

# CAMPBELL ESTATE WEST CANNING VALE WETLAND AND CONSERVATION AREA MANAGEMENT PLAN

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## **STATEMENT OF LIMITATIONS**

### **Scope of Services**

This Wetland Management Plan (“the report”) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) (“scope of services”). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

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Within the limitations imposed by the scope of services, the monitoring, appraisals, and planning for this project has been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

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The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

## EXECUTIVE SUMMARY

The Campbell Estate development proposes to re-develop approximately 62 ha of rural residential allotments into a mixture of residential development, Conservation Category Wetland (CCW), wetland Buffer Zone and Public Open Space (POS). This area is contained within Nicholson Road, Ranford Road and Campbell Road, Canning Vale (hereafter Campbell Estate). Currently, the land comprises 32 individual lots, of various ownership.

The West Canning Vale Outline Development Plan (ODP) provides a framework for the progressive subdivision and development of the area. The ODP has been approved by both the City of Gosnells and the Western Australian Planning Commission.

On the advice of the Environmental Protection Authority and the Hon. Minister for the Environment, the City of Gosnells has recognised that a Wetland Conservation and Conservation Area Management Plan is critical to facilitate to the future development of the area, ensuring that a range of environmental objectives are achieved for the wetland contained within the estate.

The objective of the WCAMP is to outline a strategic approach to rehabilitate, revegetate, landscape and maintain this wetland area and associated buffer zone, comprising a total area of 11.14 ha, to ensure that the conservation value of this area is maintained for years to come. The approach has been to disassociate the site into three main zones: 1) Conservation Category Wetland, 2) Buffer Zone and 3) Public Open Space. Each of these zones has a development theme; retain and rehabilitate, revegetate or landscape.

This report and the management recommendations within are for the management of the areas targeted for preservation (CCW, Buffer Zone and POS totalling 11.14 ha only) and refer to those areas collectively as the Study Site. The remainder of Campbell Estate is proposed for urban development, and is referred to as Campbell Estate.

Hence, a total of 46 recommendations have been proposed in this management plan that relate to the design, construction, maintenance and monitoring of the natural bushland and the public open space.

Provision has been made for the coherent and concise collection of data that will provide insight into the condition of the wetland over time, and these data will be comparable with baseline data collected prior to the development taking place.

This document clearly identifies the tasks associated with achieving the desired objectives for the site, and assigns each of these tasks to a responsible body.

# 1 INTRODUCTION

The Campbell Estate development proposes to re-develop approximately 62 ha of rural residential allotments into a mixture of residential development, Conservation Category Wetland (CCW), wetland Buffer Zone and Public Open Space (POS). This area is contained within Nicholson Road, Ranford Road and Campbell Road, Canning Vale (hereafter Campbell Estate). Currently, the land comprises 32 individual lots, of various ownership.

The West Canning Vale Outline Development Plan (ODP) provides a framework for the progressive subdivision and development of the area. The ODP has been approved by both the City of Gosnells and the Western Australian Planning Commission.

The ODP details many aspects of the development including, but not limited to:

- Site setting and history;
- Previous survey work (including biological surveys);
- Statutory planning considerations;
- The Outline Development Plan overview;
- Cost of the proposed work;
- Development strategy; and
- Concluding statements.

Other documents relevant to this site, and this WCAMP, include an Environmental Assessment Report produced by RPS Bowman Bishaw and Gorham (November, 2004), a Rare Flora Search and Vegetation Survey completed by Dr Authur Weston (December, 2004), and the Environmental Protection Authority's report to the Minister of the Environment on the proposed development (January, 2005).

Implementation of the development proposal was contingent on approval from the Minister for the Environment after the proposal was referred to the Minister by the EPA. The Minister granted approval for the project in May 2005, following consideration of several appeals lodged against the Report and Recommendations of the EPA, specifically to do with the extent and significance of wetlands identified as occurring in the site.



The Ministers approval formed the foundation of the Addendum to the Outline Development Plan (June 2005) in which a total of 4.5524 ha had been identified as Conservation Category Wetlands (CCW) and a further 6.59 ha as drainage and Public Open Space (POS).

The objective of the WCAMP is to outline a strategic approach to rehabilitate, revegetate, landscape and maintain this wetland area and associated buffer zone, comprising a total area of 11.14 ha, to ensure that the conservation value of this area is maintained for years to come. The approach has been to disassociate the site into three main zones: 1) Conservation Category Wetland, 2) Buffer Zone and 3) Public Open Space. Each of these zones has a development theme; retain and rehabilitate, revegetate or landscape.

This report and the management recommendations within are for the management of the areas targeted for preservation (CCW, Buffer Zone and POS totalling 11.14 ha only) and refer to those areas collectively as the Study Site. The remainder of Campbell Estate is proposed for urban development, and is referred to as Campbell Estate.

## **1.1 GENERAL AIMS AND OBJECTIVES**

Specifically the aims and objectives of the WCAMP are as follows:

1. Identify the conservation potential of the remnant bushland identified for conservation (4. 5524 ha);
2. Outline a strategy to enhance this remnant bushland (rehabilitation and revegetation);
3. Outline a strategy to link wetlands that will be fragmented due to the urban landscape design;
4. Outline a strategy to maintain the flora and fauna conservation values of the CCW and buffer it against the adverse impacts of altered fire regimes, feral fauna and weeds;
5. Outline a strategy to maintain the hydrological integrity of the CCW;
6. Create a buffer zone that satisfies the dual role of protecting the CCW and integrating the peripheral urban design;
7. Create a natural ecoscape within the POS that is coherent with the urban design principles of the ODP and is representative of the historic natural vegetation; and

8. Prepare a Wetland and Conservation Area Management Plan to the requirements of the Minister for the Environment, on advice of the Environmental Protection Authority, which is made available for Public comment.

## **2 BACKGROUND ENVIRONMENT**

### **2.1 PHYSICAL ENVIRONMENT**

#### **2.1.1 Location**

Campbell Estate is located in the suburb of Canning Vale, in the City of Gosnells (Figure 2.1). The area occupies some 62 ha, and is bound on three sides by Nicholson Road, Campbell Road, and Ranford Road.

#### **2.1.2 Title, Ownership and Land Use**

Ownership and description of the project area is described in detail in the ODP (Robertsday Town Planning and Design, 2004). Currently, the land comprises 32 individual lots.

The principal land use is semi rural hobby farm style lots. Many firebreaks, tracks and paths transect the remnant bushland, making it exposed and vulnerable to disturbance. It was noted, during the site visit in September 2005 that off-road vehicles, including trail bikes, had frequently and recently been used in the area.

#### **2.1.3 Topography and Landform**

At present the subject land is generally low lying with a gentle gradient from the south (corner of Campbell and Nicholson Roads) to the north (corner of Nicholson and Ranford Roads). Along, Nicholson Road the highest elevation is 28.1 m (south end) and the lowest elevation is 24.7 m (north end). Along Campbell Road the highest elevation is 30.4 m dropping to only 28.1 m at the northern end.

#### **2.1.4 Geology and Soils**

The site lies within the Southern River Landform and Soil Unit and is comprised of sand plain with low dunes and many intervening swamps, characterised by iron and humus podsol, peats and clays (Churchward and McArthur, 1978). The lowland areas within the site represent typical inter-dune swales.

The soil is described as sand over sandy clay to clayey sand of the Guilford Formation (S<sub>10</sub>). This soil unit is typically described as having a high water table and little water permeability.

#### **2.1.5 Hydrology and Drainage**

At the time of the field assessment of the site (end of September 2005) there were no surface water expressions within the lowest lying areas of the damp-land, with the exception of some small puddles less than 10 cm deep and 2 m in diameter. These were mainly associated with compacted vehicle tracks through the Teatree Heath. One local drain was observed running parallel to Nicholson

Road. This drain is obviously designed to take additional stormwater from the roads and lots of the estate.

Groundwater flow direction on the site is northerly, towards Southern River. The Average Annual Maximum Groundwater Level (AAMGL) across the site varies between 26 m AHD in the south of the site and 23 m AHD in the north (Figure 5 UWMP). The depth to AAMGL varies between 4.6 m at the top of the hill in the southern corner of the site to roughly 0.5 m AHD to a minimum of 0.44 m AHD in the north-eastern section of the site (JDA, 2005). In general, the depth to AAMGL in the central and northern sections is less than 1 m, while in the south and south-eastern sections, the depth is greater than 1 m. The depth to groundwater will vary seasonally, with undisturbed levels generally peaking in September or October.

Where coffee rock is present, the water table may be perched during summer. However, perching is probably limited as recorded water levels in coffee rock affected areas are similar to those in surrounding areas where coffee rock does not occur. The study site is located to the north-east of the Jandakot Ground water mound and located within the Swan and Canning Rivers surface water catchment. Groundwater flow is to the north east toward Southern River.

The development of Campbell Estate will most likely be staged over more than one year. At each stage of development the current drainage regime and local water table may be altered in various ways. Land clearing may result in a slight increase in the ground water level, due to an increase in water infiltration and a reduction of water uptake by vegetation post-clearing. Conversely, urban development and irrigation from bores may cause a subsequent drop in the water table. However, natural recharge during winter should remain un-influenced as the recharge is coming from the Jandakot Mound (ATA Environmental, 2004).

ENV have prepared an Urban Water Management Plan (UWMP) in association with the preparation of this WCAMP (ENV, 2005).

### **2.1.6 Water Quality**

ENV (2005) has produced the UWMP with the objectives of maintaining water quality, quantity and outlining methods or conservation mechanisms. It includes a broad drainage design, and the design of location of drainage swales and other drainage infrastructure.

Water quality on site was measured by JDA in August 2005. The results are given in Table 5 of the UWMP (included as an appendix). The low electrical conductivity indicates that the water is fresh. Phosphorus levels in the water were generally lower than background levels found in the Perth region (JDA, 2005). The nitrogen concentrations are similar to levels found in the Perth region

(JDA, 2005). Most of the nitrogen was in the form of Kjeldahl nitrogen rather than nitrate or ammonia (JDA, 2005). The main recommendations of the Plan are:

In an effort to ensure maintenance of water quality the UWMP recommends that the amount of fertiliser used on Public Open Space should be minimised, monitoring of surface water nutrient levels be undertaken, and drainage swales and compensations be constructed with the secondary purpose of bioremediation.

## 2.2 BIOLOGICAL ENVIRONMENT

### 2.2.1 Flora and Vegetation

The flora and vegetation of Campbell Estate has been surveyed on two previous occasions; in October/November 1998, and again during a similar period in 2004. Methodology for floristic and vegetation analysis, and vegetation condition assessment is described in detail in (Weston, 2004). This report is attached as an Appendix to this document to ensure that it is available to all parties as a reference for future management.

Due to the comprehensiveness of Weston's (2004) full report, this section describes a very limited summary of the vegetation of the Campbell Estate. The flora species list was determined from four (4) quadrats. Declared Rare Flora (DRF) and Priority Flora searches were undertaken broadly across the site. Special attention was focussed on habitat extent and quality of habitats known to support DRF and Priority flora. Further specific focus was directed toward locating the DRF Donkey Orchid *Diuris purdiei*, first collected in 1999.

Based on the assimilation of information from all authors listed by Weston (2004), aerial photography and field observations (4 vegetation plots and broad searching) the following three vegetation units have been described as occurring in Campbell Estate:

1. *Banksia attenuata* – *Banksia menziesii* Low Open Forest to Low Woodland
2. Paperbark (*Melaleuca preissiana*) Low Woodland to Low Open Woodland
3. Teatree Bush (*Pericalymma ellicpticum*) Closed Heath.

Two plots (CE01 and CE02 – Teatree Bush Closed Heath and Paperbark Low Woodland to Low Open Woodland) were located within the area of the Estate proposed for conservation (the Study Site), and the remaining two plots (CE03 and CE04 – *Banksia* Low Open Forest to Low Woodland) were located in areas proposed for urban development. Weston reports that all three of these vegetation units had shown signs of degradation from when they were first surveyed in 1998 to the latest survey in 2004. Hence the general vegetation

attributes of Campbell Estate, including those that will remain post-development, are relatively well documented.

Approximately 230 flora taxa (species, sub species and varieties) occur within the site. Approximately, 34 of these taxa are weeds. It was estimated more than 70% of the native species, and 60% of the introduced species have been collected and therefore the estate is described as being floristically rich (Weston, 2004).

Five flora taxa of conservation significance were recorded during the 2004 survey with Campbell Estate. *Byblis gigantea* is poorly reserved, at the extent of its range and occurs as a population disjunct from others. *Hensmania turbinata* is also at the extent of its known distribution. *Jacksonia gracilis* and *Stylidium utricularioides* are both endemic to the Swan Coastal Plain. *Tripterococcus paniculatus* is a Priority 1 species. The Declared Rare Flora Donkey Orchid (*Diuris purdiei*), which had been recorded in Campbell Estate during 1999, was not recorded during the 2004 study. However, as it is a species that responds to fire, its periodical absence from record does not suggest it no longer occurs.

In his concluding statements, Weston (2004) stated that the Paperbark (*Melaleuca preissiana*) Low Woodland and Low Open Woodland on the western side of Campbell Estate and the Teatree Bush (*Pericalymma ellipticum*) Closed Heath are both in Excellent to Very Good condition and are of the highest conservation value within the estate. This is the same habitat type within which the Donkey Orchid typically occurs. These areas correspond to those identified as the CCW, Buffer Zone and POS. As these areas will be preserved and managed for the future, the potential for re-emergence of the Donkey Orchid, post-fire, has been assured.

### 2.2.2 Fauna

The fauna of the Swan Coastal Plain is well described and documented and fauna assemblages that persist in remnant vegetation, in spite of urbanisation, are also well described. No specific fauna surveys have been carried out within the Campbell Estate. However, M.J. and A.R. Bamford Consulting Ecologists have presented a comprehensive fauna summary of similar habitats as part of the Roe Highway Stage 7 Review of Fauna Investigations (Bamford and Bamford, 2003). The Roe Highway Stage 7 PER also contains a review of the Carnaby's Cockatoo *Calyptorhynchus latirostris* habitat and resource dependency for the same area. A similar subset of flora described in Bamford and Bamford (2003) may occur at the current study site. Hence, the fauna potentially occurring in the site are relatively well documented for such a small piece of remnant vegetation. The habitat of the Study Site is in Very Good to Excellent condition and will not be degraded. Hence, those fauna that occur are likely to persist. There would appear to be no need to undertake further on-ground fauna survey work beyond the September 2005 site visit.

Other fauna records near to Campbell Estate are contained in the following reports (listed in the references):

- Bamford and Bamford (1998);
- Bamford et al. (2003);
- ERM Mitchell McCotter (1998); and
- Dell and Cooper (1992).

A summary of these reports indicates that up to 5 species of frog, 40 species of reptile, 67 species of birds and 14 native mammal species potentially occur in the Study Site. However, due to the size of the Study Site not all of these species are specifically likely to occur. Some that may be of particular interest due to their current conservation status.

The Heath Dragon (*Rankinia adelaidensis*), Southern Heath Monitor (*Varanus rosenbergi*), Black-headed Tree Goanna (*Varanus tristis*), Perth Lined Lerista (*Lerista lineata*) Worm Lerista (*Lerista praepedita*), Western Bluetongue (*Teliqua occipitalis*) Crowned Snake (*Drysdalia coronata*) are all species that are of local conservation significance due to their current distribution and frequency of records on the Swan Coastal Plain.

Sixty-seven species of birds, excluding water birds, may utilise habitats within the Study Site. Waterbirds have been excluded as the CCW within the estate currently does not experience seasonal inundation. However, the development of the Study Site and the creation of artificial open water bodies may result in the utilisation of the site by waterbirds, potentially increasing the total species richness.

Small passerines are likely to be the dominant avifauna once the development progresses, as the Paperbark Woodland and Teatree Bush Heath will become the dominant vegetative type. These species, prone to range reductions on the Swan Coastal Plain, will most likely benefit from the management of the wetland vegetation associated with the CCW.

Two bird species that may occur in the estate are worthy of note. These are the Peregrine Falcon (*Falco peregrinus*) and the Carnaby's (Short-billed) Black-cockatoo (*Calyptorhynchus latirostris*) (Schedule 4 and Schedule 1, respectively). A breeding pair of Peregrine Falcons were presumed to occur nearby the site in 2003 (Bamford and Bamford 2003). The Carnaby's Black-cockatoo is perhaps of greater significance due to the pressure placed on food and nesting resources that comes of clearing for urban development. Flocks of over 100 individuals were seen foraging at Jandakot Airport (Bamford et al. 2003) and 42 individuals

have been recorded at Ken Hurst Park (Dell and Cooper, 1992), with both areas less than 5 km from the study site.

Bamford and Bamford (2003) suggest that the Western Grey Kangaroo *Macropus fuliginosus* is present in Ken Hurst Park. As this species occupies woodlands and wet and dry heaths it may have been present in the Campbell Estate, though would have not likely resided.

The Western Brush Wallaby *Macropus irma* was also recorded in Ken Hurst Park in 1992 (Dell and Cooper 1992). It favours woodland and forest but would be reliant on thick scrub or heath for refuge. Jandakot Airport is also known to harbour a reasonable population of this species (Bamford et al., 2003) and therefore it is possible that there may be some transient movement of this species between significant patches of remnant bushland on the Swan Coastal Plain.

The Quenda or Southern Brown Bandicoot *Isodon obesulus* is listed as a Priority species by CALM. However, it is fairly ubiquitous through most significant patches of remnant vegetation supporting the necessary habitat of low dense/closed scrub, heath or sedges (pers. obsv.). In fact, this species was described as being common in Ken Hurst Park (Dell and Cooper 1992), and Bamford *et al.* (2003) found it to be common at Jandakot Airport. Fresh evidence of the presence of this species was recorded during the September 2005 site visit and the development as per this WCAMP will help to ensure persistence of this species within the Study Site.

Seven species of bat may utilise the site for foraging. All of these species are listed as being under some threat or as specially protected fauna by CALM. In all cases these species roost in tree hollows and under bark. Commitments contained in this WCAMP to maintaining mature trees will contribute to the conservation of these species.

### **2.2.3 Wetlands**

Historically the wetlands/damplands within the site may have extended significantly to the west, on the opposite side of Nicholson Road. However, this area has long since been developed. To the east, the extension of any wetland would have been limited by the higher relief.

Many, but not all, Bush Forever sites contain Conservation Category Wetlands. The current CCW is not a Bush Forever site (Anon, 2000). The commitment to protect these CCW is found in the Governments of Western Australia Wetland Conservation Policy for Western Australia.

The wetland area that is now defined as CCW has been the focal point of much scrutiny over its extent and assessment. In 2003 the EPA Services Unit identified



the CCW as comprising 18 ha of lowlands distributed throughout the Campbell Estate. The DoE determined later defined only 9.86 ha as being worthy of conservation and a further 2 ha be set aside as a buffer. Most of this lay adjacent Nicholson Road. The EPA assessed the Campbell Estate development and provided an assessment to the Minister for the Environment as part of the Environmental Approvals process. This report referred to the 9.86 ha of wetland identified by the DoE as that being in need of conservation. Several appeals were lodged against the assignment of such a large area of wetland. An independent consultant (Bioscience) had previously been commissioned to reassess the extent of the wetlands. This independent assessment was considered with respect to the EPA report and the outcome of the Appeals process saw the wetland area (CCW) reduced to that which is currently identified in this document (4.55 ha).

Within the proposed estate, the areas currently identified as Conservation Category Wetlands are in private ownership and not subject to any structured management. The Campbell Estate development and this WCAMP represent an opportunity to strategically and coherently manage the CCW and enhance its value as a conservation refuge.

Across the site the various components of the wetland environment have been identified. In 1996 Hill et al. identified a great majority of the site to be Conservation Category, Resource Enhancement or Multiple Use. These areas were all later considered and refined by the Water and Rivers Commission. In December 2003 the EPA advised that only 9.86 ha be identified as priority conservation area to be set aside for protection. Following appeals on the Campbell Road Estate Super-lot Subdivision: Report and recommendations of the EPA to the Minister for the Environment, the area to be conserved as CCW was further reduced to 4.55 ha.

It is this remaining 4.55 ha that is the focal area for the ODP and this WCAMP.

#### **2.2.4 Biodiversity**

The Campbell Estate has been described as floristically rich, and the vegetation assemblages (similar to others along the Southern River Complex) are known to be quite diverse within their categories. Many of the flora of significance are identified as so because they are locally endemic.

In terms of fauna, adjacent surveys have documented the presence of 24 species of bird that are in decline in the Perth area, and many if not all of these species have the potential to occur, or at least utilise habitats within the study site. Similarly, many ground and arboreal reptiles and mammals may also occur in the Campbell Estate.

The south west is noted as a biodiversity ‘hot spot’, and the Swan Coastal Plain is one of the principal bioregions under threat due to anthropogenic disturbance. The vegetation complexes that support the native fauna are said to be represented by less than 10% of their former distribution (Weston 2004).

All of these elements indicate that preservation and management of habitat within the CCW, Buffer Zone and POS may contribute to the preservation of local flora and fauna diversity.

### 3 MANAGEMENT ISSUES AND MEASURES

#### 3.1 GENERAL MANAGEMENT OBJECTIVES AND ACTIONS

This section details seven (7) broad management objectives that apply to the Study Site, or that serve to define the three principal zones of the Study Site (the CCW, Buffer Zone and POS) and their overall management (Figure 3.1).

The total area set aside as CCW is 4.5524 ha (4.5 ha). This area is divided into two main blocks. The largest block occurs adjacent Nicholson Rd, north and south of Govan Road. The smaller block is again adjacent Nicholson Road, but north of Fairlie Road. The Govan Road block is just less than 350m along its longest side (Nicholson Road) and 150m wide at its widest point and less than 75m wide at its thinnest point. The Fairlie Road block is an oblong block approximately 100 m x 200 m.

The vegetation is part of the Southern River Vegetation complex (42) (Hedde et al. 1980) of which the EPA states less 7% of the complex remains. Moreover, the estate lies on the eastern side of the Swan Coastal Plain, where most complexes are represented by less than 10% of the remaining vegetation. Hence, preservation of small areas of this vegetation type is fundamentally important.

Within the Study Site, the area identified as CCW (4.5 ha) is in Very Good to Excellent condition and will not be disturbed. The principal management objective of this WCAMP is to retain, preserve, and monitor the CCW.

**RECOMMENDATION 1(3.1): Minimise disturbance of the CCW to that which is absolutely necessary to retain, preserve and monitor the flora, vegetation and fauna attributes of the wetland areas.**

The CCW will be comprised predominantly of Teatree *Pericalymma ellicpticum* Closed Heath with some remaining Paperbark (*Melaleuca preissiana*) Low Woodland to Low Open Woodland. It is irregular in shape and divided in to two portions. As such, it will be prone to edge effects and vulnerable to disturbance and an exclusion fence should be immediately erected to minimise any potential for disturbance during development (Figure 3.2)

**RECOMMENDATION 2(3.1): Construct a small ringlock fence around the entire CCW (see ensuing text relating to fence construction and the movement of fauna)**

Edge effects will be compounded by the sites proximity to a major arterial road (Nicholson Road), from which weeds, hydrocarbons and rubbish can potentially infiltrate.

**RECOMMENDATION 3(3.1): The portion of the fence adjacent Nicholson Road should be approximately 1.2m in height, and have a mesh diameter of no less than 7cm.**

**RECOMMENDATION 4(3.1): Direct surface water drainage from Nicholson Road away from the CCW.**

The Buffer Zone surrounding the CCW requires only minor disturbance associated with construction of a drainage swales and compensation basins. The exact location of this system of swales and basins should be determined based on the principle of minimising disturbance to remnant vegetation.

**RECOMMENDATION 5(3.1): The location of the swale and compensation basins within the Buffer Zone should be designed in such a way to minimise impact on remnant vegetation that is in good condition and supports mature (large) *Eucalyptus*, *Melaleuca* and *Banksia* trees.**

The POS, which comprises the land on the urban side of the swales, will essentially comprise an artificially created landscape that imbues the essence of the native Southern River Vegetation Complex on the community, but at the same time remains amenable to passive recreation.

The best approach to conserve and manage the Study Site is to accurately delineate the natural attributes of this site. For flora and vegetation, this means comprehensive searches for DRF and Priority Flora. For vegetation this means the undertaking of a detailed vegetation condition assessment of all of the vegetation targeted for preservation. To control introduced weeds, an accurate weed mapping survey also needs to be undertaken (see ensuing sections).

**RECOMMENDATION 6(3.1): Undertake a comprehensive vegetation condition assessment and weed mapping survey as soon as practicable. This survey must take place toward the end of Spring (November).**

Conservation of fauna is more immediately manageable, and requires only a general commitment to maintain the fauna habitat that is presently contained within the Study Site. As retention of vegetation within the CCW is a condition of project approval, then this commitment is already an obligation. A further commitment to the preservation of mature trees around the periphery of the Study Site, where possible, will further contribute to the habitat value of the site to fauna. Many of these trees outside of the Study Site have already been identified for preservation.

**RECOMMENDATION 7(3.1): Maintain all mature *Eucalyptus*, *Banksia* and *Melaleuca* trees outside of the Study Site where practicable.**

### 3.2 ZONE SPECIFIC MANAGEMENT OBJECTIVES AND ACTIONS

The WCAMP and the objectives herein target three main zones and three main activities associated with these zones. These are detailed in the following Table (Table 3.1).

The objectives and actions relating to clearing and construction of these zones are broadly described in this section. Specific guidelines and recommendations for planting, rehabilitation and revegetation are detailed in the ensuing sections.

**Table 3.1: Management objectives and zones of management for Study Site.**

Zone	Objective
Conservation Category Wetland	Retain/Rehabilitate
Buffer Zone	Revegetate
Public Open Space	Landscape

#### Conservation Category Wetland

The objective for the CCW is to retain the integrity of the vegetation which is in excellent condition. Therefore, the need for construction is minimal. However, the need for monitoring and protection should be the priority.

The Teatree Closed Heath will form the core habitat of the CCW just north of Govan Road. This vegetation unit will be encapsulated in the surround Paperbark Low Woodland and Low Open Woodland that exists along the west side of the site, south of Govan Road and North of Fairlie Road.

This vegetation is in Very Good to Excellent condition and should not need rehabilitation. However, any areas that need rehabilitation, such as disused firebreaks or existing tracks, should be attended to at the earliest opportunity (See Section 3.4 and Table 3.2)

**RECOMMENDATION 8(3.2): Based on the vegetation condition report, identify any patches of cleared, degraded or disturbed vegetation within the CCW as areas in need of rehabilitation (see Section 3.4 for rehabilitation strategy).**

Maintenance of the integrity and conservation value of the CCW will be dependant on maintenance of the current water table and seasonal fluctuations in soil saturation. This will only be achieved through the appropriate management of ground water infiltration and storm water management. Four ground water monitoring bores are presently distributed within the site (Figure 3.2). Monitoring of the ground water table and levels of soil saturation in the CCW should take place biannually, when the water table is at its highest (October) and its lowest (March). Prior to development, however, it is important to establish an accurate baseline for ground water levels. Therefore, it is recommended that, in the first year of the development, the water table be measured once per month from November to April. In subsequent years the frequency of monitoring can be reduced (see Section 3.7) to biannual. Monitoring results should be recorded on the template Monitoring Data Sheets provided as Appendix A.

