Balline Garnet Project

Level 2 Flora and Vegetation Survey

Prepared for Australian Garnet Pty Ltd
November 2013

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Executive Summary

Onshore Environmental Consultants Pty Ltd (Onshore Environmental) was commissioned by Australian Garnet Pty Ltd (Australian Garnet) to complete a one season Level 2 flora and vegetation survey of the Menari Mineral Sands Deposit within the Balline Project Area, herein referred to as the study area. The study area covered 1,736 ha of which approximately 1,080 ha is currently cleared for agriculture.

The survey was completed between the 5th and 11th October 2013 with a total of 15 quadrats and 163 releve plots assessed. A total number of 151 plant taxa (including varieties and subspecies) from 54 families and 116 genera were recorded from the study area by Onshore Environmental during October 2013. Species representation was greatest among the Poaceae, Asteraceae, Fabaceae, Chenopodaceae and Myrtaceae families.

Following intensive quadrat sampling and extensive ground truthing of the study area none of the plant taxa recorded were gazetted as Threatened Flora (T) pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950* (WC Act), or listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

There were four Priority flora taxa (as defined by DPaW) recorded from the study area; *Melaleuca huttensis* (Priority 1), *Cryptandra glabriflora* (Priority 2), *Anthocercis intricata* (Priority 3) and *Beyeria cinerea* subsp. *cinerea* (Priority 3).

There were 24 introduced (weed) species recorded from the study area. None of the weeds are listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act).

Vegetation within the study area was described and mapped as 19 vegetation associations. The vegetation associations were classified into sixteen Broad Floristic Formations on the basis of canopy structure. None of the vegetation associations from the study area were affiliated with any Commonwealth listed TECs. However, Vegetation association 4 does show similarities to the State listed PEC 'Coastal sands dominated by *Acacia rostellifera, Eucalyptus oraria* and *Eucalyptus obtusiflora* (Priority 1)'.

A large proportion of the study area has been historically cleared for agriculture and vegetation condition was subsequently mapped as completely degraded. The larger area of remnant vegetation was rated as good, with smaller sections rated as very good or degraded. The major disturbances recorded within the study area were related to historical agriculture, specifically clearing of native vegetation, establishment of annual pasture and seasonal crops, grazing by domestic stock, and introduction of weeds and feral animals such as rabbits.

The majority of vegetation recorded within the study area occurs on undulating low hills and ridges comprising limestone and sand. Associated vegetation is dominated by xerophytic plant taxa that have no reliance of groundwater to survive. Vegetation associations 1, 2, 3 and 15 occur on exposed limestone clay loam flats situated at the lowest position in the landscape, close to the coastline in the south-west sector of the study area, and where depth to groundwater is at its shallowest. Given the salinity of groundwater from monitoring bores closest to

coast and at the very top of the water table is in the range 4,000 – 7,000 mg/L TDS, it is likely that Vegetation associations 1, 2, 3 and 15 have interaction with this groundwater at least seasonally during the year.

Currently, flora and vegetation values of significance within the study area include the four Priority flora taxa; *Melaleuca huttensis* (Priority 1), *Cryptandra glabriflora* (Priority 2), *Anthocercis intricata* (Priority 3) and *Beyeria cinerea* subsp. *cinerea* (Priority 3), as well as Vegetation association 4 which is closely affiliated with a State listed PEC.

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1.0 Introduction

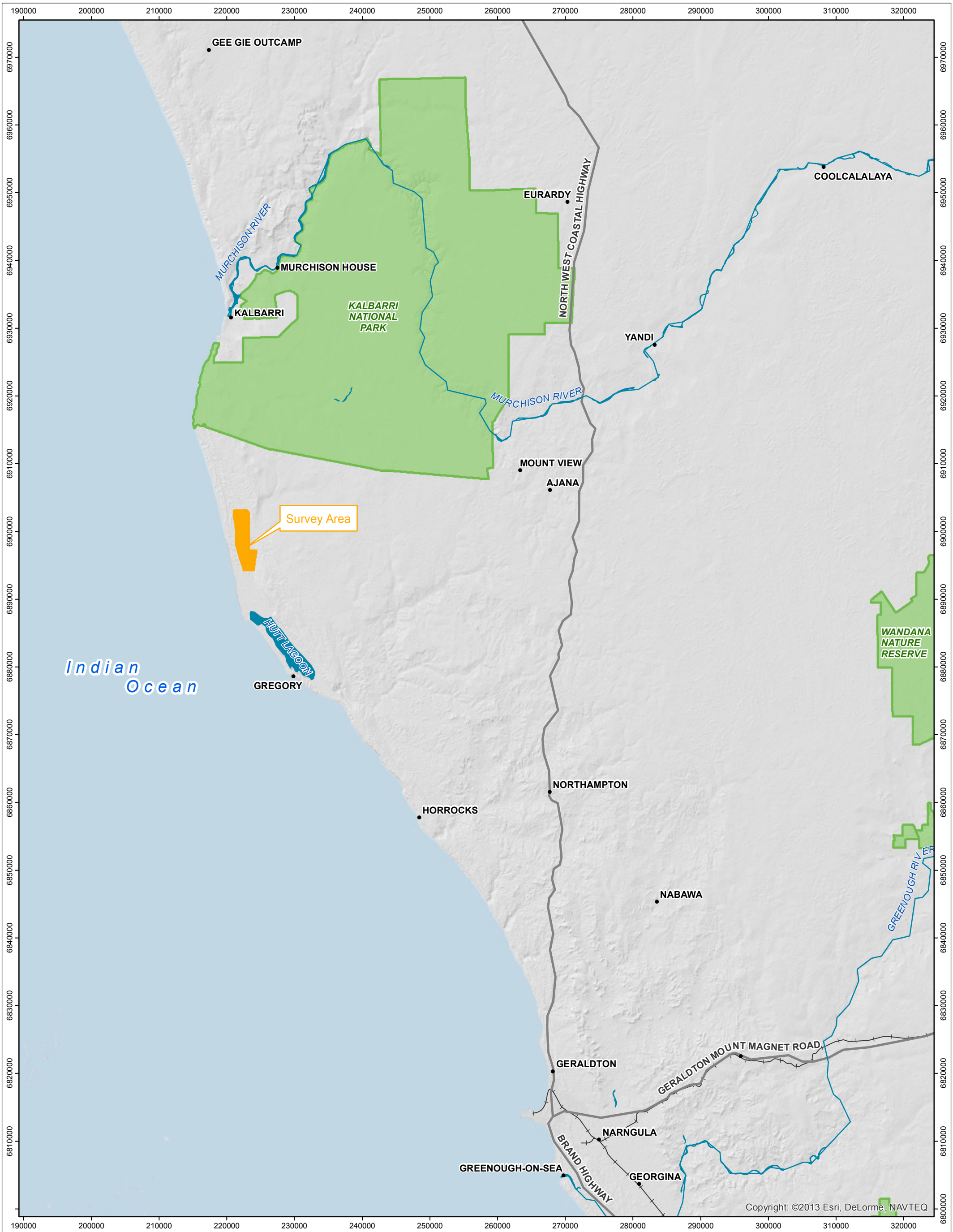
1.1 Preamble

Onshore Environmental was commissioned by Australian Garnet to undertake a Level 2 flora and vegetation survey of the Menari Mineral Sands Deposit, which forms part of the Balline Project, situated approximately 35 km south of Kalbarri in the Mid-West region of Western Australia (Figure 1). The 1,736 ha study area occurs on privately owned farmland of which approximately 1,080 ha has been previously cleared for agriculture and the remaining 675 ha comprises disjunct remnant vegetation.

1.2 Previous Surveys

There are five previous flora and vegetation surveys completed within a 100 km radius of the study area that are publically available. These surveys are listed below and described in more detail in Section 3.1.1:

- Ecoscape (2009) *Haddington Resources Balline Level 1 Flora and Fauna assessment*;
- GHD (2011) *City of Geraldton-Greenough Report for Lots 3012 and 3013 Olive Street, Geraldton Flora and Fauna Survey*;
- Ecoscape (2010) *Geraldton Regional Flora and Vegetation Survey*;
- Ecologica (2010) *Oakajee Port and Rail OPR Rail Development Vegetation and Flora Assessment;* and
- Northern Agricultural Catchment Council (2010), *Dongara to Cape Burney Coastal Vegetation Survey.*



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BALLINE

REGIONAL LOCATION

0 5 10 15 20
Kilometers

1:500,000

Datum: GDA94
Projection: MGA Zone 50

ONSHORE ENVIRONMENTAL

ONSHORE ENVIRONMENTAL CONSULTANTS		Date:	09/12/2013
Sheet Size:	A3	Status:	Draft
Drawn by GSM	Requested by DB	Internal Reference Kalbarri_LOC_20131113	

Legend

- Survey Area
- Nature Conservation Reserve
- Watercourses
- Roads
- Railways

N

1.3 Climate

The climate of the Mid-west comprises mild wet winters and warm to hot dry summers. Annual rainfall totals are relatively consistent decreasing from 350 mm on the coast to 275 mm at the eastern margin of the survey area. Average maximum summer temperatures range between 31°C to 35°C and winter maximum temperatures range from 22°C and 30°C (Figure 2). Prevailing winds are easterly to southerly.

Rainfall was below average for the six months prior to the October field survey, with the June 2013 total significantly lower than the long term average (Figure 2, BOM 2013a).

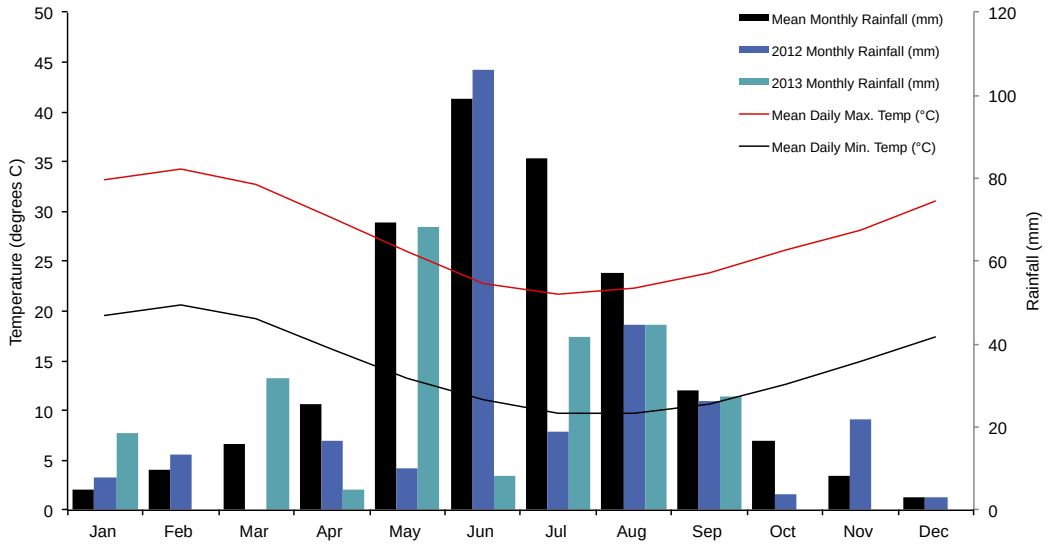

Figure 2 **Rainfall data recorded from Balline for 2012 and 2013. Long term average rainfall for Balline (1930-2012) and climatic data is for Kalbarri from 1970 to 2013 (BOM 2013a, 2013b).**

1.4 Biogeographic Regions

The latest version of the Interim Biogeographic Regionalisation for Australia (IBRA) describes a system of 89 'biogeographic regions' (bioregions) and 419 subregions covering the entire Australian continent (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2013). Bioregions are defined on the basis of climate, geology, landform, native vegetation and fauna information. The bioregions and subregions are the reporting unit for status of native ecosystems and their level of protection in the National Reserve System (DSEWPaC 2013).

The study area lies within the Geraldton Hills subregion of the Geraldton Sandplains bioregion. The bioregion consists of endemic rich, proteaceous scrub-heaths on undulating sand plains mesas and coastal sands and limestones. Outwash plains and drainage lines have extensive stands of York Gum and Jam woodlands. Sandplains, alluvial plains and coastal limestones dominate the Geraldton Hills subregion. The vegetation includes heaths of *Banksia* and *Actinostrobus,* York gum woodlands and *Acacia* species. The climate is semi-arid to Mediterranean and the subregional area is 2,242,033 ha (Desmond and Chant 2001).

1.5 Existing Land Use

The primary land use in the Balline area is agriculture which extends across 79% of the subregion. Dry-land agriculture is the dominant practice with a smaller extent utilized for grazing native pastures. Conservation areas, unallocated crown land and Crown Reserves are less prominent land uses (Desmond and Chant 2001).

1.6 Soils

Tille (2006) collated the most recent and detailed mapping of Western Australia's rangelands and arid interior into a hierarchy of soil-landscape mapping units. The study area lies within the Carnarvon Province. The Carnarvon Province occupies approximately 92,475 km^2 (3.7% of Western Australia) and includes the towns of Carnarvon, Denham, Kalbarri, Useless Loop, Horrocks, Port Gregory and Gascoyne Junction. Areas of sand plain have deep red sands with some yellow sands occurring in the south. Interdune flats are comprised of red sandy earths, red shallow sands and red/brown non-cracking clays. Alluvial plains are mostly comprised of deep red sandy duplexes with some red/brown non-cracking clays, red shallow sandy duplexes, red loamy earths and red sandy earths. Red deep sands are also common on alluvial plains typically occurring on sandy banks and rises. Red deep sandy duplexes, red sandy earths and red shallow loams, occur on stony plains, with some red shallow sandy duplexes and red/brown non-cracking clays. Red sandy earths, red loamy earths and red shallow loams dominate the wash plains and the hilly terrain has stony soils with red shallow sandy duplexes, red loamy earths and red shallow sands. Calcareous shallow loams and calcareous loamy earths occur on the calcrete plains with calcareous deep sands and red deep sands on the coastal dunes. Salt lake soils cover the bed of Lake MacLeod.

The Carnarvon Province is comprised of seven soil landscape zones:

- Muggon Zone;
- Port Gregory Zone;
- Kalbarri Sandplain Zone;
- Yalbalgo Sandplain Zone;
- Victoria Red Sandplain Zone;
- Lower Gascoyne Alluvial Plains Zone; and
- Wandagee-Byro Plains and Hills Zone.

The study area lies within the Port Gregory Zone. This zone is described as coastal plains, sand plains, alluvial plains and sea cliffs. The area consists of limestone and sand with cretaceous sedimentary rocks of the Carnarvon basin covered by red shallow sands, deep sands, stony soils and calcareous deep sands. Some yellow deep sands and yellow / brown shallow sands also occur. The vegetation consists of coastal scrub-heath of *Banksia, Acacia* and *Hakea* with some *Acacia* thickets.

1.7 Geology

The ancient continental Western Shield dominates the geology of Western Australia. The study area lies close to the border between the southern end of the Carnarvon Basin and the northern end of the Perth Basin. The area includes some exposed Permian/Silurian siltstone and Jurassic sandstones (Desmond and Chant 2001). The Ordovician Tumblagooda Sandstone outcrops lie to the south of the Murchison River, on the Gascoyne Platform. There is also Jurassic sandstone and conglomerate, and Triassic shale and siltstone in the area (Tille 2006).

1.8 Flora and Vegetation

The study area is located within the Irwin Botanical District of the South-west Botanical Province (Beard 1990). Vegetation was broadly mapped as *Acacia – Casuarina* Thickets and Scrub, and mapped more specifically as two units; Low Forest of *Acacia rostellifera* (Greenough 371) and *Acacia rostellifera* Thicket (Greenough 17) on dunes (Figure 3). The remaining Pre-European extent for each of the two vegetation association approximates 10% and 48% respectively, with less than ten percent of each association currently protected within conservation reserves (Table 1).

Table 1 Pre-European extent of vegetation associations that intersect the study area (as described by Beard 1975 and reviewed by Shepherd *et al.* 2002).

