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Bemax Resources NL
incorporating Cable Sands

TUTUNUP SOUTH PROJECT

Field Survey of Flora & Vegetation

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EXECUTIVE SUMMARY

Bemax Resources NL are undertaking a feasibility study of the Tutunup South project, which incorporates a mineral sands ore body situated on two parcels of privately owned farmland, the majority of which has been historically cleared for grazing. The farms are divided east west by a narrow gravel road, Williamson Road. As part of the larger study, Onshore Environmental Consultants Pty Ltd (OEC) was commissioned by Bemax Resources to review flora and vegetation values for small pockets of remnant native vegetation occurring within the mining lease.

A total of 152 plant taxa (including varieties and subspecies) from 42 families and 107 genera were recorded within the survey area, 5-6 May 2005. Species representation was greatest among the Proteaceae (19), Papilionaceae (18), Myrtaceae (17), Poaceae (14), Cyperaceae (11), Restionaceae (9), Dasypogonaceae (8), Asteraceae (6) and Mimosaceae (5). Extensive grouth truthing and the establishment of eight sampling plots resulted in the identification of four Priority flora within the survey area; *Cyathochaeta teretifolia* (P3), *Acacia semitrullata* (P3), *Acacia flagelliformis* (P4) and *Jacksonia sparsa* ms (P4). No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were recorded. Of the 38 introduced species recorded from the survey area, none are 'Declared Plants' pursuant to Section 37 of the Agricultural and Related Resources Protection Act (1976).

Native vegetation across the survey area was mapped and described as the eight vegetation complexes outlined below, none of which are inferred to be Threatened Ecological Communities.

1 *Melaleuca rhaphiophylla* Low Woodland B over *Cyathochaeta teretifolia* Heath B (*Juncus pallidus* occurred as Heath B around the outer perimeter of the swamp)

2 *C. calophylla* Open Low Woodland A over *T. linearifolia* Dense Thicket over **Cynodon dactylon / *Hypochaeris glabra* Open Dwarf Scrub D

3 *C. calophylla / E. marginata* Tall Forest over *T. linearifolia* Open Scrub over **Cynodon dactylon / *Avena barbata / *Bromus diandrus / *Hypochaeris glabra* Dwarf Scrub D

4 *C. calophylla / E. marginata* Tall Forest over *Agonis flexuosa* Open Low Woodland B over *X. preissii* Open Low Scrub B over **Briza maxima / *Phalaris paradoxa / *Hypochaeris glabra* Dwarf Scrub D

5 *C. calophylla* Open Woodland over *C. calophylla / M. preissiana* Low Woodland A over *T. linearifolia* Scrub over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D

6 *C. calophylla* Woodland over *J. sparsa / X. preissii / C. equitans* Open Low Scrub B over *X. gracilis* Open Dwarf Scrub C over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D

7 *E. marginata / C. calophylla / E. resinifera* Low Woodland A over *J. sparsa / M. thymoides* Open Low Scrub B over *A. meisneri* Open Dwarf Scrub D

8 *E. marginata / C. calophylla / N. floribunda* Open Low Woodland A over *J. sparsa / A. humilis / K. recurva / M. thymoides* Low Scrub B over *A. meisneri / D. bromeliifolius / M. trichophylla / S. latifolia / D. fasicularis* Low Heath D

The condition of remnant native vegetation situated on the Kemp (complex 1) and Hood (complexes 2 & 3) properties, along the narrow verge of Williamson Road west (complexes 4 & 5), and in the corner of the Abba State Forest block was rated as 'degraded' (score 5) or 'completely degraded (score 6). Uncontrolled grazing by domestic stock, excavation of upper sands, and increasing fragmentation of native remnants were all contributing factors to decreased vegetation condition. Vegetation along the verge of Williamson Road east (complex 6) and within the Abba State Forest block proper was rated as 'good' (score 4) and 'excellent' (score 2) with higher native species richness, better definition of vegetation structure, and fewer introduced grasses in the ground cover.

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1 INTRODUCTION

1.1 Preamble

Bemax Resources NL are undertaking a feasibility study to determine the viability of developing the Tutunup South project, which incorporates a mineral sands ore body situated primarily on cleared farmland that is privately owned by the Kemp and Hood families. As part of the larger study, Onshore Environmental Consultants Pty Ltd (OEC) was commissioned by Bemax Resources NL to review flora and vegetation values for small pockets of remnant native vegetation occurring within the mining lease.

1.2 Site Location

The Tutunup South project area is situated approximately 18 km south from the town of Capel. The survey area comprises two parcels of freehold farmland owned by the Kemp's (north of Williamson Road) and Hood's (south of Williamson Road; see Figure 1). The Abba River is situated along the western boundary of the survey area, aligned north-south through both properties.

The majority of the Kemp's property has been cleared and is currently utilised as pasture to graze dairy cattle; one isolated wetland remnant remains in the middle of the property. Similarly, the Hood property has also been largely cleared, with approximately half being utilised for intensive viticulture. A small wetland remnant remains on the northern boundary. The verge of Williamson Road also retains a narrow strip of native vegetation along the entire length that occurs within the survey area. The State Forest block adjoins the eastern boundary of the Hood property, but will not be impacted by mine development.

1.3 Climate

The project area experiences a Mediterranean climate with hot dry summers and cool wet winters. Winter lows from the south west are accompanied by strong southwest - northwest winds. Summer highs are associated with warmer temperatures and light easterly winds; afternoon sea breezes are common from the southwest.

Mean annual rainfall approximates 990 mm, with monthly rainfall peaking during June and July (up to 180 mm). Mean daily maximum temperatures range from 30.4°C in January down to 16.4°C in July. Mean minimum temperatures range from 14.1°C in February to 5.6°C in July.