**RECOMMENDATION 9(3.2): Utilise the four (4) existing bores within the estate to monitor ground water levels monthly from November to June in the first year of the development.**

The vegetation that occurs in the CCW is specifically dependent on saturated, but not inundated, soils. If the development was to influence the water table, causing it to rise or fall, then the floristics of the site would be greatly influenced and the conservation value of the site would be compromised, particularly if ground storey species such as herbs and including priority species, such as local declared orchids, are lost.

Common native herb species can be used as indicator species, to identify whether or not the development has had a detrimental influence of the soil moisture properties of the CCW. If common species are not robust to changes in soil moisture, either inundation or drying of soil, then they will not persist once the soil moisture levels have changed. This could provide an early warning that the vegetation of the CCW is under threat from the development.

A series of six 1 m x 1m long-term vegetation monitoring plots should be established in the CCW adjacent to the existing bores. These plots should be pegged and flagged with bright surveyor's tape (Figure 3.2). However, if development constraints influence the locations of these plots, it should be ensured that they are at least located in the CCW Teatree Heath or *Melaleuca* Low Woodland. Final placement may be dependant on what portion of the land (and CCW) is successfully vested with the State and under control of the City of Gosnells.

The vegetation monitoring plots should be identified prior to any clearing and construction. They should be representative of the major vegetation types (Teatree Heath or *Melaleuca* Low Woodland) in the CCW and contain within them a strong suite of undisturbed herbaceous species. Three common herb

species should be selected as indicator species. Photos of the species selected should be included on the template for the Data sheet in Appendix 1.

These species need to be common in all six plots. The percentage (%) cover and condition should be documented and the plots should be photographed. The cover, condition and photograph will represent the baseline information for ongoing monitoring.

**RECOMMENDATION 10(3.2): Locate and permanently mark six (6) vegetation monitoring plots in the CCW Teatree Heath or *Melaleuca* Low Woodland. Record % cover of common herbs (TBA) in each plot on Data sheets provided as Appendix 1.**

Prior to any development around the periphery of the CCW, a rural-style fence should be erected immediately as close to or just within the CCW vegetation. Natural regeneration will conceal the fence from site over time (Figure 3.2 and 3.6).

Govan Road has been identified as a Pedestrian Desire Line (PDL). Management for this PDL is described in Section 3.8. In the period preceding the decommissioning of Govan Road, the fencing around the CCW should persist along each side of Govan Road. However, the fencing along Govan Road should be of a design that facilitates movement of fauna across Govan Road, but inhibits the penetration of vehicles into the CCW.

**RECOMMENDATION 11(3.2): Further to previous recommendation, enclose all of the CCW areas with ring lock fencing and erect fencing abutting, or just inside, the vegetation boundary. Use a different fence design along Govan Road that does not prohibit fauna movement.**

### **Buffer Zone**

The principal objective of the Buffer Zone is to afford protection to the CCW, so it is to be designed and constructed to minimise the level human interference in the CCW. Interference can be from direct disturbances (e.g. trampling, litter) or secondary disturbances (e.g. pollution or nutrient inflow).

The only clearing that is required in the Buffer Zone is that associated with the construction of the swales and compensation basins. Maintenance of the majority of the vegetation will minimise the cost of revegetation and allow the creation of a transitional vegetation type from the CCW to the POS.

**RECOMMENDATION 12(3.2): Clearing in the Buffer Zone should be limited to that which is necessary to construct the swales and compensation basins.**

The middle portion of the Buffer will be the swale, which needs to be heavily propagated with sedges (see Section 3.5, Table 3.3). A heavily vegetated swale will provide a barrier against weed penetration into the CCW once the sedges become fully established. The vegetation of the swale will also serve as a nutrient and pollutant trap. On the POS side of the buffer the buffer should be edged with a dual use pathway that circumnavigates both of the CCW areas and adjoins the Pedestrian Desire Line that bisects the areas (see Section 3.8).

Along the entire Buffer Zone, a swale and compensation basins should be constructed (Figure 3.3). The design should be as per the Campbell Estate Hydrology Investigation (JDA Consultant Hydrologists, 2005) and the location has previously been discussed.

**RECOMMENDATION 13(3.2): Construct swales and compensation basins as per the Campbell Estate Hydrology Investigation.**

The swales within the Buffer Zone will have the capacity to accept infiltration from 1-in-10 year storm events where the alternative would be water flowing into the CCW and subsequently raising the water table. Storm events more significant than 1-in-10 year will be detained within the compensation basins with ultimate overflow into the CCW only after major storm events. The complementary UWMP will incorporate a design that ensures that development of the estate will have limited influence on the water levels of the CCW.

The Buffer Zone also serves the purpose of providing access to the CCW for maintenance. More importantly, it will facilitate access for fire control. Because the CCW is irregular in shape and bound on most sides by roads, access for fire control is mostly adequate. However, there are some parts of the CCW that are less accessible where the Buffer Zone is at its widest. To facilitate access for fire suppression activities, the landscape and revegetation design will facilitate emergency access in the interface vegetation between the CCW and the swales (Figure 3.2 and Figure 3.6). Design and location of pedestrian access paths will also address this requirement.

Provision must be made for the installation of fire hydrants in Campbell Estate, along the road that bounds the POS. These hydrants should be positioned every 200 m and be marked by BLUE Cats Eyes on the road, and with signage on the nearest adjacent power, or street light pole.

**RECOMMENDATION 14(3.2): Facilitate emergency fire suppression access between the Buffer Zone and the CCW through landscape and drainage design and construction and install appropriately signed and marked fire hydrants along the road adjacent POS at 200 m intervals.**



## Public Open Space

The fundamental principle in the design of the POS will be making the best use of the limited space available. The objective of the POS is to provide residents of Campbell Estate an opportunity to engage the natural environment that surrounds them, without impacting or reducing its conservation value.

Predominantly the design will build on the disturbed landscape and comprise some small grassed areas (mainly between the swales/compensation basins and the roads), seating, rubbish facilities, signage and a dual use pathway that separates it from the Buffer Zone.

**RECOMMENDATION 15(3.2): Create a landscaped environment within the POS that is predominantly open space, with some patches of vegetated landscape around compensation basins.**

The recommendations associated with this design better described in Section 3.8. The compensation basins represent the only opportunity to further landscape the estate, as these are the only parcels of space large enough to accommodate a comprehensive landscape plan. Once the swales are constructed along the Buffer Zone, limited public open space will remain along the thinner margins between the CCW and the road verges. Landscaped areas around the compensation basins are to comprise species of the Southern River Complex. The basic design structure for planting will be tall woodland species around the outer periphery, graduating to tall shrubs, then dense low shrubs and sedges in the centre (see Section 3.6). Essentially the idea is to create a riverine fringe; Open woodland of *Eucalyptus callophylla* and *Eucalyptus marginata* and Banksia species with fringing woodland of *Eucalyptus rudis* – *Melaleuca preissiana* and sedgelands. As well as providing an aesthetic landscape, the vegetation structure will secure the compensation basins, without creating a visual barrier that would make the area feel small than it is (Figure 3.4 and 3.7).

**RECOMMENDATION 16(3.2): Maintain the vegetation around the compensation basins so that, once mature, it provides a barrier to accessing the water in the basin.**

### 3.3 GENERAL PLANTING STRATEGY

The type of plants and method of cultivation are critical to successful rehabilitation and revegetation.

A contract should be established with a company that is able to culture plant stocks from the existing vegetation that is targeted for clearing. This could result in considerable savings in the cost of the rehabilitation and revegetation of the site, as well as ensuring that plantings post-clearing are more successful. Tables

within Sections 3.4 to 3.6 suggest some species recommended for planting. However a full species list of viable local species is presented in Appendix B

**RECOMMENDATION 17(3.3): Establish liaison and a contract with a registered seed collector or native plant cultivator.**

**RECOMMENDATION 18(3.3): Collect viable seed and plant stock for later propagation in rehabilitation and revegetation areas.**

All plant stock for rehabilitation and revegetation should be tube stock, approximately 55mm to 70mm in size. Taller shrubs and wooded species should be planted at 1-2 m centre spacing, whilst lower shrub and herb species should be planted at 0.75 – 0.5 m centre spacing, respectively.

Planting should take place between May and August. Tube stock of over-storey and mid-storey species to be planted in the CCW/Buffer interface are to be protected with tree guards, which need to remain in place for one summer and be removed at or prior to the following winter.

**RECOMMENDATION 19(3.3): Plant at a density of one plant in the centre of each square metre of earth for over-storey species, one plant in the centre of each 0.75 square metre for mid-storey species and one plant in the centre of each 0.5 square metre for ground storey species.**

An assessment should be made for infill planting 12 months after the initial planting round when the success of the first round can be established. A second assessment should be made at 24 months after initial planting. Propagated species should be trickle watered for a period of two years post planting, after which time the irrigation should be removed and the plants should be self sufficient.

**RECOMMENDATION 20(3.3): Assess the success of planting after 12 months, and then 24 months from initial planting. Infill plant at 12 months and remove tree guards and irrigation at 24 months.**

**RECOMMENDATION 21(3.3): Make provision for further annual monitoring of planting success and possible infill planting in each zone, based on the success of the initial surveys.**

### **3.4 REHABILITATION STRATEGY**

The objective for rehabilitation is to create a uniform Teatree Closed Heath within the CCW. Due to its condition, the CCW will require little rehabilitation. However, vegetation assessment and weed mapping (see Recommendation 6(3.1)) will assist to determine the exact area(s) requiring rehabilitation and the total number of species to be planted. Species used will be those species described as

dominant in the vegetation report of Weston (2004). The species are detailed in Table 3.2.

The list presented below for the rehabilitation of the CCW comprises only species recorded in the sites by Weston (2004) that correlate with the Southern River endemic species list provided by the City of Gosnells and the list of species identified as suitable for rehabilitation in Teatree Closed Heath by Apace Aid (Inc)(2004). If rehabilitation planting is required, the structure should reflect the vegetation in the surrounding CCW.

**RECOMMENDATION 22(3.4): Rehabilitation (CCW) planting to comprise species listed in Table 3.2 of the WCAMP and should reflect the natural vegetation of the CCW.**

**Table 3.2: Suggested species for revegetation and their propagation densities for the CCW and the creation of Teatree Closed Heath.**

Genus	Species	Height (m)	Density (1)	No. of individuals
<i>Acacia</i>	<i>pulchella</i>	2	1 per 2m <sup>2</sup>	
<i>Bossiaea</i>	<i>eriocarpa</i>	groundcover	1 per 0.5m <sup>2</sup>	
<i>Hypocalymma</i>	<i>angustifolium</i>	1	1 per 0.75 m <sup>2</sup>	
<i>Lepidosperma</i>	<i>longitudinale</i>	2.5	1 per 2m <sup>2</sup>	
<i>Melaleuca</i>	<i>preissiana</i>	10	1 per 2m <sup>2</sup>	
<i>Melaleuca</i>	<i>thymoides</i>	1	1 per 0.75 m <sup>2</sup>	
<i>Pericalymma</i>	<i>ellipticum</i>	1	1 per 0.75 m <sup>2</sup>	
<b>Total Individuals to be planted</b>				

### 3.5 REVEGETATION

The objective of revegetation for the Buffer Zone is to clear only for construction, and utilise the attributes of the remaining vegetation to create a vegetation inter-zone between the CCW and the POS. The view from the POS will be of progressively thickening native vegetation. At the same time access to the CCW for management will be maintained (Figure 3.5).

A greater variety of plants are available for the revegetation of the Buffer Zone. This is principally because of the variation in the original vegetation. The revegetation table for the Buffer Zone is also based on the Southern River endemic species list provided by the City of Gosnells and the list of species identified as suitable for rehabilitation in Teatree Closed Heath by Apace Aid (Inc)(2004). However, the assimilation of both tables, and Weston (2004) did not suggest planting of the two dominant species identified by Weston as occurring in

this zone (upland). These two species were *Banksia menziesii* and *Melaleuca thymoides*. It is recommended that some representatives of these two species should be collected and propagated from the surrounding bushland if the desired buffer vegetation or transition vegetation is to be truly representative of what occurred previously.

Sedge species proposed for planting in the swale are not indicative of the normal dampland vegetation native to the site. However, they are necessary for inclusion in the planting table within the swale as they serve the purpose of creating a barrier from weed and human penetration and also for bioremediation. These species include *Baumea juncea*, *Isolepis nodosa*, *Juncus holosechoenus* and *Juncus pallidus*. Other species can be considered with the approval of the City of Gosnells.

The planting structure is illustrated diagrammatically in Figure 3.6. The planting of the wetland interface zone should comprise the species in Table 3.3. The vegetation of the swales should be as described and also noted in Table 3.3.

**RECOMMENDATION 23(3.5): Revegetation (Buffer Zone) planting to comprise species listed in Table 3.3 of the WCAMP and should reflect the vegetation of the Paperbark (*Melaleuca preissiana*) Low Woodland to Low Open Woodland.**

**RECOMMENDATION 24(3.5): Swales to be planted densely with *Baumea juncea*, *Isolepis nodosa*, *Juncus holosechoenus* and *Juncus pallidus*.**

**Table 3.3: Suggested species for revegetation and their propagation densities for the transitional vegetation of the proposed Buffer Zone.**

Genus	Species	Height (m)	Density (1)	No. of Individuals
<i>Adenanthos</i>	<i>cygnorum</i>	3	1 per 2m <sup>2</sup>	
<i>Allocasuarina</i>	<i>fraseriana</i>	12	1 per 2m <sup>2</sup>	
<i>Allocasuarina</i>	<i>humilis</i>	1.5	1 per 0.75m <sup>2</sup>	
<i>Banksia</i>	<i>illicifolia</i>	7	1 per 2m <sup>2</sup>	
<i>Banksia</i>	<i>menziesii</i>	8	1 per 2m <sup>2</sup>	
<i>Bossiaea</i>	<i>eriocarpa</i>	0.5	1 per 0.5 m <sup>2</sup>	
<i>Burchardia</i>	<i>umbellata</i>	0.5	1 per 0.5 m <sup>2</sup>	
<i>Jacksonia</i>	<i>furcellata</i>	3	1 per 2m <sup>2</sup>	
<i>Lepidosperma</i>	<i>longitudinale</i>	2.5	1 per 2m <sup>2</sup>	
<i>Xanthorrhoea</i>	<i>preissii</i>	3	1 per 2m <sup>2</sup>	
<b>Not listed in Apace Aid inc. 2004</b>				
<i>Banksia</i>	<i>menziesii</i>	8	1 per 2m <sup>2</sup>	

<i>Melaleuca</i>	<i>thymoides</i>	1	1 per 0.75 m <sup>2</sup>	
<i>Baumea</i>	<i>juncea</i> (2)	1	1 per 0.75 m <sup>2</sup>	
<i>Isolepis</i>	<i>nodosa</i> (2)	1	1 per 0.75 m <sup>2</sup>	
<i>Juncus</i>	<i>holosechoenus</i> (2)	1.5	1 per 2m <sup>2</sup>	
<i>Juncus</i>	<i>Pallidus</i> (2)	2	1 per 2m <sup>2</sup>	
<b>Total Individuals to be planted</b>				

### 3.6 LANDSCAPING

The POS, which comprises the land on the urban side of the swales, will essentially comprise an artificially created landscape that imbues the essence of the native Southern River Vegetation Complex on the community, but at the same time remains amenable to passive recreation.

From the swales and compensation basins, which will be located towards the perimeter of the Buffer Zone/POS, through to the road verge there will be little available land to be utilised as active POS. Some grassed areas will be established amongst the landscaping, providing a transition from the urban environment to a bushland environment.

Where an opportunity exists to create a landscape feature, then a recreation of the vegetation of the Southern River Complex will be the target or the theme. Hence the target vegetation complex will be “Open woodland of *Eucalyptus callophylla* and *Eucalyptus marginate*, Banksia species with fringing woodland of *Eucalyptus rudis* – *Melaleuca preissiana* and sedgelands.” (Bush Forever 2000). The following table (Table 3.4) lists species that are common in the Southern River Vegetation Complex. This table has been provided as a guide for revegetation and landscaping by the City of Gosnells. The full Southern River Complex species assemblage is provided in Appendix B. The structure of the complex to be created will simply be tall woodland on the periphery of the compensation basins, which will serve the dual purpose of providing shade, and thicker shrubland and sedges on the lower contour to prevent access to the basin but not create a visual barrier. Species to create the appropriate landscape should be selected from those in Table 3.4 or Appendix B.

Pedestrian access will be facilitated and managed throughout the Buffer Zone/POS area, with provision for seating and interpretive signage.

A diagram to illustrate the proposed planting strategy is provided as Figure 3.7

**RECOMMENDATION 25(3.6): Landscape (POS) planting to comprise species listed in Table 3.4 of the WCAMP.**

**Table 3.4: Suggested species for landscaping, based on the regionally endemic species of the Southern River Complex (robust species >1m).**

Genus	Species	Height (m)	Density (1)	No. of Individuals
<i>Acacia</i>	<i>dentifera</i>	3	1 per 2m <sup>2</sup>	
<i>Acacia</i>	<i>saligna</i>	6	1 per 2m <sup>2</sup>	
<i>Adenanthos</i>	<i>cygnorum</i>	3	1 per 2m <sup>2</sup>	
<i>Agonis</i>	<i>linearifolia</i>	4	1 per 2m <sup>2</sup>	
<i>Banksia</i>	<i>illicifolia</i>	7	1 per 2m <sup>2</sup>	
<i>Banksia</i>	<i>littoralis</i>	10	1 per 2m <sup>2</sup>	
<i>Eucalyptus</i>	<i>rudis</i>	15	1 per 2m <sup>2</sup>	
<i>Hakea</i>	<i>varia</i>	3	1 per 2m <sup>2</sup>	
<i>Jacksonia</i>	<i>furcellata</i>	3	1 per 2m <sup>2</sup>	
<i>Jacksonia</i>	<i>sternbergiana</i>	3	1 per 2m <sup>2</sup>	
<i>Kunzea</i>	<i>ericifolia</i>	3	1 per 2m <sup>2</sup>	
<i>Lepidosperma</i>	<i>longitudinale</i>	2.5	1 per 2m <sup>2</sup>	
<i>Melaleuca</i>	<i>preissiana</i>	10	1 per 2m <sup>2</sup>	
<i>Melaleuca</i>	<i>rhaphiophylla</i>	8	1 per 2m <sup>2</sup>	
<i>Melaleuca</i>	<i>teretifolia</i>	4	1 per 2m <sup>2</sup>	
<i>Viminaria</i>	<i>juncea</i>	4	1 per 2m <sup>2</sup>	
<i>Xanthorrhoea</i>	<i>preissii</i>	3	1 per 2m <sup>2</sup>	
<b>Total Individuals to be planted</b>				

### 3.7 GROUNDWATER MONITORING

The objective of the ground water monitoring is to protect the wetland against a severe alteration of the ground water regime.

Groundwater monitoring should be undertaken throughout the development process and continue beyond hand over of responsibility to the City of Gosnells (Table 3.5). Groundwater levels should be measured in late March and September each year at the JDA bores G3, G7, G8 and G9 (Figure 3.2 & 3.4). The September level is used as a measure of the Maximum Groundwater Level (MGL), while the late March level approximately represents the minimum groundwater level. If bores are required to be moved during the development process, a new equivalent bore must be reinstated as close to the old bore as possible.

**Table 3.5: Parameters, tests and actions associated with ground water monitoring**

Parameter	Test	Trigger	Action
Groundwater Levels	Compare records to JDA Average Annual Maximum Groundwater Level (AAMGL) and historical data obtained from the site.	March or September water level more than 0.5 m higher or lower than the JDA AAMGL.	Responsible body to investigate reasons for this change. If intervention is required, this shall be undertaken prior to the next winter.
Transect Inundation	Assess the percentage of the transect that is inundated	Compare to historical baseline data (% inundation at project inception)	Responsible body to investigate reasons for this change. If intervention is required, this shall be undertaken prior to the next winter.

**Table 3.6: Current JDA bore labels and ground water (AAMGL) levels as at August, 2005**

Bore	JDA AAMGL (m AHD)
G3	24.76
G7	25.08
G8	24.41
G9	23.39

While a value of 0.5 m higher or lower than the AAMGL has been set, this value is considered somewhat arbitrary and a number of other factors should be considered. Historical variation has been as high as +/- 1.5 m. Annual transects should be used to determine the level of inundation present on the site. However, intensive sampling, as previously described, is required to establish a baseline of ground water levels. Figure 3.2 illustrates where the transect lines are to be constructed, and they are to comprise a linear path (0.5m wide) of compacted limestone at the lowest contour of the CCW. The percentage of the transect line that is inundated will be measured and compared to previous records. Transects should be conducted in September, at least two days after any rain to ensure that they are not affected by temporary inundation during storm events.

**See previous recommendation pertaining to ground water.**

**RECOMMENDATION 26(3.7): Establish an Inundation Transect that spans each of the CCWs.**

Nutrient levels will initially be monitored in stormwater rather than groundwater. This is because the effects of urbanisation will be seen in stormwater before groundwater. Stormwater monitoring is covered in the Urban Water Management Plan. If the nutrient levels in stormwater are above the guideline levels outlined in the UWMP for more than two years, groundwater monitoring for nutrients will need to be initiated.

Records of groundwater levels transect inundation and stormwater nutrient concentrations will be maintained in a spreadsheet that is updated after each monitoring event. This information will be provided, immediately following updates to the City of Gosnells. The City will maintain the sampling regime and the database subsequent to the conclusion of a developer's maintenance period. The information will also be provided to the Department of Environment and the Department of Conservation and Land Management for information and advice.

If the groundwater level is being influenced by the Estate to an extent that it is observed, or is anticipated, to negatively impact on the ecology of the conservation areas, advice should be sought from the City, DEP and CALM. Remedial action must take place at the earliest possible opportunity. Actual or potential negative impacts will be informed by monitoring of the groundwater levels, stormwater nutrient status, inundation transects (see Recommendation 26(3.7)), and the series of vegetation monitoring plots established in the CCW (see Recommendation 10(3.2)), all of which will be comprehensively maintained in database form and updated to relevant agencies as previously described.

If the monitoring reveals that ground water levels are fluctuating beyond the tolerated variances, then the data should be crossed referenced with local rainfall to determine if the effects are site specific. If the groundwater is being influenced by the Estate, advice should be sought from the City, DEP and CALM.

**RECOMMENDATION 27(3.7): Comprehensive monitoring and reporting on groundwater levels, stormwater, nutrient status, inundation transects and long-term vegetation monitoring plots is to be forwarded regularly to the City of Gosnells, DEP and CALM.**

**RECOMMENDATION 28(3.7): Should monitoring advise actual or potential negative impacts on the conservation areas due to development and operation of the Estate, advice will be sought from the City of Gosnells, DEP and CALM Comprehensive and remedial action taken at the earliest opportunity.**

**RECOMMENDATION 29(3.7): Biannual monitoring of ground water levels, percentage (%) inundation and storm water nutrients to be recorded on**



**Data sheets provided in Appendix 1. Monitoring to take place in September and March.**

### **3.8 ACCESS AND FACILITIES**

The CCW, Buffer Zone and POS together will exhibit many attributes that contribute to the aesthetic appeal and sense of place of the Campbell Estate. Public facilities should be provided so that people might enjoy these areas. However, the design should not deviate from the fundamental objective which is to protect the wetland environment.

For the purpose of ongoing monitoring of vegetation health and ground water, gates should be constructed that are accessible only to maintenance staff and that are not highly visible. These gateways should be located in the Buffer Zone behind the compensation basins that will be heavily vegetated (Figure 3.2 and 3.5).

**RECOMMENDATION 30(3.8): Establish discreet access gates to the CCW's for maintenance and monitoring activities.**

At various points around the periphery of the CCW, subject to liaison with Fire and Emergency Services (FESA), penetration points will be constructed within the ringlock fencing. These will provide vehicle access for fire suppression activities. At these points, fencing will comprise a discrete panel that can be pushed over by a vehicle, and these points will be identified by visual means as agreed with FESA (Figure 3.5).

**RECOMMENDATION 31(3.8): Liaison will be undertaken with FESA to determine fire suppression access requirements. Landscape and rehabilitation design will provide for and facilitate emergency access as required.**

The only point where the CCW can be penetrated by the Public is along the proposed Pedestrian Desire Line PDL (Figure 3.5). Currently this exists as Govan Road, which bisects the Teatree Closed Heath and Low Open Woodland that comprises the larger of the two CCW's. However, when Govan Road is decommissioned this road will be reduced to a pedestrian walkway. A Road Construction and Rehabilitation Management Plan will be produced to guide the decommissioning of Govan Road, and the outcome will be that the road is revegetated to a similar vegetation complex as that which naturally occurs either side (see Table 3.2). Once the road has been ripped, the contours will be set to the level of the surrounding land (CCW). Following this, a walkway/board walk should be constructed connecting Nicholson Road to the terminating edge of Govan Road at the edge of the Buffer Zone and the interface with the CCW. This board walk should be elevated to 1m above ground level (facilitating the movement of fauna), should be constructed of metal and designed with the

objective of minimising contact/disturbance with the ground. The floor of the overpass should be mesh, rather than slats to reduce the amount of debris falling into the CCW. The sides should be 1.2m high. At no point along the footpass should there be an opportunity for users to enter the CCW.

**RECOMMENDATION 32(3.8): The decommissioning of Govan Road will be proceeded by the development of a Road Construction and Rehabilitation Management Plan addressing sensitive decommissioning and appropriate rehabilitation of the road reserve.**

**RECOMMENDATION 33(3.8): Following the decommissioning of Govan Road, a pedestrian board walk will be constructed that bisects the CCW from the Buffer Zone on the east to Nicholson Road on the west. Construction should take place prior to the commencement of rehabilitation along the former road corridor.**

Currently, the ODP identifies a dual use path to be constructed between Nicholson Road and the CCW. A vehicle barrier will need to be constructed between the road and the path (Figure 3.2). Though this is suggested, it is not a recommendation that is relevant for inclusion in this WCAMP.

A fauna linkage corridor will need to be established to link each of the two CCWs and facilitate the movement of terrestrial fauna between the wetlands. Without a fauna corridor the conservation value of the site will be significantly degraded for species such as the bandicoot and local amphibians. Given that the corridor is only approximately 25m wide and over 300m long bandicoots are unlikely to move between the CCW unless they are afforded sufficient cover. It is proposed that the swale be no less than 5m wide and heavily vegetated between each of the two disjunct CCWs (Figure 3.5).

**RECOMMENDATION 34(3.8): Construct a fauna linkage corridor between the two CCWs by ensuring that vegetated swale is no less than 5m wide between the two CCWs.**

Minimal infrastructure is proposed for the POS portion of the buffer zone. Typical passive recreation facilities can be incorporated into the Local Open space area identified in the middle of the development zone. Passive recreation facilities along the buffer zone should encourage the flow of the movement in the area. Limited seating and signage is proposed for installation where appropriate. Bins will not be provided with visitors encouraged to take away their rubbish. Seating should be placed at the base of the tall vegetation in the landscape complexes planted around the compensation basins (Figure 3.5).

