

INTERIM RECOVERY PLAN NO. 315

***Corymbia calophylla* - *Kingia australis* woodlands on heavy soil
(Swan Coastal Plain Community type 3a - Gibson *et al.* 1994)**

**INTERIM RECOVERY PLAN
2011-2016**



September 2011
Department of Environment and Conservation
Species and Communities Branch
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Department of
Environment and Conservation



FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Environment and Conservation (DEC) Policy Statements Nos 44 and 50.

This Interim Recovery Plan replaces plan number 59 *Corymbia calophylla - Kingia australis* woodlands on heavy soil (Swan Coastal Plain Community type 3a - Gibson *et al.* 1994) 2000-2003' by V. English and J. Blyth.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

DEC is committed to ensuring that critically endangered ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by DEC's Director of Nature Conservation.

This Interim Recovery Plan will operate from September 2011 but will remain in force until withdrawn or replaced. It is intended that, if the community is still listed as critically endangered after five years, the need for an updated plan will be evaluated.

The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

Information in this IRP was accurate at September 2011.

ACKNOWLEDGMENTS

This Interim Recovery Plan was prepared by Valerie English.

Cover photograph by Valerie English.

The following people provided valuable advice and assistance in the preparation of this Interim Recovery Plan:

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CITATION

This Interim Recovery Plan should be cited as:

Department of Environment and Conservation (2011). Interim Recovery Plan 2011-2016 for *Corymbia calophylla - Kingia australis* woodlands on heavy soil, Swan Coastal Plain. Interim Recovery Plan No. 315. Department of Environment and Conservation, Perth.

SUMMARY

Name: *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils

Description: A woodland community located on heavy soils of the eastern side of the Swan Coastal Plain between Capel and Hazelmere. Typical and common native taxa in the community are: *Corymbia calophylla*; the shrubs *Banksia nivea*, *Philotheca spicata*, *Kingia australis* and *Xanthorrhoea preissii*; herbs, rushes and sedges, *Cyathochaeta avenacea*, *Dampiera linearis*, *Haemodorum laxum*, *Desmocladus fasciculatus*, *Mesomelaena tetragona* and *Tetraria octandra*. The introduced grass *Briza maxima* is also common in the community.

DEC Regions: Swan and Southwest.

DEC Districts: Blackwood and Swan Coastal.

Shires: Swan, Gosnells, Kalamunda, Armadale, Serpentine-Jarrahdale, Murray, Waroona and Capel.

Current status: Assessed 21 November 1995 as Critically Endangered. Listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Habitat requirements: Marri (*Corymbia calophylla*) dominated plant communities were historically probably some of the most common on heavy soils on the eastern side of the Swan Coastal Plain. Gibson *et al.* (1994) recognised three distinct communities in this group. The floristic composition of these communities varies with water regime, with the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils occurring on the wettest of the sites and being associated with the median species richness, and lowest level of weed invasion and disturbance. Groundwater is generally within 3m of the natural ground surface in occurrences of this community, and this indicates that these wetlands have a high level of dependence on groundwater.

Important occurrences: Occurrences that provide for representation of the community across its geographic range and that can be managed for conservation and/or with conservation included in their purpose are considered critical to the survival of this community.

Affected interests: Land owners and managers of all occurrences may be affected by actions in this plan, in particular those lands not managed by DEC or intended to be transferred to DEC management.

Indigenous interests: The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Comment was sought from the Council about any aspects of the plan, but particularly about the proposed on-ground actions. Table 2 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. No general significance to indigenous people has been identified for the ecological community. Action 2 identifies the intention to continue liaison with relevant groups, including indigenous groups.

Social and economic impacts and benefits: Pedestrian access by means of formal walk trails has potential to allow the aesthetic values of the community to be appreciated without degrading the community, and this provides a social benefit. Where specific active recreational pursuits such as four wheel driving are prevented through access control, this may be perceived as a social impact, however such access control also helps to prevent the continued degradation of the community and maintain other social benefits.

Occurrences may be threatened by proposals to clear for various developments or from hydrological change following clearing and development of adjacent land. Implementation of actions such as seeking to protect the hydrological processes in the adjacent community may result in an impact on development.

Wetlands such as this community provide various ecosystem services such as absorption of nutrients and other chemicals from polluted surface and groundwater. These services would have an economic value but are lost when wetlands are cleared and filled.

Related biodiversity impacts and benefits: Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community and other associated vegetation types within managed areas of remnant vegetation. Seven other TECs co-occur within remnant vegetation containing the community, and one declared rare flora and nine priority flora have been identified as occurring within or adjacent to this community. One species of priority fauna is believed to occur in this community.

Term of plan: The plan will operate from 2011 to 2016 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated.

IRP Objective: To maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat.

Criteria for success:

- An increase in the number of occurrences of this community managed for conservation and/or with conservation included in the purpose.
- Representative areas of the community across its geographical range with condition rank maintained, or with improved condition rank (Bush Forever 2000 scales).
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales)

Criteria for failure:

- Decline in condition rank of 10% of the area of the community or more.
- Failure to achieve an increase in the area managed for conservation.

Summary of Recovery Actions

Coordinate recovery actions	Implement weed control
Continue liaison to implement recommendations	Determine 'normal range' of groundwater levels, quality
Continue to disseminate information	Seek to influence land management practices to manage hydrology
Continue to monitor extent and boundaries	Fence remnants that contain the community
Encompass monitoring in adaptive management framework	Clarify the floristic community present at specified occurrences
Map habitat critical to survival	Support private landowners to conserve the community
Survey for dieback	Develop management guidelines
Ensure adequate hygiene conditions	Seek long term protection of areas of the community
Develop and implement fire management strategy	Report on success of management strategies

1. BACKGROUND

1.1 History, defining characteristics of ecological community, and conservation significance

A series of Marri (*Corymbia calophylla*) dominated plant communities occur on heavy soils between Ruabon (near Capel) and Guildford. These communities are considered to have been some of the most extensive on the eastern side of the Swan Coastal Plain, but have suffered extensive clearing and are now regionally rare (Keighery and Trudgen 1992; Gibson *et al.* 1994; Department of Environmental Protection 1996; Government of Western Australia 2000). The dominant species in the overstorey vary between the three community types recognised by Gibson *et al.* (1994). The wettest sites are dominated by *Corymbia calophylla* and *Kingia australis* (this community); the intermediate group (type 3b) by *Corymbia calophylla* and *Eucalyptus marginata*; and the driest group (type 3c) is dominated by *Corymbia calophylla* and *Xanthorrhoea preissii*. The driest type is also critically endangered, and the community on sites of intermediate dryness is ranked vulnerable.

Twenty six occurrences of this Marri community totalling about 98 ha have been located between Ruabon and Guildford and are recorded on the Threatened Ecological Communities Database (Appendix 3). The sites were located through extensive survey of the southern Swan Coastal Plain that involved compilation and analysis of data from over 1,500 plots (Keighery and Trudgen 1992; Gibson *et al.* 1994; Government of Western Australia 2000).

Some of the occurrences within the area considered under Bush Forever that contain the community are included in the Bush Forever document (Government of Western Australia 2000). This document provides that any proposals likely to affect occurrences of threatened ecological communities will be dealt with through the Bush Forever process, coordinated between the WA Planning Commission, Department of Environment and Conservation (DEC) and the Water and Rivers Commission (now Department of Water). The aim of Bush Forever is to ensure protection of sites listed within the Bush Forever documents.

As at January 2011, areas of the community recorded on the TEC database are as follows: about 4 ha is in Nature Reserves or Freehold with Director General of DEC, about 10 ha is on freehold land, and about 84 ha is on various other reserves, such as Shire reserves.

Typical and common native plant taxa in the community are: *Corymbia calophylla*; the shrubs *Banksia nivea*, *Philotheca spicata*, *Kingia australis* and *Xanthorrhoea preissii*; and herbs, rushes and sedges *Cyathochaeta avenacea*, *Dampiera linearis*, *Haemodorum laxum*, *Desmocladius fasciculatus*, *Mesomelaena tetragona* and *Tetraria octandra* (Gibson *et al.* 1994). The introduced grass *Briza maxima* is also common in the community, although weed cover in most occurrences is currently quite low. A list of taxa that commonly occur in the community is at Appendix 1.

There have been several occurrences identified and vested as conservation reserves since the last Recovery Plan was written (English and Blyth 2000). As a result, the threat of clearing has declined but may still represent a threat for occurrences whose purpose is not primarily conservation. It is also possible that occurrences of this community may be subject to impacts from proposals to develop areas. Weed invasion, altered fire regimes, hydrological changes, grazing, and the introduction of disease are still current threats to occurrences of the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils. Dieback disease caused by *Phytophthora* species has been recorded from three occurrences, and may potentially be present in more as not all occurrences of the community have been surveyed for this pathogen (Department of Environment and Conservation (DEC) 2007).

Too frequent fire is another major threat to the community. Fires have recently burnt through occurrences at Brickwood Road (Brickwood reserve - Occurrences 14, 15: refer Table 1 below), close to or within the community on Mundijong Road (Occurrence 18), Occurrence 3 in the Brixton Street wetlands and at Punrack Road (Occurrence 19).

Almost all of the occurrences are very close to or surrounded by highly urbanised areas. The frequency of fires, impact of recreational uses, risk of hydrological impacts, and incidence of illegal rubbish dumping are generally increased in urban areas. These factors can all lead to degradation of plant communities through increasing weed invasion and alteration of structure, species composition or loss of component taxa.

Salinisation and increased inundation as a consequence of clearing in the catchment may also represent threats to the community as it occurs in low lying sites in highly cleared areas, and most occurrences experience seasonal waterlogging or inundation.

Table 1: Extent, location and management of occurrences (listed from north to south – not as listed in TEC database; see also Appendix 3)

Occ. Number	Location	Land Owner/ Manager	Management comments	Estmtd area (ha)	Comments
Occurrence 1 (StirlCres Plot 2, 3, StirlCres08)	Public Road reserve (~4ha) Privately owned land in the City of Swan (~2ha)	Main Roads WA Private freehold	Potential impact from future road development	6	Bush Forever site 481 Stirling Crescent Bushland, Hazelmere
Occurrence 2 (M5305, M5306, Dundas02)	Reserve 37981 adjacent to Roe Highway, Forrestfield Reserve 37260 adjacent to Roe Highway, Forrestfield	Western Power Fire and Emergency Services Authority (FESA)	Not in secure conservation tenure	9.6	Bush Forever site
Occurrences 3-8 (Brix02, 06, 07, 08, 09, 10)	Brixton Street reserve; Crown Reserve 49200	Conservation Commission	Conservation tenure. Managed under Management Plan.	2.8	Bush Forever site
Occurrence 9, 10, 11 (Lamb01, 02, Fletcher01, 02)	Railway reserve 38079 Reserve 42044, Lambert Rd, Wungong (3.6ha) Reserve 14217 (for Recreation, Club)	Freehold Conservation Commission of WA City of Armadale	Part for conservation (nature reserve), part recreation, rail reserve and other uses	12.9	Bush Forever site
Occurrence 12, 13 (MyAbern01, 03)	Lot 96 on Plan 31286 Lot 9000 on Plan 24461	WA Planning Commission	Acquired for conservation	2.4	Bush Forever site
Occurrence 14, 15 (Brick01, 03, 05, 06, 07, 08,)	Brickwood Recreation Reserve 17490. Byford Crown Reserve 37404 Byford Townsite Lot 48, 108	Shire of Serpentine-Jarrahdale	Currently mainly managed for conservation	43.3	Bush Forever site
Occurrence 16 (MyByford04)	Rail and road reserve Cardup	Road and Rail Reserve – listed as Freehold (unnamed)	Rail and road purposes	2.4	Bush Forever site 350 (Byford to Serpentine Rail/Road Reserves and Adjacent Bushland)
Occurrence 17 (MyRoman03)	Reserve 46818 for Conservation of Flora and Fauna	Conservation Commission	Acquired for conservation	1.5	Bush Forever site
Occurrence 18 (MUD04, 05)	Mundijong Rd road reserve	Dept for Regional Development and Lands (planned for transfer to DEC management, previously Shire of Serpentine Jarrahdale)	Listed as 'Unmanaged for the purpose of government requirements'. Managed as Flora Reserve, but impacted by other factors (eg road planning) -	2.3	Not fenced
Occurrence 19 (Punr02)	WAPC land (previously private land), UCL and road reserve, Punrack Rd Serpentine	WAPC, DEC and Shire of Serpentine Jarrahdale	Part acquired for conservation, remainder on road reserve and Unallocated Crown Land (UCL)	1.8	Bush Forever site 74 – Rapids Road Bushland, Peel Estate
Occurrence 20 (Turner 01, 02, 03)	Road Reserve	Shire of Serpentine Jarrahdale	Current development proposal would impact	0.4	
Occurrence 21 (Pind01)	Reserve 34033 (Recreation)	Shire of Murray	Not in secure conservation tenure, but fenced	1.4	Not fenced
Occurrence 22, 23 (WARO06, 07)	Road reserve, rail reserve, Reserve 31347 for Conservation and Parklands	Shire of Waroona	Part road and rail reserves but majority of areas have conservation in purpose.	48.3	Not fenced

