



CARDUP BUSINESS PARK

Spring Flora and Vegetation Survey and Wetland Assessment

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EXECUTIVE SUMMARY

Cardno was engaged by Koltasz Smith Consultants (Koltasz Smith) to assess the flora, vegetation and wetlands associated with a parcel of land within the locality of Cardup (Figure 1). This parcel of land consists of seven allotments (Lot 10 and 60 Robertson Road, Lot 21 Norman Road, Lot 41 Cardup Siding Road and Lots 1, 6 and 7 South Western Highway) and comprises a total area of approximately 208 hectares (ha). The allotments will be collectively referred to throughout this report as the "Study Area".

The flora and vegetation survey and wetland assessment will be submitted in association with other preliminary site investigations including land capability and hydrological investigations to support a Local Structure Plan (LSP) and a Metropolitan Region Scheme (MRS) rezoning and amendment process.

The purpose of this report is to document the botanical values of the study area and determine the presence, if any, of:

- ≠ significant flora (Declared Rare Flora or Priority Flora);
- ≠ significant plant communities (Threatened Ecological Communities, Priority Ecological Communities and regionally significant or restricted communities/complexes);
- ≠ protected areas (Bush Forever, Environmentally Sensitive Areas and Biodiversity Linkages); and
- ≠ significant wetland environments.

Investigations into the botanical values of the site found a total of 49 flora species from 44 genera and 19 families. 29 of the 49 flora species recorded were introduced weed species, which is 60% of the total species recorded. No DRF or PF species were identified.

One native plant community was described (CcEI – *Corymbia calophylla* and *Eucalyptus lane-poolei* open woodland) that occurred within the south western portion of the study area. Plant community CcEI was determined to be Floristic Community Type (FCT) 3b – *Corymbia calophylla* and *Eucalyptus marginata* mixed woodland, which is a known "Vulnerable" Threatened Ecological Community (TEC). This community comprises Bush Forever (BF) Site 361 (Norman Road Bushland) and is currently in a "Good" to "Degraded" condition.

The remaining areas within the study area are cleared agricultural land with remnant scattered trees and shrubs in places in a "Degraded" to "Completely Degraded" condition.

A biodiversity linkage and Environmentally Sensitive Areas (ESAs) extend across the western, southern and northern boundaries of the study area. The ESA along the western boundary represents a buffer associated with BF Site 350 (Byford to Serpentine Rail/Road Reserve), which comprises a federally listed TEC (FCT 3a – *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils). The ESA along the southern boundary comprises BF Site 361 and its associated buffer and the ESA along the northern boundary is a buffer associated with BF Site 271 (Cardup Brook Bushland), which contains a Conservation Category Wetland (CCW) with Unique Feature Identifier (UFI) No. 12158.

Four Multiple Use wetlands (UFI 12161 Dampland, UFI 13011 Palusplain, UFI 14014 Palusplain and UFI 13910 Armadale Palusplain) occur within the study area. All wetlands are in a "Completely Degraded" condition, with only Dampland UFI 12161 retaining some remnant wetland vegetation (*Juncus pallidus* and *Casuarina obesa*).

From the above information, Cardno's recommendations are that:

- ≠ native plant community CcEI, that comprises BF Site 361 and contains FCT 3b, should be retained within the study area with an appropriate buffer;
- ≠ A buffer or delineating boundary should be established along the western and northern edges of the study area for the protection of the adjacent BF Site 360 (comprising FCT 3a) and BF Site 271 (comprising CCW UFI 12158) and to enhance the regional biodiversity linkage; and
- ≠ Retain scattered native trees for heritage value where possible.

CARDUP BUSINESS PARK SPRING FLORA AND VEGETATION SURVEY

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1. INTRODUCTION

1.1 Backg round

Cardno (WA) Pty Ltd (Cardno) was appointed by Koltasz Smith Consulting (Koltasz Smith) to undertake a flora and vegetation survey and wetland assessment of seven allotments within the locality of Cardup. These allotments are Lot 10 and 60 Robertson Road, Lot 21 Norman Road, Lot 41 Cardup Siding Road and Lots 1, 6 and 7 South Western Highway and comprise a total area of approximately 208 hectares (ha). The allotments will be collectively referred to throughout this report as the "Study Area". The general locality of the study area, their extent and allotment boundaries are illustrated on Figures 1 and 2 respectively.