Vegetation Association	Description	Pre-Euro. Extent (ha)	Pre-Euro. Extent Remaining (ha)	% Remaining	Current Extent Protected for Conservation (ha)
Greenough 371	Low forest; *Acacia rostellifera*	32,816	3,499	10.66%	242 (7%)
Greenough 17	Shrublands; *Acacia rostellifera* thicket	16,865	8,179	48.50%	849 (10%)

215000 220000 225000 230000 235000 240000

6915000 6910000 6905000 6900000 6895000 6890000 6885000

ZUYTDORP_440
KALBARRI_1142
KALBARRI_1142
GREENOUGH_387
GREENOUGH_129
GREENOUGH_371
KALBARRI_408
GREENOUGH_440
KALBARRI_1142
KALBARRI_1142
GREENOUGH_17
INDIAN OCEAN
GREENOUGH_129
GREENOUGH_440
GREENOUGH_371
GREENOUGH_440
GREENOUGH_440
GREENOUGH_125
GREENOUGH_440
HUTT_675
KALBARRI_408
HUTT_408
HUTT_1141
GREENOUGH_371
GREENOUGH_17
GREENOUGH_125
GREENOUGH_129
HUTT_675
HUTT_408
GREENOUGH_387
HUTT_352
GREENOUGH_440
N

215000 220000 225000 230000 235000 240000

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BALLINE

PRE EUROPEAN VEGETATION

0 1 2 3 4
Kilometers

1:100,000

Datum: GDA94
Projection: MGA Zone 50

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Legend

- Survey Area

Pre-European Vegetation SYSTEM / VEG ASSOC

- GREENOUGH, 125
- GREENOUGH, 129
- GREENOUGH, 17
- GREENOUGH, 371
- GREENOUGH, 387
- GREENOUGH, 440
- HUTT, 1141
- HUTT, 352
- HUTT, 408
- HUTT, 675
- KALBARRI, 1142
- KALBARRI, 408
- ZUYTDORP, 440

2.0 Methodology

2.1 Legislation and Guidance Statements

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

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

2.2 Desktop Searches

Three desktop searches were undertaken for information relating to rare flora Threatened Ecological Communities (TECs) and Priority Ecological Communities (PECs) previously collected or described within, or in close proximity to the study area (Wildlife Conservation (Rare Flora) Notice 2013, TEC List 2013 and PEC List 2013). The database search was extended beyond the immediate survey limits to place flora values into a local and regional context. The search criteria used was a 50 km radius around the central point of the study area: GDA94 Zone 50 J 227318E 6898038N. The State database search investigated three DPaW databases:

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

A search of the EPBC Act Protected Matters database was undertaken (DSEWPaC 2013) within a 10 km buffer of the study area (EPBC Act 1999 Protected Matters Tool 2013). A search of the International Union for Conservation of Nature (IUCN) database was also conducted (IUCN 2013).

2.3 Field Survey Methodology

2.3.1 Timing and Personnel

The single season field survey was completed between the 5th and 11th October 2013. Field work was undertaken by Principal Botanist with Onshore Environmental, Dr Jerome Bull.

2.3.2 Sampling of Study Sites

The survey involved systematic sampling using quadrats (referred to as study sites). The study sites were generally 10 m by 10 m, or an equivalent area (100 m^2) along narrow associations such as minor drainage lines. The area sampled for each study site is standard for the South-West Bioregion.

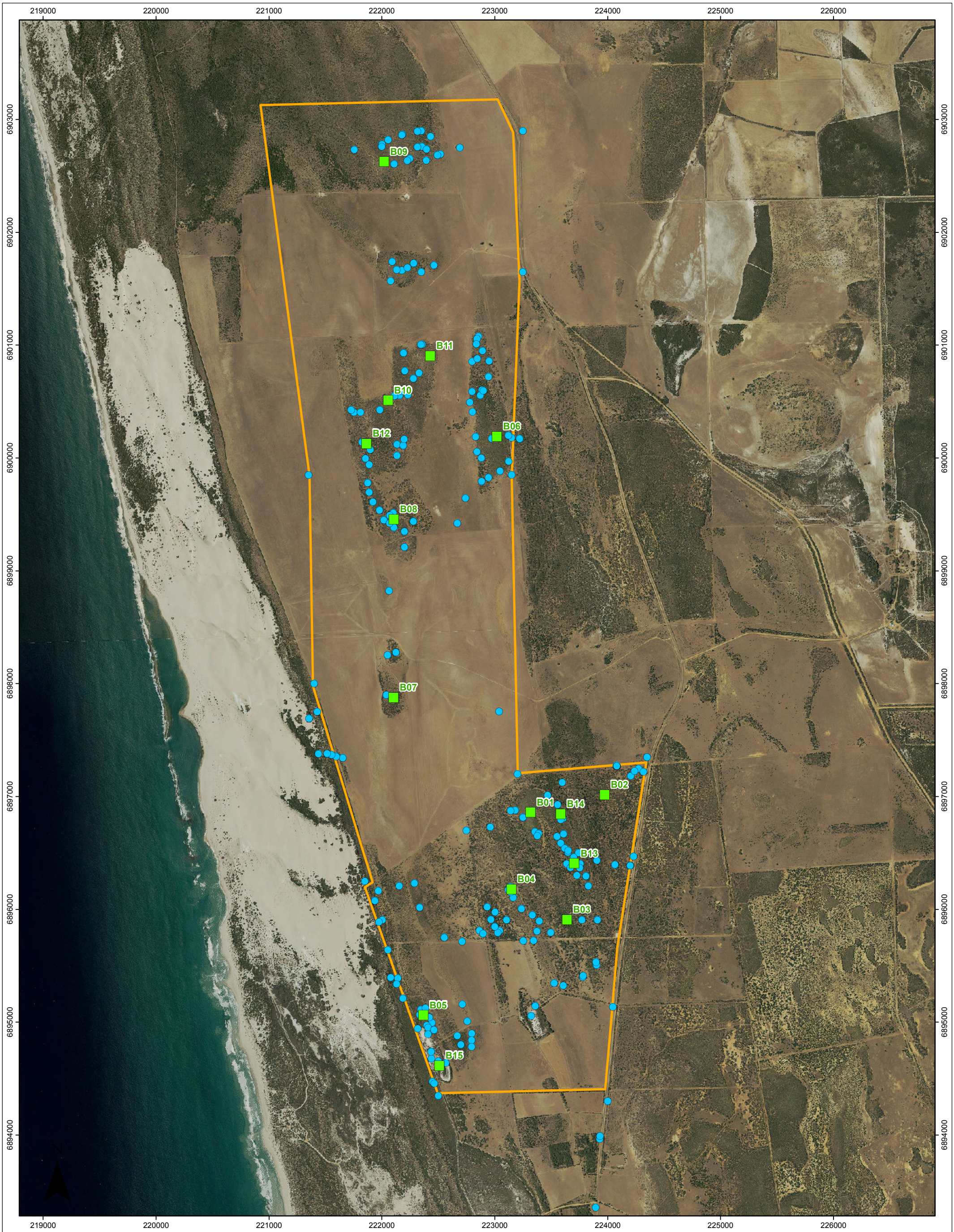
The number of study sites sampled was determined by the size and heterogeneity of each study area surveyed. A total of 15 quadrats were formally assessed within

the study area during the 2013 field survey. Vegetation descriptions were made at an additional 163 relevé sites to support vegetation mapping (Figure 4). Data was simultaneously collected on a range of other environmental parameters including:

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

Other parameters recorded for each study site were:

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



BALLINE

SAMPLE LOCATIONS

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Meters

1:30,000

Datum: GDA94
Projection: MGA Zone 50

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Drawn by GSM	Requested by DB	Internal Reference Kalbarri_Sample_sites_20131121	

Legend

- Vegetation Sample Sites
- Releve Locations
- **Survey Area**

2.3.3 Targeted Surveys for Conservation Significant Flora

The entire study area was ground-truthed at less than 100 m intervals during the field assessment. This ground coverage provided the opportunity to record opportunistic locations for significant flora, and also undertake closer examination of specific landforms where flora of interest may be expected to occur.

2.3.4 Vegetation Association Mapping

The vegetation mapping utilised high-resolution aerial photography of the entire study area at a scale of 1:10,000, with definition of vegetation polygons based on contrasting shading patterns. The location of 15 quadrats (10 m x 10 m) and 163 relevé plots was overlaid on the aerial photography, and associated flora and vegetation data was used to provide vegetation association descriptions for the polygons defined. Ground-truthing of the study area, formal assessment quadrats and numerous relevé vegetation descriptions were made within selected vegetation polygons to confirm dominant structural layers and associated plant taxa.

Description of vegetation structure follows the height, life form and density classes of Specht (1970) as modified by Aplin (1979) (see Appendix 1). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account. Vegetation condition for each of the sampling sites was determined using a recognised rating scale (based on Keighery 1994, see Appendix 2).

2.3.5 Vouchering

At least one voucher specimen was taken for each species collected to verify identification. Dr Eleanor Bennett confirmed specimen identifications at the Western Australian State Herbarium. Use was made of the Western Australian Herbarium for confirmation of species identification. Nomenclature follows Green (1985 and 1987), Paczkowska and Chapman (2000) and the Western Australian State Herbarium. Commonwealth and State conservation codes are outlined in Appendices 3 and 4.

2.3.6 Field Survey Constraints

The EPA Guidance Statement for Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004) list twelve potential constraints that field surveys may encounter. These constraints are addressed in Table 2.

Table 2 Relevance of constraints, as identified by EPA (2004), to the flora and vegetation survey.

Constraint	Relevance
Scope	The scope was established by Onshore Environmental and Australian Garnet and is in compliance with relevant EPA Guidance Statements.
Proportion of flora collected and identified	The field survey was completed during optimum seasonal conditions which maximised the total flora recorded from the study area.
Sources of information	There were five previous flora and vegetation surveys identified during a desktop review of the region. One of the previous surveys covered part of the current study area and along with the other four surveys provides excellent regional context (Ecoscape 2009).
The proportion of the task achieved and further work which might be needed	All allocated tasks were achieved during the investigation. Some of the plant taxa were not flowering at the time of assessment and could not be identified to species level; an additional targeted survey would facilitate confirmation of these identifications.
Timing / weather / season / cycle	Rainfall for the six months preceding the field survey was below the long term average but sufficient to facilitate normal flowering cycles expected during Spring.
Disturbances, e.g. fire, flood	Disturbances within the study area include grazing of remnant vegetation by domestic stock and extensive establishment of introduced weed species. None of these disturbances affected the ability to complete the survey.
Intensity	Fifteen quadrats and 163 relevé plots were assessed during early October 2013 by Onshore Environmental. This represents an intensive Level 2 flora and vegetation survey given the relatively small size of the study area.
Completeness	Relevant tasks related to assessing flora and vegetation values within the study area were completed including vegetation association mapping and targeted surveys for weeds and species of conservation significance.
Resources	Appropriate resources were applied to surveying the study area during October 2013.
Access problems	The entire study area was accessed by vehicle and on foot, noting that vegetation mapping was facilitated by high-resolution aerial photography.
Availability of contextual information	Five previous flora and vegetation surveys were sourced within a 100 km radius of the study area, providing an extensive local database.
Experience levels	The Principal Botanist working on the survey has extensive experience completing flora and vegetation surveys throughout Western Australia.

3.0 Results

3.1 Literature Review

3.1.1 Previous flora and vegetation surveys within close proximity to the study area

The results from five previous flora and vegetation surveys undertaken within a 100 km radius of the study area are tabulated below (Table 3).

Table 3 Summary of significant flora and environmental weeds recorded during previous flora and vegetation surveys within, or in close proximity to, the study area.

Report	Company	Location	Field Survey	Significant Flora	Introduced Flora	TEC / PEC
Haddington Resources Balline Level 1 Flora and Fauna assessment	Ecoscape (2009)	Near Balline in the Shire of Northampton, 35km south of Kalbarri	27th February 2008	None	**Avena fatua *Bromus diandrus, *Hordeum leporinum *Rumex vesicarius *Carpobrotus edulis, *Brassica napus, *Geranium molle, *Lysimachia arvensis, *Hypochaeris glabra, *Sonchus oleraceus*	None
City of Geraldton-Greenough Report for Lots 3012 and 3013 Olive Street, Geraldton Flora and Fauna Survey	GHD (2011)	Lots 3012 and 3013 Olive Street, Mahomets Flats	April 2011	None	** Tetragonia decumbent, *Schinus terebinthifoliu, *Tropaeolum majus, *Phoenix dactylifera, *Washingtonia filifera, *Agave americana, *Hedypnois rhagadiloloides, *Helianthus annuus, *Lactuca serriola, *Reichardia tingitana, *Sonchus oleracus, *Echium plantagineum, *Raphanus raphanistrum, * Opuntia* sp., **Chenopodium* sp., **Euphorbia terracina, *Lupinus cosentinii, *Medicago polymorpha, *Melillotus indicus, *Fumaria capreolata, *Malva parviflora, *Oxalis pes-caprae, *Avena barbata, *Bromus diandrus, *Ehrharta longifolia, *Enharta calycina, *Stenotaphrum secundatum, *Portulaca filifolia, * Lysimachia arvensis, * Lycium ferocissimum, *Tamarix aphylla*	None

Report	Company	Location	Field Survey	Significant Flora	Introduced Flora	TEC / PEC
Geraldton Regional Flora and Vegetation Survey	Ecoscape (2011)	424 km north of Perth on the Indian Ocean Coast Road, in the Mid-West region of Western Australia	March 2010	*Anthocercis intricata* (P3), *Caladenia hoffmanii* (T), *Diuris recurva* (P4), *Eucalyptus blaxellii* (T), *Grevillea triloba* (P3), *Hibbertia glomerosa* var. bistrata (P3), *Leucopogon* sp. Moresby Range (P3), *Thryptomene* sp. Moresby Range (P3), *Thryptomene stenophylla* (P2)	73 species in total with most common taxa including **Avena barbata, *Brassica tournefortii, *Hypochaeris glabra, *Ehrharta longiflora, *Lycium ferocissimum*	None
Oakajee Port and Rail OPR Rail Development Vegetation and Flora Assessment	Ecologica (2010)	24 km north of Geraldton	Phase 1 April and August 2009. Phase 2 August and October 2009	*55 Priority flora*	62 species	Four Priority 1 PECs
Dongera to Cape Burney Coastal Vegetation Survey	Ecoscape (2010)	Geraldton Sandplains bioregion, GS2 – Geraldton Hills subregion	30th November and 4th December 2009	*Anthocercis intricata* (Priority 3)	**Lysimachia arvensis, *Arctotheca calendula, *Avena barbata, *Brassica tournefortii, *Bromus diandrus, *Bromus rubens, *Carpobrotus edulis, *Carthamus lanatus, *Chenopodium murale, *Cynodon dactylon, *Ehrharta* sp., ** Euphorbia terracina, *Hordeum leporinum, *Hypochaeris glabra, *Lolium* sp., **Lycium ferocissimum, *Mesembryanthemum crystallinum, *Parapholis incurva, *Petrorhagia dubia, *Polypogon monspeliensis, *Reichardia tingitana, *Silene gallica, *Sonchus oleraceus, *Tetragonia decumbens, *Trachyandra divaricata, *Trifolium campestre, * Urospermum picroides, *Vulpia bromoides, *Vulpia myuros*	None

3.2 Desktop Review

3.2.1 Significant Flora Database Searches

There were 17 records identified from a search of the EPBC Act Protected Matters Database (DSEWPaC 2013) or the IUCN database (IUCN 2012) for a 50 km radius surrounding the study area (Table 4).

The DPaW database search (DPaW 2013) identified 112 Priority flora and 13 Threatened Flora within a 50 km radius surrounding the study area (Table 4).

Table 4 Significant flora species previously recorded from a 50 km search radius of the study area. SCC - State Conservation Code, FCC - Federal Conservation Code.

