

**VEGETATION AND FLORA
OF
LOT 21 BROCKMAN ROAD
COWARAMUP**



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i. SUMMARY

On 5th December 2001 a vegetation and flora survey was undertaken by Bennett Environmental Consulting of Lot 21 Brockman Road, Cowaramup, "the site". It is proposed to develop the site as strata lots where building envelopes will be stipulated and caveats placed to prevent the clearing of native vegetation on the blocks. By placing these requirements on the blocks it will ensure the continued conservation and in some areas the enhancement of the remnant bushland.

A total of 192 species were recorded from the area of which 44 were weeds. Although the percentage of weeds (22%) seems relatively high, most were restricted to damp areas with only a few recorded from the higher Jarrah/Marri forest areas. Most of the weeds in the Jarrah/Marri forest occurred along tracks rather than in the remnant bushland.

Only one weed, *Bromus diandrus* was rated by CALM as High and as invasive and recorded as having environmental impacts on bushland. Twenty five weeds were rated by CALM as having Moderate impact but have the potential to invade bushland in good or better condition. This indicates that with any development weed management will be essential.

Two remnant vegetation communities were recorded from the site.

- Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermint) and *Callistachys lanceolata* (Native willow) over a Sedgeland, by the creek; and
- Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over a Shrubland on the higher, lateritic slopes.

In addition a degraded community

- Closed Grassland of mixed species with occasional scattered, emergent trees was recorded from cleared areas which generally retained water in the soil ground cover.

Weeds were dominant away from the direct influence of the creek under some very large Karri and Peppermint trees. These areas could readily be turned into a parkland setting. In sections of the creek an introduced mint (Spearmint ?) has

become dominant, which provides a pleasant scent when trampled, but an effort should be made with the proposed development to remove this plant. There were several "green" areas along the creek where some native species were dominant and care will need to be taken to ensure that only weed and not native species are removed with any enhancement to the area.

The Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over a Shrubland, had different dominant species in the Shrubland depending upon height up the slope, dampness of the soil and many unknown factors which could include time since disturbance, eg fire. All of this vegetation community had been logged with very few, large trees remaining. Many plants, especially the jarrahs were multistemmed from regrowth after previous logging, believed to be about 20 years ago.

This Jarrah/Marri forest was classified as having a Good to Very Good Vegetation Condition due to it having been logged previously and the vegetation along the creek as Good to Degraded.

No Declared Rare Flora were recorded from the site although the field work was not undertaken until early December when annual and ephemeral species had completed flowering and were dead or dying. *Thysanotus isantherus*, a Priority species may have been recorded from the site but a collection earlier in the season will be required to confirm its identification. However this plant was recorded in the proposed Conservation area in the north east of the site as well in the remnant bushland on the eastern slope above the creek.

The vegetation communities identified at the site are widespread in the region and have a Fair Condition (Connell *et al.*, 1999). The site is not on one of the designated linkages and is not listed as having a High Ecological Value.

Generally the brief outline provided of the proposed development indicates that the development will occur in an environmentally sensitive manner with a concern to maintaining the quality of the remnant bushland and enhancing other areas, including the creek line. The methods to be employed will be address in the Environmental Management Plan.

1 INTRODUCTION

The site surveyed, Lot 21 occurs to the west of Cowaramup townsite and south of Brockman Road. A Village Development is proposed where residential blocks of 1200m² to 3000m² are planned in vegetated areas and lots of 2-3ha in degraded areas. Clearing caveats and building envelopes will be placed on all blocks within the vegetated areas.

Cowaramup is part of the Warren Botanical Subdistrict in the Darling Botanical District of the Southwest Botanical Province. It stretches from the south of Cape Naturaliste to Albany, typically consists of forests delimited by the presence of Karri (*Eucalyptus diversicolor*) (Beard, 1990).

Beard further divided the Warren Botanical Subdistrict into 5 systems and Cowaramup is included in the Boranup System. The Boranup System extends from Cape Naturaliste to Irwin Inlet and covers the Leeuwin-Naturaliste Ridge and the coastal dunes of the Scott River Plain. The Leeuwin-Naturaliste Ridge is a north-south trending horst of Precambrian granite and granulite forming hills rising to 200m. Most of the outcrop is obscured by laterite and sand on the inland side, and by dune sand and calcarenite on the western, seaward side. On the inland side the soils are acid grey earths, sometimes containing ironstone gravels and some yellow mottled sands, whilst the seaward side the soil are calcareous sands (Beard, 1981).

The vegetation is described by Beard (1981) as Tall forest of Karri (*Eucalyptus diversicolor*) on red earths, Forest of Jarrah-Marri (*E. marginata* – *Corymbia calophylla*) on the red and yellow podzolic soils. Extensive paperbark (*Melaleuca* sp.) and sedge swamps in valleys and flood plains.

For the RFA project, Matiske and Havel (1998) described the pre-1750 distribution of vegetation complexes for the Busselton-Augusta area. Cowaramup is included in the Margaret River Plateau and has two Vegetation Complexes listed for the area. These are:

- Uplands, Cowaramup (C2) – Open forest of *Corymbia calophylla* (Marri) – *Eucalyptus marginata* subsp. *marginata* (Marri)- *Banksia*

grandis (Bull Banksia) on lateritic uplands in perhumid and humid zones; and

- Valleys, Cowaramup (CW1) – Mixture of open forest to woodland of *Eucalyptus diversicolor* (Karri) – *Corymbia calophylla* (Marri) and woodland of *Eucalyptus marginata* subsp. *marginata* (Jarrah) – *Corymbia calophylla* (Marri) on slopes and low woodland of *Melaleuca preissiana* (Moonah) - *Banksia littoralis* (Swamp banksia) on depressions in the hyperhumid zone.

Connell *et al.* (1999) state that in Pre-1770 there was 88.2 sq. km of C2 and that 29.29 sq. km remain today, representing 33.2% of the original area of which 1% is currently reserved. For CW1, there was 61.2 sq. km and 10.27 sq. km remains today, representing 27% of which 2.3% is currently reserved.

Grein (2000a,b) states that the site was included as a potential “Conservation Park” in the Leeuwin-Naturaliste Ridge Planning Review Urban Settlements Study but felt that the closed canopy cover identified from aerial photographs led to this decision. He ground truthed the area in November 2000 and identified the vegetation as regrowth forest, no more than 20 years old where the trees are 2-5 metres apart leading to the dense canopy cover. As a result of this survey, he recommended that the proposed conservation area within the development be relocated.

2 SURVEY METHODOLOGY

A field survey of the site, as defined in the aerial photograph and plans provided by S. Palmer, was undertaken on 5th December 2001. It was surveyed by driving all tracks and by transects on foot through the vegetated areas. The vegetation associations present and the species within each association were recorded.

Prior to undertaking the field work a list of known Rare and Priority flora for the area was obtained. These species were checked with collections at the Western Australian Herbarium to ensure their recognition in the field.

Species were recorded in the field, but where the identity was unknown or uncertain these were collected and pressed, then later identified using keys and by comparison with the specimens housed at the Western Australian Herbarium.

Current nomenclature was checked using FloraBase (Western Australian Herbarium, 2001a) and MAX (Western Australian Herbarium, 2001b).

2.1 Vegetation

The descriptions were prepared using the vegetation layers as listed in Table 1.

Table 1. Vegetation layers. Adapted from: Bush Forever (Government of Western Australia, 2000)

| Life Form/ Height Class | Canopy Cover | | | |
|----------------------------|---------------------|------------------|-------------------|------------------------|
| | 100-70% | 70-30% | 30-10% | 10-2% |
| Trees over 30m | Tall Closed Forest | Tall Open Forest | Tall Woodland | Tall Open Woodland |
| Trees 10-30m | Closed Forest | Open Forest | Woodland | Open Woodland |
| Trees under 10m | Low Closed Forest | Low Open Forest | Low Woodland | Low Open Woodland |
| Tree mallee/Mallee | Closed Tree Mallee | Tree Mallee | Open Tree Mallee | Very Open Tree Mallee |
| Shrub mallee | Closed Shrub Mallee | Shrub Mallee | Open Shrub Mallee | Very Open Shrub Mallee |
| Shrubs over 2m | Closed Tall Scrub | Tall Open Scrub | Tall Shrubland | Tall Open Shrubland |
| Shrubs 1-2m | Closed Heath | Open Heath | Shrubland | Open Shrubland |
| Shrubs under 1m | Closed Low Heath | Open Low Heath | Low Shrubland | Low Open Shrubland |
| Grasses | Closed Grassland | Grassland | Open Grassland | Very Open Grassland |
| Sedges | Closed Sedgeland | Sedgeland | Open Sedgeland | Very Open Sedgeland |
| Herbs | Closed Herbland | Herbland | Open Herbland | Very Open Herbland |

2.2 Vegetation Condition

The vegetation condition of each vegetation community was recorded using the 6-scale condition rating as appeared in Bush Forever Vol 2, p. 48 (Government of Western Australia, 2000).

Table 2: Condition rating scale from Bush Forever (Government of Western Australia, 2000)

| Rating | Description | Explanation |
|--------|---------------------|--|
| 1 | Pristine | Pristine or nearly so, no obvious signs of disturbance. |
| 2 | Excellent | Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. |
| 3 | Very Good | Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure covers repeated fire, aggressive weeds, dieback, logging, grazing. |
| 4 | Good | Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure covers frequent fires, aggressive weeds at high density, partial clearing, dieback and grazing. |
| 5 | Degraded | Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure includes frequent fires, presence of very aggressive weeds, partial clearing, dieback and grazing. |
| 6 | Completely degraded | The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs. |

2.3 Rare and Priority Flora

A search was undertaken by the Department of Conservation and Land Management in the Cowaramup area for the co-ordinates 33°45' - 33° 55' and 114° 55' - 115° 10'. This resulted in 30 species being identified. These are listed in Table 3, together with their code and known distribution. It can be seen that 10 significant species have been recorded from the Cowaramup area.