**RECOMMENDATION 35(3.8): Place seating and signage at a low density along the POS**

Bollard fencing should be the final unobtrusive barrier to vehicle movement penetrating the POS. Bollards should be erected around the entire periphery of the Buffer Zone and CCW (Figure 3.5)

**RECOMMENDATION 36(3.8): Construct bollard fencing of the interface of the road verge and the POS.**

### **3.9 WEED AND RUBBISH MANAGEMENT**

The objective of weed management is to maintain the integrity of the Study Site by preserving natural vegetation and managing weed growth in conservation, revegetation and landscape areas.

Adequate weed management is essential to maintain the integrity of natural vegetation in an urban environment. This is particularly important when a site is subjected to major disturbances such as clearing and development. In the first instance, an accurate weed mapping survey must be undertaken at the end of Spring in the first year of the development. This has been previously recommended. This will inform weed management, a prescription for which will be developed by a suitably qualified and experienced environmental weed manager to guide ongoing weed control.

A dieback interpretation of the site will be made, with reference to proposed adjacent developments, revegetation and landscaping. Based on the interpretations findings and recommendations, dieback management procedures will be developed.

**RECOMMENDATION 37(3.9): Assess the site for the presence of, and susceptibility to, dieback disease and develop dieback management procedures accordingly. Liaise on outcomes with the City of Gosnells.**

In the first instance it should be noted that weed treatment using artificial herbicides is somewhat problematic due to the fact that the area is subject to inundation. Due to the sensitivity of the area, it is recommended that a professional weed management contractor be commissioned for long-term weed maintenance.

**RECOMMENDATION 38(3.9): A weed management strategy, informed by weed mapping, will be developed and implemented by a suitably qualified and experienced environmental weed manager.**

The majority of the areas that will remain as CCW are in Very Good to Excellent condition and as such have a low level of weed invasion. There will be no need for machinery to enter the CCW area. Nevertheless, all equipment used for rehabilitation works in those areas must be weed and weed seed free. Similarly, all machinery and equipment entering the Buffer Zone and POS area must also

be weed and weed seed free. Minimal disturbance and a proactive rehabilitation / revegetation program will assist to maintain the integrity of the wetland and surrounding areas. If machinery and equipment is weed free prior to entering the Study Site, then works will not contribute to weed invasion during construction.

**RECOMMENDATION 39(3.9): All equipment entering the wetland area and Buffer Zone / POS should be weed and weed seed free prior to entering the Study Site.**

**RECOMMENDATION 40(3.9): Works in the Study Site should be staged and occur from the periphery of the CCW to the periphery of the POS.**

Thirty-four (34) weed species were identified during Weston's (2004) flora inventory and many of these are common to site in the City of Gosnells.

Timely weed control is necessary because many weeds establish in disturbed areas and then become dominant in these areas. The weed management strategy will complement and be supportive of that proposed in Recommendation 39(3.9). Ideally, both strategies will be combined into one comprehensive strategy.

The use of pre-emergent herbicides is not to be encouraged due to the sensitivity of the area and the high ground water table.

**RECOMMENDATION 41(3.9): A weed management strategy for revegetated and landscaped areas will be developed and implemented by a suitably qualified and experienced environmental weed manager. The strategy will not involve the use of pre-emergent herbicides.**

The CCW and Buffer interface is the going to be the area most susceptible and vulnerable to weeds. Selective application of Fusilade® or another environmentally sensitive herbicide will be required. This should be applied across the interface and as far in as is penetrable. Beyond that, the density of the vegetation should act as a natural barrier to weed penetration

Controlled access to the CCW, good rehabilitation landscape design and implementation, and the general rise in profile and pride of the area amongst the community should all contribute to abating the typical spread of weeds associated with disturbance and other anthropogenic influences. Weeds that will be harder to control are those that disperse more naturally, such as those seeds that are dispersed by the wind. These include *Ursinia anthemoides* and *Cladiolus caryophyllaceus*, both of which were found in the natural bushland of the Campbell Estate. The heavily vegetated Buffer Zone swale should help to retard weed species from penetrating the CCW.

As the extent of infestation has not yet been quantified it is not practical or necessary to list all 34 weed species and their specific control. Once the natural bushland has contracted to that which will remain post-development, then far fewer species will remain. Managing Perth's Bushlands (Scheltema and Harris 1995), details quite comprehensively in Table 5 each weed species and its control. The list of weed species recorded is presented in Table 3.4 in this document.

Rubbish infiltrating the Study Site during and post-construction will be collected on a regular basis, particularly during the housing construction phase when wind-blown rubbish and dumping are common occurrences.

**RECOMMENDATION 42(3.9): All rubbish will be removed from the Study Site on a regular basis, at a frequency of no less than monthly during construction. This will take place until the conclusion of the housing construction phase, and thereafter will take place on an as-needs basis.**

### **3.10 MONITORING AND REVIEW**

Given the condition of the CCW and the vegetation within (Very Good to Excellent [Weston, 2004]) the management strategies and recommendations prescribed in this WCAMP are structured more towards preservation of the vegetation that is naturally occurring and the creation of a buffer environment to augment that strategy.

Therefore strategic monitoring will be crucial in ensuring that the conservation value of the site is maintained. However, the WCAMP needs to be flexible, with scope for modification should the development impinge on the condition of the CCW in a way that was neither predicted nor accounted for. The success of the implementation of the WCAMP should be reviewed, including analysis of the data collected, annually. A final report will be submitted to the City at least 6 months prior to management handover to the City.

**RECOMMENDATION 43(3.9): An assessment report that outlines the success or otherwise of the WCAMP should be prepared and submitted to the City of Gosnells annually, with a final report submitted to the City approximately 6 months prior to management handover to the City.**

To ensure that the commitment to monitoring is honoured, this document requires that representatives of the Developer and the City of Gosnells sign off on the Recommendations contained within this report.

**RECOMMENDATION 44(3.10): Representatives of the Developer and the City of Gosnells to sign off on honouring the commitments outlined in this WCAMP.**

Appendix 1 represents a proposed Data sheet for the monitoring of issues within the Campbell Estate. At the intervals defined in the Monitoring Activity Table (Table 3.7) the person undertaking the monitoring should record the data on the Data sheets provided. This will ensure that all data are recorded in a standardised format. Standardised data acquisition will facilitate a quantitative and coherent assessment of the status of the wetlands.

**RECOMMENDATION 45(3.10): Utilise Data sheets for recording off all data collected during the monitoring of the Campbell Estate.**

At this stage (Draft WCAMP) it is difficult to tabulate an accurate monitoring schedule as the start date for the development is not yet defined. However, Table 3.7 does identify the months in which each activity should take place.

**Table 3.7: Monitoring Activity table for ongoing tasks related to the maintenance of the Campbell Estate.**

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Planting					√	√	√	√				
Rehabilitation plant monitoring					Annually							
In-fill planting					12 / 24 months from planting	12 / 24 months from planting	12 / 24 months from planting	12 / 24 months from planting				
Removal of tree guard and irrig.				12 months from planting								
Removal of irrigation				24 months from planting								
Rubbish collection during construction	√	√	√	√						√	√	√
Ongoing rubbish collection			√						√			
Baseline Ground Water Levels	√	√	√	√	√	√			√	√	√	√
Ongoing Ground Water Levels			√						√			
Ground Water Levels			√						√			



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Vegetation Plots									√			
Inundation									√			
Monitoring disturbance and fencing									√			
Weed Mapping									√			
Weed Control			√						√			



## **4 IMPLEMENTATION TIMING AND RESPONSIBILITY**

Implementation of the WCAMP will coincide with implementation of the Drainage and Nutrient Management Plan and this should take place as soon as practicable.

The Road Construction and Rehabilitation Management Plan will be implemented at a later date, so recommendations pertaining to the Pedestrian Desire Line will not be able to be implemented until that time.

Implementation will start from the time at which each of the management plans is signed off by the Developer and the City of Gosnells representatives.

### **4.1 SUMMARY OF RECOMMENDATIONS AND ALLOCATION OF RESPONSIBILITY**

The implementation of the management recommendations contained within this plan will be the responsibility of the developer, as negotiated, until such time as the site is formally handed over to the City of Gosnells for management. This is normally a period of two (2) years. Table 4.1 represents a summation of all of the Recommendations in this WCAMP.

Following stakeholder consultation on the Draft of this WCAMP, and the resolution and refinement practical recommendations, responsibilities for each of the recommendations in Table 4.1 will be officially assigned.

**Table 4.1: Summary of recommendations and allocation of responsibility.**

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
1	3.1	CCW	Minimise disturbance of the CCW to that which is absolutely necessary to retain, preserve and monitor the flora, vegetation and fauna attributes of the wetland areas.	Ongoing	Developer
2	3.1	CCW	Construct a small ringlock fence around the entire CCW (see ensuing text relating to fence construction and the movement of fauna)	At construction	Developer
3	3.1	All	The portion of the fence adjacent Nicholson Road should be approximately 1.2m in height, and have a mesh diameter of no less than 7cm.	At construction	Developer
4	3.1	CCW	Direct surface water drainage from Nicholson Road away from the CCW.	At construction	Developer
5	3.1	Buffer Zone	The location of the swale and compensation basins within the Buffer Zone should be designed in such a way to minimise impact on remnant vegetation that is in good condition and supports mature (large) <i>Eucalyptus</i> , <i>Melaleuca</i> and <i>Banksia</i> trees.	At construction	Developer and City of Gosnells
6	3.1	All	Undertake a comprehensive vegetation condition assessment and weed mapping survey as soon as practicable. This survey must take place toward the end of Spring (November).	Pre construction	Developer

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
7	3.1	All	Maintain all mature <i>Eucalyptus</i> , <i>Banksia</i> and <i>Melaleuca</i> trees outside of the Study Site where practicable.	At construction	Developer
8	3.2	CCW	Based on the vegetation condition report, identify any patches of cleared, degraded or disturbed vegetation within the CCW as areas in need of rehabilitation (see Section 3.4 for rehabilitation strategy).	At construction	Developer and City of Gosnells
9	3.2	CCW	Utilise the four (4) existing bores within the estate to monitor ground water levels monthly from November to June in the first year of the development.	At construction	Developer, then City of Gosnells
10	3.2	CCW	Locate and permanently mark six (6) vegetation monitoring plots in the CCW Teatree Heath or Melaleuca Low Woodland. Record % cover of common herbs (TBA) in each plot on Data sheets provided as Appendix 1.	Ongoing Annual	City of Gosnells
11	3.2	CCW	Further to previous recommendation, enclose all of the CCW areas with ring lock fencing and erect fencing abutting, or just inside, the vegetation boundary. Use a different fence design along Govan Road that does not prohibit fauna movement.	At construction	Developer
12	3.2	Buffer Zone	Clearing in the Buffer Zone should be limited to that which is necessary to construct the swales and compensation basins	At construction	Developer

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
13	3.2	All	Construct swales and compensation basins as per the Campbell Estate Hydrology Investigation.	At construction	Developer
14	3.2	All	Facilitate emergency fire suppression access between the Buffer Zone and the CCW through landscape and drainage design and construction and install appropriately signed and marked fire hydrants along the road adjacent POS at 200 m intervals.	At construction	Developer
15	3.2	POS	Create a landscaped environment within the POS that is predominantly open space, with some patches of vegetated landscape around compensation basins.	At construction	Developer
16	3.2	POS	Maintain the vegetation around the compensation basins so that, once mature, it provides a barrier to accessing the water in the basin.	Ongoing Annual	City of Gosnells
17	3.3	All	Establish liaison and a contract with a registered seed collector or native plant cultivator.	At construction	Developer and City of Gosnells
18	3.3	All	Collect viable seed and plant stock for later propagation in rehabilitation and revegetation areas.	At construction	Developer and City of Gosnells

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
19	3.3	All	Plant at a density of one plant in the centre of each square metre of earth for over-storey species, one plant in the centre of each 0.75 square metre for mid-storey species and one plant in the centre of each 0.5 square metre for ground storey species.	Post construction	Developer and City of Gosnells
20	3.3	All	Assess the success of planting after 12 months, and then 24 months from initial planting. Infill plant at 12 months and remove tree guards and irrigation at 24 months.	At construction	City of Gosnells
21	3.3	All	Make provision for further annual monitoring of planting success and possible infill planting in each zone, based on the success of the initial surveys.	Annual	City of Gosnells
22	3.4	CCW	Rehabilitation (CCW) planting to comprise species listed in Table 3.2 of the WCAMP and should reflect the natural vegetation of the CCW.	Post construction	Developer and City of Gosnells
23	3.5	Buffer Zone	Revegetation (Buffer Zone) planting to comprise species listed in Table 3.3 of the WCAMP and should reflect the vegetation of the Paperbark ( <i>Melaleuca preissiana</i> ) Low Woodland to Low Open Woodland.	Post construction	Developer and City of Gosnells
24	3.5	Buffer Zone	Swales to be planted densely with <i>Baumea juncea</i> , <i>Isolepis nodosa</i> , <i>Juncus holosechoenus</i> and <i>Juncus pallidus</i> .	Post construction	Developer and City of Gosnells

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
25	3.6	POS	Landscape (POS) planting to comprise species listed in Table 3.4 of the WCAMP.	Post construction	Developer and City of Gosnells
26	3.7	CCW	Establish an Inundation Transect that spans each of the CCWs.	At construction	Developer
27	3.7	CCW	Comprehensive monitoring and reporting on groundwater levels, stormwater, nutrient status, inundation transects and long-term vegetation monitoring plots is to be forwarded regularly to the City of Gosnells, DEP and CALM.	Ongoing	Developer, then City of Gosnells
28	3.7	CCW	Should monitoring advise actual or potential negative impacts on the conservation areas due to development and operation of the Estate, advice will be sought from the City of Gosnells, DEP and CALM Comprehensive and remedial action taken	Ongoing	Developer, then City of Gosnells
29	3.7	CCW	Biannual monitoring of ground water levels, percentage (%) inundation and storm water nutrients to be recorded on Data sheets provided in Appendix 1. Monitoring to take place in September and March.	Bi-annual	Developer, then City of Gosnells
30	3.8	CCW	Establish discrete access gates to the CCW's for maintenance and monitoring activities.	Bi-annual	Developer

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
31	3.8	CCW/Buffer Zone	Liaison will be undertaken with FESA to determine fire suppression access requirements. Landscape and rehabilitation design will provide for and facilitate emergency access as required.	At construction	Developer
32	3.8	CCW	The decommissioning of Govan Road will be proceeded by the development of a Road Construction and Rehabilitation Management Plan addressing sensitive decommissioning and appropriate rehabilitation of the road reserve.	Pre construction	Developer
33	3.8	CCW	Following the decommissioning of Govan Road, a pedestrian board walk should be constructed that bisects the CCW from the Buffer Zone on the east to Nicholson Road on the west. Construction should take place prior to the commencement of rehabilitation along the former road corridor.	Post construction	Developer
34	3.8	Buffer Zone	Construct a fauna linkage corridor by ensuring swale width between the two CCWs is no less than 5m.	At construction	Developer
35	3.8	POS	Place seating and signage at a low density along the POS	At construction	City of Gosnells
36	3.8	POS	Construct bollard fencing of the interface of the road verge and the POS.	At construction	City of Gosnells

Recomm. #	Section	Zone	Objective	Frequency	Responsibility
37	3.9	All	Assess the site for the presence of, and susceptibility to, dieback disease and develop dieback management procedures accordingly. Liaise on outcomes with the City of Gosnells.	Pre-clearing of Study Site	Developer
38	3.9	All	A weed management strategy, informed by weed mapping, will be developed and implemented by a suitably qualified and experienced environmental weed manager	At construction	City of Gosnells
39	3.9	All	All equipment entering the wetland area and Buffer Zone / POS should be weed and weed seed free prior to entering the Study Site.	Pre-clearing of Study Site	Developer
40	3.9	All	Works in the Study Site should be staged and occur from the periphery of the CCW to the periphery of the POS.	Pre-clearing of Study Site	Developer
41	3.9	All	A weed management strategy for revegetated and landscaped areas will be developed and implemented by a suitably qualified and experienced environmental weed manager. The strategy will not involve the use of pre-emergent herbicides...	Biannual	City of Gosnells
42	3.9	All	All rubbish will be removed from the Study Site on a regular basis, at a frequency of no less than monthly during construction. This will take place until the conclusion of the housing construction phase, and thereafter will take place on an as-needs basis.	Biannual	Developer then City of Gosnells



Recomm. #	Section	Zone	Objective	Frequency	Responsibility
43	3.9	All	An assessment report that outlines the success or otherwise of the WCAMP should be prepared and submitted to the City of Gosnells annually, with a final report submitted to the City approximately 6 months prior to management handover to the City.	At handover	Developer
44	3.10	All	Representatives of the Developer and the City of Gosnells to sign off on honouring the commitments outlined in this WCAMP.	Pre construction	Developer and City of Gosnells
45	3.10	All	Utilise Data sheets for recording off all data collected during the monitoring of the Campbell Estate.	Ongoing	Developer, then City of Gosnells



## **4.2 PRACTICAL COMPLETION**

As this document exists as a Draft for comment, and as such there are not yet any proposed timeframes for practical completion.

However, as a guide, practical completion should be regarded as the time at which all of the landscape works are completed to the satisfaction of the City of Gosnells, including the completion of all rehabilitation, revegetation and landscaping.

## **4.3 PERFORMANCE AGREEMENT**

A Performance Agreement will be jointly signed by the City of Gosnells and Developers whose subdivisional development(s) include areas subject to the WCAMP. The Performance Agreement will be binding on both parties.

## 5 REFERENCES

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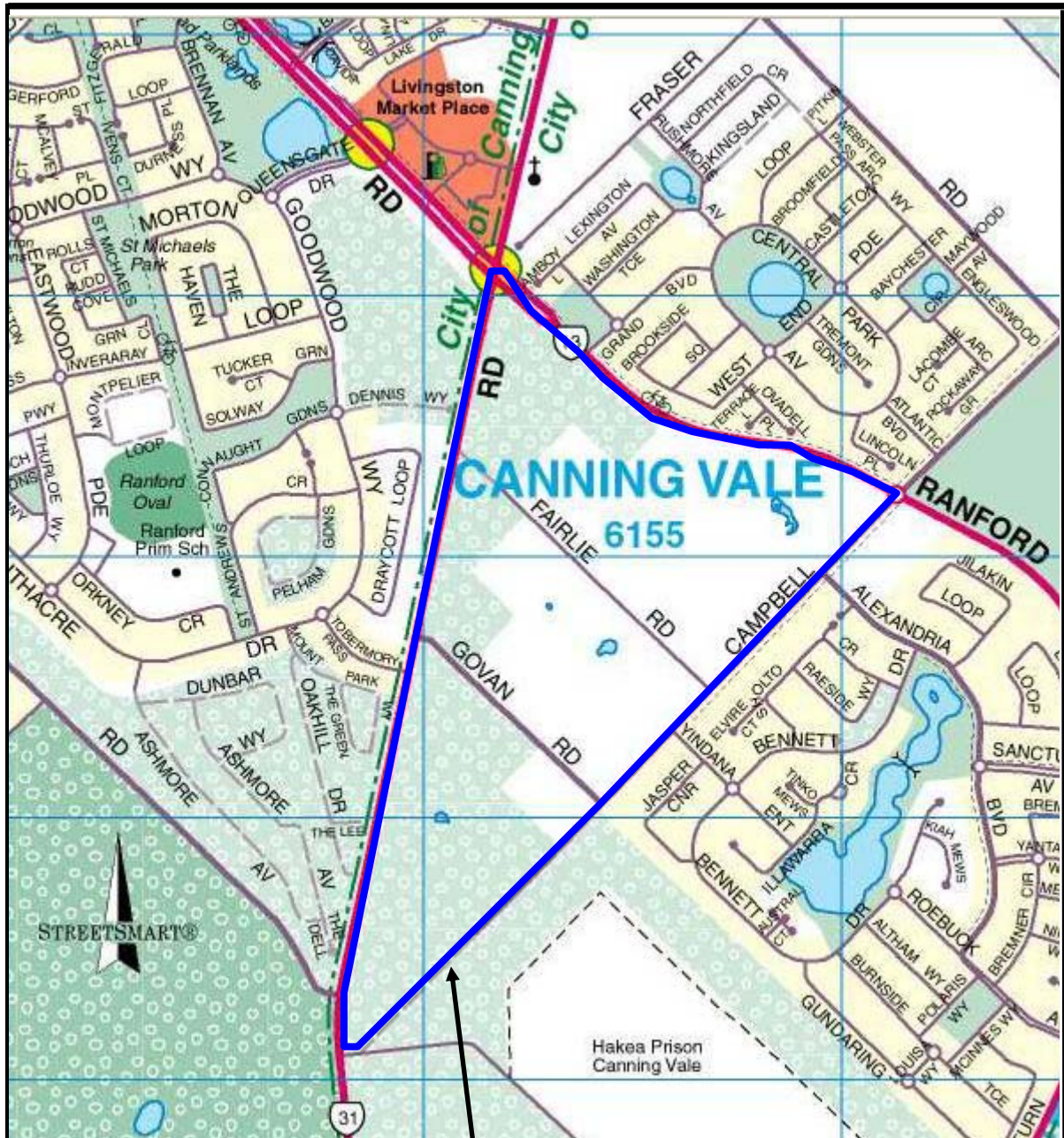
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# FIGURES



Site Location



FIGURE 2.1 Site Location

CLIENT: City of Gosnells and Fermanagh Pty Ltd

DRAWN BY: MD

CHECKED BY: MD

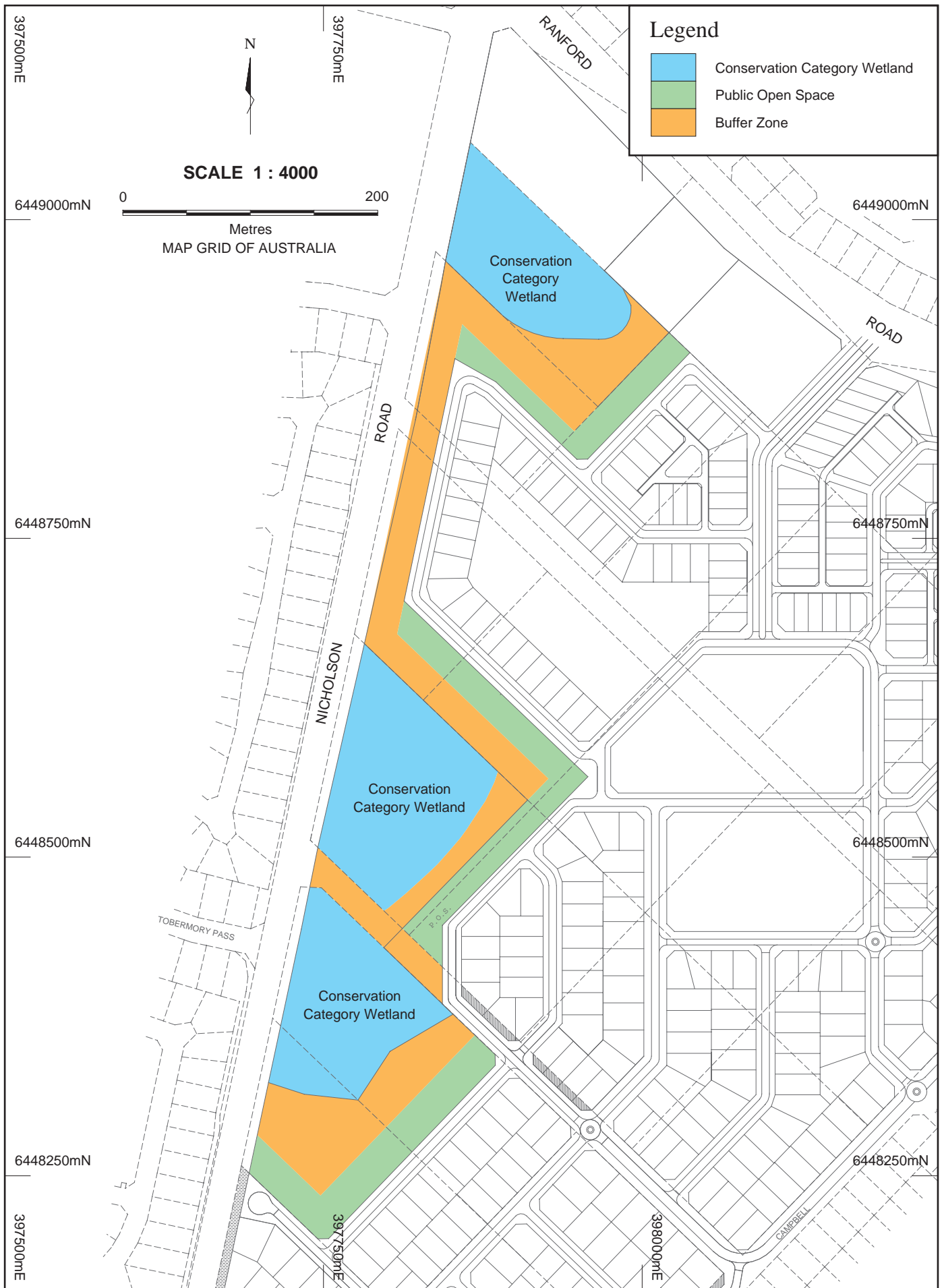
JOB NUMBER: 05.128

DATE: 28/9/05

REPORT ISSUE: FINAL



Australia



Client:  
**CITY OF GOSNELLS**

Project:  
**CAMPBELL ESTATE**

**MAP DELINEATING THE  
CONSERVATION CATEGORY WETLANDS,  
BUFFER ZONE AND  
PUBLIC OPEN SPACE.**

Date: 12 October 2005

Scale: 1:4 000

Author: M.Ladyman

Figure No. **3.1**

A4 Plan No. **CBE-001**



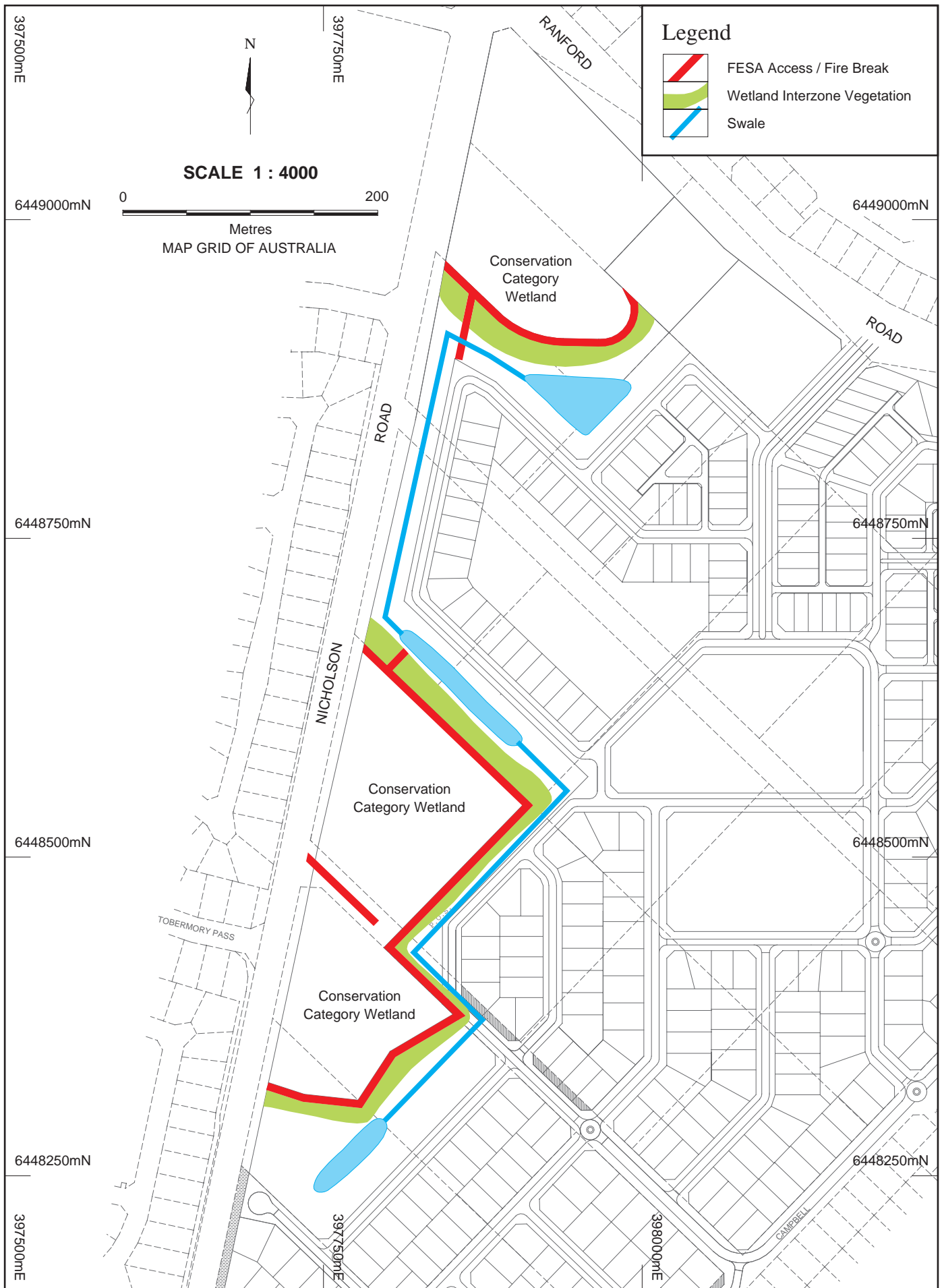
Client:  
**CITY OF GOSNELLS**

Project:  
**CAMPBELL ESTATE**

**EXTENT AND LOCATION OF  
FEATURES WITHIN THE  
CONSERVATION CATEGORY WETLAND**

Date: 12 October 2005  
Scale: 1:4 000  
Author: M.Ladyman  
Figure No. **3.2**  
Plan No. **CBE-002**