Species	SCC	FCC
Acacia gelasina	2	
Acacia latipes subsp. *licina*	3	
Acacia leptospermoides subsp. *obovata*	2	
Acacia pelophila	1	
Acacia plautella	3	
Acacia ridleyana	3	
Acacia stereophylla var. *cylindrata*	2	
Acanthocarpus parviflorus	3	
Androcalva microphylla	2	
Anthocercis intricata	3	
Anthotroche myoporoides	2	
Arnocrinum drummondii	3	
Astroloma inopinatum	1	
Baeckea subcuneata	2	
Beyeria cinerea subsp. *cinerea*	3	
Beyeria gardneri	3	
Beyeria lepidopetala	T	E
Blackallia nudiflora	3	
Bossiaea calcicola	3	
Bossiaea inundata	2	
Caladenia barbarella	T	E
Caladenia bryceana subsp. *cracens*	T	V
Caladenia elegans	T	E
Caladenia hoffmanii	T	E
Caladenia wanosa	T	V
Calectasia browneana	2	
Calocephalus aervoides	3	
Calothamnus cupularis	2	
Calytrix ecalycata subsp. *ecalycata*	3	
Calytrix formosa	3	
Calytrix harvestiana	2	
Calytrix paucicostata	2	
Calytrix pimeleoides	3	
Calytrix purpurea	2	
Centrolepis cephaloformis subsp. *murrayi*	3	
Chamelaucium marchantii	3	
Cryptandra glabriflora	2	

Species	SCC	FCC
Dampiera sp. Jurien (G. Lullfitz s.n. 10/7/1986)	2	
Desmocladus biformis	3	
Dicrastylis micrantha	3	
Diuris drummondii	T	V
Diuris recurva	4	
Drakaea concolor	T	V
Drummondita ericoides	T	E
Enekbatus cristatus	2	
Eremophila microtheca	4	
Eremophila occidens	2	
Eucalyptus arachnaea subsp. *arrecta*	3	
Eucalyptus beardiana	T	V
Eucalyptus cuprea	T	E
Frankenia confuse	2	
Gastrolobium hamulosum	T	E
Gastrolobium propinquum	3	
Geleznowia sp. Binnu (K.A. Shepherd & J. Wege KS 1301)	3	
Geleznowia sp. Red Bluff (A. Crawford ADC 597) PN	2	
Grevillea costata	3	
Grevillea leucoclada	3	
Grevillea rogersoniana	3	
Grevillea stenomera	2	
Guichenotia impudica	3	
Hemiandra sp. Kalbarri (D. Bellairs 1505)	2	
Hemigenia pimelifolia	2	
Hibbertia spicata subsp. *leptotheca*	3	
Hypocalymma angustifolium subsp. Hutt River (S. Patrick 2982)	T	?
Hypocalymma longifolium	T	V
Isopogon uncinatus	T	E
Jacksonia velutina	4	
Keraudrenia saxatilis	2	
Lasiopetalum oldfieldii subsp. *oldfieldii*	3	
Lasiopetalum oppositifolium	3	
Lechenaultia chlorantha	T	V
Lepidobolus densus	3	
Lepidosperma rupestre	4	
Leucopogon psammophilus	1	
Liparophyllum congestiflorum	4	
Macarthuria intricata	3	
Malleostemon sp. Hardabutt Rapids (D. Bellairs 1654A)	1	
Malleostemon sp. Kalbarri (L.A. Craven 7083)	2	
Malleostemon sp. Moonyoonooka (R.J. Cranfield 2947)	2	
Malleostemon sp. Yerina (S.J. Patrick 2728)	1	
Melaleuca boeophylla	2	
Melaleuca huttensis	1	
Melaleuca oldfieldii	2	
Microcorys tenuifolia	3	
Millotia jacksonii	2	
Mirbelia corallina	3	
Murchisonia fragrans	2	

Species	SCC	FCC
Paracaleana alcockii	2	
Parmeliopsis macrospora	3	
Persoonia brachystylis	2	
Philotheca kalbarriensis	2	
Physopsis chrysophylla	3	
Pileanthus aurantiacus	1	
Pileanthus bellus	3	
Pityrodia viscida	4	
Platysace sp. Kalbarri (D. & B. Bellairs 1383)	2	
Psilotum nudum	3	
Pterostylis sinuata	T	E
Scaevola kallophylla	4	
Scaevola oldfieldii	3	
Scaevola sp. Golden hairs (D. & B. Bellairs 1450 A)	1	
Schoenus sp. Kalbarri (K.R. Newbey 9352)	2	
Scholtzia sp. Ajana (T.A. Halliday 137)	3	
Scholtzia sp. Eradu (R.D. Royce 8016)	2	
Scholtzia sp. Eurardy (J.S. Beard 6886)	2	
Scholtzia sp. Folly Hill (M.E. Trudgen 12097)	2	
Scholtzia sp. Ross Graham Lookout (S. Maley 6)	2	
Scholtzia sp. Z-Bend (Bellairs-Kalflora 912a)	2	
Stachystemon nematophorus	T	V
Stenanthemum divaricatum	3	
Stylidium torticarpum	3	
Thryptomene johnsonii	2	
Thryptomene sp. Eagle Gorge (A.G. Gunness 2360)	2	
Thryptomene sp. Kalbarri limestone (D. & B. Bellairs 1652 A)	2	
Thryptomene sp. Wandana (M.E. Trudgen MET 22016)	3	
Thryptomene stenophylla	2	
Thryptomene striata	2	
Thysanotus sp. Kalbarri (D. & B. Bellairs 1523 A)	2	
Triodia bromoides	4	
Triodia dielsii	3	
Verticordia capillaris	4	
Verticordia dasystylis subsp. *kalbarriensis*	2	
Verticordia densiflora var. *roseostella*	3	
Verticordia dichroma var. *dichroma*	3	
Verticordia dichroma var. *syntoma*	3	
Verticordia galeata	2	
Verticordia polytricha	4	
Verticordia x eurardyensis	1	
Wurmbea tubulosa	T	E
Xanthoparmelia norpraegnans	2	

3.3 Flora Species

A total number of 151 plant taxa (including varieties and subspecies) from 54 families and 116 genera were recorded from the study area by Onshore Environmental during October 2013 (Appendix 5). Species representation was greatest among the Poaceae, Asteraceae, Fabaceae, Chenopodaceae and Myrtaceae families (Table 5).

Table 5 Statistics for total flora recorded from within the study area.

Parameter	No.
No. Families	54
No. Genera	116
No. Species (incl. subspecies and varieties)	151
No. Native Species (incl. subspecies and varieties)	127
Threatened Flora	0
Priority Flora	4
No. Introduced Species	24
Speciose Families	
Poaceae	16
Asteraceae	12
Fabaceae	12
Chenopodiaceae	10
Myrtaceae	9
Malvaceae	6
Goodeniaceae	5
Euphorbiaceae	4
Convolvulaceae	4
Amaranthaceae	4
Solanaceae	4
Speciose Genera	
Acacia (Fabaceae)	**5**
Melaleuca (Myrtaceae)	4
Ptilotus (Amarathaceae)	4
Amyema (Loranthaceae)	3
Eucalyptus (Mrytaceae)	3
Goodenia (Goodeniaceae)	3
Austrostipa (Poaceae)	3

3.4 Significant Flora

3.4.1 Threatened Flora

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

3.4.2 Priority Flora

There were four Priority flora taxa (as defined by DPaW) recorded from the study area (Figure 5, Appendix 6); *Melaleuca huttensis* (Priority 1), *Cryptandra glabriflora* (Priority 2), *Anthocercis intricata* (Priority 3) and *Beyeria cinerea* subsp. *cinerea* (Priority 3).

Melaleuca huttensis (Priority 1)

Melaleuca huttensis is an upright shrub to 3 m in height flowering white to grey cream-yellow between June and September (Plate 1). It has distinctive gnarled bark and occurs in light yellow or beige sand on lower slopes of undulating plains and on sandplains. It is restricted to the coastal strip of the Geradton Sandplains. Within the study area it was restricted to two points where plants occurred as scattered individuals approximating five plants per 100 m^2. Associated vegetation was described as Shrubland of *Rhagodia latifolia* var. *latifolia, Pimelea microcephala* and *Olearia* sp. indet. with High Open Shrubland of *Grevillea argyrophylla, Acacia rostellifera* and *Santalum spicatum* over Low Open Shrubland of *Melaleuca cardiophylla, Scholtzia* sp. Kalbarri (N. Hoyle 623) and *Diplopeltis petiolaris.*

Plate 1 *Melaleuca huttensis* **(Priority 1)** (photograph sourced from WAH)

Cryptandra glabriflora (Priority 2)

Cryptandra glabriflora is a low shrub reaching 0.5 m in height. It produces white or pink flowers between May to August and grows on gravelly soils on plains. Within the study area if was recorded at one location on a hillcrest. The vegetation association at this location was: Low Open Heath of *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Olearia* sp. indet *Acanthocarpus preissii* over Open Shrubland of *Olearia* sp. indet *Pimelea microcephala, Anthocercis intricata* over Scattered Tussock Grassland of *Austrostipa elegantissima* and *Austrostipa crinita.*

Anthocercis intricata (Priority 3)

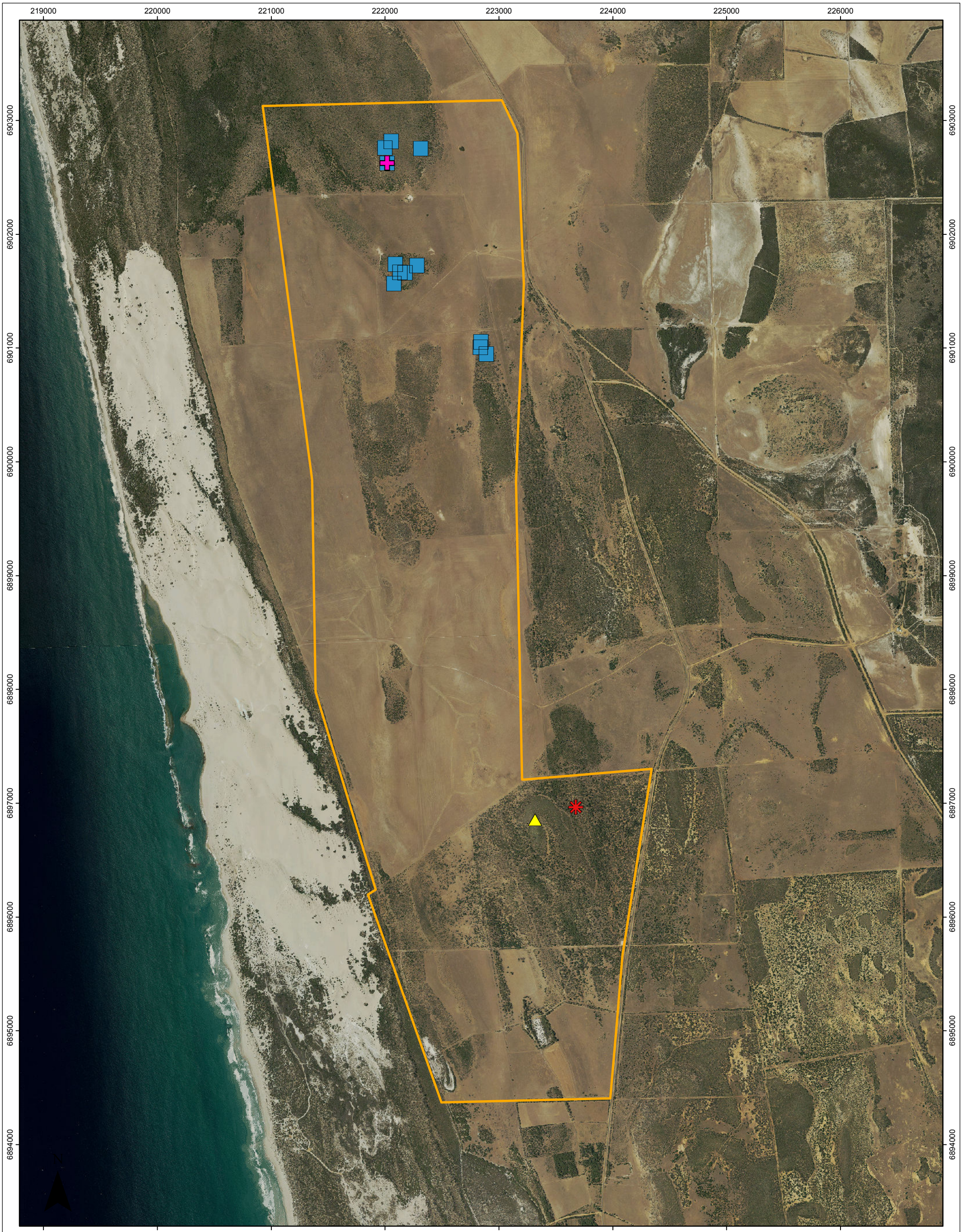
Anthocercis intricata is a dense spiny shrub reaching 3 m in height and flowering white or cream between June to September (Plate 2). It grows in sand or loam over limestone on consolidated sand dunes. Within the study area it was recorded at one location on a hillcrest. The vegetation association at this location was: Low Open Heath of *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Olearia* sp. indet *Acanthocarpus preissii* over Open Shrubland of *Olearia* sp. indet *Pimelea microcephala, Anthocercis intricata* over Scattered Tussock Grassland of *Austrostipa elegantissima* and *Austrostipa crinita.*

Plate 2 *Anthocercis intricata* **(Priority 3)** (photograph sourced from WAH)

Beyeria cinerea subsp. *cinerea* (Priority 3)

Beyeria cinerea subsp. *cinerea* is a prostrate, erect or spreading shrub reaching 0.5m in height (Plate 3). Flowers are green or yellow and appear from May to October. This species grows in grey/white or red sand on coastal limestones and dunes. Within the study area it was recorded at one location on a hillcrest. The vegetation association was: Low Closed Heath of *Melaleuca cardiophylla*, *Beyeria cinerea subsp. cinerea* over Very Open Herbs of **Brassica tournefortii* and **Lysimachia arvensis.*

Plate 3 *Beyeria cinerea* **subsp.** *cinerea* **(Priority 3)** (photograph sourced from WAH)



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BALLINE

SIGNIFICANT FLORA

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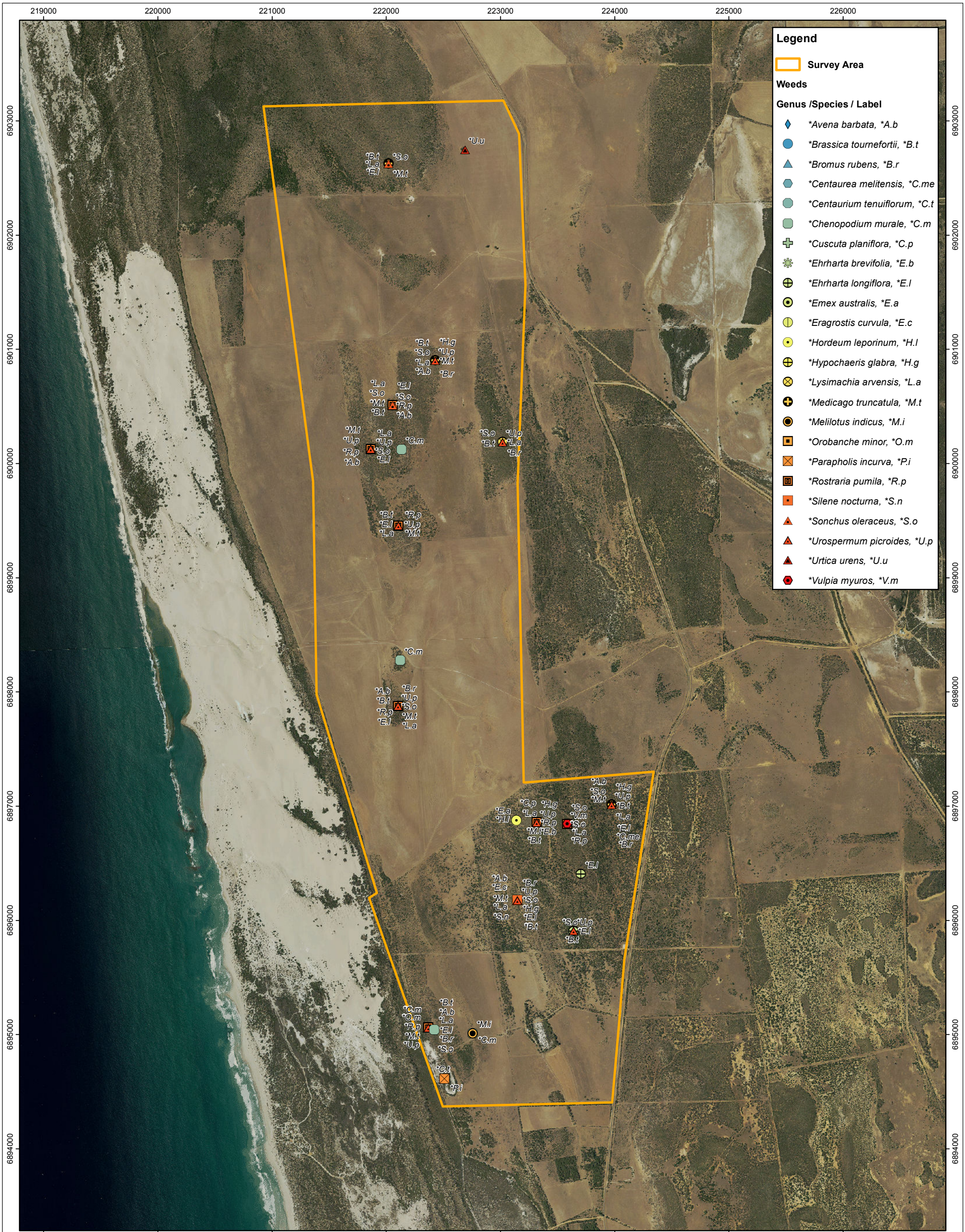
Legend

- Survey Area
- Significant Flora
- Genus/Species
  - ^*Anthocercis intricata*
  - ^*Beyeria cinerea* subsp *cinerea*
  - ^*Cryptandra glabriflora*
  - ^*Melaleuca huttensis*

3.5 Introduced Flora

There were 24 introduced (weed) species recorded from the study area; **Avena barbata, *Brassica tournefortii, *Bromus rubens, *Centaurea melitensis, *Centaurium tenuiflorum, *Chenopodium murale, *Cuscuta planiflora, *Ehrharta brevifolia* var. *cuspidata, *Ehrharta longiflora, *Emex australis, *Eragrostis curvula, *Hordeum leporinum, *Hypochaeris glabra, *Lysimachia arvensis, *Medicago truncatula, *Melilotus indicus, *Orobanche minor, *Parapholis incurva, *Rostraria pumila, *Silene nocturna, *Sonchus oleraceus, *Urospermum picroides, *Urtica urens* and **Vulpia myuros* (Figure 6, Appendix 7). None of the introduced species are listed as Declared Pests under the BAM Act.