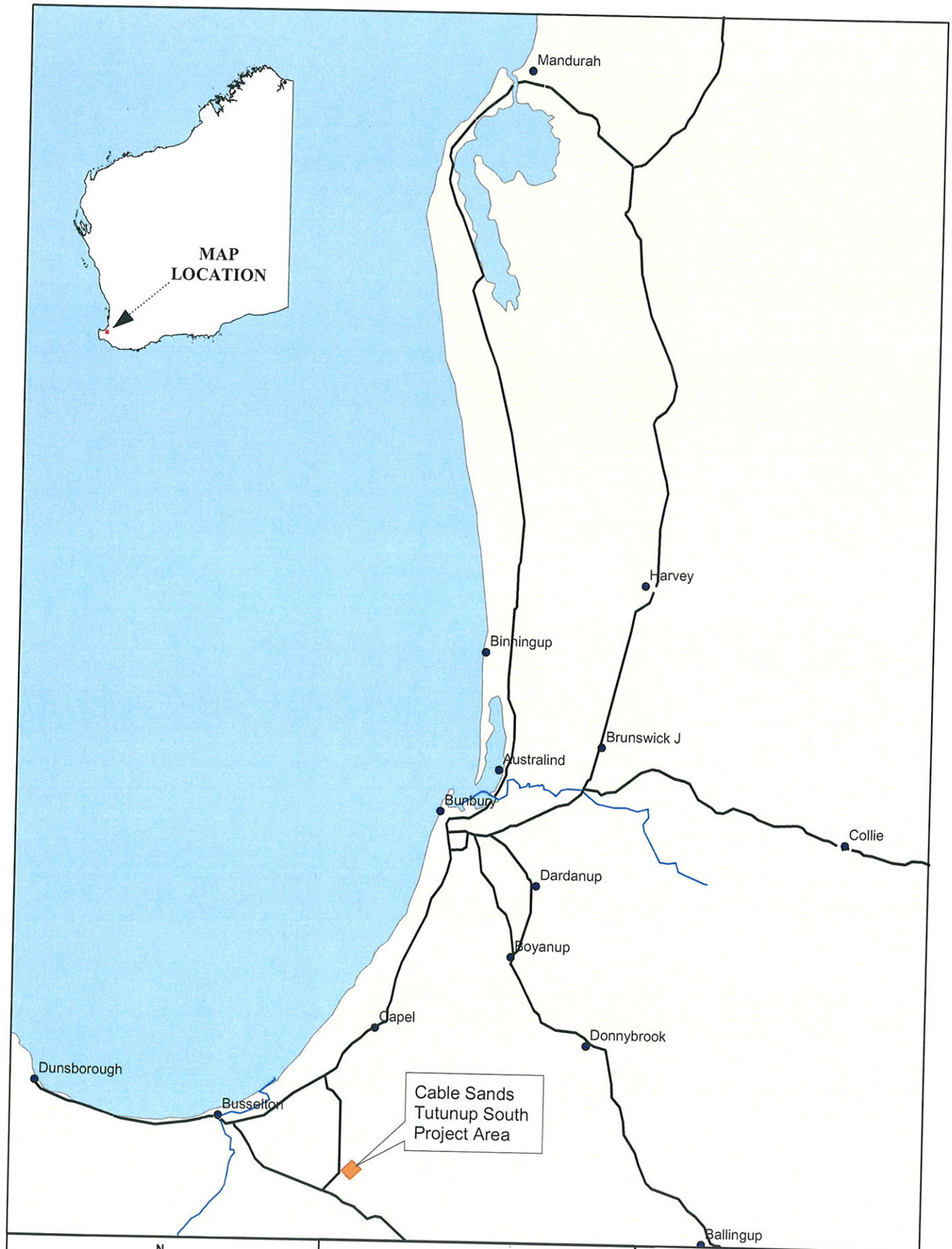


Figure One
Tutunup South Project

BEMAX
INCORPORATING CABLE SANDS

Drawn : Todd Griffin	Originator :	File Name :
Date : 1 June 2005	Version : 1	Datum : GDA Zone 50

1.4 Landform Systems

Two land systems are represented within the survey area, as defined and mapped by Tille and Lantzke (1990, see Table 1). The Abba Plain land system of the Swan Coastal Plain covers the lower northwest portion of the survey area, and the Yelverton Shelf land system of the Blackwood Plateau covers the elevated southeast portion of the survey area.

The Abba Plain covers an area of 460 km^2 occupying the major portion of the Swan Coastal Plain within the south west Capes region. It extends approximately 10 km inland from the southern edge of the Ludlow Plain land system to the edge of the Blackwood Plateau. The Abba Plain is a level to gently undulating plain between 10-40 m above sea level, characterised by extensive areas of poor drainage. The plain is dominated by a random series of slight depressions (Aw) and slight rises (A) with minimal difference in relief. Both areas comprise sandy grey-brown gradational (Busselton) and duplex (Abba) soils, however, the depressions tend to become waterlogged during winter months while the rises show subsoil waterlogging.

The Yelverton Shelf is situated on the northern edge of the Blackwood Plateau covering an area approximating 130 km^2. It wraps around the southern edge of the Abba Plain, tapering from 5-6 km wide in the west to less than 1 km wide in the east. Gently inclined slopes rise from the Swan Coastal Plain onto a gently undulating plain (Y) positioned between 60-80 m above sea level. The dominant soil type on the plain and slopes are yellow-bown gravely duplex (Forest Grove) soils, and pale grey mottled (Mungite) soils. Also present are patches of deep bleached sands (Yd), shallow gravel over ironstone (Yi), and poorly drained depressions (Yw). The plain has been dissected in parts by small valleys (Yv), some of which have broad swampy floors (Yvw). In some places this dissection has resulted in a landform of undulating rises. Fertile alluvium flats (Yf) occur along some drainage lines.

1.5 Status of the Landform Systems

The representation of vegetation complexes within the reserve system was published as part of the Regional Forest Agreement (The Commonwealth of Australia and the State of Western Australia 1999), and updated as part of the next Forest Management Plan (July 2003). As part of this process, poorly represented vegetation complexes have been reviewed in detail (Havel & Mattiske 2002). More than one-third of the vegetation complexes that occur in the southwest forest region of Western Australia are considered poorly reserved on the basis of (i) <10% of pre-European area in proposed and existing formal reserves, and (ii) <15% in proposed and existing formal and informal reserves. The highest priority for protection of values on poorly reserved vegetation complexes are those that occur outside State forest and particularly, those with zero or a very low level of reservation (Havel & Mattiske 2002).

Poorly reserved vegetation complexes that occur in the western Blackwood sub-region include six units from the Abba Plains land system and four units from the Yelverton Shelf land system (Table 1): Abba Wet Flats (Aw), Abba Flats (AB), Abba Deep Sandy Dunes (Ad), Abba Deep Sandy Wet Flats (Adw), Abba Very Fertile Flats (AF) and Abba Fertile Flats (Af) (Havel & Mattiske 2002).

The main threats to conservation of the remaining native vegetation are the degree of fragmentation and resulting influences of invasive introduced species, isolation of the remnants, and changes in local hydrological condition (Havel & Mattiske 2002).

TABLE 1: Status of poorly represented vegetation complexes associated with the Abba Plains & Yelverton Shelf land systems (from Havel & Mattiske, 2002).

Vegetation Complex		% Pre-European Area Remaining	% Reservation
ABBA PLAINS LAND SYSTEM			
Abba Flats (A)	Located on the flats & low rises of the Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by woodland & open forest of *Corymbia calophylla*. There are very limited options for improving conservation through repurchase or covenants on private property & some options for catchment management strategies.	2%	0
Abba Deep Sandy Dunes (Ad)	Located on the mild slopes of the low undulating Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by woodland of *Corymbia calophylla – Agonis flexuosa – Allocasuarina fraseriana – Nuytsia floribunda*. There are limited options for improving conservation through repurchase or covenants on private property & some options for catchment management strategies.	14%	0
Abba Deep Sandy Wet Flats (Adw)	Located on the mild slopes & wetter depressions of the low undulating Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by woodland of *Corymbia calophylla – Agonis flexuosa* on the lower slopes & a low woodland of *Melaleuca* spp. on the depressions. There are limited options for improving conservation through repurchase or covenants on private property & some options for catchment management strategies.	17%	0
Abba Very Fertile Flats (AF)	Located on the terraces & valley floors of the low undulating Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by woodland of *Corymbia calophylla – Agonis flexuosa* & a tall shrubland of Myrtaceae – Proteaceae spp. There are virtually no options for improving conservation as few areas (8 ha) remain uncleared.	0% (8 ha of 1,901 ha remaining)	0
Abba Fertile Flats (Af)	Located on the lower slopes of the low undulating Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by woodland of *Corymbia calophylla – Agonis flexuosa – Acacia saligna*. There are virtually no options for improving conservation as few areas (20 ha) remain uncleared.	1% (20 ha of 2,581 ha remaining)	0
Abba Wet Flats (Aw)	Located on the broad depressions of the low undulating Abba Plains, which have been largely cleared for agriculture. Vegetation complex dominated by tall shrubland of *Melaleuca viminea* & woodland of *Eucalyptus rudis – M. rhaphiophylla* with occasional *Corymbia calophylla*. There are limited options for improving conservation, as few areas (140 ha) remain uncleared.	2% (140 ha of 9,111 ha remaining)	0
YELVERTON SHELF LAND SYSTEM			
Yelverton Flats & Slopes (Y)	Uplands carrying woodland of jarrah & marri *(Eucalyptus marginata & Corymbia calophylla)* with second storey of sheoak & peppermint *(Allocasuarina fraseriana & Agonis flexuosa)*	20%	6%
Yelverton Wet Flats (Yw)	Valleys & depressions carrying woodland of sheoak *(Allocasuarina fraseriana), Banksia attenuate, Nuytsia floribunda* & peppermint *(Agonis flexuosa)* on sandy slopes, and marri-yarri-jarrah *(Corymbia calophylla, Eucalyptus patens, Eucalyptus marginata)* on loamier lower slopes	12%	1.8%
Yelverton Fertile Flats (Yf)	Less undulating lower slopes supporting woodland of marri-yarri-peppermint *(Corymbia calophylla, Eucalyptus patens, Agonis flexuosa)*	4%	0%
Yelverton Deep Sandy Flats & Low Slopes (Yd)	Sandy deposits carrying woodland of jarrah *(Eucalyptus marginata)*, sheoak *(Allocasuarina fraseriana), Xylomelum occidentale* & *Banksia* species	12%	2.8%

Of 50 vegetation complexes represented in the Shire of Busselton, 13 are considered to be poorly represented (less than 30% of their original cover remaining in the catchments) and of these, one is considered to be endangered (less that 10% remaining; see Table 2).

