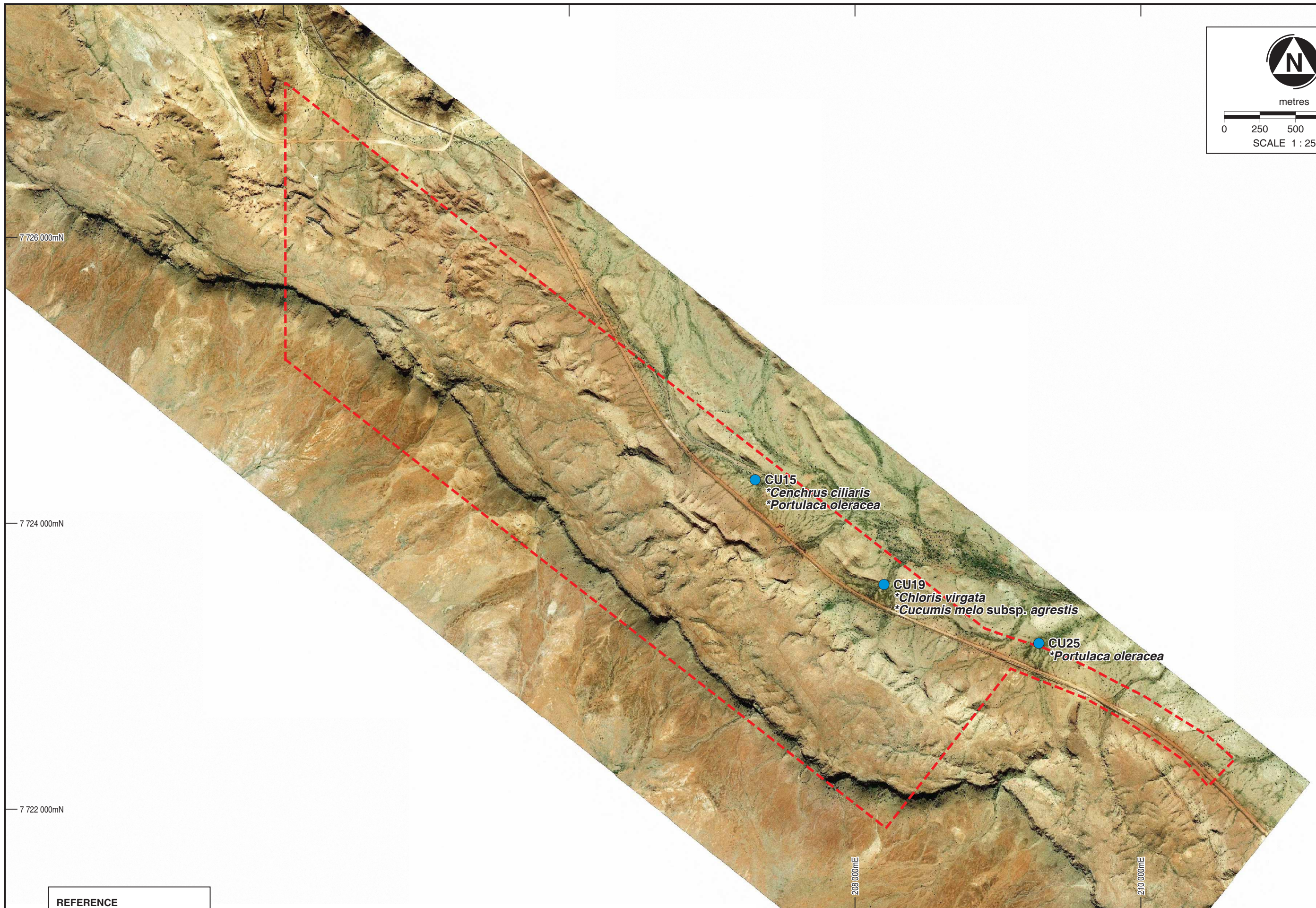
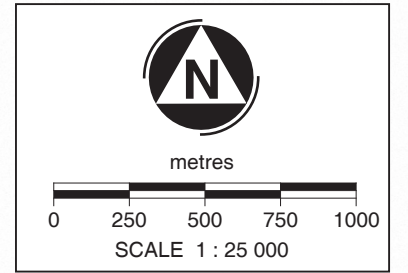




**REFERENCE**

- Study area
- Disturbance footprint
- Priority 2 flora
- Priority 3 flora





**REFERENCE**

--- Study area

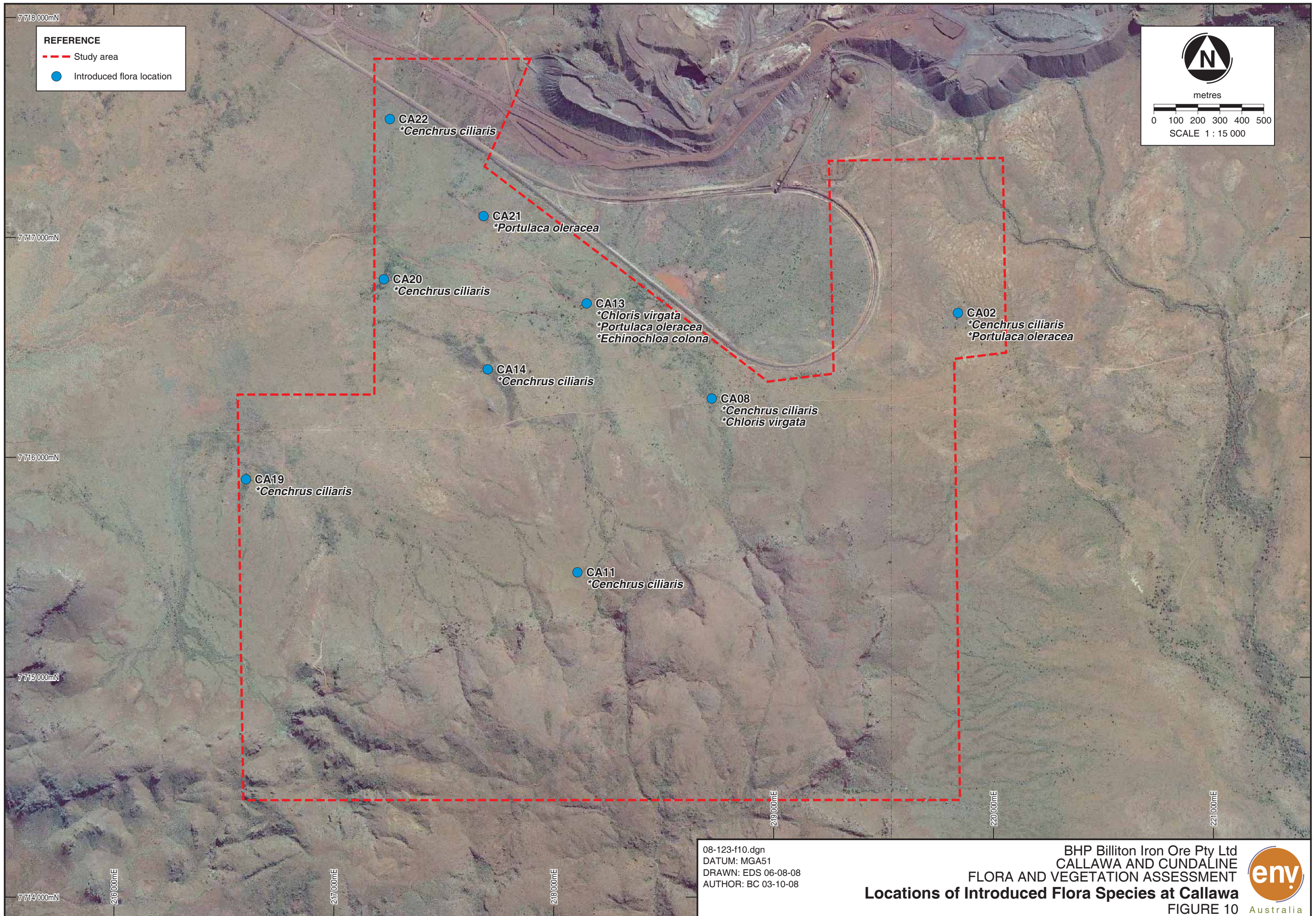
● Introduced flora location

08-123-f09.dgn  
DATUM: MGA51  
DRAWN: EDS 06-08-08  
AUTHOR: BC 03-10-08

BHP Billiton Iron Ore Pty Ltd  
CALLAWA AND CUNDALINE  
FLORA AND VEGETATION ASSESSMENT  
**Locations of Introduced Flora Species at Cundaline**  
FIGURE 9









# **APPENDIX A**

## **DEFINITIONS OF DECLARED RARE, PRIORITY AND THREATENED FLORA SPECIES AND THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES**



## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX A

#### DEFINITIONS OF DECLARED RARE, PRIORITY AND THREATENED FLORA SPECIES AND THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

Definition of Rare and Priority Flora Species  
(Department of Environment and Conservation 2008b)

Conservation Code	Category
<b>R</b>	<b>Declared Rare Flora - Extant Taxa</b> 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.
<b>X</b>	<b>Declared Rare Flora - Presumed Extinct Taxa</b> Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
<b>P1</b>	<b>Priority One - Poorly Known Taxa</b> Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
<b>P2</b>	<b>Priority Two - Poorly Known Taxa</b> Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
<b>P3</b>	<b>Priority Three - Poorly Known Taxa</b> Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
<b>P4</b>	<b>Priority Four - Rare Taxa</b> Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.



## Categories of Threatened Flora Species (Department of Environment and Conservation 2008b)

Category Code	Category
<b>Ex</b>	<b>Extinct</b> Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.
<b>ExW</b>	<b>Extinct in the Wild</b> Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
<b>CE</b>	<b>Critically Endangered</b> Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
<b>E</b>	<b>Endangered</b> Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
<b>V</b>	<b>Vulnerable</b> Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
<b>CD</b>	<b>Conservation Dependent</b> Taxa which at a particular time if, at that time, 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.



## Definition of Threatened Ecological Communities (Department of Environment and Conservation 2008c)

### **Presumed Totally Destroyed (PD)**

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

- A) records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats;
- B) all occurrences recorded within the last 50 years have since been destroyed.

### **Critically Endangered (CR)**

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

- A) the estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii):
  - i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years);
  - ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated.
- B) current distribution is limited, and one or more of the following apply (i, ii or iii):
  - i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years);
  - ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
  - iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.



- C) the ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years).

### **Endangered (EN)**

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

- A) the estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and either or both of the following apply (i or ii):
- i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years);
  - ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated.
- B) current distribution is limited, and one or more of the following apply (i, ii or iii):
- i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years);
  - ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;
  - iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.
- C) the ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).

### **Vulnerable (VU)**

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



- A) the ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated;
- B) the ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations;
- C) the ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.



## Definition of Priority Ecological Communities (Department of Environment and Conservation 2008c)

### **Priority One (P1)** Poorly known ecological communities:

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

### **Priority Two (P2)** Poorly known ecological communities:

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

### **Priority Three (P3)** Poorly known ecological communities:

- (i) communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
- (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;
- (iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

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

**Priority Four (P4)** Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring:

- (a) Rare: ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could



be if present circumstances change. These communities are usually represented on conservation lands.

- (b) Near Threatened: ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.
- (c) Ecological communities that have been removed from the list of threatened communities during the past five years.

**Priority Five (P5)** Conservation dependent ecological communities:

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



# **APPENDIX B**

## **FLORA SURVEY QUADRAT LOCATIONS**



## CUNDALINE AND CALLAWA FLORA AND VEGETATION ASSESSMENT

### APPENDIX B

#### FLORA SURVEY QUADRAT LOCATIONS

##### Appendix B1: Flora Survey Quadrat and Relevé Locations at Cundaline

Site Number	# Easting	# Northing
CU01	204007	7726793
CU02	204526	7726608
CU03	204788	7726414
CU04	204352	7725722
CU05	204774	7725807
CU06	205366	7725794
CU07	205512	7725395
CU08	205660	7725581
CU09	205862	7725153
CU10	205952	7724829
CU11	206438	7724661
CU12	206581	7724426
CU13	206845	7723821
CU14	206973	7724572
CU15	207302	7724304
CU16	207262	7723794
CU17	207627	7724071
CU18	207979	7723748
CU19	208202	7723571
CU20	208279	7723261
CU21	207995	7722853
CU22	208396	7722731
CU23	208455	7722387
CU24	208904	7722887



Site Number	# Easting	# Northing
CU25	209286	7723161
CU26	209758	7722872
CU27	210245	7722586
CU28	205052	7724296
CU29	205331	7724131
CU30	207367	7723463
CU31	205247	7725584
CU32	204393	7726245
CU33	206238	7724988
CU34	206005	7725087
CU36	205291	7724179
CU37	207031	7724188
CU R01	206397	7724830

# Coordinate from northwest corner; Geocentric 1994 (GDA94), Zone 50K



## Appendix B2: Flora Survey Quadrat and Relevé Locations at Callawa

Site Number	# Easting	# Northing
CA01	219766	7717027
CA02	219838	7716657
CA03	219221	7716153
CA04	219725	7715814
CA05	219280	7715829
CA06	219668	7715283
CA07	219720	7714920
CA08	218719	7716267
CA09	218637	7715630
CA10	218373	7716172
CA11	218108	7715477
CA12	217814	7715762
CA13	218150	7716700
CA14	217700	7716400
CA15	217403	7716198
CA16	217375	7715582
CA17	216799	7715248
CA18	216600	7715400
CA19	216600	7715900
CA20	217228	7716810
CA21	217681	7717097
CA22	217255	7717538
CA R01	219713	7715608
CA R02	217637	7717221

# Coordinate from northwest corner; Geocentric 1994 (GDA94), Zone 50K



# **APPENDIX C**

## **FLORA QUADRAT PHOTOGRAPHS**



## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX C

#### FLORA QUADRAT PHOTOGRAPHS

##### Appendix C1: Flora Quadrat Photographs at Cundaline Survey Area

CU01



CU02





CU03



CU04





CU05



CU06





CU07



CU08





CU09



CU10





CU11



CU12





CU13



CU14





CU15



CU16





CU17



CU18





CU19



CU20





## CU21



## CU22





CU23



CU24





CU25



CU26





CU27



CU28





CU29



CU30





CU31



CU32





CU33



CU34





CU36



CU37





## Appendix C2: Flora Quadrat Photographs at Callawa Survey Area

CA01



CA02





CA03



CA04





CA05



CA06





CA07



CA08





CA09



CA10





CA11



CA12





CA13



CA14





CA15

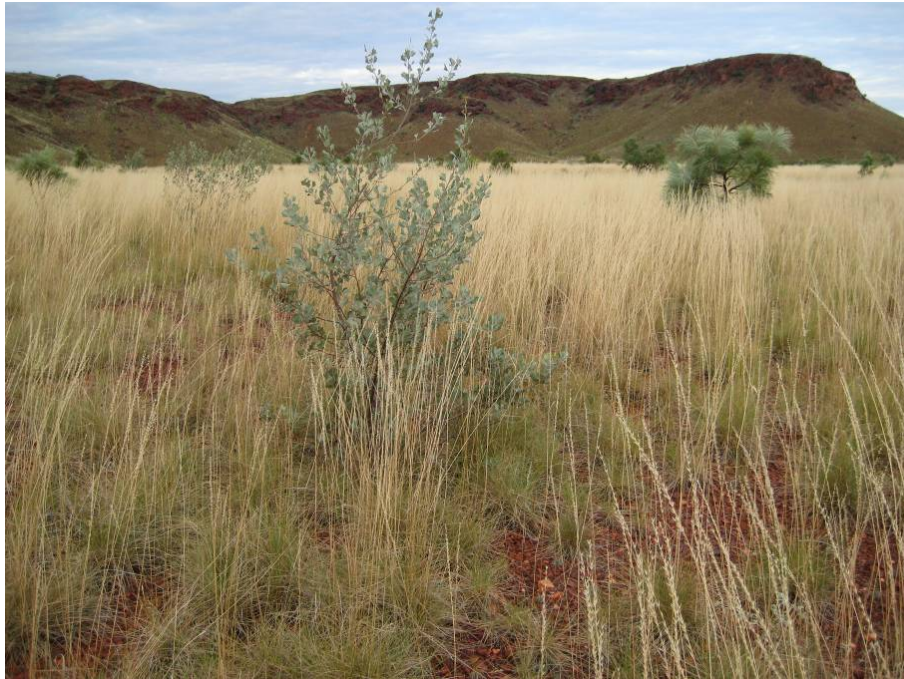


CA16





CA17



CA18





CA19



CA20





CA21



CA22





# **APPENDIX D**

## **VEGETATION CONDITION SCALES**



## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX D

#### VEGETATION CONDITION SCALES

Definition of Condition Scales (Trudgen 1991)

Condition Code	Definition
<b>E</b>	<b>Excellent</b> Pristine or nearly so, no obvious signs of damage caused by the activities of European man.
<b>VG</b>	<b>Very Good</b> Some relatively slight signs of damage caused by the activities of European man, e.g. some signs of damage to tree trunks caused by repeated fire and the presence of some relatively non-aggressive weeds such as <i>Ursinia anthemoides</i> or <i>Briza</i> species, or occasional vehicle tracks.
<b>G</b>	<b>Good</b> More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.
<b>P</b>	<b>Poor</b> Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as <i>Ehrharta</i> species.
<b>VP</b>	<b>Very Poor</b> Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but, not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.
<b>D</b>	<b>Completely Degraded</b> Areas that are completely or almost completely without native species in the structure of their vegetation, e.g. areas that are cleared or “parkland cleared” with their flora comprising weed or crop species with isolated native trees or shrubs.



# **APPENDIX E**

## **FLORA QUADRAT DATA SHEETS**



## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX E

#### FLORA QUADRAT DATA SHEETS

##### Appendix E1: Cundaline Flora Quadrat Data Sheets

<b>Cundaline</b>		<b>Site</b> CU01		
<b>Described by</b>	KC	<b>Date</b> 27/03/2008	<b>Type</b> Q	50 x 50 m
<b>Location</b>	North Cundaline ridge.			
<b>MGA Zone</b>	51	204007 mE	7726793 mN	
<b>Habitat</b>	Lower hillslope.			
<b>Soil</b>	Yellow/brown skeletal loam surface covered with pebbles and cobbles.			
<b>Rock Type</b>	Ironstone, silicates and conglomerates.			
<b>Vegetation</b>	Eucalyptus leucophloia subsp. leucophloia low open woodland over Triodia epactia hummock grassland over Cymbopogon procerus and Eriachne mucronata (typical form) scattered tussock grasses.			
<b>Vegetation Condition</b>	Excellent.			
<b>Fire Age</b>	Old.			
<b>Notes</b>	Disturbance type: Track 200 m South. Aspect: South. Bare ground: 50%. Litter cover: + Logs, + Twigs, + Leaves.			

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		0.5m	CU01.04	
	Acacia stellaticeps	+		0.5m	CU01.09	
	Atalaya hemiglauc	1%		3m	CU01.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.4m	CU01.12	
	Cymbopogon procerus	1%		0.5m	CU01.08	
	Cyperus cunninghamii	+		<0.1m	CU01.06	
	Eriachne mucronata (typical form)	1%		0.4m	CU01.14	
	Eucalyptus leucophloia subsp. leucophloia	2%		5-8m	CU01.01	
	Eucalyptus leucophloia subsp. leucophloia	1%		3m	CU01.02	
	Hakea chordophylla	+		1.5m	CU01.18	
	Indigastrium parviflorum	+		<0.1m	CU01.17	
	Indigofera trita	+		0.2m	CU01.15	
	Pterocaulon serrulatum	+		0.4m	CU01.13	
	Senna glutinosa subsp. glutinosa	+		0.5m	CU12.23	
	Tephrosia spechtii	+		0.4m	CU01.10	
	Themeda sp.	+		0.5m	CU01.11	
	Triodia epactia	45%		<0.6m	CU01.07	
	Triumfetta maconochieana	+		<0.5m	CU01.05	
	Triumfetta maconochieana	+		0.3m	CU01.16	



## Cundaline

Site CU02

Described by JSF Date 27/03/2008 Type Q 100 x 25 m

### Location

MGA Zone 51 204526 mE 7726608 mN

Habitat Drainage line.

Soil Red/brown clay.

Rock Type Ironstone.

Vegetation Corymbia hamersleyana scattered low trees over Acacia tumida var. pilbarensis high shrubland over Acacia pyrifolia open shrubland over Acacia ptychophylla and Acacia adoxa var. adoxa low scattered shrubs over Triodia epactia closed hummock grassland.

Vegetation Condition Excellent.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 10%.  
Litter cover: + Logs, + Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	1%		0.5m	CU02.05	
	Acacia ptychophylla	1%		0.8m	CU02.09	
	Acacia pyrifolia	4%		1.5m	CU02.10	
	Acacia stellaticeps	+		1m	CU02.16	
	Acacia tumida var. pilbarensis	20%		2-4m	CU02.02	
	Acacia tumida var. pilbarensis	+		0.2m	CU02.06	
	Boerhavia coccinea	+		0.1m	CU02.26	
	Bulbostylis barbata	+		0.05m	CU02.36	
	Cleome uncifera subsp. uncifera	+		0.3m	CU02.01	
	Cleome viscosa	+		0.4m	CU02.31	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.4m	CU02.17	
	Corchorus elachocarpus	+		0.5m	CU02.12	
	Corymbia hamersleyana	+		5m	CU02.24	
	Cymbopogon procerus	+		1m	CU02.21	
	Dampiera candidans	+		0.5m	CU02.08	
	Enneapogon lindleyanus	+		0.4m	CU02.27	
	Eriachne mucronata (typical form)	+		0.4m	CU02.20	
	Goodenia stobbsiana	+		0.3m	CU18.06	
	Hybanthus aurantiacus	+		0.3m	CU02.13	
	Indigofera monophylla (small calyx form)	+		0.5m	CU02.03	
	Mollugo molluginea	+		0.1m	CU02.11	
	Paspalidium clementii	+		0.2m	CU02.32	
	Pluchea tetranthera	+		0.4m	CU02.22	
	Polymeria calycina	+		0.1m	CU02.15	
	Pterocaulon sphacelatum	+		0.4m	CU02.23	
	Pterocaulon sphaeranthoides	+		0.4m	CU02.34	
	Ptilotus axillaris	+		0.05m	CU02.28	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU02.29	
	Ptilotus fusiformis var. fusiformis	+		0.4m	CU02.30	
	Streptoglossa decurrens	+		0.4m	CU02.35	
	Tephrosia aff. rosea (HD292-37)	+		0.4m	CU02.07	
	Tephrosia aff. rosea (HD292-37)	+		1m	CU02.18	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+		0.4m	CU02.04	
	Trichodesma zeylanicum var. zeylanicum	+		1m	CU02.19	
	Triodia epactia	70%		1m	CU02.14	



Triumfetta plumigera	+	0.5m	CU02.25
Waltheria indica	+	0.4m	CU02.33



## Cundaline

Site CU03

Described by JSF Date 30/03/2008 Type Q 50 x 50 m

### Location

MGA Zone 51 204788 mE 7726414 mN

Habitat Low Hilltop.

Soil Skeletal soil.

Rock Type Ironstone.

**Vegetation** Grevillea wickhamii subsp. hispidula, Grevillea pyramidalis subsp. pyramidalis and Acacia pyrifolia high open shrubland over Acacia bivenosa open shrubland over Acacia ptychophylla low open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: N/A.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia bivenosa	10%		1.5m	CU03.02	
	Acacia ptychophylla	5%		0.5m	CU02.09	
	Acacia pyrifolia	1%		2m	CU16.25	
	Cajanus cinereus	1%		1.5m	CU12.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.8m	CU03.03	
	Corymbia hamersleyana	+		2m	CA19.01	
	Cymbopogon ambiguus	1%		0.8m	CU16.04	
	Cyperus cunninghamii subsp. cunninghamii	+		0.5m	CU16.22	
	Eriachne mucronata (typical form)	+		0.3m	CU16.07	
	Euphorbia sp. (site 1089)	+		1m	Opp 6	51206712E 7724581N
	Euphorbia wheeleri	+		0.2m	CU03.10	
	Euphorbia wheeleri	+		0.2m	CU03.11	
	Evolvulus alsinoides var. villosicalyx	+		0.3m	Opp 7	51206712E 7724581N
	Gossypium australe (Whim Creek form)	+		0.3m	CU03.09	
	Grevillea pyramidalis subsp. pyramidalis	1%		2m	CA17.04	
	Grevillea wickhamii subsp. hispidula	2%		3m	CA07.02	
	Hibiscus aff. coatesii (MET 15 305)	+		0.8m	Opp 5	51206712E 7724581N
	Mollugo molluginea	+		0.1m	CU03.05	
	Pluchea tetranthera	+		0.5m	CU03.12	
	Ptilotus axillaris	+		0.2m	Opp 4	51206715E 7724492N
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.3m	CU03.13	
	Tephrosia aff. supina	+		0.1m	CU03.06	
	Themeda sp.	5%		0.5m	CU03.08	
	Tribulus sp.	+		0.2m	Opp 8	51206715E 7724492N
	Tribulus suberosus	+		0.5m	CU03.07	
	Triodia epactia	50%		0.4m	CU03.01	
	Triumfetta clementii	+		0.2m	CU03.04	

## Cundaline

## Site CU04

**Described by** TE **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 204352 mE 7725722 mN

**Habitat** Sloping hilltop.

**Soil** Red/brown skeletal loam with exposed bedrock.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana scattered trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Acacia ptychophylla low scattered shrubs over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: North.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU08.04	
	Acacia ptychophylla	1%		0.5m	CU21.01	
	Acacia pyrifolia	+		1m	CU21.04	
	Acacia tumida var. pilbarensis	2%		2-3m	CU21.07	
	Bonamia media var. villosa	+		0.5m	CU18.08	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.6m	CU04.04	
	Corymbia hamersleyana	+		6m	CA09.09	
	Dampiera candidans	+		0.5m	CU07.04	
	Eriachne lanata	+		<0.2m	CU21.03	
	Eriachne mucronata	1%		0.5m	CU13.06	
	Fimbristylis dichotoma	+		<0.1m	CU04.03	
	Grevillea wickhamii subsp. hispidula	8%		2-3m	CA18.02	
	Hybanthus aurantiacus	+		1.5m	CU21.12	
	Pluchea tetranthera	+		1.5m	CA12.16	
	Sida subarticulata	+		1.5m	CU04.02	
	Stemodia grossa	+		0.4m	CU15.12	
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Triodia epactia	55%		0.5m	CU05.01	



## Cundaline

Site CU05

Described by TE Date 30/03/2008 Type Q 50 x 50 m

Location Cundaline.

MGA Zone 51 204774 mE 7725807 mN

Habitat Hilltop.

Soil Red/brown skeletal loam with exposed bedrock and surface covered with pebbles and cobbles.

Rock Type Ironstone and silicates.

Vegetation Corymbia hamersleyana scattered low trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Acacia ptychophylla and Acacia adoxa var. adoxa low open shrubland over Triodia epactia hummock grassland.

Vegetation Condition Very good.

Fire Age Old.

Notes Disturbance type: Track 50 m North.  
Aspect: North.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	1%		0.5m	CU08.04	
	Acacia ptychophylla	3%		0.5m	CU21.01	
	Acacia tumida var. pilbarensis	5%		2-3m	CU21.07	
	Bonamia media var. villosa	+		0.5m	CU18.08	
	Corymbia hamersleyana	+		8m	CA09.09	
	Cymbopogon ambiguus	+		1m	CU05.02	
	Dampiera candidans	+		0.4m	CU07.04	
	Eriachne lanata	+		0.8m	CU21.03	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CU11.02	
	Grevillea wickhamii subsp. hispidula	10%		2-3m	CA18.02	
	Hybanthus aurantiacus	+		0.5m	CU21.12	
	Indigofera monophylla (small calyx form)	+		<0.5m	CU10.08	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU19.09	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.4m	CU05.04	
	Sida pilbarensis (ferruginous form)	+		0.4m	CU05.03	
	Stemodia grossa	+		0.2m	CU15.12	
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Triodia epactia	55%		0.5m	CU05.01	

## Cundaline

Site CU06

**Described by** TE **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 205366 mE 7725794 mN

**Habitat** Undulating low hills.

**Soil** Red/brown skeletal loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and red rock.

**Vegetation** Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia inaequilatera high open shrubland over Acacia ptychophylla and Acacia adoxa var. adoxa low open shrubland over Triodia epactia and Triodia wiseana open hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: 50m North of track.  
Aspect: N/A, multiple North/South valleys.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Abutilon dioicum	+		1m	CU06.15	
	Acacia adoxa var. adoxa	2%		0.5m	CU08.04	
	Acacia inaequilatera	2%		2m	CA18.05	
	Acacia inaequilatera	+		0.6m	CU06.09	
	Acacia ptychophylla	5%		0.5m	CU06.04	
	Aristida inaequiglumis	+		0.4m	CU06.17	
	Bonamia media var. villosa	+		<0.1m	CU06.07	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		1m	CU33.04	
	Corymbia hamersleyana	+		1-3m	CA09.09	
	Cymbopogon ambiguus	+		0.6m	CU06.03	
	Cymbopogon ambiguus	+		0.6m	CU06.13	
	Dodonaea coriacea	+		0.3m	CU06.05	
	Eriachne mucronata (typical form)	1%		0.5m	CU33.09	
	Eucalyptus leucophloia subsp. leucophloia	1%		5-8m	CU13.03	
	Eucalyptus leucophloia subsp. leucophloia	2.5%		6m	CU06.12	
	Gomphrena cunninghamii	+		<0.1m	CU06.16	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CU06.14	
	Grevillea wickhamii subsp. hispidula	+		3m	CA18.02	
	Hibiscus coatesii	+		0.5m	CU06.18	
	Hibiscus sturtii var. campylochlamys	+		0.5m	CU06.11	
	Indigofera monophylla (small calyx form)	+		0.4m	CU06.08	
	Indigofera monophylla (small calyx form)	+		0.5m	CA02.23	
	Senna glutinosa subsp. glutinosa	+		1.5m	CU12.23	
	Tephrosia aff. rosea (HD292-37)	+		1m	CU06.06	
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Tribulus suberosus	+		0.4m	CU06.10	
	Triodia epactia	5%		0.5m	CU06.01	
	Triodia wiseana	5%		0.8m	CU06.02	



## Cundaline

Site CU07

Described by TE Date 29/03/2008 Type Q 50 x 50 m

Location Cundaline.

MGA Zone 51 205512 mE 7725395 mN

Habitat Gorge/breakaway.

Soil Skeletal soil with exposed bedrock and cliffs.

Rock Type Ironstone and silicates.

Vegetation Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia pyrifolia and Acacia tumida var. pilbarensis high shrubland over Grevillea wickhamii subsp. hispidula low open shrubland over Triodia biflora, Triodia epactia and Triodia wiseana hummock grassland.

Vegetation Condition Excellent.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 45%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU08.04	
	Acacia ptychophylla	+		0.5-1m	CU21.01	
	Acacia pyrifolia	5%		2-3m	CU07.02	
	Acacia tumida var. pilbarensis	5%		2-3m	CU07.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CU33.04	
	Cymbopogon procerus	+		0.6m	CU10.07	
	Dampiera candidans	+		0.5m	CU07.04	
	Eriachne mucronata	1%		0.5m	CU13.06	
	Eriachne sp. Port Hedland	+		0.5m	CA12.14	
	Eucalyptus leucophloia subsp. leucophloia	+		8m	CU13.03	
	Fimbristylis simulans	+		<0.1m	CU31.05	
	Grevillea wickhamii subsp. hispidula	4%		1m	CA18.02	
	Indigofera monophylla (small calyx form)	+		1.5m	CU06.08	
	Sida subarticulata	+		0.8m	CU07.06	
	Solanum dioicum	+		0.5m	CA12.17	
	Triodia biflora	30%		0.8m	CU31.02	
	Triodia epactia	20%		0.5m	CU07.01	
	Triodia wiseana	10%		0.6m	CU07.05	

## Cundaline

Site CU08

**Described by** TE **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 205660 mE 7725581 mN

**Habitat** Plain above drainage line.

**Soil** Red/brown loam.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia hamersleyana and Eucalyptus leucophloia subsp. leucophloia scattered low trees over Acacia ptychophylla low open shrubland over Acacia stellaticeps low open shrubland over Triodia epactia and Triodia epactia closed hummock grassland.

**Vegetation Condition** Very good/excellent.

**Fire Age** Old/very old.

**Notes** Disturbance type: Nil.

Aspect: N/A.

Bare ground: 20%.

Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	1%		0.5m	CU08.04	
	Acacia ptychophylla	3%		0.6m	CU08.07	
	Acacia stellaticeps	10%		0.5m	CU08.02	
	Acacia tumida var. pilbarensis	+		2m	CU08.08	
	Chrysopogon fallax	+		0.5m	CA14.06	
	Corchorus elachocarpus	1%		0.5-1m	CU08.06	
	Corymbia hamersleyana	1%		5-8m	CU08.05	
	Dampiera candidans	+		0.3m	CU07.04	
	Eucalyptus leucophloia subsp. leucophloia	+		5m	CU08.01	
	Grevillea wickhamii subsp. hispidula	+		2-3m	CA18.02	
	Hybanthus aurantiacus	+		CL	CU08.12	
	Indigofera monophylla (small calyx form)	+		0.5m	CU08.11	
	Ptilotus astrolasius var. astrolasius	+		0.5m	CU08.10	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU19.09	
	Stemodia grossa	+		<0.2m	CU15.12	
	Triodia epactia	1%		0.6m	CU08.09	
	Triodia epactia	75%		0.5m	CU08.03	



## Cundaline

Site CU09

**Described by** TE **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 205862 mE 7725153 mN

**Habitat** Cliff face and drainage line.

**Soil** Red/brown skeletal loam with exposed bedrock.

**Rock Type** Ironstone.

**Vegetation** Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia tumida var. pilbarensis and Grevillea wickhamii subsp. hispidula high shrubland over Eriachne mucronata (typical form) very open tussock grassland over Solanum dioicum open herbland.

**Vegetation Condition** Excellent.

**Fire Age** Very old.

**Notes** Disturbance type: Nil.  
Aspect: North.  
Bare ground: 60%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU31.04	
	Acacia ptychophylla	+		0.5-1m	CU21.01	
	Acacia tumida var. pilbarensis	15%		3-5m	CU07.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.6m	CU33.04	
	Cymbopogon procerus	+		1m	CU10.07	
	Eriachne mucronata (typical form)	2%		0.5m	CU33.09	
	Eriachne obtusa	+		<0.1m	CA12.13	
	Eriachne sp. Port Hedland	+		<0.2m	CU09.06	
	Eucalyptus leucophloia subsp. leucophloia	5%		5-8m	CU13.03	
	Fimbristylis microcarya	+		<0.1m	CU09.02A	
	Fimbristylis simulans	+		0.2m	CU31.05	
	Gomphrena cunninghamii	+		0.5m	CU09.04	
	Gossypium australe (Whim Creek form)	+		1m	CU09.01	
	Grevillea wickhamii subsp. hispidula	3%		2-3m	CA18.02	
	Indigofera monophylla (small calyx form)	+		0.8m	CU06.08	
	Iseilema dolichotrichum	+		<0.1m	CU09.03	
	Iseilema dolichotrichum				CU09.02B	
	Sida subarticulata	+		0.5m	CU09.05	
	Solanum dioicum	20%		0.8m	CU31.07	

## Cundaline

Site CU10

Described by TE Date 29/03/2008 Type Q 50 x 50 m  
Season Uniformity

Location Cundaline.

MGA Zone 51 205952 mE 7724829 mN

Habitat Hillcrest.

Soil Red/brown skeletal loam, surface covered with pebbles and cobbles.

Rock Type Ironstone and silicates.

Vegetation Eucalyptus leucophloia subsp. leucophloia scattered low trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Triodia epactia hummock grassland over Dampiera candidans scattered herbs.

Vegetation Condition Very good.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 35%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	+		0.5m	CU21.01	
	Acacia pyrifolia	+		0.5m	CU21.04	
	Acacia tumida var. pilbarensis	3%		2.5m	CU21.07	
	Aristida holathera var. latifolia	+		0.3m	CU21.09	
	Aristida holathera var. latifolia	+		0.5m	CU10.04	
	Boerhavia gardneri	+		0.1m	CU10.12	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.3m	CU10.06	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.3m	CU10.10	
	Cymbopogon procerus	+		0.6m	CU10.07	
	Dampiera candidans	1%		0.5m	CU07.04	
	Eriachne obtusa	+		<0.5m	CU10.02	
	Eucalyptus leucophloia subsp. leucophloia	+		8m	CU10.09	
	Eulalia aurea	+		0.2m	CU10.05	
	Fimbristylis simulans	+		<0.1m	CU21.08	
	Grevillea pyramidalis subsp. leucadendron	+		0.3m	CA04.09	
	Grevillea wickhamii subsp. hispidula	20%		2-3m	CA18.02	
	Hybanthus aurantiacus	+		0.2m	CU21.12	
	Indigofera monophylla (small calyx form)	+		<0.5m	CU10.08	
	Indigofera monophylla (small calyx form)	+		<0.1m	CU11.05	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU19.09	
	Senna glutinosa subsp. glutinosa	+		1m	CU12.23	
	Sida pilbarensis	+		0.5m	CU10.03	
	Sida pilbarensis (ferruginous form)	+		0.6m	CU10.01	
	Solanum beaugleholei	+		0.5m	CU21.06	
	Tephrosia aff. supina	+		0.4m	CU10.11	
	Triodia epactia	50%		0.6m	CU30.01	



## Cundaline

Site CU11

**Described by** TE **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 206438 mE 7724661 mN

**Habitat** Steep hillslope.

**Soil** Red/brown loam, surface covered with pebbles and cobbles. Exposed bedrock with small cliffs.

**Rock Type** Ironstone.

**Vegetation** Eucalyptus leucophloia subsp. leucophloia and Corymbia hamersleyana low open woodland over Acacia tumida var. pilbarensis and Grevillea pyramidalis subsp. leucadendron open shrubland over Acacia ptychophylla and Grevillea wickhamii subsp. hispidula low open shrubland over Triodia wiseana hummock grassland over Tephrosia aff. supina scattered herbs.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: North.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	3%		0.5m	CU08.04	
	Acacia inaequilatera	+		2-3m	CA18.05	
	Acacia ptychophylla	5%		0.5m	CU21.01	
	Acacia tumida var. pilbarensis	2%		2m	CU21.07	
	Corymbia hamersleyana	+		8m	CU11.06	
	Corymbia hamersleyana	2%		3-5m	CA09.09	
	Eucalyptus leucophloia subsp. leucophloia	2%		6m	CU13.03	
	Grevillea pyramidalis subsp. leucadendron	1%		1-1.5m	CU11.02	
	Grevillea wickhamii subsp. hispidula	2%		0.5m	CA18.02	
	Indigofera monophylla (small calyx form)	+		0.3m	CU11.05	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA04.04	
	Ptilotus exaltatus	+		0.3m	NC	Op.
	Senna glutinosa subsp. glutinosa	+		1.5m	CU12.23	
	Solanum beagleholei	+		0.6m	CU11.04	
	Solanum beagleholei	+		<0.1m	CU11.03	
	Tephrosia aff. supina	1%		<0.1m	CA11.05	
	Triodia wiseana	70%		0.5m	CU11.01	

## Cundaline

Site CU12

Described by JSF Date 30/03/2008 Type Q 25 x 100 m

### Location

MGA Zone 51 206581 mE 7724426 mN

Habitat Gully/gorge.

Soil Red/brown loamy clay, surface rocks.

Rock Type Ironstone, silicates, composites.

Vegetation Corymbia flavescons and Corymbia hamersleyana low open woodland over Acacia tumida var. pilbarensis high shrubland over Acacia pyrifolia, Grevillea wickhamii and Cajanus cinereus open health over Indigofera monophylla (small calyx form) low shrubland over Triodia biflora hummock grassland.

Vegetation Condition Excellent.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: East.  
Bare ground: 5%.  
Litter cover: + Logs, 20% Twigs, 40% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU12.18	
	Acacia colei var. colei	+		2m	CA21.02	
	Acacia ptychophylla	+		1m	CU02.09	
	Acacia pyrifolia	30%		2m	CU16.25	
	Acacia tumida var. pilbarensis	50%		5m	CA13.01	
	Amaranthus aff. pallidiflorus (WC148-11)	+		0.1m	CU12.29	
	Atalaya hemiglaucula	+		0.5m	CU12.21	
	Cajanus cinereus	20%		1m	CU12.03	
	Chrysopogon fallax	1%		0.8m	CU12.10	
	Corymbia aff. hamersleyana	3%		6m	CU12.16	
	Corymbia flavescons	2%		7m	CA19.25	
	Cymbopogon ambiguus	1%		0.8m	CU12.09	
	Dampiera candidans	+		0.4m	CU13.04	
	Enneapogon lindleyanus	1%		0.5m	CU12.06	
	Eriachne ciliata	+		0.2m	CU12.13	
	Eriachne ciliata	+		0.15m	CU12.26	
	Eriachne mucronata (typical form)	1%		0.3m	CU12.25	
	Eucalyptus leucophloia subsp. leucophloia	+		5m	CU12.15	
	Ficus platypoda	+		1m	CU16.29	
	Flueggea virosa subsp. melanthesoides	1%		2m	CU12.14	
	Gomphrena cunninghamii	+		0.3m	CU12.12	
	Gomphrena cunninghamii	+		0.1m	CU12.27	
	Grevillea wickhamii subsp. hispidula	20%		2m	CA07.02	
	Hibiscus sturtii var. campylochlamys	+		0.5m	CU12.20	
	Hibiscus sturtii var. campylochlamys	+		0.5m	CU12.07	
	Hybanthus aurantiacus	+		0.5m	CU12.08	
	Indigofera monophylla (small calyx form)	10%		0.5m	CU12.01	
	Indigofera monophylla (small calyx form)	10%		0.5m	CU12.28	
	Indigofera trita	+		0.2m	CU12.19	
	Leptopus decaisnei var. orbicularis	+		0.2m	CU12.04	
	Ptilotus obovatus	+		0.5m	CU12.22	
	Rhynchosia minima var. australis	1%		0.2m	CU12.17	
	Senna glutinosa subsp. glutinosa	+		0.4m	CU12.23	
	Sida subarticulata	5%		1m	CU12.02	
	Solanum beagleholei	+		0.5m	CU16.20	



Tephrosia aff. rosea (HD292-37)	5%	1m	CU12.05
Triodia biflora	60%	1m	CU12.11
Triumfetta clementii	+	0.5m	CU12.24

## Cundaline

Site CU13

Described by JSF Date 29/03/2008 Type Q 50 x 50 m

### Location

MGA Zone 51 206845 mE 7723821 mN

Habitat Hilltop.

Soil Skeletal soil.

Rock Type Ironstone.

**Vegetation** Eucalyptus leucophloia subsp. leucophloia scattered trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Acacia pyrifolia open shrubland over Acacia ptychophylla and Dampiera candidans low open health over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: some burnt patches, mostly old.  
Aspect: N/A.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	30%		0.5m	CU02.09	
	Acacia pyrifolia	5%		1.5m	CU16.25	
	Acacia tumida var. pilbarensis	5%		2.5m	CA13.01	
	Dampiera candidans	5%		0.5m	CU13.04	
	Eriachne lanata	2%		0.5m	CU13.05	
	Eriachne mucronata	+		0.15m	CU13.06	
	Eucalyptus leucophloia subsp. leucophloia	+		3m	CU13.03	
	Grevillea wickhamii subsp. hispidula	15%		2.5m	CA07.02	
	Solanum beagleholei	+		0.5m	CU13.02	
	Triodia epactia	40%		0.8m	CU13.01	



## Cundaline

Site CU14

**Described by** KC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 206973 mE 7724572 mN

**Habitat** Hillslope.

**Soil** Orange/brown skeletal loam surface with some pebbles, cobbles and exposed bedrock.

**Rock Type** Shale.

**Vegetation** Corymbia hamersleyana scattered low trees over Acacia pyrifolia scattered shrubs over Indigofera monophylla (small calyx form) low open shrubland over Triodia wiseana open hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Young/moderate.

**Notes** Disturbance type: Road 100m away.  
Aspect: South.  
Bare ground: 50%.  
Litter cover: + Logs, 2% Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Abutilon dioicum	+		0.2m	CU14.19	
	Abutilon dioicum	+		0.1m	CU14.16	
	Acacia inaequilatera	+		5m	CU14.07	
	Acacia pyrifolia	1%		1.5m	CU14.06	
	Bonamia media var. villosa	+		0.1m	CU14.10	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.3m	CU14.13	
	Corymbia aff. hamersleyana	1%		5m	CU14.04	
	Corymbia hamersleyana	+		0.5m	CU14.03	
	Corymbia hamersleyana	+		4m	CU14.11	
	Eriachne mucronata (typical form)	+		0.2m	CU14.08	
	Evolvulus alsinoides var. villosicalyx	+		0.1m	CU14.20	
	Goodenia muelleriana	+		0.2m	CU14.21	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CU14.12	
	Indigofera monophylla (small calyx form)	+		0.1m	CU14.17	
	Indigofera monophylla (small calyx form)	3%		0.3m	CU14.02	
	Indigofera trita	+		0.2m	CU14.15	
	Indigofera trita	+		0.2m	CU14.18	
	Tephrosia aff. rosea (HD292-37)	+		0.6m	CU14.14	
	Tephrosia aff. rosea (HD292-37)	+		0.4m	CU14.05	
	Triodia sp.	35%		0.3m	CU14.01	
	Triodia wiseana	+		0.5m	CU14.09	

## Cundaline

Site CU15

**Described by** KC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 207302 mE 7724304 mN

**Habitat** Drainage line.

**Soil** Brown loam.

**Rock Type** Ironstone and silicates.

**Vegetation** *Corymbia flavescens* and *Corymbia hamersleyana* open woodland over *Acacia colei* var. *colei* high shrubland over *Acacia pyrifolia* low open shrubland over *Chrysopogon fallax* and *Cenchrus ciliaris* closed tussock grassland over *Tephrosia* aff. *rosea* (HD292-37) very open herbland over *Cyperus vaginatus* scattered sedges.

**Vegetation Condition** Very good.

**Fire Age** Young.

**Notes** Disturbance type: Track 100m away, signs of cattle.

Aspect: South.

Bare ground: 15%.

Litter cover: + Logs, 2% Twigs, 8% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	<i>Acacia colei</i> var. <i>colei</i>	10%		3m	CU15.04	
	<i>Acacia pyrifolia</i>	3%		1m	CU15.34	
	<i>Amyema sanguinea</i> var. <i>sanguinea</i>	+		3m	CU15.39	
	<i>Atalaya hemiglauc</i>	+		0.3m	CU15.05	
	<i>Boerhavia coccinea</i>	+		0.3m	CU15.17	
	<i>Cajanus cinereus</i>	+		0.5m	CU15.08	
	<i>Cenchrus ciliaris</i>	2%		0.5m	CU15.01	
	<i>Chrysopogon fallax</i>	50%		1.2m	CU15.02	
	<i>Cleome viscosa</i>	+		0.4m	CU15.41	
	<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)	+		0.4m	CU15.22	
	<i>Corymbia flavescens</i>	3%		15m	CA20.14	
	<i>Corymbia hamersleyana</i>	1%		10m	CU15.38	
	<i>Corymbia hamersleyana</i>	3%		8m	CU15.37	
	<i>Cyperus vaginatus</i>	1%		1.2m	CU15.11	
	<i>Digitaria</i> sp.	+		0.5m	CU15.16	
	<i>Eragrostis cumingii</i>	1%		0.2m	CU15.10	
	<i>Euphorbia coghlani</i>	+		0.3m	CU15.15	
	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	+		0.2m	CU15.33	
	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>	+		0.3m	CU15.07	
	<i>Goodenia nuda</i>	+		0.2m	CU15.20	
	<i>Gossypium australe</i> (Burrup Peninsula form)	+		0.3m	CU15.13	
	<i>Hybanthus aurantiacus</i>	+		0.3m	CU15.25	
	<i>Hybanthus aurantiacus</i>	+		0.3m	CU15.09	
	<i>Indigofera trita</i>	+		0.2m	CU15.23	
	<i>Mollugo molluginea</i>	1%		0.3m	CU15.21	
	<i>Mukia maderaspatana</i>	+		0.2m	CU15.06	
	<i>Perotis rara</i>	+		0.2m	CU15.40	
	<i>Pluchea rubelliflora</i>	+		0.4m	CU15.19	
	<i>Pluchea tetranthera</i>	+		0.4m	CU15.29	
	<i>Polymeria ambigua</i>	2%		0.2m	CU15.31	
	<i>Polymeria calycina</i>	+		0.4m	CU15.18	
	<i>Polymeria calycina</i>	+		0.2m	CU15.36	
	<i>Polymeria calycina</i>	1%		0.2m	CU15.35	
	<i>Portulaca oleracea</i>	+		0.1m	CU15.24	
	<i>Pterocaulon sphaeranthoides</i>	+		0.3m	CU15.27	



Ptilotus axillaris	+	0.4m	CU15.28
Sida aff. fibulifera (Site 1308)	+	0.4m	CU15.32
Sida rohlenae subsp. rohlenae	+	0.2m	CU15.26
Solanum diversiflorum	+	0.4m	CU15.42
Stemodia grossa	+	0.3m	CU15.14
Stemodia grossa	+	0.4m	CU15.12
Tephrosia aff. rosea (HD292-37)	6%	0.5m	CU15.03
Triumfetta plumigera	+	0.3m	CU15.30

## Cundaline

Site CU16

Described by JSF Date 29/03/2008 Type Q 25 x 100 m

### Location

MGA Zone 51 207262 mE 7723794 mN

Habitat Gorge/gully.

Soil Red/brown clay with exposed bedrock.

Rock Type Ironstone.

**Vegetation** Corymbia hamersleyana and Corymbia ferritcola low open woodland over Acacia tumida var. pilbarensis and Grevillea wickhamii subsp. hispidula high shrubland over Grevillea pyramidalis subsp. pyramidalis and Acacia pyrifolia open shrubland over Acacia adoxa var. adoxa, Ptilotus calostachyus var. calostachyus and Indigofera monophylla (small calyx form) over Triodia wiseana and Triodia biflora closed hummock grassland over Eriachne mucronata (typical form) very open tussock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Some burnt patches, mostly old.

Aspect: East.

Bare ground: 15%.

Litter cover: + Logs, 5% Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	10%		0.5m	CU16.01	
	Acacia adoxa var. adoxa	+		0.3m	CU16.15	
	Acacia colei var. colei	+		1.8m	CA13.03	
	Acacia ptychophylla	+		0.8m	CU02.09	
	Acacia pyrifolia	2%		2m	CU16.25	
	Acacia tumida var. pilbarensis	10%		3.5m	CA13.01	
	Amaranthus sp.	+		0.1m	CU16.16	
	Amaranthus sp.	+		0.05m	CU16.33	
	Amaranthus sp.	+		0.05m	CU16.34	
	Bulbostylis barbata	+		0.05m	CU16.35	
	Cajanus cinereus	1%		0.4m	CU16.12	
	Cleome viscosa	+		0.2m	CU16.14	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	8%		0.4m	CU16.02	
	Corymbia ferritcola	+		4m	NC	Photo 2090
	Corymbia hamersleyana	5%		4m	CA19.01	
	Cymbopogon ambiguus	5%		0.8m	CU16.04	
	Cyperus cunninghamii subsp. cunninghamii	+		0.3m	CU16.22A	
	Dampiera candidans	1%		0.5m	CU16.10	
	Eriachne ciliata			0.4m	CU16.22B	
	Eriachne ciliata	+		1.6m	CU16.24	
	Eriachne mucronata (typical form)	+		0.4m	CU12.25	
	Eriachne mucronata (typical form)	5%		0.3m	CU16.07	
	Euphorbia sp.	+		0.4m	Opp 2	51207048E 7723908N
	Ficus platypoda	+		0.8m	CU16.29	
	Gomphrena cunninghamii	+		0.1m	CU16.27	
	Grevillea pyramidalis subsp. pyramidalis	1%		2m	CA17.04	
	Grevillea wickhamii subsp. hispidula	5%		3.5m	CA07.02	
	Hibiscus aff. coatesii (MET 15 305)	+		0.5m	CU16.39	
	Hibiscus coatesii (MET 15, 305)	1%		0.3m	CU16.18	
	Indigofera monophylla (small calyx form)	10%		0.4m	CU16.03	
	Indigofera monophylla (small calyx form)	+		0.5m	CU16.38	
	Mollugo molluginea	+		0.1m	CA19.07	
	Nicotiana sp.	+		0.05m	CU16.32	



Oldenlandia crouchiana	+	0.4m	CU16.19	
Pluchea tetranthera	+	0.2m	CU16.21	
Pterocaulon serrulatum	+	0.2m	CU16.26	
Ptilotus calostachyus var. calostachyus	10%	0.5m	CU16.08	
Ptilotus fusiformis var. fusiformis	+	0.1m	CU16.28	
Ptilotus fusiformis var. fusiformis	+	0.4m	CU16.17	
Rhodanthe margarethae	+	0.05m	CU16.37	
Sida aff. pilbarensis (GLD (SRH) 59-3)	+	0.05m	CU16.36	
Sida subarticulata	+	0.5m	CU16.23	
Sida subarticulata	+	1m	Opp 1	51207134E 7723838N
Solanum beagleholei	+	0.3m	CU16.20	
Solanum dioicum	3%	0.3m	CU16.09	
Streptoglossa decurrens	+	0.3m	CU02.35	
Tephrosia spechtii	+	0.4m	CU16.13	
Tinospora smilacina	+	0.05m	Opp 3	51207029E 7723957N
Trachymene oleracea subsp. oleracea	+	0.1m	CU16.31	
Triodia biflora	20%	0.8m	CU16.05	
Triodia wiseana	70%	0.8m	CU16.06	
Triumfetta maconochieana	2%	0.3m	CU16.11	
Triumfetta maconochieana	+	0.2m	CU16.30	

<b>Cundaline</b>		<b>Site</b>	CU17		
<b>Described by</b>	BC	<b>Date</b>	30/03/2008	<b>Type</b>	Q 50 x 50 m
<b>Season</b>		<b>Uniformity</b>			
<b>Location</b>	Eastern section of project area, North of road.				
<b>MGA Zone</b>	51		207627 mE		7724071 mN
<b>Habitat</b>	Floodplain with minor drainage lines scattered throughout.				
<b>Soil</b>	Red/brown loam, surface covered with pebbles and cobbles.				
<b>Rock Type</b>	Ironstone.				
<b>Vegetation</b>	Corymbia hamersleyana low open woodland over Grevillea wickhamii subsp. hispidula, Acacia inaequilatera and Acacia tumida var. pilbarensis shrubland over Senna notabilis and Solanum cunninghamii low shrubland over Triodia epactia very open hummock grassland over Corchorus aff. parviflorus (1)(GLD SRH67-5) and Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16) very open herbland.				
<b>Vegetation Condition</b>	Excellent.				
<b>Fire Age</b>	Young.				
<b>Notes</b>	Disturbance type: Nil. Aspect: North. Bare ground: 75%. Litter cover: + Logs, + Twigs, + Leaves.				