The flora and vegetation survey and wetland assessment will be submitted in association with other preliminary site investigations including land capability and hydrological investigations to support a Local Structure Plan (LSP) and a Metropolitan Region Scheme (MRS) rezoning and amendment process.

1.2 Purpos e of the Asses sment

The purpose of this report is to provide a comprehensive assessment of the current extent and condition of vegetation within the study area and document the botanical values of the site. This report will determine the presence, if any, of:

- ≠ significant flora (Declared Rare Flora or Priority Flora);
- ≠ significant plant communities (Threatened Ecological Communities, Priority Ecological Communities and regionally significant or restricted communities/complexes);
- ≠ protected areas (Bush Forever, Environmentally Sensitive Areas and Biodiversity Linkages); and
- ≠ significant wetland environments.

The report will include:

- ≠ background research into the existing environment (topography, soils, vegetation, wetlands) utilising reference material, high resolution aerial photography and various online mapping database services;
- ≠ database searches of significant flora and plant communities held by the Department of Environment and Conservation (DEC), Western Australian Herbarium and the Department of Environment, Heritage and the Arts (DEHWA);
- ≠ a complete species list of the study areas compiled across two seasons;
- ≠ determination of plant communities and plant community mapping;
- ≠ vegetation condition mapping; and
- ≠ discussion of results and recommendations.

The information contained within this report will help determine the way in which the ultimate future development could impact upon or be impacted by the flora and vegetation of the study area.

2. EXISTING ENVIRONMENT

2.1 Climate

Cardup is located within the South West of Western Australia, which experiences a Mediterranean climate of mild, wet winters and hot, dry summers. Climatic data obtained from the closest monitoring station (Perth Metro) provides average temperature and rainfall statistics. The mean maximum temperature, calculated from data collected between 1994 to 2008, shows a temperature of 31.2°C in February and 18.4°C in July and a mean minimum temperature of 18.0°C in February and 7.9°C in July. The mean maximum rainfall falls in July with 151.3 mm and the mean minimum rainfall falls in December with 6.1 mm (Bureau of Meteorology 2008).

2.2 Soils, Landforms and Topography

The study area is located on the Swan Coastal Plain, which is the central portion of the Perth Basin extending from the Darling Fault in the east to the continental slope west of Rottnest, and from the Murchison River in the north to the Southern Ocean in the south. The Perth Basin is sedimentary in origin and is marginal to the West Australian Shelf (Seddon 2004). The surface features of the Swan Coastal Plain (i.e. soils and topography) influences flora and vegetation assemblages and therefore are discussed below.

The Swan Coastal Plain is generally flat, approximately 20 to 30 km wide and consisting of two wide belts of differing origin. The coastal belt, which is of Aeolian origin, consists of a series of dunes running parallel to the coastline. The youngest and most western dune system is the Quindalup dunes, followed by the Spearwood dunes and finally on the most eastern side the Bassendean dunes. The Pinjarra Plain, which is of fluvial origin, extends from the eastern side of the Bassendean dunes to the western edge of the Darling Scarp, where it joins the Ridge Hill Shelf, which is the denuded slope of the Darling Fault (Seddon 2004). The study area lies on the Pinjarra Plain landform, with a small south eastern portion of the study area crossing over onto the Ridge Hill Shelf.

Landform and soil mapping undertaken by Churchward and McArthur (1980) indicates that two soil associations occur within the study area. The main soil association is the Guilford complex and covers a majority of the site. The Guilford Complex has been described as a flat plain with yellow duplex soils. The remaining south eastern corner is represented by the Forrestfield complex, which is described as the laterised foothills of the Darling Scarp and dominated by gravelly and sandy soils.