Client:  
**CITY OF GOSNELLS**

Project:  
**CAMPBELL ESTATE**

**EXTENT AND LOCATION OF  
FEATURES IN THE BUFFER ZONE**

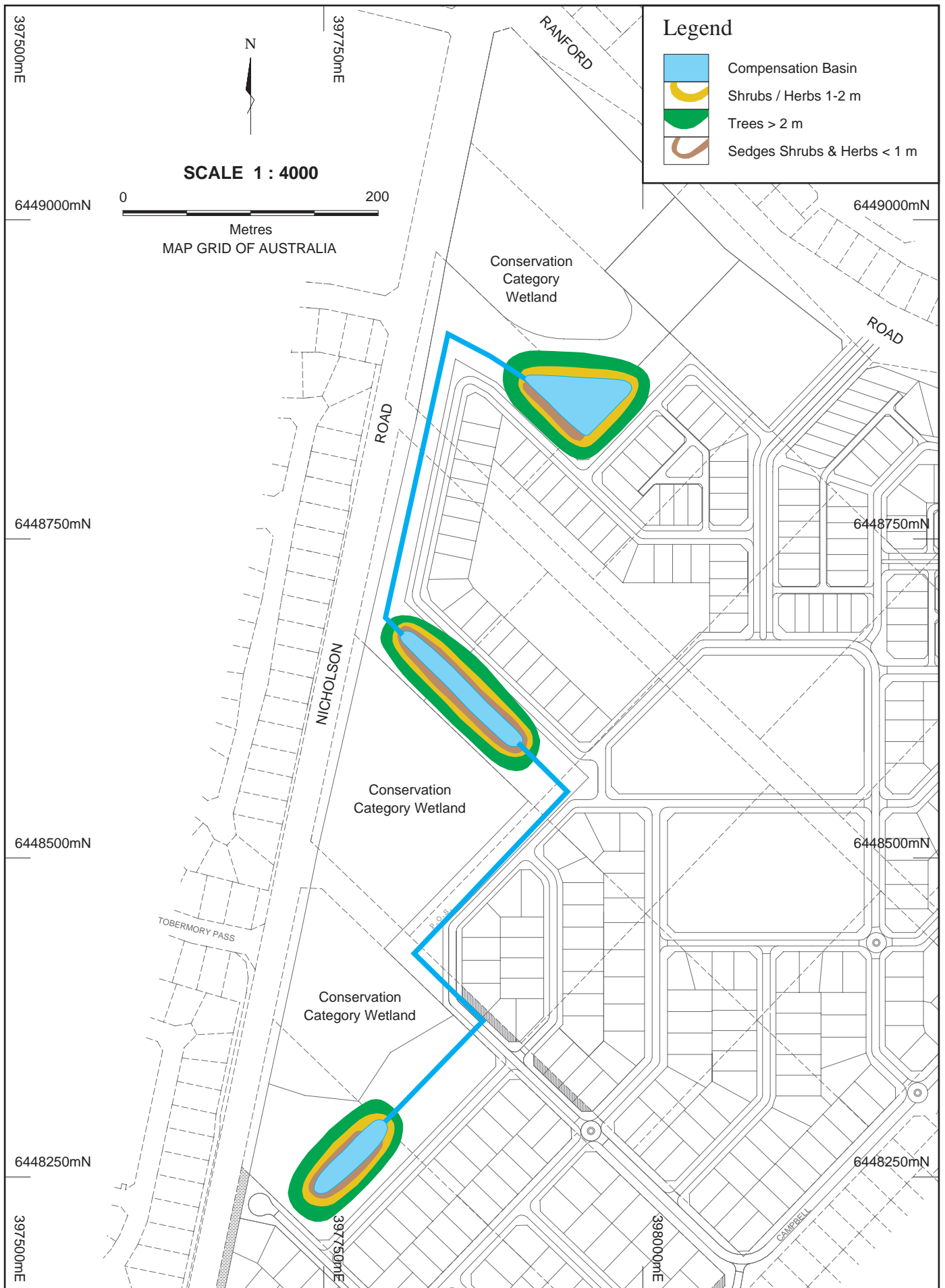
Date: 12 October 2005

Scale: 1:4 000

Author: M.Ladyman

Figure No. **3.3**

Plan No. **CBE-003**



Client:  
**CITY OF GOSNELLS**

Project:  
**CAMPBELL ESTATE**

**EXTENT AND LOCATION  
OF FEATURES WITHIN  
PUBLIC OPEN SPACE**

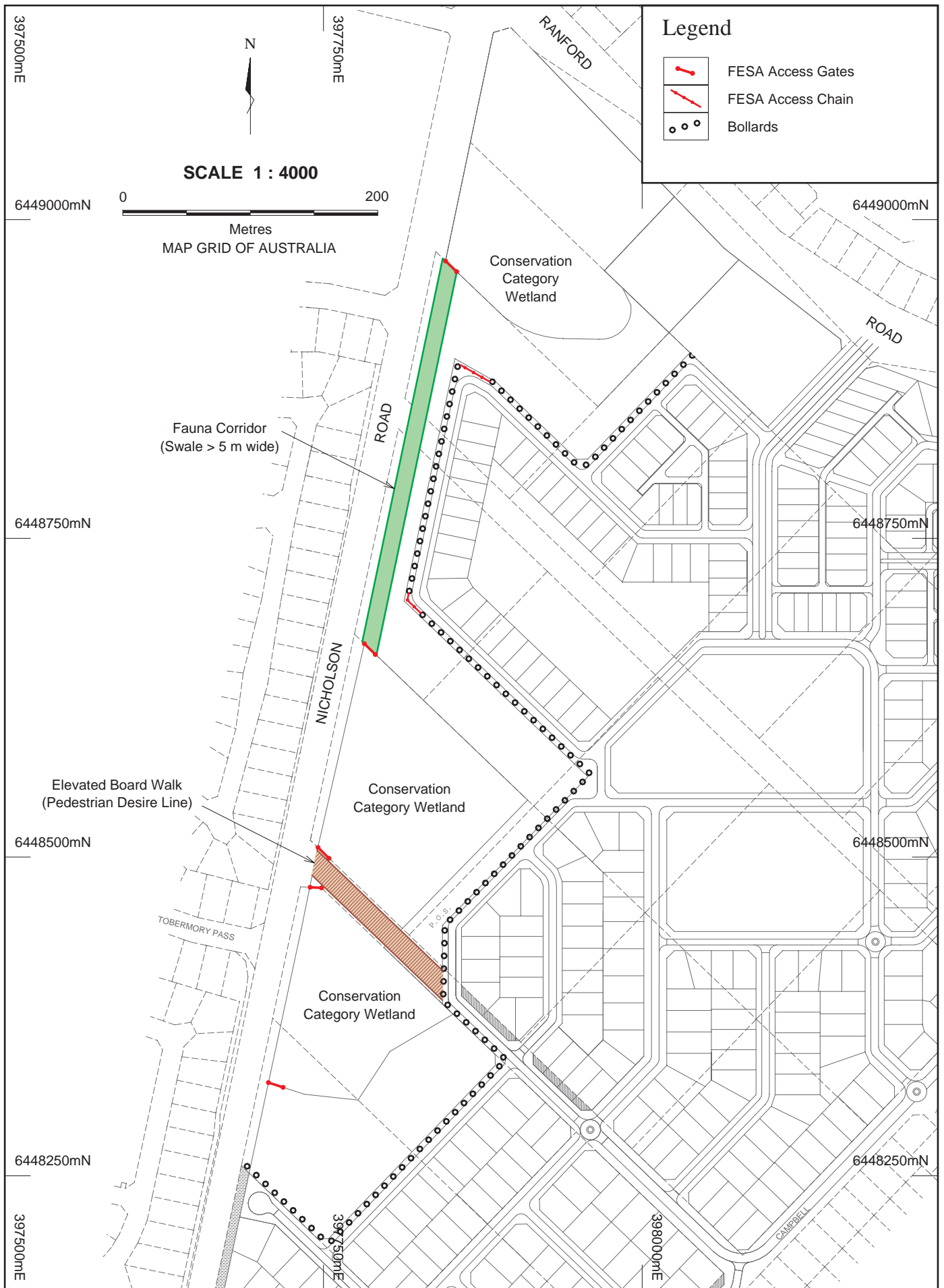
Date: 12 October 2005

Scale: 1:4 000

Author: M.Ladyman

Figure No. **3.4**

A4 Plan No. **CBE-004**



Client:  
**CITY OF GOSNELLS**

Project:  
**CAMPBELL ESTATE**

**ACCESS AND FACILITIES**

Date: 12 October 2005

Scale: 1:4 000

Author: M.Ladyman

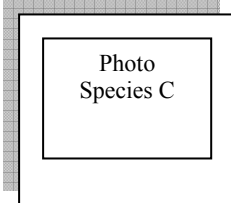
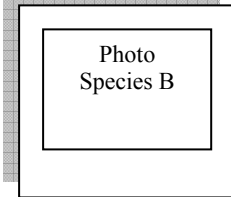
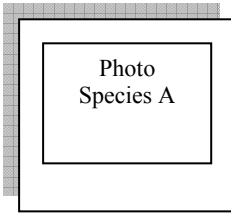
Figure No. **3.5**

Plan No. **CBE-005**

# APPENDIX A

**Appendix A: Campbell Estate WCAMP Monitoring Data Sheet**

**Date of Recording** \_\_\_\_\_



**Vegetation Monitoring**

Plot #1      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

Plot #2      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

Plot #3      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

Plot #4      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

Plot #4      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

Plot #6      % Cover \_\_\_\_ # of Individuals \_\_\_\_  
 Comment \_\_\_\_\_

**Ground Water Levels**

Bore	JDA AAMGL (m AHD)	AAMGL at Time of Recording
G3	24.76	
G7	25.08	
G8	24.41	
G9	23.39	

**Inundation Transects**

Transect A (CCW south of Govan Road)

% Inundated    10-20%     20-50%     50-80%     80-100%

Transect B (CCW north of Govan Road)

% Inundated    10-20%     20-50%     50-80%     80-100%

Transect C (CCW north of Fairlie Road)

% Inundated    10-20%     20-50%     50-80%     80-100%

# APPENDIX B

## Appendix B: Flora species of the Southern River Complex, arranged by size (strata) class.

Southern River Vegetation Complex					
Genus	Species	Common Name	Size (m)	Flowering	Colour
Species < 1m					
<i>Acacia</i>	<i>huegelli</i>		1	Oct-Dec	yellow
<i>Acacia</i>	<i>incurva</i>		0.5	Aug-Sept	yellow
<i>Acacia</i>	<i>stenoptera</i>	Narrow Winged Wattle	1	May-Sept	yellow
<i>Acacia</i>	<i>willdenowiana</i>	Grass Wattle	0.5	June-Oct	yellow
<i>Alexgeorgea</i>	<i>arenicola</i>		0.3	Apr-May	brown
<i>Allocasuarina</i>	<i>microstachya</i>		1	Aug-Jan	
<i>Andersonia</i>	<i>involutrata</i>		0.5	Sept-Nov	
<i>Andersonia</i>	<i>lehmanniana</i>		0.3	Jan-Oct	
<i>Anigozanthos</i>	<i>bicolour</i>	Little Kangaroo Paw	0.5	Aug-Oct	green/red
<i>Anigozanthos</i>	<i>humilis</i>	Catspaw	0.5	Aug-Oct	yellow/red
<i>Anigozanthos</i>	<i>manglesii</i>	Mangles Kangaroo Paw	0.5	Sept-Nov	red/green
<i>Anigozanthos</i>	<i>viridis</i>	Green Kangaroo Paw	0.5	Aug-Oct	green
<i>Astroloma</i>	<i>ciliatum</i>	Candle Cranberry	0.3	May-Oct	red
<i>Baeckea</i>	<i>camphorosmae</i>	Camphor Myrtle	1	Jul-Feb	pink
<i>Baumea</i>	<i>juncea</i>	Bare Twig-rush	1	Oct-Jan	brown
<i>Beaufortia</i>	<i>elegans</i>	Elegant Beaufortia	1	Nov-Feb	purple
<i>Bolboschoenus</i>	<i>caldwellii</i>	Marsh Club-rush	1	Aug-Nov	brown
<i>Boronia</i>	<i>crenulata</i>	Aniseed Boronia	1	Aug-Oct	red
<i>Bossiaea</i>	<i>eriocarpa</i>	Common Brown Pea	0.5	Jul-Oct	brown/yellow
<i>Bossiaea</i>	<i>ornata</i>	Broad-leaved Brown Pea	1	Aug-Oct	brown/yellow
<i>Brachycome</i>	<i>iberidifolia</i>	Swan River Daisy	groundcover	Aug-May	blue
<i>Burchardia</i>	<i>multiflora</i>	Dwarf Burchardia	groundcover	Jul-Oct	pink
<i>Burchardia</i>	<i>umbellata</i>	Milkmaids	0.5	Aug-Oct	white
<i>Burtonia</i>	<i>conferta</i>		1	Sept-Dec	blue
<i>Burtonia</i>	<i>scabra</i>	Painted Lady	1	Aug-Sept	red
<i>Calothamnus</i>	<i>hirsutus</i>		1	Sept-Dec	red
<i>Calothamnus</i>	<i>lateralis</i>		1	Aug-Dec	red
<i>Calothamnus</i>	<i>sanguineus</i>	Silky Leaved Blood Flower	1	Mar-Nov	red
<i>Calothamnus</i>	<i>villosus</i>	Woolly Net Bush	1	Sept-Dec	red
<i>Calytrix</i>	<i>angulata</i>	Yellow Starflower	1	Sept-Dec	yellow
<i>Calytrix</i>	<i>flavescens</i>	Summer Starflower	0.5	Nov-Jan	yellow
<i>Centella</i>	<i>asiatica</i>	Centella	0.1	All Year	pink
<i>Chamaescilla</i>	<i>corymbosa</i>	Blue Squill	0.3	Aug-Oct	pink
<i>Chorizema</i>	<i>ilicifolium</i>	Holly Flame Pea	0.5	Jul-Nov	yellow/purple
<i>Conospermum</i>	<i>incurvum</i>	Plume Smokebush	1	Aug-Oct	white
<i>Conostylis</i>	<i>aculeata</i>	Prickly Conostylis	0.5	Sept-Oct	yellow
<i>Conostylis</i>	<i>candicans</i>	Grey Cottonheads	0.5	Aug-Sept	yellow
<i>Conostylis</i>	<i>setigera</i>	Bristly Cottonhead	0.5	Sept-Oct	yellow
<i>Cryptandra</i>	<i>arbutiflora</i>	Waxy Cryptandra	1	May-Oct	white
<i>Dampiera</i>	<i>alata</i>	Winged Stem Dampiera	0.6	Aug-Nov	blue
<i>Dampiera</i>	<i>linearis</i>	Common Dampiera	0.5	Jul-Nov	purple
<i>Daviesia</i>	<i>decurrans</i>	Prickly Bitter Pea	0.5	Jun-Aug	orange/red
<i>Daviesia</i>	<i>divaricata</i>	"Marno"	1	Jul-Nov	red/yellow
<i>Daviesia</i>	<i>horrida</i>	Prickly Bitter Pea	1	Jul-Sept	orange/red
<i>Daviesia</i>	<i>nudiflora</i>		0.5	Sept-Nov	orange/yellow
<i>Daviesia</i>	<i>triflora</i>		0.5	May-Sept	orange/yellow
<i>Dianella</i>	<i>divaricata</i>	Flax Lily	1	Jun-Aug	orange
<i>Dryandra</i>	<i>nivea</i>	Couch Honey-pot	groundcover	May-Sept	gold
<i>Eremaea</i>	<i>pauciflora</i>		1	Sept-Dec	orange
<i>Eremophila</i>	<i>glabra</i>	Tar Bush	0.5	Jul-Jan	orange
<i>Eriostemon</i>	<i>spicatus</i>	Salt and Pepper	0.5	Aug-Sept	mauve
<i>Gompholobium</i>	<i>aristatum</i>		0.5	Jul-Dec	yellow
<i>Gompholobium</i>	<i>confertum</i>		1	Sept-Dec	yellow

Southern River Vegetation Complex					
Genus	Species	Common Name	Size (m)	Flowering	Colour
<i>Gompholobium</i>	<i>marginatum</i>		0.5	Aug-Sept	yellow
<i>Gompholobium</i>	<i>tomentosum</i>	Yellow Pea	0.5	Aug-Dec	yellow
<i>Grevillea</i>	<i>bipinnatifida</i>	Fuschia Grevillea	1	Mar-Nov	red
<i>Haemodorum</i>	<i>laxum</i>	Bloodroot	0.5	Nov	black
<i>Haemodorum</i>	<i>paniculatum</i>	"Mardja"	0.5	Oct-Dec	yellow
<i>Haemodorum</i>	<i>simplex</i>	"Mardja"	0.5	Oct-Nov	black
<i>Haemodorum</i>	<i>spicatum</i>	"Mardja"	0.5	Nov-Dec	black
<i>Hakea</i>	<i>candolleana</i>		0.5	Jun-Sept	white
<i>Hakea</i>	<i>ceratophylla</i>	Horned Leaved Hakea	1	Sept-Dec	red
<i>Hakea</i>	<i>erinacea</i>	Hedgehog Hakea	1	May-Sept	white
<i>Hakea</i>	<i>stenocarpa</i>	Narrow-fruited Hakea	1	Jul-Nov	white
<i>Hardenbergia</i>	<i>comptoniana</i>	Native Wisteria	climber	Jun-Sept	purple
<i>Hemiantra</i>	<i>pungens</i>	Snake Bush	groundcover	All Year	purple
<i>Hibbertia</i>	<i>racemosa</i>	Stalked Guinea Flower	0.3	Jul-Nov	yellow
<i>Hovea</i>	<i>chorizemifolia</i>	Holly Leaved Hovea	0.5	Jun-Sept	blue/purple
<i>Hovea</i>	<i>pungens</i>	Devils Pins	0.5	Jun-Sept	purple
<i>Hovea</i>	<i>trisperma</i>	Common Hovea	0.5	Jun-Sept	purple
<i>Hypocalymma</i>	<i>angustifolium</i>	White Myrtle	1	Jul-Oct	pink
<i>Hypocalymma</i>	<i>robustum</i>	Swan River Myrtle	1	Jul-Oct	pink
<i>Isolepis</i>	<i>cernua</i>	Nodding Club-rush	0.2	All Year	
<i>Isolepis</i>	<i>nodosa</i>	Knotted Club Rush	1	Nov-Mar	brown
<i>Isopogon</i>	<i>asper</i>		1	Jul-Oct	pink
<i>Isotropis</i>	<i>cuneifolia</i>	Granny Bonnets	groundcover	Aug-Oct	red
<i>Jacksonia</i>	<i>sericea</i>	"Waldjumi"	0.6	Dec-Feb	orange
<i>Juncus</i>	<i>planifolius</i>	Broadleaf Rush	0.6	Oct-Nov	brown
<i>Kennedia</i>	<i>coccinea</i>	Coral-vine	climber	Aug-Nov	red/yellow
<i>Kennedia</i>	<i>prostrata</i>	Running Postman	groundcover	Jul-Nov	red
<i>Kennedia</i>	<i>stirlingii</i>	Bushy Kennedia	climber	Aug-Sept	red/yellow
<i>Labichea</i>	<i>punctata</i>	Lanced-leaved Cassia	1	Aug-Oct	yellow
<i>Lechenaultia</i>	<i>biloba</i>	Blue Leschenaultia	0.6	Oct-Dec	blue
<i>Leptocarpus</i>	<i>coangustus</i>		1	Aug-Oct	brown
<i>Leptocarpus</i>	<i>scariosus</i>		1	Sept-May	brown
<i>Lobelia</i>	<i>alata</i>	Angled Lobelia	0.3	Mar-Apr	blue
<i>Lobelia</i>	<i>tenoiur</i>	Slender Lobelia	0.3	Oct-Jan	blue
<i>Loxycarya</i>	<i>flexuosa</i>		0.3	Sept-Oct	
<i>Melaleuca</i>	<i>acerosa</i>	Coastal Honeymyrtle	1	Sept-Dec	cream
<i>Melaleuca</i>	<i>pauciflora</i>		1	Jun-Feb	cream
<i>Melaleuca</i>	<i>scabra</i>	Rough Honey Myrtle	0.5	Sept-Dec	purple
<i>Melaleuca</i>	<i>seriata</i>		1	Oct-Dec	pink
<i>Melaleuca</i>	<i>thymoides</i>		1	Sept-Jan	yellow
<i>Melaleuca</i>	<i>trichophylla</i>		0.7	Nov-Jan	pink/purple
<i>Nemcia</i>	<i>capitatum</i>	Bacon and Eggs	0.5	Jun-Sept	yellow
<i>Neurachne</i>	<i>alopeuroidea</i>	Foxtail Mulga Grass	0.5	Aug-Nov	
<i>Orthrosanthus</i>	<i>laxus</i>	Morning Iris	0.5	Aug-Oct	mauve
<i>Patersonia</i>	<i>occidentalis</i>	Western Patersonia	0.5	Sept-Dec	purple
<i>Pericalymma</i>	<i>ellipticum</i>	Swamp Tea Tree	1	Sept-Dec	white
<i>Petrophile</i>	<i>linearis</i>	Pixie Mops	0.5	Sept-Nov	pink
<i>Petrophile</i>	<i>macrostachya</i>		0.5	Aug-Nov	yellow
<i>Phyllanthus</i>	<i>calycinus</i>	False Boronia	0.3	Jun-Nov	white
<i>Pimelea</i>	<i>rosea</i>	Rose Bangine	1	Aug-Nov	pink
<i>Pimelea</i>	<i>sulphurea</i>	Yellow Banjine	0.5	Oct-Nov	yellow
<i>Pronaya</i>	<i>fraseri</i>	Elegant Pronaya	climber	Jan-Feb	blue
<i>Ptilotus</i>	<i>polystachyus</i>	"Mulla"	0.5	Jul-Nov	yellow
<i>Restio</i>	<i>stenostachyus</i>		0.6	Feb-May	
<i>Restio</i>	<i>tremulus</i>	Quivery Cord Rush	1	Nov-Feb	
<i>Schoenus</i>	<i>grandiflorus</i>		1	Apr-Jul	brown
<i>Scholtzia</i>	<i>involuta</i>	Spiked Scholtzia	1	Dec-Mar	white
<i>Sphaerolobium</i>	<i>medium</i>	Globe Pea	0.5	Aug-Nov	yellow/orange
<i>Stipa</i>	<i>flavescens</i>		0.5	Sept-Oct	