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.3m	CU25.19	
	Acacia inaequilatera	1%		2m	CA01.01	
	Acacia pyrifolia	+		1.5m	CU02.10	
	Acacia stellaticeps	+		<0.3m	CU29.09	
	Acacia tumida var. pilbarensis	2%		<1m	CU17.05	
	Aristida holathera var. latifolia	+		0.3m	CU27.13	
	Bonamia pannosa	+		<0.2m	CU17.13	
	Bonamia pannosa	+		0.3m	CU17.18B	
	Bonamia rosea	+		CR	CU17.12	
	Bonamia rosea	+		0.3m	CU17.11	
	Cleome uncifera subsp. uncifera	+		0.3m	CA04.05	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.4m	CA05.01	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	1%		<0.3m	CU17.22	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.2m	CU17.02	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.3m	CU17.06	
	Corymbia hamersleyana	5%		3-6m	CU37.05	
	Eragrostis aff. eriopoda (WAS site 963)	1%		0.3m	CU17.16	
	Fimbristylis simulans	+		0.1m	CU17.14	
	Goodenia microptera	+		0.3m	CU17.07	
	Goodenia microptera	+		0.3m	CU17.18A	
	Goodenia stobbsiana	+		0.2m	CU18.06	
	Grevillea pyramidalis subsp. leucadendron	+		2m	CA06.02	
	Grevillea wickhamii subsp. hispidula	10%		<1m	CA07.02	



Hibiscus sturtii var. campylochlamys	+	0.2m	CU17.08
Hybanthus aurantiacus	+	0.3m	CU26.04
Hybanthus aurantiacus	+	0.3m	CU17.04
Indigofera monophylla (small calyx form)	+	0.4m	CU17.03
Mollugo molluginea	+	<0.2m	CA04.06
Pluchea tetranthera	+	0.2m	CU17.09
Polygala aff. isingii	+	<0.05m	CU17.20
Pterocaulon sphacelatum	+	0.2m	CU27.06
Ptilotus astrolasius var. astrolasius	+	0.3m	CU17.17
Ptilotus calostachyus var. calostachyus	20%	<0.5m	CU17.01
Ptilotus fusiformis var. fusiformis	+	0.4m	CU17.10
Ptilotus fusiformis var. fusiformis	+	0.3m	CU26.05
Senna notabilis	15%	<0.4m	CA07.05
Sida pilbarensis	+	0.4m	CU17.19
Solanum cunninghamii	+	0.3m	CU26.14
Solanum diversiflorum	1%	0.3m	CU26.12
Stemodia grossa	+	0.3m	CU15.12
Synaptantha tillaeacea var. tillaeacea	+	<0.05m	CU17.21
Triodia epactia	5%	<0.2m	CU17.15

## Cundaline

## Site CU18

**Described by** BC **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Eastern section of project area, North of road.

**MGA Zone** 51 **207979 mE** **7723748 mN**

**Habitat** Hilltop and spur between two hills.

**Soil** Orange/brown loam with surface covered with pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana scattered trees over Acacia inaequilatera, Hakea lorea subsp. lorea and Grevillea pyramidalis subsp. leucadendron open shrubland over Carissa lanceolata, Indigofera trita and Triumfetta clementii low open shrubland over Triodia wiseana very open hummock grassland over Eriachne mucronata (typical form) very open tussock grassland over Goodenia stobbsiana very open herbland.

**Vegetation Condition** Excellent.

**Fire Age** Young.

**Notes** Disturbance type: Nil.  
Aspect: N/A.  
Bare ground: 90%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Abutilon dioicum	+		0.2m	CU18.32	
	Abutilon dioicum	+		0.7m	CU18.19	
	Acacia adoxa var. adoxa	+		0.2m	CU25.19	
	Acacia inaequilatera	2%		2m	CA01.01	
	Acacia ptychophylla	+		0.3m	CU20.03	
	Alysicarpus muelleri	+		0.4m	CU18.16	
	Atalaya hemiglauca	1%		<1m	CU18.24	
	Boerhavia coccinea	+		CR	CU18.23	
	Bonamia media var. villosa	+		<0.1m	CU18.08	
	Carissa lanceolata	1%		1m	CU18.20	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.3m	CA05.01	
	Corymbia hamersleyana	1%		2m	CU37.05	
	Cymbopogon ambiguus	1%		0.6m	CU18.22	
	Eriachne lanata	1%		0.3m	CU18.03	
	Eriachne lanata	1%		0.3m	CU18.02	
	Eriachne mucronata (typical form)	1%		<0.4m	CU18.17	
	Eriachne mucronata (typical form)	1%		<0.3m	CU18.29	
	Eucalyptus leucophloia subsp. leucophloia	+		<3m	CU18.27	
	Euphorbia tannensis subsp. eremophila	+		0.5m	CU18.14	
	Gomphrena cunninghamii	+		0.2m	CU18.12	
	Goodenia stobbsiana	1%		<0.2m	CU18.06	
	Grevillea pyramidalis subsp. leucadendron	1%		1.5m	CU18.18	
	Hakea lorea subsp. lorea	1%		2m	CU18.01	
	Hibiscus aff. coatesii (MET 15 305)	+		0.2m	CU18.05	
	Indigofera trita	1%		0.3m	CU18.10	
	Mukia maderaspatana	+		CR	CU18.13	
	Ptilotus calostachyus var. calostachyus	+		<0.5m	CA04.04	
	Rhynchosia minima var. australis	+		CR	CU18.21	
	Senna artemisioides subsp. oligophylla	+		0.4m	CU18.09	
	Senna glutinosa subsp. glutinosa	+		0.4m	CA04.20	
	Senna notabilis	+		0.2m	CA07.05	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.1m	CU18.31	
	Solanum dioicum	+		<0.2m	CU18.07	
	Solanum dioicum	+		0.3m	CA06.05	



Solanum diversiflorum	+	0.2m	CU26.12
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	1%	0.2m	CU18.04
Themeda triandra	+	0.3m	CU18.25
Tribulus platypterus	+	0.5m	CU18.11
Triodia wiseana	+	0.2m	CU18.28
Triodia wiseana	7%	<0.3m	CU18.26
Triumfetta clementii	1%	<0.2m	CU18.15
Triumfetta clementii	+	0.2m	CU18.30

## Cundaline

Site CU19

**Described by** KC **Date** 30/03/2008 **Type** Q 100 x 25 m

**Location** Cundaline.

**MGA Zone** 51 208202 mE 7723571 mN

**Habitat** Drainage line.

**Soil** Orange brown loam with some clay.

**Rock Type** Ironstone, shale and silicates.

**Vegetation** Corymbia hamersleyana scattered low trees over Acacia tumida var. pilbarensis, Acacia pyrifolia and Acacia colei var. colei shrubland over Tephrosia aff. rosea (HD292-37) low shrubland over Triodia epactia very open hummock grassland over Pluchea rubelliflora and Stemodia grossa very open herbland.

**Vegetation Condition** Very good.

**Fire Age** Young.

**Notes** Disturbance type: Track 200 m away.  
Aspect: West.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, 2% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Abutilon aff. hannii	+		1m	CU19.33	
	Acacia adoxa var. adoxa	+		0.3m	CU19.51	
	Acacia bivenosa	+		0.8m	CU19.41	
	Acacia colei var. colei	3%		1.5m	CU19.49	
	Acacia pyrifolia	5%		1.5m	CU19.05	
	Acacia tumida var. pilbarensis	10%		1.5m	CU19.22	
	Amaranthus aff. pallidiflorus (WC148-11)	+		0.4m	CU19.46	
	Brachyachne convergens	+		0.4m	CU19.45	
	Cassutha filiformis	+		0.3m	CU19.40	
	Chloris virgata	1%		0.6m	CU19.30	
	Cleome viscosa	+		0.6m	CU19.42	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		1m	CU19.35	
	Corymbia aff. hamersleyana	1%		6m	CU19.48	
	Corymbia hamersleyana	+		4m	CU19.57	
	Corymbia hamersleyana	1%		8m	CU19.47	
	Cucumis melo subsp. agrestis	+		0.2m	CU19.34	
	Cyperus vaginatus	+		0.4m	CU19.16	
	Digitaria sp.	+		0.4m	CU19.23	
	Eragrostis cumingii	+		0.2m	CU19.26	
	Eragrostis tenellula	+		<0.1m	CU19.19	
	Eulalia aurea	+		0.5m	CU19.31	
	Euphorbia biconvexa	+		0.5m	CU19.44	
	Euphorbia coghlani	+		0.1m	CU19.43	
	Gomphrena affinis subsp. pilbarensis	+		0.4m	CU19.54	
	Gossypium robinsonii	1%		1m	CU19.27	
	Grevillea wickhamii subsp. hispidula	+		0.4m	CU19.04	
	Hibiscus sturtii var. campyloclamyd	+		0.8m	CU19.36	
	Hybanthus aurantiacus	+		0.4m	CU19.53	
	Hybanthus aurantiacus	+		0.8m	CU19.38	
	Hybanthus aurantiacus	+		0.1m	CU19.18	
	Hybanthus aurantiacus	+		0.5m	CU19.37	
	Indigofera monophylla (small calyx form)	+		0.4m	CU19.08	
	Isotropis atropurpurea	+		0.3m	CU19.56	
	Mollugo molluginea	+		0.2m	CU19.55	
	Paspalidium rarum	+		0.2m	CU19.17	



Pluchea rubelliflora	4%	0.3m	CU19.10
Polymeria ambigua	+	0.2m	CU19.24
Polymeria calycina	+	0.2m	CU19.25
Polymeria sp. (site 1365)	+	0.1m	CU19.52
Pterocaulon sphaeranthoides	+	0.2m	CU19.14
Ptilotus calostachyus var. calostachyus	1%	0.8m	CU19.09
Senna notabilis	+	0.3m	CU19.39
Sida aff. fibulifera (Site 1308)	+	0.3m	CU19.28
Sida pilbarensis (ferruginous form)	+	0.3m	CU19.12
Solanum dioicum	+	0.3m	CU19.02
Solanum diversiflorum	+	0.4m	CU19.03
Sporobolus australasicus	+	0.2m	CU19.20
Sporobolus australasicus	+	0.2m	CU19.21
Sporobolus australasicus	+	0.3m	CU19.32
Stemodia grossa	3%	0.5m	CU19.11
Stemodia grossa	+	0.4m	CU19.29
Tephrosia aff. rosea (HD292-37)	2%	1m	CU19.13
Tephrosia aff. rosea (HD292-37)	+	0.3m	CU19.06
Tephrosia aff. rosea (HD292-37)	20%	1m	CU19.50
Tephrosia aff. supina	+	0.3m	CU19.07
Triodia epactia	10%	0.5m	CU19.01
Triumfetta clementii	+	0.2m	CU19.15

## Cundaline

Site CU20

Described by BC Date 29/03/2008 Type Q 50 x 50 m

### Location

MGA Zone 51 208279 mE 7723261 mN

Habitat Undulating plain at the base of a low hillslope.

Soil Red/brown loam, surface covered with pebbles and cobbles.

Rock Type Ironstone.

Vegetation Corymbia hamersleyana low open woodland over Acacia inaequilatera open shrubland over Triodia wiseana very open hummock grassland.

Vegetation Condition Excellent.

Fire Age Young/recent.

Notes Disturbance type: Nil.  
Aspect: N/A, undulating.  
Bare ground: 90%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.3m	CU25.19	
	Acacia inaequilatera	2%		0.5-2m	CA01.01	
	Acacia ptychophylla	+		0.3m	CU20.03	
	Cleome uncifera subsp. uncifera	+		0.2m	CA01.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.2m	CA05.01	
	Corymbia hamersleyana	5%		6m	CU24.01	
	Dampiera candidans	+		0.3m	CA07.04	
	Euphorbia aff. australis	+		0.1m	CU20.04	
	Fimbristylis simulans	+		0.2m	CU20.07	
	Goodenia stobbsiana	+		0.1m	CU23.27	
	Grevillea pyramidalis subsp. leucadendron	+		<0.5m	CA04.09	
	Grevillea wickhamii subsp. hispidula	+		0.2m	CA07.02	
	Hibiscus sturtii var. campylochlamys	+		0.5m	CU20.06	
	Hibiscus sturtii var. campylochlamys	+		0.2m	CU20.02	
	Ptilotus calostachyus var. calostachyus	+		0.4m	CA04.04	
	Ptilotus fusiformis var. fusiformis	+		0.3m	CU26.05	
	Sida pilbarensis (ferruginous form)	+		0.3m	CU20.05	
	Solanum cunninghamii	+		0.3m	CU26.14	
	Solanum diversiflorum	+		0.3m	CU26.12	
	Stemodia grossa	+		0.4m	CU15.12	
	Triodia epactia	+		0.3m	CU25.18	
	Triodia wiseana	7%		<0.3m	CU20.01	
	Triumfetta clementii	+		0.3m	CU20.08	



## Cundaline

Site CU21

**Described by** TE **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 207995 mE 7722853 mN

**Habitat** Hillcrest.

**Soil** Red/brown loam with cobbles and pebbles, some exposed rocks.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana scattered low trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Acacia ptychophylla low open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: N/A.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	5%		<0.5m	CU21.01	
	Acacia pyrifolia	+		2-5m	CU21.04	
	Acacia tumida var. pilbarensis	2%		2-3m	CU21.07	
	Aristida holathera var. latifolia	+		<0.1m	CU21.09	
	Cassytha capillaris	+		CL	CU21.15	Op.
	Corymbia hamersleyana	1%		5m	CU21.05	
	Dampiera candidans	+		0.5m	CU07.04	
	Eriachne lanata	+		0.5m	CU21.03	
	Euphorbia sp.	+		<0.1m	CU21.10	
	Fimbristylis simulans	+		<0.1m	CU21.08	
	Grevillea wickhamii subsp. hispidula	15%		2-3m	CA18.02	
	Hybanthus aurantiacus	+		0.4m	CU21.11	
	Hybanthus aurantiacus	+		1-2m	CU21.12	
	Mollugo molluginea	+		<0.1m	CA04.06	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU19.09	
	Solanum beagleholei	+		0.5m	CU21.06	
	Solanum dioicum	+		<0.5m	CU21.14	Op.
	Stemodia grossa	+		<0.5m	CU15.12	Op.
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Triodia epactia	40%		0.5m	CU21.02	

## Cundaline

Site CU22

Described by JSF Date 29/03/2008 Type Q 100 x 25 m

### Location

MGA Zone 51 208396 mE 7722731 mN

Habitat Upper hillslope.

Soil Skeletal soil with exposed bedrock.

Rock Type Ironstone.

Vegetation Corymbia hamersleyana scattered low trees over Acacia pyrifolia, Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis open low shrubland over Eriachne mucronata and Eriachne lanata very open tussock grassland over Pterocaulon serrulatum open herbland.

Vegetation Condition Excellent.

Fire Age Young.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 60%  
Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	+		0.3m	CU02.09	
	Acacia pyrifolia	5%		0.8m	CU22.03	
	Acacia pyrifolia	+		0.8m	CU16.25	
	Acacia tumida var. pilbarensis	1%		0.5m	CA13.01	
	Amaranthus sp.	+		0.05m	CU16.16	
	Corymbia hamersleyana	1%		2m	CA19.01	
	Cyperus cunninghamii subsp. cunninghamii	+		0.1m	CU16.18	
	Cyperus cunninghamii subsp. cunninghamii	+		0.3m	CU16.22	
	Cyperus cunninghamii subsp. cunninghamii	+		0.2m	CU16.23	
	Dampiera candidans	2%		0.3m	CU13.04	
	Eriachne ciliata	+		0.3m	CU16.24	
	Eriachne lanata	2%		0.3m	CU22.02	
	Eriachne lanata	+		0.05m	CU22.05	
	Eriachne mucronata (typical form)	2%		0.3m	CU22.06	
	Ficus platypoda	+		0.8m	CU16.29	
	Fimbristylis simulans	+		0.1m	CU22.04	
	Gomphrena cunninghamii	+		0.2m	CU16.27	
	Goodenia microptera				CU22.07	
	Goodenia stobbsiana	+		0.1m	CU18.06	
	Grevillea wickhamii subsp. hispidula	4%		0.5m	CA07.02	
	Indigofera monophylla (small calyx form)	2%		0.3m	CU12.28	
	Mollugo molluginea	+		0.1m	CA19.07	
	Oldenlandia crouchiana	+		0.05m	CU16.19	
	Pluchea tetranthera	+		0.1m	CU03.12	
	Pluchea tetranthera	+		0.5m	CU16.21	
	Pterocaulon serrulatum	20%		0.4m	CU16.26	
	Ptilotus fusiformis var. fusiformis	+		0.1m	CU16.17	
	Ptilotus fusiformis var. fusiformis	+		0.2m	CU16.28	
	Solanum beaugleholei	+		0.5m	CU16.20	
	Solanum beaugleholei	+		0.3m	CU16.20	
	Solanum dioicum	1%		0.2m	CU16.09	
	Solanum dioicum	1%		0.4m	CU22.01	
	Solanum diversiflorum	+		0.2m	CU26.12	
	Tephrosia aff. rosea (HD292-37)	1%		0.2m	CU02.17	
	Trachymene oleracea subsp. oleracea	+		1m	CU16.31	
	Triumfetta maconochieana	+		0.2m	CU16.30	



<b>Cundaline</b>		<b>Site</b>	CU23		
<b>Described by</b>	KC	<b>Date</b>	29/03/2008	<b>Type</b>	Q 100 x 25 m
<b>Location</b>	Cundaline.				
<b>MGA Zone</b>	51		208455 mE		7722387 mN
<b>Habitat</b>	Drainage line.				
<b>Soil</b>	Yellow/brown loam with some clay.				
<b>Rock Type</b>	Ironstone.				
<b>Vegetation</b>	Corymbia flavescens scattered low trees over Acacia tumida var. pilbarensis and Grevillea wickhamii subsp. hispidula open scrub over Acacia ptychophylla open shrubland over Triodia epactia and Triodia biflora hummock grassland.				
<b>Vegetation Condition</b>	Very good.				
<b>Fire Age</b>	Moderate.				
<b>Notes</b>	Disturbance type: Track 150 m away. Aspect: East. Bare ground: 40%. Litter cover: 1% Logs, 5% Twigs, 10% Leaves.				

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	1%		1m	CU23.03	
	Acacia tumida var. pilbarensis	30%		5m	CU23.02	
	Bulbostylis barbata	+		0.1m	CU23.22	
	Bulbostylis barbata	+		0.2m	CU23.17	
	Bulbostylis turbinata	+		0.2m	CU23.20	
	Corymbia aff. hamersleyana	+		3m	CU23.31	
	Corymbia flavescens	+		3m	CU23.32	
	Cymbopogon ambiguus	+		1m	CU23.09	
	Cyperus cunninghamii subsp. cunninghamii	+		0.2m	CU23.19	
	Cyperus cunninghamii subsp. cunninghamii	+		0.3m	CU23.23	
	Cyperus cunninghamii subsp. cunninghamii	+		0.2m	CU23.25	
	Cyperus pulchellus	+		0.2m	CU23.10	
	Cyperus pulchellus	+		<0.1m	CU23.14	
	Dampiera candidans	+		0.3m	CU23.30	
	Eragrostis cumingii	+		0.1m	CU23.15	
	Eriachne ciliata	+		0.2m	CU23.24	
	Eriachne mucronata (typical form)	+		0.4m	CU23.21	
	Fimbristylis microcarya	+		0.2m	CU23.13	
	Goodenia stobbsiana	+		0.1m	CU23.27	
	Grevillea wickhamii subsp. hispidula	5%		3m	CU23.04	
	Indigofera monophylla (small calyx form)	+		1m	CU23.06	
	Polycarpaea involucrata	+		0.1m	CU23.18	
	Polycarpaea involucrata	+		0.1m	CU23.16	
	Rotala diandra	+		0.1m	CU23.11	
	Sida subarticulata	+		1m	CU23.08	
	Sida subarticulata	+		1.5m	CU23.05	
	Solanum dioicum	+		0.4m	CU23.07	
	Synaptantha tillaeacea var. tillaeacea	+		<0.1m	CU23.12	
	Templetonia hookeri	+		2m	CU23.33	
	Tinospora smilacina	+		0.3m	CU23.34	
	Triodia biflora	5%		1m	CU23.28	
	Triodia epactia	25%		1.5m	CU23.01	
	Triumfetta plumigera	+		0.5m	CU23.29	

## Cundaline

Site CU24

**Described by** BC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** South of rail, eastern section of project area.

**MGA Zone** 51 208904 **mE** 7722887 **mN**

**Habitat** Plain at bottom of small hillslopes.

**Soil** Red/brown loam surface covered with pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana low open woodland over Grevillea wickhamii subsp. hispidula and Acacia inaequilatera scattered tall shrubs over Acacia ptychophylla, Senna glutinosa subsp. glutinosa and Acacia adoxa var. adoxa low open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: North.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	1%		<0.5m	CU25.19	
	Acacia bivenosa	+		1m	CU27.01	
	Acacia colei var. colei	+		1.5m	CU27.03	
	Acacia inaequilatera	1%		0.8m	CA04.01	
	Acacia ptychophylla	3%		0.5-1m	CA06.11	
	Bonamia media var. villosa	+		<0.1m	CU24.05	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.3m	CA05.01	
	Corymbia hamersleyana	10%		2-4m	CU24.01	
	Grevillea pyramidalis subsp. leucadendron	+		1.5m	CA04.09	
	Grevillea wickhamii subsp. hispidula	1%		5m	CA06.01	
	Indigofera monophylla (small calyx form)	+		0.3m	CU24.03	
	Mollugo molluginea	+		0.1m	CA04.06	
	Ptilotus astrolasius var. astrolasius	+		0.3m	CU24.04	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA04.04	
	Senna glutinosa subsp. glutinosa	1%		0.7m	CA04.20	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.4m	CU24.02	
	Solanum dioicum	+		0.4m	CA06.05	
	Triodia epactia	55%		<0.5m	CU24.06	



## Cundaline

Site CU25

**Described by** BC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Eastern 'strip' section of project area, North of road.

**MGA Zone** 51 **209286 mE** **7723161 mN**

**Habitat** Drainage line.

**Soil** Red/brown clayey loam.

**Rock Type** None.

**Vegetation** Corymbia hamersleyana low open woodland over Grevillea wickhamii subsp. hispidula, Pluchea tetranthera and Senna notabilis low shrubland over mixed scattered tussock grasses over Bonamia pannosa very open herbland.

**Vegetation Condition** Very good.

**Fire Age** Young.

**Notes** Disturbance type: Some cow dung and tracks.

Aspect: North.

Bare ground: 80%.

Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	assoc		0.3m	CU25.19	
	Acacia tumida var. pilbarensis	+		0.5m	CA07.07	
	Aristida holathera var. latifolia	+		0.2m	CU25.06	
	Aristida holathera var. latifolia	+		0.3m	CU27.13	
	Boerhavia coccinea	+		CR	CU25.02	
	Bonamia pannosa	1%		CR	CU25.01	
	Brachyachne convergens	+		0.2m	CU25.17	
	Bulbostylis barbata	+		0.1m	CU25.12	
	Cleome uncifera subsp. uncifera	+		0.3m	CA04.05	
	Cleome viscosa	+		0.4m	CU02.31	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.3m	CU26.08	
	Corymbia hamersleyana	5%		3-8m	CA03.01	
	Dampiera candidans	+		0.4m	CA07.04	
	Dysphania rhadinostachya subsp. rhadinostachya	+		0.1m	CU25.09	
	Eragrostis cumingii	+		0.1m	CU25.14	
	Eriachne aristidea	+		0.1m	CU25.08	
	Eriachne aristidea	+		0.2m	CU25.16	
	Euphorbia coghlani	+		0.1m	CU25.10	
	Goodenia microptera	+		0.2m	CU25.04	
	Grevillea pyramidalis subsp. leucadendron	assoc		1-2m	CA04.09	
	Grevillea wickhamii subsp. hispidula	15%		0.5m	CA07.02	
	Hybanthus aurantiacus	+		0.2m	CU26.04	
	Indigofera trita	+		0.1m	CU25.07	
	Mollugo molluginea	+		0.2m	CA04.06	
	Paraneurachne muelleri	+		0.4m	CU25.03	
	Pluchea tetranthera	2%		0.4m	CA07.10	
	Portulaca oleracea	+		0.1m	CU25.13	
	Pterocaulon sphacelatum	+		0.4m	CU27.06	
	Ptilotus axillaris	+		CR	CU25.05	
	Ptilotus fusiformis var. fusiformis	+		0.3m	CU26.05	
	Senna notabilis	1%		0.3m	CA07.05	
	Sida pilbarensis (ferruginous form)	+		0.3m	CU26.07	
	Solanum cunninghamii	+		0.6m	CU26.14	
	Sporobolus australasicus	+		0.1m	CU25.11	
	Stemodia grossa	+		0.5m	OPCA.02	

Stemodia grossa	+	0.3m	CU15.12
Triodia epactia	+	0.3m	CU25.18
Yakirra australiensis var. australiensis	+	0.1m	CU25.15



## Cundaline

Site CU26

**Described by** BC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Eastern 'strip' section of project area, North of road.

**MGA Zone** 51 209758 mE 7722872 mN

**Habitat** Floodplain.

**Soil** Red/brown clayey loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and quartz.

**Vegetation** Corymbia hamersleyana low open woodland over Acacia pyrifolia scattered shrubs over Ptilotus calostachyus var. calostachyus and Indigofera monophylla (Burrup form) low open shrubland over Triodia epactia very open hummock grassland over Solanum diversiflorum and Mollugo molluginea very open herbland.

**Vegetation Condition** Very good.

**Fire Age** Young.

**Notes** Disturbance type: Road 100 m away, cow dung.  
Aspect: East.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, 2% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		0.4m	CU27.03	
	Acacia pyrifolia	1%		1m	CU02.10	
	Boerhavia gardneri	+		CR	CA04.17	
	Bonamia pannosa	+		0.1m	CU26.02	
	Bonamia pannosa	+		CR	CU26.06	
	Carissa lanceolata	+		1m	CU26.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.2m	CA05.01	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	1%		<0.2m	CU26.09	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.2m	CU26.08	
	Corymbia hamersleyana	2%		5m	CA03.01	
	Crotalaria medicaginea	+		0.1m	CU26.10	
	Dampiera candidans	+		0.3m	CA07.04	
	Euphorbia aff. australis	+		0.1m	CU26.15	
	Euphorbia clementii	+		0.3m	CU26.17	
	Goodenia microptera	+		0.1m	CU26.16	
	Goodenia muelleriana	+		0.3m	CU26.11	
	Hakea chordophylla	+		2m	CU01.18	
	Hybanthus aurantiacus	+		0.3m	CU26.04	
	Indigofera monophylla (Burrup form)	1%		0.3m	CU26.01	
	Mollugo molluginea	1%		<0.2m	CA04.06	
	Pluchea tetranthera	+		0.2m	CA07.10	
	Ptilotus calostachyus var. calostachyus	1%		0.5m	CA04.04	
	Ptilotus fusiformis var. fusiformis	+		0.4m	CU26.05	
	Senna notabilis	+		0.2m	CA07.05	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.2m	CA03.15	
	Sida pilbarensis (ferruginous form)	+		0.3m	CU26.07	
	Solanum cunninghamii	+		0.3m	CU26.14	
	Solanum diversiflorum	1%		0.3m	CU26.12	
	Stemodia grossa	+		0.2m	OPCA.02	
	Triodia epactia	10%		<0.2m	CU26.13	

## Cundaline

Site CU27

**Described by** BC **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Eastern 'strip' sections of project area, North of road.

**MGA Zone** 51 210245 mE 7722586 mN

**Habitat** Rocky plain.

**Soil** Orange/brown clayey loam, surface covered with pebbles and cobbles.

**Rock Type** Mostly quartz, some ironstone.

**Vegetation** Corymbia hamersleyana scattered low trees over Acacia bivenosa and Acacia victoriae open shrubland over Triodia wiseana hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Road 200m South.  
Aspect: N/A.  
Bare ground: 60%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia bivenosa	5%		1-2m	CU27.01	
	Acacia colei var. colei	+		1.5m	CU27.03	
	Acacia inaequilatera	+		2m	CA04.01	
	Acacia sp.	+		0.3m	CU27.08	
	Acacia victoriae	2%		1-2m	CU27.02	
	Aristida holathera var. latifolia	+		0.2m	CU27.13	
	Bonamia linearis	+		0.1m	CA03.12	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.1m	CA05.01	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.1m	CU27.09	
	Corymbia hamersleyana	1%		2m	CU27.04	
	Pluchea rubelliflora	+		0.3m	CU27.05	
	Pluchea tetranthera	+		0.5m	CA03.10	
	Pluchea tetranthera	+		0.15m	CU27.07	
	Pterocaulon sphacelatum	+		0.2m	CU27.06	
	Scaevola amblyanthera var. centralis	+		0.1m	CU27.10	
	Senna notabilis	+		0.2m	CA07.05	
	Sida rohlenae subsp. rohlenae	+		0.2m	CU27.12	
	Triodia wiseana	40%		<0.4m	CU27.11	

## Cundaline

Site CU28

**Described by** TE **Date** 30/03/2008 **Type** Q 25 x 100 m

**Location** Cundaline plain.

**MGA Zone** 51 205052 mE 7724296 mN

**Habitat** Plain with minor drainage line.

**Soil** Red/brown loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Grevillea wickhamii subsp. hispidula high open shrubland over Acacia stellaticeps open shrubland over Dampiera candidans and Leptosema anomalum scattered low shrubs over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: South.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU08.04	
	Acacia pyrifolia	+		2m	CU28.08	
	Acacia stellaticeps	5%		0.5-1.5m	CU28.01	
	Aristida holathera var. latifolia	+		0.5m	CU27.13	
	Bonamia linearis	+		<0.1m	CU28.07	
	Dampiera candidans	1%		0.5m	CU07.04	
	Eriachne obtusa	+		0.5m	CU28.04	
	Eriachne sp. Port Hedland	+		0.2m	CU28.05	
	Fimbristylis simulans	+		<0.1m	CU28.06	
	Flaveria australasica	+		<0.1m	CU28.10	
	Grevillea pyramidalis subsp. leucadendron	+		2m	CA12.06	
	Grevillea wickhamii subsp. hispidula	2%		2-3m	CA18.02	
	Hybanthus aurantiacus	+		0.2m	CU28.11	
	Leptosema anomalum	1%		0.3m	CU28.02	
	Phyllanthus maderaspatensis	+		0.3m	CU28.13	
	Pluchea tetranthera	+		0.5m	CA12.16	
	Ptilotus calostachyus var. calostachyus	+		0.2m	CU19.09	
	Stemodia viscosa	+		0.3m	CU28.12	
	Triodia epactia	35%		0.5m	CU28.03	



## Cundaline

Site CU29

**Described by** BC **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Western section of flats.

**MGA Zone** 51 205331 mE 7724131 mN

**Habitat** Plain.

**Soil** Orange/brown loam, surface with scattered cobbles and boulders.

**Rock Type** Ironstone and quartz.

**Vegetation** Grevillea pyramidalis subsp. leucadendron and Grevillea wickhamii subsp. hispidula open shrubland over Acacia ptychophylla, Acacia adoxa var. adoxa and Tephrosia aff. rosea (HD292-37) low shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: South.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	10%		0.5m	CU25.19	
	Acacia ptychophylla	12%		0.5m	CA06.11	
	Acacia ptychophylla	1%		0.6m	CU20.03	
	Acacia spondylophylla	+		0.6m	RELCA01.01	
	Acacia stellaticeps	1%		0.5m	CU29.09	
	Aristida holathera var. holathera	+		0.2m	CU29.08	
	Bonamia media var. villosa	+		<0.05m	CU18.08	
	Bonamia media var. villosa	+		CR	CU29.13	
	Cleome uncifera subsp. uncifera	+		0.3m	CU29.11	
	Cleome uncifera subsp. uncifera	+		0.2m	CA04.05	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	3%		0.3m	CA05.01	
	Dampiera candidans	+		0.5m	CA07.04	
	Eriachne mucronata (typical form)	+		0.3m	CU18.17	
	Eriachne sp. Port Hedland	+		0.3m	CU29.07	
	Goodenia microptera	+		0.4m	CU29.04	
	Grevillea pyramidalis subsp. leucadendron	2%		2m	CA06.02	
	Grevillea wickhamii subsp. hispidula	3%		1.5-2m	CA07.02	
	Hybanthus aurantiacus	1%		0.3m	CU26.04	
	Indigofera monophylla (small calyx form)	+		0.3m	CU29.12	
	Indigofera monophylla (small calyx form)	+		0.3m	CA01.05	
	Indigofera monophylla (small calyx form)	1%		0.3m	CU17.03	
	Mollugo molluginea	+		0.1m	CA04.06	
	Phyllanthus maderaspatensis	+		0.2m	CU29.05	
	Phyllanthus maderaspatensis	+		0.3m	CU29.02	
	Pterocaulon sphacelatum	+		0.1m	CU27.06	
	Ptilotus fusiformis var. fusiformis	+		0.3m	CU17.10	
	Solanum dioicum	+		0.3m	CU29.01	
	Stemodia grossa	+		0.2m	CU15.12	
	Stemodia viscosa	+		0.2m	CU29.06	
	Tephrosia aff. rosea (HD292-37)	2%		0.8m	CU29.03	
	Triodia epactia	50%		<0.5m	CU29.10	

## Cundaline

Site CU30

**Described by** TE **Date** 29/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 207367 mE 7723463 mN

**Habitat** Hilltop.

**Soil** Red/brown loam, surface with exposed bedrock.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana scattered low trees over Grevillea wickhamii subsp. hispidula and Acacia tumida var. pilbarensis high shrubland over Acacia tumida var. pilbarensis low open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: N/A.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia pyrifolia	+		1m	CU21.04	
	Acacia tumida var. pilbarensis	1%		3m	CU21.07	
	Acacia tumida var. pilbarensis	3%		<0.5m	CU21.07	
	Corymbia hamersleyana	1%		8m	CA09.09	
	Dampiera candidans	+		<0.5m	CU07.04	
	Eriachne lanata	+		<0.1m	CU21.03	
	Grevillea wickhamii subsp. hispidula	25%		2-3m	CA18.02	
	Hakea chordophylla	+		3m	CU01.18	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CU19.09	
	Senna glutinosa subsp. glutinosa	+		1.5m	CU12.23	
	Solanum beagleholei	+		0.7m	CU30.02	
	Solanum beagleholei	+		<0.5m	CU11.03	
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Triodia epactia	40%		0.6m	CU30.01	

## Cundaline

Site CU31

**Described by** TE **Date** 29/03/2008 **Type** Q 25 x 100 m

**Location** Cundaline.

**MGA Zone** 51 205247 mE 7725584 mN

**Habitat** Drainage line at base of hills and breakaway.

**Soil** Red/brown skeletal soil, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Eucalyptus leucophloia subsp. leucophloia open woodland over Acacia tumida var. pilbarensis high open shrubland over Grevillea wickhamii subsp. hispidula and Acacia adoxa var. adoxa low shrubland over Triodia biflora hummock grassland over Cymbopogon procerus scattered tussock grasses.

**Vegetation Condition** Excellent.

**Fire Age** Very old.

**Notes** Disturbance type: Nil.

Aspect: N/A.

Bare ground: 60%.

Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	2%		0.5-1m	CU31.04	
	Acacia ptychophylla	+		0.5-1m	CU21.01	
	Acacia tumida var. pilbarensis	5%		3-5m	CU31.01	
	Aristida holathera var. latifolia	+		0.5m	CU31.13	
	Cajanus cinereus	+		0.5m	CU31.12	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.6m	CU31.16	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.6m	CU31.03	
	Cymbopogon procerus	1%		1m	CU31.10	
	Cyperus cunninghamii subsp. cunninghamii	+		0.3m	CU31.14	
	Dampiera candidans	+		0.3m	CU07.04	
	Desmodium filiforme	+		CL	CA02.16	
	Eriachne ciliata	+		<0.1m	CU31.06	
	Eriachne lanata	+		0.4m	CU31.15	
	Eriachne mucronata	+		0.5m	CU13.06	
	Eriachne sp. Port Hedland	+		<0.1m	CU31.11	
	Eucalyptus leucophloia subsp. leucophloia	10%		5-15m	CU13.03	
	Fimbristylis simulans	+		<0.1m	CU31.05	
	Grevillea wickhamii subsp. hispidula	10%		0.5m	CA18.02	
	Hibiscus sturtii var. campylochlamys	+		0.3m	CU31.09	
	Phyllanthus maderaspatensis	+		<0.1m	CU31.08	
	Ptilotus astrolasius var. astrolasius	+		0.5m	CU08.10	
	Senna glutinosa subsp. glutinosa	+		1m	CU12.23	
	Solanum dioicum	+		0.5m	CU31.07	
	Triodia biflora	30%		0.8m	CU31.02	



## Cundaline

Site CU32

**Described by** KC **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 204393 mE 7726245 mN

**Habitat** Hillslope.

**Soil** Red/brown loam surface covered with cobbles and pebbles.

**Rock Type** Ironstone.

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

**Vegetation Condition** Excellent.

**Fire Age** Moderate.

**Notes** Disturbance type: Nil.  
Aspect: East.  
Bare ground: 50%.  
Litter cover: + Logs, 2% Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia inaequilatera	3%		1m	CU32.02	
	Acacia inaequilatera	2%		2m	CU32.08	
	Acacia ptychophylla	+		0.5m	CU32.07	
	Boerhavia gardneri	+		0.3m	CU32.18	
	Bonamia media var. villosa	+		0.1m	CU32.15	
	Bonamia sp.	+		0.1m	CU32.16	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.4m	CU32.10	
	Corymbia sp.	+		1m	CU32.14	
	Eucalyptus leucophloia subsp. leucophloia	+		4m	CU32.13	
	Eucalyptus leucophloia subsp. leucophloia	+		4m	CU32.12	
	Mollugo molluginea	+		0.1m	CU32.03	
	Mollugo molluginea	+		0.1m	CU32.09	
	Mollugo molluginea	+		0.1m	CU32.17	
	Rhynchosia minima var. australis	+		0.4m	CU32.19	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.2m	CU32.04	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.2m	CU32.11	
	Tephrosia aff. supina	+		0.1m	CU32.06	
	Tephrosia aff. supina	+		0.1m	CU32.05	
	Triodia wiseana	40%		0.5m	CU32.01	

## Cundaline

Site CU33

Described by TE Date 30/03/2008 Type Q 50 x 50 m

Location Cundaline.

MGA Zone 51 206238 mE 7724988 mN

Habitat Plain.

Soil Red loam, surface covered with pebbles and cobbles.

Rock Type Ironstone.

Vegetation Corymbia hamersleyana scattered low trees over Acacia inaequilatera high open shrubland over Tephrosia spechtii scattered shrubs over Triodia epactia hummock grassland.

Vegetation Condition Very good.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU08.04	
	Acacia elachantha (silvery hairy variant)	+		2m	CU33.10	
	Acacia inaequilatera	3%		2-3m	CA18.05	
	Acacia ptychophylla	+		0.5m	CU21.01	
	Aristida holathera var. holathera	+		<0.1m	CU33.02	
	Bonamia sp. (HD94-6)	+		0.1m	CU33.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CU33.04	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.6m	CU33.04	
	Corymbia flavescens				TECU06	Op. photo 10:06
	Corymbia hamersleyana	1%		3-5m	CA11.01	
	Eriachne mucronata (typical form)	+		<0.3m	CU33.09	
	Euphorbia sp. (site 1089)	+		<0.1m	CU33.08	
	Fimbristylis simulans	+		0.1m	CU33.02	
	Goodenia muelleriana	+		<0.1m	CU33.11	
	Mollugo molluginea	+		<0.1m	CA12.10	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA04.04	
	Solanum diversiflorum	+		<0.1m	CU26.12	
	Tephrosia aff. rosea (HD292-37)	+		0.5m	CU33.05	
	Tephrosia aff. supina	+		<0.1m	CA11.05	
	Tephrosia spechtii	1%		1-2m	CU33.07	
	Triodia epactia	50%		0.5m	CU33.01	
	Triumfetta clementii	+		0.2m	CU33.06	

## Cundaline

Site CU34

Described by TE Date 30/03/2008 Type Q 50 x 50 m

Location Cundaline.

MGA Zone 51 206005 mE 7725087 mN

Habitat Breakaway.

Soil Red/brown skeletal loam surface covered with pebbles and cobbles. Exposed bedrock.

Rock Type Ironstone.

Vegetation Corymbia hamersleyana and Eucalyptus leucophloia subsp. leucophloia low open woodland over Acacia inaequilatera open shrubland over Acacia ptychophylla low scattered shrubs over Triodia epactia open hummock grassland.

Vegetation Condition Very good.

Fire Age Old.

Notes Disturbance type: Nil.  
Aspect: North.  
Bare ground: 60%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	+		0.5m	CU08.04	
	Acacia inaequilatera	5%		1-1.5m	CA18.05	
	Acacia ptychophylla	1%		0.5m	CU21.01	
	Acacia tumida var. pilbarensis	+		1-2m	CU07.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CU33.04	
	Corymbia hamersleyana	1%		6m	CA11.01	
	Cymbopogon ambiguus	+		0.3m	CU34.05	
	Dampiera candidans	+		0.5m	CU07.04	
	Eriachne lanata	+		0.1m	CU21.03	
	Eriachne lanata	+		<0.1m	CU34.01	
	Eriachne mucronata	20%		0.5m	CU13.06	
	Eucalyptus leucophloia subsp. leucophloia	1%		6m	TEOPCO6	
	Grevillea wickhamii subsp. hispidula	+		0.6m	CA18.02	
	Hibiscus aff. coatesii (MET 15 305)	+		0.5m	CU34.04	
	Indigofera monophylla (small calyx form)	+		0.5m	CU11.05	
	Senna glutinosa subsp. glutinosa	+		1-2m	CU12.23	
	Sida subarticulata	+		2m	CU34.03	
	Solanum phlomoides	+		<0.3m	CA09.06	
	Triodia epactia	25%		0.5m	CU34.02	
	Triumfetta chaetocarpa	+		0.4m	CU34.06	



## Cundaline

Site CU36

**Described by** TE **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Cundaline.

**MGA Zone** 51 205291 mE 7724179 mN

**Habitat** Low rise hillslope.

**Soil** Red/brown skeletal soil surface covered with pebbles and cobbles. Exposed bedrock.

**Rock Type** Ironstone.

**Vegetation** Acacia orthocarpa, Grevillea pyramidalis subsp. leucadendron and Grevillea wickhamii subsp. hispidula high shrubland over Corchorus aff. parviflorus (1)(GLD SRH67-5) and Acacia adoxa var. adoxa low open shrubland over Triodia epactia hummock grassland over Cymbopogon ambiguus scattered tussock grasses.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: South.  
Bare ground: 60%  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	1%		0.5m	CU08.04	
	Acacia orthocarpa	20%		2-3m	CU36.01	
	Aristida inaequiglumis	+		0.5m	CU36.13	
	Cleome viscosa	+		0.5m	CU19.42	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.3m	CA05.01	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.5-1m	CU36.14	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CU33.04	
	Cullen sp.	+		0.6m	CU36.12	
	Cymbopogon ambiguus	1%		0.5m	CU36.09	
	Dampiera candidans	+		0.5m	CU07.04	
	Eriachne lanata	+		0.4m	CU21.03	
	Eriachne mucronata	+		0.5m	CU13.06	
	Eriachne mucronata (typical form)	+		0.3m	CU36.11	
	Eriachne obtusa	+		0.2m	CU36.03	
	Euphorbia wheeleri	+		0.3m	CU36.07	
	Gomphrena cunninghamii	+		<0.1m	CU36.10	
	Grevillea pyramidalis subsp. leucadendron	1%		2-3m	CU11.02	
	Grevillea wickhamii subsp. hispidula	1%		2-3m	CA18.02	
	Hibiscus sturtii var. campylochlamys	+		0.2m	CU36.02	
	Hybanthus aurantiacus	+		CL	CU28.11	
	Indigofera monophylla (small calyx form)	+		0.3m	CU11.05	
	Polymeria calycina	+		0.2m	CU36.06	
	Senna glutinosa subsp. pruinosa	+		0.5m	CU12.23	
	Sida pilbarensis (ferruginous form)	+		0.5m	CU36.05	
	Triodia epactia	40%		0.5m	CU36.04	
	Triumfetta maconochieana	+		0.3m	CU36.08	

## Cundaline

Site CU37

**Described by** BC **Date** 30/03/2008 **Type** Q 50 x 50 m

**Location** Eastern section of project area, South of rail.

**MGA Zone** 51 **207031 mE** **7724188 mN**

**Habitat** Plain at the bottom of hills.

**Soil** Red/brown loam surface covered with pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia hamersleyana low open woodland over Acacia inaequilatera open shrubland over Acacia ptychophylla, Acacia adoxa var. adoxa and Corchorus aff. parviflorus (1)(GLD SRH67-5) over Triodia epactia open hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Moderate.

**Notes** Disturbance type: Nil.  
Aspect: North.  
Bare ground: 50%  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia adoxa var. adoxa	7%		<0.5m	CU25.19	
	Acacia inaequilatera	5%		<2m	CA01.01	
	Acacia ptychophylla	25%		<0.7m	CA06.11	
	Acacia pyrifolia	+		<1m	CU07.02	
	Acacia tumida var. pilbarensis	+		<1m	CU17.05	
	Alysicarpus muelleri	+		0.7m	CU18.16	
	Cleome uncifera subsp. uncifera	+		0.2m	CU37.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	3%		0.4m	CA05.01	
	Corchorus sidoides subsp. aff. vermicularis (GLD NIM17-16)	+		0.4m	CU17.22	
	Corymbia hamersleyana	2%		2m	CU37.05	
	Goodenia stobbsiana	+		0.2m	CU18.06	
	Grevillea pyramidalis subsp. leucadendron	+		0.7m	CA06.02	
	Grevillea wickhamii subsp. hispidula	+		2.5m	CA07.02	
	Hibiscus sturtii var. campylochlamys	+		0.3m	CU17.08	
	Hybanthus aurantiacus	+		0.3m	CU37.04	
	Indigofera monophylla (small calyx form)	1%		0.4m	CA01.04	
	Indigofera monophylla (small calyx form)	+		0.2m	CU37.02	
	Indigofera monophylla (small calyx form)	+		0.4m	CU29.12	
	Indigofera trita	+		0.1m	CU25.07	
	Mollugo molluginea	+		0.1m	CA04.06	
	Ptilotus calostachyus var. calostachyus	1%		0.7m	CU17.01	
	Triodia epactia	15%		<0.3m	CU37.01	

## Cundaline Site Releve

**Described by** TE **Date** 30/03/2008 **Type** R

### Location

**MGA Zone** 50 206397 mE 7724830 mN

**Habitat** Small drainage line.

### Soil

### Rock Type

**Vegetation** Acacia inaequilatera high open shrubland over Acacia ptychophylla low open health over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

### Notes

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Abutilon dioicum	+		0.2m	R01.04	
	Acacia inaequilatera	2%		2-3m	CA18.05	
	Acacia ptychophylla	80%		0.5-1m	CU21.01	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CU33.04	
	Eriachne mucronata	+		0.1m	CU13.06	
	Hybanthus aurantiacus	+		0.3m	R01.02	
	Indigofera monophylla (small calyx form)	+		0.6m	R01.01	
	Senna glutinosa subsp. glutinosa	+		1m	CU12.23	
	Triodia epactia	30%		0.6m	R01.03	
	Triumfetta maconochieana	OPCUTE01A				



## Appendix E2: Callawa Flora Quadrat Data Sheets

### Callawa

Site CA01

Described by BC Date 28/03/2008 Type Q 50 x 50 m

Location East of rail loop, South of stock pile, North-eastern section.

MGA Zone 51 219766 mE 7717027 mN

Habitat Plain.

Soil Orange/brown loam, surface covered with pebbles and cobbles.

Rock Type Ironstone and quartz.

Vegetation Acacia inaequilatera high open shrubland over Acacia ptychophylla and Indigofera monophylla (small calyx form) low open shrubland over Triodia epactia very open hummock grassland.

Vegetation Condition Excellent.

Fire Age Moderate.

Notes Disturbance type: Fence nearby.  
Aspect: South-west.  
Bare ground: 70%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	C Class	Height	Specimen	Notes
	Acacia inaequilatera	2%		1-3m	CA01.01	
	Acacia ptychophylla	4%		<0.5m	CA01.02	
	Acacia victoriae	+		0.2m	CA01.08	
	Bonamia rosea	+		0.2m	CA01.12	
	Cleome uncifera subsp. uncifera	+		0.3m	CA01.03	
	Cleome uncifera subsp. uncifera	+		0.4m	CA04.05	
	Euphorbia sp. (site 1089)	+		0.1m	CA01.14	
	Goodenia microptera	+		0.1m	CA03.13	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CA06.02	
	Grevillea wickhamii subsp. hispidula	+		1m	CA06.01	
	Indigofera monophylla (small calyx form)	+		0.3m	CA01.05	
	Indigofera monophylla (small calyx form)	+		0.3m	CA01.04	
	Mollugo molluginea	+		0.1m	CA01.10	
	Pluchea tetranthera	+		0.4m	CA07.10	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA04.04	
	Ptilotus fusiformis var. fusiformis	+		0.3m	CA01.15	
	Salsola tragus subsp. tragus	+		0.3m	CA03.17	
	Senna glutinosa subsp. luerssenii	+		0.8m	CA01.09	
	Sida pilbarensis (ferruginous form)	+		0.7m	CA01.11	
	Solanum beagleholei	+		0.3m	CA05.02	
	Tribulus sp.	+		0.2m	CA01.13	
	Triodia epactia	20%		<0.4m	CA01.07	
	Triumfetta chaetocarpa	+		0.4m	CA01.06	

## Callawa

## Site CA02

**Described by** TE **Date** 30/03/2008 **Type** Q 30 x 80 m

**Location** Callawa.

**MGA Zone** 51 219838 mE 7716657 mN

**Habitat** Minor drainage line and plain.

**Soil** Orange/brown sandy loam, surface with scattered pebbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia opaca and Corymbia flavescentis low woodland over Grevillea wickhamii subsp. hispidula, Acacia tumida var. pilbarensis and Acacia inaequilatera high open shrubland over Hibiscus

leptocladus

and Corchorus elachocarpus low open shrubland over Eragrostis cumingii and Cenchrus ciliaris open tussock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Cattle.

Aspect: N/A.

Bare ground: 30%.

Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ancistrocarpa	+		2-3m	CA02.33	
	Acacia inaequilatera	2%		2-3m	CA02.25	
	Acacia sp.	1%		2-3m	CA02.01	
	Acacia stellaticeps	+		0.5-1.5m	CU28.01	
	Acacia tumida var. pilbarensis	3%		2-3m	CA02.06	
	Alysicarpus muelleri	+		0.1m	CA02.20	
	Aristida holathera var. latifolia	+		0.2m	CA02.02	
	Bonamia rosea	+		<0.4m	CA02.09	
	Bulbostylis barbata	+		<0.1m	CA02.15	
	Cajanus marmoratus	+		CL	CA02.03	
	Cenchrus ciliaris	10%		0.4m	CA19.26	
	Chrysopogon fallax	5%		0.6-1m	CA02.11	
	Cleome uncifera subsp. uncifera	+		CL	CA04.05	
	Corchorus elachocarpus	1%		0.4m	CA02.13	
	Corymbia aff. hamersleyana	+		6m	CA02.10B	
	Corymbia flavescentis	+		8m	CA08.29	
	Corymbia opaca	10%		10m	CA02.10A	
	Crotalaria ramosissima	+		0.3m	CA02.07	
	Dampiera candidans	+		0.5m	CU07.04	
	Desmodium filiforme	+		CL	CA02.16	
	Dolichandrone heterophylla	+		0.5-2m	CA02.28	
	Eragrostis cumingii	15%		0.5m	CA02.24	
	Eragrostis sp.	3%		0.5m	CA02.04	
	Eriachne aristidea	+		<0.1m	CA02.17	
	Evolvulus alsinoides var. decumbens	+		CL	CA02.29	
	Goodenia microptera	+		0.1m	CA02.19	
	Grevillea pyramidalis subsp. leucadendron	+		<1m	CA02.21	
	Grevillea wickhamii subsp. hispidula	3%		2-3m	CA18.02	
	Heliotropium cunninghamii	+		<0.1m	CA02.18	
	Hibiscus leptocladus	1%		0.4m	CA02.12	
	Indigofera monophylla (small calyx form)	+		<0.3m	CA02.23	
	Mollugo molluginea	+		<0.1m	CA12.10	
	Mollugo molluginea	+		<0.1m	CA04.06	
	Paraneurachne muelleri	1%		<0.2m	CA02.22	

Pluchea tetranthera	+	0.5-1m	CA12.16
Pluchea tetranthera	+	0.6m	CA12.16
Portulaca oleracea	+	<0.1m	CA02.14
Pterocaulon sphaeranthoides	+	<0.2m	CA14.02
Sclerolaena convexula x costata	+	0.2m	CA02.31
Senna notabilis	+	<0.1m	CA07.05
Sida pilbarensis (ferruginous form)	+	0.5m	CA02.30
Sida rohlenae subsp. rohlenae	+	0.4m	CA02.05
Solanum diversiflorum	+	0.3m	CU26.12
Stemodia grossa	+	0.3m	CU15.12
Tephrosia aff. supina (MET 12,357)	+	0.4m	CA02.27
Trianthema triquetra	+	<0.1m	CA02.32
Trichodesma zeylanicum var. zeylanicum	+	0.4m	CA02.08
Zornia muelleriana subsp. congesta	+	CL	CA02.26



## Callawa

## Site CA03

**Described by** BC **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South of rail loop, on flats near main track.

**MGA Zone** 51 219221 mE 7716153 mN

**Habitat** Plain.

**Soil** Red/brown clayey loam surface covered with pebbles and cobbles.

**Rock Type** Ironstone and quartz.

**Vegetation** Corymbia hamersleyana scattered low trees over Grevillea pyramidalis subsp. leucadendron open shrubland over Acacia ptychophylla and Tephrosia spechtii low open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Track 100 m North.  
Aspect: N/A.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, 2% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia inaequilatera	+		<1m	CA03.03	
	Acacia ptychophylla	3%		<1m	CA06.11	
	Acacia sp.	+		1.5m	CA03.02	
	Bonamia linearis	+		0.1m	CA03.12	
	Bonamia media var. villosa	+		0.1m	CA04.08	
	Bulbostylis barbata	+		0.1m	CA07.11	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.2m	CA03.07	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.2m	CA05.01	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CA03.16	
	Corymbia hamersleyana	1%		7m	CA03.01	
	Goodenia microptera	+		0.2m	CA03.13	
	Grevillea pyramidalis subsp. leucadendron	2%		2m	CA06.02	
	Grevillea pyramidalis subsp. leucadendron	+		<0.2m	CA03.11	
	Grevillea wickhamii subsp. hispidula	1%		1.5m	CA06.01	
	Mollugo molluginea	+		0.1m	CA04.06	
	Pluchea tetranthera	+		0.5m	CA03.10	
	Salsola tragus subsp. tragus	+		0.2m	CA03.17	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.2m	CA03.06	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.3m	CA03.14	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.3m	CA03.15	
	Sida pilbarensis (ferruginous form)	+		0.2m	CA03.05	
	Solanum beaugleholei	+		0.3m	CA05.02	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+		0.3m	CA03.08	
	Tephrosia spechtii	2%		1m	CA03.04	
	Triodia epactia	40%		<0.5m	CA03.09	

## Callawa

## Site CA04

**Described by** BC **Date** 28/03/2008 **Type** Q 50 x 50 m

### Location

**MGA Zone** 51 219725 mE 7715814 mN

**Habitat** Plain at the bottom of hillslope.

**Soil** Red/brown loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Grevillea pyramidalis subsp. leucadendron high open shrubland over Grevillea wickhamii subsp. hispidula open shrubland over Tephrosia aff. rosea (HD292-37) low scattered shrubs over Triodia epactia open hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: East.  
Bare ground: 65%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia elachantha (silvery hairy variant)	+		1.5m	CA04.10	
	Acacia inaequilatera	+		<1m	CA04.01	
	Acacia ptychophylla	+		0.6m	CA06.11	
	Acacia spondylophylla	+		0.7m	RELCA01.01	
	Aristida contorta	+		0.2m	CA04.14	
	Boerhavia gardneri	+		CR/0.1m	CA04.17	
	Bonamia media var. villosa	+		CR	CA04.08	
	Cleome uncifera subsp. uncifera	+		0.3m	CA04.05	
	Cleome viscosa	+		0.4m	CA04.11	
	Dampiera candidans	+		0.4m	CA07.04	
	Eriachne pulchella	+		0.1m	CA04.15	
	Goodenia muelleriana	+		0.2m	CA04.16	
	Grevillea pyramidalis subsp. leucadendron	3%		2-4m	CA04.09	
	Grevillea wickhamii subsp. hispidula	2%		1-2m	CA06.01	
	Mollugo molluginea	+		<0.2m	CA04.06	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA04.04	
	Senna glutinosa subsp. glutinosa	+		0.6m	CA04.20	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.3m	CA04.13	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		<0.4m	CA04.02	
	Solanum dioicum	+		0.3m	CA06.05	
	Tephrosia aff. rosea (HD292-37)	1%		<0.7m	CA04.03	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+		0.3m	CA04.07	
	Tribulus hirsutus	+		CR/0.1m	CA04.18	
	Tribulus platypterus	+		0.4m	CA04.12	
	Triodia epactia	30%		<0.5m	CA04.19	

## Callawa

## Site CA05

**Described by** BC **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South of road loop on hillslope.

**MGA Zone** 51 219280 mE 7715829 mN

**Habitat** Hillslope.

**Soil** Red/brown loam with exposed large boulders and surface covered with pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Grevillea pyramidalis subsp. leucadendron high open shrubland over Triodia wiseana hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type:  
Aspect: North.  
Bare ground: 50%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Bulbostylis barbata	+		0.1m	CA07.11	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.3m	CA05.01	
	Grevillea pyramidalis subsp. leucadendron	+		0.1m	CA06.10	
	Grevillea pyramidalis subsp. leucadendron	+		2m	CA06.02	
	Grevillea pyramidalis subsp. leucadendron	2%		2-3m	CA04.09	
	Grevillea wickhamii subsp. hispidula	+		1.5m	CA06.01	
	Mollugo molluginea	+		0.1m	CA04.06	
	Solanum beaugleholei	+		<0.8m	CA05.02	
	Triodia epactia	+		0.3m	CA07.19	
	Triodia wiseana	40%		<0.5m	CA06.09	



**Callawa** **Site** CA06

**Described by** BC **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South-eastern section of project area.

**MGA Zone** 51 219668 mE 7715283 mN

**Habitat** Lower hillslope.

**Soil** Red/brown loam with large exposed boulders and scattered pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Grevillea pyramidalis subsp. leucadendron and Grevillea wickhamii subsp. hispidula open shrubland over Triodia wiseana hummock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old/moderate.

**Notes** Disturbance type:  
Aspect: East.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, 1% Leaves.

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia ptychophylla	+		<0.7m	CA06.11	
	Bonamia media var. villosa	+		CL	CA07.21	
	Bulbostylis barbata	+		0.1m	CA07.11	
	Cajanus cinereus	+		0.5m	CA07.03	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.2m	CA06.12	
	Cyperus cunninghamii subsp. cunninghamii	+		0.3m	CA06.06	
	Eriachne mucronata (typical form)	+		0.2m	CA06.07	
	Grevillea pyramidalis subsp. leucadendron	+		0.1m	CA06.10	
	Grevillea pyramidalis subsp. leucadendron	2%		1-3m	CA06.02	
	Grevillea wickhamii subsp. hispidula	2%		1-2m	CA06.01	
	Solanum dioicum	+		0.4m	CA06.05	
	Tephrosia aff. supina	+		0.1m	CA06.03	
	Triodia wiseana	50%		<0.5m	CA06.09	
	Triodia wiseana	+		0.3m	CA06.08	
	Triumfetta sp.	+		<0.05m	CA06.04	

**Callawa** **Site** CA07

**Described by** BC **Date** 28/03/2008 **Type** Q 25 x 100 m

**Location** South-eastern corner of project area.

**MGA Zone** 51 219720 mE 7714920 mN

**Habitat** Minor drainage line.

**Soil** Orange/brown loam, surface with scattered pebbles and cobbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia opaca scattered low trees over Acacia tumida var. pilbarensis and Grevillea wickhamii subsp. hispidula high open shrubland over Cajanus cinereus, Tephrosia aff. rosea (HD292-37) and Tephrosia spechtii low open shrubland over Triodia epactia hummock grassland over Cymbopogon ambiguus and Eriachne mucronata very open tussock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.  
Aspect: East.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, 2% Leaves.

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia tumida var. pilbarensis	5%		1-2.5m	CA07.07	
	Bonamia media var. villosa	+		CL	CA07.21	
	Bulbostylis barbata	+		0.1m	CA07.11	
	Cajanus cinereus	2%		1m	CA07.03	
	Corymbia opaca	1%		6m	CA07.01	
	Cymbopogon ambiguus	1%		0.5m	CA07.13	
	Cymbopogon ambiguus	1%		0.5m	CA07.14	
	Dampiera candidans	+		0.4m	CA07.04	
	Eriachne mucronata (typical form)	2%		0.4m	CA07.15	
	Eriachne tenuiculmis	+		0.3m	CA07.17	
	Eriachne tenuiculmis	+		0.4m	CA07.18	
	Eriachne tenuiculmis	+		0.4m	CA07.16	
	Grevillea wickhamii subsp. hispidula	3%		2-4m	CA07.02	
	Indigofera monophylla (small calyx form)	1%		<0.5m	CA07.20	
	Mollugo molluginea	+		0.1m	CA07.12	
	Pluchea tetranthera	+		0.3m	CA07.10	
	Senna notabilis	+		1.5m	CA07.23	
	Senna notabilis	+		0.1m	CA07.05	
	Tephrosia aff. rosea (HD292-37)	+		0.4m	CA07.22	
	Tephrosia aff. rosea (HD292-37)	1%		<1m	CA07.08	
	Tephrosia spechtii	1%		<1m	CA07.09	
	Triodia epactia	60%		<0.5m	CA07.19	
	Triumfetta sp.	+		0.1m	CA07.06	

## Callawa

## Site CA08

**Described by** TE **Date** 31/03/2008 **Type** Q 50 x 50 m

**Location** Callawa.

**MGA Zone** 51 218719 mE 7716267 mN

**Habitat** Drainage line.

**Soil** Red/brown clayey loam, surface with scattered pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia hamersleyana and Corymbia flavesceus open woodland over Acacia tumida var. pilbarensis and Grevillea wickhamii subsp. hispidula high shrubland over Acacia inaequilatera scattered shrubs over Triodia epactia hummock grassland over Pterocaulon sphaeranthoides scattered herbs.

**Vegetation Condition** Very Good.

**Fire Age** Old.

**Notes** Disturbance type: Cattle.  
Aspect: N/A.  
Bare ground: 20%.  
Litter cover: + Logs, 1% Twigs, 20% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia inaequilatera	1%		1-2m	CA02.25	
	Acacia spondylophylla	+		1-2m	CA08.13	
	Acacia tumida var. pilbarensis	35%		2-3m	CA08.03	
	Alternanthera nana	+		0.2m	CA08.32	
	Aristida holathera var. latifolia	+		0.3m	CA02.02	
	Boerhavia coccinea	+		<0.1m	CA02.30	
	Boerhavia coccinea	+		0.6m	CA02.30	
	Bulbostylis barbata	+		<0.1m	CA02.15	
	Cajanus cinereus	+		1-1.5m	CA08.21	
	Cajanus cinereus	+		0.8m	CA08.30	
	Cenchrus ciliaris	+		0.6m	CA22.16	
	Chloris virgata	+		0.5m	CA08.22	
	Chrysopogon fallax	+		0.6m	CA02.11	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.4m	CA08.19	
	Corymbia flavesceus	2%		3-8m	CA08.29	
	Corymbia hamersleyana	2%		8-15m	CA08.20	
	Cullen stipulaceum	+		0.3m	CA08.33	
	Cymbopogon procerus	+		1m	CA08.34	
	Eriachne aristidea	+		<0.1m	CA08.09	
	Eriachne sp. Port Hedland	+		0.5m	CA08.07	
	Eriachne tenuiculmis	+		0.5m	CA08.08	
	Euphorbia coghlanii	+		<0.1m	CA08.25	
	Evolvulus alsinoides var. villosicalyx	+		0.3m	CA08.14	
	Grevillea wickhamii subsp. hispidula	3%		2-3m	CA18.02	
	Hibiscus leptocladus	+		<0.4m	CA08.16	
	Hibiscus sturtii var. campylochlamys	+		<0.4m	CA08.15	
	Hybanthus aurantiacus	+		0.4m	CA08.12	
	Mollugo molluginea	+		<0.1m	CA04.06	
	Mukia maderaspatana	+		CL	CA08.31	
	Paspalidium rarum	1%		0.3m	CA08.26	
	Perotis rara	+		<0.1m	CA14.03	
	Phyllanthus maderaspatensis	+		0.2m	CA08.06	
	Pluchea sp.	+		0.4m	CA08.01	
	Pluchea tetranthera	+		<0.5m	CA08.27	
	Polymeria sp. (site 1365)	+		0.2m	CA08.23	



Polymeria sp. (site 1365)	+	CL	CA08.04
Pterocaulon sphaeranthoides	1%	0.2m	CA08.28
Sida pilbarensis (ferruginous form)	+	0.2m	CA08.05
Sida pilbarensis (ferruginous form)	+	<0.4m	CA08.17
Sida rohlenae subsp. rohlenae	+	0.4m	CA08.11
Sporobolus australasicus	+	<0.1m	CA08.02
Tephrosia spechtii	+	0.5-1m	CA08.18
Trianthema triquetra	+	<0.1m	CA02.32
Triodia epactia	35%	0.5m	CA08.10

## Callawa

## Site CA09

**Described by** TE **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** Callawa.

**MGA Zone** 51 218637 mE 7715630 mN

**Habitat** Hillslope.

**Soil** Red/brown loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia hamersleyana and Corymbia opaca low open woodland over Grevillea pyramidalis subsp. Leucadendron open shrubland over Triodia wiseana closed hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Cattle.  
Aspect: North.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		1m	CA09.04	
	Acacia inaequilatera	+		0.6m	CA18.05	
	Acacia spondylophylla	+		0.5m	CA18.15	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.5m	CA09.05	
	Corymbia hamersleyana	3%		5-8m	CA09.09	
	Corymbia opaca	2%		5-8m	CA09.12	Op.
	Grevillea pyramidalis subsp. leucadendron	1%		1-1.5m	CA09.02	
	Grevillea pyramidalis subsp. leucadendron	5%		1-3m	CA09.07	
	Grevillea wickhamii subsp. hispidula	+		1m	CA18.02	
	Mollugo molluginea	+		<0.1m	CA12.10	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.3m	CA09.15	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.4m	CA09.14	Op.
	Sida pilbarensis (ferruginous form)	+		<0.5m	CA09.03	
	Solanum dioicum	+		0.5m	CA18.08	
	Solanum diversiflorum	+		0.5m	CA09.10	
	Solanum phlomoides	+		1m	CA09.06	
	Tephrosia spechtii	+		1m	CA09.11	
	Trachymene oleracea subsp. oleracea	+		<0.1m	OPTECA04	Op.
	Triodia sp.	70%		0.8m	CA09.01	
	Triumfetta maconochieana	+		0.5m	CA09.08	
	Triumfetta maconochieana	+		<0.5m	CA09.13	Op.

## Callawa

## Site CA10

**Described by** TE **Date** 31/03/2008 **Type** Q 50 x 50 m

**Location** Callawa.

**MGA Zone** 51 218373 mE 7716172 mN

**Habitat** Plain.

**Soil** Red/brown clayey loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia hamersleyana scattered low trees over Acacia colei var. colei and Acacia inaequilatera high open shrubland over Grevillea pyramidalis subsp. leucadendron and Acacia spondylophylla open shrubland over Triodia epactia closed hummock grassland over Eragrostis aff. eriopoda (WAS site 963) open tussock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Cow dung.  
Aspect: N/A.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	2%		2-3m	CA10.05	
	Acacia colei var. colei	3%		2-3m	CA09.04	
	Acacia elachantha (silvery hairy variant)	+		1-2m	CA10.03	
	Acacia inaequilatera	1%		2-3m	CA18.05	
	Acacia spondylophylla	1%		0.5-1.5m	CA08.13	
	Bonamia linearis	+		<0.1m	CA10.04	
	Cleome uncifera subsp. uncifera	+		<0.1m	CA10.06	
	Cleome uncifera subsp. uncifera	+		0.2m	CA04.05	
	Corchorus elachocarpus	+		0.5m	CA10.08	
	Corymbia hamersleyana	1%		6m	CA11.01	
	Dampiera candidans	+		0.5m	CU07.04	
	Eragrostis aff. eriopoda (WAS site 963)	15%		<0.5m	CA10.01	
	Fimbristylis simulans	+		<0.1m	CU21.08	
	Grevillea pyramidalis subsp. leucadendron	2%		1-1.5m	CA06.02	
	Grevillea wickhamii subsp. hispidula	+		2-3m	CA18.02	
	Hakea chordophylla	+		1.5m	CU01.18	
	Mollugo molluginea	+		<0.1m	CA04.06	
	Pluchea tetranthera	+		0.6m	CA12.16	
	Stemodia grossa	+		0.1m	CA19.08	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+		0.5m	CA10.09	
	Triodia epactia	80%		0.5m	CA10.02	
	Triodia wiseana	+		0.6m	CA10.07	



## Callawa

## Site CA11

**Described by** TE **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South central Callawa.

**MGA Zone** 51 218108 mE 7715477 mN

**Habitat** Plain at base of hills.

**Soil** Red/brown loam, surface covered with pebbles and cobbles. Some exposed bedrock.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia hamersleyana and Corymbia flavesceus low open woodland over Grevillea wickhamii subsp. hispidula scattered shrubs over Triodia epactia closed hummock grassland over Tephrosia aff. supina very open herbland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type:  
Aspect: North.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		1.2m	CA18.13	
	Acacia spondylophylla	+		0.5m	CA18.15	
	Bonamia media var. villosa	+		<0.1m	CA11.06	
	Cajanus cinereus	+		0.6m	CA12.11	Op.
	Cajanus cinereus	+		1m	CA12.11	
	Cenchrus ciliaris	+		0.4m	OPCOLTE2.	
	Corymbia flavesceus	1%		10m	CA11.04	
	Corymbia hamersleyana	3%		6m	CA11.01	
	Eragrostis aff. eriopoda (WAS site 963)	+		0.4m	OPCOLTE2.	
	Eriachne pulchella subsp. dominii	+		<0.1m	CA12.05	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CA12.08	Op.
	Grevillea pyramidalis subsp. pyramidalis	+		1.5m	CA18.01	Op.
	Grevillea wickhamii subsp. hispidula	1%		1-2m	CA18.02	
	Mollugo molluginea	+		<0.1m	CA12.10	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA11.02	
	Tephrosia aff. supina	2%		<0.1m	CA11.05	
	Tephrosia spechtii	+		1.5m	CA18.09	
	Triodia epactia	70%		0.6m	CA11.03	
	Triodia wiseana	1%		0.8m	CA11.07	

## Callawa

## Site

CA12

**Described by**

TE

**Date** 28/03/2008

**Type** Q

50 x 50 m

**Location** South Callawa (central).

**MGA Zone** 51

217814 mE

7715762 mN

**Habitat** Plain.

**Soil** Red/brown loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Grevillea wickhamii subsp. hispidula high open shrubland over Acacia spondylophylla low scattered shrubs over Triodia wiseana and Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Old track near plot, 30 m away.

Aspect: North.

Bare ground: 40%.

Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia spondylophylla	1%		<1m	CA18.15	
	Acacia synchronicia	+		2m	CA12.18	Op.
	Bonamia linearis	+		<0.1m	CA12.09	
	Cajanus cinereus				NC	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		1m	CA12.11	
	Eriachne obtusa	+		<0.4m	CA12.13	
	Eriachne pulchella	+		<0.1m	CA04.15	Dead.
	Eriachne sp. Port Hedland	+		<0.2m	CA12.14	
	Goodenia muelleriana	+		<0.1m	CA12.12	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CA12.06	
	Grevillea pyramidalis subsp. leucadendron	+		1-1.5m	CA12.08	
	Grevillea wickhamii subsp. hispidula	2%		2-2.5m	CA18.02	
	Mollugo molluginea	+		<0.1m	CA12.10	
	Pluchea tetranthera	+		<0.2m	CA12.16	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA12.04	
	Ptilotus fusiformis var. fusiformis	+		0.2m	CA12.03	
	Salsola tragus subsp. tragus	+		0.2m	CA12.07	
	Senna notabilis	+		0.6m	CA12.15	
	Solanum dioicum	+		0.5m	CA18.08	
	Solanum dioicum	+		1m	CA12.17	
	Stemodia grossa	+		<0.1m	CA19.08	
	Synaptantha tillaeacea var. tillaeacea	+		<0.1m	CA18.16	
	Triodia epactia	25%		0.5m	CA12.01	
	Triodia wiseana	25%		0.5m	CA12.02	

## Callawa

## Site CA13

**Described by** JSF **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** Callawa

**MGA Zone** 51 218150 mE 7716700 mN

**Habitat** Floodplain.

**Soil** Red clay.

**Rock Type** Ironstone.

**Vegetation** Corymbia flavescent low open woodland over Acacia colei var. colei and Acacia tumida var. pilbarensis open scrub over Pluchea tetranthera low open shrubland over Triodia epactia closed hummock grassland over Chrysopogon fallax open tussock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Between track and rail line, some grazing.  
Aspect: N/A.  
Bare ground: 30%.  
Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	20%		2.5m	CA13.03	
	Acacia inaequilatera	+		1.5m	CA18.05	
	Acacia tumida var. pilbarensis	20%		2.5m	CA13.01	
	Aristida holathera var. latifolia	+		0.2m	CA13.21	
	Carissa lanceolata	+		0.8m	CA13.17	
	Chloris pumilio	+		0.2m	CA13.22	
	Chloris virgata	+		0.2m	CA13.15	
	Chrysopogon fallax	10%		1m	CA13.06	
	Corymbia flavescent	2%		8m	CA13.04	
	Cyperus iria	+		0.1m	CA13.08	
	Dactyloctenium radulans	+		0.1m	CA13.23	
	Desmodium sp.	+		0.2m	CA13.11	
	Echinochloa colona	+		0.3m	CA13.13	
	Eragrostis cumingii	+		0.1m	CA13.12	
	Eriachne aristidea	+		0.2m	CA13.10	
	Grevillea pyramidalis subsp. pyramidalis	+		2m	CA17.04	
	Ipomoea muelleri	+		CL	CA13.14	
	Mollugo molluginea	+		0.1m	CA13.18	
	Pluchea sp.	1%		0.4m	CA13.16	
	Pluchea tetranthera	4%		0.5m	CA19.03	
	Portulaca oleracea	+		0.1m	CA13.09	
	Sporobolus australasicus	+		0.1m	CA13.07	
	Stemodia grossa	+		0.5m	CA19.08	
	Synaptantha tillaeacea var. tillaeacea	+		0.05m	CA13.19	
	Tephrosia aff. rosea (HD292-37)	+		0.5m	CA13.20	
	Triodia epactia	30%		1m	CA13.05	
	Triodia epactia	60%		1.8m	CA13.02	



## Callawa

## Site CA14

**Described by** TE **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** Callawa (middle).

**MGA Zone** 51 **217700 mE** **7716400 mN**

**Habitat** Drainage line.

**Soil** Red/brown clayey loam, surface with scattered pebbles.

**Rock Type** Ironstone.

**Vegetation** Corymbia flavescent open woodland over Acacia tumida var. pilbarensis closed scrub over Cajanus cinereus, Pluchea tetranthera and Sida rohlenae subsp. rohlenae open low shrubland over Triodia epactia open hummock grassland over Chrysopogon fallax and Cenchrus ciliaris tussock grassland over Pterocaulon sphaeranthoides open herbland.

**Vegetation Condition** Very good.

**Fire Age** Old/very old.

**Notes** Disturbance type: Grazing (cow dung), weeds.

Aspect: N/A.

Bare ground: 30%.

Litter cover: + Logs, 2% Twigs, 10% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia inaequilatera	+		0.6m	CA14.20	
	Acacia tumida var. pilbarensis	70%		3-5m	CA14.01	
	Alysicarpus muelleri	+		0.3m	CA14.24	
	Amaranthus aff. pallidiflorus (WC148-11)	+		0.2m	CA14.21	
	Aristida holathera var. latifolia	+		0.2m	CA14.14	
	Bulbostylis barbata	+		<0.1m	CA14.15	
	Cajanus cinereus	2%		<0.5m	CA14.18	
	Cajanus marmoratus	+		CL	CA14.30	
	Cenchrus ciliaris	10%		<0.4m	OPTE02.01	
	Chrysopogon fallax	+		0.3m	CA14.28	
	Chrysopogon fallax	25%		0.5m	CA14.06	
	Chrysopogon fallax	10%		0.8m	CA14.25	
	Corymbia flavescent	10%		10-15m	CA14.22	
	Corymbia flavescent	+		1.5m	CA14.17	
	Cymbopogon ambiguus	+		1m	CA14.31	
	Cyperus cunninghamii subsp. cunninghamii	+		<0.2m	CA14.33	Op.
	Dactyloctenium radulans	+		<0.1m	CA14.26	
	Eragrostis cumingii	+		<0.1m	CA14.04	
	Eriachne aristidea	1%		<0.1m	CA14.07	
	Eriachne sp. Port Hedland	+		0.3m	CA14.13	
	Euphorbia coghlanii	+		0.3m	CA14.12	
	Grevillea pyramidalis subsp. leucadendron	+		0.5m	CA14.29	
	Grevillea wickhamii subsp. hispidula	+		1-2m	CA18.02	
	Ipomoea muelleri	1%		CL	CA14.09	
	Perotis rara	+		<0.1m	CA14.03	
	Pluchea tetranthera	1%		0.3m	CA12.16	
	Polymeria calycina	+		CL	CA14.08	
	Pterocaulon sphaeranthoides	10%		<0.1m	CA14.02	
	Rhynchosia minima var. australis	+		CL	CA14.34	Op.
	Senna notabilis	+		<0.2m	CA07.05	
	Sida pilbarensis (ferruginous form)	+		<0.5m	OPTECA03	
	Sida rohlenae subsp. rohlenae	+		<0.5m	CA14.19	
	Sida rohlenae subsp. rohlenae	1%		0.5m	CA14.23	
	Stemodia grossa	+		0.8m	CA14.27	
	Tinospora smilacina	+		CL	CA14.35	

Triodia epactia	20%	0.5m	CA14.05	
Triumfetta chaetocarpa	+	<0.4m	CA14.32	Op.
Yakirra australiensis var. australiensis	+	<0.1m	CA14.16	

## Callawa

## Site CA15

**Described by** KC **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** Callawa.

**MGA Zone** 51 217403 mE 7716198 mN

**Habitat** Plain.

**Soil** Orange/brown loam, surface with scattered pebbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Grevillea pyramidalis subsp. leucadendron high open shrubland over Grevillea wickhamii subsp. hispidula, Acacia inaequilatera and Acacia colei var. colei open shrubland over Corchorus elachocarpus, Indigofera monophylla and Pluchea tetranthera low open shrubland over Triodia epactia hummock grassland over Mollugo molluginea scattered herbs.

**Vegetation Condition** Very good.

**Fire Age** Moderate.

**Notes** Disturbance type: Track 100 m South.  
Aspect: N/A.  
Bare ground: 40%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	3%		2m	CA15.16	
	Acacia inaequilatera	+		1m	CA15.13	
	Acacia inaequilatera	1%		2m	CA15.19	
	Bonamia linearis	+		0.2m	CA15.24	
	Bonamia linearis	+		0.1m	CA15.03	
	Bonamia linearis	+		0.2m	CA15.18	
	Cleome uncifera subsp. uncifera	+		0.3m	CA15.09	
	Cleome uncifera subsp. uncifera	+		0.3m	CA15.21	
	Corchorus elachocarpus	5%		0.3m	CA15.02	
	Eragrostis aff. eriopoda (WAS site 963)	+		0.2m	CA15.14	
	Eragrostis aff. eriopoda (WAS site 963)	+		0.3m	CA15.12	
	Grevillea pyramidalis	+		3m	CA15.06	
	Grevillea pyramidalis subsp. leucadendron	1%		3m	CA15.04	
	Grevillea pyramidalis subsp. leucadendron	1%		4m	CA15.20	
	Grevillea wickhamii subsp. hispidula	3%		2m	CA15.05	
	Indigofera monophylla	2%		0.3m	CA15.07	
	Indigofera monophylla (small calyx form)	+		0.3m	CA15.17	
	Isotropis atropurpurea	+		0.4m	CA15.25	
	Mollugo molluginea	+		0.2m	CA15.22	
	Mollugo molluginea	+		0.1m	CA15.11	
	Mollugo molluginea	1%		0.1m	CA15.08	
	Pluchea tetranthera	1%		0.4m	CA15.10	
	Tephrosia aff. supina	+		0.3m	CA15.15	
	Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+		0.3m	CA15.23	
	Triodia epactia	50%		1m	CA15.01	



## Callawa

Site CA16

Described by  
Season

JSF

Date 28/03/2008

Type Q

50 x 50 m

Uniformity

### Location

MGA Zone 51

217375 mE

7715582 mN

Habitat Drainage line.

Soil Red/brown clay, surface with scattered pebbles and cobbles.

Rock Type Ironstone and silicates.

**Vegetation** Corymbia hamersleyana scattered low trees over Acacia tumida var. pilbarensis and Acacia inaequilatera open scrub over Petalostylis labicheoides and Grevillea wickhamii subsp. hispidula open shrubland over Acacia spondylophylla and Corchorus aff. parviflorus (1)(GLD SRH67-5) low open shrubland over Triodia epactia closed hummock grassland over Eriachne tenuiculmis very open tussock grassland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: Nil.

Aspect: N/A.

Bare ground: 10%.

Litter cover: + Logs, 2% Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia inaequilatera	1%		2m	CA18.05	
	Acacia spondylophylla	2%		0.8m	CA17.07	
	Acacia tumida var. pilbarensis	50%		2.5m	CA13.01	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	1%		0.4m	CA17.05	
	Corymbia flavescens	+		3m	CA19.25	
	Corymbia hamersleyana	1%		6m	CA19.01	
	Eriachne tenuiculmis	2%		0.4m	CA16.02	
	Grevillea pyramidalis subsp. pyramidalis	+		3m	CA17.04	
	Grevillea wickhamii subsp. hispidula	1%		1.2m	CA17.02	
	Petalostylis labicheoides	+		1m	CA16.05	
	Petalostylis labicheoides	4%		1.8m	CA16.03	
	Pluchea tetranthera	+		0.5m	CA19.03	
	Tephrosia spechtii	+		0.4m	CA16.04	
	Triodia epactia	90%		1.2m	CA16.01	

## Callawa

## Site CA17

**Described by** KC **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South-west Callawa.

**MGA Zone** 51 216799 mE 7715248 mN

**Habitat** Plains.

**Soil** Orange/red loam, surface with pebbles and cobbles.

**Rock Type** Ironstone with silicates.

**Vegetation** Corymbia hamersleyana scattered low trees over Grevillea wickhamii subsp. hispidula and Grevillea pyramidalis subsp. leucadendron and Acacia inaequilatera open shrubland over Acacia spondylophylla

and Corchorus aff. parviflorus (1)(GLD SRH67-5) low shrubland over Triodia epactia and Triodia wiseana closed hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Moderate.

**Notes** Disturbance type: Track 50 m away.  
Aspect: North.  
Bare ground: 20%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		1.2m	CA17.15	
	Acacia inaequilatera	1%		1.2m	CA18.05	
	Acacia spondylophylla	10%		0.5m	CA17.07	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	4%		0.5m	CA17.05	
	Corymbia hamersleyana	1%		4m	CA17.01	
	Goodenia stobbsiana	+		<0.3m	CA17.06	
	Grevillea pyramidalis subsp. leucadendron	1%		2m	CA17.03	
	Grevillea pyramidalis subsp. pyramidalis	+		4m	CA17.04	
	Grevillea wickhamii subsp. hispidula	2%		2m	CA17.02	
	Hybanthus aurantiacus	+		<0.3m	CA17.14	
	Ptilotus calostachyus var. calostachyus	+		0.8m	CA17.08	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.5m	CA17.18	
	Solanum cunninghamii	+		0.3m	CA17.11	
	Synaptantha tillaeacea var. tillaeacea	+		<0.3m	CA17.10	
	Tephrosia aff. supina	+		<0.3m	CA17.09	
	Triodia epactia	75%		0.8m	CA17.12	
	Triodia epactia	20%		1m	CA17.16	
	Triodia wiseana	2%		0.8m	CA17.13	

## Callawa

## Site CA18

**Described by** TE **Date** 28/03/2008 **Type** Q 50 x 50 m

**Location** South-west Callawa.

**MGA Zone** 51 216600 mE 7715400 mN

**Habitat** Plain with low undulations.

**Soil** Red/brown loam, surface covered with pebbles and cobbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Acacia inaequilatera, Grevillea wickhamii subsp. hispidula and Grevillea pyramidalis subsp. pyramidalis high open shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Track past drill, 30 m East.  
Aspect: North.  
Bare ground: 25%.  
Litter cover: + Logs, + Twigs, + Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	+		1m	CA18.13	
	Acacia inaequilatera	1%		3m	CA18.05	
	Acacia ptychophylla	+		0.6m	CA18.12	
	Acacia spondylophylla	+		0.6m	CA18.15	
	Bonamia linearis	+		<0.1m	CA18.17	
	Corchorus aff. parviflorus (1)(GLD SRH67-5)	+		0.4m	CA18.04	
	Eriachne mucronata (typical form)	+		<0.1m	CA18.10A	
	Eriachne pulchella	+		0.4m	CA18.10B	
	Euphorbia wheeleri	+		0.3m	OPTECA01	
	Goodenia stobbsiana	+		0.5m	CA18.11	
	Grevillea pyramidalis subsp. pyramidalis	1%		2-3m	CA18.01	
	Grevillea wickhamii subsp. hispidula	3%		2-3m	CA18.02	
	Pluchea tetranthera	+		<0.1m	CA18.06	
	Pterocaulon sphaeranthoides	+		0.1m	CA14.02	
	Ptilotus calostachyus var. calostachyus	+		0.5m	CA11.02	Op.
	Senna notabilis	+		<0.3m	CA07.05	Op.
	Solanum dioicum	+		0.5m	CA18.08	
	Synaptantha tillaeacea var. tillaeacea	+		<0.1m	CA18.16	
	Tephrosia aff. supina	+		<0.1m	CA18.07	
	Tephrosia spechtii	+		1m	CA18.09	
	Themeda triandra	+		0.4m	CA18.25	
	Triodia epactia	65%		0.5m	CA18.03	
	Triumfetta chaetocarpa	+		0.4m	CA18.14	



## Callawa

Site CA19

Described by

JSF

Date 28/03/2008

Type Q

50 x 50 m

### Location

MGA Zone 51

216600 mE

7715900 mN

Habitat Drainage line.

Soil Red/brown clay.

Rock Type Ironstone.

**Vegetation** Corymbia flavescens and Corymbia hamersleyana low woodland over Acacia tumida var. pilbarensis open scrub over Acacia spondylophylla low open shrubland over Triodia epactia closed hummock grassland over mixed tussock grasses over Rhynchosia minima var. australis and Crotalaria ramosissima very open herbland.

**Vegetation Condition** Excellent.

**Fire Age** Old.

**Notes** Disturbance type: 200m from track.  
Aspect: N/A.  
Bare ground: 10%.  
Litter cover: + Logs, 5% Twigs, 10% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia sp.	1%		2m	CA19.17	
	Acacia spondylophylla	5%		0.5m	CA17.07	
	Acacia trachycarpa subsp. tumida var. pilbarensis	1%		1.5m	CA19.16	
	Acacia tumida var. pilbarensis	50%		2m	CA19.02	
	Aristida holathera var. latifolia	1%		0.4m	CA19.09	
	Cenchrus ciliaris	1%		0.8m	CA19.26	
	Cleome uncifera subsp. uncifera	+		0.3m	CA19.13	
	Cleome uncifera subsp. uncifera	+		0.3m	CA19.23	
	Corymbia flavescens	+		2.5m	CA19.14	
	Corymbia flavescens	2%		10m	CA19.25	
	Corymbia hamersleyana	5%		6m	CA19.05	
	Corymbia hamersleyana	5%		6m	CA19.01	
	Crotalaria ramosissima	1%		0.2m	CA19.11	
	Dampiera candidans	1%		0.5m	CA19.06	
	Dampiera candidans	+		0.5m	CA19.21	
	Desmodium filiforme	+		0.1m	CA19.10	
	Eragrostis aff. eriopoda (WAS site 963)	1%		0.3m	CA19.12	
	Eriachne obtusa	1%		0.5m	CA19.27	
	Eulalia aurea	+		0.4m	CA19.18	
	Grevillea wickhamii subsp. hispidula	+		0.5m	CA07.02	
	Isotropis atropurpurea	+		0.5m	CA19.20	
	Mollugo molluginea	+		0.1m	CA19.07	
	Pluchea ferdinandi-muelleri	+		0.5m	CA19.19	
	Pluchea tetranthera	1%		0.5m	CA19.03	
	Rhynchosia minima var. australis	1%		0.2m	CA19.24	
	Stemodia grossa	1%		0.4m	CA19.08	
	Tephrosia aff. bidwillii (HD153-5)	+		0.4m	CA19.22	
	Triodia epactia	90%		1m	CA19.04	
	Triodia epactia	+		1m	CA19.15	

<b>Callawa</b>		<b>Site</b>	CA20		
<b>Described by</b>	KC	<b>Date</b>	28/03/2008	<b>Type</b>	Q 100 x 25 m
<b>Location</b>	Callawa.				
<b>MGA Zone</b>	51		217228 mE		7716810 mN
<b>Habitat</b>	Drainage line.				
<b>Soil</b>	Orange/brown clayey loam.				
<b>Rock Type</b>	Ironstone and silicates.				
<b>Vegetation</b>	Corymbia flavescens low woodland over Acacia coleii var. coleii and Acacia tumida var. pilbarensis high shrubland over Carissa lanceolata scattered shrubs over Corchorus elachocarpus low open shrubland over Triodia epactia open hummock grassland over Cyperus vaginatus scattered sedges.				
<b>Vegetation Condition</b>	Very good.				
<b>Fire Age</b>	Old.				
<b>Notes</b>	Disturbance type: Signs of cattle. Aspect: North-east. Bare ground: 50%. Litter cover: + Logs, 5% Twigs, 20% Leaves.				

#### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia coleii var. coleii	25%		4m	CA20.01	
	Acacia tumida var. pilbarensis	1%		3m	CA20.12	
	Cajanus cinereus	+		1.5m	CA20.10	
	Carissa lanceolata	1%		2m	CA20.24	
	Cenchrus ciliaris	+		0.4m	CA20.13	
	Cenchrus ciliaris	1%		0.6m	CA20.15	
	Corchorus elachocarpus	3%		0.3m	CA20.03	
	Corymbia flavescens	1%		10m	CA20.14	
	Cyperus vaginatus	10%		1m	CA20.08	
	Indigofera colutea	+		0.1m	CA20.23	
	Indigofera trita	+		0.3m	CA20.18	
	Indigofera trita	+		0.3m	CA20.11	
	Ipomoea muelleri	+		0.2m	CA20.22	
	Mollugo molluginea	+		0.1m	CA20.07	
	Mukia maderaspatana	+		0.3m	CA20.17	
	Pluchea tetranthera	+		0.3m	CA20.19	
	Pluchea tetranthera	+		0.2m	CA20.04	
	Polymeria calycina	+		0.2m	CA20.06	
	Polymeria calycina	+		0.2m	CA20.05	
	Polymeria calycina	+		0.1m	CA20.09	
	Sida rohlenae var. rohlenae	+		0.3m	CA20.20	
	Triodia angusta	+		0.5m	CA20.16	
	Triodia epactia	25%		1m	CA20.02	

## Callawa

**Site** CA21

**Described by**

JSF

**Date** 31/03/2008

**Type** Q

50 x 50 m

### Location

**MGA Zone** 51

217681 mE

7717097 mN

**Habitat** Drainage line and floodplain.

**Soil** Red/brown clay.

**Rock Type** Ironstone.

**Vegetation** Acacia colei var. colei high shrubland over Triodia epactia hummock grassland over Eriachne obtusa very open tussock grassland.

**Vegetation Condition** Good.

**Fire Age** Old.

**Notes** Disturbance type: Grazing, track 30m away.  
Aspect: NW - Slight.  
Bare ground: 50%.  
Litter cover: + Logs, + Twigs, 1% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia colei var. colei	20%		2m	CA21.02	
	Acacia inaequilatera	+		1.5m	CA18.05	
	Bonamia linearis	+		0.05m	CA21.13	
	Cleome uncifera subsp. uncifera	+		0.2m	CA21.14	
	Cleome uncifera subsp. uncifera	+		0.4m	CA21.11	
	Corchorus elachocarpus	+		0.4m	CA21.10	
	Eriachne aristidea	+		0.15m	CA21.06	
	Eriachne obtusa	2%		0.5m	CA21.03	
	Mollugo molluginea	+		0.2m	CA21.04	
	Pluchea tetranthera	+		0.5m	CA19.03	
	Portulaca oleracea	+		0.1m	CA21.05	
	Ptilotus fusiformis var. fusiformis	+		0.4m	CA21.15	
	Salsola tragus subsp. tragus	+		0.3m	CA21.08	
	Senna notabilis	+		0.2m	CA07.05	
	Sida aff. pilbarensis (GLD (SRH) 59-3)	+		0.4m	CA21.07	
	Sida pilbarensis (ferruginous form)	+		0.5m	CA21.09	
	Sporobolus australasicus	+		0.1m	CA21.16	
	Tephrosia aff. supina	+		0.1m	CA21.12	
	Triodia epactia	50%		1m	CA21.01	



## Callawa

## Site CA22

**Described by** KC **Date** 31/03/2008 **Type** Q 50 x 50 m

**Location** Callawa.

**MGA Zone** 51 217255 mE 7717538 mN

**Habitat** Plain.

**Soil** Orange/brown loam, surface with scattered pebbles.

**Rock Type** Ironstone and silicates.

**Vegetation** Corymbia flavescentis scattered trees over Acacia tumida var. pilbarensis, Acacia colei var. colei and Acacia aneura high open shrubland over Acacia inaequilatera open shrubland over Cajanus marmoratus, Sida aff. pilbarensis (GLD (SRH) 59-3) and Cleome uncifera subsp. uncifera open low shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age** Old.

**Notes** Disturbance type: Signs of cattle, road 100 m away.

Aspect: East.

Bare ground: 10%.

Litter cover: + Logs, + Twigs, 5% Leaves.

### SPECIES LIST:

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia aneura	1%		2m	CA22.21	
	Acacia colei var. colei	+		0.2m	CA22.06	
	Acacia colei var. colei	1%		2m	CA22.20	
	Acacia elachantha (silvery hairy variant)	+		0.3m	CA22.12	
	Acacia inaequilatera	3%		1.5m	CA22.37	
	Acacia stellaticeps	1%		1m	CA22.43	
	Acacia tumida var. pilbarensis	1%		3m	CA22.40	
	Acacia tumida var. pilbarensis	1%		3m	CA22.39	
	Amaranthus aff. pallidiflorus (WC148-11)	+		0.5m	CA22.05	
	Boerhavia coccinea	+		0.3m	CA22.02	
	Bonamia linearis	+		0.4m	CA22.36	
	Bonamia linearis	+		0.4m	CA22.11	
	Bulbostylis barbata	+		0.1m	CA22.08	
	Cajanus marmoratus	1%		0.5m	CA22.29	
	Cenchrus ciliaris	2%		0.6m	CA22.16	
	Cleome uncifera subsp. uncifera	+		0.4m	CA22.41	
	Cleome uncifera subsp. uncifera	1%		0.4m	CA22.32	
	Cleome viscosa	+		0.5m	CA22.30	
	Corchorus elachocarpus	+		0.5m	CA22.10	
	Corymbia aff. hamersleyana	+		3m	CA22.38	
	Corymbia flavescentis	1%		10m	CA22.23	
	Corymbia flavescentis	+		3m	CA22.27	
	Corymbia flavescentis	+		4m	CA22.22	
	Digitaria sp.	+		0.4m	CA22.25	
	Eragrostis cumingii	+		0.1m	CA22.15	
	Eragrostis cumingii	+		0.1m	CA22.07	
	Eriachne aristidea	+		0.3m	CA22.13	
	Grevillea pyramidalis subsp. leucadendron	+		1m	CA22.24	
	Indigofera linnaei	+		0.3m	CA22.34	
	Mukia maderaspatana	+		0.3m	CA22.04	
	Mukia maderaspatana	+		0.4m	CA22.17	
	Pluchea tetranthera	+		0.8m	CA22.19	
	Pterocaulon sphaeranthoides	+		0.4m	CA22.14	
	Pterocaulon sphaeranthoides	+		0.4m	CA22.09	
	Rhynchosia minima var. australis	+		0.2m	CA22.03	

Sida aff. pilbarensis (GLD (SRH) 59-3)	1%	0.7m	CA22.31
Tephrosia sp. Bungaroo Creek (M.E. Trudgen 11601)	+	0.3m	CA22.33
Tephrosia spechtii	+	1.2m	CA22.35
Tephrosia spechtii	+	1m	CA22.42
Tinospora smilacina	+	0.4m	CA22.01
Triodia epactia	60%	1.2m	CA22.26
Waltheria indica	+	1m	CA22.18
Yakirra australiensis var. australiensis	+	0.2m	CA22.28

**Callawa Site** Relevé CA R01

**Described by** BC **Date** 28/03/2008 **Type** R

**Location** South-eastern section of project area.

**MGA Zone** 51 219713 mE 7715608 mN

**Habitat** Minor drainage line.

**Soil**

**Rock Type**

**Vegetation** Grevillea pyramidalis subsp. leucadendron and Grevillea wickhamii subsp. hispidula shrubland over Acacia spondylophylla low shrubland over Triodia epactia hummock grassland.

**Vegetation Condition** Very good.

**Fire Age**

**Notes** Disturbance type: Nil.  
Aspect: East.

**SPECIES LIST:**

Quad	Name	Cover	Class	Height	Specimen	Notes
	Acacia spondylophylla	50%		<0.5m	RELCAC1.01	
	Grevillea pyramidalis subsp. leucadendron	10%		<1.5m	CA06.02	
	Grevillea wickhamii subsp. hispidula	2%		<1.5m	CA07.02	
	Tephrosia aff. rosea (HD292-37)	+		0.5m	CA07.08	
	Triodia epactia	40%		<0.5m	CA07.19	



# **APPENDIX F**

## **STANDARDISED VEGETATION MATRIX**

## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX F

#### STANDARDISED VEGETATION MATRIX (Developed by Malcolm Trudgen)

	Under 2%	2-10%	10-30%	30-70%	70-100%
Trees over 30m	Scattered tall trees	High open woodland	High woodland	High open forest	High closed forest
Trees 10-30m	Scattered trees	Open woodland	Woodland	Open forest	Closed forest
Trees under 10m	Scattered low trees	Low open woodland	Low woodland	Low open forest	Low closed forest
Shrubs 2-5m	Scattered tall shrubs	High open shrubland	High shrubland	Open scrub	Closed shrub
Shrubs 1-2m	Scattered shrubs	Open shrubland	Shrubland	Open heath	Closed heath
Shrubs under 1m	Low scattered shrubs	Low open shrubland	Low shrubland	Low open heath	Low closed heath
Grasses	Scattered grasses	Very open grassland	Open grassland	Grassland	Closed grassland
Herbs	Scattered herbs	Very open herbland	Open herbland	Herbland	Closed herbland
Sedges	Scattered sedges	Very open sedgeland	Open sedgeland	Sedgeland	Closed sedgeland

# **APPENDIX G**

## **FLORA SPECIES INVENTORY**

## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX G

#### FLORA SPECIES INVENTORY

##### Appendix G1: Cundaline Flora Species Inventory

Family	Species Name
Amaranthaceae	<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)
Amaranthaceae	<i>Amaranthus</i> sp.
Amaranthaceae	<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>
Amaranthaceae	<i>Gomphrena cunninghamii</i>
Amaranthaceae	<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>
Amaranthaceae	<i>Ptilotus axillaris</i>
Amaranthaceae	<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>
Amaranthaceae	<i>Ptilotus exaltatus</i>
Amaranthaceae	<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>
Amaranthaceae	<i>Ptilotus obovatus</i>
Apiaceae	<i>Trachymene oleracea</i> subsp. <i>oleracea</i>
Apocynaceae	<i>Carissa lanceolata</i>
Asteraceae	<i>Flaveria australasica</i>
Asteraceae	<i>Pluchea rubelliflora</i>
Asteraceae	<i>Pluchea tetranthera</i>
Asteraceae	<i>Pterocaulon serrulatum</i>
Asteraceae	<i>Pterocaulon sphacelatum</i>
Asteraceae	<i>Pterocaulon sphaeranthoides</i>
Asteraceae	<i>Rhodanthe margarethae</i>
Asteraceae	<i>Streptoglossa decurrens</i>
Boraginaceae	<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>
Caesalpiniaceae	<i>Senna artemisioides</i> subsp. <i>oligophylla</i>
Caesalpiniaceae	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
Caesalpiniaceae	<i>Senna glutinosa</i> subsp. <i>pruinosa</i>
Caesalpiniaceae	<i>Senna notabilis</i>



Family	Species Name
Capparaceae	<i>Cleome uncifera</i> subsp. <i>uncifera</i>
Capparaceae	<i>Cleome viscosa</i>
Caryophyllaceae	<i>Polycarpaea involucrata</i>
Chenopodiaceae	<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>
Convolvulaceae	<i>Bonamia linearis</i>
Convolvulaceae	<i>Bonamia media</i> var. <i>villosa</i>
Convolvulaceae	<i>Bonamia pannosa</i>
Convolvulaceae	<i>Bonamia rosea</i>
Convolvulaceae	<i>Bonamia</i> sp.
Convolvulaceae	<i>Bonamia</i> sp. (HD94-6)
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>
Convolvulaceae	<i>Polymeria ambigua</i>
Convolvulaceae	<i>Polymeria calycina</i>
Convolvulaceae	<i>Polymeria</i> sp. (site 1365)
Cucurbitaceae	* <i>Cucumis melo</i> subsp. <i>agrestis</i>
Cucurbitaceae	<i>Mukia maderaspatana</i>
Cyperaceae	<i>Bulbostylis barbata</i>
Cyperaceae	<i>Bulbostylis turbinata</i>
Cyperaceae	<i>Cyperus cunninghamii</i>
Cyperaceae	<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>
Cyperaceae	<i>Cyperus pulchellus</i>
Cyperaceae	<i>Cyperus vaginatus</i>
Cyperaceae	<i>Fimbristylis dichotoma</i>
Cyperaceae	<i>Fimbristylis microcarya</i>
Cyperaceae	<i>Fimbristylis simulans</i>
Euphorbiaceae	<i>Euphorbia</i> aff. <i>australis</i>
Euphorbiaceae	<i>Euphorbia biconvexa</i>
Euphorbiaceae	<i>Euphorbia clementii</i>
Euphorbiaceae	<i>Euphorbia coghlanii</i>
Euphorbiaceae	<i>Euphorbia</i> sp.