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INTRODUCED FLORA

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Projection: MGA Zone 50

3.6 Threatened & Priority Ecological Communities

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

In addition to TECs, DPaW has generated a list of PECs occurring in the Mid-West region of Western Australia. The list identifies communities that require further investigation prior to nomination for TEC status. The following PECs were identified to occur within 90 km radius of the study area (Figure 7):

Kalbarri ironstone community (Priority 1)

This community consists of winter wet, mallees and *Melaleucas* over herbs. It forms a dense shrubland when burnt and is surrounded by areas of sandplains. It occurs at Yerina Springs, north Eurardy Station, Z-bend loop and Junga Dam. *Eremophila microtheca,* a Threatened Flora occurs in this community. It is located approximately 10 km to the south east of the study area.

Shrublands of the Northampton area, dominated by Melaleuca species over exposed Kockatea Shale (Priority 1)

The Kockatea Shale PEC occurs in Port Gregory, west of Northampton approximately 25 km south-east of the study area. It consists of heath on breakaways and contains several Priority flora taxa including *Ptilotus chortophytum* (P1), *Leucopogon* sp. Port Gregory, *Ozothamnus* sp. Northampton, *Gastrolobium propinquum* (P1) and *Ptilotus helichrysoides.* The geology of the area is unusual with outcropping of Kockatea Shale at the surface.

Plant assemblages of the Moresby Range system (Priority 1)

These plant assemblages include *Melaleuca megacephala* and *Hakea pycnoneura* thickets on stony slopes, *Verticordia* dominated low heath, and *Allocasuarina campestris* and *Melaleuca uncinata* thickets on superficial laterite. It occurs on the Morseby Range approximately 60 km to the south-east of the study area and is threatened by clearing for infrastructure.

Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs (Priority 1)

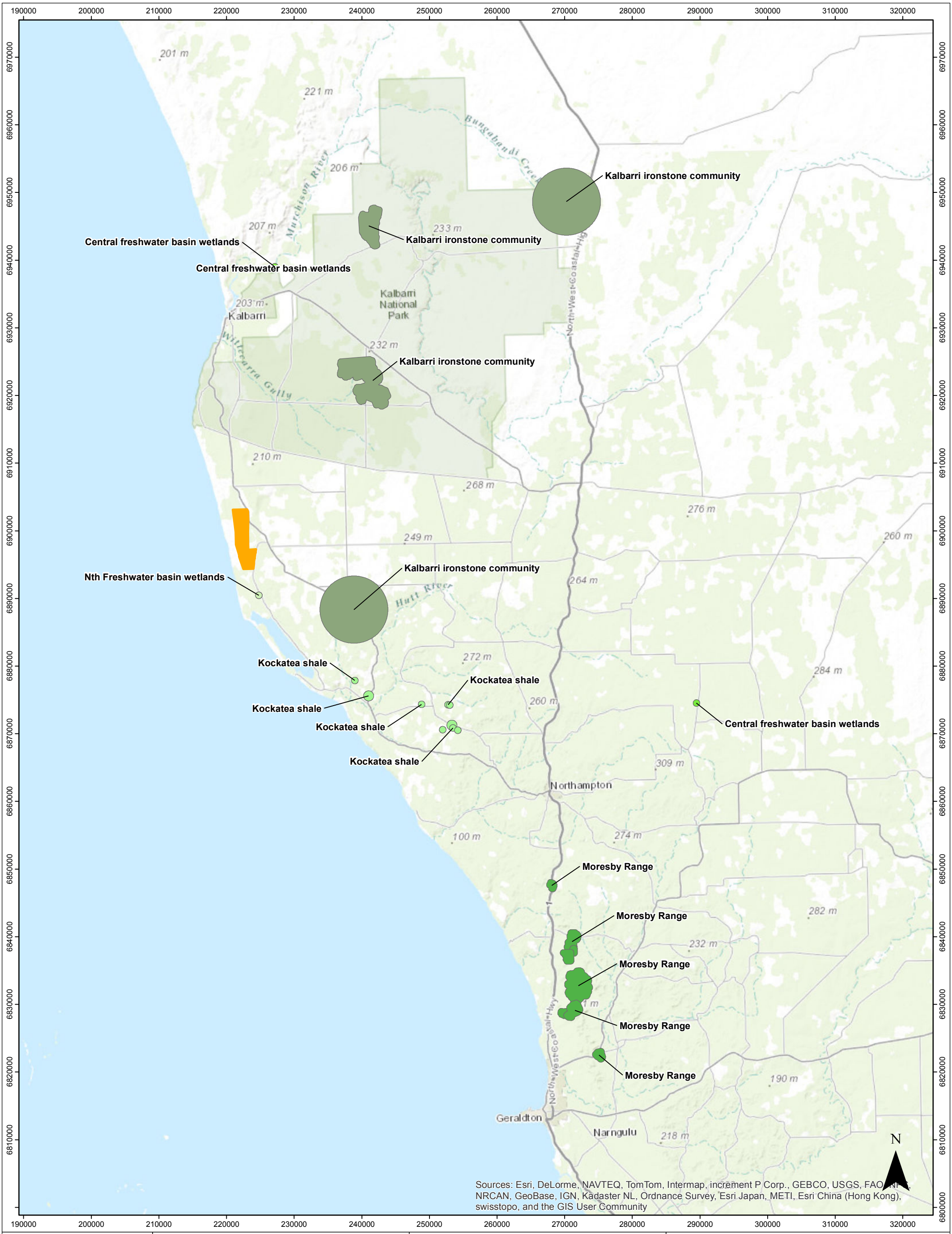
Claypans (predominantly basins) usually dominated by a shrubland of *Melaleuca lateritia* occurring both on the coastal plain and the adjacent plateau. These claypans are characterised by aquatic (*Hydrocotyle lemnoides* – Priority 4) and amphibious taxa (e.g. *Glossostigma diandrum, Villarsia capitata* and *Eleocharis keigheryi* - T). The community has previously been recorded approximately 5 km south of the study area with additional know locations to the north-east of Kalbarri.

None of the four PECs identified from the State communities database search occur within the study area, and none of the vegetation associations described and mapped from the study area have any affiliation with these PECs. However, Vegetation association 4 does have affiliations with a fifth PEC listed as occurring within the Mid-West region:

- Coastal sands dominated by *Acacia rostellifera, Eucalyptus oraria* and *Eucalyptus obtusiflora* (Priority 1).

Floristically, this community is similar to other *Acacia rostellifera* communities but is differentiated on structure, being dominated by mallee eucalypts. The community occurs on limestone ridges, in some swales in the coastal dunes

between Cape Burney and Dongara, on the Greenough Alluvial Flats on limestone soil and near Tarcoola Beach. Some very small occurrences have also been recorded on the limestone scarp north of the Buller River. Within the study area Vegetation association 4 is described as 'Mallee of *Eucalyptus fruticosa* and *Eucalyptus oraria* over Scattered High Shrubs of *Acacia rostellifera* and *Pittosporum ligustrifolium* over Scattered Low Shrubs of *Rhagodia latifolia* var. *latifolia*'. Vegetation is defined by the mallee cover which occurs on sandy hill slopes.



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KALBARRI

TEC / PEC SEARCH RESULTS

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Kilometers

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Legend

Survey Area

TEC / PEC Search Results

- Central freshwater basin wetlands
- Kalbarri ironstone community
- Kockatea shale
- Moresby Range
- Nth Freshwater basin wetlands

3.7 Vegetation

A total of 19 vegetation associations were described and mapped within the study area (Figure 8, Table 6). The vegetation associations were classified into sixteen Broad Floristic Formations on the basis of canopy structure. Raw data for the 15 study sites is provided as Appendix 8.

Table 6 Vegetation associations described and mapped from the study area by Onshore Environmental.

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Casuarina Low Open Forest	1	Low Open Forest of *Casuarina obesa* over Low Shrubland of *Atriplex amnicola, Sarcocornia blackiana* and *Dissocarpos paradoxus* over Very Open Tussock Grass of *Sporobolus virginicus*		Limestone clay loam flats in leeward side of white sand dunes	RB150, RB151, RB152	Very Good
Eucalyptus Low Woodland	2	Low Woodland of *Eucalyptus camaldulensis, Eucalyptus sargentii* and *Casuarina obesa* over High Open Shrubland of *Acacia rostellifera, Melaleuca viminea* subsp. *viminea* and *Acacia saligna* subsp. *saligna* over Scattered Low Shrubs of *Atriplex amnicola*		Planted and partly rehabilitated vegetation adjacent to exposed limestone	RB33, RB39	Degraded

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Casuarina Low Woodland	3	Low Woodland of *Casuarina obesa* over Low Open Shrubland of *Sarcocornia blackiana, Frankenia pauciflora* and *Dissocarpos paradoxus*		Limestone clay loam flats	B15	Very Good
Eucalyptus Mallee	4	Mallee of *Eucalyptus fruticosa* and *Eucalyptus oraria* over Scattered High Shrubs of *Acacia rostellifera* and *Pittosporum ligustrifolium* over Scattered Low Shrubs of *Rhagodia latifolia* var. *latifolia*		Sandy hill slopes	B13, RB95, RB137, RB138	Very Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Acacia Closed Scrub	5	Closed Scrub of *Acacia rostellifera* over Very Open Annual Tussock Grassland of **Ehrharta longiflora* over Scattered Herbs of **Sonchus oleraceus* and **Brassica tournefortii*		Sandy swales between broad dunes, lower hill slopes	B3, RB24, RB25, RB34	Very Good
Acacia High Shrubland	6a	High Shrubland to Open Scrub *Acacia rostellifera* over Open Annual Tussock Grassland of **Avena barbata, *Bromus rubens* and **Ehrharta longiflora* with Open Shrubland of *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala* and *Olearia* sp. indet.		Sandy hill slopes	B2, 4, 7, 10, 12	Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Acacia High Shrubland	6b	High Shrubland of *Acacia rostellifera* and *Alyogyne hakeifolia* over Open Annual Tussock Grassland of **Avena barbata,* and**Bromus rubens* over Open Herbland of **Brassica tournefortii* and **Medicago truncata*		Parkland cleared, sandy hill slopes	RB9,22,29	Degraded
Acacia High Shrubland	6c	High Shrubland of *Acacia rostellifera* over Open Shrubland of *Rhagodia latifolia* var. *latifolia, Olearia axillaris* and *Scaevola crassifolia* over Very Open Hummock Grassland of *Spinifex longifolius*		White sand dunes	RB88, RB90	Excellent

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Acacia High Shrubland	6d	High Shrubland of *Acacia rostellifera* over Shrubland *Olearia* sp. indet., *Pimelea microcephala* and *Zygophyllum fruticulosum* over Low Shrubland of *Acanthocarpos preissii, Pimelea sessilis* and *Solanum oldfieldii*		Sandy hill slopes	RB98, RB104	Very Good
Melaleuca High Shrubland	7	High Shrubland of *Melaleuca cardiophylla* over Shrubland of *Diplolaena grandiflora, Rhagodia latifolia* var. *latifolia* and *Pimelea microcephala* over Very Open Herbs of **Brassica tournefortii*		Limestone hill crest (with boulders)	B8, RB82, RB124	Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Grevillea High Shrubland	8	High Shrubland of *Grevillea argyrophylla, Acacia rostellifera* and *Melaleuca cardiophylla* over Shrubland of *Pittosporum ligustrifolium, Rhagodia latifolia* var. *latifolia* and *Zygophyllum fruticulosum* over Open Climbers of *Clematicissus angustissimus, Tetragonia implexicoma* and *Dioscorea hastifolia*		Sandplain (brown sands) in lee of white sand dunes	RB40, RB87	Very Good
Melaleuca Open Heath	9	Open Heath of *Melaleuca cardiophylla* and *Olearia* sp. indet. over Low Shrubland of *Comesperma scoparium*, *Scholtzia* sp. Kalbarri (N. Hoyle 623), and *Acanthocarpos preissii* over Very Open Herbland of **Medicago truncata, *Brassica tournefortii* and **Lysimachia avensis*		Limestone hill crest and slopes	B11, RB71, RB108	Very Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Olearia Open Heath	10	Open Heath of *Olearia* sp. indet. with High Open Shrubland of *Acacia rostellifera* over Low Open Shrubland of *Acanthocarpos preissii* and *Solanum oldfieldii*		Sandy hill slopes and swales (orange sands)	B6	Very Good
Pimelea Shrubland	11	Shrubland of *Pimelea microcephala, Olearia* sp. indet. and *Quoya loxocarpa* over Low Shrubland of *Quoya loxocarpa, Zygophyllum fruticulosum* and *Tricoryne elatior* over Open Annual Tussock Grassland of **Avena barbata, *Bromus rubens* and ** Ehrharta longiflora*		Sandplain (orange sands)	B5	Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Rhagodia Shrubland	12	Shrubland of *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala* and *Olearia* sp. indet. with High Open Shrubland of *Grevillea argyrophylla, Acacia rostellifera* and *Santalum spicatum* over Low Open Shrubland of *Melaleuca cardiophylla, Scholtzia* sp. Kalbarri (N. Hoyle 623) and *Diplopeltis petiolaris*		Mid to lower limestone hill slopes	B14, RB134, RB141, RB145	Very Good
Melaleuca Low Closed Heath	13	Low Closed Heath of *Melaleuca cardiophylla, Melaleuca campanae* and *Cryptandra arbutiflora* over Very Open Herbs of **Brassica tournefortii* and **Lysimachia arvensis*		Limestone hill crest (unbroken ridge)	B1	Very Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
Scholtzia Low Open Heath	14	Low Open Heath of *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Comesperma scoparium* and *Acanthocarpos preissii* with Open Shrubland of *Olearia* sp. indet., *Acacia rostellifera* and *Pimelea microcephala* over Scattered Tussock Grass of *Austrostipa crinita*		Limestone hill crest and slopes	B9, RB103	Very Good
Sarcocornia Low Shrubland	15	Low Shrubland of *Sarcocornia blackiana* and *Frankenia pauciflora* with Scattered Low Trees of *Casuarina obesa*		Lower parts of limestone clay loam flats	RB41, RB149	Very Good