TABLE 2: Poorly represented vegetation complexes within the Shire of Busselton (source Naturaliste Environmental Services, 2002).

Vegetation Complex	% Remaining	Status
Abba (Aw)	6	Endangered
Abba (AB)	12	Poorly Represented
Abba (Ad)	24	Poorly Represented
Abba (Adw)	30	Poorly Represented
Abba (AF)	18	Poorly Represented
Abba (Af)	15	Poorly Represented
Cartis (CSs)	17	Poorly Represented
Cowaramup(Cw2)	24	Poorly Represented
Ludlow (Lw)	28	Poorly Represented
Quindalup (QD)	28	Poorly Represented
Quindalup (Qw)	28	Poorly Represented
Yelverton (Yf)	27	Poorly Represented
Yelverton (Yw)	29	Poorly Represented

While the Leeuwin-Naturaliste National Park and the Whicher Range and Yelverton State Forest areas provide a substantial area of consolidated remnant vegetation in the Shire, the remaining vegetation occurring on private land has been highly fragmented. The degree of fragmentation is particularly notable in the Swan Coastal Plain section of the Shire within which there are numerous but very small, isolated and degraded patches of remnant vegetation. The sustainability of these remnants is considered to be very low as most are less tha 5 hectares and have little to no connection to adjoining remnants. The high degree of fragmentation vastly reduces habitat value for fauna species with poor mobility that depend on large areas of bushland for their survival. The edge effect of weeds is vastly increased within the high perimeter area of these remnants while the genetic pool available for regeneration of species is dramatically reduced (Naturaliste Environmental Services 2002).

1.6 Flora & Vegetation

Beard (1980) mapped vegetation of the Swan region at a scale of 1: 1,000,000, describing vegetation of the study area broadly as 'marri-woodland'.

Tille and Lantzke (1990) describe the dominant vegetation complex of the Abba Plain as marri and marri/jarrah *(Corymbia calophylla, Eucalyptus marginata)* forest and woodland, both having been extensively cleared for agriculture. Department of Agriculture (2003) land profiler maps describe vegetation across the survey area as 'medium woodland; marri with some jarrah, wandoo, river gum and casuarinas'.

Heddle *et al.* (1980) described vegetation complexes of the Darling System. Three vegetation complexes, Cartis, Jarrahwood and Abba are mapped across the survey area. The Cartis Complex occurs on upper sandy slopes in the southeast portion of the survey area and consists of a low open forest to open forest of Jarrah (*Eucalyptus marginata*), Marri (*Corymbia calophylla*) and Mountain gum (*Corymbia haematoxylon*) with a second storey of *Banksia* species. Common understorey species include *Xylomelum occidentale, Melaleuca thymoides, Pultenaea reticulata, Podocarpus drouynianus, Hibbertia subvaginata* and *Hakea ruscifolia*. The Abba Complex is described as

consisting of a mixture of open forest of *Corymbia calophylla*, *Eucalyptus marginata* and *Banksia* species, woodland of *Corymbia calophylla* with minor occurrences of *Corymbia haematoxylon,* and woodland of *Eucalyptus rudis* and *Melaleuca* species along creeks and on flood plains. The Cartis complex marks the edge of the Blackwood Plateau and the Abba unit is sandy with poor drainage (Churchward & McArthur, 1980). The Jarrahwood Complex is restricted to the western boundary of the survey area, as defined by the Abba River. Associated vegetation is described broadly as open forest of *E. marginata - C. calophylla* on the slopes, woodland of *E. patens - E. megacarpa - Banksia littoralis* with patches of *Melaleuca preissiana* on the moister soils.

1.7 Declared Rare & Priority Flora

All native flora species are protected under the *Wildlife Conservation Act 1950 - Wildlife Conservation (Rare Flora) Notice 2005.* A number of plant species are assigned an additional level of conservation significance based on a limited number of known populations and the perceived threats to these locations. Species of the highest conservation significance are gazetted Declared Rare Flora (DRF) under subsection 2 of section 23F of the *Wildlife Conservation Act 1950*, while species which are believed to warrant a lesser level of protection are assigned to one of four Priority Flora categories (see Appendix 1).

The Department of Conservation and Land Management (CALM) regularly reviews and revises the schedule of Declared Rare and Priority Flora listings in Western Australia (Atkins 2005), and is responsible for collating and distributing this information. It is an offence to 'take' or damage DRF without Ministerial approval. Flora with conservation significance known to occur in the Tutunup locality are outlined in Table 3.

TABLE 3: Declared Rare and Priority flora previously recorded from the Tutunup area.

Taxon	Description	Conservation Code
Darwinia sp. Williamson	Shrub 70cm x 40cm	R - E
Dryandra nivea subsp. *uliginosa*	Mounded shrub to 80cm tall	R - E
Gastrolobium papilio	Erect shrub 1.5m x 1m	R - E
Grevillea mccutcheonii	Dense shrub 1.5mx3m	R - E
Lambertia echinata subsp. *occidentalis*	Sprawling shrub 2m x 1m	R - E
Petrophile latericola	Erect shrub 75cm x 40cm	R - E
Brachysema modestum	Decumbent shrub 0.5m x 1.5m	R - V
Dryandra squarrosa subsp. *argillacea*	Shrub 1-5m	R - V
Grevillea elongata	Shrub 3m x 2m	R - V
Chamelaucium roycei	Erect, compact shrub 50cm x 40cm	R - V
Andersonia ferricola	Small slender shrub	P1
Calothamnus affin *crassus*	Much branched upright shrub to 2m tall	P1
Calothamnus sp. Whicher	Dense much branched shrub to 4m tall	P1
Hakea oldfieldii	Shrub 1m-3m tall.	P3
Isopogon formosus subsp. *dasylepis*	Erect shrub 1m-2m tall.	P3
Loxocarya magna	Tall sedge 1m-1.5m tall	P3
Myriophyllum echinatum	Erect annual, herb, 0.02–0.03 m high	P3
Verticordia attenuata	Shrub, 0.4–1 m high	P3
Banksia meisneri subsp. *ascendens*÷	Shrub to 2m tall	P4
Boronia humifusa	Low shrub to 0.2m tall	P4
Franklandia triaristata	Erect, lignotuberous shrub, 0.2–1 m high	P4

2 OBJECTIVES

The main objectives of the survey were to:

- Provide an inventory of vascular plants;
- Describe & map vegetation complexes;
- Describe vegetation condition of the above vegetation complexes using a recognized condition scale such as that used in *Bush Forever;*
- Review the conservation status of all plant taxa recorded; and
- Provide an inventory of exotic plants including declared taxa.

3 METHODOLOGY

3.1 Flora and Vegetation

Prior to the field survey a variety of topographic, vegetation, and land system maps were used to provide preliminary vegetation classification of the survey area, and select sites of interest for detailed ground traverses (native vegetation remnants).

The survey comprised a total of two days effort to ground truth the survey area, establish sampling plots, collect voucher specimens, and assess vegetation classification; 5-6 May 2005. For each of eight sampling plots a number of parameters were recorded on data sheets including GPS coordinate, photographic record, vegetation description, dominance of life-form strata, percentage cover provided by individual species, surface soil type, litter cover and disturbance details. All plant taxa occurring within the sampling plots were recorded in accordance with Appendix 2 of the Guidance Statement No. 51 (Environmental Protection Authority, 2004). Voucher specimens were taken for selected species to verify identification that could not be confidently substantiated in the field. Use was made of the Western Australian State Herbarium for confirmation of species identification. Nomenclature follows Green (1985 & 1987), Paczkowska and Chapman (2000) and the Western Australian Herbarium.

During the field survey a classification was developed as a basis for mapping. The resultant map, Figure 2, represents the eight vegetation associations subsequently described. Description of vegetation structure follows the height, life form and density classes of Muir (1977, see Appendix 2). This is largely a structural classification suitable for broader scale mapping, but taking all ecologically significant strata into account.