Family	Species Name
Euphorbiaceae	<i>Euphorbia</i> sp. (site 1089)
Euphorbiaceae	<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>
Euphorbiaceae	<i>Euphorbia wheeleri</i>
Euphorbiaceae	<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>
Euphorbiaceae	<i>Leptopus decaisnei</i> var. <i>orbicularis</i>
Euphorbiaceae	<i>Phyllanthus maderaspatensis</i>
Goodeniaceae	<i>Dampiera candidans</i>
Goodeniaceae	<i>Goodenia microptera</i>
Goodeniaceae	<i>Goodenia muelleriana</i>
Goodeniaceae	<i>Goodenia nuda</i>
Goodeniaceae	<i>Goodenia stobbsiana</i>
Goodeniaceae	<i>Scaevola amblyanthera</i> var. <i>centralis</i>
Lauraceae	<i>Cassytha capillaris</i>
Lauraceae	<i>Cassytha filiformis</i>
Loranthaceae	<i>Amyema sanguinea</i> var. <i>sanguinea</i>
Lythraceae	<i>Rotala diandra</i>
Malvaceae	<i>Abutilon</i> aff. <i>hannii</i>
Malvaceae	<i>Abutilon dioicum</i>
Malvaceae	<i>Gossypium australe</i> (Burrup Peninsula form)
Malvaceae	<i>Gossypium australe</i> (Whim Creek form)
Malvaceae	<i>Gossypium robinsonii</i>
Malvaceae	<i>Hibiscus</i> aff. <i>coatesii</i> (MET 15 305)
Malvaceae	<i>Hibiscus coatesii</i>
Malvaceae	<i>Hibiscus coatesii</i> (MET 15, 305)
Malvaceae	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>
Malvaceae	<i>Sida</i> aff. <i>fibulifera</i> (Site 1308)
Malvaceae	<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)
Malvaceae	<i>Sida pilbarensis</i>
Malvaceae	<i>Sida pilbarensis</i> (ferruginous form)
Malvaceae	<i>Sida rohlenae</i> subsp. <i>rohlenae</i>

Family	Species Name
Malvaceae	<i>Sida subarticulata</i>
Menispermaceae	<i>Tinospora smilacina</i>
Mimosaceae	<i>Acacia adoxa</i> var. <i>adoxo</i>
Mimosaceae	<i>Acacia bivenosa</i>
Mimosaceae	<i>Acacia colei</i> var. <i>colei</i>
Mimosaceae	<i>Acacia elachantha</i> (silvery hairy variant)
Mimosaceae	<i>Acacia inaequilatera</i>
Mimosaceae	<i>Acacia orthocarpa</i>
Mimosaceae	<i>Acacia ptychophylla</i>
Mimosaceae	<i>Acacia pyrifolia</i>
Mimosaceae	<i>Acacia</i> sp.
Mimosaceae	<i>Acacia spondylophylla</i>
Mimosaceae	<i>Acacia stellaticeps</i>
Mimosaceae	<i>Acacia tumida</i> var. <i>pilbarensis</i>
Mimosaceae	<i>Acacia victoriae</i>
Molluginaceae	<i>Mollugo molluginis</i>
Moraceae	<i>Ficus platypoda</i>
Myrtaceae	<i>Corymbia</i> aff. <i>hamersleyana</i>
Myrtaceae	<i>Corymbia ferritcola</i>
Myrtaceae	<i>Corymbia flavescens</i>
Myrtaceae	<i>Corymbia hamersleyana</i>
Myrtaceae	<i>Corymbia</i> sp.
Myrtaceae	<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>
Nyctaginaceae	<i>Boerhavia coccinea</i>
Nyctaginaceae	<i>Boerhavia gardneri</i>
Papilionaceae	<i>Alysicarpus muelleri</i>
Papilionaceae	<i>Cajanus cinereus</i>
Papilionaceae	<i>Crotalaria medicaginea</i>
Papilionaceae	<i>Cullen</i> sp.
Papilionaceae	<i>Desmodium filiforme</i>

Family	Species Name
Papilionaceae	<i>Indigastrum parviflorum</i>
Papilionaceae	<i>Indigofera monophylla</i> (Burrup form)
Papilionaceae	<i>Indigofera monophylla</i> (small calyx form)
Papilionaceae	<i>Indigofera trita</i>
Papilionaceae	<i>Isotropis atropurpurea</i>
Papilionaceae	<i>Leptosema anomalum</i>
Papilionaceae	<i>Rhynchosia minima</i> var. <i>australis</i>
Papilionaceae	<i>Templetonia hookeri</i>
Papilionaceae	<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)
Papilionaceae	<i>Tephrosia</i> aff. <i>supina</i>
Papilionaceae	<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)
Papilionaceae	<i>Tephrosia spechtii</i>
Poaceae	<i>Aristida holathera</i> var. <i>holathera</i>
Poaceae	<i>Aristida holathera</i> var. <i>latifolia</i>
Poaceae	<i>Aristida inaequiglumis</i>
Poaceae	<i>Brachyachne convergens</i>
Poaceae	* <i>Cenchrus ciliaris</i>
Poaceae	* <i>Chloris virgata</i>
Poaceae	<i>Chrysopogon fallax</i>
Poaceae	<i>Cymbopogon ambiguus</i>
Poaceae	<i>Cymbopogon procerus</i>
Poaceae	<i>Digitaria</i> sp.
Poaceae	<i>Enneapogon lindleyanus</i>
Poaceae	<i>Eragrostis</i> aff. <i>eriopoda</i> (WAS site 963)
Poaceae	<i>Eragrostis cumingii</i>
Poaceae	<i>Eragrostis tenellula</i>
Poaceae	<i>Eriachne aristidea</i>
Poaceae	<i>Eriachne ciliata</i>
Poaceae	<i>Eriachne lanata</i>
Poaceae	<i>Eriachne mucronata</i>



Family	Species Name
Poaceae	<i>Eriachne mucronata</i> (typical form)
Poaceae	<i>Eriachne obtusa</i>
Poaceae	<i>Eriachne</i> sp. Port Hedland
Poaceae	<i>Eulalia aurea</i>
Poaceae	<i>Iseilema dolichotrichum</i>
Poaceae	<i>Paraneurachne muelleri</i>
Poaceae	<i>Paspalidium clementii</i>
Poaceae	<i>Paspalidium rarum</i>
Poaceae	<i>Perotis rara</i>
Poaceae	<i>Sporobolus australasicus</i>
Poaceae	<i>Themeda</i> sp.
Poaceae	<i>Themeda triandra</i>
Poaceae	<i>Triodia biflora</i>
Poaceae	<i>Triodia epactia</i>
Poaceae	<i>Triodia</i> sp.
Poaceae	<i>Triodia wiseana</i>
Poaceae	<i>Yakirra australiensis</i> var. <i>australiensis</i>
Polygalaceae	<i>Polygala</i> aff. <i>isingii</i>
Portulacaceae	* <i>Portulaca oleracea</i>
Proteaceae	<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>
Proteaceae	<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>
Proteaceae	<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>
Proteaceae	<i>Hakea chordophylla</i>
Proteaceae	<i>Hakea lorea</i> subsp. <i>lorea</i>
Rubiaceae	<i>Oldenlandia crouchiana</i>
Rubiaceae	<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>
Sapindaceae	<i>Atalaya hemiglauca</i>
Sapindaceae	<i>Dodonaea coriacea</i>
Scrophulariaceae	<i>Stemodia grossa</i>
Scrophulariaceae	<i>Stemodia viscosa</i>

Family	Species Name
Solanaceae	<i>Nicotiana</i> sp.
Solanaceae	<i>Solanum beaugleholei</i>
Solanaceae	<i>Solanum cunninghamii</i>
Solanaceae	<i>Solanum dioicum</i>
Solanaceae	<i>Solanum diversiflorum</i>
Solanaceae	<i>Solanum phlomoides</i>
Sterculiaceae	<i>Waltheria indica</i>
Tiliaceae	<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)
Tiliaceae	<i>Corchorus elachocarpus</i>
Tiliaceae	<i>Corchorus sidoides</i> subsp. aff. <i>vermicularis</i> (GLD NIM17-16)
Tiliaceae	<i>Triumfetta chaetocarpa</i>
Tiliaceae	<i>Triumfetta clementii</i>
Tiliaceae	<i>Triumfetta maconochieana</i>
Tiliaceae	<i>Triumfetta plumigera</i>
Violaceae	<i>Hybanthus aurantiacus</i>
Zygophyllaceae	<i>Tribulus platypterus</i>
Zygophyllaceae	<i>Tribulus</i> sp.
Zygophyllaceae	<i>Tribulus suberosus</i>

## Appendix G1: Callawa Flora Species Inventory

Family	Species Name
Aizoaceae	<i>Trianthema triquetra</i>
Amaranthaceae	<i>Alternanthera nana</i>
Amaranthaceae	<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)
Amaranthaceae	<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>
Amaranthaceae	<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>
Apiaceae	<i>Trachymene oleracea</i> subsp. <i>Oleracea</i>
Apocynaceae	<i>Carissa lanceolata</i>
Asteraceae	<i>Pluchea ferdinandi-muelleri</i>
Asteraceae	<i>Pluchea</i> sp.
Asteraceae	<i>Pluchea tetranthera</i>
Asteraceae	<i>Pterocaulon sphaeranthoides</i>
Bignoniaceae	<i>Dolichandrone heterophylla</i>
Boraginaceae	<i>Heliotropium cunninghamii</i>
Boraginaceae	<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>
Caesalpiniaceae	<i>Petalostylis labicheoides</i>
Caesalpiniaceae	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>
Caesalpiniaceae	<i>Senna glutinosa</i> subsp. <i>luerssenii</i>
Caesalpiniaceae	<i>Senna notabilis</i>
Capparaceae	<i>Cleome uncifera</i> subsp. <i>uncifera</i>
Capparaceae	<i>Cleome viscosa</i>
Chenopodiaceae	<i>Salsola tragus</i> subsp. <i>tragus</i>
Chenopodiaceae	<i>Sclerolaena convexula</i> x <i>costata</i>
Convolvulaceae	<i>Bonamia linearis</i>
Convolvulaceae	<i>Bonamia media</i> var. <i>villosa</i>
Convolvulaceae	<i>Bonamia rosea</i>
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>decumbens</i>
Convolvulaceae	<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>
Convolvulaceae	<i>Ipomoea muelleri</i>
Convolvulaceae	<i>Polymeria calycina</i>
Convolvulaceae	<i>Polymeria</i> sp. (site 1365)

Family	Species Name
Cucurbitaceae	<i>Mukia maderaspatana</i>
Cyperaceae	<i>Bulbostylis barbata</i>
Cyperaceae	<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>
Cyperaceae	<i>Cyperus iria</i>
Cyperaceae	<i>Cyperus vaginatus</i>
Cyperaceae	<i>Fimbristylis simulans</i>
Euphorbiaceae	<i>Euphorbia coghlanii</i>
Euphorbiaceae	<i>Euphorbia</i> sp. (site 1089)
Euphorbiaceae	<i>Euphorbia wheeleri</i>
Euphorbiaceae	<i>Phyllanthus maderaspatensis</i>
Goodeniaceae	<i>Dampiera candidans</i>
Goodeniaceae	<i>Goodenia microptera</i>
Goodeniaceae	<i>Goodenia muelleriana</i>
Goodeniaceae	<i>Goodenia stobbsiana</i>
Malvaceae	<i>Hibiscus leptocladus</i>
Malvaceae	<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>
Malvaceae	<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)
Malvaceae	<i>Sida pilbarensis</i> (ferruginous form)
Malvaceae	<i>Sida rohlenae</i> subsp. <i>rohlenae</i>
Malvaceae	<i>Sida rohlenae</i> var. <i>rohlenae</i>
Menispermaceae	<i>Tinospora smilacina</i>
Mimosaceae	<i>Acacia ancistrocarpa</i>
Mimosaceae	<i>Acacia aneura</i>
Mimosaceae	<i>Acacia colei</i> var. <i>colei</i>
Mimosaceae	<i>Acacia elachantha</i> (silvery hairy variant)
Mimosaceae	<i>Acacia inaequilatera</i>
Mimosaceae	<i>Acacia ptychophylla</i>
Mimosaceae	<i>Acacia</i> sp.
Mimosaceae	<i>Acacia spondylophylla</i>
Mimosaceae	<i>Acacia stellaticeps</i>
Mimosaceae	<i>Acacia synchronicia</i>



Family	Species Name
Mimosaceae	<i>Acacia trachycarpa</i> subsp. <i>tumida</i> var. <i>pilbarensis</i>
Mimosaceae	<i>Acacia tumida</i> var. <i>pilbarensis</i>
Mimosaceae	<i>Acacia victoriae</i>
Molluginaceae	<i>Mollugo molluginis</i>
Myrtaceae	<i>Corymbia</i> aff. <i>hamersleyana</i>
Myrtaceae	<i>Corymbia flavescens</i>
Myrtaceae	<i>Corymbia hamersleyana</i>
Myrtaceae	<i>Corymbia opaca</i>
Nyctaginaceae	<i>Boerhavia coccinea</i>
Nyctaginaceae	<i>Boerhavia gardneri</i>
Papilionaceae	<i>Alysicarpus muelleri</i>
Papilionaceae	<i>Cajanus cinereus</i>
Papilionaceae	<i>Cajanus marmoratus</i>
Papilionaceae	<i>Crotalaria ramosissima</i>
Papilionaceae	<i>Cullen stipulaceum</i>
Papilionaceae	<i>Desmodium filiforme</i>
Papilionaceae	<i>Desmodium</i> sp.
Papilionaceae	<i>Indigofera colutea</i>
Papilionaceae	<i>Indigofera linnaei</i>
Papilionaceae	<i>Indigofera monophylla</i>
Papilionaceae	<i>Indigofera monophylla</i> (small calyx form)
Papilionaceae	<i>Indigofera trita</i>
Papilionaceae	<i>Isotropis atropurpurea</i>
Papilionaceae	<i>Rhynchosia minima</i> var. <i>australis</i>
Papilionaceae	<i>Tephrosia</i> aff. <i>bidwillii</i> (HD153-5)
Papilionaceae	<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)
Papilionaceae	<i>Tephrosia</i> aff. <i>supina</i>
Papilionaceae	<i>Tephrosia</i> aff. <i>supina</i> (MET 12,357)
Papilionaceae	<i>Tephrosia</i> sp. <i>Bungaroo Creek</i> (M.E. Trudgen 11601)
Papilionaceae	<i>Tephrosia spechtii</i>
Papilionaceae	<i>Zornia muelleriana</i> subsp. <i>congesta</i>

Family	Species Name
Poaceae	<i>Aristida contorta</i>
Poaceae	<i>Aristida holathera</i> var. <i>latifolia</i>
Poaceae	* <i>Cenchrus ciliaris</i>
Poaceae	<i>Chloris pumilio</i>
Poaceae	* <i>Chloris virgata</i>
Poaceae	<i>Chrysopogon fallax</i>
Poaceae	<i>Cymbopogon ambiguus</i>
Poaceae	<i>Cymbopogon procerus</i>
Poaceae	<i>Dactyloctenium radulans</i>
Poaceae	<i>Digitaria</i> sp.
Poaceae	* <i>Echinochloa colona</i>
Poaceae	<i>Eragrostis</i> aff. <i>eriopoda</i> (WAS site 963)
Poaceae	<i>Eragrostis cumingii</i>
Poaceae	<i>Eragrostis</i> sp.
Poaceae	<i>Eriachne aristidea</i>
Poaceae	<i>Eriachne mucronata</i> (typical form)
Poaceae	<i>Eriachne obtusa</i>
Poaceae	<i>Eriachne pulchella</i>
Poaceae	<i>Eriachne pulchella</i> subsp. <i>dominii</i>
Poaceae	<i>Eriachne</i> sp. Port Hedland
Poaceae	<i>Eriachne tenuiculmis</i>
Poaceae	<i>Eulalia aurea</i>
Poaceae	<i>Paraneurachne muelleri</i>
Poaceae	<i>Paspalidium rarum</i>
Poaceae	<i>Perotis rara</i>
Poaceae	<i>Sporobolus australasicus</i>
Poaceae	<i>Themeda triandra</i>
Poaceae	<i>Triodia angusta</i>
Poaceae	<i>Triodia epactia</i>
Poaceae	<i>Triodia</i> sp.
Poaceae	<i>Triodia wiseana</i>

Family	Species Name
Poaceae	<i>Yakirra australiensis</i> var. <i>australiensis</i>
Portulacaceae	* <i>Portulaca oleracea</i>
Proteaceae	<i>Grevillea pyramidalis</i>
Proteaceae	<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>
Proteaceae	<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>
Proteaceae	<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>
Proteaceae	<i>Hakea chordophylla</i>
Rubiaceae	<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>
Scrophulariaceae	<i>Stemodia grossa</i>
Solanaceae	<i>Solanum beaugleholei</i>
Solanaceae	<i>Solanum cunninghamii</i>
Solanaceae	<i>Solanum dioicum</i>
Solanaceae	<i>Solanum diversiflorum</i>
Solanaceae	<i>Solanum phlomoides</i>
Sterculiaceae	<i>Waltheria indica</i>
Tiliaceae	<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)
Tiliaceae	<i>Corchorus elachocarpus</i>
Tiliaceae	<i>Triumfetta chaetocarpa</i>
Tiliaceae	<i>Triumfetta maconochieana</i>
Tiliaceae	<i>Triumfetta</i> sp.
Violaceae	<i>Hybanthus aurantiacus</i>
Zygophyllaceae	<i>Tribulus hirsutus</i>
Zygophyllaceae	<i>Tribulus platypterus</i>
Zygophyllaceae	<i>Tribulus</i> sp.

# **APPENDIX H**

## **FLORA SPECIES BY SITE MATRIX**



CUNDALINE AND CALLAWA  
FLORA AND VEGETATION ASSESSMENT

## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	CU15	CU16
<i>Abutilon</i> aff. <i>hannii</i>																
<i>Abutilon dioicum</i>						+								+		
<i>Acacia adoxa</i> var. <i>adoxo</i>		1%		+	1%	2%	+	1%	+		3%	+				10%
<i>Acacia bivenosa</i>			10%													
<i>Acacia colei</i> var. <i>colei</i>	+											+			10%	+
<i>Acacia elachantha</i> (silvery hairy variant)																
<i>Acacia inaequilatera</i>						2%					+			+		
<i>Acacia orthocarpa</i>																
<i>Acacia ptychophylla</i>		1%	5%	1%	3%	5%	+	3%	+	+	5%	+	30%			+
<i>Acacia pyrifolia</i>		4%	1%	+			5%			+		30%	5%	1%	3%	2%
<i>Acacia</i> sp.																
<i>Acacia spondylophylla</i>																
<i>Acacia stellaticeps</i>	+	+						10%								
<i>Acacia tumida</i> var. <i>pilbarensis</i>		20%		2%	5%		5%	+	15%	3%	2%	50%	5%			10%
<i>Acacia victoriae</i>																
<i>Alysicarpus muelleri</i>																
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)												1				
<i>Amaranthus</i> sp.																1
<i>Amyema sanguinea</i> var. <i>sanguinea</i>															+	
<i>Aristida holathera</i> var. <i>holathera</i>																
<i>Aristida holathera</i> var. <i>latifolia</i>										+						
<i>Aristida inaequiglumis</i>						+										
<i>Atalaya hemiglauc</i>	1%											+			+	
<i>Boerhavia coccinea</i>		+													+	
<i>Boerhavia gardneri</i>										+						
<i>Bonamia linearis</i>																
<i>Bonamia media</i> var. <i>villosa</i>				+	+	+								+		
<i>Bonamia pannosa</i>																
<i>Bonamia rosea</i>																
<i>Bonamia</i> sp.																
<i>Bonamia</i> sp. (HD94-6)																
<i>Brachyachne convergens</i>																
<i>Bulbostylis barbata</i>		+														+
<i>Bulbostylis turbinata</i>																
<i>Cajanus cinereus</i>			1%									20%			+	1%
<i>Carissa lanceolata</i>																
<i>Cassytha capillaris</i>																
<i>Cassytha filiformis</i>																
<i>Cenchrus ciliaris</i>															20%	
<i>Chloris virgata</i>																
<i>Chrysopogon fallax</i>								+				1%			50%	
<i>Cleome uncifera</i> subsp. <i>uncifera</i>		+														
<i>Cleome viscosa</i>		+													+	+
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)	+	+	1%	+		+	+		+	+				+	+	8%
<i>Corchorus elachocarpus</i>		+						1%								
<i>Corchorus sidioides</i> subsp. aff. <i>vermicularis</i> (GLD NIM17-16)																
<i>Corymbia</i> aff. <i>hamersleyana</i>												3%		1%		
<i>Corymbia ferricola</i>																+
<i>Corymbia flavescens</i>												2%			3%	
<i>Corymbia hamersleyana</i>		+	+	+	+	+		1%		2%				+	3%	5%
<i>Corymbia</i> sp.																
<i>Crotalaria medicaginea</i>																

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	CU15	CU16
<i>Cucumis melo</i> subsp. <i>agrestis</i>																
<i>Cullen</i> sp.																
<i>Cymbopogon ambiguus</i>			1%		+	+						1%				5%
<i>Cymbopogon procerus</i>	1%	+					+		+	+						
<i>Cyperus cunninghamii</i>	+															
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>			+													+
<i>Cyperus pulchellus</i>																
<i>Cyperus vaginatus</i>															1%	
<i>Dampiera candidans</i>		+		+	+		+	+		1%		+	5%			1%
<i>Desmodium filiforme</i>																
<i>Digitaria</i> sp.															+	
<i>Dodonaea coriacea</i>						+										
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>																
<i>Enneapogon lindleyanus</i>		+										1%				
<i>Eragrostis</i> aff. <i>eripoda</i> (WAS site 963)																
<i>Eragrostis cumingii</i>															1%	
<i>Eragrostis tenellula</i>																
<i>Eriachne aristidea</i>																
<i>Eriachne ciliata</i>												+				+
<i>Eriachne lanata</i>				+	+								2%			
<i>Eriachne mucronata</i>				1%			1%						+			
<i>Eriachne mucronata</i> (typical form)	1%	+	+			1%			2%			1%		+		5%
<i>Eriachne obtusa</i>									+	+						
<i>Eriachne</i> sp. Port Hedland							+		+							
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	2%					1%	+	+	5%	+	2%	+	+			
<i>Eulalia aurea</i>										+						
<i>Euphorbia</i> aff. <i>australis</i>																
<i>Euphorbia biconvexa</i>																
<i>Euphorbia clementii</i>																
<i>Euphorbia coghlanii</i>															+	
<i>Euphorbia</i> sp.																+
<i>Euphorbia</i> sp. (site 1089)			+													
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>																
<i>Euphorbia wheeleri</i>			+													
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>			+											+	+	
<i>Ficus platypoda</i>												+				+
<i>Fimbristylis dichotoma</i>				+												
<i>Fimbristylis microcarya</i>									+							
<i>Fimbristylis simulans</i>							+		+	+						
<i>Flaveria australasica</i>																
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>												1%				
<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>																
<i>Gomphrena cunninghamii</i>						1			1			1				1
<i>Goodenia microptera</i>																
<i>Goodenia muelleriana</i>														+		
<i>Goodenia nuda</i>															+	
<i>Goodenia stobbsiana</i>		+														
<i>Gossypium australe</i> (Burrup Peninsula form)															+	
<i>Gossypium australe</i> (Whim Creek form)			+					+								
<i>Gossypium robinsonii</i>																
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>					+	+				+	1%			+		
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>			1%													1%

CUNDALINE AND CALLAWA  
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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	CU15	CU16
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>			2%	8%	10%	+	4%	+	3%	20%	2%	20%	15%			5%
<i>Hakea chordophylla</i>	+															
<i>Hakea lorea</i> subsp. <i>lorea</i>																
<i>Hibiscus</i> aff. <i>coatesii</i> (MET 15 305)			+													+
<i>Hibiscus coatesii</i>						+										
<i>Hibiscus coatesii</i> (MET 15, 305)																1%
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>						+						+				
<i>Hybanthus aurantiacus</i>		+		+	+			+		+		+			+	
<i>Indigostrum parviflorum</i>	+															
<i>Indigofera monophylla</i> (Burrup form)																
<i>Indigofera monophylla</i> (small calyx form)		+			+	+	+	+	+	+	+	10%		3%		10%
<i>Indigofera trita</i>	+											+		+	+	
<i>Iseilema dolichotrichum</i>									+							
<i>Isotropis atropurpurea</i>																
<i>Leptopus decaisnei</i> var. <i>orbicularis</i>												+				
<i>Leptosema anomalum</i>																
<i>Mollugo molluginis</i>		+	+												1%	+
<i>Mukia maderaspatana</i>															+	
<i>Nicotiana</i> sp.																+
<i>Oldenlandia crouchiana</i>																+
<i>Paraneurachne muelleri</i>																
<i>Paspalidium clementii</i>		+														
<i>Paspalidium rarum</i>																
<i>Perotis rara</i>															+	
<i>Phyllanthus maderaspatensis</i>																
<i>Pluchea rubelliflora</i>															+	
<i>Pluchea tetranthera</i>		+	+	+											+	+
<i>Polycarpaea involucrata</i>																
<i>Polygala</i> aff. <i>isingii</i>																
<i>Polymeria ambigua</i>															2%	
<i>Polymeria calycina</i>		+													+	
<i>Polymeria</i> sp. (site 1365)																
<i>Portulaca oleracea</i>															+	
<i>Pterocaulon serrulatum</i>	+															+
<i>Pterocaulon sphacelatum</i>		+														
<i>Pterocaulon sphaeranthoides</i>		+													+	
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>								1								
<i>Ptilotus axillaris</i>		1	1												1	
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>		1			1			1		1	1					10%
<i>Ptilotus exaltatus</i>										1						

CUNDALINE AND CALLAWA  
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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU01	CU02	CU03	CU04	CU05	CU06	CU07	CU08	CU09	CU10	CU11	CU12	CU13	CU14	CU15	CU16
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>		1														1
<i>Ptilotus obovatus</i>												1				
<i>Rhodanthe margarethae</i>																+
<i>Rhynchosia minima</i> var. <i>australis</i>												1%				
<i>Rotala diandra</i>																
<i>Scaevola amblyanthera</i> var. <i>centralis</i>																
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>																
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	+					+				+	+	+				
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>																
<i>Senna notabilis</i>																
<i>Sida</i> aff. <i>fibulifera</i> (Site 1308)															+	
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)			+		+											+
<i>Sida pilbarensis</i>										+						
<i>Sida pilbarensis</i> (ferruginous form)					+					+						
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>																
<i>Sida subarticulata</i>				+			+		+			5%				+
<i>Solanum beaugholei</i>										+	+	+	+			+
<i>Solanum cunninghamii</i>																
<i>Solanum dioicum</i>							+		20%							3%
<i>Solanum diversiflorum</i>															+	
<i>Solanum phlomoides</i>																
<i>Sporobolus australasicus</i>																
<i>Stemodia grossa</i>				+	+			+							+	
<i>Stemodia viscosa</i>																
<i>Streptoglossa decurrens</i>		+														+
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>																
<i>Templetonia hookeri</i>																
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)		+				+						5%		+	6%	
<i>Tephrosia</i> aff. <i>supina</i>			+	+	+	+				+	1%					
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)		+														
<i>Tephrosia spechtii</i>	+															+
<i>Themeda</i> sp.	+		5%													
<i>Themeda triandra</i>																
<i>Tinospora smilacina</i>																+
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>																1
<i>Tribulus platypterus</i>																
<i>Tribulus</i> sp.			+													
<i>Tribulus suberosus</i>			+			+										
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>		+														
<i>Triodia biflora</i>							30%					60%				20%
<i>Triodia epactia</i>	45%	70%	50%	55%	55%	5%	20%	75%		50%			40%			
<i>Triodia</i> sp.														35%		
<i>Triodia wiseana</i>						5%	10%			70%				+		70%
<i>Triumfetta chaetocarpa</i>																
<i>Triumfetta clementii</i>			+									+				
<i>Triumfetta maconochieana</i>	+															2%
<i>Triumfetta plumigera</i>		+													+	
<i>Waltheria indica</i>		+														
<i>Yakirra australiensis</i> var. <i>australiensis</i>																



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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU17	CU18	CU19	CU20	CU21	CU22	CU23	CU24	CU25	CU26	CU27	CU28	CU29	CU30	CU31	CU32	CU33
<i>Abutilon</i> aff. <i>hannii</i>			+														
<i>Abutilon dioicum</i>		+															
<i>Acacia adoxa</i> var. <i>adoxo</i>	+	assoc	+	+				1%	assoc			+	10%		2%		+
<i>Acacia bivenosa</i>			+					+									
<i>Acacia colei</i> var. <i>colei</i>			3%					+		+	5%						
<i>Acacia elachantha</i> (silvery hairy variant)																	+
<i>Acacia inaequilatera</i>	1%	2%		2%				1%			+					3%	3%
<i>Acacia orthocarpa</i>																	
<i>Acacia ptychophylla</i>		+		+	5%	+	1%	3%					12%		+	+	+
<i>Acacia pyrifolia</i>	+		5%		+	5%				1%		+		+			
<i>Acacia</i> sp.											+						
<i>Acacia spondylophylla</i>													+				
<i>Acacia stellaticeps</i>	+											5%	1%				
<i>Acacia tumida</i> var. <i>pilbarensis</i>	2%		10%		2%	1%	30%		+					3%	5%		
<i>Acacia victoriae</i>											2%						
<i>Alysicarpus muelleri</i>		+															
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)			1														
<i>Amaranthus</i> sp.						1											
<i>Amyema sanguinea</i> var. <i>sanguinea</i>																	
<i>Aristida holathera</i> var. <i>holathera</i>													+				+
<i>Aristida holathera</i> var. <i>latifolia</i>	+				+				+		+	+			+		
<i>Aristida inaequiglumis</i>																	
<i>Atalaya hemiglaucula</i>		1%															
<i>Boerhavia coccinea</i>		+							+								
<i>Boerhavia gardneri</i>										+						+	
<i>Bonamia linearis</i>											+	+					
<i>Bonamia media</i> var. <i>villosa</i>		+						+					+			+	
<i>Bonamia pannosa</i>	+								1%	+							
<i>Bonamia rosea</i>	+																
<i>Bonamia</i> sp.																+	
<i>Bonamia</i> sp. (HD94-6)																	+
<i>Brachyachne convergens</i>			+						+								
<i>Bulbostylis barbata</i>							+		+								
<i>Bulbostylis turbinata</i>							+										
<i>Cajanus cinereus</i>															+		
<i>Carissa lanceolata</i>		1%								+							
<i>Cassytha capillaris</i>					+												
<i>Cassytha filiformis</i>			+														
<i>Cenchrus ciliaris</i>																	
<i>Chloris virgata</i>			1%														
<i>Chrysopogon fallax</i>																	
<i>Cleome uncifera</i> subsp. <i>uncifera</i>	+			+					+				+				
<i>Cleome viscosa</i>			+						+								
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)	1%	1%	+	+				+		+	+		3%		+	1%	+
<i>Corchorus elachocarpus</i>																	
<i>Corchorus sidioides</i> subsp. aff. <i>vermicularis</i> (GLD NIM17-16)	+								+	+	+						
<i>Corymbia</i> aff. <i>hamersleyana</i>			1%				+										
<i>Corymbia ferricola</i>																	
<i>Corymbia flavescentis</i>							+										+
<i>Corymbia hamersleyana</i>	5%	1%	1%	5%	1%	1%		10%	5%	2%	1%			1%			1%
<i>Corymbia</i> sp.																+	
<i>Crotalaria medicaginea</i>										+							

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU17	CU18	CU19	CU20	CU21	CU22	CU23	CU24	CU25	CU26	CU27	CU28	CU29	CU30	CU31	CU32	CU33
<i>Cucumis melo</i> subsp. <i>agrestis</i>			+														
<i>Cullen</i> sp.																	
<i>Cymbopogon ambiguus</i>		1%					+										
<i>Cymbopogon procerus</i>															1%		
<i>Cyperus cunninghamii</i>																	
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>						+	+								+		
<i>Cyperus pulchellus</i>							+										
<i>Cyperus vaginatus</i>		+															
<i>Dampiera candidans</i>				+	+	2%	+		+	+		1%	+	+	+		
<i>Desmodium filiforme</i>															+		
<i>Digitaria</i> sp.		+															
<i>Dodonaea coriacea</i>																	
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>									+								
<i>Enneapogon lindleyanus</i>																	
<i>Eragrostis</i> aff. <i>eripoda</i> (WAS site 963)	1%																
<i>Eragrostis cumingii</i>			+				+		+								
<i>Eragrostis tenellula</i>			+														
<i>Eriachne aristidea</i>									+								
<i>Eriachne ciliata</i>						+	+								+		
<i>Eriachne lanata</i>		1%			+	2%								+	+		
<i>Eriachne mucronata</i>															+		
<i>Eriachne mucronata</i> (typical form)		1%				2%	+					+					+
<i>Eriachne obtusa</i>												+					
<i>Eriachne</i> sp. Port Hedland												+	+		+		
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>		assoc													10%	+	
<i>Eulalia aurea</i>			+														
<i>Euphorbia</i> aff. <i>australis</i>				+						+							
<i>Euphorbia biconvexa</i>			+														
<i>Euphorbia clementii</i>										assoc							
<i>Euphorbia coghlanii</i>			+						+								
<i>Euphorbia</i> sp.					+												
<i>Euphorbia</i> sp. (site 1089)																	+
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>		+															
<i>Euphorbia wheeleri</i>																	
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>																	
<i>Ficus platypoda</i>						+											
<i>Fimbristylis dichotoma</i>																	
<i>Fimbristylis microcarya</i>							+										
<i>Fimbristylis simulans</i>	+			+	+	+						+			+		+
<i>Flaveria australasica</i>												+					
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>																	
<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>			1														
<i>Gomphrena cunninghamii</i>		1				1											
<i>Goodenia microptera</i>	+					+			+	+		+					
<i>Goodenia muelleriana</i>										+						+	
<i>Goodenia nuda</i>																	
<i>Goodenia stobbsiana</i>	+	1%		+		+	+										
<i>Gossypium australe</i> (Burrup Peninsula form)																	
<i>Gossypium australe</i> (Whim Creek form)																	
<i>Gossypium robinsonii</i>			1%														
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>	+	1%		+				assoc	assoc			+	2%				
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>																	

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU17	CU18	CU19	CU20	CU21	CU22	CU23	CU24	CU25	CU26	CU27	CU28	CU29	CU30	CU31	CU32	CU33
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	10%		+	+	15%	4%	5%	1%	15%								
<i>Hakea chordophylla</i>										assoc				+			
<i>Hakea lorea</i> subsp. <i>lorea</i>		1%															
<i>Hibiscus</i> aff. <i>coatesii</i> (MET 15 305)		+															
<i>Hibiscus coatesii</i>																	
<i>Hibiscus coatesii</i> (MET 15, 305)																	
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>	+		+	+											+		
<i>Hybanthus aurantiacus</i>	+		+		+				+	+		+	1%				
<i>Indigastrium parviflorum</i>																	
<i>Indigofera monophylla</i> (Burrup form)										1%							
<i>Indigofera monophylla</i> (small calyx form)	+		+			2%	+	+					1%				
<i>Indigofera trita</i>		1%							+								
<i>Iseilema dolichotrichum</i>																	
<i>Isotropis atropurpurea</i>			+														
<i>Leptopus decaisnei</i> var. <i>orbicularis</i>																	
<i>Leptosema anomalum</i>												1%					
<i>Mollugo molluginis</i>	+		+		+	+		+	+	1%			+			+	+
<i>Mukia maderaspatana</i>		+															
<i>Nicotiana</i> sp.																	
<i>Oldenlandia crouchiana</i>						+											
<i>Paraneurachne muelleri</i>									+								
<i>Paspalidium clementii</i>																	
<i>Paspalidium rarum</i>			+														
<i>Perotis rara</i>																	
<i>Phyllanthus maderaspatensis</i>																	
<i>Pluchea rubelliflora</i>			4%									+	+		+		
<i>Pluchea tetranthera</i>	+					+			2%	+	+	+					
<i>Polycarpaea involucrata</i>							+										
<i>Polygala</i> aff. <i>isingii</i>	+																
<i>Polymeria ambigua</i>			+														
<i>Polymeria calycina</i>			+														
<i>Polymeria</i> sp. (site 1365)			+														
<i>Portulaca oleracea</i>									+								
<i>Pterocaulon serrulatum</i>						20%											
<i>Pterocaulon sphacelatum</i>	+								+		+		+				
<i>Pterocaulon sphaeranthoides</i>			+														
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>	1							1							1		
<i>Ptilotus axillaris</i>									1								
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>	20%	1	1%	1	1			1		1%		1		1		1	
<i>Ptilotus exaltatus</i>																	

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU17	CU18	CU19	CU20	CU21	CU22	CU23	CU24	CU25	CU26	CU27	CU28	CU29	CU30	CU31	CU32	CU33
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>	1			1		1			1	1			1				
<i>Ptilotus obovatus</i>																	
<i>Rhodanthe margarethae</i>																	
<i>Rhynchosia minima</i> var. <i>australis</i>		+														+	
<i>Rotala diandra</i>							+										
<i>Scaevola amblyanthera</i> var. <i>centralis</i>											+						
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>		+															
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>		+						1%					+		+		
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>																	
<i>Senna notabilis</i>	15%	+	+						1%	+	+						
<i>Sida</i> aff. <i>fibulifera</i> (Site 1308)			+														
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)		+						+		+						+	
<i>Sida pilbarensis</i>	+																
<i>Sida pilbarensis</i> (ferruginous form)			+	+					+	+							
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>											+						
<i>Sida subarticulata</i>							+										
<i>Solanum beaughleholei</i>					+	+								+			
<i>Solanum cunninghamii</i>	+			+					+	+							
<i>Solanum dioicum</i>		+	+		+	1%	+	+					+		+		
<i>Solanum diversiflorum</i>	1%	+	+	+		+				1%							+
<i>Solanum phlomoides</i>																	
<i>Sporobolus australasicus</i>			+						+								
<i>Stemodia grossa</i>	+		3%	+	+				+	+			+				
<i>Stemodia viscosa</i>												+	+				
<i>Streptoglossa decurrens</i>																	
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>	+						+										
<i>Templetonia hookeri</i>							+										
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)			+			1%							2%				+
<i>Tephrosia</i> aff. <i>supina</i>			+		+									+		+	+
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)		1%															
<i>Tephrosia spechtii</i>																	1%
<i>Themeda</i> sp.																	
<i>Themeda triandra</i>		+															
<i>Tinospora smilacina</i>							+										
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>						1											
<i>Tribulus platypterus</i>		+															
<i>Tribulus</i> sp.																	
<i>Tribulus suberosus</i>																	
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>																	
<i>Triodia biflora</i>							5%								30%		
<i>Triodia epactia</i>	5%		10%	+	40%		25%	55%	+	10%		35%	50%	40%			50%
<i>Triodia</i> sp.																	
<i>Triodia wiseana</i>		+		7%							40%					40%	
<i>Triumfetta chaetocarpa</i>																	
<i>Triumfetta clementii</i>		1%	+	+													+
<i>Triumfetta maconochieana</i>						+											
<i>Triumfetta plumigera</i>							+										
<i>Waltheria indica</i>																	
<i>Yakirra australiensis</i> var. <i>australiensis</i>									+								



CUNDALINE AND CALLAWA  
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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU34	CU36	CU37	CU R01
<i>Abutilon</i> aff. <i>hannii</i>				
<i>Abutilon dioicum</i>				+
<i>Acacia adoxa</i> var. <i>adoxo</i>	+	1%	7%	
<i>Acacia bivenosa</i>				
<i>Acacia colei</i> var. <i>colei</i>				
<i>Acacia elachantha</i> (silvery hairy variant)				
<i>Acacia inaequilatera</i>	5%		5%	2%
<i>Acacia orthocarpa</i>		20%		
<i>Acacia ptychophylla</i>	1%		25%	80%
<i>Acacia pyrifolia</i>			+	
<i>Acacia</i> sp.				
<i>Acacia spondylophylla</i>				
<i>Acacia stellaticeps</i>				
<i>Acacia tumida</i> var. <i>pilbarensis</i>	+		+	
<i>Acacia victoriae</i>			+	
<i>Alysicarpus muelleri</i>			+	
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)				
<i>Amaranthus</i> sp.				
<i>Amyema sanguinea</i> var. <i>sanguinea</i>				
<i>Aristida holathera</i> var. <i>holathera</i>				
<i>Aristida holathera</i> var. <i>latifolia</i>				
<i>Aristida inaequiglumis</i>		+		
<i>Atalaya hemiglauc</i>				
<i>Boerhavia coccinea</i>				
<i>Boerhavia gardneri</i>				
<i>Bonamia linearis</i>				
<i>Bonamia media</i> var. <i>villosa</i>				
<i>Bonamia pannosa</i>				
<i>Bonamia rosea</i>				
<i>Bonamia</i> sp.				
<i>Bonamia</i> sp. (HD94-6)				
<i>Brachyachne convergens</i>				
<i>Bulbostylis barbata</i>				
<i>Bulbostylis turbinata</i>				
<i>Cajanus cinereus</i>				
<i>Carissa lanceolata</i>				
<i>Cassytha capillaris</i>				
<i>Cassytha filiformis</i>				
<i>Cenchrus ciliaris</i>				
<i>Chloris virgata</i>				
<i>Chrysopogon fallax</i>				
<i>Cleome uncifera</i> subsp. <i>uncifera</i>			+	
<i>Cleome viscosa</i>		+		
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)	+	+	3%	+
<i>Corchorus elachocarpus</i>				
<i>Corchorus sidoides</i> subsp. aff. <i>vermicularis</i> (GLD NIM17-16)			+	
<i>Corymbia</i> aff. <i>hamersleyana</i>				
<i>Corymbia ferritcola</i>				
<i>Corymbia flavesces</i>				
<i>Corymbia hamersleyana</i>	1%		2%	
<i>Corymbia</i> sp.				
<i>Crotalaria medicaginea</i>				

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU34	CU36	CU37	CU R01
<i>Cucumis melo</i> subsp. <i>agrestis</i>				
<i>Cullen</i> sp.		+		
<i>Cymbopogon ambiguus</i>	+	1%		
<i>Cymbopogon procerus</i>				
<i>Cyperus cunninghamii</i>				
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>				
<i>Cyperus pulchellus</i>				
<i>Cyperus vaginatus</i>				
<i>Dampiera candidans</i>	+	+		
<i>Desmodium filiforme</i>				
<i>Digitaria</i> sp.				
<i>Dodonaea coriacea</i>				
<i>Dysphania rhadinostachya</i> subsp. <i>rhadinostachya</i>				
<i>Enneapogon lindleyanus</i>				
<i>Eragrostis</i> aff. <i>eripoda</i> (WAS site 963)				
<i>Eragrostis cumingii</i>				
<i>Eragrostis tenellula</i>				
<i>Eriachne aristidea</i>				
<i>Eriachne ciliata</i>				
<i>Eriachne lanata</i>	+	+		
<i>Eriachne mucronata</i>	20%	+		+
<i>Eriachne mucronata</i> (typical form)		+		
<i>Eriachne obtusa</i>		+		
<i>Eriachne</i> sp. Port Hedland				
<i>Eucalyptus leucophloia</i> subsp. <i>leucophloia</i>	1%			
<i>Eulalia aurea</i>				
<i>Euphorbia</i> aff. <i>australis</i>				
<i>Euphorbia biconvexa</i>				
<i>Euphorbia clementii</i>				
<i>Euphorbia coghlanii</i>				
<i>Euphorbia</i> sp.				
<i>Euphorbia</i> sp. (site 1089)				
<i>Euphorbia tannensis</i> subsp. <i>eremophila</i>				
<i>Euphorbia wheeleri</i>		+		
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>				
<i>Ficus platypoda</i>				
<i>Fimbristylis dichotoma</i>				
<i>Fimbristylis microcarya</i>				
<i>Fimbristylis simulans</i>				
<i>Flaveria australasica</i>				
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>				
<i>Gomphrena affinis</i> subsp. <i>pilbarensis</i>				
<i>Gomphrena cunninghamii</i>		1		
<i>Goodenia microptera</i>				
<i>Goodenia muelleriana</i>				
<i>Goodenia nuda</i>				
<i>Goodenia stobbsiana</i>			+	
<i>Gossypium australe</i> (Burrup Peninsula form)				
<i>Gossypium australe</i> (Whim Creek form)				
<i>Gossypium robinsonii</i>				
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>		1%	+	
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>				

CUNDALINE AND CALLAWA  
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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU34	CU36	CU37	CU R01
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	+	1%	+	
<i>Hakea chordophylla</i>				
<i>Hakea lorea</i> subsp. <i>lorea</i>				
<i>Hibiscus</i> aff. <i>coatesii</i> (MET 15 305)	+			
<i>Hibiscus coatesii</i>				
<i>Hibiscus coatesii</i> (MET 15, 305)				
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>		+	+	
<i>Hybanthus aurantiacus</i>		+	+	+
<i>Indigastrium parviflorum</i>				
<i>Indigofera monophylla</i> (Burrup form)				
<i>Indigofera monophylla</i> (small calyx form)	+	+	+	+
<i>Indigofera trita</i>			+	
<i>Iseilema dolichotrichum</i>				
<i>Isotropis atropurpurea</i>				
<i>Leptopus decaisnei</i> var. <i>orbicularis</i>				
<i>Leptosema anomalum</i>				
<i>Mollugo molluginis</i>			+	
<i>Mukia maderaspatana</i>				
<i>Nicotiana</i> sp.				
<i>Oldenlandia crouchiana</i>				
<i>Paraneurachne muelleri</i>				
<i>Paspalidium clementii</i>				
<i>Paspalidium rarum</i>				
<i>Perotis rara</i>				
<i>Phyllanthus maderaspatensis</i>				
<i>Pluchea rubelliflora</i>				
<i>Pluchea tetranthera</i>				
<i>Polycarpaea involucrata</i>				
<i>Polygala</i> aff. <i>isingii</i>				
<i>Polymeria ambigua</i>				
<i>Polymeria calycina</i>		+		
<i>Polymeria</i> sp. (site 1365)				
<i>Portulaca oleracea</i>				
<i>Pterocaulon serrulatum</i>				
<i>Pterocaulon sphacelatum</i>				
<i>Pterocaulon sphaeranthoides</i>				
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>				
<i>Ptilotus axillaris</i>				
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>			1%	
<i>Ptilotus exaltatus</i>				

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## APPENDIX H

## Appendix H1: Cundaline Species Matrix

Species Name	CU34	CU36	CU37	CU R01
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>				
<i>Ptilotus obovatus</i>				
<i>Rhodanthe margarethae</i>				
<i>Rhynchosia minima</i> var. <i>australis</i>				
<i>Rotala diandra</i>				
<i>Scaevola amblyanthera</i> var. <i>centralis</i>				
<i>Senna artemisioides</i> subsp. <i>oligophylla</i>				
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	+			+
<i>Senna glutinosa</i> subsp. <i>pruinosa</i>		+		
<i>Senna notabilis</i>				
<i>Sida</i> aff. <i>fibulifera</i> (Site 1308)				
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)				
<i>Sida pilbarensis</i>				
<i>Sida pilbarensis</i> (ferruginous form)		+		
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>				
<i>Sida subarticulata</i>	+			
<i>Solanum beaugleholei</i>				
<i>Solanum cunninghamii</i>				
<i>Solanum dioicum</i>				
<i>Solanum diversiflorum</i>				
<i>Solanum phlomoides</i>	+			
<i>Sporobolus australasicus</i>				
<i>Stemodia grossa</i>				
<i>Stemodia viscosa</i>				
<i>Streptoglossa decurrens</i>				
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>				
<i>Templetonia hookeri</i>				
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)				
<i>Tephrosia</i> aff. <i>supina</i>				
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)				
<i>Tephrosia spechtii</i>				
<i>Themeda</i> sp.				
<i>Themeda triandra</i>				
<i>Tinospora smilacina</i>				
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>				
<i>Tribulus platypterus</i>				
<i>Tribulus</i> sp.				
<i>Tribulus suberosus</i>				
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>				
<i>Triodia biflora</i>				
<i>Triodia epactia</i>	25%	40%	15%	30%
<i>Triodia</i> sp.				
<i>Triodia wiseana</i>				
<i>Triumfetta chaetocarpa</i>	+			
<i>Triumfetta clementii</i>				
<i>Triumfetta maconochieana</i>		+		+
<i>Triumfetta plumigera</i>				
<i>Waltheria indica</i>				
<i>Yakirra australiensis</i> var. <i>australiensis</i>				



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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA01	CA02	CA03	CA04	CA05	CA06	CA07	CA08	CA09	CA10
<i>Acacia ancistrocarpa</i>		+								
<i>Acacia aneura</i>										
<i>Acacia colei</i> var. <i>colei</i>									+	3%
<i>Acacia elachantha</i> (silvery hairy variant)				assoc						+
<i>Acacia inaequilatera</i>	2%	2%	+	+				1%	+	1%
<i>Acacia ptychophylla</i>	4%		3%	+		assoc				
<i>Acacia</i> sp.		1%	+							
<i>Acacia spondylophylla</i>				assoc				+	+	1%
<i>Acacia stellaticeps</i>		+								
<i>Acacia synchronicia</i>										
<i>Acacia trachycarpa</i> subsp. <i>tumida</i> var. <i>pilbarensis</i>										
<i>Acacia tumida</i> var. <i>pilbarensis</i>		3%					5%	35%		
<i>Acacia victoriae</i>	+									
<i>Alternanthera nana</i>								+		
<i>Alysicarpus muelleri</i>		+								
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)										
<i>Aristida contorta</i>				+						
<i>Aristida holathera</i> var. <i>latifolia</i>		+						+		
<i>Boerhavia coccinea</i>								+		
<i>Boerhavia gardneri</i>				+						
<i>Bonamia linearis</i>			+							+
<i>Bonamia media</i> var. <i>villosa</i>			+	+		+	+			
<i>Bonamia rosea</i>	+	+								
<i>Bulbostylis barbata</i>		+	+		+	+	+	+		
<i>Cajanus cinereus</i>						+	2%	+		
<i>Cajanus marmoratus</i>		+								
<i>Carissa lanceolata</i>										
<i>Cenchrus ciliaris</i>		10%						+		
<i>Chloris pumilio</i>										
<i>Chloris virgata</i>								+		
<i>Chrysopogon fallax</i>		5%						+		
<i>Cleome uncifera</i> subsp. <i>uncifera</i>	+	+		+						+
<i>Cleome viscosa</i>				+						
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)			+		+	assoc		+	+	
<i>Corchorus elachocarpus</i>		1%								+

CUNDALINE AND CALLAWA  
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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA01	CA02	CA03	CA04	CA05	CA06	CA07	CA08	CA09	CA10
<i>Corymbia</i> aff. <i>hamersleyana</i>		+								
<i>Corymbia flavesces</i>		+						2%		
<i>Corymbia hamersleyana</i>			1%					2%	3%	1%
<i>Corymbia opaca</i>		10%					1%		2%	
<i>Crotalaria ramosissima</i>		+								
<i>Cullen stipulaceum</i>								+		
<i>Cymbopogon ambiguus</i>							1%			
<i>Cymbopogon procerus</i>								+		
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>						+				
<i>Cyperus iria</i>										
<i>Cyperus vaginatus</i>										
<i>Dactyloctenium radulans</i>										
<i>Dampiera candidans</i>		+		+			+			+
<i>Desmodium filiforme</i>		+								
<i>Desmodium</i> sp.										
<i>Digitaria</i> sp.										
<i>Dolichandrone heterophylla</i>		+								
<i>Echinochloa colona</i>										
<i>Eragrostis</i> aff. <i>eriopoda</i> (WAS site 963)										15%
<i>Eragrostis cumingii</i>		15%								
<i>Eragrostis</i> sp.		3%								
<i>Eriachne aristidea</i>		+						+		
<i>Eriachne mucronata</i> (typical form)						+	2%			
<i>Eriachne obtusa</i>										
<i>Eriachne pulchella</i>				+						
<i>Eriachne pulchella</i> subsp. <i>dominii</i>										
<i>Eriachne</i> sp. Port Hedland								+		
<i>Eriachne tenuiculmis</i>							+	+		
<i>Eulalia aurea</i>										
<i>Euphorbia coghlanii</i>								+		
<i>Euphorbia</i> sp. (site 1089)	+									
<i>Euphorbia wheeleri</i>										
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>		+								
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>								+		
<i>Fimbristylis simulans</i>										+

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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA01	CA02	CA03	CA04	CA05	CA06	CA07	CA08	CA09	CA10
<i>Goodenia microptera</i>	+	+	+							
<i>Goodenia muelleriana</i>				+						
<i>Goodenia stobbsiana</i>										
<i>Grevillea pyramidalis</i>										
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>	+	+	2%	3%	2%	2%			1%	2%
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>										
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	+	3%	1%	2%	+	2%	3%	3%	+	+
<i>Hakea chordophylla</i>										+
<i>Heliotropium cunninghamii</i>		+								
<i>Hibiscus leptocladus</i>		1%						+		
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>								+		
<i>Hybanthus aurantiacus</i>								+		
<i>Indigofera colutea</i>										
<i>Indigofera linnaei</i>										
<i>Indigofera monophylla</i>										
<i>Indigofera monophylla</i> (small calyx form)	+	+					1%			
<i>Indigofera trita</i>										
<i>Ipomoea muelleri</i>										
<i>Isotropis atropurpurea</i>										
<i>Mollugo molluginis</i>	+	+	+	+	+		+	+	+	+
<i>Mukia maderaspatana</i>								+		
<i>Paraneurachne muelleri</i>		1%								
<i>Paspalidium rarum</i>								1%		
<i>Perotis rara</i>								+		
<i>Petalostylis labicheoides</i>										
<i>Phyllanthus maderaspatensis</i>								+		
<i>Pluchea ferdinandi-muelleri</i>										
<i>Pluchea</i> sp.								+		
<i>Pluchea tetranthera</i>	+	+	+				+	+		+
<i>Polymeria calycina</i>										
<i>Polymeria</i> sp. (site 1365)								+		
<i>Portulaca oleracea</i>		+								
<i>Pterocaulon sphaeranthoides</i>		+						1%		
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>	+			+						
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>	+									

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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA01	CA02	CA03	CA04	CA05	CA06	CA07	CA08	CA09	CA10
<i>Rhynchosia minima</i> var. <i>australis</i>										
<i>Salsola tragus</i> subsp. <i>tragus</i>	+		+							
<i>Sclerolaena convexula</i> x <i>costata</i>		+								
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>				+						
<i>Senna glutinosa</i> subsp. <i>luerssenii</i>	+									
<i>Senna notabilis</i>		+					+			
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)			+	+					+	
<i>Sida pilbarensis</i> (ferruginous form)	+	+	+					+	+	
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>		+						+		
<i>Sida rohlenae</i> var. <i>rohlenae</i>										
<i>Solanum beagleholei</i>	+		+		+					
<i>Solanum cunninghamii</i>										
<i>Solanum dioicum</i>				+		+			+	
<i>Solanum diversiflorum</i>		+							+	
<i>Solanum phlomoides</i>									+	
<i>Sporobolus australasicus</i>								+		
<i>Stemodia grossa</i>		+								+
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>										
<i>Tephrosia</i> aff. <i>bidwillii</i> (HD153-5)										
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)				1%			1%			
<i>Tephrosia</i> aff. <i>supina</i>						+				
<i>Tephrosia</i> aff. <i>supina</i> (MET 12,357)		+								
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)			+	+						+
<i>Tephrosia spechtii</i>			2%				1%	+	+	
<i>Themeda triandra</i>										
<i>Tinospora smilacina</i>										
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>									+	
<i>Trianthema triquetra</i>		+						+		
<i>Tribulus hirsutus</i>				+						
<i>Tribulus platypterus</i>				+						
<i>Tribulus</i> sp.	+									
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>		+								
<i>Triodia angusta</i>										
<i>Triodia epactia</i>	20%		40%	30%	+		60%	35%		80%
<i>Triodia</i> sp.									70%	



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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA01	CA02	CA03	CA04	CA05	CA06	CA07	CA08	CA09	CA10
<i>Triodia wiseana</i>					40%	+				+
<i>Triumfetta chaetocarpa</i>	+									
<i>Triumfetta maconochieana</i>									+	
<i>Triumfetta</i> sp.						+	+			
<i>Waltheria indica</i>										
<i>Yakirra australiensis</i> var. <i>australiensis</i>										
<i>Zornia muelleriana</i> subsp. <i>congesta</i>		+								

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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20
<i>Acacia ancistrocarpa</i>										
<i>Acacia aneura</i>										
<i>Acacia colei</i> var. <i>colei</i>	+		20%		3%		+	+		25%
<i>Acacia elachantha</i> (silvery hairy variant)										
<i>Acacia inaequilatera</i>			+	+	+	1%	1%	1%		
<i>Acacia ptychophylla</i>								+		
<i>Acacia</i> sp.									1%	
<i>Acacia spondylophylla</i>	+	1%				2%	10%	+	5%	
<i>Acacia stellaticeps</i>										
<i>Acacia synchronicia</i>		+								
<i>Acacia trachycarpa</i> subsp. <i>tumida</i> var. <i>pilbarensis</i>									1%	
<i>Acacia tumida</i> var. <i>pilbarensis</i>			20%	70%		50%			50%	1%
<i>Acacia victoriae</i>										
<i>Alternanthera nana</i>										
<i>Alysicarpus muelleri</i>				+						
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)				+						
<i>Aristida contorta</i>										
<i>Aristida holathera</i> var. <i>latifolia</i>			+	+					1%	
<i>Boerhavia coccinea</i>										
<i>Boerhavia gardneri</i>										
<i>Bonamia linearis</i>		+			+			+		
<i>Bonamia media</i> var. <i>villosa</i>	+									
<i>Bonamia rosea</i>										
<i>Bulbostylis barbata</i>				+						
<i>Cajanus cinereus</i>	+	nc		2%						+
<i>Cajanus marmoratus</i>				+						
<i>Carissa lanceolata</i>			+							1%
<i>Cenchrus ciliaris</i>	+			10%					1%	+
<i>Chloris pumilio</i>			+							
<i>Chloris virgata</i>			+							
<i>Chrysopogon fallax</i>			10%	25%						
<i>Cleome uncifera</i> subsp. <i>uncifera</i>					+				+	
<i>Cleome viscosa</i>										
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)		+				1%	4%	+		
<i>Corchorus elachocarpus</i>					5%					3%

CUNDALINE AND CALLAWA  
FLORA AND VEGETATION ASSESSMENT

APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20
<i>Corymbia</i> aff. <i>hamersleyana</i>										
<i>Corymbia flavescens</i>	1%		2%	+		+			+	1%
<i>Corymbia hamersleyana</i>	3%					1%	1%		5%	
<i>Corymbia opaca</i>										
<i>Crotalaria ramosissima</i>									1%	
<i>Cullen stipulaceum</i>										
<i>Cymbopogon ambiguus</i>				+						
<i>Cymbopogon procerus</i>				+						
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>				+						
<i>Cyperus iria</i>			+							
<i>Cyperus vaginatus</i>										10%
<i>Dactyloctenium radulans</i>			+	+						
<i>Dampiera candidans</i>									1%	
<i>Desmodium filiforme</i>									+	
<i>Desmodium</i> sp.			+							
<i>Digitaria</i> sp.										
<i>Dolichandrone heterophylla</i>										
<i>Echinochloa colona</i>			+							
<i>Eragrostis</i> aff. <i>eriopoda</i> (WAS site 963)	+				+				1%	
<i>Eragrostis cumingii</i>			+	+						
<i>Eragrostis</i> sp.										
<i>Eriachne aristidea</i>			+	1%						
<i>Eriachne mucronata</i> (typical form)								+		
<i>Eriachne obtusa</i>		+							1%	
<i>Eriachne pulchella</i>		+						+		
<i>Eriachne pulchella</i> subsp. <i>dominii</i>	+									
<i>Eriachne</i> sp. Port Hedland		+		+						
<i>Eriachne tenuiculmis</i>						2%				
<i>Eulalia aurea</i>									+	
<i>Euphorbia coghlanii</i>				+						
<i>Euphorbia</i> sp. (site 1089)										
<i>Euphorbia wheeleri</i>								+		
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>										
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>										
<i>Fimbristylis simulans</i>										

CUNDALINE AND CALLAWA  
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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20
<i>Goodenia microptera</i>										
<i>Goodenia muelleriana</i>		+								
<i>Goodenia stobbsiana</i>							+	+		
<i>Grevillea pyramidalis</i>					+					
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>	+	+		+	1%		1%			
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>	+		+			+	+	1%		
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>	1%	2%		+	3%	1%	2%	3%	+	
<i>Hakea chordophylla</i>										
<i>Heliotropium cunninghamii</i>										
<i>Hibiscus leptocladus</i>										
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>										
<i>Hybanthus aurantiacus</i>							+			
<i>Indigofera colutea</i>										+
<i>Indigofera linnaei</i>										
<i>Indigofera monophylla</i>					2%					
<i>Indigofera monophylla</i> (small calyx form)					+					
<i>Indigofera trita</i>										+
<i>Ipomoea muelleri</i>			+	1%						+
<i>Isotropis atropurpurea</i>					+				+	
<i>Mollugo molluginis</i>	+	+	+		1%				+	+
<i>Mukia maderaspatana</i>										+
<i>Paraneurachne muelleri</i>										
<i>Paspalidium rarum</i>										
<i>Perotis rara</i>				+						
<i>Petalostylis labicheoides</i>						4%				
<i>Phyllanthus maderaspatensis</i>										
<i>Pluchea ferdinandi-muelleri</i>									+	
<i>Pluchea</i> sp.			1%							
<i>Pluchea tetranthera</i>		+	4%	1%	1%	+		+	1%	+
<i>Polymeria calycina</i>				+						+
<i>Polymeria</i> sp. (site 1365)										
<i>Portulaca oleracea</i>			+							
<i>Pterocaulon sphaeranthoides</i>				10%				+		
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>	+	+					+	+		
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>		+								

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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20
<i>Rhynchosia minima</i> var. <i>australis</i>				+					1%	
<i>Salsola tragus</i> subsp. <i>tragus</i>		+								
<i>Sclerolaena convexula</i> x <i>costata</i>										
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>										
<i>Senna glutinosa</i> subsp. <i>luerssenii</i>										
<i>Senna notabilis</i>		+		+				+		
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)							+			
<i>Sida pilbarensis</i> (ferruginous form)				+						
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>				+						
<i>Sida rohlenae</i> var. <i>rohlenae</i>										+
<i>Solanum beaugleholei</i>										
<i>Solanum cunninghamii</i>							+			
<i>Solanum dioicum</i>		+						+		
<i>Solanum diversiflorum</i>										
<i>Solanum phlomoides</i>										
<i>Sporobolus australasicus</i>			+							
<i>Stemodia grossa</i>		+	+	+					1%	
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>		+	+				+	+		
<i>Tephrosia</i> aff. <i>bidwillii</i> (HD153-5)									+	
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)			+							
<i>Tephrosia</i> aff. <i>supina</i>	2%				+		+	+		
<i>Tephrosia</i> aff. <i>supina</i> (MET 12,357)										
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)					+					
<i>Tephrosia spechtii</i>	+					+		+		
<i>Themeda triandra</i>								+		
<i>Tinospora smilacina</i>				+						
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>										
<i>Trianthema triquetra</i>										
<i>Tribulus hirsutus</i>										
<i>Tribulus platypterus</i>										
<i>Tribulus</i> sp.										
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>										
<i>Triodia angusta</i>										+
<i>Triodia epactia</i>	70%	25%	60%	20%	50%	90%	75%	65%	90%	25%
<i>Triodia</i> sp.										