BFF	Code	Final Vegetation Description	Photograph	Landform	Sites/ releves	Condition
*Avena Annual Tussock Grassland	16	Annual Tussock Grassland of **Avena barbata* and**Bromus rubens* over Open Herbland of **Brassica tournefortii* and **Medicago truncata* with Scattered High Shrubs of *Acacia rostellifera*		Sandy hill slopes	RB35,81	Completely Degraded

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VEGETATION MAPPING

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Meters

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Projection: MGA Zone 50

Legend

Survey Area

Vegetation Mapping

***Casuarina* Low Open Forest**

1 — Low Open Forest of *Casuarina obesa* over Low Shrubland of *Atriplex amnicola*, *Sarcocornia blackiana*, *Dissocarpos paradoxus* over Very Open Tussock Grass of *Sporobolus virginicus*

***Eucalyptus* Low Woodland**

2 — Low Woodland of *Eucalyptus camaldulensis*, *Eucalyptus sargentii*, *Casuarina obesa* over High Open Shrubland of *Acacia rostellifera*, *Melaleuca vimineaa* subsp. *vimineaa*, *Acacia saligna* subsp. *saligna* over Scattered Low Shrubs of *Atriplex amnicola*

***Casuarina* Low Woodland**

3 — Low Woodland of *Casuarina obesa* over Low Open Shrubland of *Sarcocornia blackiana*, *Frankenia pauciflora*, *Dissocarpos paradoxus*

***Eucalyptus* Mallee**

4 — Mallee of *Eucalyptus fruticosa*, *Eucalyptus oraria* over Scattered High Shrubs of *Acacia rostellifera*, *Pittosporum ligustrifolium* over Scattered Low Shrubs of *Rhagodia latifolia* var. *latifolia*

***Acacia*Closed Scrub**

5 — Closed Scrub of *Acacia rostellifera* over Very Open Annual Tussock Grassland of **Ehrharta longiflora* over Scattered Herbs of **Sonchus oleraceus*, **Brassica tournefortii*

***Acacia* High Shrubland**

6a — High Shrubland to Open Scrub *Acacia rostellifera* over Open Annual Tussock Grassland of **Avena barbata*, **Bromus rubens*, **Ehrharta longiflora* with Open Shrubland of *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala*, *Olearia* sp. *indet.*

6b — High Shrubland of *Acacia rostellifera*, *Alyogyne hakeifolia* over Open Annual Tussock Grassland of **Avena barbata*, **Bromus rubens* over Open Herbland of **Brassica tournefortii*, **Medicago truncata*

6c — High Shrubland of *Acacia rostellifera* over Open Shrubland of *Rhagodia latifolia* var. *latifolia*, *Olearia axillaris*, *Scaevola crassifolia* overVery Open Hummock Grassland of *Spinifex longifolius*

6d — High Shrubland of *Acacia rostellifera* over Shrubland *Olearia* sp. *indet.*, *Pimelea microcephala*, *Zygophyllum fruticulosum* over Low Shrubland of *Acanthocarpos preissii*, *Pimelea sessilis*, *Solanum oldfieldii*

***Melaleuca* High Shrubland**

7 — High Shrubland of *Melaleuca cardiophylla* over Shrubland of *Diplolaena grandiflora*, *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala* over Very Open Herbs of **Brassica tournefortii*

***Grevillea* High Shrubland**

8 — High Shrubland of *Grevillea argyrophylla*, *Acacia rostellifera*, *Melaleuca cardiophylla* over Shrubland of *Pittosporum ligustrifolium*, *Rhagodia latifolia* var. *latifolia*, *Zygophyllum fruticulosum* over Open Climbers of *Clematicissus angustissimus*, *Tetragona implexa*, *Dioscorea hastifolia*

***Melaleuca* Open Heath**

9 — Open Heath of *Melaleuca cardiophylla*, *Olearia* sp. *indet.* over Low Shrubland of *Comesperma scoparium*, *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Acanthocarpos preissii* over Very Open Herbland of **Medicago truncata*, **Brassica tournefortii*, **Anagallis avensis*

***Olearia* Open Heath**

10 — Open Heath of *Olearia* sp. *indet.* with High Open Shrubland of *Acacia rostellifera* over Low Open Shrubland of *Acanthocarpos preissii*, *Solanum oldfieldii*

***Pimelea* Shrubland**

11 — Shrubland of *Pimelea microcephala*, *Olearia* sp. *indet.*, *Quoya loxocarpa* over Low Shrubland of *Quoya loxocarpa*, *Zygophyllum fruticulosum*, *Tricoryne elatoir* over Open Annual Tussock Grassland of **Avena barbata*, **Bromus rubens*, * *Ehrharta longiflora*

***Rhagodia* Shrubland**

12 — Shrubland of *Rhagodia latifolia* var. *latifolia*, *Pimelea microcephala*, *Olearia* sp. *indet.* with High Open Shrubland of *Grevillea argyrophylla*, *Acacia rostellifera*, *Santalum spicatum* over Low Open Shrubland of *Melaleuca cardiophylla*, *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Diplopeltis petiolaris*

***Melaleuca* Low Closed Heath**

13 — Low Closed Heath of *Melaleuca cardiophylla*, *Melaleuca campanae*, *Cryptandra arbutiflora* over Very Open Herbs of **Brassica tournefortii*, **Anagallis arvensis*

***Scholtzia* Low Open Heath**

14 — Low Open Heath of *Scholtzia* sp. Kalbarri (N. Hoyle 623), *Comesperma scoparium*, *Acanthocarpos preissii* with Open Shrubland of *Olearia* sp. *indet*., *Acacia rostellifera*, *Pimelea microcephala* over Scattered Tussock Grass of *Austrostipa crinita*

***Sarcocornia* Low Shrubland**

15 — Low Shrubland of *Sarcocornia blackiana*, *Frankenia pauciflora* with Scattered Low Trees of *Casuarina obesa*

***Avena* Annual Tussock**

16 — Annual Tussock Grassland of **Avena barbata*, **Bromus rubens* over Open Herbland of **Brassica tournefortii*, **Medicago truncata* with Scattered High Shrubs of *Acacia rostellifera*

Cleared

Cleared Areas

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KALBARRI

VEGETATION MAPPING LEGEND

ONSHORE ENVIRONMENTAL

ONSHORE ENVIRONMENTAL CONSULTANTS		Date:	21/11/2013
Sheet Size:	A3	Status:	Draft
Drawn by GSM	Requested by DB	Internal Reference Kalbarri_Vegmap_Legend_20131114	

LEGEND

3.8 Vegetation Condition

Vegetation condition within the study area ranged from excellent to completely degraded, with the largest proportion of the area having been historically cleared for agriculture and mapped as completely degraded (Figure 9). The larger area of remnant vegetation was rated as good, with smaller sectors rated as very good or degraded. Very small areas of vegetation situated along the western border of the study area were rated as excellent; these extended onto sand dunes further west and outside the study area. The major disturbances recorded within the study area were related to historical agriculture, specifically clearing of native vegetation, establishment of annual pasture and seasonal crops, grazing by domestic stock, and introduction of weeds and feral animals such as rabbits. There were established access tracks throughout a majority of the study area and remnant vegetation was typically long unburnt (> 10 years) with some of the stands in a senescent phase.

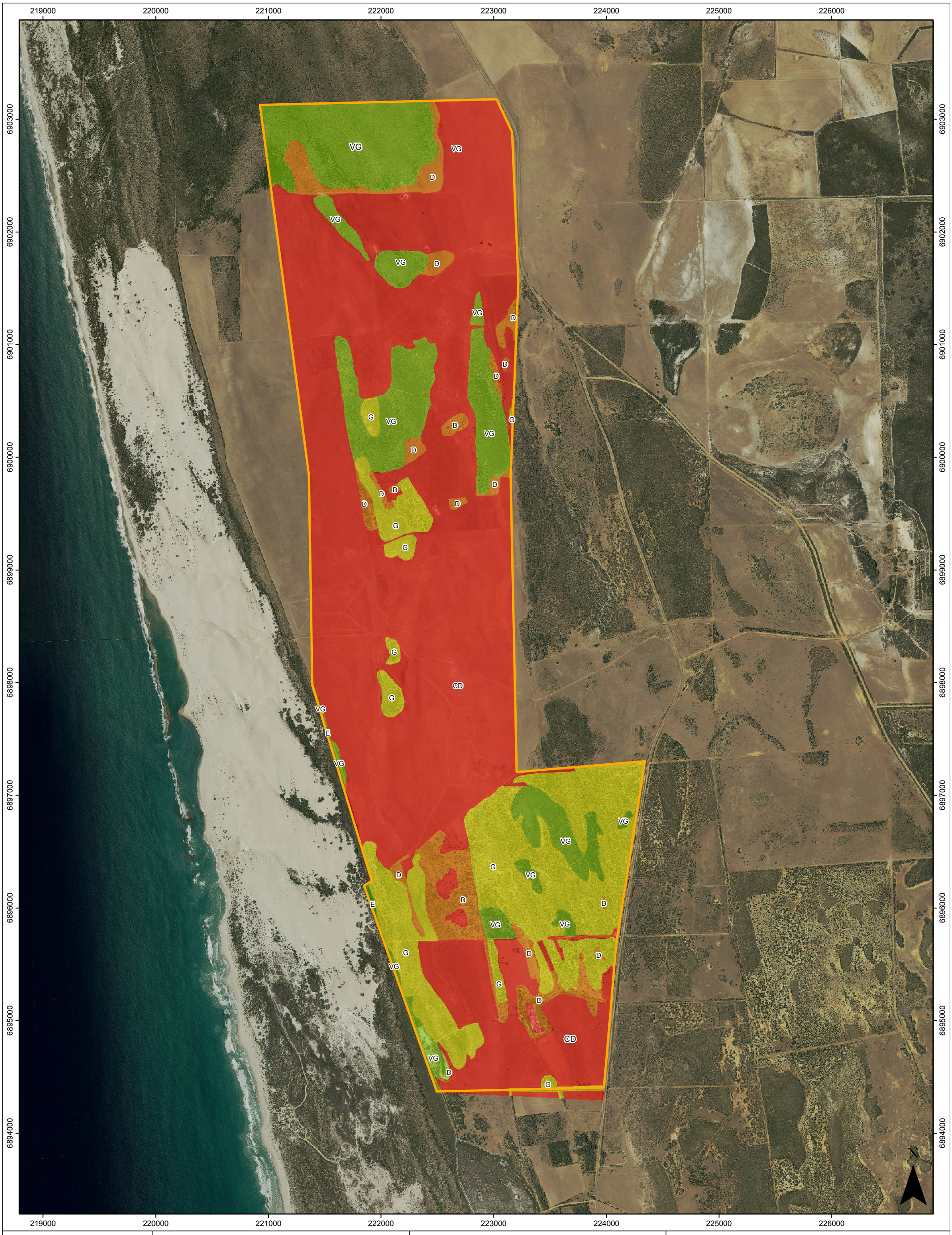
3.9 Groundwater Dependence of Vegetation

The majority of vegetation recorded within the study area occurs on undulating low hills and ridges comprising limestone and sand. Associated vegetation is dominated by xerophytic plant taxa that have no reliance of groundwater to survive.

There are four localised vegetation associations restricted to the south-western corner of the study area where seasonal interaction between groundwater and vegetation is likely to be occurring (Figure 8):

- Vegetation association 1 - Low Open Forest of *Casuarina obesa* over Low Shrubland of *Atriplex amnicola, Sarcocornia blackiana* and *Dissocarpos paradoxus* over Very Open Tussock Grass of *Sporobolus virginicus* on limestone clay loam flats in leeward side of white sand dunes;
- Vegetation association 2 - Low Woodland of *Eucalyptus camaldulensis, Eucalyptus sargentii* and *Casuarina obesa* over High Open Shrubland of *Acacia rostellifera, Melaleuca viminea* subsp. *viminea* and *Acacia saligna* subsp. *saligna* over Scattered Low Shrubs of *Atriplex amnicola* occurring as planted and partly rehabilitated vegetation adjacent to exposed limestone;
- Vegetation association 3 - Low Woodland of *Casuarina obesa* over Low Open Shrubland of *Sarcocornia blackiana, Frankenia pauciflora* and *Dissocarpos paradoxus* on limestone clay loam flats; and
- Vegetation association 15 - Low Shrubland of *Sarcocornia blackiana* and *Frankenia pauciflora* with Scattered Low Trees of *Casuarina obesa* on lower parts of limestone clay loam flats.

Vegetation associations 1, 2, 3 and 15 occur on exposed limestone clay loam flats situated at the lowest position in the landscape, close to the coastline in the south-west sector of the study area, and where depth to groundwater is at its shallowest. Data from site monitoring bores confirms groundwater depth approximates 4m to 7m in the south-west, increasing to 20m to 40m at central and northern sectors of the study area. Species composition of the four vegetation associations is characterised by halophytic plant taxa that are known to tolerate elevated soil salinity and interaction with brackish water at least seasonally. Given the salinity of groundwater from monitoring bores closest to coast and at the very top of the water table is in the range 4,000 – 7,000 mg/L TDS, it is likely that Vegetation associations 1, 2, 3 and 15 have interaction with this groundwater at least seasonally during the year.



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BALLINE

VEGETATION CONDITION

0 250 500 750 1,000
Meters

1:30,000

Datum: GDA94
Projection: MGA Zone 50

ONSHORE ENVIRONMENTAL

ONSHORE ENVIRONMENTAL CONSULTANTS		Date:	09/12/2013
Sheet Size:	A3	Status:	Draft
Drawn by GSM	Requested by DB	Internal Reference Kalbarri_Vegcond20131114	

Legend

Survey Area

Vegetation Mapping

- Completely Degraded
- Degraded
- Good
- Very Good
- Excellent

4.0 Summary

A total number of 151 plant taxa (including varieties and subspecies) from 54 families and 116 genera were recorded from the study area by Onshore Environmental during October 2013. Species representation was greatest among the Poaceae, Asteraceae, Fabaceae, Chenopodaceae and Myrtaceae families.

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

There were four Priority flora taxa (as defined by DPaW) recorded from the study area; *Melaleuca huttensis* (Priority 1), *Cryptandra glabriflora* (Priority 2), *Anthocercis intricata* (Priority 3) and *Beyeria cinerea* subsp. *cinerea* (Priority 3).

There were 24 introduced (weed) species recorded from the study area. None of the weeds are listed as Declared Pests under the BAM Act.

Vegetation within the study area was described and mapped as 19 vegetation associations. The vegetation associations were classified into sixteen Broad Floristic Formations on the basis of canopy structure.

None of the vegetation associations from the study area were affiliated with any Commonwealth listed TECs. However, Vegetation association 4 does show similarities to the State listed PEC 'Coastal sands dominated by *Acacia rostellifera, Eucalyptus oraria* and *Eucalyptus obtusiflora* (Priority 1)'.

A large proportion of the study area has been historically cleared for agriculture and vegetation condition was subsequently mapped as completely degraded. The larger area of remnant vegetation was rated as good, with smaller sections rated as very good or degraded. The major disturbances recorded within the study area were related to historical agriculture, specifically clearing of native vegetation, establishment of annual pasture and seasonal crops, grazing by domestic stock, and introduction of weeds and feral animals such as rabbits.

The majority of vegetation recorded within the study area occurs on undulating low hills and ridges comprising limestone and sand. Associated vegetation is dominated by xerophytic plant taxa that have no reliance of groundwater to survive. Vegetation associations 1, 2, 3 and 15 occur on exposed limestone clay loam flats situated at the lowest position in the landscape, close to the coastline in the south-west sector of the study area, and where depth to groundwater is at its shallowest. Given the salinity of groundwater from monitoring bores closest to coast and at the very top of the water table is in the range 4,000 – 7,000 mg/L TDS, it is likely that Vegetation associations 1, 2, 3 and 15 have interaction with this groundwater at least seasonally during the year.