4 RESULTS

4.1 Flora

A total of 154 plant taxa (including varieties and subspecies) from 42 families and 107 genera were recorded within the survey area, 5-6 May 2005 (see Appendix 3). Species representation was greatest among the following families: Proteaceae (19), Papilionaceae (18), Myrtaceae (17), Poaceae (16), Cyperaceae (11), Restionaceae (9), Dasypogonaceae (8), Asteraceae (6) and Mimosaceae (5).

4.2 Declared Rare and Priority Flora

Extensive grouth truthing and the establishment of eight sampling plots resulted in the identification of four Priority flora within the survey area; *Cyathochaeta teretifolia* (P3), *Acacia semitrullata* (P3), *Acacia flagelliformis* (P4) and *Jacksonia sparsa* ms (P4). No plant taxa gazetted as Declared Rare Flora pursuant to subsection (2) of section 23F of the Wildlife Conservation Act (1950) were recorded.

Cyathochaeta teretifolia (Priority 3 flora) was restricted to one isolated remnant situated on the Kemp's property (vegetation complex 1), surrounded by cleared farmland. *C. teretifolia* was the dominant understorey species recorded as occurring 'frequently'.

Acacia semitrullata (Priority 3 flora) was restricted to undisturbed vegetation in the State Forest block (vegetation complex 8), where it occurred as 'scattered individuals' growing inconspicuously amongst other understorey species.

Acacia flagelliformis (Priority 4 flora) occurred as 'scattered individuals' restricted to a minor unincised drainage line along the verge of Williamson Road (vegetation complex 5).

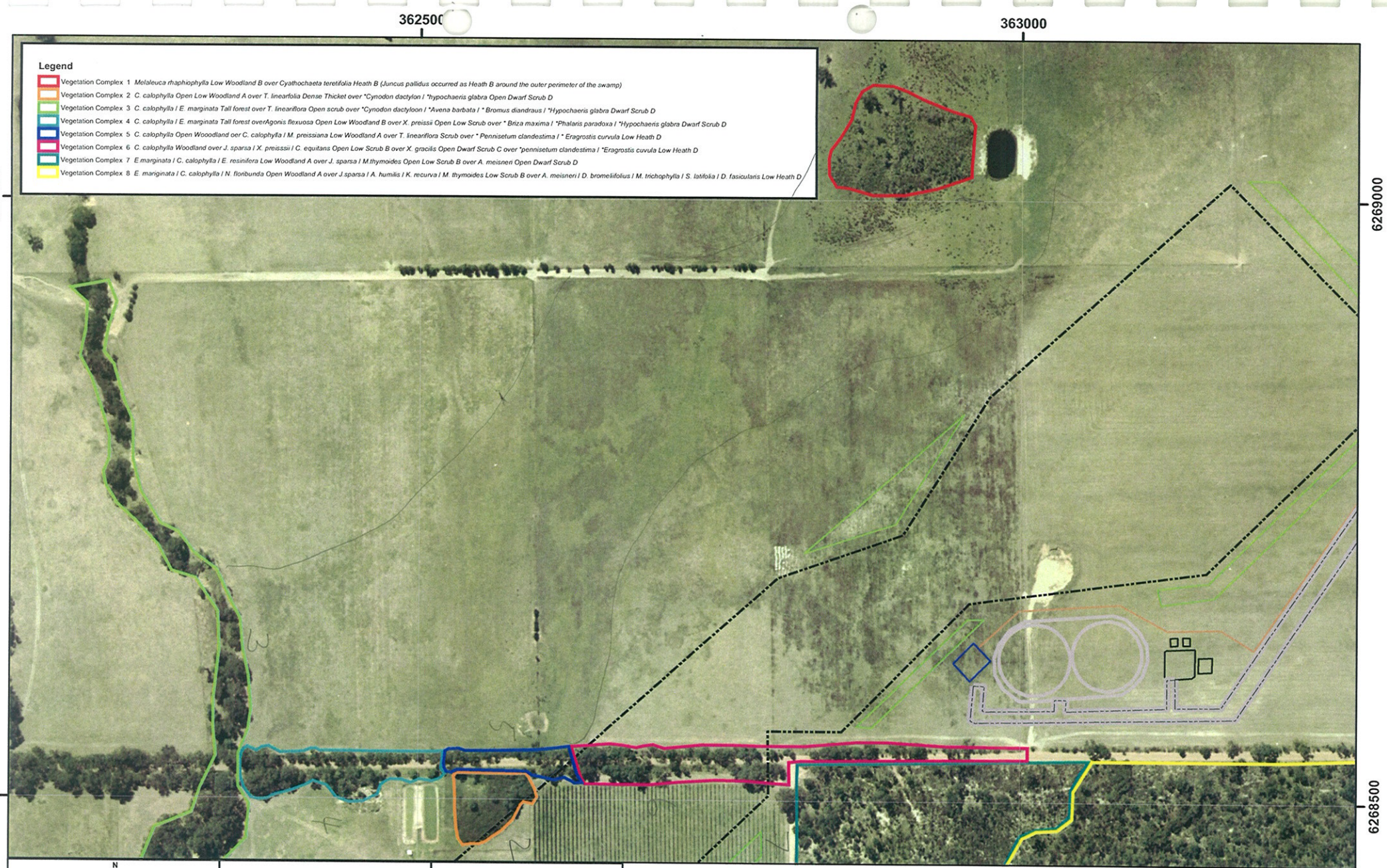
Jacksonia sparsa ms (Priority 4 flora) was 'common' along the verge of Williamson Road for the eastern half of the survey area (vegetation complex 6), and extended into the Abba State Forest block (vegetation complexes 7 & 8).

4.3 Vegetation

Native vegetation within the survey area was delineated into eight distinct remnants based on changes in vegetation structure and composition. Each site was sampled intensively within a 10 m x 10 m plot, with additional ground truthing occurring throughout each remnant. Vegetation at each sampling site has been described (Table 4) and mapped (Figure 2). Photographic plates for each vegetation complex are presented as Figure 3.

TABLE 4: Summary of vegetation descriptions for each of eight sampling sites across the Tutunup South survey area.