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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA11	CA12	CA13	CA14	CA15	CA16	CA17	CA18	CA19	CA20
<i>Triodia wiseana</i>	1%	25%					2%			
<i>Triumfetta chaetocarpa</i>				+				+		
<i>Triumfetta maconochieana</i>										
<i>Triumfetta</i> sp.										
<i>Waltheria indica</i>										
<i>Yakirra australiensis</i> var. <i>australiensis</i>				+						
<i>Zornia muelleriana</i> subsp. <i>congesta</i>										

CUNDALINE AND CALLAWA  
FLORA AND VEGETATION ASSESSMENT

APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA21	CA22	CA R01	CA R02
<i>Acacia ancistrocarpa</i>				
<i>Acacia aneura</i>		1%		
<i>Acacia colei</i> var. <i>colei</i>	20%	+		40%
<i>Acacia elachantha</i> (silvery hairy variant)		+		
<i>Acacia inaequilatera</i>	+	3%		+
<i>Acacia ptychophylla</i>				
<i>Acacia</i> sp.				
<i>Acacia spondylophylla</i>			50%	
<i>Acacia stellaticeps</i>		1%		
<i>Acacia synchronicia</i>				
<i>Acacia trachycarpa</i> subsp. <i>tumida</i> var. <i>pilbarensis</i>				
<i>Acacia tumida</i> var. <i>pilbarensis</i>		1%		
<i>Acacia victoriae</i>				
<i>Alternanthera nana</i>				
<i>Alysicarpus muelleri</i>				
<i>Amaranthus</i> aff. <i>pallidiflorus</i> (WC148-11)		+		
<i>Aristida contorta</i>				
<i>Aristida holathera</i> var. <i>latifolia</i>				
<i>Boerhavia coccinea</i>		+		
<i>Boerhavia gardneri</i>				
<i>Bonamia linearis</i>	+	+		
<i>Bonamia media</i> var. <i>villosa</i>				
<i>Bonamia rosea</i>				
<i>Bulbostylis barbata</i>		+		
<i>Cajanus cinereus</i>				
<i>Cajanus marmoratus</i>		1%		
<i>Carissa lanceolata</i>				
<i>Cenchrus ciliaris</i>		2%		
<i>Chloris pumilio</i>				
<i>Chloris virgata</i>				
<i>Chrysopogon fallax</i>				
<i>Cleome uncifera</i> subsp. <i>uncifera</i>	+	1%		
<i>Cleome viscosa</i>		+		
<i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5)				
<i>Corchorus elachocarpus</i>	+	+		

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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA21	CA22	CA R01	CA R02
<i>Corymbia</i> aff. <i>hamersleyana</i>		+		
<i>Corymbia flavescent</i>		+		5%
<i>Corymbia hamersleyana</i>				1%
<i>Corymbia opaca</i>				
<i>Crotalaria ramosissima</i>				
<i>Cullen stipulaceum</i>				
<i>Cymbopogon ambiguus</i>				
<i>Cymbopogon procerus</i>				
<i>Cyperus cunninghamii</i> subsp. <i>cunninghamii</i>				
<i>Cyperus iria</i>				
<i>Cyperus vaginatus</i>				
<i>Dactyloctenium radulans</i>				
<i>Dampiera candidans</i>				
<i>Desmodium filiforme</i>				
<i>Desmodium</i> sp.				
<i>Digitaria</i> sp.		+		
<i>Dolichandrone heterophylla</i>				
<i>Echinochloa colona</i>				
<i>Eragrostis</i> aff. <i>eriopoda</i> (WAS site 963)				+
<i>Eragrostis cumingii</i>		+		
<i>Eragrostis</i> sp.				
<i>Eriachne aristidea</i>	+	+		
<i>Eriachne mucronata</i> (typical form)				
<i>Eriachne obtusa</i>	2%			
<i>Eriachne pulchella</i>				
<i>Eriachne pulchella</i> subsp. <i>dominii</i>				
<i>Eriachne</i> sp. Port Hedland				
<i>Eriachne tenuiculmis</i>				
<i>Eulalia aurea</i>				
<i>Euphorbia coghlanii</i>				
<i>Euphorbia</i> sp. (site 1089)				
<i>Euphorbia wheeleri</i>				
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>				
<i>Evolvulus alsinoides</i> var. <i>villosicalyx</i>				
<i>Fimbristylis simulans</i>				

CUNDALINE AND CALLAWA  
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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA21	CA22	CA R01	CA R02
<i>Goodenia microptera</i>				
<i>Goodenia muelleriana</i>				
<i>Goodenia stobbsiana</i>				
<i>Grevillea pyramidalis</i>				
<i>Grevillea pyramidalis</i> subsp. <i>leucadendron</i>		+	10%	
<i>Grevillea pyramidalis</i> subsp. <i>pyramidalis</i>				2%
<i>Grevillea wickhamii</i> subsp. <i>hispidula</i>			2%	
<i>Hakea chordophylla</i>				
<i>Heliotropium cunninghamii</i>				
<i>Hibiscus leptocladus</i>				
<i>Hibiscus sturtii</i> var. <i>campylochlamys</i>				
<i>Hybanthus aurantiacus</i>				
<i>Indigofera colutea</i>				
<i>Indigofera linnaei</i>		+		
<i>Indigofera monophylla</i>				
<i>Indigofera monophylla</i> (small calyx form)				
<i>Indigofera trita</i>				
<i>Ipomoea muelleri</i>				
<i>Isotropis atropurpurea</i>				
<i>Mollugo molluginis</i>	+			+
<i>Mukia maderaspatana</i>		+		
<i>Paraneurachne muelleri</i>				
<i>Paspalidium rarum</i>				
<i>Perotis rara</i>				
<i>Petalostylis labicheoides</i>				
<i>Phyllanthus maderaspatensis</i>				
<i>Pluchea ferdinandi-muelleri</i>				+
<i>Pluchea</i> sp.				
<i>Pluchea tetranthera</i>	+	+		1%
<i>Polymeria calycina</i>				
<i>Polymeria</i> sp. (site 1365)				
<i>Portulaca oleracea</i>	+			
<i>Pterocaulon sphaeranthoides</i>		+		
<i>Ptilotus calostachyus</i> var. <i>calostachyus</i>				
<i>Ptilotus fusiformis</i> var. <i>fusiformis</i>	+			

CUNDALINE AND CALLAWA  
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Appendix H2: Callawa Species Matrix

Species Name	CA21	CA22	CA R01	CA R02
<i>Rhynchosia minima</i> var. <i>australis</i>		+		
<i>Salsola tragus</i> subsp. <i>tragus</i>	+			
<i>Sclerolaena convexula</i> x <i>costata</i>				
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>				
<i>Senna glutinosa</i> subsp. <i>luerssenii</i>				
<i>Senna notabilis</i>	+			
<i>Sida</i> aff. <i>pilbarensis</i> (GLD (SRH) 59-3)	+	1%		
<i>Sida pilbarensis</i> (ferruginous form)	+			
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>				
<i>Sida rohlenae</i> var. <i>rohlenae</i>				
<i>Solanum beaugleholei</i>				
<i>Solanum cunninghamii</i>				
<i>Solanum dioicum</i>				
<i>Solanum diversiflorum</i>				
<i>Solanum phlomoides</i>				
<i>Sporobolus australasicus</i>	+			
<i>Stemodia grossa</i>				
<i>Synaptantha tillaeacea</i> var. <i>tillaeacea</i>				
<i>Tephrosia</i> aff. <i>bidwillii</i> (HD153-5)				
<i>Tephrosia</i> aff. <i>rosea</i> (HD292-37)			+	
<i>Tephrosia</i> aff. <i>supina</i>	+			
<i>Tephrosia</i> aff. <i>supina</i> (MET 12,357)				
<i>Tephrosia</i> sp. Bungaroo Creek (M.E. Trudgen 11601)		+		
<i>Tephrosia spechtii</i>		+		
<i>Themeda triandra</i>				
<i>Tinospora smilacina</i>		+		
<i>Trachymene oleracea</i> subsp. <i>oleracea</i>				
<i>Trianthema triquetra</i>				
<i>Tribulus hirsutus</i>				
<i>Tribulus platypterus</i>				
<i>Tribulus</i> sp.				
<i>Trichodesma zeylanicum</i> var. <i>zeylanicum</i>				
<i>Triodia angusta</i>				
<i>Triodia epactia</i>	50%	60%	40%	80%
<i>Triodia</i> sp.				



CUNDALINE AND CALLAWA  
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APPENDIX H

Appendix H2: Callawa Species Matrix

Species Name	CA21	CA22	CA R01	CA R02
<i>Triodia wiseana</i>				
<i>Triumfetta chaetocarpa</i>				
<i>Triumfetta maconochieana</i>				
<i>Triumfetta</i> sp.				
<i>Waltheria indica</i>		+		
<i>Yakirra australiensis</i> var. <i>australiensis</i>		+		
<i>Zornia muelleriana</i> subsp. <i>congesta</i>				

# **APPENDIX I**

## **LOCATIONS OF FLORA SPECIES OF INTEREST**

## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX I

#### LOCATIONS OF FLORA SPECIES OF INTEREST

##### Appendix I1: Locally Significant Flora Recorded During the Cundaline Supplementary Survey

Taxa	Site Number	# Easting	# Northing
<i>Stemodia</i> sp. Shay Gap	Opportunistic Collections	205234	7724987
		208688	7722164
		208664	7722159
		208550	7722104
		204776	7725113
		204688	7725185
<i>Sida</i> sp. Callawa	Opportunistic Collections	205337	7724691
		205430	7724926
		207253	7723848
		207224	7723848
		207188	7723859
		207136	7723863
		204106	7726302
		204299	7726173
		204313	7726147
		204330	7726147
		208695	7722156
<i>Enneapogon lindleyanus</i>	CU02	204526	7726608
	CU12	206581	7724426
<i>Solanum beaugleholei</i>	CU10	205952	7724829
	CU11	206438	7724661
	CU12	206581	7724426

Taxa	Site Number	# Easting	# Northing
	CU13	206845	7723821
	CU16	207262	7723794
	CU21	207995	7722853
	CU22	208396	7722731

# Australian Geocentric 1994 (GDA94), Zone 51K

## Appendix I2: Locally Significant Flora Recorded During the Callawa Supplementary Survey

Taxa	Site Number	# Easting	# Northing
<i>Eriachne tenuiculmis</i>	CA07	219720	7714920
	CA08	218719	7716267
	CA16	217375	7715582
<i>Solanum beaugleholei</i>	CA01	219766	7717027
	CA03	219221	7716153
	CA05	219280	7715829

# Australian Geocentric 1994 (GDA94), Zone 51K

# **APPENDIX J**

## **LOCATIONS OF INTRODUCED FLORA SPECIES**



## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX J

#### LOCATIONS OF INTRODUCED FLORA SPECIES

##### Appendix J1: Location of Introduced Flora Species Recoded During the Cundaline Supplementary Survey

Taxa	Site Number	# Easting	# Northing
* <i>Cenchrus ciliaris</i>	CU15	207302	7724304
* <i>Chloris virgata</i>	CU19	208202	7723571
* <i>Cucumis melo</i> subsp. <i>agrestis</i>	CU19	208202	7723571
* <i>Portulaca oleracea</i>	CU15	207302	7724304
	CU25	209286	7723161

# Australian Geocentric 1994 (GDA94), Zone 51K

##### Appendix J2: Location of Introduced Flora Species Recoded During the Callawa Supplementary Survey

Taxa	Site Number	# Easting	# Northing
* <i>Cenchrus ciliaris</i>	CA02	219838	7716657
	CA08	218719	7716267
	CA11	218108	7715477
	CA14	217700	7716400
	CA19	216600	7715900
	CA20	217228	7716810
	CA22	217255	7717538
* <i>Chloris virgata</i>	CA08	218719	7716267
	CA13	218150	7716700
* <i>Echinochloa colona</i>	CA13	218150	7716700
* <i>Portulaca oleracea</i>	CA02	219838	7716657

Taxa	Site Number	# Easting	# Northing
	CA13	218150	7716700
	CA21	217681	7717097

# Australian Geocentric 1994 (GDA94), Zone 51K

# **APPENDIX K**

## **DEFINITIONS OF INTRODUCED FLORA SPECIES CATEGORIES AND RATINGS**

## CALLAWA AND CUNDALINE FLORA AND VEGETATION ASSESSMENT

### APPENDIX K

#### DEFINITIONS OF INTRODUCED FLORA SPECIES CATEGORIES AND RATINGS

##### Appendix K1: Definition of Introduced Flora Species

The DEC's Environmental Weed Strategy for Western Australia ranks weeds in terms of their environmental impact on biodiversity using the criteria: invasiveness, distribution, and environmental impacts:

- **Invasiveness** - ability to invade bushland in good to excellent condition or ability to invade waterways.
- **Distribution** - wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.
- **Environmental Impacts** - ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community.

The rating of each weed is determined by the following scoring system:

- **High** - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritising this weed for control and/or research i.e. prioritising funding to it.
- **Moderate** - a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** - a weed species scoring one of the criteria. A mild rating would indicate monitoring of the weed and control where appropriate.
- **Low** - a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

## Appendix K2: Introduced Flora Species Potentially Occurring within the Project Area

Species	Rating	Description
<i>*Aerva javanica</i>	High	Kapok Bush Weed of coastal areas in rocky or stony soil.
<i>*Cenchrus ciliaris</i>	High	Buffel grass Widely planted as a pastoral grass. Has become a widespread weed of roadsides, creeklines and most vegetation types in the Pilbara
<i>*Vachellia farnesiana</i>	High	Mimosa Bush Widespread in low-lying areas, river and creek banks and disturbed sites.
<i>*Cynodon dactylon</i>	Moderate	Couch grass Widely planted as a lawn grass.
<i>*Indigofera oblongifolia</i>	Moderate	Favours grasslands and along road verges.
<i>*Malvastrum americanum</i>	Moderate	Spiked Malvastrum Weed of river and creek margins, wastelands and arid zone habitats.
<i>*Parkinsonia aculeata</i>	Moderate	Found amongst low trees and grasslands on plains, watercourses, flood plains and drainage lines.
<i>*Argemone ochroleuca</i>	Mild	Mexican Poppy Widely distributed in pastoral areas, mainly along rivers and in moist flats.
<i>*Chloris gayana</i>	Low	Rhodes Grass Common on roadsides and disturbed land.
<i>*Chloris virgata</i>	Low	Feathertop Rhodes Grass Common on sand dunes and disturbed lands.
<i>*Cucumis melo subsp. agrestis</i>	TBA	Ulicardo Melon Annual herb or climber common in the Pilbara region.
<i>*Portulaca oleracea</i>	Not Listed	Purslane Common on clayey loam and disturbed land.





APPENDIX I

TARGETED FAUNA ASSESSMENT  
(OUTBACK ECOLOGY, 2008)





# Goldsworthy Iron Ore Mining Operations – Cundaline and Callawa Mining Operations

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## Targeted Fauna Assessment

October 2008



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# BHP Billiton Iron Ore

## Goldsworthy Iron Ore Mining Operations: Cundaline and Callawa Mining Operations

### Targeted Fauna Assessment

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## Executive Summary

BHP Billiton Iron Ore Pty Ltd (BHPBIO) commissioned Outback Ecology Services (OES) to undertake a targeted fauna assessment of the Cundaline and Callawa deposits within the Goldsworthy Iron Ore Mining Operations. The Cundaline and Callawa deposits are located approximately 170 kilometres (km) and 190 km to the south-east of Port Hedland respectively, in the north-eastern Pilbara region of Western Australia.

This fauna assessment was prepared as part of the environmental assessment for the Cundaline and Callawa deposits. It draws from a number of previous vertebrate fauna surveys in the area including specific surveys undertaken within the Cundaline and Callawa study areas by *ecologia* (2005a, 2005b). This report contains the relevant components of the *ecologia* (2005a, 2005b) reports, including methods, results and fauna species lists. This fauna assessment also documents the terrestrial invertebrate short-range endemic (SRE) surveys undertaken by ENV and OES in 2008.

The specific objectives for the targeted fauna assessment are:

- Conduct an all-inclusive fauna database search and literature review of the two study areas drawing on information from comprehensive surveys conducted in 2005 by *ecologia*.
- Undertake a comprehensive terrestrial invertebrate short-range endemic (SRE) survey to identify species occurring or likely to occur within the study areas.
- Provide a description of available terrestrial SRE habitat within the study areas.
- Provide a description of available vertebrate fauna habitat assessment of the study areas.
- Assess survey findings in the regional context by comparisons with available data from other localities to provide an evaluation of SREs of conservation significance.

### Short-range Endemics

With consideration to the existing study area environment and following consultation with specialists at the DEC, WAM and UWA, the following invertebrate groups prone to short-range endemism were targeted in this assessment: Mygalomorph Spiders (Mygalomorphae); Pseudoscorpions (Pseudoscorpionida); Scorpions (Scorpionida); Millipedes (Myriopods); and Terrestrial Molluscs (Pulmonata).

The surveys were completed in two stages. The first stage involved a targeted mygalomorph spider survey within the study areas by ENV Australia. The second stage was conducted by OES and involved a comprehensive survey for all invertebrate groups with potential for short-range endemism; a SRE habitat assessment; and a vertebrate fauna habitat assessment.

There were no known SRE invertebrate species identified as a result of the survey within the Cundaline and Callawa study areas. However, some specimens were collected where their potential for short-range endemism could not be determined due to taxonomy. These were: the mygalomorph spider *Conothele* sp., the pseudoscorpion *Austrohorus* sp., the centipede *Cryptops* sp. and centipedes from the Family Schendylidae.

Habitat with the potential to support SRE invertebrates was identified on both ridges in the form of south-west-facing and south-east-facing ridges. These south-west-facing and south-east-facing ridges make up a relatively small proportion of the overall study areas; however sections of these ridges lie within the proposed disturbance footprints of the Cundaline and Callawa mining operations..

### ***Vertebrate Fauna Species***

Systematic sampling and opportunistic collecting during the 2005 Cundaline field survey by *ecologia* yielded 11 mammal species (10 native), 41 birds, 18 reptiles and one amphibian. Systematic sampling and opportunistic collecting during the 2005 Callawa field survey by *ecologia* yielded 12 mammal species (11 native), 43 birds, 19 reptiles and one amphibian.

Eight conservation significant vertebrate fauna species have been recorded at Callawa and Cundaline, across two separate surveys since 2005: Northern Quoll, Pilbara Leaf-nosed Bat, Ghost Bat, Western Pebble-mound Mouse, Peregrine Falcon, Australian Bustard, Rainbow Bee-eater and Pilbara Olive Python.

At both the Cundaline and Callawa study areas, four main vertebrate fauna habitats were identified. These were: drainage lines, hilltops, ridges, and slopes and plains. Drainage lines and ridges provide good quality habitat for vertebrate fauna species as they contain areas of shelter and refuge (caves, crevices, water bodies, leaf litter and woody debris). Hilltops as well as slopes and plains provide less complex habitats for vertebrate fauna species, as very few of the above characteristics are present. Shelter is found for some vertebrate fauna species under rocky screes.

All vertebrate habitats present over the study area are widely represented throughout the region, and the vertebrate fauna assemblage recorded is similar to other regional sites. Considering the measures to manage potential impacts outlined in the previous Goldsworthy Environmental Management Plan, it is considered that the continuation of those measures for the planned Cundaline and Callawa mining operations would minimise potential impacts on vertebrate fauna.

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## 1.0 INTRODUCTION

### 1.1 Project Background

BHP Billiton Iron Ore Pty Ltd (BHPBIO) commissioned Outback Ecology Services (OES) to undertake a targeted fauna assessment of the Cundaline and Callawa deposits within the Goldsworthy Iron Ore Mining Operation. The Cundaline and Callawa deposits are located approximately 170 kilometres (km) and 190 km to the south-east of Port Hedland, respectively, in the north-eastern Pilbara region of Western Australia (**Figure 1**).

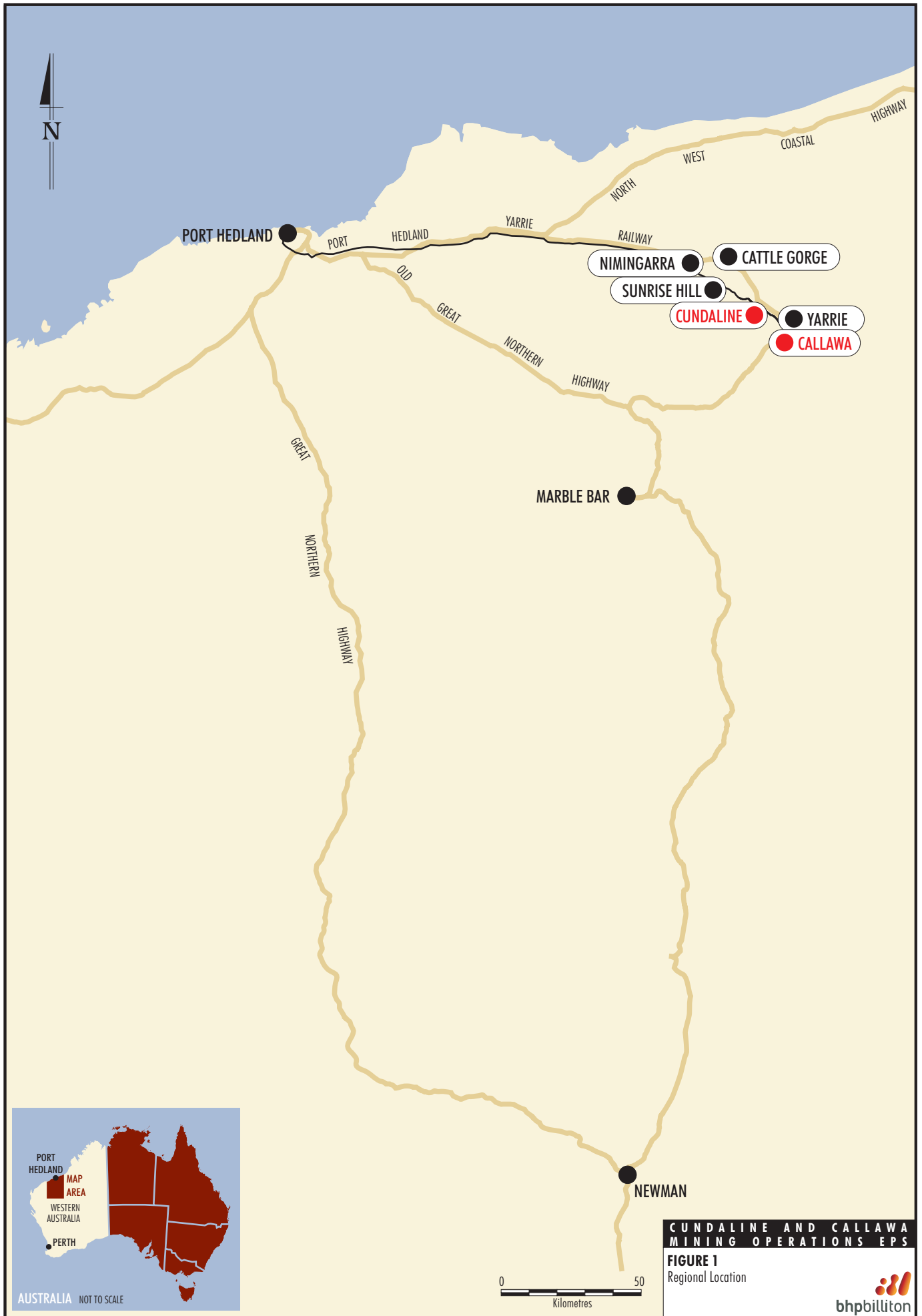
This fauna assessment was prepared as part of the environmental assessment for the Cundaline and Callawa deposits. It draws a number of previous vertebrate fauna surveys in the area including specific surveys undertaken within the Cundaline and Callawa study areas by *ecologia* (2005a, 2005b). This report contains the relevant components of the *ecologia* (2005a, 2005b) reports, including methods, results and fauna species lists. This fauna assessment also documents the terrestrial invertebrate short-range endemic (SRE) surveys undertaken by ENV Australia (ENV) and OES in 2008.

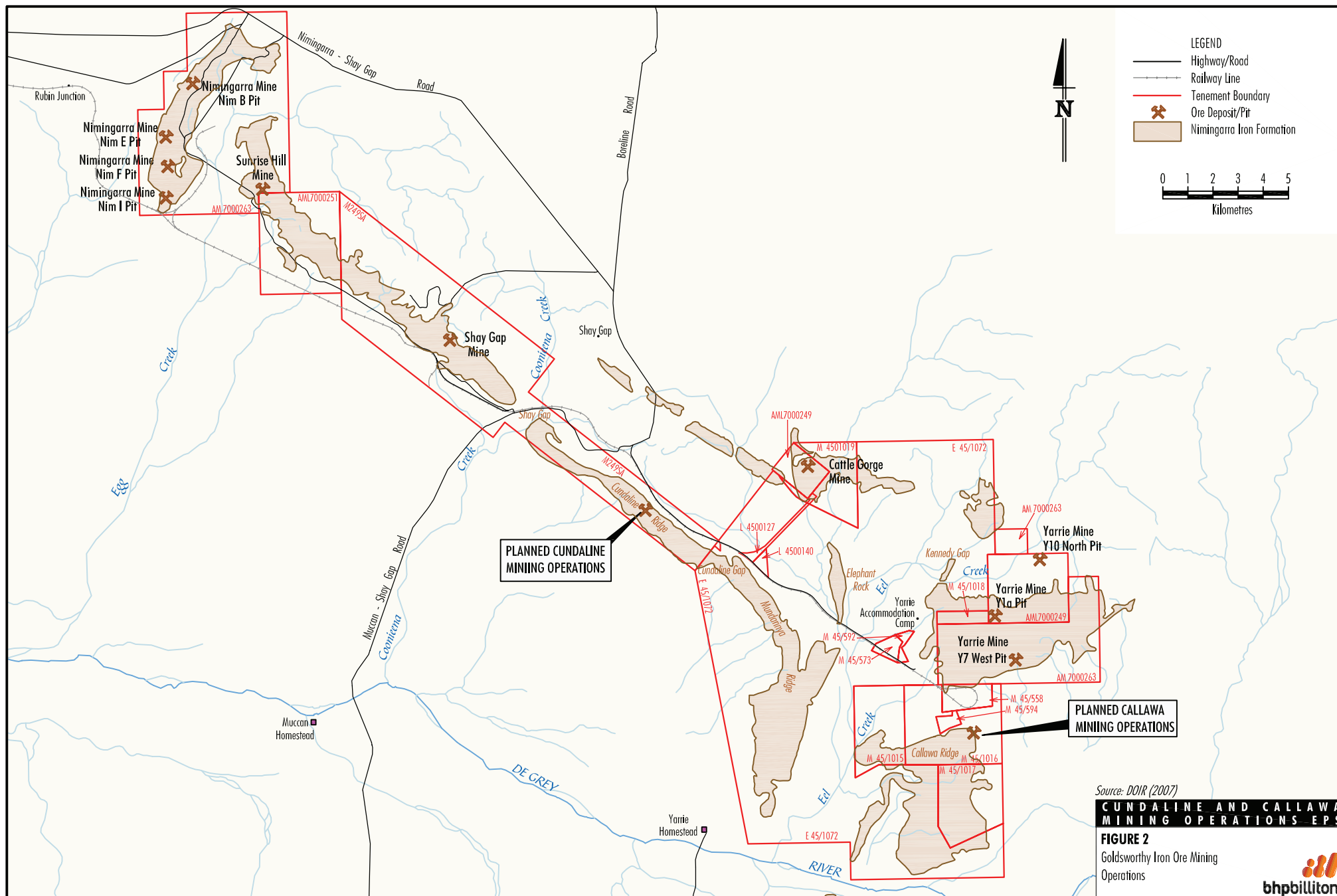
The mining components and activities that are proposed for the planned Cundaline and Callawa mining operations include:

- progressive open pit mining of overburden and ore;
- placement of overburden in mined-out voids and out-of-pit storage areas adjacent to the Cundaline and Callawa open pits;
- transportation of ore by haul truck or road train to the Yarrie crushing, screening and rail loading facilities, which are located approximately 20 km to the east of the Cundaline deposit and 2 km north of the Callawa deposit;
- stockpiling, crushing, screening and load-up of iron ore at the existing Yarrie facilities;
- continued groundwater abstraction from the Shay Gap Wellfield to meet operational demands, and distribution through the existing water supply system and pipeline extensions to the proposed mining operations at the Cundaline and Callawa deposits;
- either supply of power to the Cundaline and/or Callawa deposits via an electricity transmission line extension from the existing power supply network, or installation and use of direct generators at Cundaline and/or Callawa to meet power demand;
- construction and use of small day rooms, workshops and storage areas at the Cundaline and Callawa areas; and
- construction and use of haul and access roads to the Cundaline and Callawa areas.

**Figure 2** shows the location of the planned Cundaline and Callawa mining operations in relation to the existing Goldsworthy Iron Ore Mining Operations. **Figures 3** and **4** show the Cundaline and Callawa

study areas, respectively, encompassing the deposits and associated mining components. These areas herein are referred to as the Cundaline and Callawa study areas.





Source: DOIR (2007)

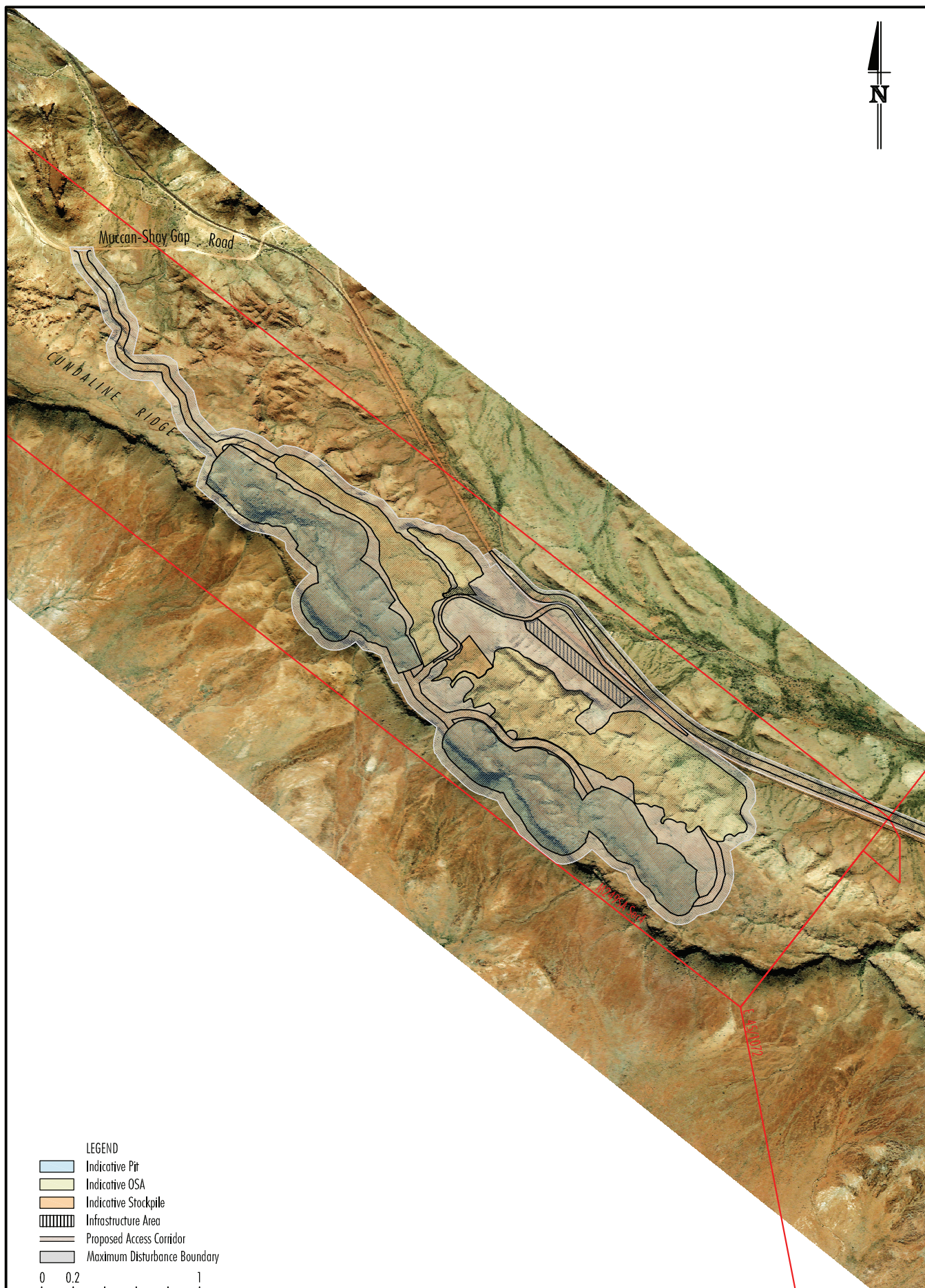
# CUNDALINE AND CALLAWA MINING OPERATIONS EPS

## FIGURE 2

Goldsworthy Iron Ore Mining Operations







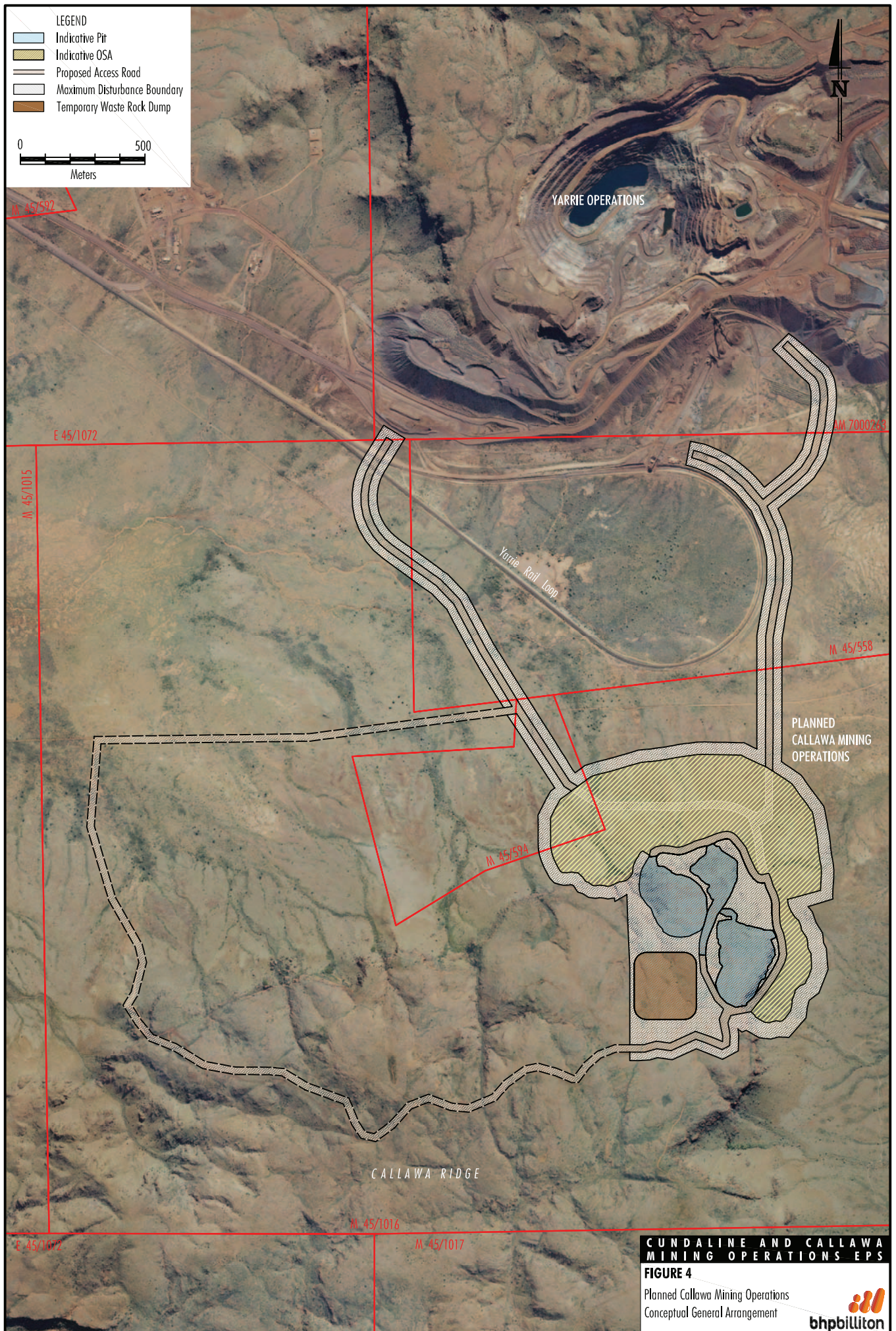
CUNDALINE AND CALLAWA  
MINING OPERATIONS EPS

FIGURE 3

Planned Cundaline Mining Operations  
Conceptual General Arrangement









## 1.2 Short-range Endemism and Targeted Short-range Endemic Groups

### **Short-range Endemism**

Endemism refers to the restriction of a species to a particular area, whether it is at the continental, national or local scale (Allen *et al.*, 2002). SRE species have restricted distributional ranges, usually less than 10,000 square kilometres (km<sup>2</sup>) (Harvey, 2002).

A number of invertebrate groups have been identified as containing SRE species, such as Mygalomorph Spiders (Mygalomorphae), Pseudoscorpions (Pseudoscorpionida), Scorpions (Scorpionida), Millipedes (Myriopods) and Terrestrial Molluscs (Pulmonata) (Harvey, 2002). SRE species are generally characterised by poor dispersal, heavy reliance on discontinuous habitats, low growth rates, and low fecundity (Harvey, 2002).

In Western Australia, it is postulated that many terrestrial SRE invertebrate species have Gondwanan origins as they are relics of previously widespread species common to the southern hemisphere continents (Gondwanaland) during the Mesozoic and early Tertiary periods. The fragmentation, drifting apart and aridification of the continents has resulted in many species having restricted ranges dependant upon particular habitat requirements (Harvey, 2002; Main, 1999).

A species endemism is shaped by a range of factors such as climate variation, ecological specificity (e.g. habitat preference and physiology), life history attributes (e.g. reproductive strategies and dispersal capabilities), geological history and abiotic and biotic interactions (Ponder and Colgan, 2002; Main, 1982).

The following broad habitats have been recognised as potentially harbouring terrestrial SRE invertebrate fauna:

- Mountainous terrains/gorges - due to topographic relief providing refugial habitats that are absent from the surrounding landscape (Western Australia Environmental Protection Authority [EPA], 2004; Harvey, 2002), the presence of sheltered environments and geographically isolated habitats, and habitats receiving runoff water and plant nutrients which may produce relatively resource-rich areas (Morton *et al.*, 1995).
- Rainforest patches - providing refugial habitats that are absent from the surrounding landscape (Larson, 2001), (e.g. Kimberley region) (Abbott, 1994).
- Freshwater habitats (e.g. rivers, pool and wetlands) – as species are restricted to the individual river systems or drainage basins. However, an ephemeral stream will probably never establish a differentiated population of aquatic invertebrates that lack a desiccation-resistant phase in their lifecycle (Ponder and Colgan, 2002).
- Islands (e.g. Barrow Island) (Morton *et al.*, 1995).

### ***Study of Short-range Endemic Groups***

Considering the existing environment of the study area (Section 2), the results of the database and literature review (Section 3.1) and consultation between BHPBIO/Resource Strategies and Dr Mark Harvey (Western Australian Museum [WAM]), Professor Barbara York-Main (University of Western Australia [UWA]) and Professor Mike Johnson (UWA), invertebrate groups prone to short-range endemism which may occur within the study area are:

- Mygalomorph Spiders (Mygalomorphae);
- Pseudoscorpions (Pseudoscorpionida);
- Scorpions (Scorpionida);
- Millipedes (Myriopods); and
- Terrestrial Molluscs (Gastropoda).

These groups are described below.

#### ***Mygalomorph Spiders***

Phylum **ARTHROPODA**

Class **ARACHNIDA**

Order **ARANEAE**

Sub-order **MYGALOMORPHA**

Harvey (2002) indicates that many mygalomorph spiders exhibit patterns of short-range endemism.

Mygalomorph Spiders comprise of the trapdoor and funnelweb spiders and are represented in Western Australia by eight families (Main, 2005). A large proportion of Mygalomorph Spider species are unnamed (Main, 2002).

In arid and semi-arid areas, mygalomorph spiders have been known to dig deep burrows (up to 60 centimetres [cm] deep) (Brunet, 1996), and exit burrows at night to feed when the temperature is lower and humidity is higher (Main, 1982). Nest micro-climate (e.g. soil moisture and temperature) is an important factor in mygalomorph spider burrow suitability (after Main, 1982).

Most mygalomorph spiders are sedentary and tend to live their entire lives within a single burrow (Main, 1982). Mygalomorph spiders are unlikely to establish new burrows, in the event their burrows are removed (after Main, 2002).

Mygalomorph spiders are sexually dimorphic, and as such both male and females are usually needed for specific identifications (Main, 2002; Framenau and Yoo, 2006). Mature males may abandon the nest when finding a mate (Main, 1982). Male mygalomorph spiders can be caught in pitfall traps at times when they are wandering in search of females (Main, 1982).

### ***Pseudoscorpions***

Phylum **ARTHROPODA**

Class **ARACHNIDA**

Order **PSEUDOSCORPIONES**

Harvey (2002) indicates that very few pseudoscorpions are SREs (after Harvey, 1998).

Pseudoscorpions occur in leaf litter, and under rocks and the bark of trees (Harvey and Yen, 1989). Similarly to scorpions, all pseudoscorpions are predators, feeding on small invertebrates (Harvey and Yen, 1989) and are generally only active during the night or in dark places during the day (Australian Museum, 2008a).

In some species of pseudoscorpion, it is common for individuals to cling to larger animals (usually insects), resulting in the pseudoscorpion being transported across distances (Harvey and Yen, 1989). The sexes are separate in pseudoscorpions (Harvey and Yen, 1989).

### ***Scorpions***

Phylum **ARTHROPODA**

Class **ARACHNIDA**

Order **SCORPIONES**

Scorpions are found all over Australia, occurring under rocks and logs, and in burrows, while a few species occur under the bark of trees, especially eucalypts (Harvey and Yen, 1989). Scorpions are predators and feed on beetles, millipedes and spiders (Harvey and Yen, 1989). Scorpions are generally only active during the night or in dark places during the day (Australian Museum, 2008a). Scorpions are typically solitary and the sexes are separate (Australian Museum, 2008a; Harvey and Yen, 1989).

### ***Millipedes***

Phylum **ARTHROPODA**

Class **DIPLOPODA**

Order **CHORDEUMATIDA, POLYDESMIDA**

Harvey (2002) indicates that many millipedes from the order Chordeumatida are SREs (after Shear and Mesibov, 1997).

Most millipedes are detritivores (Sierwald and Bond, 2007), obtaining nutrients from consumption of decomposing organic matter. Millipedes are susceptible to desiccation, movement is limited, and they are unlikely to be transported by larger animals (Sierwald and Bond, 2007).



## **Terrestrial Molluscs**

Phylum **MOLLUSCA**

Class **GASTROPODA**

Order **ARCHAEOGASTROPODA, SORBEOCONCHA, EUPULMONATA, STYLOMMATOPHORA**

Harvey (2002) indicates that many snails of the order Archaeogastropoda are SREs. Numerous snails from the orders Sorbeoconcha and Eupulmonata are also SREs (after Ponder *et al.*, 1993 and Miller *et al.*, 1999).

Snails of the order Archaeogastropoda are herbivorous and can be found amongst leaf litter, rocks or in trees (Harvey and Yen, 1989). The sexes are separate in the order Archaeogastropoda (Harvey and Yen, 1989).

Land snails prefer moist habitats, though some species of the order Archaeogastropoda are found in areas that are only occasionally moist (Harvey and Yen, 1989). EPA (2006) states that currently no mainland species of *Rhagada* sp. (order Stylommatophora) are known to have overlapping distributions. Land snails require a source of calcium for shell construction, usually sourced from soil or rock (Slack-Smith, 2002).

### **1.3 Report Scope and Objectives**

The specific objectives for the targeted fauna survey were to:

- Conduct an all-inclusive fauna database review of the two study areas.
- Undertake a comprehensive terrestrial invertebrate SRE survey to identify species occurring or likely to occur within the study areas.
- Provide a description of available terrestrial SRE habitat within the study areas.
- Provide a description of available vertebrate fauna habitat assessment of the study areas.
- Assess survey findings in the regional context by comparisons with available data from other localities to provide an evaluation of SRE conservation significance.

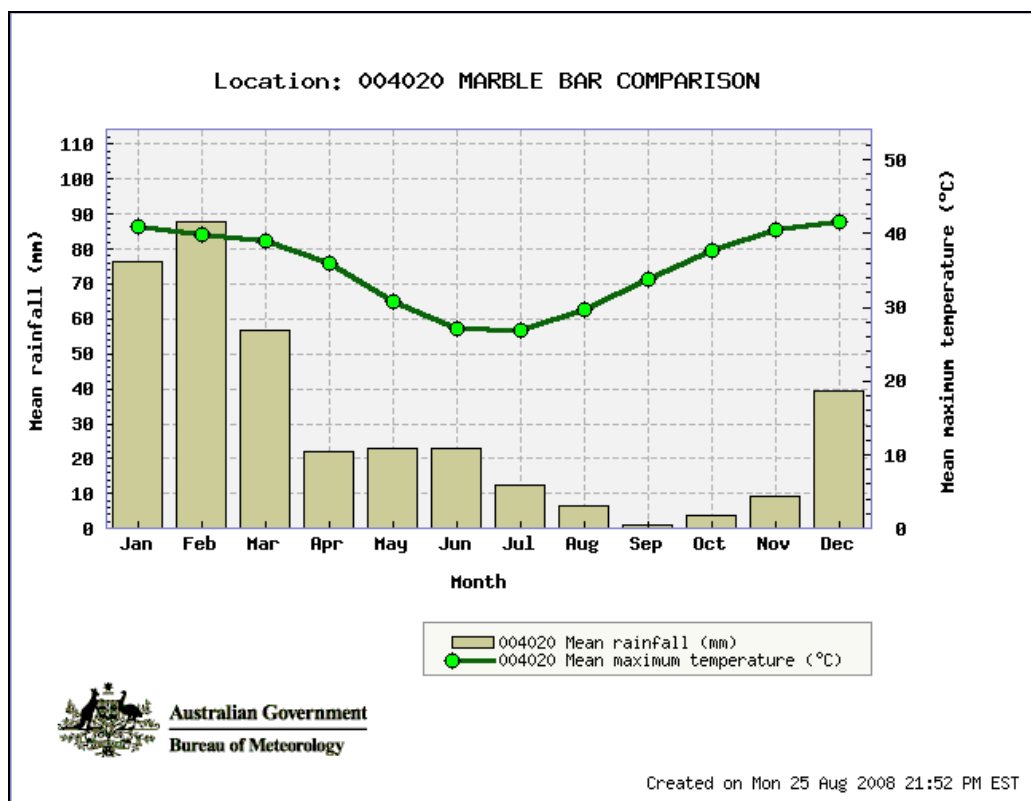
## 2.0 EXISTING ENVIRONMENT

### 2.1 Climate

The study areas are located in the north-eastern Pilbara region of Western Australia. The Pilbara region experiences an arid-tropical climate which is characterised by a hot, relatively wet summer (between October and April) and a mild dry winter (between May and September). Tropical cyclones occur occasionally, usually in the months of January to April, bringing sporadic drenching rains to the region (Bureau of Meteorology [BOM] 2008).