Southern River Vegetation Complex					
Genus	Species	Common Name	Size (m)	Flowering	Colour
<i>Stipa</i>	<i>semibarbata</i>	Bearded Spear Grass	0.5	Aug-Nov	
<i>Styidium</i>	<i>brunonianum</i>	Pink Fountain Triggerplant	0.2	Sept-Nov	pink
<i>Styidium</i>	<i>calcaratum</i>	Book Triggerplant	0.2	Sept-Nov	pink
<i>Styidium</i>	<i>dichotomum</i>	Pins and Needles	0.2	Oct-Dec	pink
<i>Styidium</i>	<i>junceum</i>	Reed Triggerplant	0.2	Aug-Dec	pink
<i>Styidium</i>	<i>pubigerum</i>	Yellow Butterfly	0.2	Sept-Oct	yellow
<i>Styidium</i>	<i>schoenoides</i>	Cow Kicks	0.2	Aug-Oct	white
<i>Templetonia</i>	<i>biloba</i>		0.5	Sept	yellow/red
<i>Thysanotus</i>	<i>manglesianus</i>	Fringed Lily	climber	Aug-Nov	purple
<i>Thysanotus</i>	<i>multiflorus</i>	Many Flowered Fringed Lily	0.5	Sept-Nov	purple
<i>Thysanotus</i>	<i>thyrsoideus</i>	Fringed Lily	0.5	Sept-Nov	purple
<i>Verticordia</i>	<i>acerosa</i>		1	Aug-Nov	yellow
<i>Verticordia</i>	<i>plumosa</i>	Plumed Feather Flower	1	Sept-Dec	pink
<i>Xanthorrhoea</i>	<i>gracilis</i>	Graceful Grass Tree	1	Oct-Dec	cream
Species > 1m < 2m					
<i>Acacia</i>	<i>pulchella</i>	Prickly Moses	2	Jun-Oct	yellow
<i>Actinostrobus</i>	<i>pyramidalis</i>	Swamp Cypress	2		
<i>Allocasuarina</i>	<i>humilis</i>	Dwarf Sheoak	1.5	May-Nov	
<i>Astartea</i>	<i>fascicularis</i>		1.5	Dec-Feb	pink
<i>Banksia</i>	<i>telmatiaea</i>	Swamp Fox Banksia	2	Apr-Aug	brown
<i>Beaufortia</i>	<i>squarrosa</i>	Sand Bottlebrush	1.5	Jan-Apr	orange
<i>Calothamnus</i>	<i>quadrifidus</i>	One-sided Bottlebrush	2	Aug-Dec	red
<i>Calytrix</i>	<i>fraseri</i>	Pink Summer Calytrix	1.5	Nov-May	pink
<i>Conospermum</i>	<i>stoechadis</i>	Common Smokebush	1.5	Jul-Nov	blue
<i>Dryandra</i>	<i>armata</i>	Prickly Dryandra	2	Jun-Oct	yellow
<i>Eleocharis</i>	<i>acuta</i>	Common Spike-rush	1.5	Sept-Dec	
<i>Euchilopsis</i>	<i>linearis</i>	Swamp Pea	1.5	Jul-Dec	orange/red
<i>Hakea</i>	<i>lissocarpa</i>	Honey Bush	1.5	Jun-Sept	white
<i>Hakea</i>	<i>sulcata</i>	Furrowed Hakea	1.5	Aug-Sept	white
<i>Hakea</i>	<i>trifurcata</i>	Two-leaf Hakea	2	Jul-Oct	white
<i>Isopogon</i>	<i>sphaerocephalus</i>	Drumstick Isopogon	1.5	Aug-Nov	yellow
<i>Juncus</i>	<i>holoschoenus</i>	Jointleaf Rush	1.5	Sept-Nov	brown
<i>Juncus</i>	<i>krausii</i>	Sea Rush	1.5	Nov-Dec	brown
<i>Juncus</i>	<i>pallidus</i>	Giant Rush	2	Oct-Nov	white
<i>Kunzea</i>	<i>recurva</i>	Mountain Kunzea	1.5	Aug-Nov	mauve
<i>Macrozamia</i>	<i>riedlei</i>	Zamia	2		
<i>Melaleuca</i>	<i>lateritia</i>	Robin Redbreast Bush	2	Sept-Apr	red
<i>Melaleuca</i>	<i>radula</i>	Graceful Honeymyrtle	2	Sept-Nov	mauve
<i>Persoonia</i>	<i>saccatta</i>	Snottygobble	1.5	Jul-Jan	yellow
<i>Petrophile</i>	<i>squamata</i>		1.5	Aug-Nov	yellow
<i>Regelia</i>	<i>ciliata</i>		2	Nov-Feb	red
<i>Regelia</i>	<i>inops</i>		2	Oct-Jan	mauve
<i>Stipa</i>	<i>elegantissima</i>	Feather Spear Grass	2	Aug-Jan	
<i>Thomasia</i>	<i>macrocarpa</i>	Large Fruited Thomasia	1.5	Aug-Dec	mauve
Species > 2m					
<i>Acacia</i>	<i>dentifera</i>		3	Aug-Nov	yellow
<i>Acacia</i>	<i>saligna</i>	"Coojong"	6	Aug-Oct	yellow
<i>Adenanthos</i>	<i>cygnorum</i>	Common Woolly Bush	3	Sept-Feb	white
<i>Agonis</i>	<i>linearifolia</i>	Swamp Peppermint	4	All Year	white
<i>Allocasuarina</i>	<i>fraseriana</i>	Common Sheoak	12	May-Nov	
<i>Banksia</i>	<i>attenuata</i>	Candle Banksia	8	Sept-Oct	yellow
<i>Banksia</i>	<i>grandis</i>	Bull Banksia	8	Sept-Dec	yellow
<i>Banksia</i>	<i>illicifolia</i>	Holly-leaved Banksia	7	All Year	red
<i>Banksia</i>	<i>littoralis</i>	Swamp Banksia	10	Mar-Jul	yellow
<i>Banksia</i>	<i>menziesii</i>	Firewood Banksia	8	Feb-Aug	red
<i>Casuarina</i>	<i>obesa</i>	Salt Sheoak	10		
<i>Conospermum</i>	<i>triplinervum</i>	Tree Smokebush	4	Aug-Nov	white
<i>Dodonaea</i>	<i>hackettiana</i>	Perth Hopbush	4	Jul-Oct	green
<i>Dryandra</i>	<i>sessilis</i>	Parrot Bush	4	May-Nov	yellow

<b>Southern River Vegetation Complex</b>					
<b>Genus</b>	<b>Species</b>	<b>Common Name</b>	<b>Size (m)</b>	<b>Flowering</b>	<b>Colour</b>
Eucalyptus	calophylla	Marri	35	Jan-May	white
Eucalyptus	lane-poolei	Salmon Ghost Gum	15	May-Sept	cream
Eucalyptus	marginata	Jarrah	30	Sept-Feb	cream
Eucalyptus	rudis	Flooded Gum	15	Apr-Nov	cream
Eucalyptus	totdiana	Prickly Bark	10	Feb	cream
Eucalyptus	wandoo	Wandoo	15	Dec-Apr	white
Hakea	prostrata	Harsh Hakea	3	Aug-Nov	white
Hakea	ruscifolia	Candle Hakea	3	Dec-Mar	white
Hakea	varia	Variable Leaved Hakea	3	Jul-Oct	white
Jacksonia	furcellata	Grey Stinkwood	3	Aug-Mar	yellow
Jacksonia	sternbergiana	Green Stinkwood	3	All Year	orange
Kunzea	ericifolia	Spear Wood	3	Sept-Nov	yellow
		Many Flowered			
Lambertia	multiflora	Honeysuckle	2.4	Jun-Oct	yellow
Lepidosperma	longitudinale	Pithy Sword-hedge	2.5	May-Jun	brown
Melaleuca	cuticularis	Saltwater Paperbark	7	Sept-Nov	cream
Melaleuca	lateriflora	"Gorada"	4	Jan-Mar	white
Melaleuca	polygaloides		3	Jul-Oct	yellow
Melaleuca	preissiana	"Modong"	10	Nov-Jan	white
Melaleuca	rhaphiophylla	Swamp Paperbark	8	Sept-Jan	white
Melaleuca	teretifolia	"Banbar"	4	Oct-Jan	white
Melaleuca	uncinata	Broom Honey Myrtle	3	Sept-Dec	yellow
Melaleuca	viminea	"Mohan"	5	Aug-Oct	white
Nuytsia	floribunda	"Nuytsia" Christmas Tree	8	Nov-Dec	orange
Trymalium	floribundum	Karri Hazel	3	Aug-Sept	white
Viminaria	juncea	Swish Bush	4	Oct-Dec	yellow
Xanthorrhoea	preissii	Grass Tree	3	Nov-Jan	white
Xylomeleum	occidentale	Woody Pear	8	Dec-Feb	cream

# APPENDIX C

**Appendix C: Weston A (2004) Flora Survey of the Campbell Road Estate.**

**RARE FLORA SEARCH AND VEGETATION SURVEY  
CAMPBELL ESTATE  
CANNING VALE  
CITY OF GOSNELLS**

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## SUMMARY

This report describes methods and presents results of searches for rare flora and of vegetation surveys in the Campbell Estate, a suite of private properties in Canning Vale between Ranford, Nicholson and Campbell Roads. The principal objectives of the study were to search for Declared Rare and Priority Flora and other significant plants in the estate and to describe and/or map, in terms of structure, floristic community type and condition, the vegetation of the study area. An ancillary aim was the compilation of a list of species of vascular plants recorded during the study.

### Vegetation

Campbell Estate is in the Southern Rivers Vegetation Complex, which encompasses a wide range of diverse plant communities on a wide range of soil types and water relations. The three principal and significant plant communities of the study area are (1) *Banksia attenuata* – *Banksia menziesii* Low Open Forest to Low Woodland, (2) Paperbark (*Melaleuca preissiana*) Low Woodland to Low Open Woodland and (3) *Pericalymma ellipticum* Closed Heath. The distributions of these plant communities in the estate, and their condition assessments, are shown on Map 2, the vegetation map. Typically for the Southern River Complex, and as suggested by the relatively large number of *Banksia*, *Eucalyptus* and Paperbark plant communities described for the estate by Trudgen and Keighery (1995), these three communities encompass a wide range of variation. All three are now less extensive and more degraded than in 1998 at the time of the first survey.

These plant communities correspond, at least roughly and mainly, to Floristic Community Type 23a: Central *Banksia attenuata* – *Banksia menziesii* woodlands, and Community Type 4: *Melaleuca preissiana* damplands. It is possible, though not likely, that there are also small representations of one or more of Type 22: *Banksia ilicifolia* woodlands, Type 21a: Central *Banksia attenuata* – *Eucalyptus marginata* woodlands, Type 21c: Low-lying *Banksia attenuata* woodlands or shrublands, Type 5: Mixed shrub damplands, Type S2: Northern *Pericalymma ellipticum* dense low shrublands, Type 8 Herb rich shrublands in claypans, Type 10a: Shrublands on dry clay flats, Type 12: *Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands, and Type 13: Deeper wetlands on heavier soils.

### Flora

No attempt was made to compile a comprehensive list of flora for the study area, but approximately 230 taxa (species, subspecies and varieties) of vascular plants were recorded in the study area. Approximately 34 of the taxa recorded are established introduced weeds and 199, are natives. It is estimated that the list contains at least 70% of the native species in the estate and 60% of the introduced species. The estate may, consequently, be considered to be floristically rich.

Five (5) significant species were recorded in the estate during this study. The five species, and their significance codes, are *Byblis gigantea* (d, p, r), *Hensmania turbinata* (r), *Jacksonia gracilis* (e), *Stylidium utricularioides* (e) and *Tripterococcus paniculatus* (P1). At least one of these species, the Priority One Flora *Tripterococcus paniculatus*, plus the Declared Rare Flora Purdie's Donkey Orchid (*Diuris purdiei*) have been recorded in the estate prior to this study. Purdie's Donkey Orchid was found in the estate close to the intersection of Ranford Road and Nicholson Road, in a subpopulation of Population 1 that was, itself, one of the largest populations of this rare Donkey Orchid ever found.

### Recommendations

It is recommended that as much as possible of the native bushland be retained, particularly the Paperbark (*Melaleuca preissiana*) Low Woodland and Low Open Woodland on the western side of the estate, the Teatree Bush (*Pericalymma ellipticum*) Closed Heath north of it and the bushland south of Govan Road. The Paperbark Low Woodland and Low Open Woodland is shown on Map 2, the vegetation map, as 'P' and the Teatree Bush (*Pericalymma ellipticum*) Closed Heath is shown as 'L'.

Because the *Pericalymma ellipticum* Closed Heath in Excellent (E) to Very Good (VG) condition has the highest conservation significance, in part because it may support the DRF orchid *Diuris purdiei*, preservation and protection of this heath, perhaps as public open space, should be given top priority. The area immediately north of the heath, which was cleared, filled and built upon since 1998, had a subpopulation of the large Population 1 of the DRF Purdie's Donkey Orchid and several other species of significant flora. These may still occur in the surviving Closed Heath.

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**RARE FLORA SEARCH AND VEGETATION SURVEY  
CAMPBELL ESTATE  
CANNING VALE**

**CITY OF GOSNELLS**

**1.0 INTRODUCTION**

This report describes methods and presents results of two sets of searches for rare flora and of vegetation surveys in the Campbell Estate, a suite of private properties in the southwestern part of the City of Gosnells. The first set of searches and surveys was done in late October and November 1998 and February 1999. The second set was done in early October and November 2004.

The searches and surveys were commissioned by Steve Rolls, of Bowman Bishaw Gorham, in October 1998 and September 2004.

**1.1 LOCATION**

The study area is the triangle of private properties between Ranford Road, Nicholson Road and Campbell Road in Canning Vale in the southwestern part of the City of Gosnells. The study area also includes two road reserves: of Govan Road, which runs through the estate between Campbell Road and Nicholson Road, and of Fairlie Road, which runs from Campbell Road into the estate almost to Nicholson Road.

Growing residential subdivisions are north and southeast of the study area, in the City of Gosnells, and west of the study area, in the City of Canning. Canning Vale Prison property is also immediately southeast of the estate, and Jandakot Airport is approximately 3 km due west of it.

The total area of the private property part of the study area is approximately 60 ha.

Campbell Estate is not part of a Bush Forever Site, but four Bush Forever Sites are next to the estate or very close to it (Government of Western Australia 2000, Volume 1, Map 1 and Map sheet 60). The four Bush Forever Sites are BS 253 (Harrisdale Swamp and Adjacent Bushland), BS 389 (Acourt Road Bushland), BS 467 (Gosnells Golf Course Bushland) and BS 472 (Canning Vale Prison Bushland).

The location of the study area, and of the nearby Bush Forever Sites, is shown in Map 1.

**1.2 OBJECTIVES**

The principal objectives of 1998-1999 phase of the study were to:

- describe and map, in terms of structure, floristic community type and condition, the vegetation of the study area, and
- search for Declared Rare and Priority Flora and other significant plants in the study area, and describe the results of the searches.

An ancillary aim was the compilation of a list of species of vascular plants recorded during the study.

The principal objectives of 2004 phase of the study were to:

- increase the number of species recorded in the survey area and to record enough species in the plots to allow a floristic community type multivariate analysis to be run, and
- search in appropriate habitats for *Caladenia huegelii*, *Diuris purdiei* and any other species listed in the results of the rare flora database searches that flower in September-October.

## 2.0 METHODS

The study was undertaken in the following series of overlapping and interrelated stages:

- preparation for field work, including consultations, the gathering and collation of available information and interpretation of aerial photography,
- field work to record and collect flora, set up and analyse floristic community type quadrats, determine parameters, condition and distributions of other types of vegetation units and search for significant flora,
- follow-up work, including pressing, drying and identification of plants recorded and collected during field work, and
- report preparation.

### 2.1 PREPARATION FOR FIELD WORK

Preparation for 1989 field work entailed:

- finding existing vegetation descriptions and maps and flora lists for the study area and the general area,
- provisional description, listing and mapping of vegetation of the study area, and
- preparing a table of significant flora to be searched for during field work.

Methods and representative sites for field work were initially chosen during this preparation stage.

The significant flora table was updated prior to the 2004 field work.

The major sources used for information on vegetation, flora and rare flora were a previous report that included the study area (Trudgen and Keighery 1995), Department of Conservation and Land Management (CALM) database printouts and files and, for the 2004 field work, Weston (1999).

These and other sources are referred to in the following sections.

#### 2.1.1 Vegetation

Provisional description, listing, mapping and understanding of vegetation of the study area were based primarily upon interpretation of aerial photography and the review of various publications, reports and maps.

Contact prints and Panairama digital printouts of aerial photography from 1:20 000 scale Metro Regional Area aerial photography flown in several years between 1996 and 2004. Reports, publications and maps used in the provisional description, listing, mapping and understanding of vegetation of the study areas include Beard (1979, 1980), Heddle *et al.* (1980), Gibson *et al.* (1994), Department of Environmental Protection (1996), Keighery (1997) and Trudgen and Keighery (1995).

### 2.1.2 Flora

Lists of flora covering nearby areas, though not the study area itself, were used to get an appreciation of the types and range of plants which might be found in the study area. These lists include Trudgen (1994) and Keighery (1992).

### 2.1.3 Significant Flora

Table A1 lists Declared Rare Flora, Priority Flora and other significant flora with distributions that may include the general area. The table, and a description of the sources and methods used to compile it, are in Appendix A. The table gives information about conservation codes, distributions, localities, growth forms, habitats and flowering times for each taxon (species, subspecies) listed. During preparation of the table, herbarium specimens in the Western Australian Herbarium of taxa listed in the table were examined for familiarisation with their appearance, habitats, distribution and flowering times.

## 2.2 FIELD WORK

The field work component of the first phase of the study was carried out on 25, 26, 29 and 30 October and 6, 7, 25 and 27 November 1998 and 12 February 1999 by botanist Arthur Weston, sometimes with assistants. The second phase field work was done on 4, 10, 14 and 15 October and 26 and 29 November 2004 by Arthur Weston, also sometimes with assistants.

Traverses were driven and walked through the study area and dominant species and subjective estimates of vegetation structure and condition were recorded at representative sites.

The physiognomic system used for recording and classifying plant communities and the six-point scale for assessing vegetation condition are described in Keighery (1994) and Government of Western Australia (2000, Volume 2, pp. 492-494). *Bush Forever* Tables summarising the system and the scale are reproduced in Appendix D.

Species lists for determining floristic community types represented in the study area were compiled from four permanent 10 m by 10 m quadrats which were laid out with cords and marked by fence droppers in each corner. Specimens of all species of vascular plants observed in each quadrat were collected and species were recorded according to the method described by Keighery (1994) and Gibson *et al.* (1994).

Most plants were identified in the field, with help from various species lists and descriptions in Marchant *et al.* (1987), Hussey *et al.* (1997) and other floras. Voucher specimens of all taxa in the quadrats and of other plants not readily identifiable in the field were collected and pressed for subsequent identification.

Searches for Declared Rare, Priority and other significant flora were made during the traverses driven and walked through the property, with native vegetation in seasonally damp, wet and inundated areas being searched in greatest detail. The principal taxa searched for are those listed in Table A1, but other Declared Rare and Priority Flora and otherwise significant flora, especially those listed in Government of Western Australia (2000, Volume 2, Table 13) were also searched for.

At the beginning of field work, known locations of the Declared Rare Flora orchid listed in Table A1 most likely to occur and be identified in the study area, *Caladenia huegelii*, were visited in order to see:

- which habitats in the study area might be similar enough to known habitats of the orchids to be considered possible habitats for them and
- at what stage of flowering the rare orchids were in at the time of the searches.

In 1998 the *Caladenia* was past flowering but still identifiable, though difficult to spot. It was still in full flower at the time of the 2004 searches.

No plants of the *Diuris* were found, nor could they have been found since no stands of vegetation in which the orchid has been recorded which were burnt within the last year were found. However, the presumed habitat of a known population of the *Diuris* within the study area was located approximately, and it was used as a known habitat for the *Diuris* against which other habitats found in the study area were compared.

### **2.3 AFTER FIELD WORK**

Plant specimens collected during the field work were pressed, then dried in the Western Australian Herbarium in South Perth. The specimens were identified by checking them against a variety of keys and descriptions in floras and taxonomic works, only some of which are referred to in the report, by consulting other botanists, and, after fumigation, by comparing them with specimens in Herbarium collections.

During the process of identification and following it, the names of the plants identified were checked against the Table A list in Appendix A and other lists of significant flora, including the *Bush Forever* list of significant flora of the Perth Metropolitan Area (Government of Western Australia 2000, Volume 2, Table 13).

The provisional vegetation descriptions and boundaries were revised, refined and finalised, and the significance of plant associations, vegetation complexes and floristic community types in the study area was assessed in terms of conservation and reservation status.

A vegetation map was drawn to show boundaries and condition of plant communities in the study area and locations of the four 10 m by 10 m floristic community type sampling quadrats, and the report was prepared. The Phase One vegetation map was revised in 2004 due to changes in and reassessments of the vegetation.

## 3.0 RESULTS

This section presents the results of the field work, plant identifications, photo interpretation and other aspects of the study. The results are described in the following sections, taxa (species, subspecies and varieties) of vascular plants recorded during the study are listed in Appendix B and plant communities and their condition are shown on Map 2, the vegetation map.

### 3.1 PHYSICAL SETTING

#### 3.1.1 Climate

The climate of the study area is temperate mediterranean, with warm dry summers and mild wet winters.

Perth's long term average annual rainfall is approximately 870 mm, with roughly 90% falling in the period between April and October. In 1998 heavy showers also fell in November and well into December.

Mean monthly temperatures range from a minimum of 10°C, in July, to a maximum of 25°C, in February. Daily minimums and maximums are, of course, much lower and higher, respectively. However, temperatures low enough for light frosts do occur, but only rarely.

#### 3.1.2 Environmental Geology

The Armadale environmental geology map sheet (Jordan 1986) correlates geology, soils, geomorphology and other physical features of the study area on two maps, one at a scale of 1:100 000 and a larger one at a scale of 1:50 000.

The Armadale sheet's 1:100 000 scale geomorphology map shows the study area as being on Bassendean Dune eolian surfaces (Ed), on slopes of 0° to 3°. The study area is shown as being essentially flat and almost level, except for two minor ridges in the northern corner of the study area and a more prominent one along the southern part of the study area's southeastern boundary.

The sheet's 1:50 000 scale environmental geology map shows the study area as being:

- largely white to pale grey sand of eolian origin over Guildford Formation sandy-clay to clayey-sand (S10, Qpb/Qpa),
- white to pale grey sand over yellow sand of eolian origin (S8, Qpb) [narrow strip along the southeastern margin of the study area and small areas in the southern corner and near the centre of the Ranford Road boundary], and
- peaty-sand of lacustrine origin (Sp1) swamp deposits (Qrw) [about one-fifth of the study area: in the centre and along parts of Nicholson Road].

## 3.2 VEGETATION

The vegetation of the study area is described below in terms of plant formations and associations of Beard (1979), vegetation complexes of Heddle *et al.* (1980), floristic community types of Gibson *et al.* (1994) and the system of structural units or plant communities used for *Bush Forever* (Government of Western Australia 2000, pp. 46, 493; Keighery 1994).

### 3.2.1 Beard's Plant Formations and Associations

According to Beard's 1:250 000 scale vegetation map (Beard 1979), one vegetation unit (or potential for one unit) is represented in the study area: *Banksia* low woodland with scattered jarrah and sheoak (e<sub>2</sub>Mb.cbLi). This vegetation belongs to the Bassendean Vegetation System, which Beard describes as being an intricate mosaic of vegetation.

The study area is in the central part of Beard's unit.

### 3.2.2 Heddle's Vegetation Complexes

According to the 1:250 000 scale vegetation map by Heddle *et al.* (1980), the native vegetation complex potential of the study area is Southern River Complex (42): open woodland of marri – jarrah – *Banksia* species on the elevated areas, and a fringing woodland of flooded gum – swamp paperbark along streams. Anonymous (1998, p. 12) describes the Southern River Vegetation Complex as encompassing “a wide range of plant communities that occur in a mosaic fashion, often with many plant communities in a very small area” and ascribes this diversity and complexity to variable topography, variable soil and variable water relations.

The study area is in the central part of Complex 42 near the complex's western boundary.

### 3.2.3 Gibson Floristic Community Types of the Study Area

Decisions about which floristic community types are represented in the study area and where they occur there are based upon four sets of sources. These sources are:

- the species recorded during this study in each of the four 10 m by 10 m sampling quadrats in Campbell Estate,
- interpretation of aerial photography,
- field traverses and
- information in reports by Keighery (1997), Trudgen and Keighery (1995) and Gibson *et al.* (1994) and unpublished information available in the Department of Environmental Protection (see, e.g., second paragraph below).

The locations of the four quadrats are shown in Weston (1999, Map 2), taxa identified in them are indicated in Appendix B, and other information about the quadrats is given in Appendix C.

Floristic community types (FCTs) have not been mapped for the study area but, according to Neil Gibson (pers. comm.), it should be possible to infer which types occur there by comparing comprehensive lists of species, key species and other information with:

- the ‘Thirty Group Classification’ descriptions of floristic community types in Gibson *et al.* (1994, pp. 29-30, 37, 39-45),
- the sorted two-way table in Gibson *et al.* (1994, pp. 31-36), which shows species frequency by community type in Species Groups A through S,
- the descriptions of community types and small scale maps in Gibson *et al.* (1994, Appendix 1) showing locations of their sampling quadrats,
- the Table 1 list in Keighery (1997) of floristic community types identified by Gibson *et al.* (1994) and additional ones identified subsequently by the Department of Environmental Protection,
- geomorphological and land system information about the study area and its vicinity in Jordan (1986),
- lists of floristic community types, bushland areas and locations of sampling quadrats given in appendices of Gibson *et al.* (1994) and Keighery (1997),
- Bushland Plant Survey Recording Sheets for sampled quadrats in similar, nearby areas of bushland, and
- looking at sampling quadrat sites of floristic community types recorded nearest the study area.

These comparisons, interpreting aerial photography, conclusions of Trudgen and Keighery (1995, pp. 25, 26), observations made during field traverses and interpretation of lists of taxa identified in the study area quadrats lead to the provisional conclusions that:

- most, or all, of the *Banksia* vegetation in the study area probably belongs to Floristic Community Type 23a, Central *Banksia attenuata* – *Banksia menziesii* woodlands, although some upland, Bassendean Dunes *Banksia* vegetation on slopes in the southeastern part of the estate, near Campbell Road but not near Ranford Road, may be Floristic Community Type 21a, Central *Banksia attenuata* – *Eucalyptus marginata* woodlands, and some lower-lying *Banksia* vegetation in the centre of the study area may belong either to Type 22, *Banksia ilicifolia* woodlands, or to Type 21c, Low-lying *Banksia attenuata* woodlands or shrublands, and
- vegetation of the wetland areas, which are in the northern, central and west central parts of the study area, is principally Community Type 4, *Melaleuca preissiana* damplands, possibly with small areas of Type 5, Mixed shrub damplands, particularly in the northeastern and northwestern corners.

The conclusion that Type 4 and Type 23a are the principal, if not the only, floristic community types represented in Campbell Estate is supported by the occurrence of these two types in the two quadrats nearest the study area of those listed in Keighery (1997). These two are Quadrat gosn01: Type 4 and Quadrat gosn02: Type 23a. Both quadrats are southeast of Gosnells Golf Course (see Trudgen and Keighery 1995, p. 26).

It is possible, though unlikely, that there are also areas of Community Type S2, Northern *Pericalymma ellipticum* dense low shrublands, Type 8, Herb rich shrublands in claypans, and Type 10a, Shrublands on dry clay flats.



Trudgen and Keighery (1995, p.25) suggest that Type 12, *Melaleuca teretifolia* and/or *Astartea* aff. *fascicularis* shrublands, and Type 13, Deeper wetlands on heavier soils, are, along with Type 4, the typical seasonal wetlands floristic community types in the Southern River Vegetation Complex of Western Gosnells, but neither Type 12 nor Type 13 was identified in the study area.

These eleven floristic community types are listed in Table C1, of Appendix C.

Although the assignment of study area vegetation to particular floristic community types may be provisional, it is highly unlikely that any other recognised floristic community type is represented in the study area.

### 3.2.4 Plant Communities (Structural Vegetation Units) of the Study Area

#### Trudgen and Keighery (1995)

Trudgen and Keighery (1995, pp. 85-98) give descriptions of the study area's plant communities in their descriptions of Gosnells Remnant Bushland Areas 11, 12, 13, 14 and 15. They describe thirteen communities for the study area, each of which is represented by one of their sites numbered between Site 60 and Site 72.