Site	Vegetation Description	Landform / Soil
1	*Melaleuca rhaphiophylla* Low Woodland B over *Cyathochaeta teretifolia* Heath B (*Juncus pallidus* occurred as Heath B around the outer perimeter of the swamp)	Swamp situated in middle of paddock, dark bown clay loam soils, heavily grazed understorey stratum
2	*C. calophylla* Open Low Woodland A over *T. linearifolia* Dense Thicket over **Cynodon dactylon / *Hypochaeris glabra* Open Dwarf Scrub D	Low lying drainage depression situated in paddock, dark brown loamy sand soils, heavily grazed understorey strata
3	*C. calophylla / E. marginata* Tall Forest over *T. linearifolia* Open Scrub over **Cynodon dactylon / *Avena barbata / *Bromus diandrus / *Hypochaeris glabra* Dwarf Scrub D	Deeply incised banks of Abba River, dark brown sandy loam soils, heavily grazed understorey strata
4	*C. calophylla / E. marginata* Tall Forest over *Agonis flexuosa* Open Low Woodland B over *X. preissii* Open Low Scrub B over **Briza maxima / *Phalaris paradoxa / *Hypochaeris glabra* Dwarf Scrub D	Lower slopes adjacent to banks of the Abba River, brown loam soils, narrow road verge with significant weed invasion in low stratum
5	*C. calophylla* Open Woodland over *C. calophylla / M. preissiana* Low Woodland A over *T. linearifolia* Scrub over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D	Unincised drainage line, brown loam soils, narrow road verge with significant weed invasion in low stratum
6	*C. calophylla* Woodland over *J. sparsa / X. preissii / C. equitans* Open Low Scrub B over *X. gracilis* Open Dwarf Scrub C over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D	Mid and lower hill slopes, red/orange gravelly loam soils, narrow road verge with significant weed invasion in low stratum
7	*E. marginata / C. calophylla / E. resinifera* Low Woodland A over *J. sparsa / M. thymoides* Open Low Scrub B over *A. meisneri* Open Dwarf Scrub D	Upper hill slopes, light brown sand over laterite, surface sands previously excavated to 2m
8	*E. marginata / C. calophylla / N. floribunda* Open Low Woodland A over *J. sparsa / A. humilis / K. recurva / M. thymoides* Low Scrub B over *A. meisneri / D. bromeliifolius / M. trichophylla / S. latifolia / D. fasicularis* Low Heath D	Upper hill slopes in grey sand over laterite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Legend
Vegetation Complex 1 Melaleuca rhaphiophylla Low Woodland B over Cyathochaeta teretifolia Heath B (Juncus pallidus occurred as Heath B around the outer perimeter of the swamp)
Vegetation Complex 2 C. calophylla Open Low Woodland A over T. linearfolia Dense Thicket over *Cynodon dactylon / *hypochaeris glabra Open Dwarf Scrub D
Vegetation Complex 3 C. calophylla / E. marginata Tall forest over T. linearifiora Open scrub over *Cynodon dactyloon / *Avena barbata / * Bromus diandraus / *Hypochaeris glabra Dwarf Scrub D
Vegetation Complex 4 C. calophylla / E. marginata Tall forest overAgonis flexuosa Open Low Woodland B over X. preissii Open Low Scrub over * Briza maxima / *Phalaris paradoxa / *Hypochaeris glabra Dwarf Scrub D
Vegetation Complex 5 C. calophylla Open Wooodland oer C. calophylla / M. preissiana Low Woodland A over T. linearifiora Scrub over * Pennisetum clandestima / * Eragrostis curvula Low Heath D
Vegetation Complex 6 C. calophylla Woodland over J. sparsa / X. preisssii / C. equitans Open Low Scrub B over X. gracilis Open Dwarf Scrub C over *pennisetum clandestima / *Eragrostis cuvula Low Heath D
Vegetation Complex 7 E marginata / C. calophylla / E. resinifera Low Woodland A over J. sparsa / M.thymoides Open Low Scrub B over A. meisneri Open Dwarf Scrub D
Vegetation Complex 8 E. mariginata / C. calophylla / N. floribunda Open Woodland A over J.sparsa / A. humilis / K. recurva / M. thymoides Low Scrub B over A. meisneri / D. bromelilifolius / M. trichophylla / S. latifolia / D. fasicularis Low Heath D
N
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Tutunup South Project
Vegetation Complexes
Drawn : Todd Griffin
Originator : BE
File Name :
Date : 27 May 2005
Version : 1
Datum : GDA Zone 50

1 ***Melaleuca rhaphiophylla* Low Woodland B over *Cyathochaeta teretifolia* Heath B (*Juncus pallidus* occurred as Heath B around the outer perimeter of the swamp)**

Vegetation Complex 1 was restricted to a small remnant surrounded by cleared agricultural land that is used for grazing dairy cattle (the Kemp's property). Vegetation occurs within a poorly drained depression that is typical across the undulating Abba Plain land system (Abba Wet Flats). Soils are dark brown clay loams beneath a moist surface humus layer. The vegetation complex comprises an open low tree cover dominated by the paperbark *Melaleuca rhaphiophylla,* over the tufted sedge *Cyathochaeta teretifolia* which forms a characteristic Heath B stratum. *Juncus pallidus* replaces *C. teretifolia* as the dominant undertsorey component around the outer perimeter of the swamp. Associated tall shrubs / low trees occurring with *M. rhaphiophylla* include *Eucalyptus rudis, Astartea scoparia* and *Taxandria parviceps.* The understorey has been heavily grazed by domestic stock with plant taxa generally represented as scattered individuals; *Taxandria linearifolia, Lepidosperma* sp., *Patersonia occidentalis, Juncus pallidus* and *J. kraussii* ssp. *australiensis,* along with a variety of introduced pasture weeds.

2 ***Corymbia calophylla* Open Low Woodland A over *Taxandria linearifolia* Dense Thicket over **Cynodon dactylon / *Hypochaeris glabra* Open Dwarf Scrub D**

Vegetation Complex 2 occurred as a small remnant along the northern boundary of the Hood property. As with Complex 1, vegetation was associated with a drainage depression that forms part of the Abba Wet Flats land system. Complex 2 was dominated by a single species, *Taxandria linearifolia,* which formed Dense Thicket below scattered taller trees of *Corymbia calophylla.* The understorey and ground cover strata had been completely removed through historical grazing by domestic stock and only two native species were recorded; *Juncus pallidus* and *Lomandra sonderi.* A variety of introduced species was recorded including **Anagallis arvensis, *Hypochaeris glabra, *Anthoxanthus odoratum, *Cynodon dactylon* and **Paspalum distichum.*

3 ***Corymbia calophylla / Eucalyptus marginata* Tall Forest over *Taxandria linearifolia* Open Scrub over **Cynodon dactylon / *Avena barbata / *Bromus diandrus / *Hypochaeris glabra* Dwarf Scrub D**

Vegetation Complex 3 occurs along the deeply incised banks of Abba River, delineating the western boundary of the survey area. This complex has previously mapped as part of the 'Abba Fertile Flats', which has been extensively cleared for agriculture. Within the survey area, the Abba River has not been fenced from adjacent paddocks, resulting in a degraded undertsorey and associated destabilization of levee banks. Vegetation was described as a Tall Forest supporting an intact canopy of large trees, with both *Corymbia calophylla* and *Eucalyptus marginata* well represented. *Taxandria linearifolia* was the dominant native understorey species occurring at greater than 2 m in height as 'Open Scrub'. All remaining native species recorded in the understorey provided individual foliage cover less than 2%; *Nuytsia floribunda, Astartea scoparia, Loxocarya striata, Isolepis nodosa, Lomandra nigricans, L. sonderi, Lobelia alata.* Introduced pasture and weed species were common in the ground cover, forming 'Dwarf Scrub D'; **Cynodon dactylon, *Avena barbata, *Bromus diandrus, *Hypochaeris glabra.*

4 ***Corymbia calophylla / Eucalyptus marginata* Tall Forest over *Agonis flexuosa* Open Low Woodland B over *Xanthorrhoea preissii* Open Low Scrub B over **Briza maxima / *Phalaris paradoxa / *Hypochaeris glabra* Dwarf Scrub D**

Vegetation Complex 4 occurred along a narrow strip of road verge extending east from the Abba River, restricted to dark brown sandy loam soils typical on lower slopes of the Abba Plain. *Corymbia calophylla* and *Eucalyptus marginata* provided the 'Tall Forest' canopy. However, it was the low tree *Agonis flexuosa* (represented as Open Low

Woodland B) and mid-tall shrubs *Xanthorrhoea preissii* (forming Open Low Scrub B) that were characteristic species of this complex. Other understorey species recorded included *Xylomelum occidentale, Kingia australis, Dasypogon hookeri, Acacia extensa, Hakea lissocarpha, Hypocalymma angustifolium, A. pulchella, Hibbertia furfuracea, Mesomelaena tetragona, Tetraria octandra, T. capillaris* and *Lepidosperma squamatum.* A variety of introduced grasses and weeds were present in the ground cover, the most common being **Briza maxima, *Phalaris paradoxa* and **Hypochaeris glabra.*

5 ***Corymbia calophylla* Open Woodland over *Corymbia calophylla / Melaleuca preissiana* Low Woodland A over *Taxandria linearifolia* Scrub over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D**

Vegetation Complex 5 was restricted to a 50 m length of verge along Williamson Road, associated with a narrow unincised drainage depression that forms part of the 'Abba Wet Flats'. Vegetation structure comprised an Open Woodland of tall *Corymbia calophylla* over a mixture of *C. calophylla* regrowth and low trees of *Melaleuca preissiana,* represented as Low Woodland A. The understorey was dominated by the tall shrub *Taxandria linearifolia,* forming Scrub over a well established ground cover of introduced weeds and grasses that included **Pennisetum clandestima* and **Eragrostis curvula.* Other species recorded as minor components in the understorey included *Acacia flagelliformis, A. extensa, Xanthorrhoea preissii, Kunzea recurva, Haemodorum spicatum, Dasypogon bromeliifolius, Hypolaena exsulca* and *Tricoryne elatior.*