The topography of the study area is undulating, with a general slope to the west. The natural surface height ranges from its lowest elevation of approximately 48.0 m Australian Height Datum (AHD) in the south west corner to its highest elevation level of approximately 80.0 m AHD in the southeast corner, resulting in a westerly aspect. The site lies less than 1.0km west from the Darling Range, and the south east corner of the site is located on the Darling Fault line, which coincides with the Forrestfield soil association.

2.3 Regional Vegetation Information

The study area lies within the Swan Coastal Plain Interim Biogeographical Regionalisation for Australia (IBRA) Region (Thackway and Cresswell 1995). This IBRA Region is broadly compatible with the Swan Coastal Plain (Drummond Botanical Subdistrict) Phytogeographical Region as described by Beard (1990). The vegetation is categorised as Banksia low woodland on leached sands with Melaleuca swamps where ill-drained and woodlands of Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) on less leached soils.

Vegetation complex mapping undertaken by Heddlow et al. 1986, which uses a combination of landform, soil and rainfall parameters, indicates the study area is, for the major part, within the Guildford Complex with a small portion of the south eastern corner falling within the Forrestfield Complex. The description given for the Guildford Complex is:

- ≠ "a mixture of open forest to tall open forest of *Corymbia calophylla* – *Eucalyptus wandoo* – *Eucalyptus marginata* and woodland of *Eucalyptus wandoo* (with rare occurrences of *Eucalyptus lane-poolei*). Minor components include *Eucalyptus rudis* and *Melaleuca raphiophylla*".

The Forrestfield Complex is described as:

- ≠ "Vegetation ranges from open forest of *Corymbia calophylla* – *Eucalyptus wandoo* – *Eucalyptus marginata* to open forest of *Eucalyptus marginata* – *Corymbia calophylla* – *Allocasuarina fraseriana* – *Banksia* spp. Fringing woodland of *Eucalyptus rudis* in the gullies that dissect this landform".

Investigations undertaken for the Bush Forever (BF) initiative (Government of Western Australia 2000b) indicate that 6% of the pre-1750 distribution (pre-European settlement) of the Guildford Complex remains. Of this area, 3% has implemented protection within designated BF sites, or protected to a degree through land use planning (zoned "Parks and Reserves" through the MRS) or through the Department of Conservation and Environment (DEC) within their managed lands and Crown Reserves with a conservation purpose.

The Forrestfield complex has 9% of its pre-1750 distribution remaining. 5% of this area currently has implemented protection or "other" protection. As part of The BF initiative (see Section 2.8), 10% of the pre-European distribution of each vegetation complex is the target for conservation on the Swan Coastal Plain. Both of these complexes fall below these levels and a specific policy statement, Bush Forever Volume 1, Policy Statement (Government of WA 2000a), recommends that there be a presumption against clearing bushland representing vegetation complexes of which less than 10% currently remains in the metropolitan area.

2.4 Threatened Ecological Communities and DEC Listed and Environment Protection and Biodiversity Conservation Act (1999) Threatened Ecological Communities

In Western Australia, "Threatened Ecological Communities" (TECs) are defined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (within the DEC) and are assigned to one of the categories outlined below in Table 1. While they are not afforded direct statutory protection at a State level (unlike DRF under the Wildlife Conservation Act 1950) their significance is acknowledged through other State environmental approval processes (i.e. Environmental Impact Assessment pursuant to Part IV of the Environmental Protection Act 1986).

Selected TECs are also afforded statutory protection at a Federal level pursuant to the EPBC Act. The EPBC Act provides for the strong protection of TECs, which are listed under section 181 of the Act, and are defined as "Critically Endangered", "Endangered" or "Vulnerable" under Section 182.

Table 1: Categories of Threatened Ecological Communities (English and Blyth 1997)

PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

A search was conducted of the DEC's TEC database and no known occurrences of TECs were recorded within the study area, however the following ecological communities were identified either directly adjacent too, or within approximately 2.5 km of the study area:

- ≠ The 'Critically Endangered' threatened ecological community – 'Corymbia calophylla - Kingia australis woodlands on heavy soils, Swan Coastal Plain (SCP 3a);
- ≠ The 'Endangered' threatened ecological community – 'Banksia attenuata and/or Eucalyptus marginata woodlands of the eastern side of the Swan Coastal Plain (SCP 20 b);
- ≠ The 'Endangered' threatened ecological community – 'Southern wet shrublands, Swan Coastal Plain (SCP02);
- ≠ The 'Vulnerable' threatened ecological community – 'Corymbia calophylla - Eucalyptus marginata woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP 3b); and
- ≠ The 'Vulnerable' threatened ecological community – 'Dense shrublands on clay flats (SCP 09).