Area 11, the stands of native vegetation south of Goven Road, is described as comprising three plant communities:

- mainly *Banksia attenuata* – *Banksia menziesii* Low Woodland to Low Open Forest over *Adenanthos cygnorum* High Open Shrubland to High Shrubland, *Acacia pulchella* Shrubland, *Eremaea pauciflora*, *Calytrix flavescens*, *Scholtzia involucrata*, *Hibbertia subvaginata*, *Leucopogon conostephioides* Low Open Heath and *Lyginia barbata*, *Patersonia occidentalis*, *Loxocarya flexuosa* Open Herbland/Sedgeland (Site 72) and, near the western end of Goven Road,
- smaller areas of *Banksia attenuata*, *Banksia menziesii*, *Banksia ilicifolia* Low Forest over *Regelia ciliata*, *Melaleuca thymoides* Tall Shrubland, *Xanthorrhoea preissii* Open Shrubland, *Scholtzia involucrata*, *Melaleuca trichophylla*, *Gompholobium tomentosum* Low Shrubland and *Lyginia barbata*, *Patersonia occidentalis*, *Phlebocarya ciliata*, *Phlebocarya filifolia*, *Dasypogon bromeliifolius* Mid-dense Herbland/Sedgeland (~Site 66) and
- *Melaleuca preissiana* Low Open Woodland over *Xanthorrhoea preissii* High Open Shrubland, *Pericalymma ellipticum* Shrubland to Closed Heath, *Hypocalymma angustifolium* Low Shrubland to Low Open Heath and *Mesomelaena tetragona*, *Schoenus rodwayanus*, *Dasypogon bromeliifolius* Sedgeland/Herbland (~Site 71).

Area 12, the native vegetation in the northern corner of the Campbell Estate study area, between Ranford, Nicholson and Fairlie Roads, comprises six vegetation units:

- *Banksia attenuata*, *Banksia menziesii* Low Woodland to Low Open Forest over *Calytrix fraseri* High Open Shrubland (Site 65),
- *Allocasuarina fraseriana*, *Eucalyptus marginata*, *Nuytsia floribunda* Low Woodland over *Calytrix fraseri*, *Xanthorrhoea preissii* Shrubland and *Phlebocarya ciliata*, *Phlebocarya filifolia*, *Amphipogon turbinatus*, *Lyginia barbata* Mid-dense Herbland/Grassland/Sedgeland (Site 64),

- *Eucalyptus marginata*, *Allocasuarina fraseriana* Low Open Woodland over *Jacksonia furcellata*, *Adenanthos cygnorum* High Open Shrubland, *Gompholobium tomentosum*, *Scholtzia involucrata*, *Melaleuca ? seriata*, *Bossiaea eriocarpa* Low Shrubland to Low Open Heath and *Patersonia occidentalis*, *Phlebocarya ciliata*, *Phlebocarya filifolia*, *Lyginia barbata* Herbland/Sedgeland (Site 62),
- *Melaleuca preissiana*, *Allocasuarina fraseriana* Low Open Woodland to Low Woodland over *Xanthorrhoea preissii* High Shrubland, *Melaleuca ? seriata*, *Acacia pulchella* Low Open Shrubland and *Dasypogon bromeliifolius*, *Amphipogon turbinatus*, *Lyginia barbata*, *Phlebocarya ciliata* Mid-dense Sedgeland/Grassland/Herbland (Site 63),
- *Melaleuca preissiana* Low Open Woodland over *Xanthorrhoea preissii* High Shrubland, *Pericalymma ellipticum* Open Shrubland to Shrubland, *Hypocalymma angustifolium* Low Open Shrubland and *Schoenus rodwayanus*, *Patersonia occidentalis*, *Lyginia barbata*, *Phlebocarya ciliata* Mid-dense Sedgeland/Herbland (Site 61), and
- *Pericalymma ellipticum* Closed Scrub over *Mesomelaena tetragona*, *Schoenus rodwayanus* Mid-dense Sedgeland (Site 60).

Area 13, the northern corner of Campbell Road and Fairlie Road, is described as having two plant communities:

- mainly *Banksia attenuata*, *Banksia menziesii*, *Banksia ilicifolia* Low Forest over *Regelia ciliata*, *Melaleuca thymoides* Tall Shrubland, *Xanthorrhoea preissii* Open Shrubland, *Scholtzia involucrata*, *Melaleuca trichophylla*, *Gompholobium tomentosum* Low Shrubland and *Lyginia barbata*, *Patersonia occidentalis*, *Phlebocarya ciliata*, *Phlebocarya filifolia*, *Dasypogon bromeliifolius* Mid-dense Herbland/Sedgeland (Site 66) (and, only as a narrow strip next to the road, the same except for the addition of *Melaleuca preissiana* and *Eucalyptus marginata* – Site 67), and
- *Melaleuca preissiana*, *Nuytsia floribunda*, *Banksia ilicifolia* Low Open Woodland over *Pericalymma ellipticum* Closed Heath to Closed Scrub, *Hypocalymma angustifolium* Low Shrubland and *Schoenus rodwayanus* Open Sedgeland (Site 68).

Area 14, between Fairlie, Campbell and Govan Roads, did not have its vegetation recorded by Trudgen and Keighery, but they noted that the vegetation appeared to be similar to the adjacent remnants, e.g. Sites 72 and 66.

Area 15 is west of Area 14, between Fairlie, Nicholson and Govan Roads; it had three plant communities recorded in it:

- *Melaleuca preissiana*, *Nuytsia floribunda* Low Open Woodland over *Xanthorrhoea preissii* High Open Shrubland, *Pericalymma ellipticum* Heath to Closed Heath, *Hypocalymma angustifolium* Low Open Shrubland and *Schoenus rodwayanus*, *Dasypogon bromeliifolius*, *Dryandra lindleyana* Sedgeland/Herbland (Site 69),
- *Melaleuca preissiana*, *Allocasuarina fraseriana* Low Open Woodland over *Xanthorrhoea preissii*, *Jacksonia furcellata* Open Shrubland to High Open Shrubland, *Gompholobium tomentosum*, *Melaleuca seriata*, *Bossiaea eriocarpa*, *Calytrix flavescens* Low Shrubland to Low Open Heath and *Phlebocarya ciliata*, *Lyginia barbata*, *Schoenus rodwayanus*, *Dasypogon bromeliifolius*, *Loxocarya fasciculata* Herbland/Sedgeland (Site 70), and
- *Melaleuca preissiana* Low Open Woodland over *Xanthorrhoea preissii* High Open Shrubland, *Pericalymma ellipticum* Shrubland to Closed Heath, *Hypocalymma*

*angustifolium* Low Shrubland to Low Open Heath and *Mesomelaena tetragona*, *Schoenus rodwayanus*, *Dasyogon bromeliifolius* Sedgeland/Herbland (~Site 71).

Trudgen and Keighery (1995, pp 85-98) give more detailed descriptions of these communities and the soils and landforms on which they were recorded.

### **Weston (this study)**

The plant communities of the Campbell Estate study area are described below, and their distributions in the study area are shown on Map 2, the vegetation map. These communities, and the letter-symbols used for them on the vegetation map, are:

<i>Banksia attenuata</i> – <i>Banksia menziesii</i> Low Open Forest to Low Woodland	B
<i>Melaleuca preissiana</i> Low Woodland to Low Open Woodland	P
<i>Pericalymma ellipticum</i> Closed Heath	L
Cleared and Parkland Cleared	CI

The *Banksia* and *Melaleuca* plant communities each encompasses a high degree of variation, as witnessed by the fact that each encompasses six plant communities described by Trudgen and Keighery (1995) for the study area.

All of the vegetation indicated on the map by the symbol 'B' is native upland vegetation, mainly dominated by one or more species of *Banksia*, and all of the vegetation indicated by the symbols 'P' and 'L' is native wetland vegetation. Vegetation represented by the symbol 'CI', either alone or in combination with other symbols, has been severely disturbed or has an understorey or ground layer which is largely weedy and non-native.

The map uses these symbols for individual units and uses strings of them for mosaics and mixtures of units. The individual units in the strings are separated from each other with a slash (/). The individual symbols and combinations of them used on the map are listed in the map's legend.

The species to which the symbols on the map and given below refer are dominants in the associations the symbols represent. Where the symbol 'CI' immediately follows a symbol for a dominant, with no slash between them, the combination of symbols indicates that the stand, such as 'PCI' and 'BCI', is in an area that has been or is being severely disturbed and that its basic vegetation structure is severely altered.

The vegetation descriptions and map in this report use the structural system of vegetation classification used by Trudgen and Keighery (1995) and for describing vegetation of Perth Bush Forever sites (Government of Western Australia 2000). It is the modification by Keighery (1994) of the Muir (1977), Specht *et al.* (1974) and Aplin (1979) systems of vegetation classification and is summarised in tabular form in Appendix D of this report.

The base map for the original vegetation map is a 1:6 500 (approximate) scale colour Panairama digital printout of Metro Regional Area aerial photography flown in January 1996.

Descriptions of plant communities of the study area are given below, beginning with the native plant community with the tallest, densest upper stratum, *Banksia attenuata* – *Banksia menziesii* Low Open Forest and Low Woodland.

### ***Banksia attenuata* – *Banksia menziesii* Low Open Forest and Low Woodland** **B**

Three-quarters of the *Banksia* community in the study area is in the study area's southern corner, in the area south of Govan Road. This community constitutes three-quarters of the native vegetation of this corner. There are also small stands of *Banksia* vegetation along Campbell Road north and south of the eastern end of Fairlie Road. Some of the boundaries between the *Banksia* vegetation and neighbouring communities are difficult to distinguish on aerial photographs.

The *Banksia* community has a dominant stratum of trees between 5 m and 10 m tall and, for the most part, have densities of 30% to 70%. In a few areas, however, the density is less.

The principal dominants of this plant community are *Banksia attenuata* and *Banksia menziesii*, but *Banksia ilicifolia*, *Allocasuarina fraseriana*, *Eucalyptus marginata*, *Eucalyptus todtiana* and *Nuytsia floribunda* are other conspicuous trees in the community. There are also a few *Melaleuca preissiana* trees, especially in lower areas near the edges of the community.

There is a wide, though rather patchy, distribution of four species of tall shrubs through the community; these are *Kunzea glabrescens*, *Adenanthos cygnorum*, *Melaleuca thymoides* and *Xanthorrhoea preissii*. Many of the *Kunzea* and *Melaleuca* shrubs died between 1998 and 2004, presumably from old age.

Other, smaller shrubs that are common through the community include *Hibbertia subvaginata*, *Bossiaea eriocarpa* and *Adenanthos obovatus*. *Hibbertia hypericoides* is present in parts of the community.

Principal herbaceous plants in the community include *Dasypogon bromeliifolius*, *Phlebocarya ciliata*, *Patersonia occidentalis* and species of *Lomandra*.

Floristic sampling quadrats CE03 and CE04 are in *Banksia* vegetation south of Govan Road.

This plant community covers the Trudgen and Keighery (1995) *Banksia* and *Eucalyptus* vegetation types listed above (for Sites 62, 64, 65, 66, 67 and 72), Trudgen's descriptions of which give some idea of the community's range of variation in the study area.

### ***Melaleuca preissiana* Low Woodland to Low Open Woodland** **P**

Paperbark woodlands with trees varying in height and density and having a range of understories occupy most of the lower-lying parts of the study area. In some places the trees have such a low density that they can better be considered as emergents in heath vegetation rather than as low open woodland. These paperbark low woodlands, low open woodlands and emergents are mainly in the northeastern corner and central and western parts of the study area, particularly from south of the western end of Govan Road to north of the western end of Fairlie Road.

Floristic sampling quadrat CE02 is in disturbed *Melaleuca preissiana* vegetation in the northeastern corner of the estate.

This plant community covers the Trudgen and Keighery (1995) *Melaleuca preissiana* vegetation types listed above (for Sites 61, 63, 68, 69, 70 and 71), Trudgen's descriptions of which give some idea of the community's range of variation in the study area.

### ***Pericalymma (Leptospermum) ellipticum* Closed Heath**

**L**

The study area has one stand of *Pericalymma ellipticum* closed heath that is large and distinct enough to be mapped as two contiguous units. The stand is in two parts: a severely disturbed area in the northern (northwestern corner) of the estate and adjacent, relatively undisturbed heath just south of it. The heath is probably the lowest part of the study area and may be seasonally temporarily inundated, although drains through it reduce the frequency and duration of inundation events.

Mature *Pericalymma ellipticum* shrubs in the study area are commonly 1 m to 1.5 m tall and have densities of over 70%. Although most of this closed heath gives the appearance of being monospecific, it has several other species, including the taller shrubs *Xanthorrhoea preissii*, *Regelia ciliata* and *Astartea* aff. *fascicularis*, the shorter shrubs *Hypocalymma angustifolium*, *Euchilopsis linearis*, *Jacksonia gracilis* and *Calothamnus lateralis*, various sedges, the herbaceous plants *Dasyopogon bromeliifolius*, *Patersonia occidentalis* and *Phlebocarya ciliata* and the emergents *Eucalyptus marginata*, *Melaleuca preissiana*, *Kunzea glabrescens* and *Nuytsia floribunda*.

Floristic sampling quadrat CE01 is in the severely disturbed part of the *Pericalymma ellipticum* Closed Heath in the northwestern corner of the estate and was obliterated by construction some time since 1999.

This plant community corresponds to the Trudgen and Keighery (1995) *Pericalymma ellipticum* vegetation type listed above (for Site 60).

### **Cleared and Parkland Cleared**

**CI**

More than half of the study area comprises cleared areas and areas with native vegetation which is severely degraded.

Some of the vegetation in western parts of the study area might be classified as Sedgeland, Herbland or Grassland.

### **3.2.5 Condition of Vegetation**

The extent of native vegetation in the study area in 2004 was less than it was in 1998, and average condition of the remaining native vegetation was more degraded than in 1998. However, the wetland vegetation in the eastern corner of the study area was in much better condition.

Assessments of condition of the plant communities described in the previous section are given below and are shown on Map 2, the vegetation map. The scale used for the assessments is the six-point scale developed by Trudgen (1991) and Keighery (1994) and used in *Bush Forever* (Government of Western Australia 2000, Volume 2, pp. 48, 493). The six steps in the scale and the corresponding letters(numbers) used on the map are: Pristine, E(2) Excellent, VG(3) Very Good, G(4) Good, D(5) Degraded and CD(6) Completely Degraded. No vegetation in pristine condition was identified. More detailed definitions of the scale are in Appendix D of this report.

Differences in appearances of stands judged to be due solely to different stages in regeneration following burning were discounted when assessing condition. However, increased establishment of weeds resulting from the burning and abundance of dead large trees which appeared to have few or no replacements did influence the condition assessment.

In general, the condition of about half of the vegetation north of Govan Road near Nicholson Road is in Excellent to Very Good condition and the native vegetation east of it has been largely cleared, severely degraded or very fragmented. The condition rating of the vegetation in the central part of this area and south of the western part of Ranford Road was much lower than Trudgen's assessment of it in 1995 (Trudgen and Keighery 1995). In fact, some of the vegetation bordering Nicholson Road near Ranford Road was destroyed during the period of this study by having had fill spread over it.

Two-thirds to three-quarters of the area south of Govan Road still has native vegetation, the condition of most of which is largely Very Good, with some areas being Good or Degraded and a few being Excellent. There are places in the area where there are many dead trees.

There are annual grasses and other weeds in most areas of *Banksia* open forest/woodland, but they are dense or conspicuous mainly along the main track and other places which have been cleared, at least of understorey vegetation.

### 3.3 FLORA

No attempt was made to compile a comprehensive list of flora for the study area, but plants that were common, characteristic or possibly significant were noted during the study and are the basis for Appendix B's Table B1, a list of vascular plant flora recorded in the study area. Table B1 also incorporates the lists of plants compiled for each of the four Campbell Estate 10 m by 10 m floristic community type sampling quadrats.

Table B1 provides information about the life form of each taxon listed and indicates which are natives or weeds or have conservation significance.

Approximately 230 taxa (species, subspecies and varieties) of vascular plants, both native and alien, were recorded in the Campbell Estate study area and are listed in Table B1. It is estimated that the list contains at least 70% of the native species in the study area and 60% of the introduced species.

It will be possible to add more species to the list and confirm names already on it after determinations and confirmation of identifications of specimens collected during the field work are completed.

#### 3.3.1 Significant Flora

Five significant species were recorded during the study in 1998. They and their Priority codes and other significance codes are listed in Table B1 of Appendix B. These species and their significance codes are *Tripterococcus paniculatus* (P1), *Byblis gigantea* (d, p, r), *Hensmania turbinata* (r), *Jacksonia gracilis* (e) and *Stylidium utricularioides* (e). *Jacksonia gracilis* is closely related to *Jacksonia sericea* and is also known as *Jacksonia* aff. *sericea* and as the swamp form of *Jacksonia sericea*.

The *Byblis* was confined to a population of fewer than 50 plants in regenerating *Pericalymma ellipticum* vegetation in the northern corner of the estate in the vicinity of Quadrat CE01. A few plants of the *Jacksonia* and of the *Tripterococcus* were in the same area. A few *Jacksonia* plants were also scattered through the seasonal wetland vegetation on the western side of the study area, and there were a few *Tripterococcus* plants in the northeastern corner and near Govan Road.

A small population of the *Stylidium* was in a low part of the firebreak running south from the central part of Fairlie Road before the spring 1998 clearing of the firebreak, and several plants of the inconspicuous *Hensmannia* were found in *Banksia* woodland in the southern corner of the estate near Quadrat CE03, also in 1998.

All of the *Byblis gigantea* plants, some, if not most, of the *Jacksonia gracilis* plants and some of the *Tripterococcus paniculatus* were destroyed when the northern corner of the study area was graded, filled and built upon.

No Declared Rare Flora (DRF) was found during the study, but the DRF donkey orchid *Diuris purdiei* has been found previously in the northern corner of the estate (coordinates: 32°05'30", 115°54'58"), probably in the area that has been cleared and which now has commercial establishments and parking lots on it. The occurrence of the orchid in the wetland south of there cannot be confirmed until a spring following a summer or early autumn fire (see Brown *et al.* 1998), because the orchid needs the stimulus of the burning to reappear and flower. It may also appear, though with diminished flowering, during a few subsequent springs.

One of the largest populations of this *Diuris* ever found was recorded in this part of the estate, close to the intersection of Ranford and Nicholson Roads (CALM records and A. Brown, pers. comm.). This is a subpopulation of *Diuris purdiei* Population 1, which was fragmented by construction of Ranford and Nicholson Roads, then largely destroyed by clearing and development north of the intersection. The orchid may also occur in parts of the remaining *Pericalymma ellipticum* heath in the Campbell Estate.

The *Banksia* woodland in the study area may have habitat that is suitable for the DRF orchids *Caladenia huegelii* and *Drakaea elastica*, both of which have been found nearby. Their occurrence there is, however, unlikely as detailed spring searches there in early October 2004 found none.

## 4.0 LIMITATIONS

### 4.1 FLORISTIC COMMUNITY TYPES

The conclusions given in Section 3.2.3 as to which floristic community types are represented in the study area are provisional for several reasons.

Prior to stating the reasons why they are provisional, it is necessary to appreciate that reliable assignment of a stand of vegetation to one or more floristic community types requires several steps:

- considered selection and placement of 10 m by 10 m sampling quadrats the number and locations of which must be sufficient to reflect the range of diversity in the stand,
- recording all species, subspecies and varieties of vascular plants, both native and alien, in each quadrat, a process which requires that the quadrat be sampled at least twice during the flowering season and that every plant identification be accurate and
- running multivariate analyses on the data sets (species lists) for the quadrats with, or against, the expansions of the data sets of Gibson *et al.* (1994) referred to in *Bush Forever* (Government of Western Australia 2000, Volume 2).

It is also necessary to appreciate that each of the 66 floristic community types listed in *Bush Forever* (*ibid.*) encompasses, to varying extents, a range of diversity.

Furthermore, the original Gibson *et al.* (1994) southern Swan coastal plain study sampling of seasonal wetlands did not adequately represent their great heterogeneity, and floristic community types may still not have been defined, even by all subsequent work, for some wetland vegetation (see Government of Western Australia 2000).

The number and placement of the four sampling quadrats in the study area may be sufficient to reflect the degree of diversity between stands, but they are not sufficient for assessing the level of diversity within stands. This is a type of insufficiency which probably applies to most, if not all, of the sampling of larger stands in the Gibson *et al.* (1994) study, but the insufficiency may be insignificant at the Thirty Group level of floristic community type classification defined by Gibson *et al.* (*ibid.*) and used in *Bush Forever* (2000).

The type and range of information about the floristic community types of Gibson *et al.* (1994) referred to in Section 3.2.3 are not available for floristic community types defined since the Gibson *et al.* study.

In the case of the study area, the use and analysis of more quadrats would help to clarify which floristic community types are represented in the stand and might help to elucidate where in the stand they are represented. It should be borne in mind, however, that there is little correlation between floristic community types and structural units such as plant communities (see Gibson *et al.* 1994, p. 51) and, consequently, distributions of floristic community types cannot be determined from aerial photo interpretation or inferred from plant community mapping.

Many of the plants collected in the four sampling quadrats in the study area have not yet been positively identified to species (see Section 4.3, below).



The floras of all four quadrats were well-sampled, twice in the case of the three extant quadrats. Two samplings of each quadrat are necessary to record a proportion of the quadrat's total flora high enough for running a floristic community type analysis.

Floristic sampling of the quadrats makes an important contribution to the flora survey because it focuses on recording all species, even the least conspicuous ones.

Although the assignment of study area vegetation to particular floristic community types may be provisional, and limitations in the survey are acknowledged, it is highly unlikely that any other recognised floristic community type is represented in the study area.

## **4.2 PLANT COMMUNITIES**

A plant community does not, unlike an individual plant, have a discrete boundary or limit; it is often a section of a continuum more or less arbitrarily defined by the presence of a suite of dominant or characteristic species, which, however, vary in their relative proportions through a stand.

These suites of species often show up as distinctive patterns on aerial photographs, but the patterns are confused or altered, on the ground as well as on the photographs, by fire and post-fire succession and regeneration. The alterations extend to structure and species composition and may persist for several years, and they affect not only classification, description and mapping of vegetation units, they also complicate assessment of their condition.

Consequently, and especially when one distinctive structural vegetation type is divided into plant communities defined by species which are different from each other although they appear similar, experts are likely to differ in their mapping and classification of stands. But they may be equally correct.

Furthermore, poor clarity, sharpness, distinctiveness and contrast of images in aerial photographs, especially digital ones, makes interpretation difficult.

Because, according to Trudgen and Keighery (1995, p. 18), the definition of vegetation types in *Banksia* woodlands can be particularly difficult, no attempt has been made here to divide the *Banksia* vegetation in the study area into two or more types.

## **4.3 FLORA**

Although no attempt was made to compile a comprehensive list of flora for the study area and although identifications of specimens upon which many of the names in the appended list (Table B1, Appendix B) are based have yet to be confirmed, the listing and identifications are sufficient to satisfy the main objectives of the study (see Section 1.2, p. 1 of this report).

Identification and confirmation of provisional determinations of plant specimens collected during the study are continuing, and selected voucher specimens will be labelled and, in due course, will be given to the Western Australian Herbarium for incorporation into the herbarium's collections.

The number of species recorded in the study area could be increased by more intensive, throughout the year.

#### 4.4 SIGNIFICANT FLORA

No single rare flora survey, or even more than a single survey, can be expected to exclude the possibility that there are, in a study area, species of rare flora which were not found during the survey. This is partly because some species flower during one season while others flower at other times of the year. Furthermore, some species, such as the orchid *Diuris purdiei*, do not flower every year, and some species are not identifiable, or even visible, except for short periods before, during and after flowering, such as this *Diuris* and other orchids. In addition, there may be rare or otherwise significant species which have not previously been recorded anywhere near the area.

*Hensmania turbinata* and *Stylidium utricularioides* were found in the study area in 1998 but would not have been identified there in 2004 because they were not in flower at the time of the 2004 searches for rare flora.

## 5.0 CONSERVATION SIGNIFICANCE

The Perth Bush Forever maps of regionally significant bushland (Government of Western Australia 2000) do not show any of the study area as being in a Bush Forever Site, although aerial photo interpretation suggests that the area of bushland in the estate is larger, in better condition or more diverse than or different to bushland in some nearby Bush Forever Sites. The nearby Bush Forever Sites are BS 253 (Harrisdale Swamp and Adjacent Bushland), BS 389 (Acourt Road Bushland), BS 467 (Gosnells Golf Course Bushland) and BS 472 (Canning Vale Prison Bushland) are next to the estate or very close to it.

Conservation significance of the study area's bushland is discussed further in Sections 5.1 and 5.2.

### 5.1 SIGNIFICANCE OF VEGETATION

All of the native vegetation of the study area, whatever its condition, has a significance deriving from the fact that much of the relatively small amount of native vegetation remaining in the Forrestdale - Canning Vale – Southern River area is being cleared at a rapid rate, and only a relatively small amount is reserved. For instance, part of the wetland remnant across Nicholson Road from the study area and part of the regenerating *Pericalymma ellipticum* vegetation in the northern corner of the study area was cleared during the course of this study.

All of the larger areas of native vegetation in the study area assessed as being in Very Good (VG/3) or Excellent (E/2) condition is particularly significant. Areas of *Pericalymma ellipticum* vegetation are especially significant because a number of significant species, including the DRF orchid *Diuris purdiei*, have been recorded in it.

The significance of the vegetation of the study area in terms of plant formations and associations of Beard (1979), vegetation complexes of Heddle *et al.* (1980), floristic community types of Gibson *et al.* (1994) and the system of structural units, or plant communities, used in *Bush Forever* ((Government of Western Australia 2000; Keighery 1994) is described below.

In summary, and in general, the native vegetation of the estate has a conservation significance that ranks high both regionally and locally, because relatively little of the types of vegetation it represents remain, and very little of what remains has been reserved. For instance, Beard and Sprenger (1984) (also see Government of Western Australia 2000) indicate that, by 1984, almost all 'Casuarina – Banksia low woodland with scattered jarrah' (eMr.bLi), which includes the study area *Banksia* vegetation, had been cleared. The Environmental Protection Authority (Anonymous 1998) estimates that less than 7% remained in 1994. There has been much more clearing of wetland and upland vegetation in the Forrestdale-Canning Vale area since 1984, and before and after 1998, when the Phase One study was done.

#### 5.1.1 Beard's Plant Formations and Associations

The 1:1 000 000 scale map by Beard (1980) shows the vegetation unit 'Casuarina – Banksia low woodland with scattered jarrah' (eMr.bLi, which is probably equivalent to the e<sub>2</sub>Mb.cbLi unit on the Beard 1979 map but may also include other, similar *Banksia* – jarrah units) as having an interrupted distribution between the Gngangara area in the north and the Serpentine River area in the south.

Beard and Sprenger (1984, p. 21 and Table 11) note that this 1:1 000 000 scale unit, eMr.bLi, which is designated Unit 30 in their tables, occupied 680 km<sup>2</sup> before European settlement but had been almost totally cleared by 1984.

### **5.1.2 Vegetation Complexes of Heddle *et al.***

The Southern River Complex is one of two combinations of Bassendean Dunes and Pinjarra Plains. According to Government of Western Australia (2000, Volume 1, Table 4), the complex originally covered 31,148 ha (312 km<sup>2</sup>) of the Swan Coastal Plain part of the Perth Metropolitan Region, and 17% of that, 5370 ha, remains there, with only 1775 ha currently protected, which is down from the 1786 ha protected in 1998 (Western Australian Planning Commission 1998, Appendix Six, p. 76). According to the Environmental Protection Authority (Anonymous 1998, p. 12), the 17% figure is a gross over-estimate based upon interpretation of older aerial photography; the EPA estimates that less than 7% remains.