6 ***Corymbia calophylla* Woodland over *Jacksonia sparsa / Xanthorrhoea preissii / Cyathochaeta equitans* Open Low Scrub B over *X. gracilis* Open Dwarf Scrub C over **Pennisetum clandestima / *Eragrostis curvula* Low Heath D**

Vegetation Complex 6 occurred in gravelly loam soils along the narrow verge of Williamson Road, extending east from Complex 5 with increasing relief to the boundary of the survey area. The well established *Corymbia calophylla* Woodland occurs above scattered tall shrubs of *Banksia grandis, Xylomelum occidentale, Dasypogon hookeri* and *Acacia extensa,* and an Open Low Scrub B stratum supporting *Jacksonia sparsa* ms, *Xanthorrhoea preissii, Cyathochaeta equitans* and *Podocarpus drouynianus.* The low shrubs *Xanthorrhoea gracilis, Macrozamia riedlei* and *Acacia pulchella* occur above a ground cover of introduced grasses that includes **Pennisetum clandestima* and **Eragrostis curvula.* Other genera recorded were *Persoonia, Jacksonia, Grevillea, Pultenaea, Melaleuca, Ricinocarpos, Hypocalymma, Daviesia, Hibbertia, Bossiaea, Adenanthos, Hovea, Patersonia, Lomandra, Lepidosperma, Anarthria, Loxocarya* and *Tricoryne.*

7 ***Eucalyptus marginata / Corymbia calophylla / Eucalyptus resinifera* Low Woodland A over *Jacksonia sparsa / Melaleuca thymoides* Open Low Scrub B over *Adenanthos meisneri* Open Dwarf Scrub D**

Vegetation Complex 7 was situated in the corner of the State Forest block adjacent to Williamson Road on the eastern boundary of the survey area. There was clear evidence that the corner block had been previously disturbed through excavation and removal of surface sands, leaving a light brown gravelly sand medium. An effort to rehabilitate the upperstorey layer had occurred through planting of the eastern states tree *Eucalyptus resinifera,* which occurred alongside sparse natural regrowth. The open understorey strata were dominated by colonizer species. *Jacksonia sparsa* ms and *Melaleuca thymoides* formed Open Low Scrub B above a sparse low shrub cover provided by *Adenanthos meisneri* (Open Dwarf Scrub D). Other understorey species providing less than 2% cover included *Agonis flexuosa, Acacia extensa, A. stenoptera, Pityrodia bartlingii, Grevillea trifida, Hypocalymma robustum, Adenanthos barbiger, Patersonia occidentalis, Mesomelaena tetragona* and *Kennedia prostrata.*

8 ***Eucalyptus marginata / Corymbia calophylla / Nuytsia floribunda*** **Open Low Woodland A over** ***Jacksonia sparsa / Allocasuarina humilis / Kunzea recurva / Melaleuca thymoides*** **Low Scrub B over** ***Adenanthos meisneri / Dasypogon bromeliifolius / Melaleuca trichophylla / Stirlingia latifolia / Desmocladus fasicularis*** **Low Heath D**

Vegetation Complex formed part of the State Forest block proper, occurring in deep grey sandy soils on upper slopes (Yelverton Deep Sandy Flats & Low Slopes). Vegetation showed highest native species richness in compison to all other sites sampled (57 taxa), and correspondingly the lowest count for introduced weeds and grasses (4 taxa). Tall trees of *Eucalyptus marginata* formed Open Wodland above a mixture of *Corymbia calophylla* and *E. marginata* regrowth, which formed Open Low Woodland A with large specimens of *Nuytsia floribunda.* A variety of mid-storey shrubs formed Low Scrub B, including the common taxa *Jacksonia sparsa* ms, *Allocasuarina humilis, Kunzea recurva* and *Melaleuca thymoides.* The most prominent stratum comprised shrubs less than 0.5 m in height, represented as Low Heath D; *Adenanthos meisneri, Dasypogon bromeliifolius, Melaleuca trichophylla, Stirlingia latifolia, Desmocladus fascicularis.* Other understorey species represented were *Xylomelum occidentale, Persoonia longifolia, Banksia attenuata, B. grandis, Xanthorrhoea preissii, Beaufortia squarrosa, Cyathochaeta equitans, Pityrodia bartlingii, Podocarpus drouynianus, Acacia pulchella, A. semitrullata, Calytrix flavescens, Persoonia saccata, Leucopogon elatior, Hibbertia furfuracea, Adenanthos sericeus* ssp. *sericeus, A. obovatus, Dryandra lindleyana, Conostylis aculeata* ssp. *aculeata, Hypolaena exsulca, Lyginea barbata* and *Stylidium repens.*

Vegetation Complex 1

Vegetation Complex 2

Vegetation Complex 3

Vegetation Complex 4

Vegetation Complex 5

Vegetation Complex 6

Vegetation Complex 7

Vegetation Complex 8

FIGURE 3: Vegetation map showing the distribution of eight vegetation complexes across the Tutunup South survey area.

4.4 Vegetation Condition

Remnant vegetation on the Kemp (complex 1) and Hood (complexes 2 & 3) properties is not fenced from surrounding farmland, and has been actively grazed by domestic stock for an extended period. Uncontrolled grazing has resulted in loss of perennial plant life forms, particularly for understorey strata, and subsequent invasion by introduced grass and weed species. As such, Vegetation complexes 1, 2 & 3 were rated as 'degraded' (score 5) or 'completely degraded (score 6; see Table 5 & Appendix 4 for rating system).

The condition for two of three vegetation complexes mapped along the narrow verge of Williamson Road (complexes 4 & 5) were rated as 'degraded' (score 5). Native species richness had been significantly reduced, and introduced weeds and grasses were dominant in the ground cover. Vegetation along the eastern portion of the Williamson Road verge (complex 6) retained higher native species richness, structure was better defined, and introduced grasses were less prominent in the ground cover. The resultant condition rating was 'good' (score 4).

The corner of the Abba State Forest block on the western boundary of the survey area was mapped as two complexes, 7 & 8. Vegetation complex 7 was restricted to a previously disturbed site where surface sands had been excavated and removed from the upper profile. Vegetation was a mixture of sparse native regrowth, and introduced tree species originating from the eastern states. Vegetation condition was rated as 'degraded' (score 5). The larger State Forest area occurring further east was represented by highest native species richness, with few introduced weeds and grasses evident. Vegetation condition was rated as 'excellent' (score 2).

TABLE 5: Summary of vegetation descriptions for each of eight sampling sites across the Tutunup South survey area.

Complex	Vegetation Description	Condition Rating
1	*Melaleuca rhaphiophylla* Low Woodland B over *Cyathochaeta teretifolia* Heath B (*Juncus pallidus* occurred as Heath B around the outer perimeter of the swamp)	5
2	*C. calophylla* Open Low Woodland A over *T. linearifolia* Dense Thicket over **Cynodon dactylon* / **Hypochaeris glabra* Open Dwarf Scrub D	6
3	*C. calophylla / E. marginata* Tall Forest over *T. linearifolia* Open Scrub over **Cynodon dactylon* / **Avena barbata* / **Bromus diandrus* / **Hypochaeris glabra* Dwarf Scrub D	5
4	*C. calophylla / E. marginata* Tall Forest over *Agonis flexuosa* Open Low Woodland B over *X. preissii* Open Low Scrub B over **Briza maxima* / **Phalaris paradoxa* / **Hypochaeris glabra* Dwarf Scrub D	5
5	*C. calophylla* Open Woodland over *C. calophylla / M. preissiana* Low Woodland A over *T. linearifolia* Scrub over **Pennisetum clandestima* / **Eragrostis curvula* Low Heath D	5
6	*C. calophylla* Woodland over *J. sparsa / X. preissii / C. equitans* Open Low Scrub B over *X. gracilis* Open Dwarf Scrub C over **Pennisetum clandestima* / **Eragrostis curvula* Low Heath D	4
7	*E. marginata / C. calophylla / E. resinifera* Low Woodland A over *J. sparsa / M. thymoides* Open Low Scrub B over *A. meisneri* Open Dwarf Scrub D	5
8	*E. marginata / C. calophylla / N. floribunda* Open Low Woodland A over *J. sparsa / A. humilis / K. recurva / M. thymoides* Low Scrub B over *A. meisneri / D. bromeliifolius / M. trichophylla / S. latifolia / D. fasicularis* Low Heath D	2

4.5 Floristic Community Types (FCT)

Three of the vegetation complexes recorded within the survey area are inferred to be degraded examples of Floristic Community Type 4, *Melaleuca preissiana* damplands (Gibson *et al.* 1994).