Table 3. Rare and Priority Flora for Co-ordinates 33°45' - 33° 55' and 114° 55' - 115° 10'

| Significant Flora | Code | Distribution Recorded for Co-ordinates |
|--|------|---|
| <i>Caladenia excelsa</i> | Rare | Margaret River, Cowaramup |
| <i>Drakaea elastica</i> | Rare | Catterick |
| <i>Hydatella dioica</i> | Rare | Midland |
| <i>Laxmannia jamesii</i> | Rare | Busselton, Yelverton |
| <i>Thomasia laxiflora</i> | 1 | Cowaramup , Whicher Range |
| <i>Acacia subracemosa</i> | 2 | Gracetown |
| <i>Boronia capitata</i> subsp. <i>gracilis</i> | 2 | Harvey, Busselton, Yarloop, Cowaramup , Waroona |
| <i>Leptomeria furtiva</i> | 2 | Cowaramup , Scott River, Ambergate, Busselton |
| <i>Acacia inops</i> | 3 | Margaret River, Yelverton |
| <i>Boronia anceps</i> | 3 | Scott River, Walpole, Cape Naturaliste, Cowaramup |
| <i>Boronia tetragona</i> | 3 | Capel, Busselton, Whicher Range, Cowaramup |
| <i>Bossiaea disticha</i> | 3 | Augusta – Margaret River, Ellen Brook |
| <i>Chorizema reticulatum</i> | 3 | Cowaramup , Vasse |
| <i>Cyathochaeta teretifolia</i> | 3 | Yelverton |
| <i>Dampiera heteroptera</i> | 3 | Scott River, Cowaramup , Karridale, Nannup |
| <i>Gahnia sclerioides</i> | 3 | Yelverton, William Bay, Denmark, Walpole, West Cape Howe |
| <i>Gonocarpus pusillus</i> | 3 | Albany, Walpole-Nornalup, Mt Frankland, Augusta, Scott River, Yelverton |
| <i>Johnsonia inconspicua</i> | 3 | Carbunup, Yelverton, Quindalup |
| <i>Lepyrodia heleocharoides</i> | 3 | Yelverton |
| <i>Pimelea ciliata</i> subsp. <i>longituba</i> | 3 | Yelverton, Cowaramup |
| <i>Pultenaea pinifolia</i> | 3 | Cowaramup , Yelverton |
| <i>Pultenaea radiata</i> | 3 | Whicher Range |
| <i>Sphenotoma parviflorum</i> | 3 | Cowaramup |
| <i>Thysanotus isantherus</i> | 3 | Cowaramup Bay |
| <i>Caladenia arrecta</i> | 4 | Margaret River |
| <i>Calothamnus pallidifolius</i> | 4 | Yelverton |
| <i>Drosera fimbriata</i> | 4 | Lecuwinn Naturaliste National Park |
| <i>Eucalyptus rudis</i> subsp. <i>cratyantha</i> | 4 | Meelup, |
| <i>Thysanotus glaucus</i> | 4 | Yelverton |

Table 4. Code and description of Rare and Priority Flora categories

| Code | Code Declared Rare and Priority Flora Categories |
|------|---|
| R | DRF (Declared Rare Flora) -Extant Taxa. Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection. |
| X | DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently. |
| 1 | Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat. |
| 2 | Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat. |
| 3 | Priority Three -Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat. |
| 4 | Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors. |

Table 5. Significant flora listed for Cowaramup with information on habit and habitat obtained from Western Australian Herbarium (2001a)

| Significant Flora | Description of Plant | Soil | Habitat |
|--|--|--|--|
| <i>Boronia anceps</i> | Shrub 30-60cm tall. Flowers pink, purple | White sand, gravelly laterite | Seasonally swampy Heath; or <i>Banksia</i> , <i>Agonis juniperina</i> Low Forest |
| <i>Boronia capitata</i> subsp. <i>gracilis</i> | Shrub 30-60cm tall. Flowers pink | White/grey or black sand | Winter-wet swamps; hillslopes; <i>Astartea</i> Heath over sedges |
| <i>Boronia tetragona</i> | Perennial herb, 30-70cm tall. Flowers pink, red | Black/white sand, laterite, brown sandy loam | Winter wet flats, swamps, Open Woodland |
| <i>Bossiaea disticha</i> | Spindly shrub 0.5-1.5m tall. Pea, flowers yellow, brown, red | Sand over limestone | Peppermint Woodland; or Jarrah-Marri Woodland |
| <i>Caladenia excelsa</i> | Spider orchid. Stem to 1m tall. Very long petals | Deep grey sand | <i>Banksia</i> , Jarrah Low Woodland/Forest |
| <i>Chorizema reticulatum</i> | Spindly shrub 25-50cm tall. Pea flowers pink, orange | Sand over laterite | Jarrah/Marri Forest or Open Scrub |
| <i>Dampiera heteroptera</i> | Few branched shrub to 45cm tall. Flowers blue | Sand | Swamps |
| <i>Leptomeria furtiva</i> | Leafless shrub 0.3-1m tall. Flowers orange, brown | Grey or black peaty sand | Winter wet swamps |
| <i>Pimelea ciliata</i> subsp. <i>longituba</i> | Shrub 0.3-1m tall. Flowers pink | Grey sand over clay, loam | Marri Woodland, Jarrah over Peppermint |
| <i>Pultenaea pinifolia</i> | Shrub 1-3m tall. Pea flowers orange-yellow | Loam or clay | Floodplains, swampy areas, Jarrah/Marri Woodland, Marri Woodland |
| <i>Sphenotoma parviflorum</i> | Slender shrub 0.15-1m tall. Flowers white | Grey or white sand | Swampy areas, gravelly hills, Jarrah Forest, Paperbark Woodland |
| <i>Thomasia laxiflora</i> | Shrub 25-45cm tall. Flowers purple-grey | Gravel or loam | Jarrah/Marri Forest |
| <i>Thysanotus isantherus</i> | Perennial herb to 15cm tall. Flowers purple. | Granite, grey sand | Moss swards, Jarrah/marri forest, Marri woodland |

3 RESULTS

3.1 Vegetation

Many of the annual and ephemeral (eg orchids) plants had completed flowering and were impossible to positively identify. Other perennial plants were not flowering eg *Mentha* species making positive identification impossible. The two remnant vegetation communities and one degraded community identified at the site, together with the dominant species present in each stratum, are described below. These are identified in Appendix C, Map 1 and the taxa present listed in Appendix B.

Remnant Vegetation Communities

1. Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermints) and *Callistachys lanceolata* (Native willow) over a Sedgeland or where degraded a Herbland.

Upper stratum: *Eucalyptus diversicolor*

Middle stratum: *Agonis flexuosa*, *A. linearifolia*, *Boronia molloyae*, *Callistachys lanceolata*

Lower stratum: *Baumea vaginalis*, *Centipeda cunninghamii*, *Juncus caespiticus*, *J. holoschoenus*, *J. planifolius*, *Lepidosperma tetraquetrum*, *Meeboldina roycei*, *Schoenus maschalinus*

2. Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over either a

- a) Closed Tall Scrub of *Bossiaea aquifolium* (Waterbush), *Hovea elliptica* (Tree hovea) and *Mirbelia dilatata* (Prickly mirbelia) over an Open Low Heath of *Hibbertia hypericoides* (Buttercup); or**
- b) Tall Shrubland dominated by *Kingia australis* (Black gin) and *Xanthorrhoea preissii* (Grasstree) over an Open Low Heath of mixed species; or**
- c) Closed Heath of *Podocarpus drouyanianus* (Native plum) and *Hovea elliptica* (Tree hovea); or**

d) Closed Low Heath of *Hibbertia hypericoides* (Buttercup); or

e) Open Heath of mixed species.

The dominant species in the strata varied depending upon where the community was sampled, the percentage cover of the upper stratum, the soil moisture and the age of the trees since logging. Dominant species common to all the above are:

Upper stratum: *Banksia grandis*, *Corymbia calophylla*, *Eucalyptus marginata* subsp. *marginata*

Middle stratum: *Bossiaea aquifolium*, *Hakea amplexicaulis*, *H. lissocarpha*, *Hovea elliptica*, *Mirbelia dilatata*, *Podocarpus drouyanianus*

Lower stratum: *Acacia pulchella* var. *pulchella*, *Hibbertia cunninghamii*, *H. hypericoides*, *Leucopogon capitatum*, *Tetrrarhena laevis*, *Tetratheca hirsuta*, *Trichocline spathulata*

Understorey complex 2a occurred on the east side of the creek about 150-200m east of the degraded area; 2b occurred in the older rehabilitating vegetation in the north east of the site; 2c occurred in the south east of the site where it appeared to be damper soil with less laterite on the surface although laterite boulders were outcropping; 2d occurred adjacent to the creek and 2e was the dominant understorey in the remnant vegetation on the west side of the creek. This is mapped in Appendix C, Map 1 with a photographic record in Appendix D.

Degraded Community

Closed Grassland of mixed species with occasional scattered, emergent trees.

Upper stratum: *Agonis flexuosa*, *Corymbia calophylla*, *Eucalyptus diversicolor*, *E. marginata* subsp. *marginata*

Lower stratum: **Arctotheca calendula*, **Anthoxanthum odoratum*, **Avena barbata*, **Bromus hordeaceus*, **Cynosurus echinatus*, **Hordeum geniculatum*, **Hypochaeris glabra*, **Lolium rigidum*, **Lotus angustissimus*, **Lotus uliginosus*, **Mentha* sp., **Polypogon monspeliensis*, **Trifolium dubium*, **Trifolium ligusticum*, **Trifolium repens*

3.2 Vegetation Condition

Referring to Table 2, all logged vegetation can be classified no higher than 3 – Very Good, although the understorey is dense and with very little weed invasion. Most of the remnant Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) is classified as Very Good, with small areas classified as Good to Degraded depending upon the amount of weed invasion (See Appendix C, Map 2).