According to calculations by Thorning (pers. comm.), the Southern River Complex may have originally covered a total area of 57,171 ha (572 km<sup>2</sup>), of which less than 18% remains. This percentage is probably also an over-estimate.

The 572 km<sup>2</sup> of Southern River Complex is a smaller area than the 680 km<sup>2</sup> of Beard's comparable unit, eMr.bLi, but the Southern River Complex extends further south than Beard's unit does.

### **5.1.3 Floristic Community Types of Gibson *et al.* and Keighery**

Two reports, by Gibson *et al.* (1994) and English and Blyth (1997), provide assessments of conservation significance and reservation status of the floristic community types described by Gibson *et al.* Table C1, in Appendix C, lists the numbers, names, conservation significance and reservation status given in Gibson *et al.* for ten of the eleven floristic community types which are definitely or possibly in the study area or nearby. It also provides information from English and Blyth about four of these ten. The eleventh floristic community type, Type S2, is not described by Gibson *et al.*, but its name and sites where it has been recorded are given by Keighery (1997). There is currently no published assessment of conservation status of Type S2 or any of the other floristic community types which have been defined since 1994.

Nine of the ten floristic community types of Gibson *et al.* (1994) which do or may occur in the study area or nearby are classified by Gibson *et al.* as well-reserved, and six of them, Types 4, 5, 12, 13, 21a and 23a, are assigned a conservation significance of low risk. All or most of the *Banksia* vegetation in the study area probably belongs to one or two of these six types (23a, 21a), and most or all of the seasonal wetland vegetation probably belongs to one (4).

Type 22, *Banksia ilicifolia* woodlands, is the only floristic community type classified by Gibson *et al.* as poorly reserved, rather than well-reserved. It, along with Type 21c, low lying *Banksia attenuata* woodlands or shrublands, is assigned a conservation significance of susceptible. Both floristic community types have been proposed for inclusion on the Threatened Ecological Community database (English and Blyth 1997). There is a possibility that one or both are represented in the estate.

Two seasonal wetlands floristic community types, Types 8 and 10a, which may, but probably do not, occur in the study area are assigned a conservation significance of vulnerable by Gibson *et al.* (1994), and both are on the Threatened Ecological Community database (English and Blyth 1997). Type 10a is a Priority 2, Endangered community and Type 8 is a Priority 3, Vulnerable community.

#### 5.1.4 Plant Communities

An indication of local significance and uniqueness of native vegetation of Campbell Estate can be inferred from stereoscopic interpretation of aerial photography flown in January 1997 combined with results of field work in the area. In particular, comparisons can be made between Bush Forever Sites 253 (Harrisdale Swamp and Adjacent Bushland), 389 (Acourt Road Bushland), 467 (Gosnells Golf Course Bushland) and 472 (Canning Vale Prison Bushland).

The *Banksia* vegetation of Campbell Estate may be similar to some of the vegetation in Bush Forever Sites 389 (Acourt Road Bushland) and 472 (Canning Vale Prison Bushland), and at least some of the *Melaleuca preissiana* wetlands of the estate may be similar to the one in Bush Forever Sites 467 (Gosnells Golf Course Bushland), but the *Pericalymma ellipticum* wetland in the northern corner of the estate does not appear to have a counterpart nearby.

Though part of it has been cleared or badly degraded, this *Pericalymma* stand may be the most significant vegetation in the estate, both locally and regionally. Keighery (1991) regards any *Pericalymma* stand this close to Perth as significant by virtue of being uncommon in the Metropolitan Region and poorly reserved there. The Campbell Estate stand is also significant for having the DRF orchid *Diuris purdiei* and several other significant species recorded in it.

Recognition of the significance of this particular stand of *Pericalymma ellipticum* is reflected in the fact that the wetland in which it occurs was classified as a Conservation Category Wetland (see Map1). This stand now appears to be the only native vegetation left in this Conservation Category Wetland.

## 5.2 SIGNIFICANCE OF FLORA

The study area's bushland is floristically significant particularly for some of the significant species in it.

Five officially recognised significant species were recorded during the study. These species and their codes are *Tripterococcus paniculatus* (P1), *Byblis gigantea* (d, p, r), *Hensmania turbinata* (r), *Jacksonia gracilis* (e) and *Stylidium utricularioides* (e). The *Byblis* was found only in the *Pericalymma ellipticum* stand in the northern corner of the estate.

Although no Declared Rare Flora (DRF) was found during the study, DRF donkey orchid *Diuris purdiei* has been found previously in the northern corner of the estate (coordinates: 32°05'30", 115°54'58") and may still be in the heath south of the developed part of the area. This is one of the largest populations of the orchid ever found (CALM records and A. Brown, pers. comm.) and has high significance. This population is a subpopulation of *Diuris purdiei* Population 1, which was fragmented by construction of Ranford and Nicholson Roads and largely destroyed by clearing and construction in the northern corner of Ranford and Nicholson Roads. The orchid may still occur throughout the *Pericalymma ellipticum* stand in the estate's northern corner, but it only appears, and flowers, in a few springs following a hot summer burn.

## 6.0 RECOMMENDATIONS

It is recommended that as much as possible of the native bushland be retained, particularly the Paperbark (*Melaleuca preissiana*) Low Woodland and Low Open Woodland on the western side of the estate, the Teatree Bush (*Pericalymma ellipticum*) Closed Heath north of it and the bushland south of Govan Road.

The Paperbark Low Woodland and Low Open Woodland is shown on Map 2, the vegetation map, as P and the Teatree Bush (*Pericalymma ellipticum*) Closed Heath is shown as L.

Because the Closed Heath in Excellent to VG condition (E/2, VG/3) has the highest conservation significance, in part because it may support the DRF orchid *Diuris purdiei*, preservation and protection of this closed heath, perhaps as open space, should be given top priority.

## **7.0 ACKNOWLEDGEMENTS**

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**Insert MAPS 1 and 2**

## **APPENDIX A**

### **Rare and other Significant Flora with Distributions and Habitats which may include the Campbell Estate Study Area, Canning Vale**

#### **Contents**

Introduction

Conservation and Significance Codes Definitions

Table A1 Significant Flora Recorded in the Forrestdale – Canning Vale – South River Area

Table A1 lists 32 taxa (species, subspecies and varieties) of rare and other flora recorded in the general vicinity of the Canning Vale property along with information about their conservation and significance codes, distributions, localities where they have been recorded, growth forms, habitats and flowering times. The information about distributions, localities, growth forms, habitats and flowering times is not always comprehensive. For instance, the localities are often selections and not all of the localities given for a listed species in the CALM printouts, which are themselves also often only selections. Information about growth form and habitat is at least indicative and should be useful in assessing how likely a taxon is to occur at particular locations in the study area.

The table lists eight DRF (R) taxa (gazetted Declared Rare Flora) and 22 taxa of Priority Flora (1, 2, 3 and 4). Seven other taxa listed in the table are neither Declared Rare nor Priority Flora but, like all of the 32 taxa in the table, are listed as significant in *Bush Forever* (Government of Western Australia 2000, Volume 2, Table 13).

The Table A1 list was compiled from searches of three CALM databases and Table 13 of *Bush Forever* (Government of Western Australia 2000) in conjunction with Keighery (1991, 1992). The three CALM databases and the search parameters for them are:

- the July 1998 and July 2004 versions of *Priority Species List* database for the locations Banjup, Canning Vale, Forrestdale, Gosnells, Huntingdale, Southern River and Thornlie,
- the *Western Australian Herbarium Specimen* database for records in the rectangle defined by the coordinates 32°04'00", 32°09'20", 115°55'00" and 115°59'00" and
- the *Threatened (Declared Rare) Flora* database for records in the rectangle defined by the coordinates 32°04'00", 32°09'20", 115°55'00" and 115°59'00".

These sources also provided information about conservation codes, localities and distributions and flowering time, and additional information for the table was obtained from examination of herbarium specimens and their labels in the Western Australian Herbarium, consultations with other botanists, observations made during my previous field work and information in Atkins (1998, 2004), Brown *et al.* (1998), Erickson (1958), Hoffman and Brown (1995), Hopper *et al.* (1990), Keighery (1991, 1992), Lowrie (1989), Marchant *et al.* (1987), Olde and Marriott (1995), Paczkowska and Chapman (2000), Weston *et al.* (1993), Weston (1989, 1990) and Hopper (1987) and other flora treatments in volumes of *Flora of Australia*. These references are listed in the report to which this is Appendix A.

Eight taxa in the 2004 CALM *Priority Species List* printout which have been recorded only in habitats and localities not represented in or near the study area have been deleted from the table. Most or all of these are Darling Range taxa, most of which are restricted to crystalline rock of the scarp and granite outcrops and the soils produced from them. Nor does the table list species recorded in the area which are regarded by some as significant, such as *Levenhookia preissii* (Trudgen and Keighery 1995, p. 73), but are not listed in the *Bush Forever* table.

Four additional species are listed as significant flora in Table 13 of *Bush Forever* and as having been recorded in Bush Forever Site 342 (Government of Western Australia 2000, Volume 2 p. 270). These species are *Evandra pauciflora*, *Myriocephalus helichrysoides*, *Dielsia stenostachyus* and *Stylidium utricularioides*.

## Conservation and Significance Codes Definitions

A summary of Department of Conservation and Land Management definitions of the Conservation Codes (Atkins 2003) in Table A1 is below.

### Summary of

#### The Department of Conservation and Land Management **CONSERVATION CODES FOR DECLARED RARE AND PRIORITY FLORA** for Western Australia

- R: Declared Rare Flora – Extant Taxa  
Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
- 1: Priority One – Poorly Known Taxa  
Taxa which are known from one or a few (generally <5) populations which are under threat, . . . Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.
- 2: Priority Two – Poorly Known Taxa  
Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat, . . . Such taxa are under consideration for declaration as ‘rare flora’, but are in urgent need of further survey.
- 3: Priority Three – Poorly Known Taxa  
Taxa which are known from several populations, and the taxa are not believed to be under immediate threat, . . . Such taxa are under consideration for declaration as ‘rare flora’, but are in need of further survey.
- 4: Priority Four – Rare Taxa  
Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Definitions of significance codes based upon *Bush Forever* (Government of Western Australia 2000, Volume 2, Table 13) are:

- d populations disjunct from the known geographic range of the taxon  
r populations at the northern or southern limit of the known geographic range of the taxon  
r(n) populations at the northern limit of the known geographic range of the taxon  
r(s) populations at the southern limit of the known geographic range of the taxon  
p taxon considered to be poorly reserved (applies to all Declared Rare Flora and Priority taxa)  
s significant populations (applies to all Declared Rare Flora and Priority taxa)  
X taxon considered to be lost in the Perth Metropolitan Region  
e taxon endemic to the Swan Coastal Plain  
E taxon endemic to the Swan Coastal Plain in the Perth Metropolitan Region

**Table A1**

**Significant Flora Recorded in the Forrestdale - Canning Vale – Southern River Area**

(based upon CALM rare flora databases printouts September 2004 and *Bush Forever*, Volume 2, Table 13 [Significant Flora, pp. 51-55])

Taxon	Cons. Code	Distribution and Localities	Flowering Period	Fam. No.	Growth Form and Features	Habitats	
<i>Acacia benthamii</i>	MIMO	2	Southern River, Yanchep, Wanneroo, Kings Park	Aug-Sep	163	Erect, few-branched shrub to > 1.5 m tall; phyllodes 3-nerved, pungent; new shoots lanuginose	Sandy soil, often clayey or over clay, and on lower slopes
<i>Anthotium junciforme</i>	GOOD	4	Upper Swan – Busselton - Scott River Plain, Kenwick, Albany	Dec-Mar	341	Grass-like tufted herb to 40 cm high; fls purple to pale blue (rarely white or pink), terminal on stalks longer than leaves	Low in the landscape in eucalypt woodlands or winter-wet sedge and heath flats
<i>Apodasmia ceramophila</i> ms = <i>Leptocarpus c.</i>	REST	2	L Muir, Yarloop, Cookernup, Kent R, Wamballup, Forrestdale Lake	Sep-Oct	039	Rush-like herb ca. 35 cm high	Sandy & clayey soils, swamps, saline clay flats
<i>Blancoa canescens</i>	HAEM	d, p	Eneabba-Moore River, Perth	Jun-Aug	055	Leaves flat, tomentose; flowers large, red, pendulous	Deep [white] sand in <i>Banksia</i> low woodland and heath
<i>Byblis gigantea</i>	BYBL	2	Yule Brook, Cannington, Jandakot, Brookton Highway, Canning Vale	Sep-Jan	154	Erect, viscid, insectivorous perennial herb <60 cm high; fls blue, pink, purple	Clayey or sandy soils; winter-wet depressions
<i>Caladenia huegelii</i>	ORCH	R	Perth-Yallingup	Aug-Oct	066	Large, few-flowered spider orchid with large labellum which is dark red and has long, often divided, usually white fringing hairs	Sandy soils in <i>Banksia</i> and eucalypt woodlands and low open forests which are usually low in the landscape
<i>Caladenia longicauda</i> subsp. <i>clivicola</i>	ORCH	4	Forrestdale, Lesmurdie, Pinjarra, Harvey, Dardanup, Cape Naturaliste	Sep	066	White spider orchid w greenish yellow tinged fls, small narrow labellum and small calli	Moist jarrah & marri forests, often adj to granite. Sheoaks on white sand in Piara MR
<i>Cyathochaeta teretifolia</i>	CYPE	3	Muchea-Denbarker, Margaret River, Casuarina	Nov-Dec	032	Densely-growing sedges w lvs to > 2 m long which are bluntly oval in cross-section	Seasonally wet swamps, creeks, often w <i>Homalospermum</i> euc, pb & <i>Agonis</i> trees or tall shrubs
<i>Dielsia stenostachya</i>	REST	e	Gingin-Pinjarra-Mandurah, Yalgorup National Park	Feb-May	039	Perennial herb to 0.6 m tall; mats; rufous furry rhizomes	Sandy winter-wet depressions and flats & along watercourses
<i>Diuris purdiei</i>	ORCH	R	Perth-Waroona, Canning Vale, Forrestdale, S of Mandurah, Busselton	Sep-Oct	066	Slender donkey orchid with 5-10 narrow, spirally twisted leaves	Seasonally wet, burnt, sand over clay, shrublands, usually of <i>Regelia</i> and <i>Pericalymma</i>

<i>Drakaea elastica</i>	ORCH	R	Gingin – Busselton – east of Albany	Oct-Nov	066	Hammer orchid; prominently hairy section in upper labellum; leaf shiny, bright green, heart-shaped, flat on the ground	On deep sand low in the landscape, usually under spearwood and banksias adjoining winter-wet swamps
<i>Drakaea micrantha</i> ms	ORCH	R	Perth-Augusta-Albany	Sep-Oct	066	Hammer orchid; flowers small; leaves small, silvery-grey, heart-shaped, with prominent dark green veins	Poorly covered infertile grey sands in sheoak-jarrah woodland and open forest
<i>Drosera occidentalis</i> subsp. <i>occidentalis</i>	DROS	4	Gingin-Pinjarra, Darling Range, Palgarup, Kenwick, Forrestdale	Nov-Dec	143	Pygmy sundew with sparse, open rosette of red leaves and white to very pale pink flowers	In white peaty sand of margins of winter wet swamps and depressions
<i>Eryngium pinnatifidum</i> subsp. <i>palustre</i> ms	APIA	p,s	Gingin – Serpentine, Kenwick, Upper Swan	Sep-Nov	281	Herb with terete, hollow lvs-many are unchanneled and not lobed or toothed; fl heads greenish or whitish, not bluish	<i>Melaleuca</i> shrublands and low open vegetation on winter-wet sandy-clay flats
<i>Evandra pauciflora</i>	CYPE	r(n)	Forrestdale-Albany	Aug-Oct	032	Tussock sedge 0.5-1 m tall; inflorescences to 1.5 m	Seasonally inundated or waterlogged sandy soil, often in low heaths and sedgelands
<i>Grevillea thelemanniana</i>	PROT	4	Forrestdale, Cannington, Kenwick, Wattle Grove, Jervoise Bay, Joondalup	Jun-Sep	090	Dense spreading lignotuberous shrub < 1 m; branchlet indumentum appressed, sparse or absent; lvs glabrous above, not pitted; fl pink-red, limb cream	Winter-wet heathland on grey sand
<i>Haloragis aculeolata</i>	HALO	2	Yalgorup N.P., (Toolbrunup, Cannington)	Dec	276	Herb	Sand or brown clay, often over limestone, with tuart, flooded gum, <i>Acacia</i> , <i>Melaleuca</i> shrubs and/or <i>Gahnia trifida</i>
<i>Hensmania turbinata</i>	ANTH	r,s		Nov-Jan	054F	Rhizomatous, tufted perennial herb < 20 cm high; fls pale yl	White, grey or yellow sandy soils
<i>Jacksonia gracilis</i>	PAPIL	e	Canningvale-Forrestdale-Southern River area	Nov-Feb	165	Low, erect to spreading, somewhat spiny shrub; flowers with red keels	Seasonally inundated or waterlogged soil in heaths of <i>Pericalymma</i> or <i>Regelia</i>
<i>Jacksonia sericea</i>	PAPIL	4	Mandurah-Pinjarra, Neerabup NPK, Canning Vale, Wanneroo, Trigg	Dec-Feb	165	Low, usually prostrate shrub	Sandy soil in woodlands, usually low in the landscape, sometimes with <i>Pericalymma</i>



<i>Myriocephalus helichrysoides</i>	ASTE	e	Cape Naturaliste – Gingin	Sep-Dec	345	Annual herb; heads white to yellow	Seasonally shallowly wet sandy, clayey, peaty soils in open sedgeland
<i>Rhodanthe pyrethrum</i>	ASTE	3	Bullsbrook-Boyanup, Kenwick, Southern River, Denmark	Sep-Nov	345	Small erect herb; stem thick at base, glabrous	Brown sandy clay winter wet flat in <i>Melaleuca viminea</i> heath
<i>Schoenus benthamii</i>	CYPE	3	Mogumber-Busselton-Esperance, Kenwick	Sep-Nov, Jan	032	<i>Mesomelaena</i> -like, caespitose, to > 30 cm; bracts dark brown to black	Grey sand to clay, winter wet
<i>Stenanthemum sublineare</i>	RHAM	2	Huntingdale, Bullsbrook	Oct-Dec	215	Very low, erect shrub ~7cm high by 15 cm wide, multi-stemmed at ground level; fls insignificant, greeny cream	Banksia woodland over mixed shrubs and herbs; grey sand on Bassendean dunes
<i>Stylidium longitubum</i>	STYL	3	Upper Swan-Busselton, Arthur River, Jandakot	Nov	343	Small erect annual; fls pink with distinct red line across near throat	Grey sandy clay over clay; winter wet flats; <i>Melaleuca viminea</i> shrubland
<i>Stylidium mimeticum</i>	STYL	p,s	Gingin-Scott River-Esperance, Forrestdale, Austin Bay	Sep-Jan	343	Branched, <i>Levenhookia</i> -like herb <7 cm tall; flower very small, pink, yellow or white	Seasonally wet, sandy peaty or clayey flats
<i>Stylidium utricularioides</i>	STYL	e	Bullsbrook-Canningvale, Forrestdale (?)	Oct-Dec	343	Branched, few-leaved herb 5-10 cm tall; 2 petals larger, paddle-like	Seasonally wet flats or creek margins
<i>Tetraria australiensis</i>	CYPE	R	Mundijong-Busselton, (Cannington Serpentine River)	Dec-Jan	032	Rhizomatous clumps to 40 cm broad and 70 cm tall; lvs flat (?), thin, bluish	Winter damp grey sand over clay especially after fire; low marri woodland
<i>Thysanotus glaucus</i>	ANTH	4	Regans Ford, Forrestdale, Busselton, Lake King, West Mt Barren, Lesueur National Park	Nov-Feb	054F	Leaves linear, terete, ½ infl., glaucous at base; panicle open, < 10 fls: stamens 3, unequal	Open sand in low <i>Banksia-Eucalyptus</i> woodland
<i>Tripterococcus paniculatus</i> ms	STAC	1	Cannington, Forrestdale, Armadale, Leeming, Forrestfield, Upper Swan, Willetton	Nov-Dec	202	Glabrous, several-stemmed herb similar to <i>T. brunonis</i> but fls later and spikes have > 1 fl	Grey sand, winter damp flats; open patches in heath with <i>Melaleuca preissiana</i>
<i>Verticordia lindleyi</i> subsp. <i>lindleyi</i>	MYRT	4	Gillingarra-Forrestdale, Cannington, Guildford, Muchea, Gingin, Moore River	Nov-Jan	273	Low slender shrub, flowers mauve	Sandy, often clayey, winter wet flats
<i>Villarsia submersa</i>	MENY	4	Gunapin, Boyanup, Lake Muir, Denmark, Forrestdale, Kenwick, Frankland River, Lane Poole	Sep-Oct	303A	Rooted herb with floating elliptic leaves and white flowers	Shallow seasonal pools on clay depressions

<i>Villarsia violifolia</i>	MENY	p, s	Geraldton, Northampton	Oct-Feb	345	Prostrate herb with small yellow flowers	Seasonally wet sandy or clayey sand flats
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Notes: The search of the *Declared Rare and Priority Flora List* database was for the place names Banjup, Canning Vale, Forrestdale, Gosnells, Huntingdale, Southern River and Thornlie. Eight (8) taxa in the results of the 2004 search from only Gosnells are not included in the 2004 table. These taxa are *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (GJ Keighery 5026), *Acacia oncinophylla* subsp. *patulifolia*, *Aotus cordifolia*, *Aristidea gracilis*, *Calothamnus rupestris*, *Calytrix breviseta* subsp. *breviseta*, *Halgania corymbosa* and *Tetratheca* sp. Granite. Four (4) taxa in the 2004 results were added to the 1998 table: *Apodasmia ceramiformis* ms, *Byblis gigantea*, *Caladenia longicauda* subsp. *clivicola* and *Stenanthemum sublineare*. Nine (9) taxa were deleted from the table because they were recorded only from Gosnells (or Cannington, Kenwick or Jandakot) but not from Banjup, Canning Vale, Forrestdale, Huntingdale, Southern River or Thornlie. These are: *Acacia lasiocarpa* var. *bracteolata* long peduncle variant (GJ Keighery 5026), *Andersonia gracilis*, *Baeckia tenuifolia*, *Calytrix breviseta* subsp. *breviseta*, *Eremaea asterocarpa* subsp. *brachyclada*, *Lepidosperma rostratum*, *Phyllota gracilis*, *Schoenus natans* and *Schoenus pennisetis*. Three of the Priority species in the 1998 table have been deleted from Priority listing: *Baeckia tenuifolia*, *Phyllota gracilis* and *Stylidium mimeticum*. The significant (but not DRF or Priority listed flora) species *Hensmania turbinata* (r), *Jacksonia gracilis* (e) and *Stylidium utricularioides* (e) were found in the Campbell Estate in 1998 and are in the table.

## **APPENDIX B**

### **Flora of the Campbell Estate, Canning Vale**

#### **Contents**

Introduction

Table B1      Flora of the Campbell Estate, Canning Vale

## APPENDIX B

### Flora of the Campbell Estate, Canning Vale

#### Introduction

Table B1 lists approximately 230 taxa (species, subspecies and varieties) of vascular plants recorded in the Campbell Estate study area. Approximately 34 of the taxa recorded are established introduced weeds and 199, natives. It is estimated that the list contains at least 70% of the native species in the study area and 60% of the introduced species.

Five (5) significant species and subspecies were recorded during the study. One of them is currently classified as Priority Flora. These species and their significance codes, according to Government of Western Australia (2000, Volume 2, Table 13) are *Tripterococcus paniculatus* (P1), *Byblis gigantea* (d, p, r), *Hensmania turbinata* (r), *Jacksonia gracilis* (e) and *Stylidium utricularioides* (e).

No Declared Rare Flora (DRF) was found during the study, but the DRF donkey orchid *Diuris purdiei* has been found previously in the northern corner of the estate (coordinates: 32°05'30", 115°54'58"), and the orchid may still be near there.

No attempt was made to compile a comprehensive list of flora for the study area, but plants that were common, characteristic or possibly significant were noted during the study and are the basis for Table B1. The table also incorporates the lists of plants compiled for each of the four Campbell Estate 10 m by 10 m floristic community type sampling quadrats.

It will be possible to add more species to the list and confirm names already on it after determinations and confirmation of identifications of specimens collected during the field work are completed.

**Table B1**  
**Flora of the Campbell Estate, Canning Vale**

**Column 1** groups the taxa (taxon: species, subspecies, variety) recorded by families, which are listed phylogenetically. The species are listed alphabetically within families.

Column 2 indicates whether the species is native (N) or an alien (W for Weed) and, if native, if it is a significant species.