Currently, flora and vegetation values of significance within the study area include the four Priority flora taxa; *Melaleuca huttensis* (Priority 1), *Cryptandra glabriflora* (Priority 2), *Anthocercis intricata* (Priority 3) and *Beyeria cinerea* subsp. *cinerea* (Priority 3), as well as Vegetation association 4 which is closely affiliated with a State listed PEC.

5.0 References

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APPENDIX 1

Vegetation Classifications for the study area based on Specht (1970), as modified by Aplin (1979)

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

APPENDIX 2

Vegetation condition scale (as developed by Keighery 1994)

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

APPENDIX 3

Conservation categories for flora described
under the EPBC Act and Conservation Codes for Western Australian Flora

Conservation Categories under the EPBC Act

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

Conservation Codes for Western Australian Flora Priority Flora list.

R: Declared Rare Flora - Extant Taxa
Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
1: Priority One - Poorly Known Taxa
Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2: Priority Two - Poorly Known Taxa
Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
3: Priority Three - Poorly Known Taxa
Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4: Priority Four - Rare, Near Threatened and other taxa in need of monitoring
(a) **Rare.** Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. (b) **Near Threatened**. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5: Priority Five - Conservation Dependent taxa
Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

APPENDIX 4

Department of Parks and Wildlife,
Western Australian Wildlife Conservation Act and Environment and Protection and Biodiversity Conservation Act Categories of Conservation.

Categories used in the assessment of conservation status. IUCN categories (based on review by Mace and Stuart 1994) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act 1950.

Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act 1950.

Category	Definition
Schedule 1	Rare and Likely to become Extinct
Schedule 2	Extinct
Schedule 3	Migratory species listed under international treaties
Schedule 4	Other Specially Protected Fauna

WA Department of Parks and Wildlife Priority species (species not listed under the Conservation Act, but for which there is some concern).

Category	Definition
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	Taxa in need of monitoring. 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.
Priority 5	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

APPENDIX 5

Total flora list from the study area

GENUS	SPECIES	SUBSP./VAR.	CONS. CODE
Carpobrotus	*virescens*		
Tetragonia	*implexicoma*		
Ptilotus	*divaricatus*		
Ptilotus	*eriotrichus*		
Ptilotus	*gaudichaudii*	subsp. *eremita*	
Ptilotus	*humilis*		
Aphanopetalum	*clematideum*		
Acanthocarpus	*preissii*		
Lomandra	*maritima*		
Thysanotus	*manglesianus*		
**Centaurea*	*melitensis*		
**Hypochaeris*	*glabra*		
**Sonchus*	*oleraceus*		
**Urospermum*	*picroides*		
Brachyscome	*ciliocarpa*		
Calocephalus	*francisii*		
Olearia	*axillaris*		
Olearia	*sp. indet*		
Podotheca	*gnaphalioides*		
Schoenia	*cassiniana*		
Senecio	*pinnatifolius*	var. *latilobus*	
Waitzia	*suaveleons*		
**Brassica*	*tournefortii*		
**Silene*	*nocturna*		
Casuarina	*obesa*		
**Chenopodium*	*murale*		
Atriplex	*amnicola*		
Chenopodium	*gaudichaudii*		
Dysphania	*melanocarpa*		
Rhagodia	*latifolia*	var. *latifolia*	
Rhagodia	sp. Watheroo (R.J. Cranfield & P.J. Spencer 8183)		
Salsola	*australis*		
Sarcocornia	*blackiana*		
Tecticornia	*halocnemoides*		
Threlkeldia	*diffusa*		
**Cuscuta*	*planiflora*		
Convolvulus	*angustissimus*	subsp. *angustissimus*	
Convolvulus	*remotus*		
Opercularia	*spermacocea*		
Gahnia	*trifida*		
Lepidosperma	*costale*		
Hibbertia	*spicata*	subsp. *spicata*	
Dioscorea	*hastifolia*		
^*Beyeria*	*cinerea*	subsp. *cinerea*	Priority 3
Euphorbia	*sharkoensis*		
Euphorbia	*tannensis*	subsp. *eremophila*	
Monotaxis	*bracteata*		
**Medicago*	*truncatula*		
**Melilotus*	*indicus*		

GENUS	SPECIES	SUBSP./VAR.	CONS. CODE
Acacia	*idiomorpha*		
Acacia	*leptospermoides*		
Acacia	*rostellifera*		
Acacia	*saligna*	subsp. *saligna*	
Acacia	*spathulifolia*		
Dillwynia	*pungens*		
Glycine	*canescens*		
Mirbelia	sp. Bursarioides (T.R. Lally 760)		
Senna	*glutinosa*	subsp. *chatelainiana*	
Templetonia	*retusa*		
Frankenia	*pauciflora*		
**Centaurium*	*tenuiflorum*		
Erodium	*cygnorum*		
Goodenia	*berardiana*		
Lechenaultia	*linarioides*		
Scaevola	*anchusifolia*		
Scaevola	*crassifolia*		
Scaevola	*tomentosa*		
Gyrostemon	*racemiger*		
Gyrostemon	*ramulosus*		
Tricoryne	*elatoir*		
Juncus	*kraussii*	subsp. *australiensis*	
Triglochin	*mucronata*		
Quoya	*loxocarpa*		
Cassytha	*aurea*	var. *hirta*	
Cassytha	*racemosa*	forma *racemosa*	
Amyema	*linophylla*		
Amyema	*miraculosa*	subsp. *boormanii*	
Amyema	*miraculosa*	subsp. *miraculosa*	
Alyogyne	*hakeifolia*		
Androcalva	*gaudichaudii*		
Guichenotia	*intermedia*		
Guichenotia	*ledifolia*		
Hannafordia	*quadrivalvis*		
Lasiopetalum	*angustifolium*		
^*Melaleuca*	*huttensis*		Priority 1
Eucalyptus	*oraria*		
Eucalyptus	*fruticosa*		
Eucalyptus	*sargentii*		
Melaleuca	*campanae*		
Melaleuca	*cardiophylla*		
Melaleuca	*lanceolata*		
Melaleuca	*viminea*	subsp. *viminea*	
Scholtzia	sp. Kalbarri (N. Hoyle 623)		
Nitraria	*billardierei*		
Commicarpus	*australis*		
Jasminum	*calcareum*		
**Orobanche*	*minor*		
Phyllanthus	*calycinus*		

GENUS	SPECIES	SUBSP./VAR.	CONS. CODE
Phyllanthus	*scaber*		
Pittosporum	*ligustrifolium*		
**Avena*	*barbata*		
**Bromus*	*rubens*		
**Ehrharta*	*brevifolia*	var. *cuspidata*	
**Ehrharta*	*longiflora*		
**Eragrostis*	*curvula*		
**Hordeum*	*leporinum*		
**Parapholis*	*incurva*		
**Rostraria*	*pumila*		
**Vulpia*	*myuros*		
Austrostipa	*crinita*		
Austrostipa	*elegantissima*		
Austrostipa	*nitida*		
Bromus	*arenarius*		
Paspalidium	*reflexum*		
Rytidosperma	*caespitosum*		
Sporobolus	*virginicus*		
Comesperma	*integerrimum*		
Comesperma	*scoparium*		
**Emex*	*australis*		
Muehlenbeckia	*adpressa*		
Calandrinia	*liniflora*		
Calandrinia	*polyandra*		
**Lysimachia*	*arvensis*		
Samolus	*repens*	var. *paucifolius*	
Grevillea	*argyrophylla*		
Grevillea	*commutata*		
Clematis	*linearifolia*		
Desmocladus	*asper*		
^*Cryptandra*	*glabriflora*		Priority 2
Cryptandra	*arbutiflora*		
Diplolaena	*grandiflora*		
Diplolaena	*mollis*		
Exocarpos	*sparteus*		
Santalum	*spicatum*		
Diplopeltis	*petiolaris*		
Dodonaea	*aptera*		
Eremophila	*decipiens*	subsp. *decipiens*	
Myoporum	*insulare*		
^*Anthocercis*	*intricata*		Priority 3
Anthocercis	*ilicifolia*	subsp. *caldariola*	
Nicotiana	*rotundifolia*		
Solanum	*oldfieldii*		
Stylobasium	*spathulatum*		
Pimelea	*microcephala*		
Pimelea	*sessilis*		
**Urtica*	*urens*		
Parietaria	*cardiostegia*		

GENUS	SPECIES	SUBSP./VAR.	CONS. CODE
Hybanthus	*floribundus*	subsp. *floribundus*	
Clematicissus	*angustissima*		
Zygophyllum	*fruticulosum*		
Zygophyllum	*simile*		

APPENDIX 6

Records of conservation significant flora
from the study area

Easting (GDA94)	Northing (GDA94)	Genus	Species	subsp. / var.	Conservation Code
222019.0	6902626	^*Anthocercis*	*intricata*		Priority 3
222176.5	6901662	^*Anthocercis*	*intricata*		Priority 3
222281.7	6901727	^*Anthocercis*	*intricata*		Priority 3
222089.4	6901738	^*Anthocercis*	*intricata*		Priority 3
222130.4	6901666	^*Anthocercis*	*intricata*		Priority 3
222078.6	6901567	^*Anthocercis*	*intricata*		Priority 3
222843.6	6901054	^*Anthocercis*	*intricata*		Priority 3
222892.0	6900948	^*Anthocercis*	*intricata*		Priority 3
222838.1	6901010	^*Anthocercis*	*intricata*		Priority 3
222315.3	6902756	^*Anthocercis*	*intricata*		Priority 3
222000.1	6902760	^*Anthocercis*	*intricata*		Priority 3
222056.2	6902818	^*Anthocercis*	*intricata*		Priority 3
223317.0	6896858	^*Beyeria*	*cinerea*	subsp. *cinerea*	Priority 3
225770.6	6792407	^*Beyeria*	*cinerea*	subsp. *cinerea*	Priority 3
222019.0	6902625	^*Cryptandra*	*glabriflora*		Priority 2
216226.6	6896440	^*Melaleuca*	*huttensis*		Priority 1
223676.8	6896966	^*Melaleuca*	*huttensis*		Priority 1

APPENDIX 7

Records for introduced weed species recorded from the study area

Latitude/Easting (GDA94)	Longitude/Northing (GDA94)	Genus	Species	Subsp/Var
222509	6894616	**Centaurium*	*tenuiflorum*	
222509	6894616	**Parapholis*	*incurva*	
222367	6895061	**Avena*	*barbata*	
222367	6895061	**Brassica*	*tournefortii*	
222367	6895061	**Bromus*	*rubens*	
222367	6895061	**Ehrharta*	*longiflora*	
222367	6895061	**Lysimachia*	*arvensis*	
222367	6895061	**Medicago*	*truncatula*	
222367	6895061	**Orobanche*	*minor*	
222367	6895061	**Rostraria*	*pumila*	
222367	6895061	**Sonchus*	*oleraceus*	
222367	6895061	**Urospermum*	*picroides*	
223641	6895909	**Brassica*	*tournefortii*	
223641	6895909	**Ehrharta*	*longiflora*	
223641	6895909	**Sonchus*	*oleraceus*	
223641	6895909	**Urospermum*	*picroides*	
223148	6896178	**Avena*	*barbata*	
223148	6896178	**Brassica*	*tournefortii*	
223148	6896178	**Bromus*	*rubens*	
223148	6896178	**Bromus*	*rubens*	
223148	6896178	**Ehrharta*	*longiflora*	
223148	6896178	**Eragrostis*	*curvula*	
223148	6896178	**Hypochaeris*	*glabra*	
223148	6896178	**Lysimachia*	*arvensis*	
223148	6896178	**Medicago*	*truncatula*	
223148	6896178	**Silene*	*nocturna*	
223148	6896178	**Sonchus*	*oleraceus*	
223148	6896178	**Urospermum*	*picroides*	
223148	6896178	**Urospermum*	*picroides*	
223705	6896406	**Ehrharta*	*longiflora*	
223584	6896845	**Lysimachia*	*arvensis*	
223584	6896845	**Rostraria*	*pumila*	
223584	6896845	**Sonchus*	*oleraceus*	
223584	6896845	**Sonchus*	*oleraceus*	
223584	6896845	**Vulpia*	*myuros*	
223317	6896858	**Brassica*	*tournefortii*	
223317	6896858	**Cuscuta*	*planiflora*	
223317	6896858	**Ehrharta*	*brevifolia*	var. *cuspidata*
223317	6896858	**Hypochaeris*	*glabra*	
223317	6896858	**Lysimachia*	*arvensis*	
223317	6896858	**Medicago*	*truncatula*	
223317	6896858	**Rostraria*	*pumila*	
223317	6896858	**Urospermum*	*picroides*	
223973	6897014	**Avena*	*barbata*	
223973	6897014	**Brassica*	*tournefortii*	
223973	6897014	**Bromus*	*rubens*	
223973	6897014	**Centaurea*	*melitensis*	
223973	6897014	**Ehrharta*	*longiflora*	
223973	6897014	**Hypochaeris*	*glabra*	

Latitude/Easting (GDA94)	Longitude/Northing (GDA94)	Genus	Species	Subsp/Var
223973	6897014	*Lysimachia	arvensis	
223973	6897014	*Medicago	truncatula	
223973	6897014	*Sonchus	oleraceus	
223973	6897014	*Sonchus	oleraceus	
223973	6897014	*Urospermum	picroides	
223973	6897014	*Urospermum	picroides	
222104	6897876	*Avena	barbata	
222104	6897876	*Brassica	tournefortii	
222104	6897876	*Bromus	rubens	
222104	6897876	*Ehrharta	longiflora	
222104	6897876	*Lysimachia	arvensis	
222104	6897876	*Medicago	truncatula	
222104	6897876	*Rostraria	pumila	
222104	6897876	*Sonchus	oleraceus	
222104	6897876	*Urospermum	picroides	
222104	6897876	*Urospermum	picroides	
222105	6899457	*Brassica	tournefortii	
222105	6899457	*Ehrharta	longiflora	
222105	6899457	*Lysimachia	arvensis	
222105	6899457	*Medicago	truncatula	
222105	6899457	*Rostraria	pumila	
222105	6899457	*Urospermum	picroides	
221864	6900129	*Avena	barbata	
221864	6900129	*Ehrharta	longiflora	
221864	6900129	*Lysimachia	arvensis	
221864	6900129	*Medicago	truncatula	
221864	6900129	*Rostraria	pumila	
221864	6900129	*Sonchus	oleraceus	
221864	6900129	*Urospermum	picroides	
221864	6900129	*Urospermum	picroides	
223019	6900189	*Brassica	tournefortii	
223019	6900189	*Bromus	rubens	
223019	6900189	*Lysimachia	arvensis	
223019	6900189	*Sonchus	oleraceus	
223019	6900189	*Urospermum	picroides	
222054	6900511	*Avena	barbata	
222054	6900511	*Brassica	tournefortii	
222054	6900511	*Ehrharta	longiflora	
222054	6900511	*Lysimachia	arvensis	
222054	6900511	*Medicago	truncatula	
222054	6900511	*Rostraria	pumila	
222054	6900511	*Sonchus	oleraceus	
222054	6900511	*Sonchus	oleraceus	
222428	6900903	*Avena	barbata	
222428	6900903	*Brassica	tournefortii	
222428	6900903	*Bromus	rubens	
222428	6900903	*Hypochaeris	glabra	
222428	6900903	*Lysimachia	arvensis	
222428	6900903	*Medicago	truncatula	

Latitude/Easting (GDA94)	Longitude/Northing (GDA94)	Genus	Species	Subsp/Var
222428	6900903	**Sonchus*	*oleraceus*	
222428	6900903	**Urospermum*	*picroides*	
222019	6902625	**Brassica*	*tournefortii*	
222019	6902625	**Ehrharta*	*longiflora*	
222019	6902625	**Lysimachia*	*arvensis*	
222019	6902625	**Medicago*	*truncatula*	
222019	6902625	**Sonchus*	*oleraceus*	
222019	6902625	**Sonchus*	*oleraceus*	
222123.7	6898276	**Chenopodium*	*murale*	
222135.1	6900121	**Chenopodium*	*murale*	
222420.1	6895042	**Chenopodium*	*murale*	
222757.1	6895010	**Chenopodium*	*murale*	
222757.1	6895010	**Melilotus*	*indicus*	
222691.3	6902750	**Urtica*	*urens*	
223140.4	6896874	**Emex*	*australis*	
223140.4	6896874	**Hordeum*	*leporinum*	