The creek, the remnant Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermint) and *Callistachys lanceolata* (Native willow) over a Sedgeland varied from Very Good to Completely Degraded. The Very Good sections of this community occurred at the north of the site with scattered Very Good or Good sections between Degraded sections for about half the length within the site. The southern section is generally Degraded to Completely Degraded.

In some areas the tree layer was dense but the understorey was completely replaced by weeds. This occurred near to the west of the degraded section in the north west of the site (indicated as 5-6 in Appendix C, Map 2).

3.3 Flora

A total of 59 plant families, 130 genera and 192 species were recorded from the site (Appendix A). The dominant families are listed in Table 6.

Table 6. Dominant Plant families recorded from the site

| Vascular Plant Family | Number of Genera | Number of Native Species | Number of Weed Species | Total Number Species |
|-----------------------|------------------|--------------------------|------------------------|----------------------|
| Poaceae | 17 | 6 | 14 | 20 |
| Papilionaceae | 11 | 12 | 5 | 17 |
| Cyperaceae | 7 | 15 | 0 | 15 |
| Asteraceae | 13 | 6 | 8 | 14 |
| Myrtaceae | 5 | 13 | 0 | 8 |
| Orchidaceae | 4 | 7 | 1 | 8 |
| Goodeniaceae | 5 | 7 | 0 | 7 |
| Proteaceae | 5 | 7 | 0 | 7 |
| TOTAL | 67 | 73 | 28 | 96 |

These eight families represent 48.9% of the total number of species, 51% of the genera and 13% of the families recorded for the site.

Out of order

3.4 Rare and Priority Flora

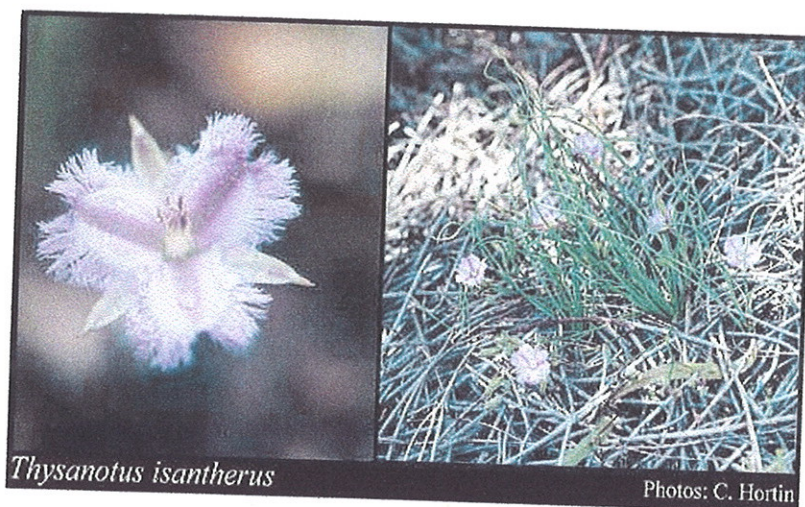
One Priority 3 species, *Thysanotus isantherus*, may have been recorded from the site. However due to the lateness in the season that the survey was undertaken a positive identification could not be made, mainly due to the fruiting and not flowering material collected. Checking the description of the species in Brittain (1987) p 317 with the collections made in the field it matched in all respects, except that the description says that the umbels (flowering heads) are 1-5 flowered whereas the collection made had over 10 flowers. Also the pedicels (flower stalks) are given as 8-10 mm long, whereas the fruiting collection made had pedicels in excess of this length. This longer length may be acceptable as several plants increase the pedicel length with fruiting. Checking with the specimens in the Herbarium collection the field collection matched with a few of these. However if this species is confirmed it was recorded from the regrowth forest as well as the more mature forest to be included in the conservation area.



Plant 10-15cm tall, with about 6 leaves at the base.

Inflorescence

Possibly a plant of *Thysanotus isantherus*



Photograph of
Thysanotus isantherus
taken from Western
Australian Herbarium
(2001a)

A “spider orchid” *Caladenia* sp. was collected but it had finished flowering and could not be positively identified. Two “spider orchids” are included in Table 3. *Caladenia arrecta*, a P4 species, grows in sandy loam and gravel in *Eucalyptus marginata* subsp. *marginata* (Jarrah) – *Corymbia calophylla* (Marri) forest but *Caladenia excelsa*, a Rare species, grows in deep grey sand in *Eucalyptus marginata* subsp. *marginata* (Jarrah), *Banksia ilicifolia* (Holly leaf banksia) Forest, *B. attenuata* (Narrow leaf banksia) Low Forest over Heath. All orchids collected have been sent to Andrew Brown at CALM for possible identification so the “spider orchid” *Caladenia* sp. could be *C. arrecta*.

3.5 Introduced (Weed) Species

A total of 44 weeds were recorded from the site. Most were very site specific being restricted to the degraded areas, which typically were very moist. All have all been determined as weeds by Department of Conservation and Land Management (1999) and the Western Australian Herbarium (2001a,b) and their rating is given below in Table 10. The rating allocated to each weed by CALM is based on three criteria:

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

Ratings indicate the following.

- **High** indicates this weed is prioritised for control and/or research ie prioritising funding to it.
- **Moderate** indicates control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** indicates monitoring of the weed and control where appropriate.
- **Low** indicates that this species would require a low level of monitoring.

Table 7. Weeds recorded during the survey classified according to CALM (1999)

| Scientific Name | CALM Rating | | |
|--|-------------|--------------|---------|
| | Rating | Invasiveness | Impacts |
| * <i>Bromus diandrus</i> | High | ✓ | ✓ |
| * <i>Aira caryophyllea</i> | Moderate | ✓ | |
| * <i>Anagallis arvensis</i> var. <i>arvensis</i> | Moderate | ✓ | |
| * <i>Anagallis arvensis</i> var. <i>caerulea</i> | Moderate | ✓ | |
| * <i>Anthoxanthum odoratum</i> | Moderate | ✓ | |
| * <i>Arctotheca calendula</i> | Moderate | ✓ | |
| * <i>Avena barbata</i> | Moderate | ✓ | |
| * <i>Briza maxima</i> | Moderate | ✓ | |
| * <i>Briza minor</i> | Moderate | ✓ | |
| * <i>Carduus pycnocephalus</i> | Moderate | ✓ | |
| * <i>Centaureum erythraea</i> | Moderate | ✓ | |
| * <i>Cynodon dactylon</i> | Moderate | ✓ | |
| * <i>Cyperus brevifolius</i> | Moderate | ✓ | |
| * <i>Cyperus tenellus</i> | Moderate | ✓ | |
| * <i>Disa bracteata</i> | Moderate | ✓ | |
| * <i>Holcus lanatus</i> | Moderate | ✓ | |
| * <i>Hypochaeris glabra</i> | Moderate | ✓ | |
| * <i>Juncus bufonius</i> | Moderate | ✓ | |
| * <i>Lolium rigidum</i> | Moderate | ✓ | |
| * <i>Lythrum hyssopifolia</i> | Moderate | ✓ | |
| * <i>Orobancha minor</i> | Moderate | ✓ | |
| * <i>Parentucellia viscosa</i> | Moderate | ✓ | |
| * <i>Polypogon monspeliensis</i> | Moderate | ✓ | |
| * <i>Solanum nigrum</i> | Moderate | ✓ | |
| * <i>Sonchus oleraceus</i> | Moderate | ✓ | |
| * <i>Trifolium dubium</i> | Moderate | ✓ | |
| * <i>Vellereophyton dealbatum</i> | Moderate | ✓ | |
| * <i>Vulpia bromoides</i> | Moderate | ✓ | |
| * <i>Cynosurus echinatus</i> | Mild | | |
| * <i>Petrorhagia dubia</i> | Mild | | |
| * <i>Rumex pulcher</i> subsp. <i>divaricatus</i> | Mild | | |
| * <i>Trifolium repens</i> | Mild | | |
| * <i>Acetosella vulgaris</i> | Low | | |
| * <i>Bromus hordeaceus</i> | Low | | |
| * <i>Conyza bonariensis</i> | Low | | |

| Scientific Name | CALM Rating | | |
|-------------------------------|-------------|--------------|---------|
| | Rating | Invasiveness | Impacts |
| * <i>Cotula turbinata</i> | Low | | |
| * <i>Cyathea cooperi</i> | Low | | |
| * <i>Filago gallica</i> | Low | | |
| * <i>Hordeum geniculatum</i> | Low | | |
| * <i>Lotus angustissimus</i> | Low | | |
| * <i>Lotus uliginosus</i> | Low | | |
| * <i>Mentha</i> sp. | Low | | |
| * <i>Ranunculus muricatus</i> | Low | | |
| * <i>Trifolium ligusticum</i> | Low | | |

Only one of the weeds identified from the site is rated as High, 27 as Moderate, 4 as Mild, 12 as Low. Most of the weeds were recorded from the moister environment with only a few eg. *Anthoxanthum odoratum*, *Arctotheca calendula*, *Briza* spp. occurring on the higher ground associated with the Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah). Most of the degraded vegetation occurred in water holding soils and in sections along the creek. Weeds were mostly abundant along tracks in the drier and higher ground.

Although care will need to be taken during any proposed development to ensure that weeds are not introduced into the Very Good and Good vegetation, there are possibly only a few of those on the site that will survive in “dry” ground. However the only weed listed as High, **Bromus diandrus*, is common in all environments and has the potential to be readily distributed.