1 *Melaleuca rhaphiophylla* Low Woodland B over *Cyathochaeta teretifolia* Heath B (*Juncus pallidus* occurred as Heath B around the outer perimeter of the swamp)
2 *Corymbia calophylla* Open Low Woodland A over *Taxandria linearifolia* Dense Thicket over **Cynodon dactylon* / **Hypochaeris glabra* Open Dwarf Scrub D
5 *Corymbia calophylla* Open Woodland over *Corymbia calophylla* / *Melaleuca preissiana* Low Woodland A over *Taxandria linearifolia* Scrub over **Pennisetum clandestima* / **Eragrostis curvula* Low Heath D

Vegetation complexes 4, 6, 7 and 8 are inferred to be representative of Floristic Community Type 1a. V. English has stated that Floristic Community Type 1a might be eventually listed as a Threatened Ecological Community once more field work has been undertaken, but at present is not recognised as such (Bennett 2004).

Vegetation complex 3, associated with the Abba River, has been degraded to the point that it is impossible to infer a floristic community type.

4.6 Weeds

Table 6 lists 38 introduced weed species recorded within from the eight vegetation complexes described within the Tutunup South survey area. None of the introduced taxa recorded are 'Declared Plants' pursuant to Section 37 of the Agricultural and Related Resources Protection Act (1976). However, four species recorded along the verge of Williamson Road are rated as being highly invasive, widely distributed and possessing the ability to change vegetation structure; *Asparagus asparagoides, Bromus diandrus, Ehrharta calycina* and *Eragrostis curvula*. These species have contributed to a progressive decline in vegetation condition.

TABLE 6: Introduced taxa recorded from the Tutunup South survey area.

Species	Common Name
Asparagus asparagoides	Bridal creeper
Bromus diandrus	Great brome
Ehrharta calycina	Perennial veldt grass
Eragrostis curvula	African lovegrass
Aira caryophyllea	Silvery hairgrass
Anthoxanthum odoratum	Sweet vernal grass
Arctotheca calendula	Cape weed
Avena barbata	Bearded oats
Briza maxima	Blow fly grass
Briza minor	Shivery grass
Cynodon dactylon	Couch
Ficus carica	Fig
Hypochaeris glabra	Flat weed
Paspalum distichum	Water couch
Pennisetum clandestinum	Jersey cudweed
Pseudognaphalium luteum	Jersey cudweed
Solanum nigrum	Blackberry nightshade
Sonchus oleraceus	Sow thistle
Trifolium campestre var *campestre*	Hop clover
Trifolium subterraneum	Subterraneum clover
Ursinia anthemoides	Ursinia
Watsonia meriana ssp. *meriana*	Watsonia
Oxalis glabra	Finger leaf sorrel
Oxalis pes-caprae	Soursob
Rumex crispus	Curled dock
Lolium perenne	Perennial ryegrass
Lotus suaveolens	Hairy birdsfoot trefoil
Anagallis arvensis	Pimpernel
Chamaecytisus palmensis	Tagasaste
Citrullus lanatus	Pig melon
Conyza bonariensis	Flaxleaf fleabane
Lagurus ovatus	Hare's tail grass
Lupinus cosentinii	WA blue lupin
Monadenia bracteata	South African orchid
Phalaris paradoxa	Paradoxa grass
Pinus pinaster	Maritime pine
Plantago lanceolata	Ribwort plantain
Veronica arvensis	Wall speedwell

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APPENDIX 1: Conservation Codes for Western Australian Flora.

Conservation & Land Management

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 which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farm land, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

2: Priority Two - Poorly Known Taxa

Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

3: Priority Three - Poorly Known Taxa

Taxa which are known from several populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further survey.

4: Priority Four - Rare Taxa

Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

EPBC Act (1999)

E: Endangered

At this time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.

V: Vulnerable

At this time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future

APPENDIX 2: Vegetation classification used for the Tutunup South flora & vegetation survey (from Muir 1977).

LIFE FORM / HEIGHT CLASS	Canopy Cover			
	DENSE 70 % - 100%	**MID DENSE** 30% - 70%	**SPARSE** 10% - 30%	**VERY SPARSE** 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 - 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 - 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass > 0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX 3: Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		Study Site							
		1	2	3	4	5	6	7	8
ANTHERICACEAE									
Agrostocrinum scabrum	R. Br.							1	
Tricoryne elatior	R.Br.					1	1		
ASPARAGACEAE									
**Asparagus asparagoides*	(L.) Wight				1				
ASTERACEAE									
**Arctotheca calendula*	(L.) Levyns								1
**Conyza bonariensis*	(L.) Cronquist					1		1	
**Hypochaeris glabra*	L.	1	1	1	1	1	1	1	1
**Pseudognaphalium luteoalbum*	(L.) Hilliard & Burtt			1					
**Sonchus oleraceus*	L.					1			
**Ursinia anthemoides*	(L.) Poir.								1
CASUARINACEAE									
Allocasuarina humilis	(Otto & F. Dietr.) Johnson								1
CENTROLEPIDIACEAE									
Aphelia sp.	-								1
CHLOANTHACEAE									
Pityrodia bartlingii	(Lehm.) Benth.							1	1
COLCHICACEAE									
Burchardia umbellata	R.Br.								1
CUCURBITACEAE									
**Citrullus lanatus*	(Thunb.) Matsum. & Nakai	1							
CYPERACEAE									
Cyathochaeta equitans	K.L. Wilson						1		1
Cyathochaeta teretifolia	W. Fitz.	1							
Isolepis nodosa	(Rottb.) R.Br.)			1					
Lepidosperma leptostachyum	Benth.								1
Lepidosperma pubisquameum	Steud.				1				
Lepidosperma sp.	-	1							
Lepidosperma squamatum	Labill.				1		1		
Mesomelaena tetragona	(R.Br.) Benth.				1			1	
Schoenus brevisetis	(R.Br.) Roem. & Schult.							1	
Tetraria capillaris	(F.Muell.) J.M. Black				1				
Tetraria octandra	(Nees) Kuk.				1			1	

APPENDIX 3: cont'd Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		Study Site 1	2	3	4	5	6	7	8
DASYPOGONACEAE									
Dasypogon bromeliifolius	R.Br.					1			1
Dasypogon hookeri	J.Drumm.				1		1		
Kingia australis	R.Br.				1				
Lomandra brittanii	T.S. Choo								1
Lomandra hermaphrodita	(Andrews) Gardner						1	1	1
Lomandra nigricans	T. Macfarlane			1					
Lomandra purpurea	(Endl.) Ewart							1	1
Lomandra sonderi	(F.Muell.)Ewart		1	1			1	1	1
DILLENIACEAE									
Hibbertia ferruginea	J.R. Wheeler								1
Hibbertia furfuracea	(DC.) Benth.				1		1		1
Hibbertia huegelii	(Endl.) F.Muell.								1
DROSERACEAE									
Drosera menziesii	DC.							1	1
Drosera pallida	Lindl								
Drosera stolonifera	Endl.								1
EPACRIDACEAE									
Andersonia caerulea	R.Br.								1
Leucopogon elatior	Sond.								1
EUPHORBIACEAE									
Ricinocarpos glaucus	Endl.						1	1	
GOODENIACEAE									
Dampiera linearis	R. Br			1					
HAEMODORACEAE									
Conostylis aculeata ssp. *aculeata*	R.Br.								1
Haemodorum spicatum	R.Br.					1	1	1	1
IRIDACEAE									
Patersonia occidentalis	R. Br.	1					1	1	1
**Watsonia meriana* var. *meriana*	(Mathews & Bolus) Cooke						1		
JUNCACEAE									
Juncus kraussii	Hochst.	1				1			
Juncus pallidus	R.Br.	1	1		1	1	1	1	
LAURACEAE									
Cassytha racemosa	Nees							1	1
LOBELIACEAE									
Lobelia alata	Labill.			1					