Occurrence 24 (Yoganup02)	Private land, Shire of Capel	Private landowner	Not in conservation tenure	1.7	
Occurrence 25 (Yoganup01)	Private land, Shire of Capel	Private landowner	Not in conservation tenure	2.1	
Occurrence 26 (Davies03)	Private land, Shire of Capel	Private landowner	Not in conservation tenure	6.1	
Total				98.1 ha	

Table 2: Threats, landform data, indigenous sites, groundwater levels, condition of occurrences

Occ. Number	Major Threats	Quadrat Analysis	Predominant Landform unit (Churchward and McArthur 1980; Tille and Lantze 1990a)	Depth to groundwater -(static m below ground) from DoW Groundwater - Water Information System (WIN)	Relative Risk of change to Groundwater levels (based on Froend et al. 2004)	Aboriginal sites	Condition (from on ground survey/GIS layer veg trend 2000-2009/ Fire/Salinity (GIS layer – Salinity Risk)/ Comments
Occurrence 1 (StirlCres Plot 2, 3, StirlCres08)	Clearing - part of road reserve proposed for 'clover-leaf' intersection Weed invasion (esp. <i>Gladiolus caryophyllaceus</i> and grassy weeds) Illegal vehicle access Illegal rubbish dumping Inappropriate fire regime (too frequent)	No (quadrats installed, data not yet analysed)	Southern River	2.4m (bore 130m south west of Occ-date unknown)	High	Artifact / scatter sites within and nearby Boundary of ceremonial/mythological/ repository or cache nearby (within approx 200m)	Mainly in Excellent Condition. Veg Trend indicates mostly no major change, but some decline in vegn condn around edges. Likely long unburnt High salinity risk Site not fenced 2003 dieback survey indicated dieback free
Occurrence 2 (M5305, M5306, Dundas02)	Weed invasion, including planted tree weeds along north and east boundary (eucalypts, Victorian tee tree, grassy weeds especially African lovegrass <i>Eragrostis curvula</i>). Watsonia along creekline. Clearing Illegal rubbish dumping, and historic use for equipment storage Too frequent fire Inappropriate fire regime (too frequent)	Yes	Southern River	2.12m (on 8 Aug 1995, bore located within Occ)	High	Birthplace/water source nearby (within approx 250m)	Mainly in Excellent Condition. Veg Trend indicates mostly no major change, but some decline in vegn condn around edges. Likely long unburnt Mainly High Salinity Risk Site fenced 2003 dieback survey indicated M5305, 06 dieback free
Occurrences 3-8 (Brix02, 06, 07, 08, 09, 10)	Weed invasion: major weeds include veldt grass (<i>Ehrharta calycina</i>), love grass (<i>Eragrostis</i> spp.), <i>Tribolium</i> spp., <i>Sparaxis</i> spp., couch (<i>Cynodon dactylon</i>) Impacts of recreational activity (motor bikes) Illegal rubbish dumping Inappropriate fire regime (too frequent)	Yes	Guildford (Pinjarra Plain)	1.52m (bore 130m NE of Occ) on 9 Oct 1976	High	Artifact/scatter site nearby (within approx 250m)	Mainly in Excellent Condition. Veg Trend indicates mostly no major change, major positive trends in Brix06, 07. Most burnt 2008, except Brix10 Occs mostly in High Salinity Risk Site now fenced 2003 dieback survey indicated dieback free
Occurrences 9, 10, 11 (Lamb01, 02, Fletcher01, 02)	Impacts of recreation use (equestrian usage in Fletcher Park in particular) Weed invasion: major weeds in Lambert Lane (west side of rail line) include <i>Babiana stricta</i> , <i>Freesia</i> (<i>Freesia</i> aff. <i>leichtlinii</i>), <i>Oxalis</i> spp., Bamboo (<i>Arundo donax</i>), tree lucerne (<i>Chamaecytisus palmensis</i>) <i>Watsonia</i> spp., African lovegrass (<i>Eragrostis curvula</i>), perennial Veldtgrass (<i>Ehrharta calycina</i>). <i>Watsonia</i> spp in Fletcher Park (east of rail line) Inappropriate fire regime (too frequent) <i>Phytophthora</i> spp. impacts (dieback disease – many susceptible species)	Yes (Gibson et al. 1994 quadrats in Lamb Additional quadrats Fletcher01/02, established by DEC scored 2003, 2008- data not analysed.	Forrestfield (Ridge Hill Shelf)	3.05m (bore 230m NE of Fletcher Park Occ – date unknown). 1.22m (bore 75m west of Lambert Lane Occ - date unknown).	High-Moderate	Mythological site nearby (within approx 500m)	Mainly in Excellent Condition Veg Trend indicates mostly no major change. Likely long unburnt Occs mostly in High Salinity Risk Bushland areas fenced 2003 dieback survey indicated Lamb01, 02 dieback free

Occurrence 12, 13 (MyAbern01, 02, 03)	Weed invasion Historical grazing (farm animals) Inappropriate fire regime (too frequent)	No. *Inferred Bush Forever	Beermullah (Pinjarra Plain)	0.3m (bore 30m east of Occ – date unknown)	High	Mythological site nearby (approx 130m)	Mainly in Very Good condition. Veg Trend indicates some positive change in MyAbern 02, 03; and some negative change in MyAbern01 Likely long unburnt Mostly Moderate to High Salinity Risk Site fenced
Occurrence 14, 15 (Brick01, 03, 05, 06, 07, 08,)	Impacts of recreation use Weed invasion: major weeds include <i>Eragrostis curvula</i> , <i>Watsonia</i> spp., <i>Ehrharta calycina</i> , introduced eucalypts, acacias (<i>Acacia longifolia</i>) and tea trees (<i>Leptospermum</i> spp.). Inappropriate fire regime (too frequent)	Yes	Guildford and Forrestfield	2.4m (bore 50m west of Occ - date unknown) 22m (bore 20m south of Occ on 11 Nov 1989)	High	Artifact/scatter site nearby (within approx 200m)	Mainly in Excellent Condition. Veg Trend indicates mostly no major change in occurrences, but some negative change in Brick03. No fire data Occs mostly in High Salinity Risk Site fenced 2003 dieback survey indicated disease present
Occurrence 16 (MyByford04)	Weed invasion Clearing Inappropriate fire regime (too frequent)	No. *Inferred Bush Forever	Forrestfield and Guildford	No bore data from close proximity	Unknown	Artifact/scatter site nearby (within approx 200m)	Mainly in Very Good condition. Veg Trend indicates mostly no major change Likely long unburnt Mostly in High Salinity Risk 2003 dieback survey indicated disease present
Occurrence 17 (MyRoman 03)	Weed invasion, especially <i>Watsonia</i> spp. Clearing Inappropriate fire regime (too frequent) Grazing (diggings by ?bandicoots, possibly rabbits)	*Inferred Bush Forever	Forrestfield	0.66m (from top of casing) in bore located 400m west of Occ on 29 Sept 1998	High	No known sites in close proximity	Mainly in Excellent Condition. Veg Trend indicates no major change Likely long unburnt High Salinity Risk Quadrats established by DEC, data not analysed. 2003 dieback survey indicated disease present in small portion of bushland
Occurrence 18 (MUD04, 05)	Weed invasion (<i>Watsonia</i> spp. from adjacent drain is major threat) Clearing for road widening/maintenance Impacts of recreational users (equestrian use along road reserve) Inappropriate fire regime (too frequent) Grazing, digging, by rabbits	Yes	Guildford	3m (in bore 150m east of Occ on 15 April 1998)	High	No known sites in close proximity	Mainly in Excellent Condition. Veg Trend indicates mostly no major change No fire data Mostly High Salinity Risk 2003 dieback survey indicated dieback free
Occurrence 19 (Punr02)	Weed invasion including <i>Ehrharta calycina</i> Clearing Inappropriate fire regime (too frequent) Grazing, digging, by rabbits Illegal rubbish dumping	Yes	Southern River	1.52m (in bore 170m NW of Occ on unknown date)	High	No known sites in close proximity	Mainly in Excellent Condition. Veg Trend indicates mostly no major change but some negative change No fire data High Salinity Risk
Occurrence 20 (Turner 01, 02, 03)	Clearing (planned for roadway in near future) Weed invasion, especially <i>Ehrharta calycina</i> , <i>Watsonia</i> spp.	Quadrats established, data not analysed	Guildford	4.75m (in bore 180m NW of Occ, unknown date)	Moderate	Within ceremonial/mythological site	Mainly in Excellent Condition. Veg Trend indicates some positive but overall no major change No fire data Moderate Salinity Risk
Occurrence 21 (Pind01)	Weed invasion (major invasion of grassy weeds) Illegal rubbish dumping (car bodies and other rubbish gradually breaking down, little new dumping, now fenced) Inappropriate fire regime (too frequent) Fragmentation - large edge to area ratio	Yes	Bassendean Complex Central and South	2.2m (in bore 130m NW of Occ on 17 July 2009)	High	No known sites in close proximity	Mainly in Excellent Condition. Veg Trend indicates no major change. No fire data Reserve fenced Low-Mod Salinity Risk

Occurrence 22, 23 (WARO06, 07)	Clearing (road reserve) Inappropriate fire regime (too frequent) Fragmentation - large edge to area ratio	Yes	Guildford	2.2m (in bore 130m NW of Occ - unknown date)	High	No known sites in close proximity	Mainly in Excellent Condition. Veg Trend indicates no major change No fire data Mostly Moderate Salinity Risk
Occurrence 24 (Yoganup0 2)	Mining activities Hydrological change (especially groundwater drawdown, altered surface hydrology associated with mining) <i>Phytophthora</i> spp. impacts Grazing (occurrence severely impacted through grazing by cattle and kangaroos - no understorey shrub layer)	No	Abba	3.66m (in bore 500m west on 30 June 1943)	Moderate – based on closest bore (too far away)	No known sites in close proximity	Mainly in Good Condition. No fire data Mostly Moderate Salinity Risk
Occurrence 25 (Yoganup0 1)	Mining activities Hydrological change (especially groundwater drawdown, altered surface hydrology associated with mining) <i>Phytophthora</i> spp. impacts Grazing (occurrence severely impacted through grazing by cattle and kangaroos - no understorey shrub layer)	No	Abba	7.62m (in bore 700m west on 30 June 1930 – too far away)	Low – based on closest bore (too far away)	No known sites in close proximity	Mainly in Good Condition. No fire data Mostly Moderate Salinity Risk
Occurrence 26 (Davies03)	Mining activities <i>Phytophthora</i> spp. impacts Weed invasion	No	Abba	17.68m (from bore 900m east on unknown date – too far away)	< Low - based on closest bore (too far away)	No known sites in close proximity	Mainly in Excellent Condition. No fire data Mostly Moderate Salinity Risk

1.2 Description of Occurrences

Occurrence 1 (StirlCres Plot 2, 3, StirlCres08) is bordered by Gt Eastern Highway Bypass, Roe Highway and cleared land. Another TEC (Swan Coastal Plain floristic community type 20a '*Banksia attenuata* woodlands over species rich dense shrublands as described in Gibson *et al.* 1994) occurs within the same bushland (Bush Forever site 481 – Stirling Crescent Bushland, Hazelmere). Part of the road reserve that contains the bushland area is apparently proposed for a clover leaf road structure in the future. Clearing and weed invasion represent the greatest threats to this occurrence. Although quadrats have been established in bushland, the data have not been analysed, so the presence of the TECs has not yet been confirmed.

Occurrence 2 (M5305, M5306, Dundas02) is located in the Shire of Kalamunda on two separate reserves managed by Western Power and FESA. The whole remnant, of which this community occupies only a small proportion, is a Bush Forever site (Bush Forever site 319 – Dundas Road Bushland, Forrestfield). Floristic community type 20a occurs to the south west of this occurrence within the same remnant.

Roe Highway is to the south of Occurrence 2. Buildings and partly cleared storage area occupy the northern portion of reserve 37981 which is managed by Western Power. This community occupies most of the remainder of the reserve, and a minor creek line occurs in the south west corner of the reserve area. The adjacent FESA reserve number 37260 also contains a small area of the community and this reserve is surrounded by a wide fire-break and a high electric fence. The community is confined to the north-east corner of reserve 37260. The Western Power reserve also has a fire-break around the perimeter, and is fenced. The Priority 1 flora taxon (see Appendix 2 for definitions) *Schoenus pennisetis* has been recorded in Occurrence 2 (DEP 1996).