3.6 Regional Significance of Vegetation

Both the vegetation communities described above are indicated as being well represented in the RFA maps produced by Matiske and Havel (1998). However the land around Busselton – Margaret River was one of the first areas developed for farming in Western Australia so it has been under development for many years, firstly for grazing and more recently as vineyards. Logging of Karri, Jarrah and Marri has continued since settlement resulting in very little mature forests of these species remaining, not only in this area, but throughout the southwest of Western Australia.

Jarrah occurs from Mount Lesueur (where it is a mallee) south, where it becomes a tall tree to the east of Albany. Marri, extends further inland than Jarrah but has a similar north-south extension. Both species and therefore the vegetation communities they form are widespread throughout the south west of Western Australia. Today the remnant Jarrah forest remains on the lateritised upper plateau levels as agricultural settlement has cleared these trees from the easier to develop valleys. Jarrah occurs as pure stands on laterite but where the soil is superficial Jarrah and Marri occur as observed at the survey site.

The Karri along the creek is a remnant only, but the presence of Karri in this area must be close to its most northern distribution. It only grows where the correct humid niche occurs. There are more extensive examples of Karri forest within the Shire of Augusta Margaret River that occur south of the site. Creeks in good or better condition are unusual although it is stated in Grein (2000b) that there is a near pristine drainage line to the north east of the development. Therefore the small remnant of Good or better sections along the creek through the site are of significance and should, as is intended, be retained and rehabilitated with species occurring in the area.

The site is classified as being in Poor Condition (Connell *et al.*, 1999). Generally they found that the remnant vegetation in Good or Very Good Condition occurred along the eastern edge of the Shire or along the coast. Typically those in Good Vcondition corresponded to the large reserved remnants and those in Poor Condition were small privately owned remnants on the heavily cleared plain.

With the proposed development areas of connected vegetation are intended to remain. This should ensure there is a corridor connecting the western area of the site with the eastern area of the site. This will be especially important for birds and mammals.

4 DISCUSSION

It is proposed to develop Lot 21, the site surveyed on the 5th December 2001 as strata lots where building envelopes will be stipulated and caveats placed to prevent the clearing of native vegetation on the blocks. In addition it is

anticipated there will be revegetation of a large, wetter area in the north east section of the Lot, which adjoins remnant forest to be conserved as part of the Common Property area of 39ha. By placing these requirements on the blocks it will ensure the continued conservation and in some areas the enhancement of the remnant bushland.

A total of 192 species were recorded from the area of which 44 were weeds. Although the percentage of weeds (22%) seems relatively high, most were restricted to damp areas with only a few recorded from the higher areas. Only one weed, *Bromus diandrus* was rated by CALM as High and as invasive and recorded as having environmental impacts on bushland. Twenty five weeds were rated by CALM as having Moderate impact but have the potential to invade bushland in good or better condition. This indicates that with any development weed management will be essential.

Two remnant vegetation communities were recorded from the site. These were Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermint) and *Callistachys lanceolata* (Native willow) over a Sedgeland, by the creek and a Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over a Shrubland on the higher, lateritic slopes.

In addition a degraded community a Closed Grassland of mixed species with occasional scattered, emergent trees was recorded from cleared areas which generally retained water in the soil. This community was common on the eastern side of the creek, the north east corner and along the western edge of the site. The creek running north south through the property included the remnant Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermint) and *Callistachys lanceolata* (Native willow) over a Sedgeland. There were several small sections where this vegetation community was in Good to Very Good condition but along most of the creek length the understorey had been replaced by weeds but included were sections where *Centipeda cunninghamii*, a native species formed a dense ground cover. The better quality creek vegetation occurred in the north of the property and should be retained with any development

and the species present in these sections used to improve the quality of the vegetation along the remainder of its length. Several Tree ferns (*Cyathea cooperi*), an Eastern Australian species, had germinated along the creek and several very young plants were observed. This species has the potential to increase considerably, and it would appear that conditions are ideal, but it will decrease the vegetation condition of those sections of the creek. It is proposed to develop wetland areas and if some of these are not intended to be restored to a natural condition some of these ferns could be transplanted there. Another alternative would be to sell them to local people or nurseries.

Weeds were dominant away from the direct influence of the creek under some very large Karri and Peppermint trees. These areas would require a lot of effort to attempt to restore to a natural condition and could readily be turned into a parkland setting for the owners who buy into the area. In sections of the creek an introduced mint (Spearmint ?) has become dominant, which provides a pleasant scent when trampled, but an effort should be made with the proposed development to remove this plant. There were several "green" areas along the creek where some native species were dominant and care will need to be taken to ensure that only weed and not native species are removed with any enhancement to the area.

The Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over a Shrubland, had different dominant species in the Shrubland depending upon height up the slope, dampness of the soil and many unknown factors which could include time since disturbance, eg fire. All of this vegetation community had been logged with very few, large trees remaining. The area to the east of the creek on the north side of the site was more open with fewer trees but those that remained were of reasonable size. Immediately above the south end of the creek on the eastern slope the trees were numerous, with thin trunks and a dense canopy. Many plants, especially the jarrahs were multistemmed from regrowth after previous logging, believed to be about 20 years ago. However the understorey was in reasonable condition with very little or no weed infestation. This community was classified as having a

Good to Very Good Vegetation Condition due to it having been logged previously.

All areas have many felled logs on the ground. These act as a refuge for native animals, especially lizards and other ground living animals. Some of the trees had dead upper limbs; again if these include hollows they will be used for nesting by native birds. Several kangaroos were observed during the field work so any proposed development of the area should ensure these animals continue to live in the area.

No Declared Rare Flora were recorded from the site although the field work was not undertaken until early December when annual and ephemeral species had completed flowering and were dead or dying. By referring to Tables 3 and 5 one Declared Rare Flora has been recorded by CALM as occurring at Cowaramup, *Caladenia excelsa*, an ephemeral species, but it has been recorded as occurring in sand, a soil type without remnant vegetation at the site. *Thysanotus isantherus*, a Priority species may have been recorded from the site but a collection earlier in the season will be required to confirm its identification. However this plant was recorded in the proposed Conservation area in the north east of the site as well in the remnant bushland on the eastern slope above the creek. All the other species are shrubs, which if present would have been recognised during the survey.

The vegetation communities identified at the site are widespread in the region and have a Fair Condition (Connell *et al.*, 1999). They used a 4-point scale of Very Good, Good, Fair and Poor. Elsewhere these communities have been recorded in much better vegetation condition. They also considered vegetation linkages and Ecological values within the Shire. The site is not on one of the designated linkages and is not listed as having a High Ecological Value.

Connell *et al.* (1999) noted that only 2.3% of the original extent of the Valleys, Cowaramup (CW1) vegetation complex remains. In addition the development and preservation of wildlife corridors, which are “considered to provide avenues for movement of individuals and populations of both flora and fauna” is noted, and the creek, in its current state, and particularly with the intended enhancement must act an important corridor. Currently the creek must be used as a corridor for

animals reliant on dense reeds, dense low trees and Karri for their food and breeding. Similarly it is essential when planning the development of the site that connections between the remnant vegetation are maintained to retain corridors for animals. In many sections of the site the understorey vegetation was dense affording protection for many smaller animals. Several of the logs that have been felled should be retained as they offer protection and nesting places for several animals.

The introduction of weeds into the remnant bushland with any development will need to be addressed. This will also include the transporting of seeds along the creek from areas upstream of the site. The application of fertiliser, especially where there is runoff into the creek will need to be addressed with development. Too high a quantity of nutrients in the water will affect the species present and may degrade the creek.

Generally the brief outline provided of the proposed development indicates that the development will occur in an environmentally sensitive manner with a concern to maintaining the quality of the remnant bushland and enhancing other areas, including the creek line. The methods to be employed will be address in the Environmental Management Plan.

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APPENDIX A

Vascular Plant Species Recorded

LEGEND

| ABBREVIATION | EXPLANATION |
|--------------|---|
| subsp. | subspecies |
| var. | variety |
| * | weed species |
| sp. | species. (This is used where unidentifiable vegetative material was only present and the correct identification to species was unknown) |
| affin. | it appears to be closest to but not the species |
| ? | uncertain name. (This is used where the species name has been tentatively identified but flowering material will definitely confirm) |