**Column 3** indicates the life form of each species is given in Column 3.

**Column 4** is the Notes column, in which questionable identifications and taxonomic synonyms are indicated.

**LEGEND**

- \* Alien, introduced, weed (preceding species names in Column 1b)
- N?n positive (+/-) identification to genus but identification to species uncertain
- ?Nn identification to genus (and species) uncertain
- W Alien, introduced, weed
- N Native
- d populations disjunct from their known geographic range
- e endemic to the Swan Coastal Plain
- p considered to be poorly reserved (this designation also applies to all DRF and Priority taxa)
- r populations at the northern or southern limit of the taxon's known geographic range
- P1 currently a Priority 1 taxon
- HE Herbaceous plant
- SH Shrub
- TR,T Tree
- VI Vine (in a broad sense)
- CE01, CE02, CE03, CE04 quadrats
- adj,x recorded adjacent to or in (x) quadrat in 1998
- ,adj,y recorded adjacent to or in (x) quadrat in 2004

**Table B1**  
**Flora of the Campbell Estate, Canning Vale**

Taxon Name		Status	Form	CE01	CE02	CE03	CE04	Notes
<b>Family: Aizoaceae (110)</b>								
*	Carpobrotus edulis	W	SH					
<b>Family: Anthericaceae (054F)</b>								
	?Agrostocrinum scabrum	N	HE			,adj		
	Arnocrinum preissii	N	HE					
	Chamaescilla corymbosa	N	HE					
	Corynotheca micrantha	N	SH/HE					
	Hensmania turbinata	r	HE					
	Laxmannia ?ramosa	N	HE	x			y	
	Laxmannia ?squarrosa	N	HE	x			x	
	Sowerbaea laxiflora	N	HE					
	Thysanotus multiflorus	N	HE			y		
	Thysanotus patersonii	N	HE/VI					
	Thysanotus sparteus	N	HE			y		
	Thysanotus ?thyrsoideus	N	HE	adj		y		
	Tricoryne elatior	N	HE		y	X	y	
<b>Family: Apiaceae (281)</b>								
	?Homalosciadium homalocarpum	N	HE	x	x			
	Platysace compressa	N	HE			y		
	Trachymene pilosa	N	HE	X	y	X	y	
	Xanthosia huegelii	N	HE			y	y	
<b>Family: Asteraceae (345)</b>								
*	Arctotheca calendula	W	HE					
	Brachyscome iberidifolia	N	HE			y		
*	Conyza ?albida	N	HE	near	x			
*	Hypochaeris glabra	W	HE	X	xy	xy	y	
*	Hypochaeris radicata	W	HE		y		y	
	Millotia sp.	N	HE					
	Podotheca angustifolia	N	HE					
	Podotheca ?gnaphalioides	N	HE	x	x			
*	?Pseudognaphalium luteoalbum	W	HE	near				
	Pterochaeta paniculata	N	HE	near				=Waitzia p.
	Quinetia urvillei	N	HE					
	Rhodanthe citrina	N	HE		y			
	Senecio ?lautus	N	HE				y	
	?Siloxerus humifusus	N	HE	x				
*	Sonchus oleraceus	W	HE		y	xy	y	
*	Ursinia anthemoides	W	HE	X	y	xy	y	
	Waitzia suaveolens	N	HE					
<b>Family: Byblidaceae (154)</b>								
	Byblis gigantea	d,p,r	HE					
<b>Family: Campanulaceae (339)</b>								
*	Wahlenbergia capensis	W	HE					
	Wahlenbergia preissii	N	HE	X	y	y		
<b>Family: Casuarinaceae (070)</b>								
	Allocasuarina fraseriana	N	TR			X		
	Allocasuarina humilis	N	SH			y		
<b>Family: Centrolepidaceae (040)</b>								
	Centrolepis aristata	N	HE	X	xy			
	Centrolepis ?drummondiana	N	HE	x			x	

Taxon Name		Status	Form	CE01	CE02	CE03	CE04	Notes
	Centrolepis sp.	N	HE	X	x			1 species
<b>Family: Colchicaceae (054J)</b>								
	Burchardia umbellata	N	HE	near		xy	y	
<b>Family: Crassulaceae (149)</b>								
	Crassula ?colorata	N	HE	x	xy		y	
*	Crassula ?glomerata	W	HE					
<b>Family: Cyperaceae (032)</b>								
	Cyathochaeta avenacea	N	SE					
	Cyperaceae sp.	N	SE		2spp?	2spp?		2 spp
	Isolepis sp.		SE		y			
	Lepidosperma longitudinale	N	SE		X			
	Lepidosperma ?tenue	N	SE		y	y	y	
	Mesomelaena tetragona	N	SE					
	?Schoenus clandestinus	N	SE				y	
	Schoenus curvifolius	N	SE					
	Schoenus efoliatus	N	SE					
	Schoenus sp(p).?	N	SE	X	xy	X	y	3 spp
	Tetraria octandra	N	SE				y	
<b>Family: Dasygogonaceae (054C)</b>								
	Dasygogon bromeliifolius	N	HE	X	y	xy	xy	
	Lomandra ?caespitosa	N	HE		?	xy		
	Lomandra ?hermaphrodita	N	HE			x	y	
	Lomandra ?maritima	N	HE				y	
	Lomandra ?nigricans	N	HE		y	xy	y	
	Lomandra ?sericea	N	HE		y	y	y	
	Lomandra ?suaveolens	N	HE					
<b>Family: Dilleniaceae (226)</b>								
	Hibbertia huegelii	N	SH			y		
	Hibbertia hypericoides	N	SH					
	Hibbertia racemosa	N	SH					
	Hibbertia subvaginata	N	SH				x ?y	
	Hibbertia vaginata	N	SH					
<b>Family: Droseraceae (143)</b>								
	Drosera ?erythrorhiza	N	HE				xy	
	Drosera menziesii	N	HE			?y	y	
	Drosera nitidula	N	HE		X		y	
<b>Family: Epacridaceae (288)</b>								
	Andersonia heterophylla	N	SH					
	Conostephium pendulum	N	SH				y	
	Leucopogon conostephioides	N	SH					
	Leucopogon gracillimus	N	SH					
	Leucopogon parviflorus	N	SH					
	Leucopogon ?pendulus	N	SH			y	y	
	Leucopogon pulchellus	N	SH		adj,y	xy		
	Leucopogon tenuis	N	SH					
<b>Family: Euphorbiaceae (185)</b>								
*	Euphorbia terracina	W	HE					
	Phyllanthus calycinus	N	SH					
	?Stachystemon sp.	N	HE				y	
<b>Family: Geraniaceae (167)</b>								
*	Pelargonium capitatum	W	HE/SH					
<b>Family: Goodeniaceae (341)</b>								
	Dampiera linearis	N	HE			X	xy	

Taxon Name	Status	Form	CE01	CE02	CE03	CE04	Notes
Lechenaultia expansa	N	SH			y		
<b>Family: Haemodoraceae (055)</b>							
Anigozanthos humilis	N	HE					
Anigozanthos manglesii	N	HE					
Conostylis aculeata	N	HE					
Conostylis juncea	N	HE		y		adj	
Conostylis ?setigera	N	HE	x	y	X		
Haemodorum ?laxum	N	HE					
Haemodorum spicatum	N	HE	near				
Phlebocarya ciliata	N	HE	X	y	xy	xy	
Phlebocarya filifolia	N	HE					
<b>Family: Haloragaceae (276)</b>							
Gonocarpus pithyoides	N	SH	near				
<b>Family: Iridaceae (060)</b>							
* Gladiolus caryophyllaceus	W	HE		y	xy	y	
* Moraea flaccida	W	HE					=Homeria f.
Patersonia occidentalis	N	HE		adj,y	xy		
Prasophyllum sp.	N	HE					
* Romulea rosea	W	HE					
<b>Family: Lamiaceae (313)</b>							
Hemiandra pungens	N	SH					
Hemiandra pungens	N	SH		y			
<b>Family: Lauraceae (131)</b>							
Cassytha flava	N	HE/VI					
Cassytha ?glabella	N	HE/VI			y		
Cassytha sp.	N	HE/VI		y			
<b>Family: Lobeliaceae (340)</b>							
Lobelia ?gibbosa	N	HE	x	y			
Lobelia ?tenuior	N	HE	adj		adj		
<b>Family: Loganiaceae (302)</b>							
Phyllangium ?paradoxum	N	HE	near		y	y	=Mitrasc.
<b>Family: Loranthaceae (097)</b>							
Nuytsia floribunda	N	TR			adj		
<b>Family: Mimosaceae (163)</b>							
Acacia huegelii	N	SH			y		
Acacia pulchella	N	SH	X	y		Xy	
Acacia saligna	N	SH					
Acacia stenoptera	N	SH		y		X	
<b>Family: Molluginaceae (110A)</b>							
Macarthuria apetala	N	SH					
<b>Family: Myrtaceae (273)</b>							
Astartea aff. fascicularis	N	SH					
Astartea sp. Brixton Rd	N	SH					(GJK 5389)
Calothamnus lateralis	N	SH					
Calytrix angulata	N	SH					
Calytrix ?flavescens	N	SH		y	y	y	
Eremaea pauciflora	N	SH			y		
Eucalyptus marginata	N	TR				X	
Eucalyptus todtiana	N	TR				X	
Hypocalymma angustifolium	N	SH		y		xy	
Kunzea ericifolia	N	SH	X				
Kunzea ?micrantha	N	SH					
Melaleuca preissiana	N	SH/T		y		X	



Taxon Name		Status	Form	CE01	CE02	CE03	CE04	Notes
	Melaleuca ?seriata	N	SH		y	x		
	Melaleuca sp.	N	SH		xy			
	Melaleuca ?sp. B Perth Flora							(F.W.Hum.)
	Melaleuca systema	N	SH				y	
	Melaleuca thymoides	N	SH		y	X	y	
	Melaleuca trichophylla	N	SH		X			
	Pericalymma ellipticum	N	SH		adj,y		X	
	Regelia ciliata	N	SH	X	X			
	Regelia ?inops	N	SH					
	Scholtzia involuocrata	N	SH			y		
	Verticordia densiflora	N	SH					
<b>Family: Orchidaceae (066)</b>								
	Caladenia flava	N	HE	?x		y	y	
	Caladenia latifolia	N	HE				y	
	Caladenia paludosa	N	HE			y	y	
*	Disa bracteata	W	HE					=Monadenia
	Diuris sp.	N	HE				y	
	Elythranthera brunonis	N	HE					
	Eriochilus ?dilatatus	N	HE			,adj		
	Oligochaetochilus vittatus	N	HE			y		=Pterostylis
	Orchidaceae sp.		HE					
	Pterostylis recurva	N	HE					
	Pyrorchis nigricans	N	HE					
	Thelymitra benthamiana	N	HE					
	Thelymitra pauciflora	N	HE					
<b>Family: Orobanchaceae (320)</b>								
*	Orobanche minor	N	HE					
<b>Family: Papilionaceae (165)</b>								
	Aotus gracillima	N	SH					
	Bossiaea eriocarpa	N	SH		y	y	y	
	Daviesia ?physodes	N	SH					
	Daviesia triflora	N	SH					
	Euchilopsis linearis	N	SH		y		X	
	Eutaxia virgata	N	SH					
	Gompholobium tomentosum	N	SH	X	y	y	X	
	Hovea trisperma	N	SH			y	y	
	Jacksonia furcellata	N	SH			y		
	Jacksonia gracilis	e	SH					=J.aff. seric.
	Jacksonia sternbergiana	N	SH					
	Kennedia prostrata	N	HE/VI					
	Latrobea tenella	N	SH					
*	Lotus ?angustissimus	N	HE	x	x			
	Nemcia capitata	N	SH					
	Nemcia reticulata	N				y		
	Pultenaea reticulata	N	SH					
*	Trifolium dubium	W	HE	X				
*	Trifolium subterraneum	W	HE	X				
	Viminaria juncea	N	SH					
<b>Family: Phormiaceae (054E)</b>								
	Dianella revoluta	N	HE			,adj		
<b>Family: Poaceae (031)</b>								
*	?Aira caryophyllea	W	GR	x	y		y	
	Amphipogon ?turbinatus	N	GR			y	xy	
	Austrodanthonia ?caespitosa	N	GR					
	Austrostipa ?compressa	N	GR	x	y	xy	y	

Taxon Name		Status	Form	CE01	CE02	CE03	CE04	Notes
*	Avena fatua	W	GR					
*	Briza maxima	W	GR	X	y	xy	y	
*	Briza minor	W	GR	X	y			
*	Cynodon dactylon	W	GR					
*	Ehrharta calycina	W	GR	?x	y	xy	y	
*	Ehrharta longiflora	N	GR		y	y		
*	Eragrostis curvula	W	GR		X			
*	Pennisetum clandestinum	W	GR				y	
*	?Pentaschistis airoides	W	GR	x		x		
	Poaceae sp.	W	GR	1 sp?	2spp?			2 spp
*	Vulpia myuros	W	GR	X	?y			
<b>Family: Polygalaceae (183)</b>								
	Comesperma ?calymega	N	SH		y			
<b>Family: Polygonaceae (103)</b>								
*	Acetosella vulgaris	W	HE	X				
	Rumex sp.	W	HE					
<b>Family: Portulacaceae (111)</b>								
	Calandrinia sp (small)	N	HE					
<b>Family: Primulaceae (293)</b>								
*	Anagallis arvensis	W	HE			X		
<b>Family: Proteaceae (090)</b>								
	Adenanthos cygnorum	N	SH	X		y		
	Adenanthos obovatus	N	SH		y		adj	
	Banksia attenuata	N	TR		y	X	y	
	Banksia ilicifolia	N	TR			X	,adj	
	Banksia menziesii	N	TR		y	X		
	Conospermum sp.	N	SH			y		
	Dryandra lindleyana	N	SH					
	Hakea varia	N	SH					
	Petrophile linearis	N	SH			xy	y	
	Stirlingia latifolia	N	SH					
<b>Family: Restionaceae (039)</b>								
	Cyrtogonidium leptocarpoides	N	SE					
	Desmocladus fasciculatus	N	SE		y		?x	=Loxocarya
	Desmocladus flexuosus	N	SE			y		=Loxocarya
	Hypolaena exsulca	N	SE				y	
	?Lyginia barbata	N	SE	x				
	Lyginia imberbis	N	SE		y	y	y	
	?Meeboldina coangustata	N	SE		x			
	Meeboldina roycei ms	N	SE					
	Restionaceae sp.	N	SE	X	adj	adj		1 sp
<b>Family: Rubiaceae (331)</b>								
	Opercularia vaginata	N	HE			y		
<b>Family: Rutaceae (175)</b>								
	Boronia ?ramosa	N	SH					
	Boronia sp.	N	SH	X	y		X	2 spp
	Boronia spathulata	N	SH					
	Philotheca spicata	N	SH		y	xy	xy	=Eriostem.
<b>Family: Santalaceae (092)</b>								
	Leptomeria sp	N	HE			y	y	
<b>Family: Solanaceae (315)</b>								
*	Solanum ?nigrum	W	SH			x		
<b>Family: Stackhousiaceae (202)</b>								

<b>Taxon Name</b>	<b>Status</b>	<b>Form</b>	<b>CE01</b>	<b>CE02</b>	<b>CE03</b>	<b>CE04</b>	<b>Notes</b>
Stackhousia monogyna	N	HE					
Tripterococcus brunonis	N	HE					
Tripterococcus paniculatus ms	P1	HE					
<b>Family: Styliaceae (343)</b>							
Levenhookia sp.	N	HE			y		
Stylidium brunonianum	N	HE		adj,y		X	
Stylidium ?diuroides	N	HE		y			
Stylidium piliferum	N	HE				y	
Stylidium repens	N	HE		y	y	X	
Stylidium schoenoides	N	HE			y	y	
Stylidium sp.	N	HE					y
Stylidium utricularioides	e	HE		X			
<b>Family: Thymelaeaceae (263)</b>							
Pimelea sp.	N	SH			y		2 spp
<b>Family: Xanthorrhoeaceae(054D)</b>							
Xanthorrhoea preissii	N	SH			X	xy	
<b>Family: Zamiaceae (016A)</b>							
Macrozamia riedlei	N	Sh					

ASW 13/12/2004

## **APPENDIX C**

### **Floristic Community Types and Sampling Quadrats of the Campbell Estate Study Area, Canning Vale**

#### **Contents**

- Table C1      Floristic Community Types which are or may be in or near the Study Area  
and their Reservation Status and Conservation Significance
- Bushland Record Sheets for Quadrats CE01, CE02, CE03 and CE04 (1998 sheets with 2004  
additions)
- PLATES 1 and 2      Plates of Quadrats CE01, CE02, CE03 and CE04 (1998 photographs)

**Table C1**

**Floristic Community Types which are or may be in or near the Study Area  
and their Reservation Status and Conservation Significance**

(based upon information in Gibson *et al.* 1994, English and Blyth 1997 and Keighery 1997)

**Key**

**Column 1: Codes of Floristic Community Types**

**Column 2: General descriptions of Floristic Community Types**

Descriptions are taken from Keighery (1997, Table 1).

**Column 3: Threatened Ecological Communities** (from English and Blyth 1997)

E – Endangered, Priority 2 and on the Threatened Ecological Community database

V – Vulnerable, Priority 3 and on the Threatened Ecological Community database

P - proposed for inclusion on the Threatened Ecological Community database

**Column 4: Reservation Status** (from Gibson *et al.* 1994)

P – Poorly reserved, W – Well reserved

**Column 5: Conservation Significance** (from Gibson *et al.* 1994)

L – Low risk, S – Susceptible, V – Vulnerable

**Supergroup 2 – Seasonal Wetlands**

4	<i>Melaleuca preissiana</i> damplands		W	L
5	Mixed shrub damplands		W	L
8	Herb rich shrublands in clay pans	V	W	V
10a	Shrublands on dry clay flats	E	W	V
12	<i>Melaleuca teretifolia</i> and / or <i>Astartea</i> aff. <i>fascicularis</i> shrublands		W	L
13	Deeper wetlands on heavy soils		W	L
S2	Northern <i>Pericalymma ellipticum</i> dense low shrublands			

**Supergroup 3 – Uplands centred on Bassendean Dunes and the Dandaragan Plateau**

21a	Central <i>Banksia attenuata</i> – <i>Eucalyptus marginata</i> woodlands		W	L
21c	Low lying <i>Banksia attenuata</i> woodlands or shrublands	P	W	S
22	<i>Banksia ilicifolia</i> woodlands	P	P	S
23a	Central <i>Banksia attenuata</i> – <i>B. menziesii</i> woodlands		W	L

**Campbell Estate CE01      Bushland Record Sheet**  
Floristic Community Type 10 m by 10 m Sampling Quadrat

Date: 30 Oct 98      Botanist: Arthur Weston      Others: J Pitfield, J Donovan  
Notes: Quadrat CE01 was no longer in existence in 2004

**Location**

Campbell Estate, Canning Vale, City of Gosnells  
ca. 100 m SE of Ranford Rd / Nicholson Rd intersection  
AMG 50H (LK) ca. 03 97 750 E, 64 48 950 N

Map: Fremantle NE 1:25 000      Sheet 2033-1 NE (Edition 1) Series R 811

**Photograph(s)**

Arthur Weston      ASW98.X.2-3,4,5  
Print(s):      ASW98.X.2-3, 35 mm,

**Site Data**

Seasonal wetland (Dampland?)      Flat

Drainage poor

Litter      Bare ground

**Vegetation Structure and Cover**

*Pericalymma ellipticum* Open Low Heath over  
Sedgeland

Shrubs <2m, 2-10%	<i>Melaleuca preissiana</i>	regeneration
<1m, ca. 50%	<i>Pericalymma ellipticum</i>	regeneration
Grasses <2%	<i>Austrostipa ?compressa</i>	
Sedges 40-50%	see collection	

**Vegetation Condition**

5 Degraded      Vegetation was chained or scraped bare in 1995 (after 11 December 1994, when Trudgen and Keighery [1995, p. 87] recorded the condition of the site as Very Good or Excellent, and before 2 January 1996, the date of Metro Regional Area aerial photography which shows the site as being bare). Fill of soil and debris was spread over an area between the quadrat and Nicholson Rd sometime during mid-summer 1998-99, and the SE corner post of the quadrat was damaged. There were drainage trenches bordering and through the stand. And by September 2004 the site had been cleared, filled and built upon.

**Campbell Estate CE02      Bushland Record Sheet**  
Floristic Community Type 10 m by 10 m Sampling Quadrat

Date: 7 Nov 98, 9 am      Botanist: Arthur Weston      Others: J Pitfield, J Donovan  
Notes:  
Date: 14 Oct 04, <9->12      Botanist: Arthur Weston      Others: M. Owen, C Love  
Notes: Condition of quadrat has improved; only 1 small plant of *Austrostipa ?compressa* was found in quadrat  
Date:      Botanist:      Others:  
Notes:

**Location**

Campbell Estate, Canning Vale, City of Gosnells  
S of Ranford Rd between Nicholson Rd and Campbell Rd  
AMG 50H (LK) 03 98 495 E, 64 48 773 N

Map: Fremantle NE 1:25 000      Sheet 2033-1 NE (Edition 1) Series R 811

**Photograph(s)**

Arthur Weston      ASW98.X.2-9      , ASW04.X.1-  
Print(s):      ASW98.X.2-9, 35 mm from NW corner of quadrat, looking SE diagonally across quadrat

**Site Data**

Seasonal wetland (Dampland?)      Flat      Grey sand to > 50 cm (moist)

Drainage moderate/poor

Litter      Bare ground < 20%

**Vegetation Structure and Cover**

*Melaleuca preissiana* Tall Open Shrubland over  
*Pericalymma ellipticum*, *Xanthorrhoea preissii*, *Euchilopsis linearis* Open Low Heath over  
*Austrostipa ?compressa* Very Open Grassland over  
Sedgeland

Trees	<10m, 10-30%	<i>Melaleuca preissiana</i>	<2%, formerly 2-10% or 10-30%
Shrubs	>2m, 2-10%	<i>Melaleuca preissiana</i>	regeneration
	1-2m, <2%	<i>Regelia ciliata</i>	few remnants
	<1m, ca. 50%	<i>Pericalymma ellipticum</i> , <i>Xanthorrhoea preissii</i> , <i>Euchilopsis linearis</i>	
Grasses	<10%	<i>Austrostipa ?compressa</i>	and others?
Sedges	40-50%	see collection	

**Vegetation Condition**

4-5 Good-Degraded      Most of *Melaleuca preissiana* trees near quadrat have been cut off at base, and some are regenerating. Shallow drainage trenches have been dug, and mounds soil from the trenches are covered in weeds, mainly *Eragrostis curvula*, *Avena fatua* and other species. The vegetation is regenerating after being burnt, probably within the previous three years.

**Campbell Estate CE03 Bushland Record Sheet**  
Floristic Community Type 10 m by 10 m Sampling Quadrat

Date: 7 Nov 98, 11:30 Botanist: Arthur Weston Others: J Pitfield, J Donovan  
Notes:

Date: 10/10/04, 8.30-12.30 Botanist: Arthur Weston Others: J Pitfield, M Owen  
Notes: Many *Banksia* trees and almost all *Melaleuca thymoides* shrubs were dead (or absent) and very few of the starred (\*) shrubs below were in quadrat. Litter had increased and condition had improved slightly.

Date: Botanist: Others:  
Notes:

**Location**

Campbell Estate, Canning Vale, City of Gosnells  
ca. 300 m NNE of entrance road to Canning Vale Prison, between Nicholson Rd and Campbell Rd  
AMG 50H (LK) 03 97 640 E, 64 47 855 N

Map: Fremantle NE 1:25 000 Sheet 2033-1 NE (Edition 1) Series R 811

**Photograph(s)**

Arthur Weston ASW98.X.2-10 ASW04.X.1-5  
Print(s): ASW98.X.2-10, 35 mm, from W corner of quadrat, looking E diagonally  
across quadrat

**Site Data**

Lower slope NW aspect Grey-brown loamy sand to  
>30cm  
Drainage well/moderate

Litter probably >70% Bare ground <10% (+ leaf-litter-covered  
ground ca. 20%)

**Vegetation Structure and Cover**

*Banksia attenuata*, *Banksia menziesii* Low Open Forest over  
*Adenanthos cygnorum* Tall Shrubland over  
*Melaleuca thymoides* Open Shrubland over  
Mixed Open Low Heath over  
*Amphipogon turbinatus*, *Ehrharta* sp., *Briza maxima* Very Open Grassland over  
Sedgeland

Trees	<6m, 40-60%	<i>Banksia attenuata</i> , <i>Banksia menziesii</i>
Shrubs	>2m, 10-30%	<i>Adenanthos cygnorum</i> * patchy
	1-2m, 2-10%	<i>Melaleuca thymoides</i> *, <i>Allocasuarin humilis</i> * (patchy)
	<1m, ca. 60%	<i>Eremaea pauciflora</i> *, <i>Bossiaea eriocarpa</i> , <i>Hibbertia hypericoides</i> *, <i>Lechenaultia floribunda</i>
Grasses	2-10%	<i>Amphipogon turbinatus</i> , <i>Ehrharta</i> sp., <i>Briza maxima</i>
Sedges	ca. 40-50%	see collection

**Vegetation Condition**

4-3 Good-Very Good Patchy deaths of *Banksia* trees (and of other shrubs), some with brown leaves still on (dieback?). Some areas upslope have no *Banksias*. Moderately weedy, more so in depression W of quadrat, which extends to Nicholson Rd.



**Campbell Estate CE04      Bushland Record Sheet**  
Floristic Community Type 10 m by 10 m Sampling Quadrat

Date: 27 Nov 98      Botanist: Arthur Weston      Others: J Pitfield, J Donovan

Notes:

Date: 10/10/04 2-4.30pm      Botanist: Arthur Weston      Others: J Pitfield, M Owen

Notes: Quadrat is still unburnt. Almost all *Melaleuca thymoides* is dead, but it is alive and healthy on the other (north) side of track, which was burnt much more recently.

Date:      Botanist:      Others:

Notes:

**Location**

Campbell Estate, Canning Vale, City of Gosnells  
ca. midway between Nicholson Rd and Campbell Rd, and S of Govan Rd, on S side of track/firebreak,  
which provides access from the W end of Govan Rd  
AMG 50H (LK) 03 97 775 E, 64 48 285 N

Map: Fremantle NE 1:25 000      Sheet 2033-1 NE (Edition 1) Series R 811

**Photograph(s)**

Arthur Weston      ASW98.XI.1-18 (400 ASA)      ASW04.X.1-6  
Print(s):      ASW98.XI.1-18, 35 mm, looking 248° diagonally across quadrat

**Site Data**

Gentle slope sandy	NW aspect	Grey loamy sand over dark grey loam at <5cm
Drainage well/moderate		
Litter		Bare ground 2-10%

**Vegetation Structure and Cover**

*Banksia attenuata* Low Open Forest over  
*Melaleuca thymoides*, *Xanthorrhoea preissii* Open Shrubland over  
*Melaleuca ?seriata* Low Shrubland over  
*Dasyogon bromeliifolius*, *Patersonia occidentalis* Open Herbland over  
Sedgeland

Trees 5-8m, ca.40%	<i>Banksia attenuata</i>	Also <i>B. menziesii</i> , <i>B. ilicifolia</i> , <i>E. todtiana</i>
Shrubs 1-2m, 60-70%	<i>Melaleuca thymoides</i> , <i>Xanthorrhoea preissii</i>	
<1m, ca. 20-30%	<i>Melaleuca ?seriata</i>	
Herbs 10-30%	<i>Dasyogon bromeliifolius</i> , <i>Patersonia occidentalis</i>	
Sedges ca. 30-70%	see collection	

**Vegetation Condition**

2-1 Excellent-Pristine      Long unburnt (though burnt in last 1 or 2 years on N side of track). No dead trees here. A few weeds.

Quadrat CE01

Quadrat CE02

PLATE 1

Quadrat CE03

Quadrat CE04

PLATE 2

## APPENDIX D

### Vegetation Structure Classes and Condition Scale Tables

#### Vegetation Structure Classes (Layers)

These vegetation structure classes are the ones defined and used in *Bush Forever* (2000, Volume 2, Table 11 and p. 493) to describe vegetation in Bush Forever sites, (except that a bracketed name refers to a dominant that has fewer plants and provides significantly less cover than others). ‘Sedges’ are in Table 11 but not on p. 493.

Life Form/ Height Class	Canopy Cover (percentage)			
	100% - 70%	70% - 30%	30% - 10%	10% - 2%
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees < 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs <1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

#### Vegetation Condition Scale

This condition scale is the one used in *Bush Forever* (2000, Volume 2, Table 12 and p. 494) to describe condition of vegetation in Bush Forever sites.

P	Pristine	No obvious signs of disturbance
E	Excellent	Vegetation structure intact, disturbance affecting individual species [plants?]; weeds are non-aggressive species
V	Very Good	Vegetation structure altered; obvious signs of disturbance
G	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance; basic vegetation structure or ability to regenerate it is retained
D	Degraded	Basic vegetation structure severely impacted by disturbance; scope for regeneration but not to a state approaching good (sic) condition without intensive management
C	Completely Degraded	Vegetation structure not intact; the area completely or almost completely without native species (‘parkland cleared’).