APPENDIX 8

Site sheets summarising raw data for quadrats within the study area

Site	Balline- Site B01
Date	7/09/13
Recorder	JB
Photo	560
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223317
Northing	6896858
Habitat	Hillcrest (HCR)
Aspect	270°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (outcrops, boulders, cobbles)
% Leaves:Logs	15:1
Vegetation Condition	Very Good
Disturbance Type	Limestone outcropping on hillcrest - upper slope
Fire Age	Fire - Old 5-10yrs
Vegetation	Low Closed Heath of Melaleuca cardiophylla, *Lysimachia arvensis, ^Beyeria cinerea subsp.cinerea over Very Open Herbs of *Brassica tournefortii, *Anagallis arvensis

Species			% Cover	Height
**Brassica*	*tournefortii*		2	0.2
**Ehrharta*	*brevifolia*	var. *cuspidata*	<1	0.15
**Hypochaeris*	*glabra*		<1	0.1
**Lysimachia*	*arvensis*		0.5	0.1
**Medicago*	*truncatula*		<1	0.1
**Rostraria*	*pumila*		<1	0.1
**Urospermum*	*picroides*		<1	0.2
^Beyeria	*cinerea*	subsp. *cinerea*	1.5	0.3
Acacia	*idiomorpha*		1	0.4
Acacia	*leptospermoides*		1	1.2
Alyogyne	*hakeifolia*		-	-
Aphanopetalum	*clematideum*		-	1-1.5
Austrostipa	*elegantissima*		<1	1.2
Calandrinia	*liniflora*		<1	0.1
Calandrinia	*polyandra*		<1	0.2
Calocephalus	*francisii*		<1	0.03
Carpobrotus	*virescens*		<1	Cr
Cassytha	*aurea*	var. *hirta*	<1	Cl
Casuarina	*obesa*		-	-
Comesperma	*integerrimum*		<1	Cl
Cryptandra	*arbutiflora*		1	0.2
Desmocladus	*asper*		<1	0.2
Dillwynia	*pungens*		-	0.5-1
Dioscorea	*hastifolia*		0.5	Cl
Dioscorea	*hastifolia*		<1	Cl
Diplolaena	*grandiflora*		-	1-2
Diplolaena	*mollis*		1	0.5
Diplopeltis	*petiolaris*		-	0.5-1
Dodonaea	*aptera*		-	1-1.5

Species			% Cover	Height
Eremophila	*decipiens*	subsp. *decipiens*	-	-
Goodenia	*berardiana*		<1	0.1
Goodenia	*berardiana*		<1	0.15
Guichenotia	*intermedia*		<1	0.4
Hibbertia	*spicata*	subsp. *spicata*	1.5	0.4
Lasiopetalum	*angustifolium*		-	
Lepidosperma	*costale*		<1	0.3
Melaleuca	*campanae*		6	0.3-0.5
Melaleuca	*cardiophylla*		70	0.5-1.2
Olearia	sp. indet		1	0.5-1
Opercularia	*spermacocea*		<1	0.15
Pimelea	*microcephala*		1.5	0.5-1
Ptilotus	*gaudichaudii*	subsp. *eremita*	<1	0.4
Rhagodia	*latifolia*	var. *latifolia*	1.5	0.5-1.1
Rhagodia	*latifolia*	var. *latifolia*	<1	0.5-1
Scholtzia	sp. Kalbarri (N. Hoyle 623)		-	1-1.5
Senna	*glutinosa*	subsp. *chatelainiana*	-	1-1.5
Tetragona	*implexa*		<1	Cl
Waitzia	*suaveleons*		<1	0.05
Zygophyllum	*fruticulosum*		<1	0.5-1

Site	Balline- Site B02
Date	7/09/13
Recorder	JB
Photo	573
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223973
Northing	6897014
Habitat	Hillslope (HSL)
Aspect	290°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (cobbles, pebbles)
% Leaves:Logs	20:10
Vegetation Condition	Good
Fire Age	Fire - Very Old >10yrs
Vegetation	High Shrubland of Acacia rostellifera over Annual Open Tussock Grassland of *Avena barbata, *Ehrharta longiflora, *Bromus rubens with Open Shrubland of Rhagodia latifolia var. latifolia, Pimelea, microcephala, Stylobasium spathulatum§

Species			% Cover	Height
**Avena*	*barbata*		6	0.3-0.5
**Brassica*	*tournefortii*		6	0.35
**Bromus*	*rubens*		3	0.15
**Ehrharta*	*longiflora*		5	0.25
**Hypochaeris*	*glabra*		<1	0.15
**Lysimachia*	*arvensis*		1	0.1
**Medicago*	*truncatula*		2	0.1
**Sonchus*	*oleraceus*		1	0.4
**Sonchus*	*oleraceus*		0.5	0.15
**Urospermum*	*picroides*		1	0.15
Acacia	*rostellifera*		20	2-4
Acanthocarpus	*preissii*		-	-
Austrostipa	*elegantissima*		1	1-2
Calandrinia	*liniflora*		<1	0.05
Clematicissus	*angustissima*		<1	Cr
Dioscorea	*hastifolia*		<1	Cl
Erodium	*cygnorum*		<1	0.3
Euphorbia	*sharkoensis*		1	Prostrate
Goodenia	*berardiana*		<1	0.1
Guichenotia	*intermedia*		<1	0.2
Guichenotia	*intermedia*		<1	1-1.5
Olearia	sp. indet		<1	1-1.5
Pimelea	*microcephala*		5	1.5-2.5
Podotheca	*gnaphalioides*		<1	0.15
Rhagodia	*latifolia*	var. *latifolia*	4.5	1.5-2.5
Solanum	*oldfieldii*		<1	0.35
Stylobasium	*spathulatum*		3	0.5-1.7
Thysanotus	*manglesianus*		<1	Cl

Site	Balline- Site B03
Date	8/09/13
Recorder	JB
Photo	578
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223641
Northing	6895909
Habitat	Hillslope (HSL)
Aspect	270°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (scattered pebbles)
% Leaves:Logs	95:25
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Closed Scrub of Acacia rostellifera over Very Open Annual Tussock Grass of *Ehrharta longiflora over Scattered Herbs of *Sonchus oleraceus, *Brassica tournefortii

Species			% Cover	Height
**Brassica*	*tournefortii*		<1	0.4
**Ehrharta*	*longiflora*		6	0.4
**Sonchus*	*oleraceus*		0.5	0.3-0.6
**Urospermum*	*picroides*		<1	0.3
Acacia	*rostellifera*		90	4-8
Alyogyne	*hakeifolia*		<1	CI
Calandrinia	*liniflora*		<1	0.05
Dioscorea	*hastifolia*		<1	CI
Guichenotia	*intermedia*		<1	2
Olearia	sp. indet		<1	1-2
Parietaria	*cardiostegia*		<1	0.25
Pimelea	*microcephala*		<1	1

Site	Balline- Site B04
Date	8/09/13
Recorder	JB
Photo	584
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223148
Northing	6896178
Habitat	Hillslope (HSL)
Aspect	270°
Slope	Moderately Inclined (MO) (5°46' to 18°)
Soil	Sand
Rock Type	Limestone (scattered pebbles)
% Leaves:Logs	12:8
Vegetation Condition	Good
Disturbance Type	
Fire Age	Fire - Moderate 2-5yrs
Vegetation	Shrubland of Acacia rostellifera, Olearia sp. indet., Pimelea mecrocephala over Open Annual Tussock Grassland of *Avena barbata, *Bromus rubens, Bromus arenarius with Low Open Shrubland of Olearia sp. indet., Acacia rostellifera, Pimelea macrocephala

Species			% Cover	Height
**Avena*	*barbata*		20	0.4
**Brassica*	*tournefortii*		4	0.35
**Bromus*	*rubens*		1.5	0.2
**Bromus*	*rubens*		<1	0.3
**Ehrharta*	*longiflora*		2	0.2
**Eragrostis*	*curvula*		<1	0.15
**Hypochaeris*	*glabra*		1	0.25
**Lysimachia*	*arvensis*		2	0.1
**Medicago*	*truncatula*		2	0.1
**Sonchus*	*oleraceus*		<1	0.4
**Urospermum*	*picroides*		<1	0.3
**Urospermum*	*picroides*		<1	0.15
Acacia	*rostellifera*		8	1-2.5
Acanthocarpus	*preissii*		0.5	0.3
Alyogyne	*hakeifolia*		<1	Cl
Austrostipa	*crinita*		0.5	0.6
Austrostipa	*elegantissima*		0.5	0.5-1
Bromus	*arenarius*		1	0.1
Clematicissus	*angustissima*		<1	Cr
Dioscorea	*hastifolia*		<1	Cl
Dioscorea	*hastifolia*		2	0.3
Euphorbia	*sharkoensis*		1	Cl
Goodenia	*berardiana*		3	0.2
Olearia	sp. indet		7	0.5-1.5
Operculina	*spermacocea*		<1	0.2
Pimelea	*microcephala*		4.5	1-2
Ptilotus	*divaricatus*		<1	1.3

Species			% Cover	Height
Ptilotus	*gaudichaudii*	subsp. *eremita*	0.5	1-1.5
Rhagodia	*latifolia*	var. *latifolia*	0.5	Prostrate
Scaevola	*crassifolia*		<1	1-2
Solanum	*oldfieldii*		0.5	0.3
Thysanotus	*manglesianus*		-	-
Waitzia	*suaveleons*		<1	0.1

Site	Balline- Site B05
Date	8/09/13
Recorder	JB
Photo	613
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222367
Northing	6895061
Habitat	Hillslope (HSL)
Aspect	270°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	None evident
% Leaves:Logs	20:20
Vegetation Condition	Good
Disturbance Type	
Fire Age	Fire - Very old >10yrs
Vegetation	Shrubland of Pimelea microcephala, Olearia sp. indet., Quoya loxocarpa over Low Shrubland of Pimelea microcephala, Olearia sp. indet., Quoya loxocarpa over Open Annual Tussock Grassland of *Avena barbata, *Ehrharta longiflora with High Open Shrubland of Acacia rostellifera

Species			% Cover	Height
**Avena*	*barbata*		20	0.3-0.5
**Brassica*	*tournefortii*		3	0.2-0.4
**Bromus*	*rubens*		1	0.1
**Ehrharta*	*longiflora*		7	0.2
**Lysimachia*	*arvensis*		2	0.05
**Medicago*	*truncatula*		<1	0.05
**Orobanche*	*minor*		<1	0.15
**Rostraria*	*pumila*		2	0.1
**Sonchus*	*oleraceus*		<1	-
**Urospermum*	*picroides*		<1	0.2
Acacia	*rostellifera*		3	1-2.5
Austrostipa	*elegantissima*		<1	1
Cassytha	*racemosa*	forma *racemosa*	<1	CI
Commicarpus	*australis*		<1	CI
Erodium	*cygnorum*		2	0.2
Euphorbia	*sharkoensis*		1.5	Prostrate
Euphorbia	*tannensis*	subsp. *eremophila*	1	0.2
Goodenia	*berardiana*		2	0.1
Lechenaultia	*linarioides*		<1	1
Olearia	sp. indet		8	1-1.5
Pimelea	*microcephala*		13	1-1.5
Quoya	*loxocarpa*		10	1-1.8
Rhagodia	*latifolia*	var. *latifolia*	1.5	0.5-1
Rhagodia	*latifolia*	var. *latifolia*	<1	CI
Solanum	*oldfieldii*		0.5	0.35
Stylobasium	*spathulatum*		1	1-2
Tetragona	*implexa*		<1	CI

Species			% Cover	Height
Threlkeldia	*diffusa*		<1	0.3
Thysanotus	*manglesianus*		<1	Cl
Tricoryne	*elatoir*		0.5	0.5
Waitzia	*suaveleons*		2	0.1
Zygophyllum	*fruticulosum*		1	0.5
Zygophyllum	*fruticulosum*		<1	0.5
Zygophyllum	*simile*		<1	0.05

Site	Balline- Site B06
Date	9/09/13
Recorder	JB
Photo	659
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223019
Northing	6900189
Habitat	Hillslope (HSL)
Aspect	90°
Slope	Moderately Inclined (MO) (5°46' to 18°)
Soil	Sand
Rock Type	Limestone
% Leaves:Logs	10:20
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Open Heath of Olearia sp. indet., Acacoa rostellifera, Pimelea microcephala over Low Open Shrubland of Acanthocarpus preisii over Very Open Herbs of Goodenia berardiana, *Brassica tournefortii, *Lysimachia arvensis with Scattered Tall Shrubs of Acacia rostellifera

Species			% Cover	Height
**Brassica*	*tournefortii*		2	0.4
**Bromus*	*rubens*		<1	0.2
**Lysimachia*	*arvensis*		2	0.05
**Sonchus*	*oleraceus*		<1	0.2
**Urospermum*	*picroides*		<1	0.1
Acacia	*rostellifera*		3	2-3
Acanthocarpus	*preissii*		5	0.4
Austrostipa	*nitida*		1	1.2
Calandrinia	*liniflora*		<1	0.05
Clematicissus	*angustissima*		<1	Cl
Comesperma	*integerrimum*		-	-
Comesperma	*scoparium*		-	-
Dioscorea	*hastifolia*		1	Cl
Dioscorea	*hastifolia*		<1	Cl
Glycine	*canescens*		<1	Cl
Goodenia	*berardiana*		5	0.3
Melaleuca	*cardiophylla*		-	-
Olearia	sp. indet		50	1-2
Operculina	*spermacocea*		<1	0.25
Phyllanthus	*calycinus*		<1	0.35
Pilotus	*gaudichaudii*	subsp. *eremita*	<1	0.25
Pimelea	*microcephala*		3	1-1.5
Rhagodia	*latifolia*	var. *latifolia*	<1	0.5-1
Rhagodia	*latifolia*	var. *latifolia*	2	1-1.5
Schoenia	*cassiniana*		<1	0.3
Scholtzia	sp. Kalbarri (N. Hoyle 623)		-	-

Species			% Cover	Height
Solanum	*oldfieldii*		0.5	0.35
Waitzia	*suaveleons*		0.5	0.1

Site	Balline- Site B07
Date	9/09/13
Recorder	JB
Photo	697
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222104
Northing	6897876
Habitat	Hillslope (HSL)
Aspect	160°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	None evident
% Leaves:Logs	25:25
Vegetation Condition	Degraded
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Open Scrub of Acacia rostellifera over Open Annual Tussock Grassland of *Avena barbata, *Bromus rubens, *Ehrharta longiflora over Open Herbs of *Brassica tournefortii, *Urospermum picroides

Species			% Cover	Height
**Avena*	*barbata*		8	0.35
**Brassica*	*tournefortii*		20	0.3
**Bromus*	*rubens*		6	0.2
**Ehrharta*	*longiflora*		5	0.15
**Lysimachia*	*arvensis*		<1	0.05
**Medicago*	*truncatula*		2	0.1
**Rostraria*	*pumila*		0.5	0.1
**Sonchus*	*oleraceus*		1	0.1
**Urospermum*	*picroides*		<1	0.1
**Urospermum*	*picroides*		1	0.15
Acacia	*rostellifera*		58	4-6
Acanthocarpus	*preissii*		<1	0.4
Austrostipa	*nitida*		<1	0.5
Calandrinia	*liniflora*		<1	0.05
Convolvulus	*remotus*		<1	Cl
Euphorbia	*sharkoensis*		<1	Prostrate
Pimelea	*microcephala*		2	1-2
Rhagodia	*latifolia*	var. *latifolia*	1	1
Rhagodia	*latifolia*	var. *latifolia*	1	1-2

Site	Balline- Site B08
Date	9/09/13
Recorder	JB
Photo	723
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222105
Northing	6899457
Habitat	Hillcrest (HCR)
Aspect	270°
Slope	Moderately Inclined (MO) (5°46' to 18°)
Soil	Sand
Rock Type	Limestone (outcrops, cobbles)
% Leaves:Logs	14:18
Vegetation Condition	Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	High Shrubland of Melaleuca cardiophylla over Shrubland of Pimelea microcephala, Rhagodia sp. Watheroo (R.J. Cranfield & P.J. Spencer 8183), Diplolaena grandiflora over Very Open Herbs of *Brassica tournefortii