| FAMILY NAME | SCIENTIFIC NAME | COMMON NAME |
|------------------|---|----------------------------|
| ADIANTACEAE | <i>Adiantum aethiopicum</i> | Common maidenhair fern |
| CYATHACEAE | * <i>Cyathea cooperi</i> | Tree fern |
| DENNSTAEDTIACEAE | <i>Pteridium esculentum</i> | Bracken |
| LINDSAEACEAE | <i>Lindsaea linearis</i> | Screw fern |
| PODOCARPACEAE | <i>Podocarpus drouynianus</i> | Wild plum |
| ZAMIACEAE | <i>Macrozamia riedlei</i> | Zamia |
| ANTHERICACEAE | <i>Agrostocrinum scabrum</i> | Blue grass lily |
| | <i>Caesia micrantha</i> | Pale grass lily |
| | <i>Chamaescilla corymbosa</i> var. <i>corymbosa</i> | Blue squill |
| | <i>Johnsonia lupulina</i> | Hooded lily |
| | <i>Thysanotus isantherus</i> | |
| | <i>Thysanotus multiflorus</i> | Many flowered fringed lily |
| COLCHICACEAE | <i>Burchardia umbellata</i> | Milkmaids |
| CYPERACEAE | <i>Baumea vaginalis</i> | Sheath twigrush |
| | <i>Chorizandra enodis</i> | Black bristlerush |
| | <i>Cyperus brevifolius</i> | Kyllinga weed |
| | <i>Cyperus tenellus</i> | Tiny flatsedge |
| | <i>Isolepis cernua</i> | Nodding clubrush |
| | <i>Isolepis cyperoides</i> | |
| | <i>Isolepis setiformis</i> | |
| | <i>Lepidosperma</i> affin. <i>leptostachyum</i> | |
| | <i>Lepidosperma gladiatum</i> | Coast sword sedge |
| | <i>Lepidosperma squamatum</i> | |
| | <i>Lepidosperma tetraquetrum</i> | |
| | <i>Mesomelaena tetragona</i> | Semaphore sedge |
| | <i>Schoenus maschalinus</i> | |
| | <i>Tetraria capillaris</i> | Hair sedge |
| | <i>Tetraria octandra</i> | |
| DASYPOGONACEAE | <i>Kingia australis</i> | Blackgin |
| | <i>Lomandra pauciflora</i> | |
| | <i>Lomandra preissii</i> | |
| | <i>Lomandra purpurea</i> | Purple mat rush |
| HAEMODORACEAE | <i>Conostylis setigera</i> subsp. <i>setigera</i> | Bristly cottonhead |
| | <i>Haemodorum laxum</i> | Bloodroot |
| IRIDACEAE | <i>Patersonia babianoides</i> | |
| | <i>Patersonia umbrosa</i> var. <i>umbrosa</i> | Blue flags |
| | <i>Patersonia umbrosa</i> var. <i>xanthina</i> | Yellow flags |
| JUNCACEAE | * <i>Juncus bufonius</i> | Toad rush |
| | <i>Juncus caespiticius</i> | Grassy rush |
| | * <i>Juncus holoschoenus</i> | Jointleaf rush |
| | <i>Juncus pallidus</i> | Pale rush |
| | <i>Juncus planifolius</i> | Broadleaf rush |
| | <i>Juncus subsecundus</i> | Finger rush |
| ORCHIDACEAE | <i>Caladenia flava</i> | Cowslip orchid |
| | <i>Caladenia</i> sp. | Spider orchid |

| FAMILY NAME | SCIENTIFIC NAME | COMMON NAME |
|---------------------|--|------------------------------|
| ORCHIDACEAE (cont.) | <i>*Disa bracteata</i> | South African orchid |
| | <i>Pterostylis recurva</i> | Jug orchid |
| | <i>Pterostylis</i> sp. 'pyramidalis group' | Snail orchid |
| | <i>Thelymitra ? macrophylla</i> | Sun orchid |
| | <i>Thelymitra</i> sp. (1) | Sun orchid |
| | <i>Thelymitra</i> sp. (2) | Sun orchid |
| POACEAE | <i>*Aira caryophylla</i> | Silvery hairgrass |
| | <i>Amphipogon amphipogonoides</i> | |
| | <i>Amphipogon laguroides</i> | |
| | <i>*Anthoxanthum odoratum</i> | Sweet vernal grass |
| | <i>Austrodanthonia setacea</i> | Small flowered wallaby grass |
| | <i>Austrostipa campylachne</i> | Spear grass |
| | <i>*Avena barbata</i> | Bearded oat |
| | <i>*Briza maxima</i> | Blowfly grass |
| | <i>*Briza minor</i> | Shivery grass |
| | <i>*Bromus diandrus</i> | Great brome |
| | <i>*Bromus hordeaceus</i> | Soft brome |
| | <i>*Cynodon dactylon</i> | Couch |
| | <i>*Cynosurus echinatus</i> | Rough dog's tail |
| | <i>Dichelachne crinita</i> | Longhair plumegrass |
| | <i>*Holcus lanatus</i> | Yorkshire fog |
| | <i>*Hordeum geniculatum</i> | Mediterranean barley grass |
| | <i>*Lolium rigidum</i> | Annual ryegrass |
| | <i>*Polypogon monspeliensis</i> | Annual barbggrass |
| | <i>Tetrarrhena laevis</i> | Forest ricegrass |
| | <i>*Vulpia bromoides</i> | Squirrel's tail fescue |
| RESTIONACEAE | <i>Anarthria prolifera</i> | |
| | <i>Desmocladius fasciculatus</i> | |
| | <i>Loxocarya cinerea</i> | |
| | <i>Meeboldina roycei</i> | |
| XANTHORRHOEACEAE | <i>Xanthorrhoea gracilis</i> | Slender grasstree |
| | <i>Xanthorrhoea preissii</i> | Grasstree |
| AMARANTHACEAE | <i>Ptilotus manglesii</i> | Pom poms |
| APIACEAE | <i>Centella asiatica</i> | Centella |
| | <i>Pentapeltis peltigera</i> | |
| | <i>Platysace tenuissima</i> | |
| | <i>Xanthosia candida</i> | |
| | <i>Xanthosia huegelii</i> | |
| ASTERACEAE | <i>*Arctotheca calendula</i> | Cape weed |
| | <i>*Carduus pycnocephalus</i> | Slender thistle |
| | <i>Centipeda cunninghamii</i> | Common sneezeweed |
| | <i>*Conyza bonariensis</i> | Flaxleaf fleabane |
| | <i>*Cotula turbinata</i> | Funnel weed |
| | <i>*Filago gallica</i> | Slender cudweed |
| | <i>*Hypochaeris glabra</i> | Flatweed |
| | <i>Lagenophora huegelii</i> | Coarse Lagenophora |
| | <i>Olearia paucidentata</i> | |

| FAMILY NAME | SCIENTIFIC NAME | COMMON NAME |
|--------------------|--|----------------------|
| ASTERACEAE (cont.) | <i>Senecio quadridentatus</i> | Cotton fireweed |
| | * <i>Sonchus oleraceus</i> | Sowthistle |
| | <i>Trichocline spathulata</i> | Native gerbera |
| | * <i>Vellereophyton dealbatum</i> | White cudweed |
| CARYOPHYLLACEAE | * <i>Petrorhagia dubia</i> | Velvet pink |
| DILLENIACEAE | <i>Hibbertia commutata</i> | |
| | <i>Hibbertia cunninghamii</i> | |
| | <i>Hibbertia hypericoides</i> | Buttercup |
| | <i>Hibbertia inconspicua</i> | |
| | <i>Hibbertia perfoliata</i> | |
| EPACRIDACEAE | <i>Astroloma ciliatum</i> | Candle cranberry |
| | <i>Astroloma pallidum</i> | Kick bush |
| | <i>Leucopogon ? australis</i> | Spiked beardheath |
| | <i>Leucopogon capitellatus</i> | |
| | <i>Leucopogon propinquus</i> | |
| | <i>Leucopogon verticillatus</i> | Tassel flower |
| GENTIANACEAE | * <i>Centaurium erythraea</i> | Common centaury |
| GOODENIACEAE | <i>Dampiera alata</i> | Winged-stem dampiera |
| | <i>Dampiera hederacea</i> | Karri dampiera |
| | <i>Dampiera linearis</i> | Common dampiera |
| | <i>Goodenia pusilla</i> | |
| | <i>Lechenaultia biloba</i> | Blue leschenaultia |
| | <i>Scaevola calliptera</i> | Royal robe |
| | <i>Velleia trinervis</i> | |
| HALORAGACEAE | <i>Gonocarpus diffusus</i> | |
| LAMIACEAE | * <i>Mentha</i> sp. | Mint |
| LAURACEAE | <i>Cassytha racemosa</i> forma. <i>racemosa</i> | Dodder |
| LOBELIACEAE | <i>Lobelia alata</i> | Angled lobelia |
| | <i>Isotoma hypocrateriformis</i> var. <i>hypocrateriformis</i> | Woodbridge poison |
| | <i>Logania serpyllifolia</i> subsp. <i>angustifolia</i> | |
| | | |
| LYTHRACEAE | * <i>Lythrum hyssopifolia</i> | Lesser loosestrife |
| MIMOSACEAE | <i>Acacia divergens</i> | |
| | <i>Acacia gilbertii</i> | |
| | <i>Acacia myrtifolia</i> | Myrtle wattle |
| | <i>Acacia pulchella</i> var. <i>pulchella</i> | Prickly moses |
| MYRTACEAE | <i>Agonis flexuosa</i> | Peppermint tree |
| | <i>Agonis linearifolia</i> | Swamp peppermint |
| | <i>Agonis parviceps</i> | |
| | <i>Astartea affin. fascicularis</i> | |
| | <i>Corymbia calophylla</i> | Marri |
| | <i>Eucalyptus diversicolor</i> | Karri |
| | <i>Eucalyptus marginata</i> subsp. <i>marginata</i> | Jarra |
| | <i>Hypocalymma cordifolium</i> subsp. <i>cordifolium</i> | |
| OROBANCHACEAE | * <i>Orobanche minor</i> | Australian broomrape |
| PAPILIONACEAE | <i>Bossiaea aquifolium</i> subsp. <i>aquifolium</i> | Waterbush |