Occurrences 3-8 (Brix02, 06, 07, 08, 09, 10) occur within a 126.7 ha parcel of land that is commonly known as the Greater Brixton Street wetlands. The land on which Occurrences 3-8 occur is under the care, control and management of DEC. This lot and the contiguous remnant to the north, between this lot and the rail line, in Canning Location 47 are part of a Planning Control Area (Bush Forever site no. 387) declared by the West Australian Planning Commission (WAPC) that extends from this remnant to Roe Highway. Significant remnants within this area are being progressively acquired for conservation as they become available. The Brixton Street wetlands are bounded by Brixton Street to the north east, Alton Street and Wannaping Road to the south east and south, and a rail line to the west and north. There is intact vegetation on the opposite side (to the north east) of Brixton Street and this is also part of the Planning Control Area. A major fire burnt over 80% of the wetlands in 2002. Occurrence 3 and a small part of the south-western corner of the wetlands were burnt in another fire during March 2009.

The Priority 3 taxon *Haemodorum loratum* occurs within the community at the Brixton St wetlands. Only a very small area of the remnant (2.75ha) defined by Brixton Street, the rail line, Alton St and Wannaping Road

contains the community '*Corymbia calophylla* - *Kingia australis* woodlands on heavy soils'. The remainder of the remnant is the Vulnerable ranked floristic community type 8 'herb rich shrublands in clay pans' as described by Gibson *et al.* (1994). This community contains additional threatened and priority flora. These are: *Aponogeton hexatepalus* (P4); *Eryngium pinnatifidum* subsp. *palustre* (Priority 3); *Triglochin stowardii* (Priority 3); and *Rhodanthe pyrethrum* (Priority 3). The Brixton Street wetlands contains over 320 species of vascular plants over an area of only 19 hectares (Keighery and Keighery 1993b; Keighery 1995). This represents over 20% of the known flora of the Perth Region, in less than 0.005% of the area (Keighery and Keighery 1993b).

The Wildflower Society and local Friends Group are involved in managing the Brixton Street reserve, and received grants to develop a Management Plan for the reserve (Keighery 1995). Funds have also been obtained for some management actions including weed control. The reserve has been fenced to help ensure only operational and foot access. Too frequent fire, weed invasion, and recreational impacts including illegal access by motor bikes represent the greatest threats to these occurrences.

Occurrences 9, 10, 11 (Lamb01, 02, Fletcher01, 02) are almost contiguous occurrences that form a small cluster adjacent to the rail line at Wungong. The occurrences are mainly contained within Bush Forever site number 264 – Lambert Land Bushland, Wungong. The occurrence covers most of reserve 42044 and extends a short distance into the rail reserve to the east. Reserve 42044 is under the care, control and management of the Conservation Commission of WA, and is managed by DEC. Its southern edge runs parallel with Lambert Lane and lies due west of Occurrences 10 and 11. The site has been used for illegal rubbish dumping in the past and a major weed infestation has occurred where garden waste has been deposited. Weed invasion, and recreational impacts including illegal access pose the most significant threats to this occurrence. Occurrences 10 and 11 occur in a railway reserve approximately 30m wide and 1km long near Armadale, and extend into a four hectare recreation reserve (R14217) in Armadale called 'Fletcher Park' that is utilised by the local pony club. The Priority 3 taxon *Synaphea acutiloba* also occurs in this occurrence. Weed invasion is a threat to this occurrence, and the City of Armadale and local Landcare groups have undertaken some weed control, revegetation and seed collection activities as part of implementing the Management Plan (Wallingarra Pony Club and City of Armadale 2002). In addition, the City of Armadale has undertaken some monitoring to investigate the impact of grazing on the TEC. The Eleventh Road end of the community has been fenced.

Occurrences 12, 13 (MyAbern01, 02, 03) occur within Bush Forever site 65 'Abernethy Road Bushland, Oakford'. The occurrences were acquired for conservation by WAPC. The bushland is managed for conservation but has not yet been transferred officially to management by DEC. The 'herb-rich shrublands in claypans' (community type 8 as described in Gibson *et al.* 1994), a vulnerable TEC, and the critically endangered declared rare flora taxon *Verticordia plumosa* var. *pleiobotrya* also occur within the Bush Forever site.

Occurrences 14, 15 (Brick01, 03, 05, 06, 07, 08) are in the Brickwood Reserve in Byford. Turner Road divides the reserve and the occurrences. Mead Street is to the north, Soldiers Road to the east, Warrington Street to the west, and private land to the south of the reserve. Residential areas also occur along a portion of the eastern and western boundaries. Altogether, the community covers approximately 37 hectares of a total of about 48 hectares occupied by the reserve. The remainder is occupied by 'dense shrublands on clay flats' and 'eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands' (Gibson *et al.* 1994 floristic community types 9 (Vulnerable) and 20b (Endangered) respectively). *Stylidium mimeticum*, a Priority 3 taxon, is also recorded in this bushland. The Brickwood reserve is used for passive recreation and is in excellent condition with very low weed invasion due to the dense sedge understorey. There is, however, pressure from adjacent residents to have the reserve burnt on a regular basis to reduce the perceived fire hazard to their properties, and a draft Management Plan has been developed for Brickwood Reserve and Briggs Park by Shire of Serpentine Jarrahdale that includes a series of recommendations about fire management (Serpentine Jarrahdale Shire 2009). Commonwealth funding recently supported weed surveys and control, dieback surveys and treatment, controlled burning and community education for Brickwood Reserve.

Occurrence 16 (MyByford04) occurs on a road and rail reserve immediately east of Brickwood Reserve. The bushland in this Bush Forever site that extends from Byford to Serpentine have been subject to historical disturbance and have suffered a level of weed invasion. Rail maintenance activities generally involve continuing levels of disturbance to adjacent bushland.

Occurrence 17 (MyRoman03) This bushland contains a small triangular-shaped occurrence bordered by cleared land to the east and Roman Road to the west. It forms a part of a conservation reserve vested with the Conservation Commission of WA. The same conservation reserve contains two other TECs. These are *Corymbia calophylla* – *Xanthorrhoea preissii* woodlands and shrublands (Gibson *et al.* 1994; community type

3c, ranked Critically Endangered) and Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (Gibson *et al.* 1994 community type 20b, ranked Endangered).

The occurrence appears to have been subject to repeated historical disturbances, which have resulted in weed invasion. Major weeds have been mapped by DEC, and *Watsonia* control was undertaken by DEC in 2009.

Occurrence 18 (Mud04, 05) comprises part of a road reserve managed by the Shire of Serpentine-Jarrahdale. This small strip of vegetation is approximately 50m wide by 400m long and has core areas of vegetation in excellent condition. Weeds are encroaching along the road reserve, and from a major drain that runs alongside the road. The remnant vegetation along the road reserve that contains Occurrence 18 continues to the east and west with a track used by horse riders running through the middle. Weeds are invading along this track. Grassy weeds also heighten the risk of hot fires during summer.

The DRF taxon *Verticordia plumosa* var. *pleibotrya* occurs adjacent to the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soil bushland that contains Occurrence 18. The Vulnerable ranked community 'herb rich shrublands in clay pans' (Gibson *et al.* 1994 community type 8) occurs to the west in the same remnant on the road reserve. Portions of this roadside remnant have been burnt recently.

Keighery (1996) provides a detailed discussion of the conservation values and management guidelines for roadside remnants on Mundijong Road.

Occurrence 19 (Punr02) was mostly previously located on Freehold private land, but the bushland has been acquired for conservation purposes as a part of a Bush Forever site, by the WAPC. The remainder of the occurrence is on Unallocated Crown Land.

Occurrence 20 (Turner 01, 02, 03) is a small occurrence located on a road reserve, and possibly extending into adjacent private land. The road reserve is proposed for clearing for access to areas proposed for subdivision.

Occurrence 21 (Pind01) occurs in a light industrial area in a Recreation Reserve (R 34033) in the Shire of Murray. The bushland occurs to the north west of the junction of Phillips and Moores Road in Pinjarra. Reserve 34033 continues on the opposite side of Phillips Road, and covers a total of about 21 hectares. This community occupies only a small proportion of the reserve. The remnant within the reserve continues to the north, west and east of Occurrence 21. Two occurrences of another TEC – dense shrublands on clay flats (floristic community type 9 as described by Gibson *et al.* 1994) also occurs within reserve 34033. A light industrial area occurs adjacent to the northern end of this reserve, and contains another small occurrence of this TEC (Field01).

The reserve in which the occurrence is located was historically damaged by illegal vehicle access and rubbish dumping including disposal of car bodies. Some parts of the reserve have been highly disturbed, in particular through indiscriminate tracks being cleared which has caused fragmentation within the area. Recently, a 40 metre wide area was slashed around the southern and eastern extremities of this community, presumably as a fire-break. Despite these disturbances this occurrence of the community has quite a dense, diverse shrub layer and appears to be relatively resistant to weed invasion. The Priority 1 taxon *Tripterococcus paniculatus* ms has been recorded within this occurrence (DEP 1996).

Occurrences 22, 23 (Waro06, 07) are generally in excellent condition although the occurrences are within long narrow road and rail reserves, and an adjacent Shire reserve. These reserves run parallel to South Western Highway approximately 4km north east of Waroona. Two other TECs (Community type 10a - Shrublands on dry clay flats and type 7 Herb rich saline shrublands in clay pans, as described in Gibson *et al.* 1994) also occur within the road and rail reserves.

Occurrence 24 (Yoganup02) Occurrence 25 (Yoganup01) and Occurrence 26 (Davies03) are small areas of the community identified on private land about 9km south-east of Capel. They are located within a Mineral Lease held by Iuka Resources, within an area used for sand mining. Occurrences are fenced, and have also been subject to fox and rabbit baiting. DEC personnel in 2004 noted that the remnant that contains Occurrence 26 is in much better condition than Occurrences 24 and 25. This occurrence is immediately down slope of a bund that retains a sludge dam but is not planned for direct clearing in future expansion of the mine. Bunds around the dam failed prior to 2004, and released large mud flows onto the TEC. The mud was removed without the use of machinery. Occurrence 26 is fenced.

Dewatering of the mine pit may represent a major threat to the hydrology of these occurrences of the community. The effects of this are expected to radiate up to 1km beyond the pit boundary. Monitoring will be required to determine impacts.

Data on all occurrences of this community are recorded on the DEC Corporate Threatened Ecological Community Database.

1.3 Habitat characteristics

This community occurs on the wettest of soils and the highest rainfall sites of the group of Marri communities that occur on the heavy soils on the eastern side of the Swan Coastal Plain (Gibson *et al.* 1994).

Plant taxa that commonly occur in the community are listed at Appendix 1. The mean species richness for ten plots in the community surveyed by Gibson *et al.* (1994) was 58.9 species in 100 square metres. An average of 3.9 weed species were recorded per plot in the Gibson *et al.* (1994) study. This is lower than in the two other Marri dominated communities in the group, and is a relatively low level of weed invasion.

This community occurs on a variety of land units and soil types. However, the soils in each occurrence all contain an impervious clay layer that would act as a barrier to drainage of water through the soil. A number of plant taxa that occur in the community are typically associated with these seasonally inundated impervious clay soils. These include *Kingia australis*, *Mesomelaena tetragona*, *Pericalymma ellipticum*, and *Hakea ceratophylla*.

Occurrences 1, 2, and 19 occur on the Southern River Geomorphological Unit of the group described as Aeolian Deposits by Churchward and McArthur (1980). Those authors describe this unit as 'sandplain with low dunes and many intervening swamps; iron and humus podzols, peats and clays'.

Occurrences 3-8, 18, 20, 22, and part 14 and 16 occur on the Guildford Unit of the Fluvial Deposit group as mapped by Churchward and McArthur (1980). The soils are otherwise known as the Guildford clays. The Guildford Unit is also part of the Pinjarra Plain System and constitutes most of the Pinjarra Plain. The Guildford Unit is found in flat terrain with medium textured deposits and yellow duplex soils of sandy loams over clay (Churchward and McArthur 1980).

Occurrences 9, 10, 11; 17, and part 14, 15, and 16 are within the Forrestfield Unit - Ridge Hill Shelf group as described by Churchward and McArthur (1980). They describe the Forrestfield Unit as 'laterised foothills of the Darling Scarp characterised by gravelly and sandy spurs'.

Occurrence 12 occurs on the Beermullah unit of the Pinjarra Plain. The Beermullah Unit of the Pinjarra Plain System has a limited range and only occupies a small area. This unit consists of poorly drained fluvial deposits of mainly sand that exhibit distinct saline and solonchic features in the soil (Churchward and McArthur 1980). Occasionally, the soil consists of deposits of ironstone (bog iron ore) or sand over ironstone (Churchward and McArthur 1980) and loam over clay which becomes waterlogged during winter.

Occurrence 21 occurs on the Bassendean Complex Central and South (Churchward and McArthur 1980). They describe the Bassendean Unit as 'sand plains with low dunes and occasional swamps: iron or humus podzols; areas of complex steep dunes'.