Species			% Cover	Height
**Brassica*	*tournefortii*		5	0.25
**Ehrharta*	*longiflora*		<1	0.15
**Lysimachia*	*arvensis*		<1	0.05
**Medicago*	*truncatula*		<1	0.05
**Rostraria*	*pumila*		1	0.1
**Urospermum*	*picroides*		<1	0.15
Acacia	*rostellifera*		2	2-3
Austrostipa	*nitida*		<1	0.4
Calandrinia	*liniflora*		1	0.05
Clematicissus	*angustissima*		<1	Cr
Diplolaena	*grandiflora*		1.5	1-2
Goodenia	*berardiana*		<1	0.15
Melaleuca	*cardiophylla*		25	2-4
Nicotiana	*rotundifolia*		<1	0.3
Olearia	sp. indet		<1	0.5-1
Phyllanthus	*calycinus*		<1	0.4
Pimelea	*microcephala*		4	1-1.5
Ptilotus	*gaudichaudii*	subsp. *eremita*	1	0.15-0.4
Rhagodia	*latifolia*	var. *latifolia*	3	1-2
Rhagodia	*latifolia*	var. *latifolia*	1	0.5-1
Zygophyllum	*simile*		<1	0.05

Site	Balline- Site B09
Date	10/09/13
Recorder	JB
Photo	742
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222019
Northing	6902625
Habitat	Hillcrest (HCR)
Aspect	320°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (pebbles)
% Leaves:Logs	5:5
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Old 5-10yrs
Vegetation	Low Open Heath of Scholtzia sp. Kalbarri (N. Hoyle 623) , Olearia sp. indet., Acanthocarpus preissii over Open Shrubland of Olearia sp. indet., Pimelea microcephala, ^Anthocercis intricata over Scattered Tussock Grassland of Austrostipa elegantissima, Austrostipa crinita

Species			% Cover	Height
**Brassica*	*tournefortii*		1	0.25
**Ehrharta*	*longiflora*		<1	0.2
**Lysimachia*	*arvensis*		<1	0.05
**Medicago*	*truncatula*		<1	0.05
**Sonchus*	*oleraceus*		<1	0.1
**Sonchus*	*oleraceus*		<1	0.2
^Anthocercis	*intricata*		<1	1-2
^Cryptandra	*glabriflora*		-	-
Acacia	*rostellifera*		1	0.5-1.5
Acanthocarpus	*preissii*		6	0.5
Austrostipa	*crinita*		1	0.5-1
Austrostipa	*elegantissima*		1	1
Brachyscome	*ciliocarpa*		<1	0.05
Comesperma	*scoparium*		3	0.5-1
Desmocladus	*asper*		-	-
Dioscorea	*hastifolia*		1	Cl
Dioscorea	*hastifolia*		3	Cl
Goodenia	*berardiana*		0.5	0.15
Lomandra	*maritima*		0.5	0.4
Olearia	sp. indet		8	0.5-1.4
Operculina	*spermacocea*		1.5	0.15
Phyllanthus	*calycinus*		0.5	0.4
Phyllanthus	*scaber*		1	0.4
Pilotus	*gaudichaudii*	subsp. *eremita*	<1	0.2
Pimelea	*microcephala*		2	1
Pimelea	*sessilis*		3	0.4
Ptilotus	*divaricatus*		3	0.6

Species			% Cover	Height
Rhagodia	*latifolia*	var. *latifolia*	0.5	0.5-1
Rhagodia	*latifolia*	var. *latifolia*	3	0.5-1
Rytidosperma	*caespitosum*		<1	0.15
Salsola	*australis*		<1	0.35
Scaevola	*crassifolia*		-	-
Scaevola	*tomentosa*		1	0.6
Scholtzia	sp. Kalbarri (N. Hoyle 623)		12	0.65
Solanum	*oldfieldii*		<1	0.2
Stylobasium	*spathulatum*		1	0.5-2
Tetragona	*implexa*		1	Cl
Waitzia	*suaveleons*		<1	0.1
Zygophyllum	*fruticulosum*		2.5	0.5

Site	Balline- Site B10
Date	10/09/13
Recorder	JB
Photo	760
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222054
Northing	6900511
Habitat	Hillslope (HSL)
Aspect	310°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (scattered pebbles)
% Leaves:Logs	20:25
Vegetation Condition	Good
Disturbance Type	Fire _ Old 5-10yrs
Fire Age	
Vegetation	Shrubland of Acacia rostellifera, Rhagodia latifolia var. latifolia, Pimelea microcephala over Very Open Annual Tussock Grassland of *Avena barbata over Very Open Herbs of *Brassica tournefortii, *Medicago truncata with Scattered Tall Shrubs of Acacia rostellifera

Species			% Cover	Height
**Avena*	*barbata*		6	0.35
**Brassica*	*tournefortii*		6	0.25
**Ehrharta*	*longiflora*		<1	0.2
**Lysimachia*	*arvensis*		1	0.05
**Medicago*	*truncatula*		1	0.05
**Rostraria*	*pumila*		0.5	0.1
**Sonchus*	*oleraceus*		1	0.2
**Sonchus*	*oleraceus*		0.5	0.15
Acacia	*rostellifera*		24	1-4
Austrostipa	*crinita*		<1	0.7
Euphorbia	*sharkoensis*		0.5	Prostrate
Jasminum	*calcareum*		<1	Cl
Phyllanthus	*calycinus*		0.5	0.3
Pilotus	*gaudichaudii*	subsp. *eremita*	<1	0.15
Pimelea	*microcephala*		1	1-1.5
Ptilotus	*divaricatus*		<1	0.6
Rhagodia	*latifolia*	var. *latifolia*	1	1-2
Rhagodia	*latifolia*	var. *latifolia*	8	1-1.5

Site	Balline- Site B11
Date	10/09/13
Recorder	JB
Photo	765
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222428
Northing	6900903
Habitat	Hillslope (HSL)
Aspect	120°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (scattered pebbles)
% Leaves:Logs	10:7
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Low Open Heath of Melaleuca cardiophylla, Comesperma scoparium, Scholtzia sp. Kalbarri (N. Hoyle 623) over Open Shrubland of Melaleuca cardiophylla over Very Open Herbs of *Medicago truncata, *Brassica tournefortii

Species			% Cover	Height
**Avena*	*barbata*		*<1*	*0.2*
**Brassica*	*tournefortii*		*B01.05*	*0.2*
**Bromus*	*rubens*		*<1*	*0.2*
**Hypochaeris*	*glabra*		*<1*	*0.1*
**Lysimachia*	*arvensis*		*1*	*0.05*
**Medicago*	*truncatula*		*2*	*0.05*
**Sonchus*	*oleraceus*		*<1*	*0.1*
**Urospermum*	*picroides*		*<1*	*0.1*
Acacia	*idiomorpha*		*<1*	*0.2*
Acacia	*rostellifera*		*<1*	*1*
Acanthocarpus	*preissii*		*4*	*0.5*
Androcalva	*gaudichaudii*		*<1*	*0.2*
Austrostipa	*crinita*		*2*	*0.4*
Clematicissus	*angustissima*		*<1*	*Cr*
Comesperma	*scoparium*		*6*	*0.5*
Cryptandra	*arbutiflora*		*<1*	*0.2*
Desmocladus	*asper*		*<1*	*0.2*
Dioscorea	*hastifolia*		*<1*	*Cl*
Erodium	*cygnorum*		*<1*	*0.1*
Euphorbia	*sharkoensis*		*<1*	*Prostrate*
Euphorbia	*tannensis*	subsp. *eremophila*	*<1*	*0.4*
Goodenia	*berardiana*		*<1*	*0.2*
Hibbertia	*spicata*	subsp. *spicata*	*<1*	*0.25*
Lomandra	*maritima*		*<1*	*0.3*
Melaleuca	*cardiophylla*		*25*	*0.5-2*
Olearia	sp. indet		*1.5*	*0.5-1*
Phyllanthus	*calycinus*		*<1*	*0.3*
Pilotus	*gaudichaudii*	subsp. *eremita*	*<1*	*0.2*

Species			% Cover	Height
Pimelea	*microcephala*		*1*	*1-1.5*
Pimelea	*sessilis*		*5*	*0.35*
Ptilotus	*divaricatus*		*1*	*0.4*
Ptilotus	*eriotrichus*		*<1*	*0.3*
Rhagodia	*latifolia*	var. *latifolia*	*2.5*	*1*
Scholtzia	sp. Kalbarri (N. Hoyle 623)		*5*	*0.3*
Solanum	*oldfieldii*		*<1*	*0.3*
Zygophyllum	*fruticulosum*		*<1*	*0.3*

Site	Balline- Site B12
Date	10/09/13
Recorder	JB
Photo	779
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	221864
Northing	6900129
Habitat	Hillcrest (HCR)
Aspect	250°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Sand
Rock Type	Limestone (pebbles)
% Leaves:Logs	15:20
Vegetation Condition	Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	High Shrubland of Acacia rostellifera over Shrubland of Olearia sp. indet., Rhagodia latifolia var. latifolia, Pimelea microcephala over Open Herbland of *Brassica tournefortii, *Sonchus oleracea, Ptilotus gaudichaudii subsp. eremita

Species			% Cover	Height
**Avena*	*barbata*		3	0.4
**Ehrharta*	*longiflora*		2	0.15
**Lysimachia*	*arvensis*		1	0.05
**Medicago*	*truncatula*		1	0.1
**Rostraria*	*pumila*		<1	0.2
**Sonchus*	*oleraceus*		2	0.1
**Urospermum*	*picroides*		1	0.1
**Urospermum*	*picroides*		<1	0.1
Acacia	*rostellifera*		28	3-5
Alyogyne	*hakeifolia*		0.5	2-3
Austrostipa	*nitida*		0.5	1
Convolvulus	*angustissimus*	subsp. *angustissimus*	10	0.25
Euphorbia	*sharkoensis*		<1	Prostrate
Olearia	sp. indet		4	1-2
Paspalidium	*reflexum*		<1	0.1
Pimelea	*microcephala*		1.5	1-2
Ptilotus	*divaricatus*		1	0.6-1.5
Ptilotus	*gaudichaudii*	subsp. *eremita*	1	0.2
Rhagodia	*latifolia*	var. *latifolia*	1	1.5
Rhagodia	*latifolia*	var. *latifolia*	5	1-2
Thysanotus	*manglesianus*		<1	Cl

Site	Balline- Site B13
Date	11/09/13
Recorder	JB
Photo	807/808
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223705
Northing	6896406
Habitat	Hillslope (HSL)
Aspect	100°
Slope	Gently Inclined (GE) (1°46' to 5°45')
Soil	Sand
Rock Type	Limestone (outcrops, cobbles, boulders)
% Leaves:Logs	30:5
Vegetation Condition	Excellent
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Low Mallee of Eucalyptus fruticosa, Eucalyptus oraria over Scattered Tall Shrubs of Acacia rostellifera, Pittosporum ligustrifolium over Scattered Low Shrubs of Rhagodia latifolia var. latifolia

Species			% Cover	Height
**Ehrharta*	*longiflora*		<1	0.15
Acacia	*rostellifera*		<1	0.5-2.5
Austrostipa	*elegantissima*		<1	1
Calandrinia	*liniflora*		<1	0.05
Convolvulus	*angustissimus*	subsp. *angustissimus*	<1	0.3
Eucalyptus	*oraria*		10	2.5-4
Eucalyptus	*fruticosa*		40	2-3
Melaleuca	*campanae*		<1	1
Monotaxis	*bracteata*		<1	0.3
Pimelea	*microcephala*		1	0.5-1
Pittosporum	*ligustrifolium*		0.5	1-2.5
Ptilotus	*divaricatus*		<1	0.4
Rhagodia	*latifolia*	var. *latifolia*	<1	1
Rhagodia	*latifolia*	var. *latifolia*	1	0.5
Zygophyllum	*fruticulosum*		<1	0.5
Zygophyllum	*simile*		<1	0.05

Site	Balline- Site B14
Date	11/09/13
Recorder	JB
Photo	822
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	223584
Northing	6896845
Habitat	Hillslope (HSL)
Aspect	90°
Slope	Moderately Inclined (MO) (5°46' to 18°)
Soil	Sand
Rock Type	Limestone (cobbles, pebbles)
% Leaves:Logs	20:12
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Shrubland of Pimelea microcephala, Olearia sp. indet., Rhagodia latifolia var. latifolia with High Open Shrubland of Grevillea commutata, Acacia rostellifera over Very Open Annual Tussock Grassland of Austrostipa elegantissima, Austrostipa crinita

Species			% Cover	Height
**Lysimachia*	*arvensis*		<1	0.05
**Rostraria*	*pumila*		<1	0.15
**Sonchus*	*oleraceus*		<1	0.3
**Sonchus*	*oleraceus*		<1	0.3
**Vulpia*	*myuros*		<1	0.3
Acacia	*rostellifera*		1	2-4
Acacia	*spathulifolia*		<1	1-2
Austrostipa	*crinita*		1	5
Austrostipa	*elegantissima*		2	1-2
Calandrinia	*polyandra*		<1	0.15
Clematicissus	*angustissima*		<1	Cr
Clematicissus	*angustissima*		0.5	Cl
Convolvulus	*angustissimus*	subsp. *angustissimus*	2	0.25
Dioscorea	*hastifolia*		1	Cl
Diplolaena	*mollis*		-	-
Diplopeltis	*petiolaris*		2.5	0.3-1.4
Eremophila	*decipiens*		<1	1
Goodenia	*berardiana*		<1	0.2
Grevillea	*commutata*		1.5	2-2.5
Guichenotia	*ledifolia*		<1	1-2
Hibbertia	*spicata*	subsp. *spicata*	<1	0.4
Hybanthus	*floribundus*	subsp. *floribundus*	1	0.5
Melaleuca	*cardiophylla*		0.5	1-2
Monotaxis	*bracteata*		1.5	0.35
Myoporum	*insulare*		1	1.5
Olearia	sp. indet		5	1-2
Operculina	*spermacocea*		<1	0.2

Species			% Cover	Height
Pimelea	*microcephala*		8.5	1-2
Ptilotus	*divaricatus*		2.5	0.4-1
Rhagodia	*latifolia*	var. *latifolia*	2	1-2
Rhagodia	*latifolia*	var. *latifolia*	1	0.5-1
Scholtzia	sp. Kalbarri (N. Hoyle 623)		1	1-2
Stylobasium	*spathulatum*		4	1-2.5
Zygophyllum	*fruticulosum*		3	0.5-1.5

Site	Balline- Site B15
Date	11/09/13
Recorder	JB
Photo	853
Shape/Size	50m x 50m
Datum	GDA 94
Zone	50K
Easting	222509
Northing	6894616
Habitat	Plain (PLA)
Aspect	270°
Slope	Very Gently Inclined (VG) (0°36' to 1°45')
Soil	Medium clay
Rock Type	None evident
% Leaves:Logs	20:2
Vegetation Condition	Very Good
Disturbance Type	
Fire Age	Fire - Very Old >10yrs
Vegetation	Low Woodland of Casuarina obesa over Low Open Shrubland of Sarcocornia blackiana, Frankenia pauciflora, Threlkeldia diffusa over Scattered Annual Tussock Grass of Parapholis incurva

Species			% Cover	Height
**Centaurium*	*tenuiflorum*		<1	0.05
**Parapholis*	*incurva*		1	0.05
Amyema	*linophylla*		<1	Parasite
Casuarina	*obesa*		30	2-5
Frankenia	*pauciflora*		4.5	0.2
Melaleuca	*cardiophylla*		3	2-3
Melaleuca	*viminea*	subsp. *viminea*	-	-
Rhagodia	*latifolia*	var. *latifolia*	<1	0.4
Sarcocornia	*blackiana*		3	0.4
Threlkeldia	*diffusa*		2	0.1-0.3
Triglochin	*mucronata*		<1	0.05
Zygophyllum	*simile*		*<1*	*0.05*