The nearest BOM weather station with the most complete data set for the 2008 survey periods is located in Marble Bar, approximately 83 km south-west of the study areas. Significant variation in rainfall is noted across the Pilbara region, and as such, data provided should be used as a guide.

The average maximum summer temperature is 36.8 degrees Celsius (°C), with daily maximum temperatures over 40°C often recorded. In winter months, the mean maximum temperature is 29.6°C, with a mean minimum of 11.7°C (BOM, 2008). Marble Bar receives an average annual rainfall of 361.7 millimetres (mm) (BOM, 2008). The majority of rainfall falls between January and March, with the yearly maximum occurring in February (**Figure 5**).



**Figure 5 Climate Data for Marble Bar Comparison Station**

## 2.2 Pilbara Biogeographic Region

Thackway and Cresswell (1995) describe a system of 85 'biogeographic regions' (bioregions) covering the whole of Australia; known as The Interim Biogeographic Regionalisation for Australia (IBRA). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna (Environment Australia, 2000).

The study areas are located within the Chichester subregion (PIL1) of the Pilbara region (Thackway and Cresswell, 1995). The Chichester subregion is characterised by granite and basalt plains and ranges with shrub steppe, uplands dominated by hummock grasslands, ephemeral drainage lines with Eucalyptus and *Corymbia hamersleyana* woodlands, ridges and mesas, alluvial flats and river deltas (Kendrick and McKenzie, 2001). The subregion is rich and diverse in both its flora and fauna and contains many species endemic to the Pilbara region (Kendrick and McKenzie, 2001). The mountain tops and gorges of the Chichester subregion form species-rich refuges with yet undescribed flora and fauna species (Australian Natural Resource Atlas [ANRA], 2007).

## 2.3 Land Systems of the Project Area

A regional survey of land systems in the Pilbara region was undertaken between 1995 and 1999 by the Department of Agriculture (now the Department of Agriculture and Food) and the Department of Land Administration (now Landgate). The purpose of the survey was to develop a comprehensive description of the biophysical resources and an assessment of the condition of the soils and the vegetation of the Pilbara (Van Vreeswyk *et al.*, 2004). A component of the survey was the mapping of land types, land units and land systems of the Pilbara including the study areas (**Table 1**).

**Table 1 Summary of Land Systems over the Study Areas**

Land Type	Description	Land Systems
Land Type 1	Hills and ranges with Spinifex grasslands	Black, Boolaloo, Capricorn, Granite, Houndstooth, Mckay, Newman, Robertson, Rocklea, Ruth, Talga
Land Type 3	Plateaux, mesas and breakaways with Spinifex grasslands	Callawa, Coongimah, Kumina, Nanutarra, Oakover, Robe
Land Type 8	Stony plains with Spinifex grasslands	Boolgeeda, Lochnivar, Macroy, Paterson, Peedamulla, Pyramid, Satirist, Stuart, Taylor
Land Type 11	Sandplains with Spinifex grasslands	Buckshot, Divide, Giralia, Gregory, Little Sandy, Nita, Uaroo
Land Type 13	Alluvial plains with soft Spinifex grasslands	Mallina, Paradise, Urandy

Source: Van Vreeswyk *et al.*, 2004

The study areas are located predominantly over Land Type 3 (Callawa Land System) and Land Type 1 (Robertson Land System) (Van Vreeswyk *et al.*, 2004). The Robertson land system is described as "Hills and ranges with Spinifex grasslands" and Callawa land system as "Plateaux, mesas and breakaways with Spinifex grasslands" (Van Vreeswyk *et al.*, 2004).

## 2.4 Landuse

Land tenure in the Pilbara region is both Aboriginal reserve and leasehold reserve, national parks and reserves and crown land which falls under a range of pastoral and mining leases. Aboriginal rock art can be found throughout the Pilbara region. The first mining explorations in the Pilbara region commenced in the early 1800s and currently the Pilbara region provides the great majority of Western Australia's petroleum, gas and iron ore export, while gold mining is also an important industry (ANRA, 2007).

The dominant landuses in the Chichester subregion include mining, pastoralism in the form of cattle grazing, native pasture, conservation, urban development and Aboriginal lands and reserves (Kendrick and McKenzie, 2001). The Chichester subregion has 6.56% of its land surface reserved under some form of conservation. The Chichester subregion contains one national park (Millstream-Chichester National Park), one conservation park (Meentheena Conservation Park) and one large nature reserve (Mungaroona Nature Reserve).

### 3.0 ASSESSMENT METHODS

The methods used to assess the potential impacts on SRE and terrestrial vertebrate fauna habitat is described in this section and includes a database and literature review, and field survey.

#### 3.1 Short-range Endemic Database and Literature Review

The SRE database and literature review was undertaken to:

- identify the occurrence of existing records of potential SRE groups in the wider area;
- to facilitate the identification of available invertebrate SRE habitat within the study area; and
- to assist with the assessment of the conservation significance of the field survey results.

Although a specific database of SRE species is not available, a review of the following databases was undertaken for records of individuals from the target SRE groups:

- A search of the Australian Museum database (Australian Museum, 2008b) for invertebrates was conducted in a 200 x 200 km search area.
- A search of Biomaps - an online database which provides “tools for accessing and analysing biodiversity data” (Australian Museum and Rio Tinto, 2008).
- A search of the maps produced for land snails (order Eupulmonata) using the Australian Museum Collections of Mollusc within the *Biodiversity Analysis Tool*<sup>1</sup> (Commonwealth Department of the Environment, Water, Heritage and Arts [DEWHA], 2008).

The literature review included a review of:

- previous biological survey work undertaken within the Cundaline and Callawa study areas by *ecologia* (2005a; 2005b);
- previous biological survey work undertaken within the wider Goldsworthy area (*ecologia*, 2005e); and
- SRE survey work conducted within the Pilbara region (e.g. Chevron Australia, 2007; Johnson *et al.*, 2004; OES, 2006; 2008a, 2008b, 2008c; ENV Australia, 2008).

#### 3.2 Terrestrial Vertebrate Fauna Database and Literature Review

##### 3.2.1 Terrestrial Vertebrate Fauna Database Searches

Database searches were made prior to the field survey. Search areas were defined using a central point with a 100 km buffer (the ‘search area’).

<sup>1</sup> Biodiversity Analysis Tool - is a component of the Australian Biodiversity Information Facility and is an online mapping system which ‘enables the user to understand patterns in the distribution of biodiversity’ (DEWHA, 2008). Biodiversity information for other short-range endemic groups listed in Section 1.2 is not provided by the Biodiversity Analysis Tool.



Database searches of these areas were made using the following databases and internet tools:

- The WAM (2008).
- Threatened and Priority Fauna Database held by the Western Australia Department of Environment and Conservation (DEC).
- The Protected Matters and Environmental Reporting Tools of DEWHA.
- The Birds Australia database (2008).
- The Australian Museum database (2008).
- The ANRA (2007) of the National Land and Water Resources Audit.

Information from the sources outlined above was augmented with additional information relating to species' likelihood of occurrence based upon personal experience and general patterns of distribution and known habitat preferences. Many of the species present on regional lists have specific habitat requirements that may be present in the general area, but not in the study areas. Some species, therefore, will be included in lists but are unlikely to be present in the actual study areas. Relevant texts from which information on general patterns of distribution was obtained included:

- Mammals: Menkhorst and Knight (2004); Van Dyck and Strahan (2008).
- Birds: Heatwole (1987); Higgins (1999); Higgins *et al.* (2001); Johnstone and Storr (1998, 2004); Morcombe (2003); Pizzey and Knight (2007); Slater *et al.* (2007).
- Reptiles: Storr *et al.* (1983, 1989, 1999, 2002); Cogger (2000); Wilson and Swan (2003, 2008).
- Amphibians: Cogger (2000); Tyler *et al.* (2000).

### 3.2.2 Previous Vertebrate Fauna Studies in the Study Areas

A review of literature was undertaken to provide a list of mammals, reptiles, amphibians and birds that have been recorded or have the potential to occur within the study areas. A number of vertebrate fauna surveys have been conducted in the surrounding Goldsworthy area for mining developments such as:

- Yarrie operations, located approximately 2 km north of the planned Callawa mining operations (Dames and Moore, 1992; *ecologia*, 1999);
- Cattle Gorge operations, located approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2004, 2005d);
- Shay Gap operations, located approximately 10 km north-west of the planned Cundaline mining operations (*ecologia*, 2005e);

- Sunrise Hill operations, located approximately 20 km north-west of the planned Cundaline mining operations (*ecologia*, 2005e); and
- Nimingarra operations, located approximately 24 km north-west of the planned Cundaline mining operations (*ecologia*, 2005e, 2005d).

The Cundaline and Callawa study areas were surveyed for terrestrial vertebrate fauna by *ecologia* in 2005. Studies conducted include:

- *ecologia* (2005a) *Cundaline Biological Assessment Survey*; and
- *ecologia* (2005b) *Callawa Biological Assessment Survey*.

An outline of the methods used in these surveys is provided below.

The Cundaline survey was undertaken by *ecologia* from 23 to 29 May, 2005. Six systematic sampling sites were established over a large study area across the Cundaline Ridge.

The Callawa survey was undertaken by *ecologia* from 9 to 28 June, 2005. Six systematic sampling sites were established over a large study area across the Callawa Ridge.

The survey methods used were systematic trapping and systematic searching, nocturnal spotlight searching and opportunistic records. Fauna groups targeted were mammals, birds, reptiles and amphibians.

#### *Trapping Grids*

Trapping grids consisted of:

- pit traps (16 cm diameter, minimum 35 cm deep PVC tubes; and 20 litre (L) buckets 30 cm diameter, 40 cm deep) set along a flywire drift fence 30 cm high and 5 metres (m) in length;
- a funnel trap was placed on each end of the drift fence (for 9 out of 10 pit traps);
- various sized cage traps; and
- ten medium Elliott traps (9 x 9 x 32 cm).

#### *Bird census*

A bird census was performed at each of the 12 survey sites. The number of individuals of each species at each site was recorded over a 60 minute period.

#### *Bats*

Bats were sampled primarily via echolocation call detection through an Anabat detector (Titley Electronics, Ballina, NSW). The transformed calls were stored on minidisks using a Sony MZ-R900

Minidisc recorder and played back through a ZCAIM (Zero-Crossings Analysis Interface Module) for analysis.

The Anabat system was set up at five locations for the Cundaline survey and at three locations for the Callawa survey. Sampling locations were based on the presence of suitable bat habitat such as caves and gorges. Echolocation call was sampled between 5.00 pm and 8.00 pm to correspond with bats leaving predicted roosting sites.

#### *Opportunistic Sightings and Secondary Evidence*

Opportunistic sightings of vertebrate fauna were recorded during targeted searching, whilst travelling and during trap establishment within the Cundaline and Callawa study areas during the day or night. Secondary evidence of vertebrate fauna recorded included tracks, diggings, scats, burrows, and nests.

#### *Survey Effort*

Survey effort during the Cundaline survey totalled 390 pit trap nights, 390 Elliot trap nights, 351 funnel trap nights, 78 cage trap nights, 13.5 hours spotlighting and 34 hours active searching.

Survey effort during the Callawa survey totalled 960 pit trap nights, 960 Elliot trap nights, 864 funnel trap nights, 192 cage trap nights, 5 hours spotlighting and 46.16 hours active searching.

### **3.3 Short-range Endemic Field Survey**

Guidelines for conducting SRE surveys were being drafted by the DEC and the EPA at the time of writing this report. Due to the absence of available guidelines, OES has maintained consultation with SRE specialists from the DEC, UWA and the WAM. Recommendations from regulators and SRE specialists were incorporated into the survey timing (Section 3.2.1), survey design (Section 3.3.2), location of sampling sites (Section 3.3.3) and survey techniques (Section 3.3.4).

Additionally, the objectives and methodology adopted for this survey are aligned, where practicable, with the following EPA Guidelines:

- Guidance Statement No. 56: *Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004); and
- Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002).

#### **3.3.1 Survey Timing and Weather**

Three separate surveys were undertaken as part of the SRE assessment of the study areas. ENV Australia conducted the first two surveys which focused on the collection of mygalomorph spiders at Callawa from 11 to 18 April 2008 and Cundaline from 26 April to the 1 May 2008. During ENV's surveys at Cundaline and Callawa minimum temperatures ranged from 18.1° to 23.3°C and 17.0° to

26.8°C, respectively, while maximum temperatures ranged from 35.8° to 37.4°C and 36.3° to 39.0°C, respectively. The third survey conducted by OES was over a ten day period from 2° to 12° July 2008 and included a comprehensive survey, targeting all terrestrial invertebrate groups outlined in Section 1.2. The weather during the survey was fine and sunny with no rain. Minimum temperatures ranged from 7.5° to 17.2°C while maximum temperatures ranged from 27.0° to 30.9°C. **Table 2** summarises climatic data recorded for the region during the survey periods.

The amount of rainfall received six weeks prior to and during a survey may have influenced the number of SRE species captured. SREs (particularly mygalomorph spiders) are known to be most active just prior, during and after a rainfall event (B. Y. Main, pers. comm., August 2008).

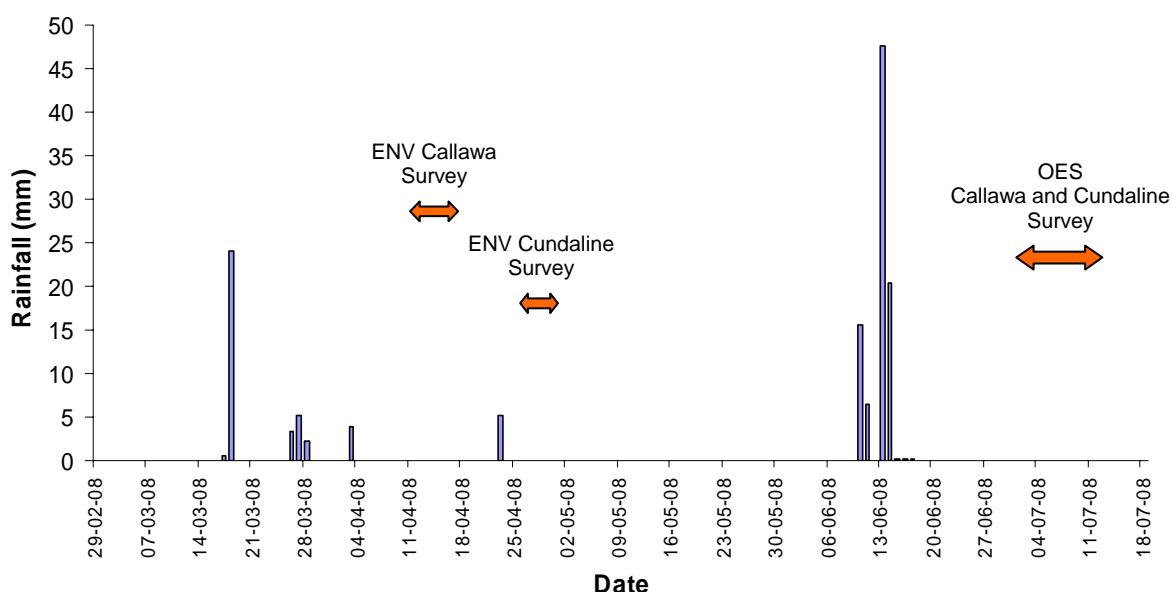
**Table 2 Meteorological Data Recorded During the Survey Periods**

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)	Average Relative Humidity (%)
Callawa ENV survey <sup>1</sup>				
11/04/08	26.8	39.0	0	19.5
12/04/08	26.3	37.1	0	26.5
13/04/08	24.6	37.0	0	20.0
14/04/08	22.6	38.2	0	14.0
15/04/08	24.6	38.4	0	12.0
16/04/08	20.0	37.2	0	10.0
17/04/08	17.0	36.3	0	8.5
Cundaline ENV survey <sup>1</sup>				
26/04/08	23.3	36.5	0	13.0
27/04/08	18.5	37.4	0	15.0
28/04/08	18.5	37.2	0	27.0
29/04/08	18.1	36.9	0	19.0
30/04/08	21.0	36.2	0	25.0
1/05/08	19.4	35.8	0	24.0
Cundaline and Callawa OES survey <sup>2</sup>				
2/7/2008	15.9	30.9	0	19
3/7/2008	17.2	27.7	0	34
4/7/2008	13.6	29.1	0	63
5/7/2008	13.5	28.7	0	54
6/7/2008	13.4	28.4	0	21
7/7/2008	15.2	27.0	0	20
8/7/2008	16.2	29.7	0	14
9/7/2008	13.1	28.4	0	26
10/7/2008	9.3	27.8	0	22
11/7/2008	7.5	28.0	0	19
12/7/2008	8.7	29.3	0	19

<sup>1</sup> Marble Bar Meteorological Station.

<sup>2</sup> Port Hedland Meteorological Station (Marble Bar data not available).

Within the six weeks prior to ENV's April surveys of the Cundaline and Callawa study areas, the region experienced 39.2 mm and 44.4 mm of rain, respectively. Within the six weeks prior to the OES July survey of Cundaline and Callawa, the region received a total of 90.6 mm of rainfall. No rainfall was recorded during any of the three survey periods. The amount of rainfall prior to and during the sampling periods is shown in **Figure 6**. Rainfall data was sourced from the Marble Bar Meteorological Station from the 29 February 2008 to 24 June 2008 and from the Port Hedland Meteorological Station from the 25 June 2008 to 18 July 2008, as the Marble Bar data was unavailable during the entire period.



**Figure 6 Rainfall Recorded Prior to and During the SRE Survey Periods**

### 3.3.2 Survey Design

The survey was designed following consultation with the DEC, and specialists from the UWA and the WAM.

#### *Autumn Survey*

Sampling for mygalomorph spiders was conducted at Callawa from the 11 to 18 April 2008; and at Cundaline from the 26 April to the 1 May 2008, by ENV.

Four sampling sites, each consisting of ten pitfall traps along a 4 m long drift fence, were established in each of the study areas. The pitfall traps on the Cundaline Ridge were left open for five nights and the

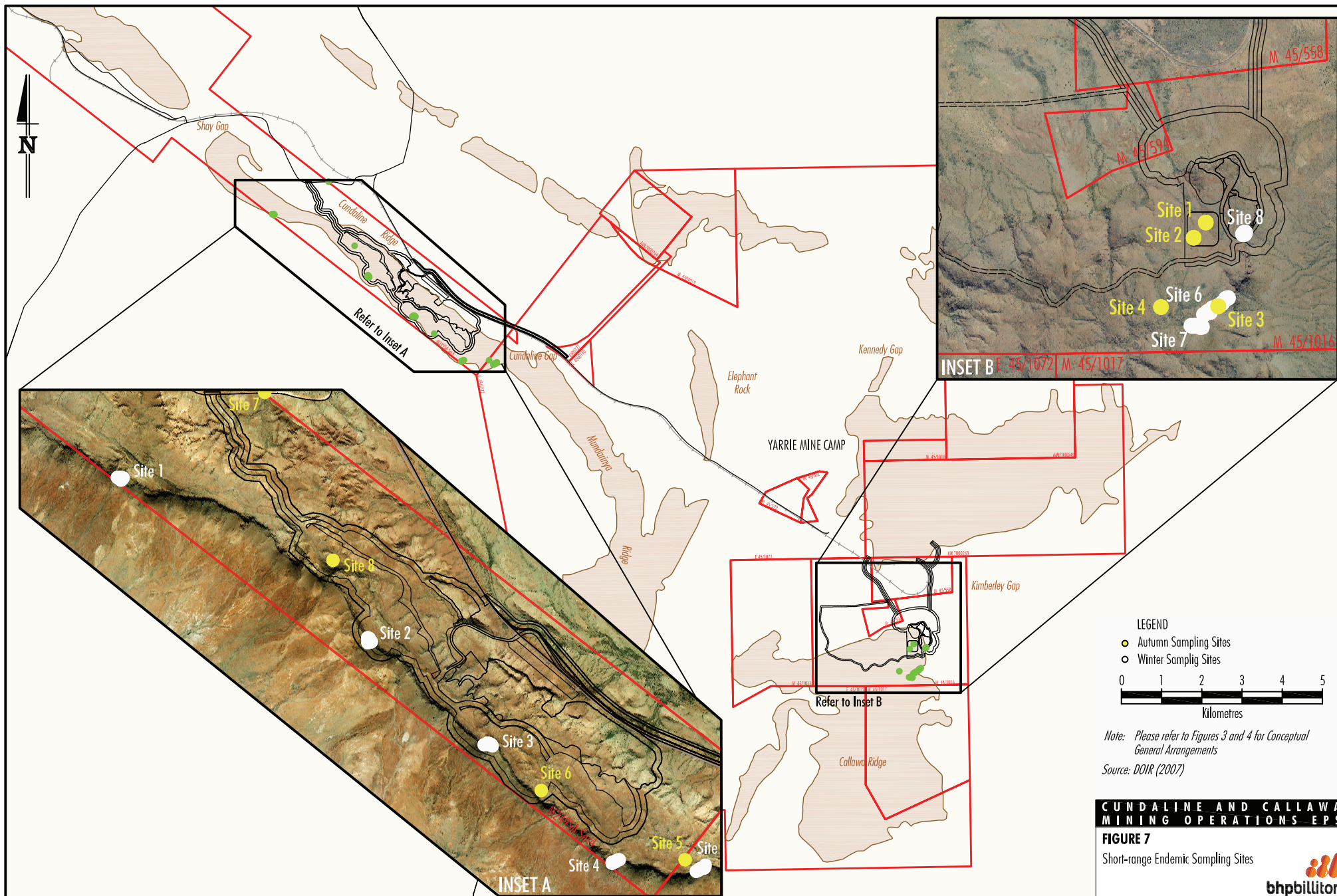


pitfall traps on the Callawa Ridge were left open for six to seven nights. The traps were checked daily for by-catch.

Opportunistic searches were conducted amongst leaf litter. The litter was placed onto a white sheet and sorted.

### ***Winter Survey***

An additional eight sites (five at Cundaline and three at Callawa) were established by OES in winter along the Callawa Ridge and Cundaline Ridge (**Figure 7**). The number of sampling sites chosen was based on the occurrence of potential SRE habitat within the study areas.



### 3.3.3 Sampling Sites

#### *Autumn Survey*

During the autumn surveys of the Cundaline and Callawa study areas, a total of eight sampling sites were established, four within each study area (**Table 3**). The location of these sites is shown in **Figure 7**.

**Table 3 Autumn Survey Short-range Endemic Sampling Site Locations**

Site Name	Site Type	Study Area	Site Co-ordinates Datum: WGS 84	
S01	Impact	Callawa	20°33'00.4"S	120°10'21.3"E
S02	Reference	Callawa	20°38'33.8"S	120°18'11.9"E
S03	Reference	Callawa	20°38'51.6"S	120°18'18.4"E
S04	Reference	Callawa	20°38'51.6"S	120°18'02.6"E
S05	Reference	Cundaline	20°34'34.7"S	120°12'15.0"E
S06	Impact	Cundaline	20°34'12.5"S	120°11'28.3"E
S07	Reference	Cundaline	20°32'08.1"S	120°10'00.0"E
S08	Impact	Cundaline	20°33'00.4"S	120°10'21.3"E

#### *Winter Survey*

During the winter survey of the Cundaline and Callawa study areas, a total of eight sampling sites were established (**Table 4**). The location of these sites is shown in **Figure 7**. Five sites were established along the Cundaline Ridge (Sites 1 to 5), and the remaining three sites were located along Callawa Ridge (Sites 6 to 8).

**Table 4 Winter Survey Short-range Endemic Sampling Site Locations**

Site Name	Site Type	Study Area	Co-ordinates Datum: WGS 84	
S01	Reference	Cundaline	20°32'34.6"S	120°09'13.5"E
S02	Impact	Cundaline	20°33'25.5"S	120°10'32.4"E
S03	Impact	Cundaline	20°33'58.1"S	120°11'11.3"E
S04	Reference	Cundaline	20°34'35.0"S	120°11'52.0"E
S05	Reference	Cundaline	20°34'37.7"S	120°12'19.9"E
S06	Reference	Callawa	20°38'51.6"S	120°18'18.2"E
S07	Reference	Callawa	20°38'56.5"S	120°18'12.3"E
S08	Impact	Callawa	20°38'33.0"S	120°18'25.9"E

Representative sampling sites were chosen with consideration to the proposed zone of direct impact, as well as the zone of wider interest. The targeted habitats contained:

- deep litter deposits accumulated under vegetation;
- south-west-facing and south-east-facing ridges, gorges, rocky outcrops, deep crevices and caves that provided shade and shelter; and
- ephemeral creeklines that provided moisture, friable soils, and deep litter.

Site selection was limited by accessibility within the study areas which is primarily governed by existing exploration/drill tracks.

A description of the sampling sites selected by OES is provided below:

Site 01 was a reference site established in the north-western end of the Cundaline study area on the south-west face of the Cundaline Ridge (**Plate 1**). The area was shaded for most of the day with some afternoon sun in the more exposed areas. The cliff face was approximately 20m high and had been undercut by water flow and formed a large overhang providing sheltered and relatively moist conditions. Vegetation was dominated by a large grove of *Ficus* sp. that had contributed to substantial levels of decomposing leaf litter. Moisture levels are likely to be higher than in the surrounds as *Ficus* usually need access to water. There were also a number of grasses such as *Eragrostis* sp. and *Cymbopogon* sp. present as well as a low story of Acacias and Eucalypts. A clear transition from these species into *Triodia* sp. was apparent on the exposed regions of the slope.



**Plate 1**      **Site 01 - Reference site located within the northern section of the Cundaline study area**



Site 02 was located in a potential impact area within the southern section of the Cundaline northern ore deposit (**Plate 2**). This site was made up of a south-west rocky slope with a series of rocky outcrops rather than a defined cliff-face. The lack of a defined cliff face increases the exposure of this site in comparison to the other sites. As a result, the vegetation was dominated by *Triodia* sp., *Acacia* sp. and *Grevillea wickhamii* subsp. *hispidula*. In the more sheltered areas beneath the outcrops grasses such as *Eragrostis* sp. and *Cymbopogon* sp. were present.



**Plate 2**      **Site 02 - Proposed impact area of the Cundaline study area**

Site 03 was located within a proposed impact area against a south to south-west facing ridge approximately 15 m high, within the southern ore deposit of Cundaline Ridge (**Plate 3**). The site was shaded for most of the day providing cool moist conditions. These conditions were conducive to several *Ficus* sp. plants which were observed to be growing at the base of the rock face. Litter accumulation and decomposition was greatest beneath these *Ficus* sp. plants. An understorey comprised grass species dominated by *Eragrostis* sp. and *Cymbopogon* sp. There was a clear transition from these grasses to *Triodia* sp. further down the slope in areas that were exposed.



**Plate 3**      **Site 03 - Proposed impact area of the Cundaline study area**

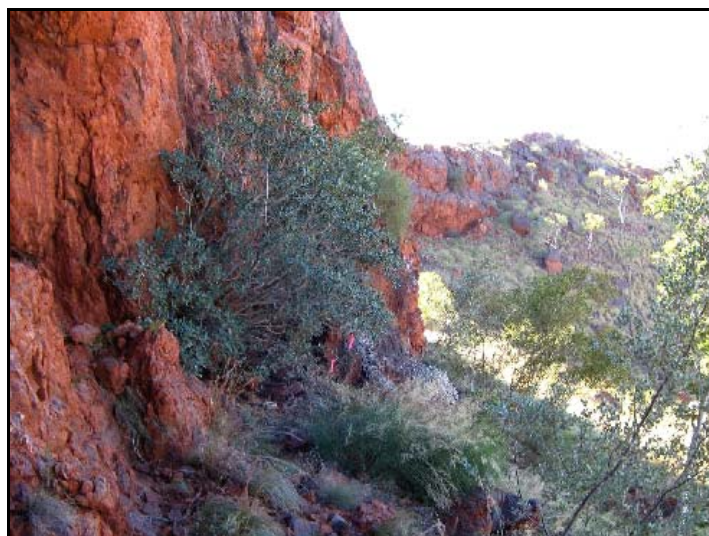


Site 04 was a reference site established at the southern end of the Cundaline study area. The ridge was approximately 15 m high and had a south to south-west aspect (**Plate 4**). The site was relatively well sheltered throughout the day and had a diverse vegetation assemblage as a result. Dominant species included *Acacia* sp. and *Eucalyptus leucophloia*, with an understorey of *Eragrostis* sp. and *Cymbopogon* sp. There were also a number of *Ficus* sp. present along with a number of ferns (*Cheilanthes* sp.). *Triodia* sp. and *Grevillea wickhamii* subsp. *hispidula* were present on the lower exposed sections of the slope.



**Plate 4**      **Site 04 - Reference site located at the southern end of the Cundaline study area**

Site 05 was a reference site located in the south-east section of the Cundaline study area. The ridge was approximately 20 m high and had a southern aspect (**Plate 5**). Vegetation at this site was predominantly *Eucalypts* spp. and *Acacia* spp. with an understorey of scattered *Eragrostis* sp. *Triodia* sp. became dominant within 5 m of the base of the ridge with a number of *Grevillea wickhamii* subsp. *hispidula* also being present in exposed areas of the slope. One *Ficus* sp. plant was present at this site.



**Plate 5**      **Site 05 - Reference site located within the south-east section of the Cundaline study area**

Site 06 was a reference site within the Callawa study area (**Plate 6**). This site was dominated by rocky outcropping, offering both protected and exposed areas. The exposed areas supported a vegetation community dominated by a number of *Acacia* spp. and *Triodia* sp., where as the more sheltered regions supported *Eucalypts* spp., *Eragrostis* sp. and *Cymbopogon* sp. grasses with some *Ficus* sp. There were substantial amounts of leaf litter that had accumulated beneath the *Ficus* sp. Sampling sites were located within the sheltered regions of this site.



**Plate 6**      **Site 06 - Reference site within Callawa study area with rocky outcropping**

Site 07 was a reference site located in a drainage line in the southern section of the Callawa study area (**Plate 7**). The drainage line was internally draining in a west direction which offered a protected south-facing slope and an exposed north facing slope. Sampling and pit trapping sites were located on the south-facing slope which offered shelter from outcropping. Dominant vegetation included *Eragrostis* sp. and *Acacia* sp., in the sheltered regions with *Triodia* sp. becoming dominant in the more exposed regions.



**Plate 7**      **Site 07 - Reference site located in a drainage line within the Callawa study area**



Site 08 was located within the proposed impact area of the Callawa deposit. The ridge was approximately 20 m high and faced a southern direction (**Plate 8**). The shelter provided by the ridge allowed for a diverse range of vegetation to become established and was dominated mostly by *Acacia* spp. and *Eucalypt* spp. Grass species were dominated by *Cymbopogon* sp. with some *Eragrostis* sp. being present. A number of caves were also present at this site. *Triodia* sp. did not become dominant at this site until some distance down the slope.



**Plate 8**      **Site 08 - Proposed impact area within the Callawa deposit**

#### **3.3.4 Survey Methods**

##### ***Autumn Survey***

The autumn survey by ENV utilised pitfall trapping to target mygalomorph spiders. This survey is reported in this report; a separate report has not been prepared.

##### ***Winter Survey***

The winter survey by OES utilised pitfall trapping to target mygalomorph spiders. The survey techniques used for the comprehensive SRE survey within the study area was based on recommendations and guidance provided by Mark Harvey (WAM), Shirley Slack-Smith (WAM), Barbara York-Main (UWA) as well as DEC staff.

A summary of the methods for the comprehensive survey is provided in **Table 5**.

**Table 5 Short-range Endemic Survey Methodology at Each Sampling Site**

Methodology	Target Group	Sampling Effort/ Site
Dry pitfall trapping	All groups	10 traps over 7 days
Targeted searching	All groups	5 hours per site
Litter collection	All groups	5 samples per site
Soil sieving	Terrestrial molluscs	5 samples per site
UV night searching	Scorpions	30 minutes per site

A description of each survey technique is provided below.

### ***Pitfall Trapping***

Both the autumn and winter surveys utilised the same pit traps at one site on the Callawa Ridge. This site was called Site 3 by ENV but was renamed as Site 6 by OES. For ease of reporting, this site will herein be referred to as Site 6. The ten traps at Site 6 were from the original vertebrate fauna trapping program installed by *ecologia* in 2005. These pitfall traps included three 150 mm PVC pipe pit traps and seven 15 L bucket pit traps. These traps all had 3 m long by 25 cm high flywire fences, the base of which was buried into the ground. The trapping methods incorporated at all other sites differed between the autumn and comprehensive winter surveys.

### ***Autumn Survey***

The autumn survey conducted by ENV utilised ten pitfall traps with fencing, at each site (total 80 pitfall traps). The pitfall traps comprised metal containers approximately 1.2 L (10 cm diameter x 15 cm high) dug into the ground so that the tops were flush with the natural soil profile (**Plate 9**). Drift fences (gutter guard) were approximately 150 cm long and 15 cm high and were set to pass over the centre of the pitfall trap. The base of each fence was dug into the ground. Traps were sheltered with a segment of cardboard.



**Plate 9 ENV pitfall trap showing fencing and trap cover**

### Winter Survey

For each of the eight sampling sites established for the winter survey by OES, a total of ten pitfall traps were established at approximately 10 m intervals, depending on the availability of a suitable substrate (total of 80 pitfall traps). Pitfall traps consisted of a cylindrical 4 L plastic container (20 cm diameter x 20 cm high) dug into the ground (**Plate 10**). This is a relatively large diameter for a pitfall trap and large pitfall trap diameters have been shown to increase the trapping efficiency (Brennan *et. al.*, 2005). The method of wet pitfall trapping with killing and preserving fluid was not utilised upon advice provided from the DEC, to reduce the risk of invertebrate and vertebrate fauna by-catch mortality. Particular attention was given to ensure the top of the container was flush with the natural surface profile and all obstructions with the potential to reduce catch were removed.

To increase the efficiency of the pitfall traps, two drift fences (flywire mesh) measuring approximately 75 cm in length and 15 cm in height were set on each side of the container. The base of the fences was buried into the ground and the ends were anchored by wire stakes. It is recognised that catch rates increase with drift fence length (after Brennan *et. al.*, 2005), however, the availability of substrate around the pit trap for fence installation was often limited and variable between trapping sites. The two 75 cm lengths of fence per trap were found to be a practical length given the substrate while also permitting for consistency between trapping sites.

To provide shade for any fauna caught in the traps, a lid was suspended approximately 5 cm over the trap by four pegs. A 'rescue rock' was placed at the bottom of the trap to provide refuge for caught fauna in the event of the trap filling with water during rain. Traps were set for a period of seven nights and checked daily for catch and pitfall maintenance. The exception was Site 8 at the Callawa study area where traps were set for six nights with two additional traps. This equated to 72 trapping nights (12 traps x six nights) for Site 8 compared to 70 trap nights (10 traps x 7 nights) for all other sites. Invertebrate and vertebrate by-catch was released.



**Plate 10** Pitfall trap showing fencing and suspended lid



Pitfall traps were removed and holes backfilled after the autumn survey by ENV and after the winter survey by OES. GPS co-ordinates of each trap location were recorded.

### ***Targeted-searching***

Each sampling site, including the general surrounds was systematically searched for the target groups in the following areas:

- amongst layers of deep leaf litter, particularly *Ficus* sp.;
- under logs, rocks and in crevices;
- at the base of shrubs, trees and Spinifex; and
- under bark and amongst debris.

At each site, two people undertook targeted searching for 2.5 hours each; this totalled five person hours per site.

Mygalomorph spiders were targeted by searching for burrow entrances which are typically cryptic in appearance and can be made of mud/clay or silk lids. Active searching is considered to be the most effective method of collecting female mygalomorph spiders which can help reveal a spider's home range within a study area. Male specimens are generally required for identification to the species level. Selected burrows were excavated and resident spiders collected with forceps (after Main, 2002).

The presence of scorpion burrows (which are typically in the form of horizontal slits) was also noted and scorpions were dug and collected from these burrows where possible.

### ***Litter Collection***

Five samples of leaf litter, approximately 1 L in volume, were collected from areas of accumulation under trees and around rocks. The top layer of litter was scraped back to reveal the decomposition layer above the soil. Samples of the decomposition layer were taken at various localities around the sampling site and collected in small plastic zip lock bags. The filled bags were sealed, kept cool and transported to the OES laboratory.

### ***Soil Sieving***

At each site, five soil samples were collected and sieved (total of 40 soil samples). Areas were targeted for soil sieving where terrestrial snails were likely to occur, such as: under vegetation, at the base of cliffs, under rock ledges and the soil under decomposing leaf material. The soil fraction between 1 mm and 10 mm was retained and transported to the OES laboratory for sorting. All terrestrial mollusc specimens were sent to the WAM for identification.

### **Ultraviolet Spotlighting**

Two people conducted 30 minutes of UV spotlighting at each sample site; this totalled one person hour per site. Different sites were searched during each night of spotlighting. The main focus of spotlighting was the collection of scorpions. Handheld ultraviolet torches were used to locate scorpions which are nocturnal and fluoresce under ultraviolet light.

### **Assessment of Habitat**

Prior to the field survey, aerial imagery was used to identify sheltered gorges and ridgelines within the study area and surrounds. During the survey, a SRE habitat assessment was conducted within the study area. The following factors were taken into consideration when identifying SRE habitat:

- aspect;
- topography;
- rock outcrops;
- soil type;
- vegetation;
- litter cover;
- existing disturbance; and
- water sources.

Habitats were assessed according to their condition and complexity in relation to each of the targeted SRE groups. The methodology relies on visual methods to assess habitat features.

#### **3.3.5 Sorting and Identification of Specimens**

With the exception of mollusc, all specimens were preserved *in situ* using 70 % ethanol. The third left leg of spiders and scorpions were removed following preservation of the specimen and then preserved in 100 % ethanol for future DNA analysis.

All samples and specimens collected in the field were transported to the OES Perth laboratory for sorting and distribution to taxonomic experts. Leaf litter samples were placed in Berlese funnels for 48 hours to extract invertebrates (**Plate 11**). The incandescent globes mounted above these funnels provide a heat source which dries out leaf litter, and a bright light source which causes invertebrates to move down through the leaf material into a collection vial containing ethanol. Specimens retrieved from the ethanol catchment vials were sorted using standard identification keys (e.g. Brunet, 1994, 1996; Commonwealth Scientific and Industrial Research Organisation [CSIRO], 1970; Commonwealth Department of the Environment and Heritage [DEH], 2006; Harvey and Yen, 1989; Raven *et al.*, 2002).



**Plate 11 Cundaline and Callawa leaf litter samples in Berlese funnels at the OES Laboratory**

The sieved soil samples were spread in a plastic tray and inspected under a 2.75 x magnifier. Terrestrial snail specimens were placed in vials fitted with suitable padding.

All collected specimens were prepared as per the WAM guidelines on the preservation and lodgement of specimens (**Appendix A**) and delivered to the Museum for identification and evaluation. These specimens included mygalomorph spiders, scorpions, millipedes, pseudoscorpions and terrestrial snails.

The taxonomic specialists for each invertebrate group were as follows:

- millipede, scorpion, pseudoscorpion and mygalomorph spiders specimens were identified by Dr Mark Harvey of the WAM (**Appendix B**); and
- terrestrial mollusc specimens were identified by Dr Shirley Slack-Smith and Cory Whisson of the WAM (**Appendix C**).

Barbara York Main also confirmed spider identifications.

### **3.3.6 Survey Limitations and Constraints**

As stated in Section 3.2, no specific formal guidance is available for the survey of terrestrial SRE invertebrates. Moreover, prescriptive survey guidelines, including standard methodologies, have not been established by regulatory authorities.

The aim of the survey was to investigate the presence of potential SRE species at the Cundaline and Callawa Ridges. Like any biodiversity sampling survey, it is recognised that there are limitations to surveying SRE species, and that a SRE survey provides a snapshot of the invertebrates which may be present in an area at the time of surveying.

Through consultation with the relevant specialists (Section 3.3), the survey has been designed to minimise the survey limitations (e.g. methods appropriate to target SRE groups). However there were limitations that may, or may not, have affected the results of the survey, these limitations may have been:

- Climatic conditions – Rainfall and the associated humid conditions are widely considered by experts to be conducive to invertebrate activity, particularly SRE species (Main pers comm. 2008). Mygalomorph spiders in particular are typically sedentary with movement of male spiders from fixed burrows restricted to specific climatic conditions associated with rainfall events. Therefore restricted opportunities for sampling either through pit-trapping or other techniques occur.
- No rainfall was recorded during the April and June surveys (**Figure 6**), which may have been a contributing factor towards the low pitfall trap success. However, March/April and June/July seem to be the best times to survey Mygalomorph Spiders in the Pilbara, and specifically within 6 to 7 weeks of a rain event (Jackson. T [DEC], pers. comm., 2008). In the Pilbara, the wet season concludes in late March and June is the dry season, therefore the amount of rainfall prior to and during the surveys was expected. Each survey was completed within a 6 to 7 week period after rainfall (**Figure 6**); however it is suggested that mygalomorph activity would have been highest during and shortly after these rainfall events. Coinciding trapping surveys with rainfall events is challenging in relation to field logistics and available personnel resources, however if achieved is likely to yield increased collection of male mygalomorph specimens which are typically required for species identification.
- Night Searching Constraints - Due to health and safety requirements associated with the demand of daytime field work, the required distance to travel to and from sites and the number of sites, night searching was restricted to the early hours of the evening, between 6.30 pm and 9.00 pm (sunset was at approximately 5.33 pm, and civil twilight at 5.57 pm, based on Port Hedland times). It is possible that scorpions may have been missed during spotlighting as they may not have been active during these hours.

### 3.4 Terrestrial Fauna Habitat Assessment

The broad fauna habitats occurring within the Cundaline and Callawa study areas were identified, assessed and described separately for their complexity and the quality of habitats that they provide for fauna. The following criteria were taken into consideration when undertaking the habitat assessment: landscape features, estimate of litter cover percentage and type, soils, outcropping, estimate percentage of bare ground, types of disturbance (e.g. evidence of fire, tracks); and the levels of disturbance in terms of the effect that it has had on the vegetation (e.g. density of overstorey vegetation, density of shrubs).



## 4.0 RESULTS/DISCUSSION: SHORT-RANGE ENDEMICS

### 4.1 Mygalomorph Spiders

During the April/May surveys, no mygalomorph specimens were collected within the Callawa or Cundaline study areas (**Table 6**). During the winter survey in July, a total of seven mygalomorph spiders were collected from the Cundaline study area and no mygalomorph spiders were collected from the Callawa study area.

**Table 6 Mygalomorph Spider Specimens Collected from the Cundaline and Callawa Study Areas between 2 and 12 June 2008**

Site No.	Specimen Co-ordinates Datum: WGS 84		Family	Genus	Species	Collection Method
01	20°32'34.1"S	120°09'12.5"E	Amaurobioidea	1	1	Pit trap 7
03	20°33'57.7"S	120°11'11.5"E	Ctenizidae	<i>Conothele</i>	2	Active search
03	20°33'57.7"S	120°11'11.5"E	Ctenizidae	<i>Conothele</i>	2	Active search
03	20°33'57.7"S	120°11'11.5"E	Ctenizidae	<i>Conothele</i>	2	Active search
03	20°33'57.7"S	120°11'11.5"E	Ctenizidae	<i>Conothele</i>	2	Active search
04	20°34'34.6"S	120°11'52.4"E	Ctenizidae	<i>Conothele</i>	2	Active search
04	20°34'34.6"S	120°11'52.4"E	Ctenizidae	<i>Conothele</i>	2	Active search

<sup>1</sup> Specimen unable to be identified/determined due to lack of taxonomic knowledge.

<sup>2</sup> Specimens not suitable for accurate identification.

#### Superfamily Amaurobioidea

One male specimen from the superfamily Amaurobioidea was collected from a pit trap at Site 1. It has not been possible to identify the specimen as the taxonomy of the group in the Pilbara is uncertain; however it is unlikely to represent a SRE species (Harvey, 2008a; **Appendix B**).

#### Family Ctenizidae: *Conothele* sp.

Six immature specimens belonging to the genus *Conothele* were collected at Cundaline during active searching. Four of these specimens were collected from Site 03 within the proposed impact area and two specimens were collected from Site 04, a reference site south of the proposed impact area (**Table 6**; **Figure 7**; **Plate 12**). The taxonomic status of the genus *Conothele* in WA is very uncertain, with the entire group representing unnamed species (Harvey, 2008a; **Appendix B**). The taxonomy of the genus is based on the first leg and pedipalp of adult male specimens to allow identification to species level. Since the specimens were immature, they could not be identified and it was not possible to determine if the species is associated with short-ranged endemism. However, given the close proximity of the two sites (1.3 km) along the same ridge, it is likely that specimens from both Site 03 and Site 04 represent the same species (M. Harvey, pers. comm., August 2008). The cryptic nature of the trapdoor burrows could indicate the species range along the ridge is larger than was found in this survey.



**Plate 12 Specimen from the genus *Conothele* collected from Site 03 and Site 04: burrow (left) and spider (right)**

From the current level of taxonomic knowledge, no mygalomorph species collected within the Cundaline or Callawa study areas were known to represent SRE species. However, the uncertain taxonomic status of the genus *Conothele* (all species of the genus are unnamed) and the collection of immature specimens infer it is not possible to determine if the *Conothele* sp. from Cundaline Ridge has been collected elsewhere or whether it is a SRE species.

## 4.2 Scorpions

A total of 11 scorpions from two genera were collected from Cundaline and Callawa study areas in the July survey, during active searching, and night spotlighting (**Table 7**).

**Table 7 Scorpion Specimens Collected from the Cundaline and Callawa Study Areas between 2 and 12 June 2008 Survey**

Site Number	Specimen Co-ordinates Datum: WGS 84		Family	Genus	Species	Collection Method
01	20°32'33.8"S	120°09'13.5"E	Buthidae	<i>Lychas</i>	1	Active searching
01	20°32'33.8"S	120°09'13.5"E	Buthidae	<i>Lychas</i>	1	Active searching
01	20°32'34.3"S	120°09'12.7"E	Buthidae	<i>Lychas</i>	1	Active searching
02	20°33'24.4"S	120°10'32.3"E	Buthidae	<i>Lychas</i>	1	Night spotlighting
03	20°33'57.9"S	120°11'11.9"E	Buthidae	<i>Lychas</i>	1	Active searching
05	20°34'38.1"S	120°12'19.2"E	Buthidae	<i>Lychas</i>	1	Night spotlighting
06	20°38'53.7"S	120°18'14.4"E	Buthidae	<i>Lychas</i>	1	Active searching
06	20°38'53.2"S	120°18'15.2"E	Buthidae	<i>Lychas</i>	1	Night spotlighting
06	20°38'52.9"S	120°18'15.6"E	Buthidae	<i>Lychas</i>	1	Active searching
06	20°38'52.1"S	120°18'16.8"E	Urodacidae	<i>Urodacus</i>	1	Active searching – dug from burrow
07	20°38'56.9"S	120°18'13.3"E	Urodacidae	<i>Urodacus</i>	1	Active searching – dug from burrow

<sup>1</sup> Specimen unable to be identified/determined due to lack of taxonomic knowledge.

### Family Buthidae: *Lychas* sp.

*Lychas* were collected from a number of sites in both study areas. Although the identity of the specimens is uncertain, Harvey (2008a; **Appendix B**) is confident that they do not represent a SRE species.

### Family Urodacidae: *Urodacus* sp.

The taxonomy of the *Urodacus* genus in northern Western Australia is poorly understood, however the species collected is unlikely to be a SRE (Harvey, 2008a; **Appendix B**).

From the current level of taxonomic knowledge, no scorpions collected within the Cundaline or Callawa study areas were found to represent SRE species.

## 4.3 Pseudoscorpions

A total of 20 pseudoscorpions were recorded from the Cundaline and Callawa study areas during the July survey; eight specimens were collected during active searches and 12 specimens were recorded from leaf litter samples placed in Berlese funnel traps (**Table 8**). The pseudoscorpions represented three genera from the family Olpiidae.

**Table 8 Pseudoscorpion Specimens Collected from the Cundaline and Callawa Study Areas between the 2 and 12 June 2008 Survey**

Site Number	Specimen Co-ordinates Datum: WGS 84		Family	Genus	Collection Method
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Active searching
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Active searching
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Active searching
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Active searching
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Berlese funnel traps
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Berlese funnel traps
01	20°32'33.6"S	120°09'11.2"E	Olpiidae	<i>Euryolpium</i>	Berlese funnel traps
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Euryolpium</i>	Active searching
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
02	20°33'25.8"S	120°10'33.2"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
03	20°33'58.1"S	120°11'09.8"E	Olpiidae	<i>Austrohorus</i>	Active searching
03	20°33'58.1"S	120°11'09.8"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps
04	20°34'35.4"S	120°11'51.1"E	Olpiidae	<i>Austrohorus</i>	Active searching
06	20°38'53.7"S	120°18'14.4"E	Olpiidae	<i>Euryolpium</i>	Active searching
06	20°38'53.7"S	120°18'14.4"E	Olpiidae	<i>Indolpium</i>	Berlese funnel traps
07	20°38'56.5"S	120°18'10.9"E	Olpiidae	<i>Euryolpium?</i>	Berlese funnel traps
08	20°38'33.1"S	120°18'25.6"E	Olpiidae	<i>Austrohorus</i>	Berlese funnel traps

***Austrohorus* sp.**

This small species was collected from a number of sites during the survey, and is very similar to other specimens of *Austrohorus* collected elsewhere in the Pilbara. From the current taxonomic knowledge of the genus, it is not possible to state whether this species is a SRE (Harvey, 2008a, 2008b; **Appendix B**).

***Euryolpium* sp.**

This was the most commonly collected species during the survey. Based on current knowledge of the genus, it appears that this species is not a SRE species (Harvey, 2008a; **Appendix B**).

***Indolpium* sp.**

There was a single specimen of this species collected during the survey; however other specimens have been collected in the region (Harvey, 2008b). Based on current taxonomic knowledge, it appears that this species is not a SRE species (Harvey, 2008a; **Appendix B**).

From the current level of taxonomic knowledge, no pseudoscorpions collected within the Cundaline or Callawa study areas were found to represent SRE species.

#### 4.4 Myriapods and Centipedes

No millipedes were collected during the survey within the Cundaline and Callawa study areas. Numerous centipede specimens were collected representing six species from four families (

Table 9).

### Order Geophilida

#### Family Schendylidae

Geophilid centipedes are very difficult to identify and their taxonomy is poorly known. It is possible that some Geophilid species in Western Australia represent SRE species, however, this cannot be determined without a full taxonomic review of the Geophilid order (Harvey, 2008a; **Appendix B**). The status of the specimen from Cundaline study area is uncertain. The one species recorded during the survey was collected from Site 3, which lies in the proposed impact area.

### Order Scutigerida

#### Family Scutigerida: *Pilbarascutigera incola*

*Pilbarascutigera incola* is widely distributed throughout the Pilbara and elsewhere in Western Australia (Edgecombe and Barrow, 2007) and thus is not a SRE (Harvey, 2008a; **Appendix B**).



**Table 9 Millipede and Centipede Specimens Collected from the Cundaline and Callawa Study Areas between the 2 and 12 June 2008 Survey**

Site Number	Specimen Co-ordinates Datum: WGS 84		Family	Genus	Species	Collection Method
01	20°32'33.6"S	120°09'11.2"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
03	20°33'58.1"S	120°11'09.8"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active search
03	20°33'58.1"S	120°11'09.8"E	Schendylidae	1	1	Active search
03	20°33'58.1"S	120°11'09.8"E	Scutigerae	<i>Pilbarascutigera</i>	<i>incola</i>	Pit trap
03	20°33'58.1"S	120°11'09.8"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
03	20°33'58.1"S	120°11'09.8"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
03	20°33'58.1"S	120°11'09.8"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
04	20°34'35.4"S	120°11'51.1"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
05	20°34'38.1"S	120°12'19.2"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
05	20°34'38.1"S	120°12'19.2"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
05	20°34'38.1"S	120°12'19.2"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
05	20°34'38.1"S	120°12'19.2"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
06	20°38'53.7"S	120°18'14.4"E	Cryptopidae	<i>Cryptops</i>	1	Active Search
06	20°38'53.7"S	120°18'14.4"E	Scolopendridae	<i>Cormocephalus</i>	<i>strigosus</i>	Active Search
06	20°38'53.7"S	120°18'14.4"E	Scolopendridae	<i>Ethmostigmus</i>	<i>curtipes</i>	Active Search
06	20°38'53.7"S	120°18'14.4"E	Scolopendridae	<i>Ethmostigmus</i>	<i>curtipes</i>	Active Search
06	20°38'53.7"S	120°18'14.4"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
08	20°38'33.1"S	120°18'25.6"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search
08	20°38'33.1"S	120°18'25.6"E	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Active Search

<sup>1</sup> Specimen unable to be identified/determined due to lack of taxonomic knowledge.

## Order Scolopendrida

### Family Cryptopidae: *Cryptops* sp.

It is possible that some species of *Cryptops* in Western Australia represent SRE species; however the status of the specimen from the Callawa study area can not be determined without a full taxonomic review of the genus (Harvey, 2008a; **Appendix B**).

### Family Scolopendridae: *Cormocephalus strigosus*

*Cormocephalus strigosus* is widely distributed throughout mainland Australia and thus is not a SRE species (Harvey, 2008a; **Appendix B**).

### Family Scolopendridae: *Ethmostigmus curtipes*

*Ethmostigmus curtipes* is widely distributed throughout mainland Australia and thus is not a SRE species (Harvey, 2008a; **Appendix B**).

### Family Scolopendridae: *Scolopendra morsitans*

*Scolopendra morsitans* is widely distributed throughout mainland Australia and thus is not a SRE species (Harvey, 2008a; **Appendix B**).

Based on the current level of taxonomic knowledge, no centipedes collected within the Callawa or Cundaline study areas were found to represent SRE species.