| FAMILY NAME | SCIENTIFIC NAME | COMMON NAME |
|-----------------------|--|-----------------------------|
| PAPILIONACEAE (cont.) | <i>Bossiaea ornata</i> | Broad leaved brown pea |
| | <i>Callistachys lanceolata</i> | Native willow |
| | <i>Chorizema nanum</i> | |
| | <i>Chorizema rhombeum</i> | |
| | <i>Daviesia decurrens</i> subsp. <i>decurrens</i> | Prickly bitter pea |
| | <i>Gompholobium polymorphum</i> | |
| | <i>Hardenbergia comptoniana</i> | Native wisteria |
| | <i>Hovea chorizemifolia</i> | Holly-leaved hovea |
| | <i>Hovea elliptica</i> | Tree hovea |
| | * <i>Lotus angustissimus</i> | Slender birdsfoot trefoil |
| | * <i>Lotus uliginosus</i> | Greater birdsfoot trefoil |
| | <i>Mirbelia dilatata</i> | Holly leaved mirbelia |
| | <i>Sphaerolobium medium</i> | |
| | * <i>Trifolium dubium</i> | Suckling clover |
| | * <i>Trifolium ligusticum</i> | Ligurian clover |
| | * <i>Trifolium repens</i> | White clover |
| PITTOSPORACEAE | <i>Billardiera variifolia</i> | |
| | <i>Pronaya fraseri</i> var. <i>fraseri</i> | Elegant pronaya |
| POLYGALACEAE | <i>Comesperma confertum</i> | |
| POLYGONACEAE | * <i>Acetosella vulgaris</i> | Sorrel |
| | * <i>Rumex pulcher</i> subsp. <i>divaricatus</i> | Fiddle dock |
| PRIMULACEAE | * <i>Anagallis arvensis</i> var. <i>arvensis</i> | Scarlet pimpernel |
| PRIMULACEAE | * <i>Anagallis arvensis</i> var. <i>caerulea</i> | Blue pimpernel |
| PROTEACEAE | <i>Banksia grandis</i> | Bull banksia |
| | <i>Dryandra lindleyana</i> subsp. <i>lindleyana</i> | Honey pots |
| | <i>Hakea amplexicaulis</i> | Prickly hovea |
| | <i>Hakea lissocarpa</i> | Honey bush |
| | <i>Persoonia elliptica</i> | Spreading snottygobble |
| | <i>Persoonia longifolia</i> | Snottygobble |
| | <i>Xylomelum occidentale</i> | Woody pear |
| RANUNCULACEAE | * <i>Ranunculus muricatus</i> | Sharp buttercup |
| RHAMNACEAE | <i>Trymalium floribundum</i> var. <i>floribundum</i> | Karri hazel |
| | <i>Trymalium ledifolium</i> var. <i>rosmarinifolia</i> | |
| RUBIACEAE | <i>Opercularia apiciflora</i> | |
| | <i>Opercularia echinocephala</i> | Bristly headed stink weed |
| | <i>Opercularia hispidula</i> | Hispid stinkweed |
| RUTACEAE | <i>Boronia molloyae</i> | Tall boronia |
| | <i>Eriostemon capitatum</i> | Pepper and salt |
| SANTALACEAE | <i>Leptomeria cumminghamii</i> | |
| SCROPHULARIACEAE | <i>Gratiola pubescens</i> | Austral brooklime |
| | * <i>Parentucellia viscosa</i> | Sticky bartsia |
| SOLANACEAE | * <i>Solanum nigrum</i> | Black berry nightshade |
| STACKHOUSIACEAE | <i>Tripterococcus brunonis</i> | Winged stackhousia |
| STERCULIACEAE | <i>Lasiopetalum floribundum</i> | Free flowering lasiopetalum |
| | <i>Thomasia paniculata</i> | |

| FAMILY NAME | SCIENTIFIC NAME | COMMON NAME |
|---------------|--|---------------------------|
| STYLIDIACEAE | <i>Levenhookia pusilla</i> | Midget stylewort |
| | <i>Stylidium amoenum</i> var. <i>amoenum</i> | Lovely triggerplant |
| | <i>Stylidium calcaratum</i> | Book triggerplant |
| | <i>Stylidium junceum</i> subsp. <i>junceum</i> | Reed triggerplant |
| | <i>Stylidium rhynchocarpum</i> | Black-beaked triggerplant |
| THYMELAEACEAE | <i>Pimelea spectabilis</i> | Banjong |
| | <i>Pimelea suaveolens</i> subsp. <i>suaveolens</i> | Scented banjine |
| | <i>Pimelea sylvestris</i> | |
| TREMADRACEAE | <i>Tetradlea hirsuta</i> | Black eyed susan |
| | <i>Tremandra diffusa</i> | |

APPENDIX B

Species Listed According to Plant Community

LEGEND

| ABBREVIATION | EXPLANATION |
|--------------|--|
| subsp. | subspecies |
| var. | variety |
| * | weed species |
| sp. | species (This is used where unidentifiable vegetative material was only present and the correct identification to species was unknown) |
| affin. | it appears to be closest to but not the species |
| ? | uncertain name. (This is used where the species name has been tentatively identified but flowering material will definitely confirm) |
| Creek | Tall Open Woodland of <i>Eucalyptus diversicolor</i> (Karri) over a Woodland of <i>Agonis</i> species (Peppermints) and <i>Callistachys lanceolata</i> (Native Willow) over a Sedgeland or where degraded a Herbland |
| Degraded | Closed Grassland of mixed species with occasional scattered, emergent trees |
| Jarrah/Marri | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) |

| SPECIES | VEGETATION COMMUNITY | | |
|--|----------------------|----------|--------------|
| | Creek | Degraded | Jarrah/Marri |
| <i>Acacia divergens</i> | | | ✓ |
| <i>Acacia gilbertii</i> | | | ✓ |
| <i>Acacia myrtifolia</i> | | | ✓ |
| <i>Acacia pulchella</i> var. <i>pulchella</i> | | | ✓ |
| * <i>Acetosella vulgaris</i> | | ✓ | |
| <i>Adiantum aethiopicum</i> | ✓ | | |
| <i>Agonis flexuosa</i> | ✓ | | |
| <i>Agonis linearifolia</i> | ✓ | | |
| <i>Agonis parviceps</i> | ✓ | | ✓ |
| <i>Agrostocrinum stypandroides</i> | | | ✓ |
| * <i>Aira caryophyllea</i> | | | ✓ |
| <i>Amhipogon amhipogonoides</i> | | | ✓ |
| <i>Amhipogon laguroides</i> | | | ✓ |
| * <i>Anagallis arvensis</i> var. <i>arvensis</i> | | ✓ | |
| * <i>Anagallis arvensis</i> var. <i>caerulea</i> | | ✓ | |
| <i>Anarthria prolifera</i> | | | ✓ |
| * <i>Anthoxanthum odoratum</i> | ✓ | ✓ | ✓ |
| <i>Arctotheca calendula</i> | | ✓ | |
| <i>Astartea</i> affn. <i>fascicularis</i> | ✓ | | |
| <i>Astroloma ciliatum</i> | | | ✓ |
| <i>Astroloma pallidum</i> | | | ✓ |
| <i>Austrodanthonia setacea</i> | | | ✓ |
| <i>Austrostipa campylachne</i> | | | ✓ |
| * <i>Avena barbata</i> | | ✓ | ✓ |
| <i>Banksia grandis</i> | | | ✓ |
| <i>Baumea vaginalis</i> | ✓ | | |
| <i>Billardiera variifolia</i> | | | ✓ |
| <i>Boronia molloyae</i> | ✓ | | |
| <i>Bossiaea aquifolium</i> subsp. <i>aequifolium</i> | | | ✓ |
| <i>Bossiaea ornata</i> | | | ✓ |
| * <i>Briza maxima</i> | | ✓ | ✓ |
| * <i>Briza minor</i> | ✓ | ✓ | ✓ |
| * <i>Bromus diandrus</i> | | ✓ | |
| * <i>Bromus hordeaceus</i> | ✓ | ✓ | ✓ |
| <i>Burchardia umbellata</i> | | | ✓ |
| <i>Caesia micrantha</i> | | | ✓ |
| <i>Caladenia flava</i> | | | ✓ |
| <i>Caladenia</i> sp. | | | ✓ |
| <i>Callistachys lanceolata</i> | ✓ | | |
| * <i>Carduus pycnocephalus</i> | ✓ | | |
| <i>Cassytha racemosa</i> forma. <i>racemosa</i> | | | ✓ |
| * <i>Centaurium erythraea</i> | | ✓ | ✓ |
| <i>Centella asiatica</i> | | | |
| <i>Centipeda cunninghamii</i> | ✓ | | |
| <i>Chamaescilla corymbosa</i> var. <i>corymbosa</i> | | | ✓ |

| SPECIES | VEGETATION COMMUNITY | | |
|--|----------------------|----------|--------------|
| | Creek | Degraded | Jarrah/Marri |
| <i>Chorizandra enodis</i> | ✓ | | |
| <i>Chorizema nanum</i> | | | ✓ |
| <i>Chorizema rhombeum</i> | | | ✓ |
| <i>Comesperma confertum</i> | | | ✓ |
| <i>Conostylis setigera</i> subsp. <i>setigera</i> | | | ✓ |
| * <i>Conyza bonariensis</i> | ✓ | ✓ | |
| <i>Corymbia calophylla</i> | ✓ | | ✓ |
| * <i>Cotula turbinata</i> | ✓ | ✓ | ✓ |
| * <i>Cyathea cooperi</i> | ✓ | | |
| * <i>Cynodon dactylon</i> | | ✓ | |
| * <i>Cynosurus echinatus</i> | | ✓ | |
| * <i>Cyperus brevifolius</i> | ✓ | | |
| * <i>Cyperus tenellus</i> | ✓ | | |
| <i>Dampiera alata</i> | | | ✓ |
| <i>Dampiera hederacea</i> | ✓ | | ✓ |
| <i>Dampiera linearis</i> | | | ✓ |
| <i>Daviesia decurrens</i> subsp. <i>decurrens</i> | | | ✓ |
| <i>Desmocladius fasciculatus</i> | | | ✓ |
| <i>Dichelachne crinita</i> | | | ✓ |
| * <i>Disa bracteata</i> | | | ✓ |
| <i>Dryandra lindleyana</i> subsp. <i>lindleyana</i> | | | ✓ |
| <i>Eriostemon capitatum</i> | | | ✓ |
| <i>Eucalyptus diversicolor</i> | ✓ | | |
| <i>Eucalyptus marginata</i> subsp. <i>marginata</i> | | | ✓ |
| * <i>Filago gallica</i> | | | ✓ |
| <i>Gompholobium polymorphum</i> | | | ✓ |
| <i>Gonocarpus diffusus</i> | ✓ | | |
| <i>Goodenia pusilla</i> | ✓ | | |
| <i>Gratiola pubescens</i> | ✓ | | |
| <i>Haemodorum laxum</i> | | | ✓ |
| <i>Hakea amplexicaulis</i> | | | ✓ |
| <i>Hakea lissocarpa</i> | | | ✓ |
| <i>Hardenbergia comptoniana</i> | | | ✓ |
| <i>Hibbertia commutata</i> | | | ✓ |
| <i>Hibbertia cunninghamii</i> | | | ✓ |
| <i>Hibbertia hypericoides</i> | | | ✓ |
| <i>Hibbertia inconspicua</i> | | | ✓ |
| <i>Hibbertia perfoliata</i> | ✓ | | |
| * <i>Holcus lanatus</i> | ✓ | ✓ | |
| * <i>Hordeum geniculatum</i> | | ✓ | ✓ |
| <i>Hovea chorizemifolia</i> | | | ✓ |
| <i>Hovea elliptica</i> | ✓ | | ✓ |
| <i>Hypocalymma cordifolium</i> subsp. <i>cordifolium</i> | ✓ | | ✓ |
| * <i>Hypochaeris glabra</i> | ✓ | ✓ | ✓ |
| <i>Isolepis cernua</i> | ✓ | | |
| <i>Isolepis cyperoides</i> | ✓ | | |