Occurrences 24-26 are found on the Abba complex (Tille and Lantzke 1990a, b) which is characterised by wet/semi-wet soils and deep, grey sandy duplexes.

Critical habitat: The critical habitat for the community is the heavy soils on which the community occurs, the fresh superficial groundwater, and/ or surface water that helps sustain flora species in this wetland community, and the catchment for this groundwater and surface water.

1.4 Threatening processes

Clearing

Clearing for agriculture has been extensive on the heavy soils on the eastern side of the Swan Coastal Plain, with approximately 97% of all vegetation in the area being cleared (Keighery and Trudgen 1992; CALM 1990). The marri dominated types on these heavy soils were probably some of the most common on this portion of the plain but are now very rare and are likely to be at least 90% cleared (Gibson *et al.* 1994). Future clearing is more likely to be associated with developments for road works, housing or industry. Occurrences 1

(Stirl Cres) and 20 (Turner Rd) are subject to development applications, and Occurrences 24-26 are within a mine site (Yoganup, Davies).

Altered fire regimes

Mediterranean ecosystems are usually fire responsive and may require a particular fire regime to assist regeneration (Abbot and Burrows 2003). If an appropriate fire frequency is exceeded, however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may senesce and be unable to regenerate. Therefore, wildfires or prescribed burns must occur at appropriate intervals, and possibly at the appropriate season and intensity, to sustain the integrity of plant communities.

Too frequent fire can increase the risk of invasive weeds establishing within small bushland remnants such as this community (Abbot and Burrows 2003). It is likely that the burning regime in the remnants containing the community has been modified to more frequent fires, especially hot burns, since European settlement.

The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the original native species in the herb layer. Many of the occurrences have been burnt recently. Fire regime is a major consideration in Management Plans that have been developed for bushland that contains TECs (eg Serpentine Jarrahdale Shire 2009).

Burrows (2008) notes that there is no single optimum fire regime that will meet all management objectives, but that there are fire regimes that can be applied based on available evidence. Burrows (2008) recommends fire regimes based on vital attributes, regimes that provide for diversity of frequency, season and intensity, and provide habitat diversity, and a fine-grain mosaic of habitats. Burrows suggests that if these fire regimes are implemented in an adaptive management framework, they provide good data and can lead to better fire management.

The juvenile period of many species that occur in the community is listed in Appendix 1. Although the juvenile periods of many taxa is not known, the data included in Appendix 1 can be used as a guide. Burrows *et al.* (2008) recommend a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. That is, the juvenile period of plant taxa that are killed by fire and only reproduce from seed can be used as a guide to determine minimum inter-fire intervals. In fire sensitive habitats, this may be increased to 3-4 times the juvenile period for fire sensitive species (Barrett *et al.* 2009). In this case, *Hakea trifurcata* and *Petrophile serruriae* are serotinous species that are killed by fire and reproduce only from seed. The juvenile period of these two taxa is 48 months, therefore a minimum inter-fire period of eight years, and up to 16 years would be recommended for occurrences that contain these species. The juvenile period for other taxa in the community is also quite long. For example, although *Regelia ciliata* and *Melaleuca scabra* (now *M. tricophylla*) survive fire, they have a juvenile period of 60 and 72 months respectively. These long juvenile periods should also be taken into account when designing appropriate fire regimes for this community.

Drying climate also needs to be considered when designing appropriate fire regimes. It is likely that reduced rainfall will cause diminishing growth rates, and plant maturation times will also therefore increase. Longer inter-fire intervals will therefore be desirable.

Weed invasion

Disturbances such as fires and grazing can predispose areas to weed invasion if weed propagules are present. All of the occurrences of this community are close to weed sources such as urban or agricultural areas and would be vulnerable to weed invasion following any disturbance. However, even small remnants often exhibit surprising resistance to weed invasion particularly if left undisturbed (Keighery 1996). In this community, such resistance relates to the density of cover, seasonal inundation and the hardness of the soils in summer, and alteration of any of these factors reduces the ability to resist weed invasion (Keighery 1996).

There are tracks through most occurrences of the community. Weeds have invaded to varying extents along these tracks and such areas should be considered a priority for weed control. In particular, piles of soil scraped from tracks generally contain high concentrations of weeds and act as a source of weed invasion. Such piles should be avoided when tracks are cleared, or be removed where they already exist.

A weed control program would be necessary to maintain or improve the current condition of occurrences of the community in the long term. Brown and Brooks (2002) state that the generic aims of weed control are to maintain the pre-invasion condition of the habitat (prevention), control or arrest ongoing weed invasion

(intervention), and reverse the degraded condition of the habitat where applicable (rehabilitation). A generic weed control program would involve the following steps (adapted from Brown and Brooks 2002):

1. Identifying weeds present at the site and classifying according to the threat they pose.
2. Accurately mapping the boundaries of weed populations (especially those of higher threat status).
3. Selecting an appropriate herbicide or other method of weed control for weed species that are present.
4. Controlling weeds that pose the greatest threat to the community and which are in the early stages of invasion.
5. Implementing a strategic control program for established weed populations, with highest priority to those posing the greatest threat to the community.
6. Rehabilitation through reintroduction of local native species where areas are no longer capable of regenerating following weed control.

Weeds have been mapped at Occurrences 3-8 (Brixton St), Occurrences 9 and 10 (Lambert Lane), Occurrences 14, 15 (Brickwood Reserve), 17 (Roman Rd). Some weed control has been undertaken at these occurrences, and also at Occurrence 11 (Fletcher Park).

Hydrological changes

The hydrology of specific areas of the eastern side of the Swan Coastal Plain has been altered through the construction of drains to lower the water-table (Keighery and Trudgen 1992). The area is characterised by much valued heavy soils, which were historically highly cleared for agriculture. Despite a likely increase in runoff and recharge of the groundwater resulting from this clearing, drainage has probably brought about an overall lowering of the watertable in localised areas (B. Keighery¹ personal communication). Altered surface flow and/or alteration of the height of the local watertable may change the length of the period or the depth of any ponding.

Occurrences may become inundated in the wetter months due to rainfall and surface flows because the community occurs mainly on soils that contain a clay layer that is quite impervious. In some areas groundwater is very close to the surface.

Groundwater levels and quality are routinely monitored by the Department of Water, and in specific areas by other groups such as Department of Agriculture and Food Western Australia and local Natural Resource Management groups. Static groundwater data from Department of Water's Groundwater Information System indicates that where bores are located close to or within occurrences of the community, that groundwater was generally within 3m of the natural ground surface when bores were drilled. Although the data are not comprehensive as they are a static water level, do not provide information about changes to groundwater levels over time, and were taken at different times of the year, the static water levels can provide a rough guide to the dependence of the community on groundwater, hence likely susceptibility to change. Available hydrological and floristic data indicates that this community is a wetland and that groundwater is likely to be generally less than 3m below the surface in occurrences of the community. Froend *et al.* (2004) notes that wetlands in which the groundwater is within 0-3m of natural ground surface, as indicated for this community by available data, are highly susceptible to changes in groundwater levels and would be considered to be highly groundwater dependent. Froend *et al.* (2004) also noted that for wetlands for which groundwater is within 0-3m of surface, a historic change in groundwater level of <0.25m is regarded as low risk, a change of between 0.25m and 0.5m is moderate risk, and a change of >0.5m results in high risk of impact to the wetlands.

Occurrences 24-26 (Yoganup01, 02 and Davies03) may potentially be threatened by dewatering from mining activities that are occurring nearby or immediately adjacent.

Salinisation

Salinity levels of around 250 to over 2,000 milligrams per litre total dissolved salts (mg/L TDS) have been recorded for the superficial aquifers where the community occurs (Davidson 1995). Levels of over 2,000 mg/L TDS were recorded for the shallow Leederville aquifer in the area of occurrences 3-8 (Brixton Street reserve) and Occurrence 18 (Mundijong Road). In these areas, Guildford clay soils inhibit the infiltration of rainfall and cause concentration of salts by evaporation (Davidson 1995).

Salinisation may increase as a result of evaporation of surface water, especially where saline superficial aquifers are in contact with the surface. If increased ponding occurs in the community due to urbanisation or

¹ Bronwen Keighery, Department of Environmental and Conservation.

clearing in the catchment, evaporation of a greater volume of water may result in larger amounts of residual salt. This is especially true for clay soils, which inhibit rainfall infiltration and result in high evaporation rates and concentration of salts (Davidson 1995). Occurrences 3-8 (Brixton St wetlands) in particular may be under threat from salinisation, but other occurrences may also be under threat in future if water-tables rise as a result of urbanisation or other causes.

The levels of salinity in the community should be monitored to determine if salinisation poses a major threat to the community. Remedial actions such as replanting with deep rooted vegetation in strategic parts of the catchment may be required if monitoring indicates salinisation is a significant issue. However, implementing such a strategy may prove difficult in areas that are surrounded by urban development, such as the Brixton Street wetlands (Occurrences 3-8).

Grazing

Grazing of plant communities causes alterations to species composition by the selective removal of edible species and the introduction and encouragement of weeds by the addition of dung, and through trampling and general disturbance. Some occurrences of the community such as occurrences 17 (Roman Rd) and 24-26 (Yoganup and Davies sites) have been grazed historically. The significance of the impact of grazing has not been quantified through monitoring.

Introduction of Disease

Dieback disease caused by *Phytophthora* species has the potential to impact the community, although it is not known if the community is particularly susceptible to the disease. Plant communities that occur on heavy soils such as this one, especially in relatively flat areas, are generally not highly susceptible to *Phytophthora* (Helyar 1994). In fact, *Corymbia calophylla*, which is a major component species in the community, has been shown to have a strong resistance to dieback (Groves *et al.* 2009). However, a series of taxa that commonly occur in the community are indicated as being susceptible or possibly susceptible to the disease, including *Allocasuarina humilis*, *Astroloma pallidum*, *Banksia lindleyana*, *Eucalyptus marginata*, *Grevillea bipinnatifida*, *Hakea ceratophylla*, *Hakea lissocarpha*, *Hakea varia*, *Patersonia occidentalis*, and *Xanthorrhoea preissii* (see Appendix 1). For most species that commonly occur in the community, susceptibility to the disease is not known. Of the 14 occurrences that were tested for dieback disease in 2003 (see Table 2), the disease was recorded in four occurrences. The risk of disease introduction should be minimised by ensuring good hygiene procedures. This would involve adequately washing down any equipment used on or adjacent to the community, and restricting access by vehicles and machinery to dry soil conditions.

1.5 Conservation status

Assessed 21 November 1995 as Critically Endangered. The community meets criterion B (ii) as follows, for Critically Endangered:

Current distribution is limited and there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes.

1.6 Important occurrences

Occurrences that provide for representation of the community across its geographic range and that can be managed for conservation and/or with conservation included in their purpose are considered critical to the survival of this community.

1.7 Affected interests

Occurrences of the community are located on land managed by DEC, other government agencies (Main Roads WA, FESA, WAPC and Department of Regional Development and Lands), utility providers (Western Power), local government and private land holders. Some lands held by WAPC and DRDL are intended to be transferred to DEC management, however government agencies, local government and private landowners managing other land will be affected by the implementation of this plan.

1.8 Indigenous interests

The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Comment was sought from the Council about any aspects of the plan, but particularly about the proposed on-ground actions. Table 2 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. No general significance to indigenous people has

been identified for the ecological community. Action 2 identifies the intention to continue liaison with relevant groups, including indigenous groups.

1.9 Social and economic impacts and benefits

Pedestrian access by means of formal walk trails has potential to allow the aesthetic values of the community to be appreciated without degrading the community, and this provides a social benefit. Where specific active recreational pursuits such as four wheel driving are prevented through access control, this may be perceived as a social impact, however such access control also helps to prevent the continued degradation of the community and maintain other social benefits.

Occurrences may be threatened by proposals to clear for various development or from hydrological change following clearing and development of adjacent land. Implementation of actions such as seeking to protect the hydrological processes in the adjacent community may result in an impact on development.

Wetlands such as this community provide various ecosystem services such as absorption of nutrients and other chemicals from polluted surface and groundwater. These services would have an economic value but are lost when wetlands are cleared and filled.

1.10 Related biodiversity impacts and benefits

Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community and other associated vegetation types within managed areas of remnant vegetation. Seven other TECs co-occur within remnant vegetation containing the community, and one declared rare flora and nine priority flora have been identified as occurring within or adjacent to this community. One species of priority fauna is believed to occur in this community. Associated species and communities are:

Corymbia calophylla – *Xanthorrhoea preissii* woodlands and shrublands (community type 3c, Critically Endangered)

Herb rich saline shrublands in clay pans (community type 7, Vulnerable)

Herb rich shrublands in clay pans (community type 8, Vulnerable)

Dense shrublands on clay flats (community type 9, Vulnerable)

Shrublands on dry clay flats and (community type 10a, Endangered)

Banksia attenuata woodlands over species rich dense shrublands (community type 20a, Endangered)

Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (community type 20b, Endangered).