#### 4.5 Terrestrial Molluscs

Terrestrial mollusc specimens were collected at both the Cundaline and Callawa study areas in litter samples, soils samples (between 10 mm and 1mm sieve) and whilst actively searching. A total of 78 terrestrial mollusc specimens were collected during the survey, 33 from the Cundaline study area, and 45 specimens from the Callawa study area (**Table 10**). Live specimens were found at sites 01, 05, 06, and 08. Terrestrial mollusc specimens were found at sites 01 and 05 on Cundaline Ridge, and sites 06, 07 and 08 on Callawa Ridge.

**Table 10 Terrestrial Mollusc Specimens Collected from the Cundaline and Callawa Study Areas between 2 and 12 June 2008 Survey**

Site Number	Specimen Co-ordinates Datum: WGS 84		Family	Species	Collection Method
01	20°32'33.6"S	120°09'11.2"E	Camaenidae	1	Active Search
05	20°34'38.1"S	120°12'19.2"E	Camaenidae	1	Active Search
06	20°38'33.1"S	120°18'25.6"E	Camaenidae	1	Active Search
07	20°38'56.5"S	120°18'10.9"E	Camaenidae	1	Active Search
08	20°38'53.7"S	120°18'14.4"E	Camaenidae	1	Active Search

1

Specimen unable to be identified/determined due to lack of taxonomic knowledge.

The camaenid landsnails collected appear to belong to a single un-named species of a currently un-named genus.

#### 4.6 Vertebrate By-catch

A total of nine vertebrate specimens were found in the pit traps over the seven nights of trapping undertaken in the winter survey (**Table 11**).

**Table 11 Vertebrate by-catch Collected from the Cundaline and Callawa Study Areas during the July 2008 Survey**

Site Number	Vertebrate	No. Specimens	Specimen Co-ordinates Datum: WGS 84		Species
01	Skink	2	20°32'33.6"S	120°09'11.2"E	<i>Ctenotus</i> sp.
01	Gecko	1	20°32'33.6"S	120°09'11.2"E	<i>Gehyra punctata</i>
02	Skink	2	20°33'25.8"S	120°10'33.2"E	<i>Ctenotus</i> sp
06	Skink	2	20°38'33.1"S	120°18'25.6"E	<i>Ctenotus</i> sp
07	Skink	2	20°38'56.5"S	120°18'10.9"E	<i>Ctenotus saxatilis</i>

## 4.7 Potential SRE Habitat

The general characteristics of habitats typical considered to support SRE species are described in Section 1.2 and a general description of the landscape features at Cundaline and Callawa is provided in Section 2.3. The study areas are characteristic of the terrain in the region, made up of exposed hill tops that drop away over extensive ridges to slopes and alluvial Spinifex plains, with the occasional intersection of the ridges by major and minor drainage lines.

The potential habitat for SRE species within the study areas is considered likely to be associated with the following:

- south-west facing ridges and slopes of the Cundaline Ridge;
- south-east facing ridges and slopes of the Callawa Ridge; and
- relatively deeper gullies and gorges within the Callawa Ridge.

South-facing ridges, slopes and gorges are generally cooler and more humid and typically provide suitable refuge habitat (Dell, 2007). South-facing ridges, slopes and gorges receive little or no sunlight throughout the day, thus making them cooler and moister compared to the surrounding exposed hills and north facing ridgelines. Gorges are generally associated with ephemeral creeklines that are abundant sources of water and moisture during the wet season. They are also sites of accumulation of leaf litter, rocks, boulders and sand washed down the creeklines. High ridges provide shelter in way of rocks, boulders, crevices and caves. Trees often follow the sheltered ridges and creeklines in gorges, which provide direct leaf litter and logs and further shade.

Different landscape features occurring in the study area are discussed below in relation to the potential occurrence of SRE invertebrate species.

### ***Drainage Lines***

Drainage lines on the Cundaline and Callawa Ridges have a moderate to high potential to support SRE species. The sheltered regions created by the steep to moderate rocky slopes provide a relatively moister and cooler environment compared to the surrounding exposed ridge tops and plains. Additionally, the moister conditions support vegetation which in turn provides opportunity for the accumulation of decomposing leaf litter which would be suitable food sources for detritivores such as millipedes and snails as well as predators such as mygalomorph spiders, pseudoscorpions, scorpions and centipedes.

### **Hilltop**

Hilltops form the upper horizon of the geological formation on the Cundaline and Callawa Ridges. These areas make up a large proportion of the landscape within the study areas. The hilltops are largely flat and exposed with sparse vegetation such as *Grevillea wickhamii* subsp. *hispidula* and *Spinifex*. They consist of large rock outcrops and stony skeletal soils, and are thus generally unsuitable for burrowing fauna.

The hard, rocky hilltops support only sparse vegetation, dominated by grasses, with fewer shrubs and small trees present. In turn, litter cover is low, ranging from 0 to 15%, consisting of leaves and twigs. Although some microhabitat is provided by the *Spinifex* hummocks and the crevices in the rocky soils, these areas have low microhabitat complexity. The lack of tall shrubs and trees in these habitats also limits habitat diversity on these landscapes.

Hilltops have a relatively low potential to support SRE species within the Cundaline and Callawa study areas. The exposed rocky nature of the hilltops would provide little shelter and the limited vegetation would provide limited sources for leaf litter accumulation. Additionally, hilltops are a relatively common habitat type in the areas surrounding the Cundaline and Callawa Ridges so it is unlikely that any species would develop ranges restricted only to the hilltops within the study area.

### **Ridge**

The Cundaline and Callawa Ridges are distinctive features of the landscape even though they only make up a relatively small proportion of the overall study area. They consist of exposed rock and bare skeletal soils overlying large cliffs above vegetated slopes below. Vegetation generally consists of *Eucalyptus* sp., *Acacia* sp. and *Ficus* sp., with some *Triodia* sp., and the grasses *Themeda* sp. and *Eragrostis* sp. in more sheltered areas. Litter cover is variable, ranging from 5 to 60%, depending on the proximity of vegetation with substantial amounts present under *Ficus* spp. often forming deep accumulations of decomposing leaf material.

Ridges that face in a south-west to south-east direction are considered to have the highest potential to support SRE species. The ridges provide areas at their base which are in almost constant shade and this forms a cool moist microclimate. This microclimate supports vegetation dominated by grasses such as *Themeda* sp. and *Eragrostis* sp. along with ferns (*Cheilanthes* sp.) and *Ficus* sp. The SRE invertebrates that have become dependant upon these habitats are often relics of previously widespread species during the Mesozoic and early Tertiary periods that became fragmented as the continent became more arid (Main, 1976).

### ***Slopes and Plains***

Below both the Cundaline and Callawa Ridges, the scree slopes are made up of hard rocky soils and boulders accumulated from the ridgelines above. The rocky soil restricts vegetation to predominantly Spinifex grasslands, which provide little leaf litter and limited cover. The plains below are less rocky, and are comprised of sandier soils. Spinifex grasslands also dominate here, with some *Eucalyptus* spp. and *Acacia* spp. shrubs and trees also present. Although some microhabitat is provided by the Spinifex hummocks and the crevices in the rocky soils, these areas have low microhabitat complexity. The lack of tall shrubs and trees in these habitats also limits habitat diversity on these landscapes.

The slopes and plains on the Cundaline and Callawa Ridges provide a low potential for SRE invertebrate habitat. The slopes and plains provide little relief from the hot summers and this effect on vegetation results in little opportunity to support relictual species. Additionally, the slopes and particularly the plains are not a limited habitat type within the areas surrounding the Cundaline and Callawa study areas.



## 5.0 RESULTS/DISCUSSION: TERRESTRIAL VERTEBRATE FAUNA

### 5.1 Vertebrate Fauna Habitat Assessment

Fauna habitats are often associated with specific land formations. Sixteen representative sites were chosen to ascertain the types of broad fauna habitats found at both Cundaline and Callawa study areas. Each site was assessed for a number of habitat variables including: percentage leaf litter cover, vegetation, landscape features, disturbance and others. At both the Cundaline and Callawa study areas, four main fauna habitats were identified. These were drainage lines, hilltops, ridges and slopes and plains.

#### ***Drainage Lines***

This landform grouping includes both major and minor drainage lines. These areas typically consist of steep to moderate rocky slopes, often with bare rock and boulders, descending down to stony soils and silty to gritty alluvium at the base of the drainage line. The presence of alluvium and rocky pool areas suggest these areas temporarily flow with water after periods of rainfall. Bare ground ranges from 5 to 30%, in the lower areas of the drainage line, and up to 70% on the upper exposed slopes. Litter cover is variable, ranging from 0 to 30% on the upper slopes, and 40 to 70% at the base of the drainage line. Litter origin is predominantly from the surrounding shrubs and trees, and consists of leaves, branches and logs.

Vegetation along the drainage lines is dense and diverse, providing shade and shelter and serving as important corridors for fauna movement between the harsher surrounding terrains. Shrubs and grasses dominate, such as *Themeda* sp., *Eragrostis* sp. and *Triodia* sp., with *Eucalyptus* sp., *Acacia monticola* and other *Acacia* sp. present to a lesser extent (**Plate 13**). Upslope from the drainage lines, both density and diversity of vegetation rapidly decreases. Fire appeared to be the only disturbance at these sites, with the upper storey and understorey vegetation height and density suggesting these sites had not been burned within the last three to five years.



**Plate 13**      **Drainage line at Callawa study area**

Major and minor drainage lines provide important microhabitats for birds, reptiles and mammals. Embankments can be utilised by burrowing reptiles and mammals, as well as some bird species such as the Rainbow Bee-eater (Cogger, 2000; Strahan, 2002; Johnstone and Storr, 1998, 2004). Drainage lines act as corridors for fauna movement and dispersal (Cogger, 2000; Strahan, 2002; Johnstone and Storr, 1998, 2004). Litter (leaves, branches and logs) is utilised by many vertebrate fauna species including fossorial reptiles, amphibians and small mammals (Cogger, 2000; Strahan, 2002).

Drainage lines provide a moderate potential for bat habitat particularly in larger drainage lines for two reasons. Firstly, outside of the study area, it had been noted that permanent water bodies could occur in drainage lines where water had carved out deep rock pools. Secondly, the rocky ridges along the sides of drainage lines have the potential for cave formation.

Both major and minor drainage lines are relatively common across both the Cundaline and Callawa study areas. Minor drainage lines tend to be more common internally on the ridges, whereas major drainage lines tend to be more common externally, descending to the flat plains below the ridgelines. However, within the Cundaline study area, drainage lines make up a smaller portion of the landscape. Within the Callawa study area, drainage lines, particularly minor drainage lines, make up a large portion of the landscape.

### **Hilltop**

The hilltops form the upper horizon of the project area, and are relatively common across both the Cundaline and Callawa study areas, and make up a large portion of the landscape. They consist of large rock outcrops and stony skeletal soils, and are thus unsuitable for burrowing fauna. The areas are largely flat, with 40 to 70 % bare ground, and are dissected by a small number of minor drainage lines.

The hard, rocky hilltops support only sparse vegetation, dominated by grasses, with fewer shrubs and small trees present (**Plate 14**). In turn, litter cover is low, ranging from 0 to 15%, consisting of leaves and twigs. *Triodia* spp. is the dominant grass species, shrub species include *Grevillea wickhamii* subsp. *hispidula*, and some *Acacia* spp. and *Eucalyptus* spp. Although some microhabitat is provided by the Spinifex hummocks and the crevices in the rocky soils, these areas have low microhabitat complexity. The lack of tall shrubs and trees in these habitats also limits habitat diversity on these landscapes.



**Plate 14 Hilltop at Cundaline study area**

Hilltop habitats have moderate fauna species richness due to the lack of shelter in the form of leaf litter, bark and woody debris (Cogger, 2000; Strahan, 2002). Burrowing and fossorial species would find the skeletal substrates hard to penetrate (Cogger, 2000; Strahan, 2002). The lack of water, even in ephemeral form, discourages the presence of amphibians (Cogger, 2000). Avian species found within scattered woodland on hilltops are also found over other habitats (Johnstone and Storr, 1998, 2004).

Fire disturbance at these hilltop sites is limited; most sites had not been burned within the last three to five years. The exception is the Cundaline hilltop adjacent to Site 1, which experienced a fire event during the survey period, burning much of the vegetation that had previously been present. Vehicle tracks are present across the hilltops, but are limited to less rocky areas.

### ***Ridge***

Ridges make up the distinctive ridgelines that snake along the ranges of the region, including the Cundaline and Callawa ridgelines and gorges, and make up a small portion of the landscape. They consist of exposed rock and bare skeletal soils overlying large cliffs above vegetated slopes below (**Plate 15**). Caves and crevices in the cliff face provide potential fauna habitat and the sheltered vegetation below the ridgeline provide further microhabitat structure and complexity. Soils in the lower slopes are rocky, with up to 70% bare rock and soil. Vegetation generally consists of *Eucalyptus* spp., *Acacia* spp. and *Ficus* spp., with some *Triodia* spp., and the grasses *Themeda* spp. and *Eragrostis* sp. in more sheltered areas. Litter cover is variable, ranging from 5 to 60%, depending on the proximity of vegetation (with substantial amounts present under *Ficus* spp.) and consists of leaves, branches and logs.



**Plate 15 Ridge at Callawa study area**

Ridge habitats have a moderate diversity of fauna species, as many species favour this type of environment. Caves and crevices provide shelter for many reptile, mammal and bird species. Sand/loam substrate at the base of outcrops provide shelter for fossorial reptile species and woodlands in gullies are utilised by reptiles, mammals and birds (Cogger, 2000; Strahan, 2002; Johnstone and Storr, 1998, 2004). Ephemeral water holes are quickly utilised by amphibian species (Cogger, 2000).

Ridges provided the highest potential for bat habitat within the study area. Although the potential for permanent water was low, cave formations were relatively common and likely to occur within the ridge habitat type in both study areas. More suitable bat habitat has been identified outside the planned disturbance areas during BHPBIO quarterly bat monitoring program (refer to Section 5.3.1).

Fire disturbance along the ridges has been limited, with vegetation health and development suggesting most sites had not been burned within the last three to five years.



### **Slopes and Plains**

The scree slopes below the ridgelines are made up of hard rocky soils and boulders accumulated from the ridgelines above (**Plate 16**). The rocky soil restricts vegetation to predominantly Spinifex grasslands, which provide little leaf litter (0 to 10%) and limited cover, with bare ground 20 to 50%. The plains below are less rocky, and are comprised of sandier soils. Spinifex grasslands also dominate here, with some *Eucalyptus/ Corymbia* spp. and *Acacia* spp. shrubs and trees also present. Although some microhabitat is provided by the Spinifex hummocks and the crevices in the rocky soils, these areas have low microhabitat complexity. The lack of tall shrubs and trees in these habitats also limits habitat diversity on these landscapes. However, breakaways along the slope can contain small caves and crevices providing important refuge for fauna.



**Plate 16**      **Slopes and plains at Cundaline study area**

Scree slopes are low in fauna species richness due to the hard rocky substrate. As with hill crests, ephemeral waterbodies are rare, this discourages the presence of amphibians. Spinifex species provide shelter and foraging opportunities for reptiles and small mammals (Cogger, 2000; Strahan, 2002). Rocks and screes provide shelter for reptiles and small mammals. Breakaways along the slope can contain small caves and crevices providing important refuge for fauna.

There has been limited fire disturbance on the slopes and plains areas; with vegetation health and development suggesting most sites had not been burned within the last three to five years. The exception is the slopes and plains within the Cundaline study area adjacent to Site 1, which experienced a fire event during the survey period, burning much of the vegetation that had previously been present.



Biological surveys in the area have concluded that the drainage lines and ridges support the highest diversity of vertebrate fauna (*ecologia*, 2005a, 2005b). Fire disturbance along the ridges has been limited; with vegetation health and development suggesting most sites had not been burned within the last three to five years.

## 5.2 Vertebrate Fauna Composition

Systematic sampling and opportunistic collecting during the 2005 Cundaline field survey yielded 11 mammal species (10 native), 41 birds, 18 reptiles and one amphibian (*ecologia*, 2005a).

Systematic sampling and opportunistic collecting during the 2005 Callawa field survey yielded 12 mammal species (11 native), 43 birds, 19 reptiles and one amphibian (*ecologia*, 2005b).

A complete list of vertebrate fauna species previously recorded and/or expected to occur within the study areas is presented in **Appendix D**.

### 5.2.1 Mammals

A total of 13 mammal species have been previously recorded at the Cundaline and Callawa study areas (*ecologia*, 2005a, 2005b; **Appendix D**). The difference in species composition between sites was small, and the total number of species found between the two sites differed by only one species (11 species found at the Cundaline study area and 12 species found at the Callawa study area) (*ecologia*, 2005a, 2005b; **Appendix D**). One species recorded within the Cundaline study area, the Little Broad-nosed Bat (*Scotorepens greyii*), was not found at the Callawa study area (*ecologia*, 2005a, 2005b; **Appendix D**). While two species not recorded at the Cundaline study area were found at the Callawa study area, namely the Northern Quoll (*Dasyurus hallucatus*) and the Red Kangaroo (*Macropus rufus*) (*ecologia*, 2005a, 2005b; **Appendix D**), although these are likely to occur throughout the greater Goldsworthy area.

### 5.2.2 Birds

A total of 56 bird species have been previously recorded at the Cundaline and Callawa study areas (*ecologia*, 2005a, 2005b; **Appendix D**). The difference in species composition between sites was small, and the total number of species found between the two sites differed by only two species (41 species found at the Cundaline study area and 43 species found at the Callawa study area) (*ecologia*, 2005a, 2005b; **Appendix D**). The majority of bird species recorded have a broad distribution across Western Australia (*ecologia*, 2005a).

### 5.2.3 Reptiles and Amphibians

A total of 26 reptile species and one amphibian species have been previously recorded at the Cundaline and Callawa study areas (*ecologia*, 2005a, 2005b; **Appendix D**). The difference in species composition between sites was small, and the total number of reptile species found between the two sites differed by only one species (18 species found at the Cundaline study area and 19 species found at the Callawa study area), while the same amphibian species (the Desert Tree Frog [*Litoria rubella*]) was found at both areas (*ecologia*, 2005a, 2005b; **Appendix D**). Results indicate that the Cundaline survey area had seven unique records of reptile species that were not found at the Callawa study area, while a total of eight species not found at the Cundaline study area were found at the Callawa study area (*ecologia*, 2005a, 2005b; **Appendix D**).

## 5.3 Conservation Significant Terrestrial Vertebrate Fauna

This section provides a summary of the occurrence of conservation significant fauna species surveyed at the Cundaline and Callawa study areas.

The conservation significance of terrestrial vertebrate fauna occurring, or potentially occurring, within the study areas are described in the following sections, including:

- Threatened fauna species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act), and declared threatened fauna and other specially protected fauna listed under the Western Australian *Wildlife Conservation Act, 1950* (WC Act) (Section 5.3.1).
- Priority fauna recognised by the DEC (Section 5.3.2).
- Species not listed under any Acts, but considered of conservation significance due to patterns of distribution (for instance bioregional endemics - Section 5.3.3).
- Migratory species listed under the EPBC Act and international agreements which include the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals) (Section 5.3.4).

### 5.3.1 Threatened Fauna Species

Fauna species that have been formally recognised as rare, threatened with extinction or as having high conservation value are protected by law under Commonwealth and State legislation.

At the national level, fauna are protected under the EPBC Act. BHPBIO referred the planned Cundaline and Callawa mining operations to the DEHWA under the EPBC Act in order to confirm whether the planned activities were considered to constitute a controlled action on matters of National Environmental Significance (including the EPBC Act listed Pilbara Leaf-nosed Bat and Northern Quoll). The DEHWA evaluated the referral and notified BHPBIO that the proposal was not a controlled action.

Within Western Australia fauna can be listed under various Schedules within the WC Act. Definitions of conservation significance are presented in **Appendix E**.

Four fauna species listed as threatened under the EPBC Act and/or the WC Act have been recorded at Cundaline and Callawa study areas and are listed in **Table 12**.

**Table 12 Threatened Species Recorded at Callawa and Cundaline**

Scientific Name	Common Name	Conservation Status <sup>1</sup>		Source
		EPBC Act	WC Act	
Mammals				
<i>Dasyurus hallucatus</i>	Northern Quoll	EN	-	3
<i>Rhinonicterus aurantia</i>	Pilbara Leaf-nosed Bat	VU	S1	3
Birds				
<i>Falco peregrinus</i>	Peregrine Falcon	-	S4	2
Reptiles				
<i>Liasis olivaceus barroni</i>	Pilbara Olive Python	VU	S1	2

<sup>1</sup> EPBC Act : VU Vulnerable, EN Endangered.

WC Act : Schedule 1, S4.

<sup>2</sup> *ecologia* (2005a).

<sup>3</sup> *ecologia* (2005b).

The fauna species listed in **Table 12** are discussed below:

- **Northern Quoll (*Dasyurus hallucatus*)**

The Northern Quoll was recorded at Callawa in 2005, within gorge, ridge and hilltop habitats (*ecologia*, 2005b). The locations of where the Northern Quoll was found within the study area are shown on **Figure 8**. The Northern Quoll has also been recorded at the Yarrie Mine (approximately 2 km north of the planned Callawa mining operations) (*ecologia*, 2005e), Cattle Gorge (approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2004, *ecologia*, 2005b), Nimingarra (approximately 24 km north-west of the planned Cundaline mining operations) and Sunrise Hill (approximately 20 km north-west of the planned Cundaline mining operations (*ecologia*, 2005e (**Figure 2**). The Northern Quoll formerly occurred across northern Australia from the Pilbara to southern Queensland, but is now confined to disjunct populations (Van Dyck and Strahan, 2008). Reasons for its population decline include; predation by introduced predators such as dingos and foxes, introduction of Cane Toads, vegetation clearance and habitat loss (Van Dyck and Strahan, 2008). This species favours wooded habitats, and rocky escarpments (Van Dyck and Strahan, 2008).







- **Pilbara (Orange) Leaf-nosed Bat** (*Rhinonicterus aurantia*)

The Pilbara (Orange) Leaf-nosed Bat was recorded at both Cundaline and Callawa in 2005 (*ecologia*, 2005a, 2005b). The locations of where the Pilbara Leaf-nosed Bat was found within the study areas are shown on **Figure 8** and **9**. A single call of the Pilbara Leaf-nosed Bat was recorded by *ecologia* (2005a) in 2005 from a rock-face located within the proposed disturbance area for the Cundaline mine (**Figure 3**). *Ecologia* (2005a) inferred from the call that the individual may have been passing by or momentarily taking shelter. *Ecologia* (2005a) described the rock face as 'highly eroded with numerous small caves and cracks situated within the rock, however, none of the caves were of any considerable depth or size.' Quarterly monitoring at the Cundaline ridge since 2005 has only recently recorded calls of the Pilbara Leaf-nosed Bat (Specialised Zoological, 2008a). However, the low number of calls and late time of recording indicates that the cave monitored on the Cundaline ridge is unlikely to be used as a roost (Specialised Zoological, 2008a).

Further surveys and quarterly bat monitoring since 2004 have identified numerous caves in the Goldsworthy region where the Pilbara Leaf-nosed Bat has been recorded (*ecologia*, 2005c, 2006a, 2006b, 2006c, 2007; ENV Australia, 2007a, 2007b). Monitoring also indicates that a stable community uses a monitored bat roost cave, located approximately 1 km south of the planned Callawa mining operations (ENV Australia, 2007a) (**Figures 8 and 9**).

The Pilbara Leaf-nosed Bat roosts in humid caves, crevices and mine shafts associated with seeping groundwater (Van Dyck and Strahan, 2008). Disjunct populations are found in the east and west of the Pilbara (Van Dyck and Strahan, 2008).

- **Peregrine Falcon** (*Falco peregrinus*)

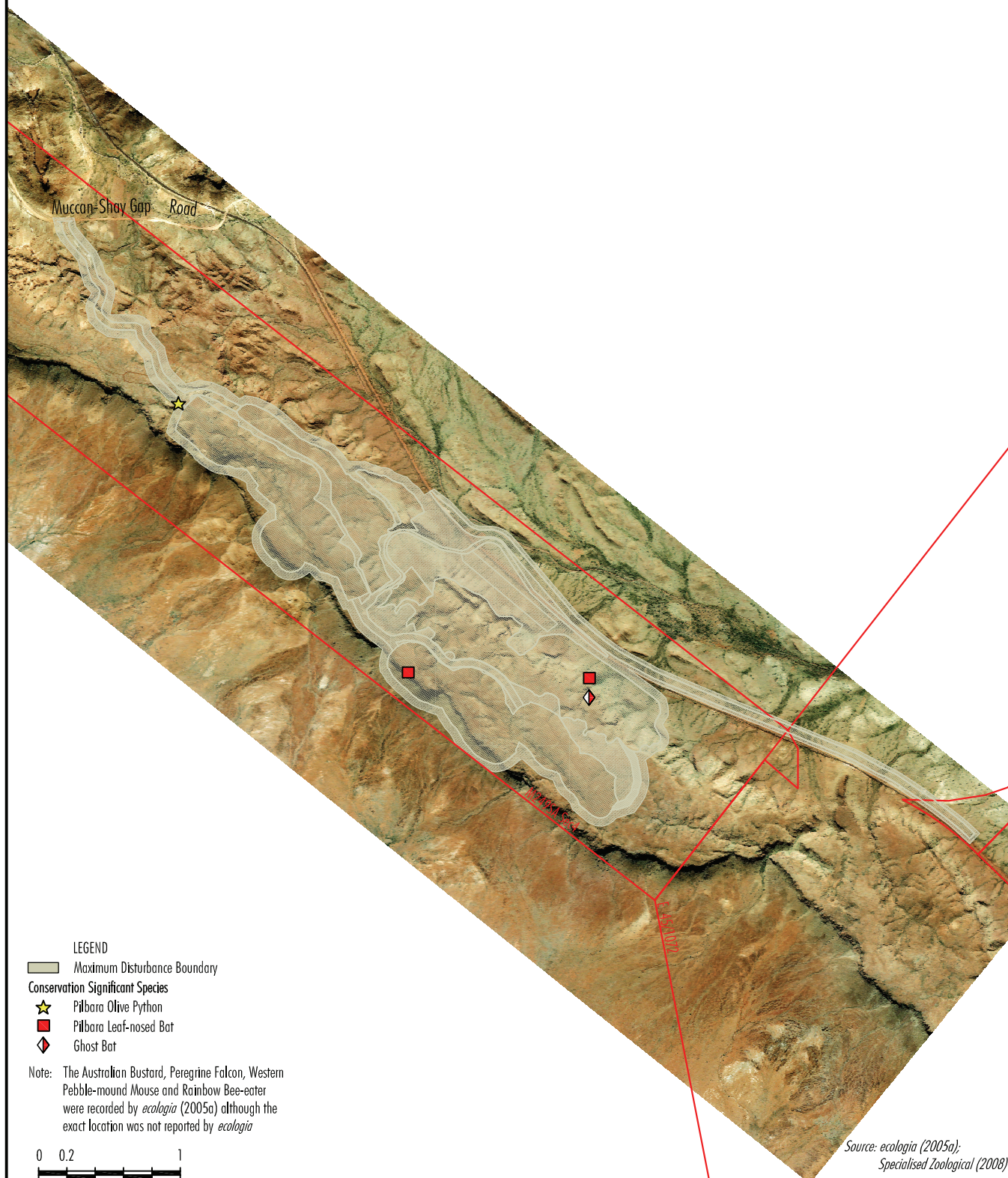
The Peregrine Falcon is a large falcon that is widely distributed throughout Australia (Pizzey and Knight, 2007). The species is nomadic to partially sedentary and inhabits cliffs along coasts, rivers and ranges (Pizzey and Knight, 2007). The Birds Australia database (2008) has records of the Peregrine Falcon for the Pilbara bioregion. It was recorded flying through the Cundaline study area in 2005 (*ecologia*, 2005a).

- **Pilbara Olive Python** (*Liasis olivaceus barroni*)

The Pilbara Olive Python is distributed across the Pilbara and Gascoyne regions of Western Australia. Pearson (2003) has reported that the Pilbara Olive Python is widespread across the Pilbara, with many significant populations remaining. Olive Python records within the WAM Faunabase database also support these findings.

One specimen was found in the hilltop Habitat during the 2005 Cundaline study (*ecologia*, 2005a). The location of the Pilbara Olive Python within the study area is shown on **Figure 9**.





LEGEND

Maximum Disturbance Boundary

Conservation Significant Species

- Pilbara Olive Python
- Pilbara Leaf-nosed Bat
- Ghost Bat

Note: The Australian Bustard, Peregrine Falcon, Western Pebble-mound Mouse and Rainbow Bee-eater were recorded by *ecologia* (2005a) although the exact location was not reported by *ecologia*

0 0.2 1  
Kilometers

Source: *ecologia* (2005a);  
*Specialised Zoological* (2008)

CUNDALINE AND CALLAWA  
MINING OPERATIONS EPS  
FIGURE 9

Planned Cundaline Mining Operations  
Conservation Significant Fauna Species



The Pilbara Olive Python has also been recorded on the Callawa Ridge (Dames and Moore, 1992), at Cattle Gorge (approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2004; *ecologia*, 2005a), and the Yarrie operations (approximately 2 km north of the planned Callawa mining operations (BHPBIO, 2005).

The Pilbara Olive Python prefers rocky escarpments and gorges, often along watercourses (Wilson and Swan, 2003).

- **Mulgara (*Dasyercus cristicauda*)**

The Mulgara is a small carnivorous marsupial that occurs in the arid sandy regions from the eastern Pilbara to central Australia (DEW-SPRAT, 2007). This species inhabits sand plains dominated by *Triodia* species, where it burrows between low sand dunes (Gibson and McKenzie, 2005). The Mulgara also prefers habitat that has not been recently burnt (Gibson and McKenzie, 2005). The Mulgara is infrequently recorded in part due to boom-bust cycles, contracting to core habitat areas in lean times, and irrupting after favourable conditions prevail (Gibson and McKenzie, 2005). The species has been recorded near Cattle Gorge approximately 6 km north-east of the planned Cundaline mining area (DEC, 2008; *ecologia*, 2005e). Limited potential habitat for the Mulgara occurs within the study areas.

### Other Threatened Fauna Species

The desktop searches also identified an additional four fauna species listed under the EPBC Act and/or the WC Act and/or listed as a Priority species by the DEC which are considered unlikely to occur in the study area. These species are described in **Table 13**.

**Table 13 Threatened Species Considered Unlikely to Occur within the Study Areas**

Scientific Name	Common Name	Conservation Status <sup>1</sup>			Notes
		EPBC Act	WC Act	Priority	
Mammals					
<i>Notoryctes caurinus</i>	Northern Marsupial Mole	EN	S1	-	The Northern Marsupial Mole is a little known insectivorous marsupial that spends virtually its entire life underground (DEW-SPRAT, 2007). The species is distributed sparsely across the arid areas of northern Western Australia, in habitats with a sandy soil (DEW-SPRAT, 2007). Very few records of the species are known, probably because it rarely comes to the surface (DEW-SPRAT, 2007). The species has been recorded at Wallal Downs approximately 150 km north-east of the study area (DEC, 2008). Given that its presence is hard to establish without digging deep trenches to search for recent tunnels, it could possibly occur in the sandy areas of the study areas.
<i>Macrotis lagotis</i>	Greater Bilby	VU	S1	-	The Greater Bilby once occurred over the study areas and a Threatened and Priority Fauna database search revealed numerous records with the most recent (2008) occurring at Eighty Mile Beach approximately 100 km north-east of the study area (DEC, 2008). The Greater Bilby has been recorded in areas of the Gibson and Great Sandy Deserts south to Warburton, the Pilbara and Dampierland bioregions, as well as the Kimberley (Faunabase, 2008; Pavey, 2006).

**Table 13 (Cont.) Threatened Species Considered Unlikely to Occur within the Study Areas**

Scientific Name	Common Name	Conservation Status <sup>1</sup>			Notes
		EPBC Act	WC Act	Priority	
Birds					
<i>Polytelis alexandrae</i>	Princess Parrot/ Alexandra's Parrot	VU	-	P4	The Princess Parrot occurs over red desert sand plains and dunes and along tree-lined watercourses (Pizzey and Knight, 2007). It was last sighted in the Hamersley region nearly a century ago (Pizzey and Knight, 2007). Given the absence of sightings near the study areas since and the fact that its preferred habitat is relatively scarce within the study areas, it is unlikely that the Princess Parrot occurs within the study area.
Reptiles					
<i>Egernia kintorei</i>	Great Desert Skink	VU	S1	-	The Great Desert Skink inhabits arid sandy areas within the Great Sandy Desert and the Gibson Desert (Pearson <i>et al.</i> , 2001). It has not been recorded in the study areas and is unlikely to occur there.

<sup>1</sup> EPBC Act: VU Vulnerable, EN Endangered

WC Act : Schedule 1

DEC Priority Species List: Priority 4

### 5.3.2 Priority Fauna Species

DEC recognises species not listed under the WC Act, but for which there is some concern, and has produced a supplementary list of 'Priority' fauna. Three fauna species listed as Priority species by the DEC have been recorded at the Cundaline and Callawa study areas and are listed in **Table 14**.

**Table 14 Priority Species Recorded within the Study Areas**

Scientific Name	Common Name	DEC Priority List <sup>1</sup>	Source
<b>Mammals</b>			
<i>Pseudomys chapmani</i> *	Western Pebble-mound Mouse	P4	2,3,
<i>Macroderma gigas</i>	Ghost Bat	P4	3
<b>Birds</b>			
<i>Ardeotis australis</i>	Australian Bustard	P4	2

<sup>1</sup> DEC Priority Species List 4: Priority 4.

<sup>2</sup> *ecologia* (2005a).

<sup>3</sup> *ecologia* (2005b).

<sup>\*</sup> Abandoned mounds only found.

The fauna species listed in **Table 14** are discussed below.

- Western Pebble-Mound Mouse (*Pseudomys chapmani*)**

The Western Pebble-mound Mouse is now a Pilbara endemic. Abandoned mounds have been found in the Murchison and Gascoyne region (Van Dyck and Strahan, 2008). Inactive pebble mounds of this species have been recorded in the Cundaline and Callawa study areas in eucalypt woodland on gravel substrates and hillcrests (*ecologia*, 2005a, 2005b). The Western Pebble-mound Mouse constructs mounds that can cover anywhere from 0.5 to 9.0 square metres (m<sup>2</sup>) (Van Dyck and Strahan, 2008).

- **Ghost Bat (*Macroderma gigas*)**

Ghost Bats are patchily distributed over northern Australia occupying a wide variety of diverse habitats including the arid Pilbara to the rainforests of North Queensland (Van Dyck and Strahan, 2008). This species requires an undisturbed cave, deep fissure or disused mine shaft within which to roost (Van Dyck and Strahan, 2008). Thus, the study areas may contain suitable roosting and/or foraging resources. The Ghost Bat was recorded at both the Cundaline ridge (ecologia, 2005a) and the Callawa ridge (ecologia, 2005b, 2005c, 2006a, 2006b, 2006c; ENV, 2007b; Specialised Zoological, 2008a, 2008b). The locations of where the Ghost Bat was found within the study areas are shown on **Figure 8** and **9**. It has also been recorded at Nimingarra (approximately 24 km north-west of the planned Cundaline mining operation) (ecologia, 2005d, 2006a; ENV Australia, 2007a; Specialised Zoological, 2008a, 2008b), Yarrie operations (approximately 2 km north of the planned Callawa mining operation) (Dames and Moore, 1992) and Cattle Gorge (approximately 6 km north-east of the planned Cundaline mining operation) (ecologia, 2005d; ENV Australia, 2007a, 2007b).

- **Australian Bustard (*Ardeotis australis*)**

The Australian has been recorded at the Cundaline study area in 2005 (ecologia, 2005a). This species has also been recorded by ecologia at Cattle Gorge (ecologia, 2004; BHPBIO, 2005).

The Australian Bustard has a wide distribution across Australia and there is a WAM record of its presence south-west of the study areas (FaunaBase, 2008). The Australian Bustard is found in areas of open to lightly timbered woodlands and grasslands, especially tussock grasses like Spinifex, arid scrub and open dry woodlands of mulga (Johnstone and Storr, 1998; Morcombe, 2003).

Desktop searches identified an additional six fauna species listed by the DEC as Priority species which may possibly occur in the study areas (**Table 15**).

**Table 15** **Priority Species Considered to Possibly Occur within the Cundaline and Callawa Study Areas**

Scientific Name	Common Name	DEC Priority List
<b>Mammals</b>		
<i>Sminthopsis longicaudata</i>	Long-tailed Dunnart	P3
<i>Leggadina lakedownensis</i>	Lakeland Downs Mouse	P4
<b>Birds</b>		
<i>Burhinus grallarius</i>	Bush Stone-curlew	P4
<i>Falco hypoleucos</i>	Grey Falcon	P4
<i>Neochmia ruficauda subclarescens</i>	Star Finch	P4
<i>Heteromunia pectoralis</i>	Pictorella Mannikin	P4



The fauna species listed in **Table 15** are discussed below.

- **Long-tailed Dunnart** (*Sminthopsis longicauda*)

The Long-tailed Dunnart has not been recorded in the study area however database searches suggest that it may occur in the region. The Long-tailed Dunnart is found in low densities in the Pilbara, Murchison, North-eastern Goldfields, Ashburton and Gibson Desert regions of Western Australia, and is also found in the Northern Territory. The Long-tailed Dunnart inhabits rocky landscapes that support a low open woodland or shrubland of Acacias with an understorey of Spinifex hummocks or perennial grasses (Burbidge *et al.*, 1995). The species may possibly occur in the study areas as suitable habitat exists.

- **Lakeland Downs Mouse** (*Leggadina lakedownensis*)

The Lakeland Downs Mouse is known to occupy a diverse range of habitats including Spinifex and tussock grasslands, samphire and sedgelands, Acacia shrublands, tropical Eucalyptus and Melaluca woodlands and stony ranges (Van Dyck and Strahan, 2008). Most habitats are seasonally inundated on red or white sandy-clay soils (Dyck and Strahan, 2008). This species was recorded at Yarrie in 1998 (DEC, 2008).

- **Bush Stone-curlew** (*Burhinus grallarius*)

The Bush Stone-curlew has been recorded at Sunrise Hill located approximately 20 km north-west of the planned Cundaline mining operations (*ecologia*, 2005a; 2005e).

The Bush Stone-curlew has been recorded at Marble Bar (approximately 75 km south-west of the study areas) and Pardoo (approximately 70 km north-west of the study areas) (DEC, 2008).

The Bush Stone-curlew inhabits open to lightly timbered woodlands of mallee and mulga that has an understorey of small sparse shrubs, grass or litter (Johnstone and Storr, 1998).

- **Grey Falcon** (*Falco hypoleucos*)

The Grey Falcon is a medium-sized falcon which occurs primarily in the northern half of Australia. The Grey Falcon was recorded at Meentheena approximately 80 km south-east of the study areas (DEC, 2008). The species inhabits open woodland areas on coastal and riverine plains in the arid and semi-arid interior of the country (Johnstone and Storr, 1998; Morcombe, 2003). Within the study area, eucalypt woodlands on drainage lines or valley plains may provide suitable habitat for the Grey Falcon. The species requires tall trees for nesting and utilises large stick nests built by other birds such as crows and ravens or other raptor species (Morcombe, 2003). While this species has not been recorded in the study areas it may potentially utilise habitat within the study areas as it is wide ranging.



- **Star Finch** (*Neochmia ruficauda subclarescens*)

The Star Finch was recorded at Cattle Gorge, located approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2005e). The species is known to inhabit areas with long grasses and shrubs within swamps and permanent water courses (Johnstone and Storr, 2004). Permanent water courses have not been recorded within the study areas.

- **Pictorella Mannikin** (*Heteromunia pectoralis*)

The Pictorella Mannikin was recorded at Cattle Gorge, located approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2005e). The species is known to inhabit lightly wooded grasslands with short grass and Spinifex over red soils (Johnstone and Storr, 2004). The species requires low trees or shrubs in which to build a dome nest (Garnett and Crowley, 2000).

### 5.3.3 Locally and Regionally Significant Species

Other species of conservation significance include endemics, those with restricted or fragmented ranges, or those that are at the extreme limits of their distribution. SRE fauna are those with naturally restricted distributional ranges.

Fauna species that are known to be endemic to the Pilbara region and have been recorded in the Cundaline and Callawa study areas and surrounds are listed in **Table 16**. The Pilbara does not have any endemic bird or frog species (ANRA, 2007; Kendrick and McKenzie, 2001).

**Table 16** Vertebrate Fauna Species Endemic to the Pilbara Region and Recorded at the Study Area

Group	Common Name	Scientific Name	Source
Mammals	Western Pebble-mound Mouse	<i>Pseudomys chapmani</i>	1,2
	Pilbara Leaf-nosed Bat	<i>Rhinonictis aurantia</i>	1,2
Reptiles	-	<i>Diplodactylus savagei</i>	1,2
	-	<i>Diplodactylus wombeyi</i>	1
	-	<i>Delma elgans</i>	2
	-	<i>Delma pax</i>	2
	Pilbara Rock Monitor	<i>Varanus pilbarensis</i>	1,2
	Pilbara Olive Python	<i>Liasis olivaceus barroni</i>	1

<sup>1</sup> *ecologia* (2005a).

<sup>2</sup> *ecologia* (2005b).

### 5.3.4 Migratory Bird Species

Migratory species listed under the EPBC Act and international agreements which include the JAMBA, CAMBA, ROKAMBA and the Bonn Convention, recorded in the Cundaline and Callawa study areas are listed in **Table 17**.

The EPBC Act incorporates the migratory species listed under the JAMBA, CAMBA and Bonn Convention.

**Table 17 Migratory Species Recorded within the Study Area**

Scientific Name	Common Name	Source
<i>Merops ornatus</i>	Rainbow Bee-eater	1

<sup>1</sup> *ecologia* (2005b).

The fauna species listed in **Table 17** are discussed below.

- **Rainbow Bee-eater** (*Merops ornatus*)

The Rainbow Bee-eater was recorded at both the Cundaline and Callawa study areas in 2005 (*ecologia*, 2005a and 2005b). The Rainbow Bee-eater has also been recorded at Hope Downs (Hope Downs Management Services, 2000). The Rainbow Bee-eater occupies numerous habitats including open woodlands with sandy loamy soil, sandridges, sandpits, riverbanks, road cuttings, beaches, dunes, cliffs, mangroves and rainforests (Morcombe, 2003).

Desktop searches identified an additional seven migratory bird species which may possibly occur in the study areas (**Table 18**) (DEC, 2008).

**Table 18 Migratory Species Considered to Potentially Occur within the Study Area**

Scientific Name	Common Name
<i>Ardea modesta</i> <sup>1</sup>	Eastern Great Egret
<i>Ardea ibis</i> <sup>2</sup>	Cattle Egret
<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle
<i>Charadrius veredus</i> *	Oriental Plover
<i>Glareola maldivarium</i> *	Oriental Pratincole
<i>Numenius madagascariensis</i>	Eastern Curlew
<i>Apus pacificus</i>	Fork-tailed Swift

\* Non-breeding migrants.

<sup>1</sup> Listed as White Egret/Great Egret *Egretta alba* under JAMBA and CAMBA.

<sup>2</sup> Listed as *Bubulcus ibis* under JAMBA, ROKAMBA.

All of these species are associated with inland rivers and lakes that contain surface water and/or near coastal areas. It is unlikely that these species would utilise habitat within the study area, with the exception of the Fork-tailed Swift. The Fork-tailed Swift is known to occupy open country from semi-deserts to coastal areas, islands and occasionally forests and cities (Pizzey and Knight, 2007). The Fork-tailed Swift was not recorded in the study areas.

## 6.0 POTENTIAL IMPACTS

### 6.1 Potential Impacts: SRE

No known SRE invertebrates were collected during the survey of the Cundaline and Callawa study areas.

There are currently large gaps in the taxonomic knowledge of the invertebrate groups with the potential for short-range endemism. Some specimens were collected where their potential for short-range endemism could not be determined. These were: the mygalomorph spider *Conothele* sp., the pseudoscorpion *Austrohorus* sp., the centipede *Cryptops* sp. and geophilid centipede sp from the Family Schendylidae.

The camaenid landsnails which were collected appear to belong to a single un-named species of a currently un-named genus, this landsnail was collected in large quantities (78 specimens) across the survey sites, on both Cundaline and Callawa ridges, which suggests that it is locally abundant, is not restricted and occurs more widely across the Goldsworthy area.

The presence or absence of SRE invertebrates during a survey should not be used as the only indicator of short-range endemism within the study areas. Instead, importance should be placed on habitat that has the highest potential for supporting SREs. These habitats are the south-west-facing and south-east-facing ridges and gorges identified and described in Section 4.7. Parts of the south-west-facing and south-east-facing ridges and gorges receive little or no direct sunlight throughout the day, thus providing a cool and moist microclimate suitable for relictual species. The south-west-facing and south-east-facing ridges make up a relatively small proportion of the overall study areas; however sections of these ridges lie within the proposed disturbance footprints of the Cundaline and Callawa mining operations.

### 6.2 Potential Impacts: Terrestrial Vertebrate Fauna

This section assesses the potential impacts of the planned Cundaline and Callawa mining operations on vertebrate fauna. Generally, potential impacts are associated with:

- habitat removal/modification (Section 6.2.1);
- conservation significant species (Section 6.2.2);
- noise (Section 6.2.3);
- light (Section 6.2.4);
- introduced flora (Section 6.2.5); and
- introduced fauna (Section 6.2.5).

Threatening processes relevant to the Pilbara Region have been identified by the ANRA (2007). Impacts identified in the bioregion by the assessment include changed fire regimes, grazing pressure, feral animals, weeds and vegetation clearing. These are discussed below, where relevant.

### **6.2.1 Habitat Removal/Modification**

The planned Cundaline and Callawa mining operations would result in the removal of habitat via land clearance. Land Clearance is listed as key threatening processes under the EPBC Act. Fauna currently residing in the habitat within the proposed disturbance areas would be displaced, however the habitats present over the study area are widely represented throughout the region, and the vertebrate fauna assemblage recorded is similar to other regional sites.

The planned Cundaline and Callawa mining operations would also result in the modification of habitat by the reduction in habitat connectivity, particularly for fauna species which inhabit rocky ridge and gorge habitats (e.g. Rock Wallabies). Habitat which occurs in between proposed disturbance areas would also become isolated for some species.

No permanent water source is present at the study area. However, ephemeral drainage lines which provide an intermittent source of water would be impacted.

Land clearance may also result in the direct loss of individuals through clearance activities, the most likely species at risk are those that inhabit arboreal habitats (e.g. hollow roosting bats), inhabit subterranean habitats (e.g. some snakes) or have low mobility (e.g. small reptiles). Nesting birds and their young may also be directly impacted, although this potential impact may be reduced by considering the timing of clearance activities. Mobile fauna able to avoid direct impact will be displaced into surrounding habitat.

Considering the management measures outlined in the previous Goldsworthy Environmental Management Plan (including minimisation of vegetation clearance, progressive rehabilitation and fire management), it is considered that the continuation of those measures for the planned Cundaline and Callawa mining operations would reduce the potential impacts on vertebrate fauna.

The planned Cundaline and Callawa mining operations would result in the long-term loss of habitat for some species dependant on Rocky Gorge habitat, as these habitats cannot be re-created by revegetation. Although, habitat removal/modification is not likely to significant impact any vertebrate fauna, as the vertebrate fauna assemblage recorded at the Cundaline and Callawa study areas is similar to other regional sites.

## 6.2.2 Conservation Significant Species

The occurrence of conservation significant species at the Cundaline and Callawa study areas is discussed in Section 5.3.

As stated in Section 5.3.1, BHPBIO referred the planned Callawa and Cundaline mining operations to the DEWHA under the EPBC Act in order to confirm whether the planned activities were considered to constitute a controlled action on matters of National Environmental Significance (including the EPBC Act listed Northern Quoll and Pilbara Leaf-nosed Bat). The DEWHA evaluated the referral and notified BHPBIO that the proposal was not a controlled action.

The likely impacts of the planned Cundaline and Callawa mining operations on conservation significant species are as follows:

- **Northern Quoll** – The Northern Quoll has been recorded at multiple locations on the Callawa Ridge (Section 5.3.1). A low-localised impact on the Northern Quoll is possible given that potential habitat for this species would be removed or modified, however, it is likely that any impacts would be limited in extent given the large extent of potential habitat remaining.
- **Pilbara Leaf-nosed Bat** - It is unlikely that the planned mining operations at the Cundaline and Callawa deposits would result in a significant impact on the Pilbara Leaf-nosed Bat, as:
  - the species record at the Cundaline study area is within the planned disturbance area, is likely to represent an individual passing through the area (rather than a substantial cave or maternity roost);
  - the specific management measures implemented for the Goldsworthy Operations (as outlined in the Bat Management Plan) have shown to be effective as ENV (2007) has reported that the Pilbara Leaf-nosed Bat community using the nearby caves is stable; and
  - a low-localised impact on the Pilbara Leaf-nosed Bat is possible as the proposed mining will involve the removal of some potential habitat for this species, however any impacts are likely to be limited in extent.
- **Peregrine Falcon** – This species is wide ranging and although it was recorded flying across the study area (*ecologia*, 2005a) only marginal habitat for this species occurs within the study area and this species is not likely to be dependant on the habitat. The ANRA (2007) discusses the need to clarify the distributions of this species.



- **Pilbara Olive Python** – This species is likely to be a resident in the gorge habitat of the study area. This habitat is considered to provide refuge for individuals of this species. The Pilbara Olive Python is a widespread species in the Pilbara and therefore while the development would result in the loss of habitat for this species in the development footprint, the species and its habitat occurs in the wider area. This species would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Mulgara** – This species has been previously recorded near the Cattle Gorge mining area (approximately 6 km north-east of the planned Cundaline mining operations). The main distribution of this species is in the Great Sandy Desert to the east. As such, it is unlikely that this species would be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Western Pebble-mound Mouse** – Evidence of this mouse has been repeatedly recorded within the study area (Section 5.3.2), as such it is likely that a local population of Western Pebble-mound Mouse utilise the habitat within the study areas. This species is widely distributed in the Pilbara, and therefore, while the development would result in the loss of habitat for this species in the development footprint, the species and its habitat occurs in the wider area. This species would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Ghost Bat** – This species was recorded at the Callawa study area in 2005 (*ecologia*, 2005b), near Yarrie in 2006 and 1992 (DEC, 2008; Dames and Moore, 1992). The Ghost Bat is presently, patchily distributed over northern Australia occupying a wide variety of diverse habitats including the arid Pilbara to the rainforests of North Queensland (Van Dyck and Strahan, 2008). A low-localised impact on the Ghost Bat is possible as the proposed mining will involve the removal potential habitat for this species, however any impacts are likely to be limited in extent.
- **Australian Bustard** – This species was recorded by *ecologia* in 2005 (*ecologia*, 2005a). The Australian Bustard is a wide-ranging species and its potential habitat is common (i.e. open grassland and open woodland [Johnstone and Storr, 1998]). This species would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Long-tailed Dunnart** – This species has not been recorded in the study areas. This Dunnart is widely distributed in low densities in the Pilbara, Murchinson, north-eastern Goldfields, Ashburton and Gibson Desert regions of Western Australia, and is also found in the Northern Territory. Therefore, while the development would result in the loss of habitat for this species in the development footprint, the species and its habitat occurs in the wider area. This species would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Lakeland Downs Mouse** – This species was recorded at Yarrie in 1998 (DEC, 2008). This species occupies a wide range of habitats that are found throughout the Pilbara region and therefore its considered it would not be significantly impacted by the planned Cundaline and Callawa ,mining operations.

- **Bush Stone-curlew** – The Bush Stone-curlew has been recorded at a number of different locations around the study areas. This species occupies a wide range of woodland habitats that are found throughout the Pilbara region and therefore it would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Grey Falcon** – The listed species was recorded at Meentheena approximately 80 km south-east of the study areas (DEC, 2008). While this species has not been recorded in the study area it may potentially utilise habitat within the study area as it is wide ranging. This species would not be significantly impacted by the planned Cundaline and Callawa mining operations.
- **Star Finch** – The Star Finch was recorded at Cattle Gorge mining area approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2005e). It is mostly associated with permanent water courses and as this habitat is not represented within the study areas, it is unlikely that it will be impacted by the planned Cundaline and Callawa mining operations.
- **Pictorella Mannikin** – The Pictorella Mannikin was recorded at Cattle Gorge mining area approximately 6 km north-east of the planned Cundaline mining operations (*ecologia*, 2005e). The species is known to inhabit lightly wooded grasslands with short grass and Spinifex over red soils (Johnstone and Storr, 2004). As this habitat is well represented outside of the study area, it is unlikely this species will be impacted by the planned Cundaline and Callawa mining operations.
- **Rainbow Bee-eater and other migratory species** – Migratory bird species are unlikely to be dependant on the specific habitat within the study areas.

Considering the management measures outlined in the previous Goldsworthy Environmental Management Plan (particularly the Significant Species Management Plan), it is considered that the continuation of those measures for the planned Cundaline and Callawa mining operations would reduce the potential impacts on conservation significant fauna.

### 6.2.3 Fauna and Noise

The development of the planned Cundaline and Callawa mining operations is likely to generate constant noise due to machinery, heavy and light vehicles and the general presence of people. The affects of noise on wildlife have been well studied, although responses vary depending on the species and on the age and sex of the individual animal (see Radle, 2007 for a comprehensive summary).

General responses to noise across a wide variety of animal species range from interruptions in feeding and resting behavior to complete abandonment of an area. Noise may lead to reduced population densities in small mammals, nest failure in birds and reduced hunting efficiency in bats due to disturbance of their echolocation system. Constant levels of noise also interfere with species communication. Species which may be especially at risk of disturbed communication are those that use calls to communicate over larger distances.