| SPECIES | VEGETATION COMMUNITY | | |
|--|----------------------|----------|--------------|
| | Creek | Degraded | Jarrah/Marri |
| <i>Isolepis setiformis</i> | ✓ | | |
| <i>Isotoma hypocrateriformis</i> var. <i>hypocrateriformis</i> | | | ✓ |
| <i>Johnsonia lupulina</i> | | | ✓ |
| * <i>Juncus bufonius</i> | ✓ | | |
| <i>Juncus caespiticius</i> | ✓ | ✓ | |
| <i>Juncus holoschoenus</i> | ✓ | | |
| <i>Juncus pallidus</i> | ✓ | ✓ | |
| <i>Juncus planifolius</i> | ✓ | | |
| <i>Juncus subsecundus</i> | | ✓ | |
| <i>Kingia australis</i> | | | ✓ |
| <i>Lagenophora huegelii</i> | | | ✓ |
| <i>Lasiopetalum floribundum</i> | ✓ | | ✓ |
| <i>Lechenaultia biloba</i> | | | ✓ |
| <i>Lepidosperma</i> affin. <i>leptostachyum</i> | | | ✓ |
| <i>Lepidosperma gladiatum</i> | ✓ | | |
| <i>Lepidosperma squamatum</i> | | | ✓ |
| <i>Lepidosperma tetraquetrum</i> | ✓ | | |
| <i>Leptomeria cumminghamii</i> | | | ✓ |
| <i>Leucopogon</i> ? <i>australis</i> | | | ✓ |
| <i>Leucopogon capitellatus</i> | | | ✓ |
| <i>Leucopogon propinquus</i> | | | ✓ |
| <i>Leucopogon verticillatus</i> | | | ✓ |
| <i>Levenhookia pusilla</i> | | | ✓ |
| <i>Lindsaea linearis</i> | | | ✓ |
| <i>Lobelia alata</i> | ✓ | | |
| <i>Logania serpyllifolia</i> subsp. <i>angustifolia</i> | | | ✓ |
| * <i>Lolium rigidum</i> | ✓ | ✓ | ✓ |
| <i>Lomandra pauciflora</i> | | | ✓ |
| <i>Lomandra preissii</i> | | | ✓ |
| <i>Lomandra purpurea</i> | | | ✓ |
| * <i>Lotus angustissimus</i> | ✓ | ✓ | ✓ |
| * <i>Lotus uliginosus</i> | ✓ | ✓ | |
| <i>Loxocarya cinerea</i> | ✓ | | ✓ |
| * <i>Lythrum hyssopifolia</i> | ✓ | ✓ | |
| <i>Macrozamia riedlei</i> | | | ✓ |
| <i>Meeboldina roycei</i> | ✓ | | |
| <i>Mentha</i> sp. | | ✓ | |
| <i>Mesomelaena tetragona</i> | | | ✓ |
| <i>Mirbelia dilatata</i> | ✓ | | ✓ |
| <i>Opercularia apiciflora</i> | | | ✓ |
| <i>Opercularia echinocephala</i> | | | ✓ |
| <i>Opercularia hispidula</i> | | | ✓ |
| * <i>Orobanche minor</i> | | ✓ | ✓ |
| * <i>Parentucellia viscosa</i> | ✓ | | |
| <i>Patersonia babianoides</i> | | | ✓ |
| <i>Patersonia umbrosa</i> | ✓ | | |

| SPECIES | VEGETATION COMMUNITY | | |
|--|----------------------|----------|--------------|
| | Creek | Degraded | Jarrah/Marri |
| <i>Patersonia umbrosa</i> var. <i>xanthina</i> | | | ✓ |
| <i>Pentapeltis peltigera</i> | | | ✓ |
| <i>Persoonia elliptica</i> | | | ✓ |
| <i>Persoonia longifolia</i> | | | ✓ |
| * <i>Petrorhagia dubia</i> | | | ✓ |
| <i>Pimelea spectabilis</i> | | | ✓ |
| <i>Pimelea suaveolens</i> subsp. <i>suaveolens</i> | | | ✓ |
| <i>Pimelea sylvestris</i> | | | ✓ |
| <i>Platysace tenuissima</i> | | | ✓ |
| <i>Podocarpus drouynianus</i> | | | ✓ |
| * <i>Polypogon monspeliensis</i> | | ✓ | |
| <i>Pronaya fraseri</i> var. <i>fraseri</i> | | | ✓ |
| <i>Pteridium esculentum</i> | ✓ | | ✓ |
| <i>Pterostylis recurva</i> | | | ✓ |
| <i>Pterostylis</i> sp. 'pyramidalis group' | | | ✓ |
| <i>Ptilotus manglesii</i> | | | ✓ |
| * <i>Ranunculus muricatus</i> | ✓ | | |
| * <i>Rumex pulcher</i> subsp. <i>divaricatus</i> | | ✓ | |
| <i>Scaevola calliptera</i> | | | ✓ |
| <i>Schoenus maschalinus</i> | ✓ | | |
| <i>Senecio quadridentatus</i> | | | ✓ |
| * <i>Solanum nigrum</i> | ✓ | ✓ | |
| * <i>Sonchus oleraceus</i> | ✓ | ✓ | |
| <i>Sphaerolobium medium</i> | | | ✓ |
| <i>Stylidium amoenum</i> var. <i>amoenum</i> | | | ✓ |
| <i>Stylidium calcaratum</i> | | | ✓ |
| <i>Stylidium junceum</i> subsp. <i>junceum</i> | ✓ | | |
| <i>Stylidium rhynchocarpum</i> | ✓ | | |
| <i>Tetraria capillaris</i> | ✓ | | ✓ |
| <i>Tetraria octandra</i> | | | ✓ |
| <i>Tetrarrhena laevis</i> | | | ✓ |
| <i>Tetradlea hirsuta</i> | | | ✓ |
| <i>Thelymitra</i> ? <i>macrophylla</i> | | | ✓ |
| <i>Thelymitra</i> sp. (1) | | | ✓ |
| <i>Thelymitra</i> sp. (2) | | | ✓ |
| <i>Thomasia paniculata</i> | | | ✓ |
| <i>Thysanotus isantherus</i> | | | ✓ |
| <i>Thysanotus multiflorus</i> | | | ✓ |
| <i>Tremandra diffusa</i> | | | ✓ |
| <i>Trichocline spathulata</i> | | | ✓ |
| * <i>Trifolium dubium</i> | ✓ | ✓ | |
| * <i>Trifolium ligusticum</i> | ✓ | ✓ | |
| * <i>Trifolium repens</i> | ✓ | ✓ | |
| <i>Tripterococcus brunonis</i> | | | ✓ |
| <i>Trymalium floribundum</i> subsp. <i>floribundum</i> | ✓ | | |
| <i>Trymalium ledifolium</i> var. <i>rosmarinifolia</i> | | | ✓ |

| SPECIES | VEGETATION COMMUNITY | | |
|-----------------------------------|----------------------|----------|--------------|
| | Creek | Degraded | Jarrah/Marri |
| <i>Velleia trinervis</i> | | | ✓ |
| * <i>Vellereophyton dealbatum</i> | ✓ | ✓ | |
| * <i>Vulpia bromoides</i> | | ✓ | ✓ |
| <i>Xanthorrhoea gracilis</i> | | | ✓ |
| <i>Xanthorrhoea preissii</i> | | | ✓ |
| <i>Xanthosia candida</i> | | | ✓ |
| <i>Xanthosia huegelii</i> | | | ✓ |
| <i>Xylomelum occidentale</i> | | | ✓ |