Verticordia plumosa var. *pleiobotrya* (DRF, Critically Endangered)

Schoenus pennisetis (Priority 1)

Tripterococcus paniculatus ms (Priority 1)

Eryngium pinnatifidum subsp. *palustre* (Priority 3)

Haemodorum loratum (Priority 3)

Rhodanthe pyrethrum (Priority 3).

Stylidium mimeticum (Priority 3)

Synaphea acutiloba (Priority 3)

Triglochin stowardii (Priority 3)

Aponogeton hexatepalus (Priority 4);

Southern Brown Bandicoot (Priority 5) may occur (yet to be confirmed)

1.11 Term of plan

The plan will operate from 2011 to 2016 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated by the recovery implementation group.

1.12 Strategy for recovery

To identify, and influence the management of, the areas in which the community occurs, so maintaining natural biological and non biological attributes of the sites and the current area covered by the community.

To conduct appropriate research into the ecological characteristics of the community to develop further understanding about the management actions required to maintain or improve its condition.

2. RECOVERY OBJECTIVE AND CRITERIA

2.1 Objective

To maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat.

2.2.1 Criteria for success

- An increase in the number of occurrences of this community managed for conservation and/or with conservation included in the purpose.
- Representative areas of the community across its geographical range with condition rank maintained, or with improved condition rank (Bush Forever 2000 scales).
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales).

2.2.1 Criteria for failure

- Decline in condition rank of 10% or more of the community.
- Failure to achieve an increase in the area managed for conservation.

3. RECOVERY ACTIONS

3.0 Completed Actions

A review of the implementation of the previous Recovery Plan was completed in 2007 (DEC 2007), with funding assistance from the Commonwealth government. This review identified that the following actions have been completed since the TEC was identified:

- the recovery actions implemented for the community have been considered through existing recovery teams established in both Swan and South West Regions that meet and report annually.
- all occurrences of the community have been entered onto the TEC database including newly recognised occurrences.
- monitoring the extent and boundaries has been undertaken for all occurrences.
- liaison with current land owners, land managers and other interested groups to implement recommendations held in the IRP (English and Blyth 2000) has resulted in many on-ground outcomes.
- information about the community has been provided to landowners and a colour A4 brochure and pamphlet has been produced, as well as signage at occurrences.
- Markers have been installed to indicate the locations of occurrences where appropriate.
- A program for monitoring flora has been designed and implemented at some sites.
- Fire response plans are in place for some occurrences (Occurrence 17 Roman Rd, Occurrences 3-8 Brixton St wetlands, Occurrences 14-15 Brickwood Reserve).
- Strategic fire breaks have been maintained.
- Fire suppression actions have been managed so that they did not adversely impact the community.
- Weed mapping and/or monitoring has been undertaken at some occurrences (Occurrence 9 - Lambert Lane, Occurrences 3-8 Brixton St wetlands, Occurrence 17 – Roman Rd, Occurrence 12 – Abernethy Rd) to evaluate the efficacy of the weed control works.
- Weed control has been undertaken at a number of occurrences (Occurrences 3-8 Brixton St wetlands, Occurrence 17 – Roman Rd, Occurrence 21 Pinjarra) and where monitored, is indicative of a decline in weed density and encroachment.
- Seed collection and rehabilitation has been undertaken at some sites (Occurrences 3-8 Brixton St wetlands, Occurrences 10, 11, 12 - Fletcher Park and Lambert Lane, and 18 - Mundijong Rd).
- Fencing has been installed at most occurrences (Occurrence 2 – Dundas Rd, Occurrences 3-8 Brixton St wetlands, Occurrences 9-11 – Fletcher Park and Lambert Lane, Occurrences 14-15 - Brickwood Reserve, Occurrence 19 – Punrack Rd, Occurrence 21 – Pinjarra, and Occurrences 24-26 on private land in a mine area).
- Hygiene conditions are maintained on all DEC managed sites.
- Fourteen occurrences (Occurrence 1 – Stirling Crescent, Occurrence 2 – M53, Occurrences 3-8 Brixton St wetlands, Occurrence 11 Lambert Lane, Occurrences 14 and 15 Brickwood Reserve, Occurrence 16 Byford, Occurrence 17 Roman Rd, Occurrence 18 Mundijong Rd) have been assessed and mapped for dieback (see Table 2).

- Additional areas have been added to the conservation estate (~9.5 ha – Occurrence 17 - Roman Rd, Occurrences 3-8 Brixton St wetlands) and two additional areas purchased by WAPC for conservation management (Occurrences 12, 13 - Abernethy Rd, Occurrence 19 - Punrack Rd).
- Management Plan and/or Interim Management Guidelines have been developed for Occurrences 3-8 - Brixton St wetlands; 24-25 - Yoganup (Iluka/Capel); 14, 15 - Brickwood Reserve (late draft), Occurrence 18 – Mundijong Rd, and Occurrence 11 - Fletcher Park.
- Three community planting days have been conducted (Occurrences 3-8 Brixton St wetlands).
- Fence repairs and replacement, and pedestrian and vehicle gates have been replaced at Occurrences 3-8 (Brixton St wetlands).
- There has been a significant reduction in weed diversity, densities and occurrence at Occurrences 3-8 Brixton St wetlands.

As at December 2007, it was estimated that \$3,086,593 had been spent on the conservation of the community. The majority of this budget was on land acquisition.

3.1 Recommended Recovery Actions

1 Coordinate Recovery Actions

The Swan and South West Region Threatened Flora and Communities recovery teams consider all threatened ecological communities and threatened flora in DEC's South West and Swan Regions. These teams will continue to assist DEC in coordinating recovery actions for the community and other declared rare flora and threatened ecological communities in their regions. They will include information on progress in their annual reports to DEC's Corporate Executive and funding bodies.

Responsibility: DEC (Swan and South West Regions) with assistance from recovery teams
Cost: \$2,000 per year
Completion date: Ongoing

2 Continue liaison with land owners, land managers and other interested groups to implement recommendations held in this IRP

Most of the occurrences of the community are managed by authorities other than DEC, or are privately owned. The involvement of land managers, local community groups, and industry in the recovery of the community is therefore essential to the recovery process.

Main Roads WA manage Occurrence 1, and Occurrence 2 is managed by Western Power. The Wildflower Society and local Friends Group are involved in managing the Brixton Street reserve (Occurrence 3-8 – Brix02, 06, 07, 08, 09, 10). The City of Armadale is involved in the management of Occurrences 9-11 (Fletcher01, 02). WAPC manages occurrences 12, 13 (MY Abern01, 03), and Occurrence 19 (Punr02 respectively). Brickwood Reserve (Brick01, 03, 05, 06, 07, 08), and Occurrence 20 (Turner 01, 02, 03) are managed by the Shire of Serpentine Jarrahdale. Occurrence 18 (Mud04, 05) is managed by the Shire of Serpentine-Jarrahdale in association with the Roadside Care Volunteers and Serpentine-Jarrahdale Landcare Group. Occurrence 16 (My Byford04) is managed by Westnet Rail and the Shire of Serpentine Jarrahdale. The Shire of Waroona and Westnet Rail manage Occurrences 22 and 23 (Waro06, 07). Occurrences 24, 25 and 26 (Yoganup 01, 02 and Davies 03 respectively) are all privately owned and within a Mineral Lease and mine site. Indigenous groups will be consulted about relevant on ground actions in this plan.

Responsibility: DEC (Swan Coastal and Blackwood Districts; Species and Communities Branch (SCB))
Cost: \$2,000 pa for all liaison (not including vehicle costs)
Completion date: Ongoing

3 Continue to disseminate information about the community

To prevent accidental destruction of the community, and gain public support for its conservation, information about the community will continue to be provided by local DEC staff to all stakeholders including landholders, and managers of land containing the community. This would include information from the threatened ecological community database, maps indicating the location of the community, and this Recovery Plan. Information about private land should only be provided to the landholder, unless permission is granted by the landholder to allow wider dissemination of the data.

Local DEC staff will ensure regular liaison with landowners and managers of land that contains the community to ensure threatened ecological community information is up to date.

Responsibility: DEC (Strategic Development & Corporate Affairs; Swan Coastal and Blackwood Districts, SCB)
Cost: \$2,000 pa
Completion date: Ongoing

4 Continue to monitor the extent and boundaries of occurrences

To date many of the occurrences have been manually mapped or mapped using aerial photographs. All occurrences will be remapped using GPS to increase accuracy of boundaries. Accurate GPS mapping of community boundaries has commenced and a Geographic Information System database has been developed. Extent and boundary information will continue to be updated on the Threatened Ecological Communities Database.

Responsibility: DEC (Swan Coastal and Blackwood Districts)
Cost: \$3,000 first year, \$2,000 to monitor every second year
Completion date: Ongoing

5 Encompass monitoring of the community within an adaptive management framework

There are permanent quadrats set up in most occurrences (Gibson *et al.* 1994; DEP 1996, DEC unpublished data), except Occurrence 12 (Abernethy Rd), 16 (myByford04), 24 (Yoganup02), 25 (Yoganup01), and 26 (Davies03). Where vegetation is in suitable condition, permanent quadrats should be established in these additional areas, utilising methods as described in Gibson *et al.* (1994). Data collected will include weed levels, plant species diversity and flora species composition. All native and weed species were recorded in quadrats that were previously established, but quantitative data that would provide information about density or cover for each species were not included in standard quadrat monitoring. Occurrences will continue to be monitored every five years to provide information on composition, and condition. This information will be added to the TEC database.

Eight monitoring transects in eight occurrences of the community have also been established to determine the impact of edge effects on the community (ie edge to area ratio). Transects measure 20m in length, are permanently marked, and were monitored in 2003 and 2008. A brief report of the 2003 data was prepared.

Other monitoring established in the community includes monitoring of success of weed control in the Brixton St wetlands (Brown and Clarke 2009), and monitoring programs established as part of the Management Plan for Brickwood Reserve (Serpentine Jarrahdale Shire 2009). The weed monitoring method for Brixton St wetlands describes the use of small quadrats to allow accurate weed counts and accurate cover estimates of native species and weeds. To monitor the effectiveness of weed management and changes in the impacted plant community over time, transects were run from the disturbed edges of the bushland into intact areas, and quadrats were placed at intervals along each transect. Transects were placed so that changes in the spread of weeds away from the disturbed edge could be detected. This type of detailed monitoring is required to quantify the effects of on-ground management and plan future management strategies. Determining the impact of factors such as changed fire frequency would require a monitoring program such as that established by Clarke (2009).

Monitoring protocols will be based on those developed through the Resource Condition Monitoring project (eg Clarke 2009, and Brown and Clarke 2009). The monitoring will be linked to areas where active management or impacts are anticipated, so analysis of results can be incorporated to improve management of fire, hydrology, disease, weed control and other factors, as is recommended for an adaptive management framework.

Remote sensing data such as 'Vegetation Trend' from Landsat TM provides a coarse measure of change in vegetation cover (see Table 1). The interpretation of these data requires ground truthing as factors such as recovery from fire may not otherwise be evident. This remote sensing method may be suitable for some aspects of monitoring in future.

Responsibility: DEC (Swan Coastal and Blackwood Districts, Science Division, SCB)
Cost: \$20,000 per year
Completion date: Ongoing

6 Map habitat critical to survival

Although habitat critical to survival is described in Section 1, the areas as described have not yet been mapped and that will be done under this action. If any additional occurrences are located, then this habitat will also be determined and mapped for these locations.

Responsibility: DEC (SCB, Swan Coastal and Blackwood District)
Cost: \$10,000 in the first year
Completion date: Year 1 and ongoing as required

7 Survey for dieback

Fourteen occurrences have been assessed and mapped for dieback. Other occurrences will require baseline and ongoing monitoring of the extent, impact and boundaries of dieback to determine if there are priority areas for dieback treatment.

Priority areas for dieback treatment in the community should be determined from the Dieback Protocol that was written by the Dieback Working Group (2000). Data on dieback presence and impact, and future biodiversity implications (eg loss or decline of DRF or Priority taxa, structurally or functionally important taxa) are likely to be important determinants of the priority of treatment of individual occurrences.

Dieback has been recorded in a few occurrences of this community. Once dieback is detected, the dieback front should be monitored at least every five years in summer and flagging tape marking the front replaced regularly. Additional quadrat or transect data would provide useful monitoring data.