#### **6.2.4 Fauna and Light**

The planned Cundaline and Callawa mining operations are likely to result in an increase in exposure of fauna to artificial light. Artificial light from the mine-site may have detrimental effects on resident bird, mammal and reptile species, as it may interfere with biological and behavioural activities that are governed by the length of day or photoperiod, including reproduction, dormancy, foraging and migration (Bradshaw and Holzapfel, 2007; Corre *et al.*, 2002). Bird *et al.* (2004) found that nocturnal mice exposed to artificial light exploited fewer food patches compared to mice exposed to areas of less light, while nocturnal frogs exposed to artificial light have been known to suspend normal feeding and reproductive behaviour (Harder, 2002).

#### **6.2.5 Fauna and Introduced Flora**

Environmental weeds may be brought in by mobile mining equipment. These may have a negative impact on fauna species as vegetation communities become simplified and out-competed. It is therefore important to check for weeds during mining operations. Considering the weed management measures outlined in the previous Goldsworthy Environmental Management Plan (particularly the Weed Management Plan), it is considered that the continuation of those measures for the planned Cundaline and Callawa mining operations would reduce the potential impacts from introduced flora.

#### **6.2.6 Introduced Fauna**

Twelve introduced fauna species have been recorded in the study areas or within the Chichester subregion (ANRA, 2007), including the House Mouse, Black Rat, Dingo (or dingo dog hybrids), Cat, Red fox, European Rabbit, Pig, Donkey, Horse, Camel, sheep and European Cattle.

While the European Cattle and sheep are domesticated within the study area, the other species are considered to be feral animals.

Predation by the Feral Cat is listed as key threatening processes under the EPBC Act, although both the Cat and Dingo have the potential to prey on native fauna species.

Expansion of the mine site may attract more individuals of the feral animals previously recorded, and attract additional feral animal species that have not been previously recorded

Considering the measures to manage potential impacts outlined in the previous Goldsworthy Environmental Management Plan, it is considered that the continuation of those measures for the

planned Cundaline and Callawa mining operations would be adequate for the prevention and control of increased feral species and attraction of new feral species.

## 7.0 CONCLUSION

### ***Short-range Endemics***

There were no known SRE invertebrate species identified as a result of the survey within the Cundaline and Callawa Ridges. However, habitat that is currently considered to potentially support SRE invertebrates was identified along both ridges. This habitat is the south-west-facing and south-east-facing ridges and gorges which provide a sheltered mesic environment capable of supporting relictual species such as SREs. The south-west-facing and south-east-facing ridges make up a relatively small proportion of the overall study areas; however sections of these ridges lie within the proposed disturbance footprints of the Cundaline and Callawa mining operations.

### ***Vertebrate Fauna***

Eight conservation significant vertebrate fauna species have been recorded at Callawa and Cundaline, across two separate surveys conducted in 2005: Northern Quoll, Pilbara Leaf-nosed Bat, Ghost Bat, Western Pebble-mound Mouse, Peregrine Falcon, Australian Bustard, Rainbow Bee-eater and; Pilbara Olive Python.

All habitats present over the study area are widely represented throughout the region, and the vertebrate fauna assemblage recorded is similar to other regional sites.

Considering the measures to manage potential impacts outlined in the previous Goldsworthy Environmental Management Plan, it is considered that the continuation of those measures for the planned Cundaline and Callawa mining operations would minimise potential impacts on vertebrate fauna.



## 8.0 SURVEY TEAM

The Cundaline and Callawa April/May 2008 Short-Range Endemic Survey was conducted by E. Guarino and S. Doody Validus, contracted to ENV.

The Cundaline and Callawa July 2008 Short-Range Endemic Survey was conducted by:

Mr Paul Bolton	B.Sc (Hons)	Outback Ecology
Ms Carly Weston	B.Sc (Hons)	Outback Ecology
Mr Jarrad Donald	B.Sc (Hons)	Outback Ecology

Invertebrate identification was undertaken by the following specialists:

Dr Mark Harvey	Museum of Western Australia
Dr Shirley Slack-Smith	Museum of Western Australia

The Cundaline and Callawa July 2008 survey was conducted under the following licence issued by DEC:

- Licence to Take Fauna for Scientific Purposes No. SF006429  
Date of issue: 03/07/2008  
Valid from: 01/07/2008  
Date of expiry: 30/06/2009

A copy of this licence is provided in **Appendix F**.

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**Appendix A**

**Western Australian Museum Guidelines: Preservation and Lodgement Arachnid  
and Myriapod Specimens**

# **Western Australian Museum**

## **Preservation and Lodgement of Specimens**

### **Arachnids and Myriapods**

#### **Preservation**

All specimens are to be fixed in ethanol as rapidly as possible after collection.

Small specimens (e.g. pseudoscorpions, schizomids) preferably to be fixed in 100% ethanol. Otherwise 75% ethanol is fine.

Large specimens (e.g. scorpions, trap-door spiders):

- Remove third left leg at point of specimen death using clean, small scissors (wash the scissors in water, and dry with clean paper towel between each specimen).
- Place leg in 100% ethanol in 2 ml Cryotube with screw cap (available from Interpath Service Pty Ltd, Melbourne).
- Preserve remainder of specimen in tube or jar (see below).
- Include Cryotube in same jar as specimen.

Each container should contain a unique coded identifier that we can quote when supplying identifications.

Each container should contain a small printed label specifying the concentration of the ethanol (e.g. "100% ETOH" or "75% ETOH").

#### **Storage**

Specimens should be stored in suitable glass containers. Plastic is not suitable as they deteriorate over time.

- Smaller specimens should be stored in SAMCO "Specimen Tubes Soda Glass Poly Stopper" vials, Size Code G050/26.
- Other vial sizes of SAMCO vials are available for different sized animals.
- Larger specimens should be in small glass jars.

Keep specimens in cool place, ideally in a refrigerator.

#### **Labels**

Each vial should contain a small, neatly trimmed printed label with the following specifications:

- Arial 4.5 font
- Use Latitudes and Longitudes (DD°MM'SS") not UTM's or decimal degrees.
- Specify the datum.
- Dates with month spelled out, not as a numeral.

W.A.: Mesa Y-09, ca. 64 km SSW. of Pannawonica  
25°18'23"S, 117°51'03"E (WGS 84)  
14 Dec. 2007-5 Jan. 2008  
J.A. Brown, T.R. Smith (Eco-company site 667-898A)  
Troglofauna trap, 10 metres

If the vial is suspected of containing multiple species, ensure that sufficient labels are included so that when we transfer specimens to new vials, we have enough labels.

Labels should be printed on "Tablex System Board, 250 GSM" cut to A4 sheets (210 x 297mm). Available from Spicers Stationery, Bassendean (ph: 9279 6860). The labels should be printed on a laser printer and baked in an oven @100°C for 20-30 minutes to fix the printing onto the card.

**Delivery**

- Specimens should be delivered to the Western Australian Museum after an appointment is made with staff members.
- A printed copy of the relevant locality data should be supplied with the specimens, along with the name, address, telephone and email address of the company representative. An electronic copy of the spreadsheet containing the relevant data should be emailed to the Museum.

**Prepared by Mark Harvey and Julianne Waldock  
May 2008**



## **Appendix B**

### **Report by Dr Mark Harvey on the Short-range Endemic Invertebrate Fauna Collected by Outback Ecology July 2008 from the Callawa and Cundaline Study Areas**

# **The Short-Range Endemic Invertebrate Fauna from Cundaline/Callawa, Western Australia**

Report to Outback Ecology  
August 2008

Mark S. Harvey

Department of Terrestrial Invertebrates, Western Australian Museum,  
Locked Bag 49, Welshpool DC, Western Australia 6986, Australia



## **Short-Range Endemism**

The terrestrial invertebrate fauna of inland Australia contains a plethora of species, with the arthropods alone recently estimated to consist of more than 250,000 species (Yeates *et al.* 2004). The vast majority of these are found within the Insecta and Arachnida, although significant numbers of millipedes are anticipated to be represented as well.

In a recent publication, the issue of Short-Range Endemism in Australian invertebrate fauna was examined (Harvey 2002), and a series of major groups were nominated as having a very high proportion of individual species that satisfied a certain set of criteria. The main criterion nominated for inclusion as a Short-Range Endemic (SRE) was that the species had a naturally small range of less than 10,000 km<sup>2</sup>. Harvey (2002) found that those species possessed a series of ecological and life-history traits, including:

- poor powers of dispersal;
- confinement to discontinuous habitats;
- usually highly seasonal activity during cooler, wetter periods; and
- low levels of fecundity.

The Western Australian fauna contains a number of SRE taxa, including millipedes, land snails, trap-door spiders, some pseudoscorpions, slaters, and onychophorans.

### **The Cundaline/Callawa region**

The short-range endemic fauna of the region was assessed by examination of pseudoscorpions and scorpions collected by staff from Outback Ecology, preserved in ethanol and submitted to the Western Australian Museum for identification. The specimens were examined using a Leica dissecting microscope (MZ16) and an Olympus compound microscope (BH-2).

## **SPIDERS**

### **Family Ctenizidae**

#### ***Conothele* sp.**

Members of the genus *Conothele* are found across much of arid and semi-arid Western Australia, where they generally dig burrows in soil which are sealed with a tight-fitting lid that is usually very difficult to find.

The taxonomic status of the Western Australian fauna is very uncertain, with the entire fauna representing unnamed species. However, the precise distributions of each species is unknown, and much taxonomic work on this genus is required before the status of individual populations can be ascertained. The taxonomy of the genus is based upon adult male specimens which have modifications of the first leg and pedipalp that can be used to separate individual species.

The Cundaline/Callawa survey collected several immature specimens which are unidentifiable.

### **Superfamily Amaurobioidea**

A single male specimen of amaurobioid spider was collected. It has not been possible to identify the specimen, as the taxonomy of the group in the Pilbara is uncertain. It is unlikely to represent a short-range endemic species.

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## **PSEUDOSCORPIONS**

The Western Australian pseudoscorpion fauna is fairly diverse with representatives of 17 different families. They are found in a variety of biotopes, but can be most commonly collected from the bark of trees, from the underside of rocks, or from leaf litter habitats.

The pseudoscorpion fauna of the Cundaline/Callawa area was found to consist of three species of Olpiidae (Appendix 1).

### **Family Olpiidae**

#### ***Austrohorus* sp. (family Olpiidae)**

This small species was collected at a number of sites throughout the survey (Appendix 1), and appears to be very similar to other samples of *Austrohorus* collected elsewhere in the Pilbara. Based on our current levels of knowledge, it is not possible to state whether this species is a short-range endemic species.

#### ***Euryolpium* sp. (family Olpiidae)**

Species of *Euryolpium* are commonly found under bark and under rocks throughout northern Australia. They can be locally abundant, and at least one species is quite widespread across northern Australia. Based on our current levels of knowledge, it appears that this species is not a short-range endemic species.

#### ***Indolpium* sp. (family Olpiidae)**

Several specimens of this pseudoscorpion species were collected at a number of sites throughout the study area (Appendix 1). The specimens comprise a single species and extremely similar specimens have been collected from other regions of Western Australia, suggesting that only a single species is involved. Based on our current levels of knowledge, it appears that this species is not a short-range endemic species.

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## **SCORPIONS**

### **Family Buthidae**

#### ***Lychas* sp.**

Several specimens of a species of *Lychas* were collected during the survey. The identity of these specimens is currently uncertain, but I am confident that they do not represent a short-range endemic species.

### **Family Urodacidae**

#### ***Urodacus* sp.**

Two specimens of *Urodacus* were collected during the survey. The identity of these specimens is currently uncertain due to our lack of knowledge of the taxonomy of urodacids in northern Western Australia. It is unlikely to represent a short-range endemic species.

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## **CENTIPEDES**

### **Order Geophilida**

#### **Family Schendylidae**

Geophilid centipedes are very difficult to identify and their taxonomy is very poorly known. The status of the sample from Cundaline is uncertain. It is possible that some geophilid species in Western Australian represent short-range endemic species, but this can only be determined after a full taxonomic treatment is undertaken.

### **Order Scutigerida**

#### **Family Scutigeridae**

#### ***Pilbarascutigera incola***

*Pilbarascutigera incola* is widely distributed throughout the Pilbara region and elsewhere in Western Australia (Edgecombe and Barrow 2007) and is not a short-range endemic species.

### **Order Scolopendrida**

#### **Family Cryptopidae**

#### ***Cryptops* sp.**

The taxonomy of the Australian cryptopid fauna is very poorly known, and the status of the sample from Callawa is uncertain. It is possible that some species of *Cryptops* in Western Australia represent short-range endemic species, but a full taxonomic analysis is necessary.

### **Family Scolopendridae**

#### ***Cormocephalus strigosus***

*Cormocephalus strigosus* is widely distributed throughout mainland Australia (Koch 1983a) and is not a short-range endemic species.

#### ***Ethmostigmus curtipes***

*Ethmostigmus curtipes* is widely distributed throughout mainland Australia (Koch 1983b) and is not a short-range endemic species.

#### ***Scolopendra morsitans***

*Scolopendra morsitans* is widely distributed throughout mainland Australia (Koch 1983c) and is not a short-range endemic species.

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**Appendix 1. Location data for samples from Cundaline/Callawa.**

REGNO	CLASS	ORDER	FAMILY	GENUS	SPECIES	SITE
T92057	Arachnida	Araneae	Amaurobioidea			Cundaline area, site 1-1M
T92053	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 3-3L
T92054	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 3-3O
T92055	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 4-4B
T92056	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 4-4E
T92051	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 3-3A
T92052	Arachnida	Araneae	Ctenizidae	<i>Conothele</i>	`indet.`	Cundaline area, site 3-3C
T92050	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Callawa area, site 8-8F
T92045	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 3-3N
T92046	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 4-4G
T92040	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 2-2C
T92041	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 2-2D
T92042	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 2-2E
T92043	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 2-2F
T92044	Arachnida	Pseudoscorpiones	Olpiidae	<i>Austrohorus</i>		Cundaline area, site 3-3K
T92039	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 2-2B
T92037	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1O
T92038	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1P
T92032	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1I
T92033	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1J
T92034	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1K
T92035	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1L
T92036	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Cundaline area, site 1-1N
T92047	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium</i>		Callawa area, site 6-6J
T92049	Arachnida	Pseudoscorpiones	Olpiidae	<i>Euryolpium?</i>		Callawa area, site 7-7C
T92048	Arachnida	Pseudoscorpiones	Olpiidae	<i>Indolpium</i>		Callawa area, site 6-6L
T92058	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 1-1A
T92059	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 1-1B

T92060	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 1-1G
T92061	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 2-2A
T92062	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 3-3E
T92063	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Cundaline area, site 5-5A
T92064	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Callawa area, site 6-6C
T92065	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Callawa area, site 6-6F
T92066	Arachnida	Scorpiones	Buthidae	<i>Lychas</i>		Callawa area, site 6-6I
T92067	Arachnida	Scorpiones	Urodacidae	<i>Urodacus</i>		Callawa area, site 6-6K
T92068	Arachnida	Scorpiones	Urodacidae	<i>Urodacus</i>		Callawa area, site 7-7C
T92031	Chilopoda	Geophilida	Schendylidae			Cundaline area, site 3-3J
T92030	Chilopoda	Scutigerida	Scutigeridae	<i>Pilbarascutigera</i>	<i>incola</i>	Cundaline area, site 3-3I
T92029	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Callawa area, site 8-8C, D
T92020	Chilopoda	Scolopendrida	Cryptopidae	<i>Cryptops</i>		Callawa area, site 6-6B
T92023	Chilopoda	Scolopendrida	Scolopendridae	<i>Cormocephalus</i>	<i>strigosus</i>	Callawa area, site 6-6E
T92021	Chilopoda	Scolopendrida	Scolopendridae	<i>Ethmostigmus</i>	<i>curtipes</i>	Callawa area, site 6-6A
T92022	Chilopoda	Scolopendrida	Scolopendridae	<i>Ethmostigmus</i>	<i>curtipes</i>	Callawa area, site 6-6H
T92027	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Cundaline area, site 5-5C, D, E, F
T92028	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Callawa area, site 6-6G
T92024	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Cundaline area, site 1-1F
T92025	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Cundaline area, site 3-3F, G, H
T92026	Chilopoda	Scolopendrida	Scolopendridae	<i>Scolopendra</i>	<i>morsitans</i>	Cundaline area, site 4-4A



## **Appendix C**

### **Report by Dr Shirley Slack-Smith on the Non-marine Molluscan Specimens Collected by Outback Ecology July 2008 from the Callawa and Cundaline Study Areas**



## **The Land Snails of the Callawa and Cundaline Areas of the Pilbara Region of Western Australia**

### **Report to *Outback Ecology***

S. Slack-Smith and C. Whisson,  
Western Australian Museum  
September 2008

#### **Background**

In considering the question of the conservation of the biota native to Western Australia the question of short-range endemism is regarded as being of great importance. Such a degree of endemism is best illustrated by organisms that are limited to specific habitats and that cannot easily spread to other appropriate habitats.

As a group, native species of land snails are considered to be among the most appropriate organisms in this regard, especially those taxa that are confined to particular habitats that tend to be patchy in their distribution. Many such habitats and the taxa associated with them are relics of once widespread environments that existed in less rigorous climatic conditions.

Knowledge of the land snail fauna of Western Australia has been limited largely by the paucity of workers in this field. In this large State, collecting has been largely limited to areas with easy access and so the fauna of huge areas of the State have not been even cursorily collected, let alone surveyed. This has resulted in a lack of information and even of relevant comparative material related to many of the land snail populations currently being encountered during surveys of areas proposed for mining and other development.

#### **Surveys of the Callawa and Cundaline areas**

The faunal survey of these areas was carried out by the environmental consultancy company *Outback Ecology* between the 2<sup>nd</sup> and the 12<sup>th</sup> of July, 2008. Information on the location of each of the 5 survey sites (3 in the Cundaline area and 2 in the Callawa area) and the collecting methods employed were provided by that company and included in Table 1.

From this survey, snail specimens of only the family Camaenidae were presented for identification and comment. These specimens, both alive and dead-taken, were

examined under a Wild dissecting microscope (M3C) and compared with specimens in the Western Australian Museum's mollusc collections and with data accompanying those specimens, in the Museum's database and in relevant scientific literature.

## **Results**

Comments on the identity of the snail specimens are included in Table 1, together with details of the location of the collecting sites, the modes of collecting and the numbers of the specimens collected

## **Discussion**

All of the submitted camaenid specimens from this survey appear to be conspecific.

A search on the WA Museum's molluscan database did not indicate any records of the family Camaenidae from the area defined by 20°32'S, 120°09'E/20°38'S; 120°18'E through to that defined by 20°20'S, 119°55'E/20°50'S, 120°30'E.

The closest locality from which records of similar camaenid snails were collected is the Spinifex Ridge area, which lies to the SSW of the Cundaline-Callawa area. The specimens from the Callawa and Cundaline sites appear to be similar to but not conspecific with those from the Spinifex Ridge area or with some more recently collected in two areas further to the south and west.

In the report on the Spinifex Ridge molluscan survey (Slack-Smith & Whisson 2008), the camaenid specimens from that area were regarded as most closely resembling a few dead-taken and eroded shells that had been determined by Solem (1997) as belonging to an un-named genus and species. Those dead-taken and eroded specimens had been collected in 1976 from an area to the south-south-east of Spinifex Ridge and north of Skull Springs within the catchment area of the Oakover River.

Although the specimens from Callawa and Cundaline also do not appear to be conspecific with the Skull Springs specimens they do resemble them more closely than do the Spinifex Ridge and other apparently congeneric specimens in:-

- shell shape,
- mean adult size, whorl count,
- diameter of the umbilicus,
- degree of overlap of the umbilicus by the columellar lip,
- angle of the descending body whorl above the aperture
- colouration of the shell and its periostracum.

The establishment of the degree of relationship between these two "populations" and with those in the areas of Spinifex Ridge and Skull Springs will also depend on future in-filling of collecting gaps. This also applies to the investigation of the possible relationship postulated for the Skull Springs specimens by Solem (1997) with members of the South Australian fauna.

## **Conclusion**

The camaenid landsnails collected during the biological survey of the Callawa and Cundaline leases appear to belong to a single un-named species of a currently un-named genus.

## **References**

Slack-Smith, S. & Whisson, C., 2008, Report to *Outback Ecology Services* - Molluscs from the area of Spinifex Ridge and Meentheena Conservation Park, Western Australia, collected by *Outback Ecology Services* during March and April, 2008. Unpublished Report, 9 pp.

Solem, A., 1997, Camaenid land snails from Western and central Australia (Mollusca: Pulmonata: Camaenidae) VII Taxa from Dampierland through the Nullarbor. *Rec. W. Aust. Mus* Suppl. 50: 1461-1906.

**Table 1. - Camaenid specimens collected during the biological survey of the Callawa and Cundaline BHP Billiton Holdings**

<b>Study area</b>	<b>Specimen numbers/condition</b>	<b>Co-ordinates</b>	<b>Collecting Notes</b>	<b>Identification</b>
<b>Cundaline</b> Site 1	1D -1 to19 (all dead-taken)	20°32' 34.6"S, 120°09'13.5 E	Active searching	Family Camaenidae, <b>Gen. &amp; sp. indet.</b> (see Solem 1997 & Slack-Smith & Whisson 2008)
“	1H -1-9 (1 live-taken, 8 dead-taken)	“	Active searching	“
<b>Cundaline</b> Site 5	5B -1 to 3 (all dead-taken)	20°34'37.7"S 120°12'19.9"E	leaf litter	“
“	5G -1 to 2 (1 live-taken, 1 dead-taken)	“	Soil sieving	“
<b>Callawa</b> Site 6	6D -1 to 8 (4 live-taken, 4 dead-taken)	20°38'51.6"S 120°18'18.2"E	Soil sieving	“
“	6M -1 to 3 (all dead-taken)	“	Soil sieving	“
<b>Callawa</b> Site 7	7A -1 to3 (all dead-taken)	20°38'56.5"S 120°18'12.3"E	Soil sieving	“
<b>Callawa</b> Site 8	8A -1 to 8 (3 live-taken, 5 dead-taken)	20°38'33.0"S 120°18'25.9"E	Whilst digging pit traps	“
“	8E -1 to 11 (1 live-taken, 10 dead-taken)	“	Soil sieving	“
“	8G -1 to 12 (all dead-taken)	“	Soil sieving	“



## **Appendix D**

### **Vertebrate Fauna Recorded at Cundaline, Callawa or the Surrounds**

## Reptile and Amphibian species observed at each site of the Goldsworthy Extension Project Area.

CGHR = Cattle Gorge Haul Road, CGOB = Cattle Gorge Ore Body, SH = Sunrise Hill, NIM = Nimingarra, YAR = Yarrie, CUN = Cundaline,  
CAL = Callawa (*ecologia*, 2005b)

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
<b>AMPHIBIA</b>								
<b>HYLIDAE</b>								
	<i>Cyclorana maini</i>	Main's Frog				x		
	<i>Litoria rubella</i>	Desert Tree Frog	x	x	x	x	x	x
<b>MYOBATRACHIDAE</b>								
	<i>Limnodynastes spenceri</i>	Spencer's Frog			x	x		
	<i>Uperoleia glandulosa</i>	Glandular Toadlet	x		x			
<b>TOTAL AMPHIBIAN SPECIES</b>			<b>2</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>
<b>REPTILIA</b>								
<b>CHELUIDAE</b>								
	<i>Chelodina steindachneri</i>	Plate-shelled Turtle		x				
<b>GEKKONIDAE</b>								
	<i>Crenadactylus ocellatus 'horni'</i>	Clawless Gecko	x					
	<i>Diplodactylus conspicillatus</i>	Fat-tailed Gecko	x	x	x	x		
	<i>Diplodactylus savagei</i>		x	x	x		x	x
	<i>Diplodactylus stenodactylus</i>	Sand-plain Gecko		x	x			
	<i>Diplodactylus wombeyi</i>			x	x		x	
	<i>Gehyra 'punctata'</i>		x					
	<i>Gehyra punctata</i>		x	x	x	x	x	x
	<i>Gehyra purpureascens</i>					x		
	<i>Gehyra variegata</i>	Varied Dtella	x	x	x			x
	<i>Heteronotia binoc</i>	Bynoe's Gecko			x	x		
	<i>Heteronotia spelea</i>	Desert Cave Gecko	x	x	x	x	x	
	<i>Nephurus levis pilbarensis</i>	Smooth Knob-tailed Gecko	x	x				

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
	<i>Rhynchoedura ornata</i>	Beaked Gecko	x					
	<i>Sirophurus ciliaris abberans</i>	Northern Spiny-tailed Gecko	x	x				
PYGOPODIDAE								
	<i>Delma elegans</i>			x				x
	<i>Delma nasuta</i>							x
	<i>Delma tincta</i>			x	x			
	<i>Delma pax (desert pax)</i>		x					x
	<i>Lialis burtonis</i>	Burton's Legless Lizard	x			x		
AGAMIDAE								
	<i>Ctenophorus caudicinctus</i>	Ring-tailed Rock Dragon	x	x	x	x	x	x
	<i>Ctenophorus isolepis</i>	Military Dragon				x		
	<i>Ctenophorus nuchalis</i>	Central Netted Dragon	x		x			
	<i>Diporiphora winneckei</i>	Canegrass Dragon		x				
	<i>Lophognathus longirostris</i>	Long-nosed Water Dragon			x	x		
	<i>Pogona mitchelli</i>	Dwarf Bearded Dragon			x			x
VARANIDAE								
	<i>Varanus ocanthurus</i>	Ridge-tailed Monitor		x	x		x	
	<i>Varanus caudolineatus</i>	Stripe-tailed Monitor		x				
	<i>Varanus eremius</i>	Pygmy Desert Monitor		x				
	<i>Varanus giganteus</i>	Perentie	x	x	x		x	
	<i>Varanus gouldii</i>	Gould's Monitor	x					
	<i>Varanus panoptes</i>	Yellow-spotted Monitor		x		x		
	<i>Varanus pilbarensis</i>	Pilbara Rock Monitor	x			x	x	x
	<i>Varanus tristis</i>	Black-headed Monitor	x		x			
SCINCIDAE								
	<i>Carteria munda</i>		x	x	x	x	x	x

Family	Species	Common Name	SH	NIM	CG	VAR	CUN	CAL
	<i>Carlia triacantha</i>		x		x			
	<i>Cryptoblepharus plagiocephalus</i>	Fence Skink				x	x	x
	<i>Ctenotus helenae</i>			x				
	<i>Ctenotus pantherinus</i>	Leopard Skink				x		
	<i>Ctenotus plankai</i>				x			
	<i>Ctenotus rubicundus</i>		x	x				
	<i>Ctenotus rubicundus</i>			x				
	<i>Ctenotus rutilans</i>						x	x
	<i>Ctenotus saxatilis</i>	Rock Ctenotus	x	x	x	x	x	x
	<i>Cyclodomorphus melanops</i>	Spinifex Slender Blue-tongue				x		x
	<i>Egernia depressa</i>	Pygmy Spiny-tailed Skink	x	x		x	x	x
	<i>Eremiascincus</i> sp.			x				
	<i>Lerista bipes</i>		x	x	x	x		
	<i>Lerista muelleri</i>		x	x	x		x	x
	<i>Lerista vermicularis</i>					x		
	<i>Menetia greyii</i>			x				
	<i>Menetia surda surda</i>							x
	<i>Morethia ruficauda</i>					x		
TYPHILOPIDAE								
	<i>Ramphotyphlops grypus</i>	Beaked Blindsnake				x	x	
BOIDAE								
	<i>Antaresia perthenis</i>	Pygmy Python	x		x		x	
	<i>Antaresia stimsoni</i>	Stimson's Python	x	x	x			
	<i>Liasis olivaceous barroni</i>	Pilbara Olive Python			x		x	
ELAPIDAE								
	<i>Acanthophis pyrrhus</i>	Desert Death Adder			x			
	<i>Brachyuropsis approximans</i>	North-western Shovel-nosed Snake		x				

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
	<i>Demansia psammophis</i>	Yellow-faced Whipsnake	x	x		x		
	<i>Demansia rufescens</i>	Rufous Whipsnake	x					
	<i>Furina ornata</i>	Moon Snake		x		x		
	<i>Pseudechis australis</i>	Mulga Snake			x	x		x
	<i>Pseudonaja modesta</i>	Ringed Brown Snake	x					
	<i>Pseudonaja nuchalis</i>	Gwardar			x			
	<i>Simoselaps anomalus</i>	Desert Banded Snake		x				
	<i>Suta fasciata</i>	Rosen's Snake					x	x
<b>TOTAL REPTILE SPECIES</b>			<b>30</b>	<b>34</b>	<b>28</b>	<b>24</b>	<b>19 *</b>	<b>19</b>

\* Please note that the number of reptile species present at the Cundaline study area is 18, not 19.



**Bird species observed at each site of the Goldsworthy Extension Project Area.**

**CG = Cattle Gorge, SH = Sunrise Hill, NIM = Nimingarra, YAR = Yarrie, CUN = Cundaline, CAL = Callawa (*ecologia*, 2005b)**

PHASIANIDAE								
	<i>Coturnix ypsilophora</i>	Brown Quail	x	x	x	x		
TURNICIDAE								
	<i>Turnix velox</i>	Little Button-quail		x		x		
PELECANIDAE								
	<i>Pelecanus conspicillatus</i>	Australian Pelican			x			
PHALACROCORACIDAE								
	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant			x			
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant						
ANATIDAE								
	<i>Anas gracilis</i>	Grey Teal			x			
	<i>Anas superciliosa</i>	Pacific Black Duck			x			
	<i>Aythya australis</i>	Hardhead			x			
RALLIDAE								
	<i>Gallinallus philippensis</i>	Buff-banded Rail			x			
	<i>Porzana fluminea</i>	Spotted Cuck	x					
ARDEIDAE								
	<i>Ardea alba</i>	Great Egret			x			
	<i>Ardea pacifica</i>	White-necked Heron		x	x			
	<i>Egretta novaehollandiae</i>	White-faced Heron		x	x	x		

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
THRESKIORNITHIDAE								
	<i>Platalea flavipes</i>	Yellow-billed Spoonbill			x			
	<i>Platalea regia</i>	Royal Spoonbill			x			
	<i>Plegadis falcinellus</i>	Glossy Ibis			x			
	<i>Threskiornis spinicollis</i>	Straw-necked Ibis			x			
CICONIIDAE								
	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork			x			
OTIDIDAE								
	<i>Ardeotis australis</i>	Australian Bustard			x		x	
SCOLOPACIDAE								
	<i>Actitis hypoleucos</i>	Common Sandpiper			x			
	<i>Gallinago sp.</i>	Gallinago Snipe sp.			x			
	<i>Tringa glareola</i>	Wood Sandpiper			x			
	<i>Tringa nebularia</i>	Common Greenshank			x			
	<i>Tringa stagnatilis</i>	Marsh Sandpiper		x	x			
BURHINIDAE								
	<i>Burhinus grallarius</i>	Bush Stone-curlew		x	x			
CHARADRIIDAE								
	<i>Charadrius ruficapillus</i>	Red-capped Plover			x			
	<i>Elsyornis melanops</i>	Black-fronted Dotterel			x	x		
	<i>Erythronyx cinctus</i>	Red-kneed Dotterel			x			
ACCIPITRIDAE								
	<i>Accipiter fasciatus</i>	Brown Goshawk		x	x		x	

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
	<i>Accipter cirrhocephalus</i>	Collared Sparrowhawk					x	
	<i>Aquila audax</i>	Wedge-tailed Eagle	x				x	x
	<i>Circus assimilis</i>	Spotted Harrier	x	x	x		x	x
	<i>Elanus axillaris</i>	Black-shouldered Kite		x		x		
	<i>Haliastur sphenurus</i>	Whistling Kite	x	x	x		x	
	<i>Hieraaetus morphnoides</i>	Little Eagle	x		x		x	x
	<i>Lophoictinia isura</i>	Square-tailed Kite					x	x
	<i>Pandion haliaetus</i>	Osprey			x			
FALCONIDAE								
	<i>Falco berigora</i>	Brown Falcon	x	x	x	x	x	
	<i>Falco cenchroides</i>	Australian Kestrel	x	x	x	x	x	x
	<i>Falco longipennis</i>	Australian Hobby	x		x		x	
	<i>Falco peregrinus</i>	Peregrine Falcon					x	
COLUMBIDAE								
	<i>Geopelia cuneata</i>	Diamond Dove	x	x	x	x	x	x
	<i>Geopelia striata</i>	Peaceful Dove		x	x			
	<i>Geophaps plumifera</i>	Spinifex Pigeon	x	x	x	x	x	x
	<i>Ocyphaps lophotes</i>	Crested Pigeon	x	x	x	x		
	<i>Phaps chalcoptera</i>	Common Bronzewing	x	x				x
CACATUIDAE								
	<i>Cacatua roseicapilla</i>	Galah	x	x	x	x	x	
	<i>Cacatua sanguinea</i>	Little Corella	x	x	x	x	x	x
PSITTACIDAE								
	<i>Barnardius zonarius</i>	Australian Ringneck				x		
	<i>Nymphicus hollandicus</i>	Cockatiel					x	x

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
CUCULIDAE								
	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo		x	x	x	x	
	<i>Cuculus pallidus</i>	Pallid Cuckoo					x	
CENTROPODIDAE								
	<i>Centropus phasianinus</i>	Pheasant Coucal	x	x	x			
STRIGIDAE								
	<i>Ninox boobook</i>	Southern Boobook			x		x	x
AEGOTHELIDAE								
	<i>Aegotheles cristatus</i>	Owlet Nightjar	x	x				
CAPRIMULGIDAE								
	<i>Eurostopodus argus</i>	Spotted Nightjar	x	x	x	x		x
HALCYONIDAE								
	<i>Dacelo leachii</i>	Blue-winged Kookaburra	x	x	x			
	<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher	x	x	x	x		
	<i>Todiramphus sanctus</i>	Sacred Kingfisher		x	x			
MEROPIDAE								
	<i>Merops ornatus</i>	Rainbow Bee-eater	x	x	x	x	x	x
MALURIDAE								
	<i>Amytornis striatus</i>	Striated Grasswren	x	x	x	x	x	x
	<i>Malurus lamberti</i>	Variegated Fairy-wren		x	x	x		x
	<i>Malurus leucopterus</i>	White-winged Fairy-wren	x					





Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
	<i>Chlamydera guttata</i>	Western Bowerbird	x	x	x	x		x
CAMPEPHAGIDAE								
	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-Shrike	x	x	x	x	x	x
	<i>Lalage tricolor</i>	White-winged Triller	x	x	x		x	x
ARTAMIDAE								
	<i>Artamus cinereus</i>	Black-faced Woodswallow	x	x	x	x		x
	<i>Artamus minor</i>	Little Woodswallow	x	x	x	x	x	x
	<i>Artamus personatus</i>	Masked Woodswallow					x	x
	<i>Cracticus nigrogularis</i>	Pied Butcherbird	x	x	x	x	x	x
	<i>Gymnorhina tibicens</i>	Australian Magpie						x
CORVIDAE								
	<i>Corvus benneti</i>	Little Crow						x
	<i>Corvus orru</i>	Torresian Crow	x	x	x	x	x	x
HIRUNDINIDAE								
	<i>Hirundo ariel</i>	Fairy Martin	x	x	x	x	x	
	<i>Hirundo nigricans</i>	Tree Martin		x				
MOTACILLIDAE								
	<i>Anthus novaeseelandiae</i>	Australian Pipit	x		x	x	x	x
ALAUDIDAE								
	<i>Cinclooramphus cruralis</i>	Brown Songlark		x				x
	<i>Cinclooramphus mathewsi</i>	Rufous Songlark			x		x	
	<i>Mirafra javanica</i>	Singing Bushlark		x	x			

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
SYLVIIDAE								
	<i>Eremiornis carteri</i>	Spinifexbird	x	x	x	x		x
ESTRILIDAE								
	<i>Emblema pictum</i>	Painted Firetail	x	x	x	x	x	x
	<i>Heteromunia pectoralis</i>	Pictorella Mannikin			x			
	<i>Neochanta ruficauda</i>	Star Finch			x			
	<i>Taeniopygia guttata</i>	Zebra Finch	x	x	x	x	x	x
DICAEDAE								
	<i>Dicaeum hirsutinaceum</i>	Mistletoe Bird				x		x
Total Bird Species			45	52	77	43	41	43

**Mammal species observed at each site of the Goldsworthy Extension Project Area.**

CGHR = Cattle Gorge Haul Road, CGOB = Cattle Gorge Ore Body, SH = Sunrise Hill, NIM = Nimingarra, YAR = Yarrie, CUN = Cundaline, CAL = Callawa (*ecologia*, 2005b)

Family	Species	Common Name	SH	NIM	CG	YAR	CUN	CAL
TACHYGLOSSIDAE								
	<i>Tachyglossus aculeatus</i>	Echidna				x		
DASYURIDAE								
	<i>Dasyercus cristicauda</i>	Mulgara			x			
	<i>Dasykaluta rosamondae</i>	Kaluta				x		
	<i>Dasyurus hallucatus</i>	Northern Quoll	x	x	x	x		x
	<i>Ningaui timealeyi</i>	Pilbara Ningaui				x		
	<i>Planigale</i> sp.		x	x				
	<i>Sminthopsis youngsoni</i>	Lesser Hairy-footed Dunnart				x		
	<i>Sminthopsis macroura</i>	Stripe-faced Dunnart		x				
MACROPODIDAE								
	<i>Macropus robustus</i>	Euro	x	x	x	x	x	x
	<i>Macropus rufus</i>	Red Kangaroo			x	x		x
	<i>Petrogale rothschildi</i>	Rothschild's Rock Wallaby	x	x			x	x
MEGADERMATIDAE								
	<i>Macroderma gigas</i>	Ghost Bat					x	x
EMBALLONURIDAE								
	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat		x				
	<i>Taphozous georgianus</i>	Common Sheath-tail Bat	x	x	x		x	x
	<i>Taphozous hilli</i>	Hill's Sheath-tail Bat				x		
HIPPOSIDERIDAE								
	<i>Rhynchonycteris aurantius</i>	Pilbara Leaf-nosed Bat		x	x		x	x

Family	Species	Common Name	SH	NIM	CG	VAR	CUN	CAL
VESPERTILIONIDAE								
	<i>Chalinolobus gouldi</i>	Gould's Wattled Bat	x	x	x		x	x
	<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat		x	x		x	x
	<i>Scotorepens greyii</i>	Little Broad-nosed Bat	x	x	x		x	
	<i>Vespadelus baverstocki</i>	Inland Forest Bat	x					
	<i>Vespadelus finlaysoni</i>	Inland Cave Bat	x	x	x		x	x
MOLOSSIDAE								
	<i>Chaerophon jobensis</i>	Northern Freetail Bat			x			
MURIDAE								
	<i>Leggadina lakedownensis</i>	Lakeland Downs Mouse				x		
	* <i>Mus musculus</i>	House Mouse		x	x	x		
	<i>Pseudomys chapmani</i>	Western Pebble-mound Mouse				x		
	<i>Pseudomys delicatulus</i>	Delicate Mouse		x		x		
	<i>Pseudomys desertor</i>	Desert Mouse			x	x		
	<i>Pseudomys hermannsburgensis</i>	Sandy Inland Mouse			x	x		
	<i>Zyzomys argurus</i>	Common Rock Rat	x	x	x	x	x	x
CANIDAE								
	* <i>Canis lupus dingo</i>	Dingo		x			x	x
FELIDAE								
	* <i>Felis catus</i>	Cat	x			x		
BOVIDAE								
	* <i>Bos Taurus</i>	Cow	x	x		x		
TOTAL MAMMAL SPECIES			12	17	15	17	11	12

## **Appendix E**

### **Summary Tables Describing Conservation Significance**



## IUCN categories also used under the Commonwealth EPBC Act and by DEC

Status	Code	Description
Extinct	(EX)	A taxon is Extinct when there is no reasonable doubt that the last individual has died.
Extinct in the Wild	(EW)	A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
Critically Endangered	(CR)	A taxon is Critically Endangered when the best available evidence indicates that it is considered to be facing an extremely high risk of extinction in the wild.
Endangered	(EN)	A taxon is Endangered when the best available evidence indicates that it is considered to be facing a very high risk of extinction in the wild.
Vulnerable	(VU)	A taxon is Vulnerable when the best available evidence indicates that it is considered to be facing a high risk of extinction in the wild.
Lower Risk	(LR)	<p>A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:</p> <ul style="list-style-type: none"> <li>○ Conservation Dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.</li> <li>○ Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.</li> <li>○ Least Concern (lc). Taxa which do not qualify for Conservation Dependent or Near Threatened.</li> </ul>
Data Deficient	(DD)	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.
Not Evaluated	(NE)	A taxon is Not Evaluated when it has not yet been evaluated against the criteria.

## Schedules of the Western Australian Wildlife Conservation Act 1950: Wildlife Conservation (Specially Protected Fauna) Notice.

Status	Code	Description
Schedule 1	(S1)	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	(S2)	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	(S3)	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection
Schedule 4	(S4)	Fauna that is in need of special protection, otherwise than for the reasons mentioned above

## Priority Fauna Codes used by the Western Australian DEC

Status	Code	Description
<b>Priority One</b> Taxa with few, poorly known populations on threatened lands.	(P1)	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
<b>Priority Two</b> Taxa with few, poorly known populations on conservation lands.	(P2)	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
<b>Priority Three</b> Taxa with several, poorly known populations, some on conservation lands.	(P3)	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
<b>Priority Four</b> Taxa in need of monitoring.	(P4)	Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.
<b>Priority Five</b> Taxa in need of monitoring.	(P5)	Taxa which are not considered threatened but are subject to a specific conservatin program, the cessation of which would result in the species becoming threatened within five years.

## **Appendix F**

### **Licence to Take Fauna for Scientific Purposes No. SF006429**



# DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Enquiries: 17 DICK PERRY AVE, KENSINGTON, WESTERN AUSTRALIA  
Telephone: 08 9334 0333  
Facsimile: 08 9334 0242



Correspondence: **Locked Bag 30**  
**Bentley Delivery Centre WA 6983**

**PAGE 1**  
**NO. SF006429**

**RECEIPT NO. AMOUNT**  
**\$0.00**

## **WILDLIFE CONSERVATION ACT 1950** **REGULATION 17**

### **LICENCE TO TAKE FAUNA FOR SCIENTIFIC PURPOSES**

**THE UNDERMENTIONED PERSON MAY TAKE FAUNA FOR RESEARCH OR OTHER SCIENTIFIC PURPOSES AND WHERE AUTHORISED, KEEP IT IN CAPTIVITY, SUBJECT TO THE FOLLOWING AND ATTACHED CONDITIONS, WHICH MAY BE ADDED TO, SUSPENDED OR OTHERWISE VARIED AS CONSIDERED FIT.**

**DIRECTOR GENERAL**

#### **CONDITIONS**

- 1 THE LICENSEE SHALL COMPLY WITH THE PROVISIONS OF THE WILDLIFE CONSERVATION ACT AND REGULATIONS AND ANY NOTICES IN FORCE UNDER THIS ACT AND REGULATIONS.
- 2 UNLESS SPECIFICALLY AUTHORISED IN THE CONDITIONS OF THIS LICENCE OR OTHERWISE IN WRITING BY THE DIRECTOR GENERAL, SPECIES OF FAUNA DECLARED AS LIKELY TO BECOME EXTINCT, RARE OR OTHERWISE IN NEED OF SPECIAL PROTECTION SHALL NOT BE CAPTURED OR OTHERWISE TAKEN.
- 3 NO FAUNA SHALL BE TAKEN FROM ANY NATURE RESERVE, WILDLIFE SANCTUARY, NATIONAL PARK, MARINE PARK, TIMBER RESERVE OR STATE FOREST WITHOUT PRIOR WRITTEN APPROVAL OF THE DIRECTOR GENERAL. NO FAUNA SHALL BE TAKEN FROM ANY OTHER PUBLIC LAND WITHOUT THE WRITTEN APPROVAL OF THE GOVERNMENT AUTHORITY MANAGING THAT LAND.
- 4 NO ENTRY OR COLLECTION OF FAUNA TO BE UNDERTAKEN ON ANY PRIVATE PROPERTY OR PASTORAL LEASE WITHOUT THE CONSENT IN WRITING OF THE OWNER OR OCCUPIER, OR FROM ANY ABORIGINAL RESERVE WITHOUT THE WRITTEN APPROVAL OF THE DEPARTMENT OF INDIGENOUS AFFAIRS.
- 5 NO FAUNA OR THEIR PROGENY SHALL BE RELEASED IN ANY AREA WHERE IT DOES NOT NATURALLY OCCUR, NOR HANDED OVER TO ANY OTHER PERSON OR AUTHORITY UNLESS APPROVED BY THE DIRECTOR GENERAL, NOR SHALL THE REMAINS OF SUCH FAUNA BE DISPOSED OF IN SUCH MANNER AS TO CONFUSE THE NATURAL OR PRESENT DAY DISTRIBUTION OF THE SPECIES.
- 6 THIS LICENCE AND THE WRITTEN PERMISSION REFERRED TO AT CONDITIONS 3 & 4 MUST BE CARRIED BY THE LICENSEE OR AUTHORISED AGENT AT ALL TIMES FOR THE PURPOSE OF PROVING THEIR AUTHORITY TO TAKE FAUNA WHEN QUESTIONED AS TO THEIR RIGHT TO DO SO BY A WILDLIFE OFFICER, ANY OTHER STATE OR LOCAL GOVERNMENT EMPLOYEE OR ANY MEMBER OF THE PUBLIC.
- 7 \*\*\*\*\*ANY INTERACTION INVOLVING GAZETTED THREATENED FAUNA THAT MAY BE HARMFUL AND/OR INVASIVE MAY REQUIRE APPROVAL FROM THE COMMONWEALTH DEPT OF THE ENVIRONMENT AND WATER RESOURCES, PHONE 02 6274 1900. INTERACTION WITH SUCH SPECIES IS CONTROLLED BY THE COMMONWEALTH GOVERNMENT'S "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999" & "ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION REGULATIONS 2000" AS WELL AS DEC'S WILDLIFE CONSERVATION ACT & REGULATIONS.\*\*\*\*\*
- 8 NO BIOPROSPECTING INVOLVING THE REMOVAL OF SAMPLE AQUATIC AND TERRESTRIAL ORGANISMS (BOTH FLORA AND FAUNA) FOR CHEMICAL EXTRACTION AND BIOACTIVITY SCREENING IS PERMITTED TO BE CONDUCTED WITHOUT SPECIFIC WRITTEN APPROVAL BY THE DIRECTOR GENERAL OF DEC.
- 9 FURTHER CONDITIONS (NUMBERED TO ) ARE ATTACHED.

**PURPOSE** TO CARRY OUT A SHORT RANGE ENDEMIC (SRE) INVERTEBRATE FAUNA SURVEY WITHIN THE YARRIE PROJECT AREA AND SURROUNDS.

**AUTHORISED PERSONS** CARLY WESTON  
JARRAD DONALD

\_\_\_\_\_

APPENDIX J

STYGOFAUNA ASSESSMENT  
(SUBTERRANEAN ECOLOGY, 2008a)







# ***Subterranean Ecology***

***Scientific Environmental Services***

## **Goldsworthy Iron Ore Mining Operations Cundaline and Callawa Mining Operations Stygofauna Assessment**



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**Prepared for *BHP Billiton Iron Ore***

**October 2008**

**Goldsworthy Iron Ore Mining Operations  
Cundaline and Callawa Mining Operations  
Stygofauna Assessment**

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Project No. 61

Prepared for BHP Billiton Iron Ore

Prepared by: Subterranean Ecology

Date: 24<sup>th</sup> October 2008

COVER: Syncarid crustacean (Parabathynellidae sp.) from Callawa groundwaters. Body length approximately 1.5 mm. Photo Kate Muirhead. Copyright Subterranean Ecology Pty Ltd.

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LIMITATIONS: This survey was limited to the requirements specified by the client and the extent of information made available to the consultant at the time of undertaking the work. Determination of pit and out-of-pit sites was based on information provided by BHP Billiton Iron Ore. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein.

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## EXECUTIVE SUMMARY

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia .

BHPBIO is planning on extending the mine life of Goldsworthy Iron Ore Mining Operations by mining the Callawa and Cundaline Deposits.

This report documents the results of a stygofauna survey conducted between December 2007 and April 2008. It also assesses the potential impacts of the planned Callawa and Cundaline satellite mining operations on the groundwater fauna.

Principle findings and context were:

- Callawa and Cundaline deposits occur on discrete elevated ridge systems composed of Nimingarra Iron Formation within the De Grey River catchment. The ridge systems are separated from each other by Eel Creek which forms an alluvial valley approximately 1 km wide.
- The sampling effort for this survey comprised 89 sample events from 60 holes involving three separate rounds of sampling.
- All holes that could be found which contained water were sampled, but the number of samples that could be obtained was limited by the number of holes that intersected water, especially at Cundaline Ridge where there were few holes containing water. Considering the limitations of survey, the sampling effort is considered adequate to enable an assessment of stygofauna in relation to the planned Callawa and Cundaline mining operations.
- No stygofauna were detected in the bores sampled on the Cundaline Ridge. This may be a consequence of limited groundwater habitat intersected at the depths of drilled bores in this location. The apparent absence at Cundaline Ridge is consistent with the apparent absence of stygofauna on nearby Nimingarra and Sunrise Hill deposits which have been sampled repeatedly over several years from 2005 to 2007 by Biota and more recently by Subterranean Ecology. The results suggest that stygofauna may not be present in the more north-western ranges of the Goldsworthy mining area, which are located at a further distance from the De Grey River than Callawa and Yarrie ridges.
- At Callawa Ridge, five morpho-species of stygofauna were detected, including one worm (Phreodrilidae sp. 1), and four crustaceans: Paramelitidae sp. 1, *Metacyclops* sp. 1 (Copepoda), Bathynellidae sp. 1 and Parabathynellidae sp. 1 (Syncarida). Morphological evidence suggests that four of these species have distributions recorded outside of the proposed pit at Callawa Ridge, including three species collected on a nearby Yarrie Ridge.
- *Metacyclops* n. sp. 1 has, to date, only been collected from one bore located inside the proposed pit at Callawa Ridge. However, the same putative morpho-species has also been collected from Quarry 8 located



approximately 215 km south-west of Yarrie Mine. As a result and for present purposes, the two widely separate records suggest that the conservation status of *Metacyclops* n. sp. 1 is not necessarily dependent on its occurrence inside the proposed pit on Callawa ridge.

- Study of potential hydrogeological impacts of the proposed mining conducted by Aquaterra indicates that mining at the Cundaline deposit will not penetrate the natural groundwater table and no dewatering will be required. In the case of Callawa deposit, Aquaterra concludes that mining will intercept the natural groundwater table and dewatering will be required. Aquaterra anticipates that the impact of dewatering will extend to a distance of less than 500 metres from the pits, but backfilling of pits is likely to result in the water table recovering to pre-mining levels.
- The other members of the stygofauna community at Callawa have been collected outside of the proposed pit. Although some members of the community may have only been collected, to date, from within the predicted zone of dewatering influence (after Aquaterra 2008), the conservation risk to the Callawa Ridge stygofauna community is likely to be low given: (1) the probable wider distribution of the community throughout the Callawa Ridge aquifer; (2) the localised zone of dewatering influence (< 500 m) in relation to the wider extent of the Callawa Ridge aquifer (after Aquaterra 2008); (3) the short mine life with backfilling of pits to above the watertable, and predicted recovery of water levels and water quality after cessation of mining (Aquaterra 2008); (4) operational experience at Yarrie Pit demonstrating localised zone of dewatering influence (Aquaterra 2008) and persistence of the stygofauna community in the Yarrie Ridge aquifer after cessation of mining.
- The diversity, distributions and conservation status of stygofauna in the Pilbara is a new field of knowledge which is building slowly, as a result of surveys and studies associated with mining and other developments. On present knowledge the five morpho-species collected at Callawa have distributions which extend beyond the proposed pits.
- Within its limitations, the survey did not demonstrate any conservation issue for stygofauna associated with mining the Cundaline or Callawa deposits as proposed.

## 1 INTRODUCTION

BHP Billiton Iron Ore Pty Ltd (BHPBIO) operates the Goldsworthy Iron Ore Mining Operations (herein referred to as the Goldsworthy Operations) which are located approximately 200 kilometres (km) east of Port Hedland in the north of the Pilbara Region of Western Australia (Figure 1).

The iron ore deposits in this area have been progressively mined since the mid 1960's. Current mining operations are centred at Yarrie, with some mining still taking place at the Nimingarra, Cattle Gorge and Sunrise Hill deposits (Figure 2).

The approved mining areas at Goldsworthy are drawing towards the end of their mine life. However, BHPBIO has identified approximately 9.6 million tonnes of additional iron ore at the planned Callawa and Cundaline mining operations that would enable it to extend the mine life by up to five years (Figures 3 and 4). Mining at the Cundaline and Callawa deposits would use conventional open pit mining methods.

Aquaterra (2008) has conducted a groundwater assessment for the planned Callawa and Cundaline mining operations. The hydrological investigations indicate that the local water table in vicinity of the Cundaline deposit occurs at between 120 and 140 metres (m) AHD (Australian Height Datum). The proposed Cundaline pits would not extend below the watertable (ie. the deepest of the proposed pits extends to 150 m AHD).

The local water table in the vicinity of the Callawa deposit occurs between 163 and 227 m AHD. The proposed pits would extend up to 50 m below the water table, which will necessitate some mine dewatering to enable mining of the lower benches.

This report documents the results of a stygofauna survey conducted from December 2007 to April 2008 at Callawa and Cundaline ridges.

The objectives of this survey were to:

1. Document the stygofauna morphospecies<sup>1</sup> and communities present within the proposed mine pits at Callawa and Cundaline ridges, and surrounding out-of-pit zones located outside of the proposed mine pits.
2. Assess the conservation status of morpho-species in relation to the proposed pits and mine layout at the planned Callawa and Cundaline mining operations.
3. Assess the potential impacts from mining below the water table for the planned Callawa mining operation.

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<sup>1</sup> Morphospecies are a group of biological organisms that differs in some morphological respect from all other groups.