APPENDIX 3: cont'd Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		Study Site 1	2	3	4	5	6	7	8
LORANTHACEAE									
Nuytsia floribunda	(Labill.) Fenzl			1					1
MIMOSACEAE									
**Acacia baileyana*	F. Muell.								
Acacia browniana	H.L. Wendl.								
Acacia extensa	Lindl.				1	1	1	1	
Acacia flagelliformis	Court					1			
Acacia pulchella	R.Br.				1		1		1
Acacia semitrullata	Maslin								1
Acacia stenoptera	Benth.							1	
MORACEAE									
**Ficus carica*	L.			1					
MYRTACEAE									
Agonis flexuosa	(Willd.) Sweet				1			1	
Astartea scoparia	Schauer	1		1					
Beaufortia squarrosa	Schauer							1	1
Calytrix flavescens	A. Cunn.								1
Corymbia calophylla	Lindley.		1	1	1	1	1	1	1
Eucalyptus marginata	Donn. ex. Smith			1	1		1	1	1
Eucalyptus resinifera	-							1	
Eucalyptus rudis	Endl.	1							
Hypocalymma angustifolium	(Endl.) Schauer				1	1			
Hypocalymma robustum	(Endl.) Lindl.						1	1	1
Kunzea recurva	Schauer					1			1
Melaleuca preissiana	Schauer					1			
Melaleuca rhaphiophylla	Schauer	1							
Melaleuca thymoides	Labill.						1	1	1
Melaleuca trichophylla	Lindl.								1
Taxandria linearifolium	(DC.) Schauer	1	1	1		1			
Taxandria parviceps	Schauer	1							
ORCHIDACEAE									
Eriochilus dilatatus ssp. *magnus*	Hopper & Brown							1	1
**Monadenia bracteata*	(Sw.) Durand & Schinz							1	
OXALIDACEAE									
**Oxalis glabra*	Thunb.							1	
**Oxalis pes-caprae*	L.							1	

APPENDIX 3: cont'd Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		Study Site 1	2	3	4	5	6	7	8
PAPILIONACEAE									
Bossiaea eriocarpa	Benth.							1	1
Bossiaea ornata	(Lindl.) Benth.						1	1	
**Chamaecytisus palmensis*	(Christ) Bisby & Nicholls						1		
Daviesia divaricata ssp. *divaricata*	Benth. ms						1	1	
Daviesia physodes	G. Don							1	1
Eutaxia virgata	Benth.					1	1		
Gompholobium tomentosum	Labill.								1
Hardenbergia comptoniana	(Andrews) Benth.				1				
Hovea chorizemifolia	(Sweet) DC.						1		
Jacksonia furcellata	(Bonpl.) DC.						1		
Jacksonia gracillima	ms								1
Jacksonia sparsa	Chappill ms						1	1	1
Kennedia prostrata	R.Br.							1	
**Lotus suaveolens*	Pers.	1							
**Lupinus cosentinii*	Guss.	1							
Pultenaea reticulata	(Sm.) Benth.						1		1
**Trifolium campestre* var *campestre*	Schreb.	1							
**Trifolium subterraneum*	L.	1							
PINACEAE									
**Pinus pinaster*	Aiton						1	1	
PITTOSPORACEAE									
Billardiera laxiflora	(Benth.) F.M. Bennett						1		
PLANTAGINACEAE									
**Plantago lanceolata*	L.				1				
POACEAE									
**Aira caryophyllea*	L.				1				
Amphipogon turbinatus	R.Br.								1
**Anthoxanthum odoratum*	L.	1	1						
**Avena barbata*	L.			1					
**Briza maxima*	L.			1	1	1		1	
**Briza minor*	L.			1					
**Bromus diandrus*	Roth			1					
**Cynodon dactylon*	(L.)Pers.		1	1			1		
**Ehrharta calycina*	Sm.				1				
**Eragrostis curvula*	(Schrad.) Nees					1	1	1	
**Lagurus ovatus*	L.						1		

APPENDIX 3: cont'd Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		Study Site 1	2	3	4	5	6	7	8
**Lolium perenne*	L.	1							
**Paspalum distichum*	L.	1	1			1			
**Pennisetum clandestinum*	Chiov.	1				1	1	1	
**Phalaris paradoxa*	L.	1			1				
PODOCARPACEAE									
Podocarpus drouynianus	F. Muel.						1		1
POLYGONACEAE									
**Rumex crispus*	L.	1		1	1	1	1		
PRIMULACEAE									
**Anagallis arvensis*	L.		1	1					
PROTEACEAE									
Adenanthos barbiger	Lindl.							1	
Adenanthos meisneri	Lehm.						1	1	1
Adenanthos obovatus	Labill.								1
Adenanthos sericeus ssp. *sericeus*	Labill.								1
Banksia attenuata	R.Br.						1	1	1
Banksia grandis	Willd.						1	1	1
Dryandra lindleyana	Meisn.								1
Grevillea trifida	(R.Br.) Meisn.						1	1	
Hakea linearis	R.Br.					1			
Hakea lissocarpha	R.Br.				1				
Hakea ruscifolia	Labill.						1	1	
Isopogon sphaerocephalus	Lindl.							1	
Persoonia elliptica	R.Br.						1		
Persoonia longifolia	R. Br.						1		1
Persoonia saccata	R.Br.								1
Stirlingia latifolia	(R.Br.) Steud.						1	1	1
Strangea stenocarpoides	(Benth.) C.A. Gardner								1
Synaphea floribunda	A.S. George							1	
Xylomelum occidentale	R.Br.				1		1		1
RESTIONACEAE									
Anarthria prolifera	R.Br.						1		
Anarthria scabra	R.Br.						1	1	
Desmocladus fasiculatus	(R. Br.) Briggs & Johnson							1	1
Empodisma gracillimum	(F.Muell.) Johnson & Cutler	1							

APPENDIX 3: cont'd Flora recorded from the Tutunup South survey area; all specimens recorded 5-6 May 2005. Shaded species are Priority flora

FAMILY Species (Botanical Terminology)		**Study Site**							
		1	2	3	4	5	6	7	8
Hypolaena exsulca	R.Br.					1		1	1
Hypolaena aff. *exsulca* (robust form)	R.Br.							1	
Loxocarya cinerea	R.Br.						1		
Loxocarya ? striata	(F.Muell.) Briggs & Johnson			1					
Lyginea barbata	R.Br.								1
RUBIACEAE									
Opercularia hispidula	Endl.			1					
SCROPHULARIACEAE									
**Veronica arvensis*	L.	1							
SOLANACEAE									
**Solanum nigrum*	L.			1		1			
STYLIDIACEAE									
Stylidium repens	R.Br.								1
XANTHORRHOEACEAE									
Xanthorrhoea gracilis	Endl.						1		1
Xanthorrhoea preissii	Endl.				1	1	1		1
ZAMIACEAE									
Macrozamia reidlei	(Fisch. ex Gaud.) Gardner						1		

APPENDIX 4: Vegetation condition scale as used in Bush Forever (Environmental Protection Authority, 1998).

CONDITION	SCALE	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 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.

CSL WATER MONITORING FIELDSHEET

Location NORTHSHORE **Personnel**

Date

Site	R.L. (m)	pH	E.C.	Temp	T.O.C		
NSMB 2							
NSMB 2R							
NSMB 3							
NSMB 4							
NSMB 5							
NSMB 6							
NSMB 7							
NSMB 8							
NSPB 2							
NSPB 4							
NSPB 5							
NSPB 6							

CSL WATER MONITORING FIELDSHEET

Location SANDALWOOD **Personnel**

Date

Site	R.L. (m)	pH	E.C.	Temp	T.O.C		
MP 1					1.13		
MP 2					0.36		
MP 3					0.18		
MP 4					0.21		
MP 5					0.23		
MP 6					0.21		
SWNBUS							
SWNBDS							
SWEXUS							
SWEXDS							
SWFRYUS							
SWFRYDS							
SWCRKUS							
SWCRKDS							
SWPB 1							
Water Dam							