Responsibility: DEC (Swan Coastal and Blackwood Districts)
Cost: \$15,000
Completion date: Year 2

8 Ensure adequate hygiene conditions

Not all occurrences have been tested for presence of dieback, and the susceptibility of the community to the disease is not known although a series of taxa that commonly occur in the community are indicated as being susceptible or possibly susceptible to the disease (see Appendix 1). For most species that commonly occur in the community, susceptibility to the disease is not known. Risk of introduction of disease should be minimised by ensuring good hygiene procedures. This would involve adequately washing down any equipment used adjacent to the community, and restricting access by vehicles and machinery to dry soil conditions. No vehicle access should be allowed onto bushland areas in the community. These measures will also act to minimise the risk of introduction of others diseases and weeds into the community.

Responsibility: All personnel using machinery in the occurrences
Cost: Costs of all liaison to be undertaken by DEC (Swan Coastal and Blackwood Districts), is included in other actions; other costs to be underwritten by user of machinery
Completion date: Ongoing

9 Develop and implement fire management strategy that encompasses the following (9.1-9.2)

9.1 Implement adaptive management of the fire regime

There is a need for research into recovery of the community from fire, and to determine the implications of findings for management. This would also include developing a fire history map of the occurrences, which is updated annually. The draft management plan for Brickwood Reserve seeks to address this issue (Serpentine Jarrahdale Shire 2009).

Burrows (2008) recommends fire regimes be determined based on vital attributes, a diversity of frequency, season and intensity, and provide for habitat diversity and a fine-grain mosaic of habitats. Available data for juvenile periods of fire-sensitive species in the community indicate a minimum inter-fire interval of between eight and sixteen years.

As a start point it is recommended that a minimum inter-fire interval of ten years be implemented in the community, and this should be applied in a variety of seasons, and intensities, for example 60-80% of the community to be burnt in a low intensity spring burn. This should be interspersed with much longer inter-fire intervals such as 3-4 times the juvenile period of the slowest maturing species, which on currently available

information for taxa in the community would be 12-16 years. The outcomes of implementation of this regime on the composition and structure of the community should be quantitatively monitored and results and data analysis incorporated into an adaptive management framework.

Responsibility: DEC (Swan Coastal and Blackwood Districts; SCB), in consultation with all stakeholders
Cost: \$2,000 per year for annual review
Completion date: Ongoing

9.2 Maintain strategic firebreaks, and ensure minimal impacts from fire suppression

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to cause spread or intensification of dieback or otherwise degrade the community. Careful use of herbicides is the preferred method of maintenance of firebreaks to minimise soil movement and risk of dieback spread or intensification in the community. No new firebreaks will be constructed in intact vegetation in occurrences.

Local DEC staff will be involved in planning fire break construction and maintenance for all occurrences of the community.

Fire management or response plans have been developed for some occurrences (Occurrences 17 Roman Rd, 3-8 Brixton St wetlands, 14-15 Brickwood Reserve). Fire fighting authorities need to recognise the importance of not constructing new tracks during their operations, including during wildfires. The use of heavy machinery to create new fire breaks within the community should be avoided because additional disturbance would encourage further weed invasion, and chemicals that may be toxic to the community should not be used.

A local DEC staff member will be present during wildfires and controlled burns in remnants that contain occurrences of the community, to advise on protecting the conservation values of the community.

Responsibility: DEC (Swan Coastal and Blackwood Districts), in liaison with surrounding landholders
Cost: Cost of firebreaks \$5,000 pa; costs of liaison included in 3.2
Completion date: Ongoing

10 Implement weed control, and replant where necessary

Weed control plans will be developed for all areas of bushland that contain the community and will be based on information from weed mapping. Plans will identify the highest priority weeds that pose the greatest threat to the community (see Table 1), in the early stages of invasion where possible. Appropriate methods of weed control are found in Brown and Brooks (2002) and may include hand weeding or localised application of herbicide. The herb layer is an integral part of this plant community and care will be taken to minimise disturbance of native herbs in any weed control program.

Rehabilitation through reintroduction of local native species may be necessary if areas are no longer capable of regenerating following weed control. Piles of weed-contaminated soil in any occurrences should be removed and the areas replanted. Tracks excess to requirements should be left to revegetate naturally. Only seed from the same occurrence should be used for rehabilitation. No seed from other areas should be introduced into occurrences.

Responsibility: DEC (Swan Coastal and Blackwood Districts) in consultation with landholders, land managers.
Cost: \$40,000 pa for weed control in all occurrences; rehabilitation requirements of other occurrences need to be determined
Completion date: Ongoing

11 Determine the 'normal range' of groundwater levels and quality, and evaluate significant changes in relation to flora composition

Historical and current data from bores within the community will be examined to determine trends in groundwater levels and quality for suitable bores in occurrences likely to be remote from most human induced changes, and in some in which hydrological change is suspected. This will provide a description of the normal range and fluctuation in water levels and quality, in the habitat of the *Corymbia calophylla* - *Kingia*

australis woodlands on heavy soils. Data may also be indicative of tolerance levels when linked with monitoring of the composition of the community.

Responsibility: DEC (Species and Communities Branch, Swan Coastal and Blackwood Districts) in consultation with landholders, land managers
Cost: \$7,000 pa in years 2, 3 to investigate available data
Completion date: Year 3

12 Seek to influence land management practices to manage hydrology

Some occurrences of the community may be at risk from increased inundation or salinisation due to rising groundwater and increased ponding as a result of clearing of the catchments. Occurrences 24-26 (private land in mine site) may be affected by groundwater drawdown if the mine proceeds with dewatering activities. Data from Iluka Resources Limited stated that the projected groundwater drawdown was expected to be between 2-6m if no proactive recharge system was in place. Modelling showed that groundwater recharge would progressively recover over four years depending on meteorological conditions. Careful monitoring and appropriate management of the groundwater levels is required to minimise impacts to these occurrences.

DEC will seek to influence the management of bushland that contains occurrences and adjacent lands that are likely to occur in areas that influence the hydrology such that groundwater and surface water processes are maintained within likely limits of tolerance. Based on available evidence from groundwater levels and presence of wetland adapted flora, this community is a wetland and may be groundwater dependent. According to the limits stated by Froend *et al.* (2004), based on available data for groundwater levels in occurrences this would indicate the need to maintain changes to groundwater levels to within 0.25m of recent historic levels. The limits of tolerance to change in groundwater quality are not known and will only be determined through the application of an adaptive management framework that links monitoring of changes to water quality to vegetation change.

Hydrology will be managed within an adaptive management framework, with detailed quantitative monitoring of floristic composition and structure linked to areas where there is likely to be significant hydrological change in terms of groundwater or surface water levels or quality.

Responsibility: DEC (Swan Coastal and Blackwood Districts); in liaison with DoW, Department of Agriculture and Food
Cost: \$5,000 pa
Completion date: Ongoing

13 Fence remnants that contain the community, where necessary

Fencing may be necessary to prevent degradation where occurrences are in high usage areas, or to prevent grazing. Some occurrences on private land may require fencing to prevent degradation by uncontrolled access. Occurrence 18 (Mundijong Rd) is suffering degradation from the impact of horse riders and indiscriminate clearing for tracks, but as the bushland is on a roadside, fencing would be difficult. The requirement for fencing at Occurrences 22 and 23 (Waroona) to prevent uncontrolled access should be assessed. Most occurrences are already fenced, and there is little evidence of broad-scale degradation of other occurrences as a result of uncontrolled vehicle access.

Responsibility: DEC (Swan Coastal and Blackwood Districts), landowners and managers
Cost: To be determined
Completion date: Year 1

14 Clarify the floristic community present at specified occurrences

The identity of the floristic community types at some occurrences has not been confirmed through establishment of quadrats, and appropriate statistical analysis of comprehensive floristic data. Where sites are degraded it is not possible to use quadrat data and statistical techniques to clarify the floristic community type present. Occurrences 12 and 13 (MyAbern01, 02, 03) are not in good condition. The presence of the *Corymbia calophylla* - *Kingia australis* woodlands on heavy soils community was inferred in Bush Forever (2000).

There is either no quadrat data, or data are not yet analysed for Occurrences 1 (StrilCres08), 12 and 13 (MyAbern01, 02, 03), 16 (MyByford04), 20 (Turner01, 02, 03), 24 and 25 (Yoganup01, 02), and 26

(Davies03). Where vegetation is in appropriate condition, quadrats will be established, and data analysed using appropriate statistical techniques to clarify the floristic community present.

Responsibility: DEC (Swan Coastal and Blackwood Districts)
Cost: \$15,000
Completion date: Year 2

15 Support private landowners to conserve the community

Various incentive schemes and other forms of support are available to private land owners for encouraging the management of areas of high biodiversity value. Biodiversity incentive schemes available in Western Australia are detailed on the DEC website (<Management and Protection> <Conservation on other lands>) at: http://www.dec.wa.gov.au/index.php?option=com_docman&task=doc_download&gid=354.

Incentives for protection include funds available when lands are protected under a DEC nature conservation covenant, and through the Australian Government 'Caring for our Country' program.

Responsibility: DEC (Swan Coastal District, Blackwood District), in liaison with landholders
Cost: Costs of liaison included in 3.1.2
Completion date: Ongoing

16 Develop management guidelines

If site-based management guidelines that would conserve the threatened ecological community are not being prepared or implemented, DEC will seek involvement in the cooperative preparation of guidelines for occurrences that include management considerations as listed in this plan. This applies specifically to public land occurrences, but assistance may also be provided to private land owners, including through the DEC Land for Wildlife scheme and nature conservation covenant program.

The Wildflower Society has developed Management Guidelines for Brixton Street reserve (Occurrences 3-8; Keighery 1995). There is a draft management plan for Occurrences 14-15 in Brickwood Reserve (Shire of Serpentine Jarrahdale 2009). Occurrence 11 (Fletcher01, 02) is also managed under Management Guidelines. The Roadside Care Volunteers and the Serpentine-Jarrahdale Landcare Group are involved in the management of the roadside remnants that contain Occurrence 18 (Mundijond Rd). Keighery (1996) and Papenfus (2004) provide a detailed account of the conservation values and management recommendations for the remnant.

Currently, there is no detailed Management Plan in place for Dundas Road Bush Forever site (Occurrence 2) or the bushland in Pinjarra Industrial area (Occurrence 21 in Reserve 34033).

Management guidelines would be required for each major bushland area that contains the community, not for each individual occurrence. The management guidelines will include a weed map, weed control strategy, and a detailed fire management strategy, as described in other actions.

Responsibility: DEC (Swan Coastal District; Blackwood District), and land managers
Cost: Costs of liaison included as part of 3.2; cost of plan development \$20,000 pa in Years 2, 3
Completion date: Year 2, 3

17 Seek long term protection of areas of the community

If effective management for conservation seems unlikely to result from recommendations held in this plan, or if suitable areas that contain the community become available, DEC will negotiate to have the remnants that contain the community, and adequate buffer areas where required, protected through perpetual protection agreements or reserved as conservation reserves vested with the Conservation Commission of WA.

This recommendation applies to the following public land areas (suggested management boundaries as listed below follow logical borders such as those of existing reserves or remnants and may be selected to include other known threatened ecological communities):

- i) bushland in public road reserve, Occurrence 1 (StirlCres08)
- ii) areas of remnant native vegetation remaining in reserves 37981 and 37260, Occurrence 2, (Dundas02);
- iii) reserve 14217, occurrence 11 (Fletcher02)

- vii) reserve 34033, occurrence 21 (Pind01); and
- viii) reserve 31437, occurrence 22 and 23 (WARO06, 07).

In addition, the linear remnant on Mundijong Road is very significant as it represents one of only two remaining cross-sections of native vegetation that span the alluvial soils of the southern Swan Coastal Plain. The western edge includes an occurrence of the critically endangered community 'Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands' (community 3c as described in Gibson *et al.* 1994) and the central portion of this remnant contains the vulnerable 'Dense shrublands on clay flats' (type 9 as described by Gibson *et al.* 1994).

DEC will continue to negotiate to seek transfer to the Conservation Commission of WA of unmanaged land along Mundijong Road that contains the community (the remnant portion of Reserve 23793 (occurrence 18) for reservation for 'Conservation and Passive Recreation'. Reserve 23793 is managed by the Shire and local community groups and is vested with the Department for Regional Development and Lands.

While the majority of the occurrences of this community are in public lands, a few are owned privately. Where required to improve the conservation outcome on these lands, DEC will seek to increase the protection of the lands through either perpetual agreements such as conservation covenants, or through acquisition and reservation as conservation reserves.

This action refers to the following occurrences:

- i) part of occurrence 1 (StirlCres)
- ii) occurrences 24-26 (Yoganup and Davies)

Responsibility: DEC (Land Unit; Swan Coastal and Blackwood Districts; SCB); Shire of Serpentine-Jarrahdale; private land owners; Landgate
Cost: Market price of private land at time of purchase; costs of liaison included as part of 3.2
Completion date: To be determined - when land, and resources available

18 Report on success of management strategies for the occurrences

Reporting should be part of annual reports prepared by the Recovery Teams for DEC's Corporate Executive, and include results of analysis of monitoring results within an adaptive management framework. A final report will be presented as part of the next review and update of the recovery plan, if deemed necessary.