APPENDIX C

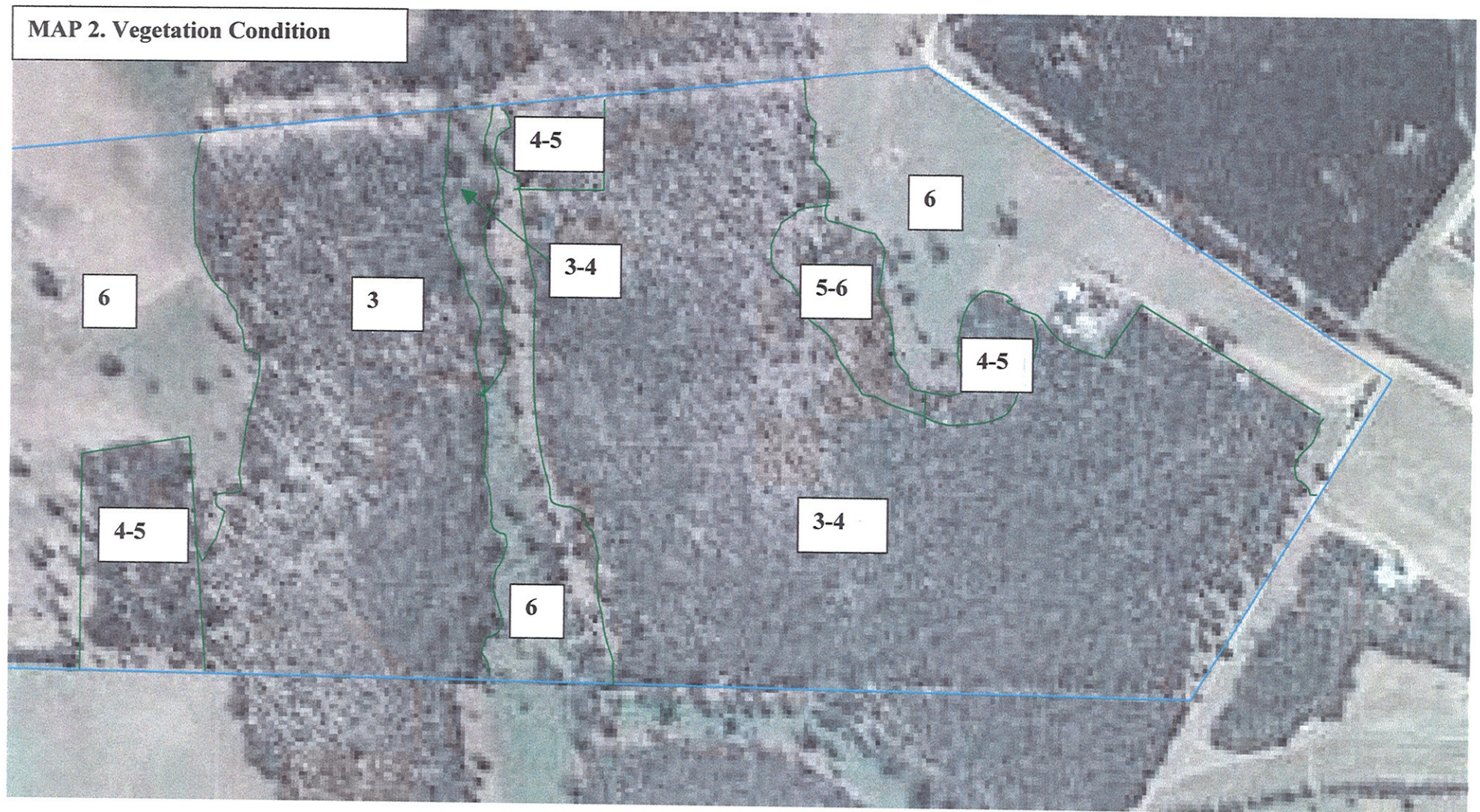
Maps

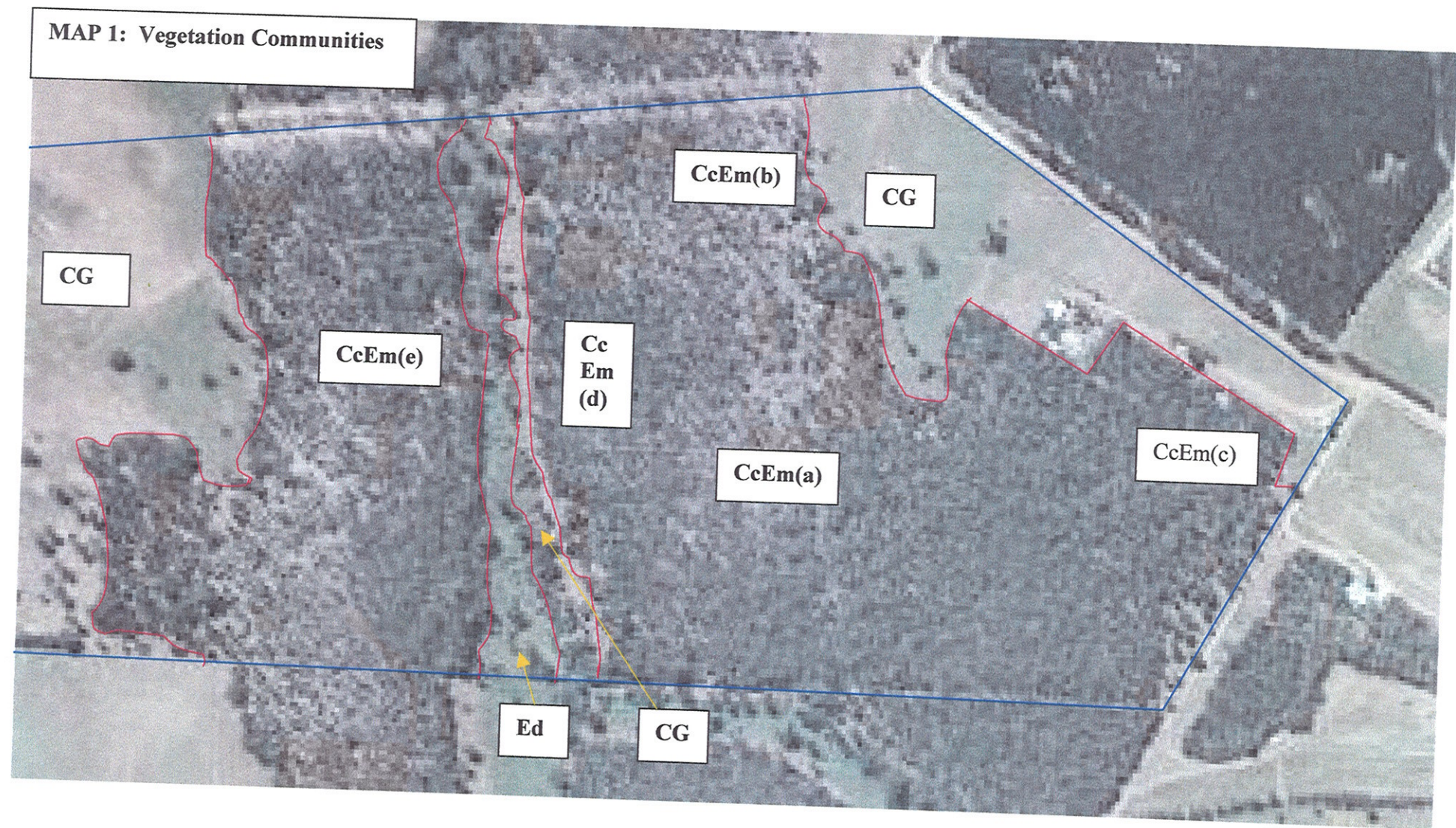
Map 1: Vegetation Communities

| ABBREVIATION | DESCRIPTION |
|--------------|--|
| Ed | Tall Open Woodland of <i>Eucalyptus diversicolor</i> (Karri) over a Woodland of <i>Agonis</i> species (Peppermints) and <i>Callistachys lanceolata</i> (Native willow) over a Sedgeland or where degraded a Herbland |
| CcEm(a) | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) over Closed Tall Scrub of <i>Bossiaea aquifolium</i> (Waterbush), <i>Hovea elliptica</i> (Tree hovea) and <i>Mirbelia dilatata</i> (Prickly mirbelia) over an Open Low Heath of <i>Hibbertia hypericoides</i> (Buttercup) |
| CcEm(b) | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) over Tall Shrubland dominated by <i>Kingia australis</i> (Black gin) and <i>Xanthorrhoea preissii</i> (Grasstree) over an Open Low Heath of mixed species |
| CcEm(c) | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) over Closed Heath of <i>Podocarpus drouyanianus</i> (Native plum) and <i>Hovea elliptica</i> (Tree hovea) |
| CcEm(d) | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) over Closed Low Heath of <i>Hibbertia hypericoides</i> (Buttercup) |
| CcEm(e) | Woodland to Low Closed Forest of <i>Corymbia calophylla</i> (Marri) and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> (Jarrah) over Open Heath of mixed species |
| CG | Closed Grassland of mixed species with occasional scattered, emergent trees |

Map 2: Vegetation Condition (See Table 2 for fuller description)

| RATING | DESCRIPTION |
|--------|---------------------|
| 1 | Pristine |
| 2 | Excellent |
| 3 | Very Good |
| 4 | Good |
| 5 | Degraded |
| 6 | Completely degraded |





APPENDIX D

Photographic Record of Vegetation Communities



Tall Open Woodland of *Eucalyptus diversicolor* (Karri) over a Woodland of *Agonis* species (Peppermints) and *Callistachys lanceolata* (Native willow) over a Sedgeland (Ed)



Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over Closed Tall Scrub of *Bossiaea aquifolium* (Waterbush), *Hovea elliptica* (Tree hovea) and *Mirbelia dilatata* (Prickly mirbelia) over an Open Low Heath of *Hibbertia hypericoides* (Buttercup) **CcEm(a)**



Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over Tall Shrubland dominated by *Kingia australis* (Black gin) and *Xanthorrhoea preissii* (Grasstree) over an Open Low Heath of mixed species **CcEm(b)**



Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over Closed Heath of *Podocarpus drouyanianus* (Native plum) and *Hovea elliptica* (Tree hovea) CcEm(c)



Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over Closed Low Heath of *Hibbertia hypericoides* (Buttercup) CcEm(d)



Woodland to Low Closed Forest of *Corymbia calophylla* (Marri) and *Eucalyptus marginata* subsp. *marginata* (Jarrah) over Open Heath of mixed species **CcEm(e)**