If a recovery actions database is developed, information about recovery and monitoring for all TECs will be stored in that database.

Responsibility: DEC (Swan Coastal and Blackwood Districts; SCB)
Cost: \$3,000 pa
Completion date: Year 5

Table 3: Summary of costs for each recovery action

Recovery Action	Year 1	Year 2	Year 3	Year 4	Year 5
Coordinate recovery actions	2,000	2,000	2,000	2,000	2,000
Continue liaison to implement recommendations	2,000	2,000	2,000	2,000	2,000
Continue to disseminate information	2,000	2,000	2,000	2,000	2,000
Continue to monitor extent and boundaries	3,000		2,000		2,000
Encompass monitoring in adaptive management framework	20,000	20,000	20,000	20,000	20,000
Map habitat critical to survival	10,000				
Survey for dieback		15,000			
Ensure adequate hygiene conditions	-	-	-	-	-
Develop and implement fire management strategy	7,000	7,000	7,000	7,000	7,000
Implement weed control	40,000	40,000	40,000	40,000	40,000

Determine 'normal range' of groundwater levels, quality		7,000	7,000		
Seek to influence land management practices to manage hydrology	5,000	5,000	5,000	5,000	5,000
Fence remnants that contain the community	TBD				
Clarify the floristic community present at specified occurrences		15,000			
Support private landowners to conserve the community	-	-	-	-	-
Develop management guidelines		20,000	20,000		
Seek long term protection of areas of the community	TDB				
Report on success of management strategies	3000	3000	3000	3000	3000
Total	\$94,000	\$138,000	\$110,000	\$81,000	\$83,000

Total of all costs over five years: \$506,000 (not including uncosted actions)

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APPENDIX 1

Ecological characteristics of vascular plants recorded from at least 50% of plots in occurrences (From TEC Database 2009)

Note: Floristic data from DEP (1996) has not been incorporated into this table. Information is based on plots in Occurrences 2, 3, 4, 5, 6, 7 and 10 only.

Occurrences 1, 8 and 9 were recorded in DEP (1996), with other floristic data from Gibson *et al.* (1994).

Taxon	Fire response (Source-Naturemap)	Months to first flowering (Source-Naturemap)	Months to peak flowering (Source-Naturemap)	Months to flowering decline (Source-Naturemap)	Longevity (Source-Naturemap)	Dieback response (Source-Naturemap)
<i>Acacia lasiocarpa</i> var. <i>bracteolata</i>	100% scorch kills, in soil seed storage	36			Perennial	Inferred evidence of resistance
<i>Acacia pulchella</i>	100% scorch kills, in soil seed storage	24	48	60	perennial	Some evidence of resistance
<i>Acacia sessilis</i>	ND					
<i>Acacia stenoptera</i>	100% scorch kills, in soil seed storage	36			perennial	Inferred evidence of resistance
<i>Actinotus leucocephalus</i>	100% scorch kills, in soil seed storage	12			perennial	
<i>Allocasuarina humilis</i>	Survives 100% scorch, basal sprouts	36			perennial	Inferred high susceptibility
<i>Amphipogon debilis</i>	Survives 100% scorch, basal sprouts	12	12			
<i>Anigozanthos viridis</i>	Survives 100% scorch, soil suckers	36				Inferred variable susceptibility
* <i>Anagallis arvensis</i> var. <i>arvensis</i>	weed					
* <i>Arundo donax</i>	weed					
<i>Astartea scoparia</i>	ND					
<i>Austrodanthonia occidentalis</i>	ND					
<i>Asteridea pulverulenta</i>	Killed by 100% scorch (any 1,2,3)	12			Annual	
<i>Astroloma pallidum</i>	Survives 100% scorch, soil suckers	24				Some evidence of moderate susceptibility
<i>Baeckea camphorosmae</i>	Survives 100% scorch, basal sprouts	6			perennial	
<i>Banksia lindleyana</i>	Survives 100% scorch, basal sprouts	48			Perennial	Inferred moderate susceptibility
<i>Banksia nivea</i>	ND					
<i>Borya scirpoidea</i>	ND					
* <i>Briza maxima</i>	weed					
* <i>Briza minor</i>	weed					
<i>Burchardia congesta</i>	ND					
<i>Burchardia multiflora</i>	Geophyte (Survives 100% scorch)	12				
<i>Caladenia ferruginea</i>	Geophyte (Survives 100% scorch)	9			Listed as perennial	
<i>Caladenia huegelii</i>	Geophyte (Survives 100% scorch)	9			Listed as perennial	
<i>Calectasia grandiflora</i> subsp. <i>grandiflora</i>	ND					
<i>Calytrix aurea</i>	ND					
<i>Calytrix flavescens</i>	100% scorch kills, in soil seed storage	30			Perennial	
<i>Calytrix fraseri</i>	Survives 100% scorch, basal sprouts	36			Perennial	
<i>Cassytha glabella</i>	ND					
<i>Caustis dioica</i>	Survives 100% scorch, soil suckers				Perennial	
<i>Centrolepis aristata</i>	ND					
<i>Chaetanthus aristatus</i>	ND					
<i>Chamaescilla corymbosa</i>	Geophyte (Survives 100% scorch)	7			Perennial	
<i>Chamaescilla spiralis</i>	ND					
* <i>Chamaecytisus palmensis</i>	weed					
<i>Conostylis aculeata</i>	Survives 100% scorch, basal sprouts	32			Perennial	Inferred evidence of resistance
<i>Conostylis setigera</i>	100% scorch kills, in soil seed storage	24			Perennial	Good evidence of resistance

<i>Corymbia calophylla</i>	Survives 100% scorch, epicormics	48			Perennial	Good evidence of resistance
<i>Cyathochaeta avenacea</i>	Survives 100% scorch, basal sprouts	6			Perennial	Good evidence of resistance
* <i>Cynodon dactylon</i>	weed					
<i>Dampiera linearis</i>	Survives 100% scorch, soil suckers	24			Perennial	Good evidence of resistance
<i>Dasypogon bromeliifolius</i>	Survives 100% scorch, large apical bud	6			Perennial	Some evidence of variable susceptibility
<i>Daviesia decurrens</i>	Survives 100% scorch, basal sprouts	18			Perennial	
<i>Desmocladius fasciculatus</i> (formerly <i>Loxocarya fasciculata</i>)	ND					
<i>Dianella revoluta</i>	Survives 100% scorch, soil suckers	36			Perennial	
* <i>Disa bracteata</i>	weed					
<i>Drosera bulbigena</i>	ND					
<i>Drosera erythrorhiza</i>	Geophyte (Survives 100% scorch)	11			Perennial	Good evidence of resistance
<i>Drosera gigantea</i>	Geophyte (Survives 100% scorch)	10			Perennial	
<i>Drosera menziesii</i> subsp. <i>menziesii</i>	ND					
<i>Drosera radicans</i>	ND					
<i>Eucalyptus lane-poolei</i>	Survives 100% scorch, basal sprouts				Perennial	
<i>Eucalyptus marginata</i>	Survives 100% scorch, epicormics	48			Perennial	Good evidence of moderate susceptibility
<i>Eucalyptus totidiana</i>	Survives 100% scorch, epicormics	48			Perennial	Inferred evidence of resistance
<i>Eucalyptus wandoo</i>	Survives 100% scorch, epicormics	48			Perennial	Good evidence of resistance
* <i>Ehrharta calycina</i>	weed					
<i>Elymus scaber</i>	ND					
* <i>Eragrostis curvula</i>	weed					
<i>Eremaea pauciflora</i>	100% scorch kills, in soil seed storage	48			Perennial	
* <i>Euphorbia terracina</i>	ND					
<i>Eutaxia virgata</i>	100% scorch kills, in soil seed storage	24			Perennial	
<i>Gastrolobium capitatum</i>	ND					
* <i>Gladiolus caryophyllaceus</i>	weed					
<i>Goodenia coerulea</i>	ND					
<i>Gompholobium aristatum</i>	100% scorch kills, in soil seed storage	24			Perennial	
<i>Gompholobium knightianum</i>	100% scorch kills, in soil seed storage	21			Perennial	Inferred evidence of resistance
<i>Gompholobium polymorphum</i>	100% scorch kills, in soil seed storage	10			Perennial	
<i>Gompholobium tomentosum</i>	100% scorch kills, in soil seed storage	31			Perennial	Inferred evidence of resistance
<i>Grevillea bipinnatifida</i>	Survives 100% scorch, basal sprouts	24			Perennial	Inferred moderate susceptibility
<i>Haemodorum laxum</i>	Geophyte (Survives 100% scorch)	6			Perennial	Inferred evidence of resistance
<i>Haemodorum loratum</i>	ND					
<i>Haemodorum simplex</i>	Geophyte (Survives 100% scorch)	8			Perennial	
<i>Hakea candolleana</i>	ND					
<i>Hakea ceratophylla</i>	Survives 100% scorch, basal sprouts	24			Perennial	Inferred variable susceptibility
<i>Hakea lissocarpha</i>	Survives 100% scorch, basal sprouts	29			Perennial	Some evidence of variable susceptibility
<i>Hakea prostrata</i>	Survives 100% scorch, basal sprouts	36			Perennial	Inferred variable susceptibility
<i>Hakea sulcata</i>	100% scorch kills, on plant seed storage				Perennial	
<i>Hakea trifurcata</i>	100% scorch kills, on plant seed storage	48			Perennial	
<i>Hakea undulata</i>	100% scorch kills, on plant seed storage	29			Perennial	
<i>Hakea varia</i>	100% scorch kills, on plant seed storage	24			Perennial	Some evidence of moderate susceptibility
<i>Hibbertia hypericoides</i>	Survives 100% scorch, basal sprouts	22			Perennial	
<i>Hibbertia vaginata</i>	ND					

<i>Homalosciadium homalocarpum</i>	ND					
<i>Hyalosperma cotula</i>	100% scorch kills, in soil seed storage	12			Annual	
<i>Hydrocotyle alata</i>	ND					
<i>Hypocalymma angustifolium</i>	ND					
* <i>Hypochaeris glabra</i>	weed					
<i>Hypolaena exsulca</i>	ND					
<i>Hypolaena pubescens</i>	ND					
<i>Hypoxis occidentalis</i>	ND					
<i>Jacksonia furcellata</i>		12			Perennial	
<i>Jacksonia floribunda</i>	100% scorch kills, in soil seed storage	24			Perennial	
<i>Jacksonia sternbergiana</i>	100% scorch kills, on plant seed storage				Perennial	
<i>Johnsonia pubescens</i>	100% scorch kills, in soil seed storage	24			Perennial	
<i>Kingia australis</i>	Survives 100% scorch, large apical bud	2				Good evidence of resistance
<i>Kunzea micrantha</i>		36			Perennial	
<i>Lambertia multiflora</i> var. <i>darlingensis</i>	ND					
<i>Laxmannia ramosa</i>	ND					
<i>Lepidosperma angustatum</i>	Survives 100% scorch, soil suckers	26			Perennial	Inferred evidence of resistance
<i>Lepidosperma pubisquameum</i>	ND					
<i>Lepidosperma squamatum</i>	Survives 100% scorch, soil suckers	22			Perennial	
<i>Lepyrodia macra</i>	ND					
<i>Leschenaultia floribunda</i>	ND					
<i>Levenhookia stipitata</i>	ND					
<i>Lomandra preissii</i>	Survives 100% scorch, soil suckers	12			Perennial	
<i>Lyginia barbata</i>	Survives 100% scorch, basal sprouts	21			Perennial	Inferred evidence of resistance
<i>Meeboldina coangustata</i>	ND					
<i>Melaleuca incana</i> subsp. <i>incana</i>	100% scorch kills, on plant seed storage	33			Perennial	
<i>Melaleuca preissiana</i>	Survives 100% scorch, epicormics	24			Perennial	
<i>Melaleuca scabra</i>	Survives 100% scorch, basal sprouts	72			Perennial	
<i>Melaleuca raphiophylla</i>	Survives 100% scorch, basal sprouts				Perennial	
* <i>Melinis minutiflora</i>	weed					
<i>Mesomelaena tetragona</i>	Survives 100% scorch, soil suckers	22			Perennial	Good evidence of resistance
<i>Neurachne alopecuroidea</i>	Survives 100% scorch, soil suckers	13			Perennial	Inferred evidence of resistance
<i>Nuytsia floribunda</i>	Survives 100% scorch, epicormics	24			Perennial	
* <i>Oxalis glabra</i>	weed					
* <i>Oxalis pes-caprae</i>	weed					
* <i>Parentucellia viscosa</i>	weed					
<i>Patersonia occidentalis</i>	100% scorch kills, in soil seed storage	36			Perennial	Inferred moderate susceptibility
* <i>Pennisetum clandestinum</i>	weed					
<i>Pericalymma ellipticum</i>	Survives 100% scorch, basal sprouts	22			Perennial	
<i>Petrophile media</i>	ND					
<i>Petrophile serruriae</i>	100% scorch kills, on plant seed storage	48			Perennial	Inferred variable susceptibility
<i>Phlebocarya ciliata</i>	Survives 100% scorch, basal sprouts	18			Perennial	
<i>Philydrella pygmaea</i>	ND					
<i>Philothea spicata</i> (formerly <i>Eriostemon spicatus</i>)	ND					
<i>Podolepis gracilis</i>	Killed by 100% scorch	12			Annual	
<i>Regelia ciliata</i>	Survives 100% scorch, basal sprouts	60			Perennial	

* <i>Romulea rosea</i>	weed					
<i>Scaevola repens</i> var. <i>repens</i>	ND					
<i>Schoenus asperocarpus</i>	ND					
<i>Schoenus efoliatus</i>	ND					
<i>Schoenus grandiflorus</i>	Survives 100% scorch, soil suckers	12			Perennial	Inferred evidence of resistance
<i>Schoenus pennisetis</i>	ND					
<i>Schoenus odontocarpus</i>	ND					
<i>Schoenus rigens</i>	ND					
<i>Siloxerus filifolius</i>	Killed by 100% scorch	12			Annual	
<i>Siloxerus humifusus</i>	ND					
<i>Sowerbaea laxiflora</i>	Survives 100% scorch, soil suckers	7			Perennial	
<i>Stirlingia latifolia</i>	100% scorch kills, in soil seed storage	24			Perennial	
<i>Stylidium brunonianum</i>	100% scorch kills, in soil seed storage	12			perennial	
<i>Stylidium calcaratum</i>	100% scorch kills, in soil seed storage	7			Ephemeral	
<i>Stylidium dichotomum</i>	ND					
<i>Synaphea acutiloba</i>	ND					
<i>Synaphea petiolaris</i> subsp. <i>triloba</i>	ND					
<i>Tetradia octandra</i>	Survives 100% scorch, soil suckers	12			perennial	
<i>Thysanotus manglesianus</i>	Survives 100% scorch, soil suckers	6			perennial	
<i>Thysanotus multiflorus</i>	Survives 100% scorch, soil suckers	12			perennial	
<i>Thysanotus sparteus</i>	Survives 100% scorch, soil suckers	12			perennial	
<i>Tribonanthes australis</i>	ND					
<i>Tribonanthes longipetala</i>	ND					
<i>Tricoryne elatior</i>	100% scorch kills, in soil seed storage	24			perennial	
<i>Tripterococcus paniculatus</i>	ND					
<i>Trymalium floribundum</i>	100% scorch kills, in soil seed storage	27			perennial	Some evidence of variable susceptibility
* <i>Tribolium uniolae</i>	weed					
<i>Tricoryne elatior</i>	100% scorch kills, in soil seed storage	24			perennial	
<i>Tricostularia neesii</i>	ND					
<i>Triglochin centrocarpa</i>	ND					
* <i>Ursinia anthemoides</i>	weed					
<i>Verticordia densiflora</i>	100% scorch kills, in soil seed storage	30			perennial	
<i>Verticordia pennigera</i>	100% scorch kills, in soil seed storage				perennial	
<i>Verticordia plumosa</i>	ND					
<i>Viminaria juncea</i>	100% scorch kills, in soil seed storage				perennial	
* <i>Vulpia bromoides</i>	weed					
* <i>Watsonia meriana</i> var. <i>bulbillifera</i>	weed					
<i>Wahlenbergia preissii</i>	ND					
<i>Wurmbea dioica</i>	ND					
<i>Xanthorrhoea brunonis</i>	ND					
<i>Xanthorrhoea drummondii</i>	Survives 100% scorch, large apical bud	6			perennial	
<i>Xanthorrhoea preissii</i>	Survives 100% scorch, large apical bud	9			perennial	Good evidence of high susceptibility
<i>Xanthosia huegelii</i>	Survives 100% scorch, basal sprouts	32			perennial	

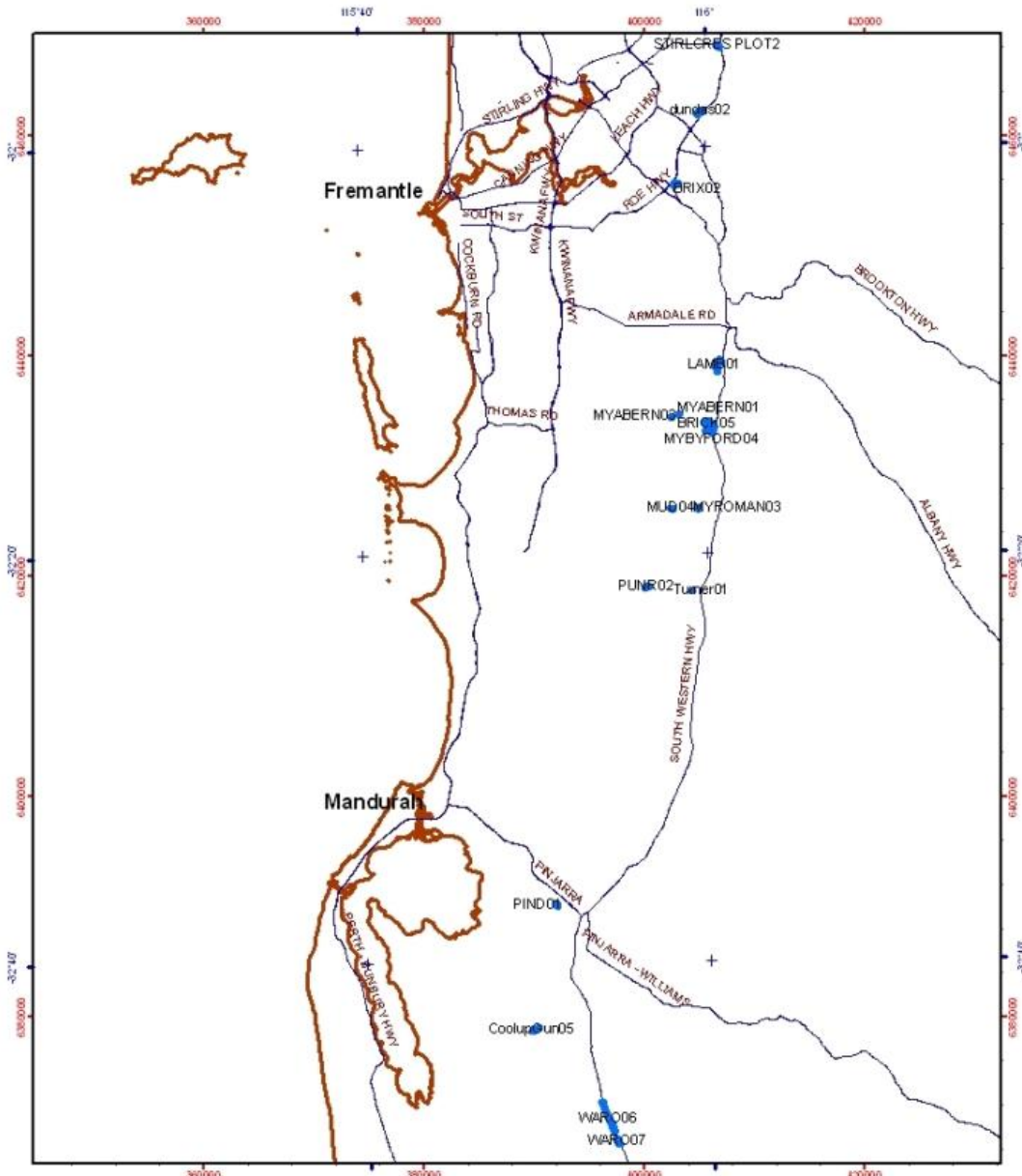
* = Introduced; ND = no data available in Naturemap

APPENDIX 2:

Status of flora taxa (from DEC 2009)

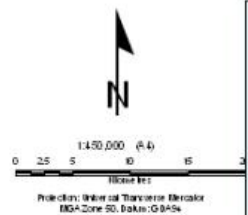
Declared rare flora	'taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.'
Priority 1	'taxa which are known from one or a few populations which are under threat.'
Priority 2	'taxa which are known from one or a few populations, at least some of which are not believed to be under immediate threat.'
Priority 3	'taxa which are known from several populations, at least some of which are not believed to be under immediate threat.'
Priority 4	'taxa which are considered to have been adequately surveyed and which, whilst being rare (In Australia), are not currently threatened by any identifiable factors.'

APPENDIX 3
Location Maps: Northern occurrences



Coordinate system: UTM
 Datum: GDA94
 Projection: UTM
 Zone: 50
 Spheroid: GRS80
 Datum: GDA94
 Units: Meter

- Legend**
- SCP3aSept2011
 - hmrds_2004
 - WA Coast



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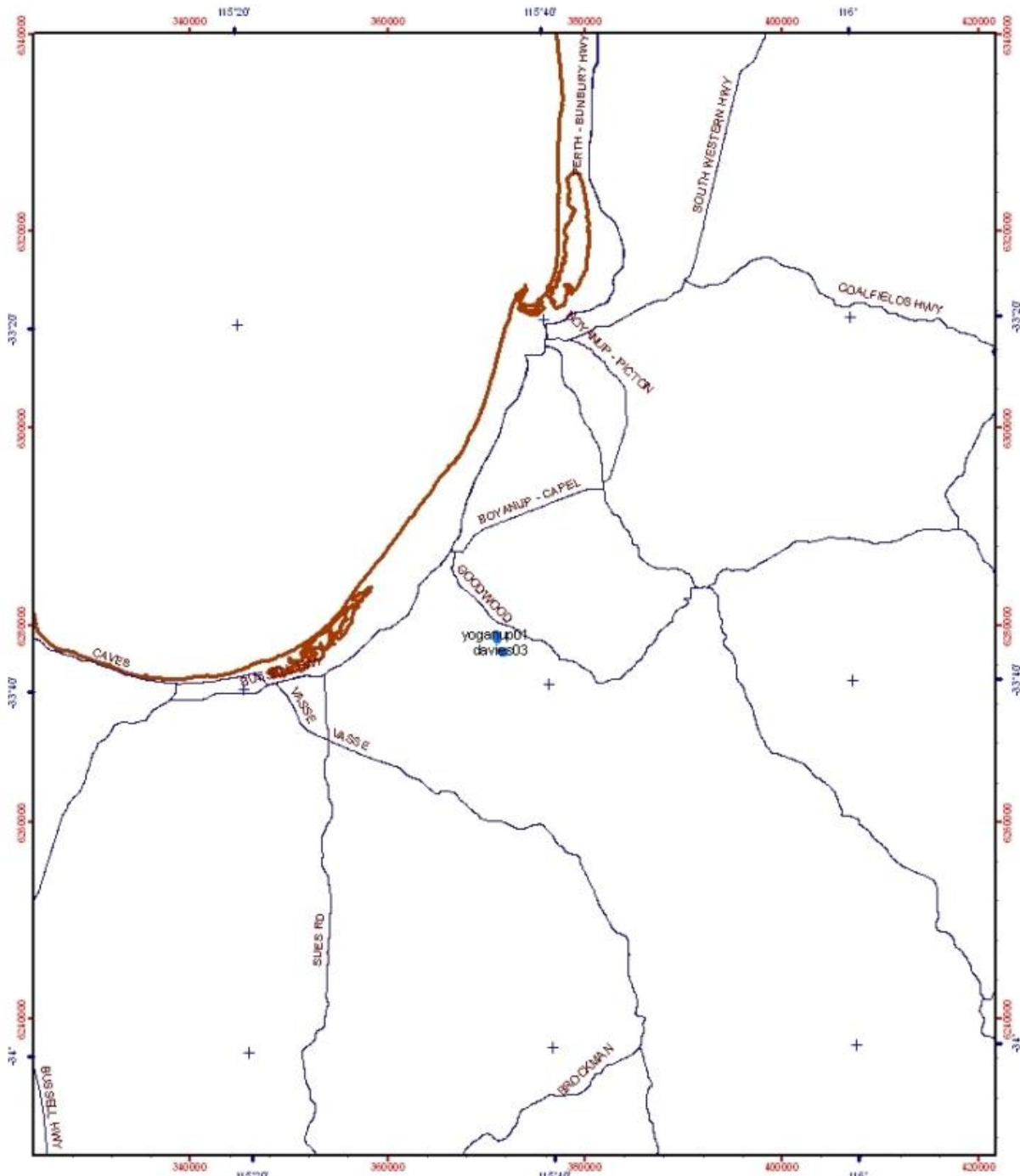
Produced at 10:45am, on September 23, 2011

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Southern Occurrences



Graphics shown at 20 metres intervals
 200 metres at 20000 metres contour

Legend

- SCP3aSept2011
- hmrds_2004
- WA Coast



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