Due to the close proximity of these plant communities to the study area, there is a possibility that they may be present onsite. The field survey will identify if these communities occur within the study area.

The publicly available list of Scheduled TECs was also searched on the Department of the Environment, Water, Heritage and the Arts (DEWHA) website (DEWHA 2008) and no TECs protected through the EPBC Act have been recorded within the boundary of the study area. The "Critically Endangered" TEC – 'Corymbia calophylla - Kingia australis woodlands on heavy soils, Swan Coastal Plain (SCP 3a)', is known to occur within 2.5 km of the study area. It is listed at a Federal level as "Endangered" (DEHWA 2008).

2.5 Priority Ecological Communities

In addition to listing as a TEC, a community may be listed as a Priority Ecological Community (PEC). An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined, is placed on the list of PECs in either Category 1, 2 or 3 (Table 2). Ecological communities that are adequately known and are rare but not threatened, or meet criteria for Near Threatened, or

that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (DEC 2008).

No PECs have been recorded within the study area or in close proximity to the study area.

Table 2: Categories of Priority Ecological Communities (DEC 2008).

Priority 1	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority 2	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority 3	<p>(i) communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or;</p> <p>(ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;</p> <p>(iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.</p> <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.
Priority 5	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

2.6 Declared Rare and Priority Flora

Species of flora acquire "Declared Rare" (DRF) or "priority" conservation status where populations are restricted geographically or threatened by local processes. The Department of Environment and Conservation (DEC) recognises these threats and subsequently applies regulations towards population protection and species conservation. The DEC enforces regulations under the Wildlife Conservation Act 1950 to conserve DRF species and protect significant populations. Priority flora species are potentially rare or threatened and are classified in order of threat. DRF and priority flora category definitions are listed in Table 3.

DRF are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act 1950 and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the Act defines "to take" as "... to gather, pluck, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means". Species of flora may also be listed as "Threatened" pursuant to Schedule 1 of the Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act). Any action likely to have a significant impact on a species listed under the EPBC Act requires approval from the Commonwealth Minister for Environment, Water, Heritage and the Arts.

Table 3: Definition of Rare and Priority Flora species (Atkins 2008)

Conservation Code	Category
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.
X	Declared Rare Flora – Presumed Extinct Taxa Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
P1	Priority One – Poorly Known Taxa Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat eg road verges, urban areas, farmland, active mineral leases etc, or the plants are under threat, eg from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey.
P4	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.

A search was conducted of the DEC's databases and the results are listed in Table 4.

Table 4: Conservation Coded Flora known to occur within the vicinity of the Study area.

Note: P= Perennial, A= Annual, Pg = Perennial geophyte.

Family	Taxon	Conservation Code	Life Strategy	Flower Period
Cyperaceae	Schoenus pennisetis	P1	P	Aug-Dec
	Tetraria australiensis	DRF	P	Dec
Centrolepidaceae	Centrolepis caespitosa	P4	A	Nov
Anthericaceae	Johnsonia pubescens subsp. cygnorum	P2	P	Sep-Nov
Orchidaceae	Drakaea elastica	DRF	Pg	Oct-Nov
Proteaceae	Synaphea odocoileops	P1	P	Aug-Oct
	Synaphea sp. Pinjarra Plain	P1	P	Oct
	Synaphea sp. Serpentine	P3	P	Aug-Nov
Droseraceae	Drosera occidentalis subsp. occidentalis	P4	P	Nov-Dec
Mimosaceae	Acacia lasiocarpa var. bracteolata long peduncle variant	P1	P	May-Aug
Papilionaceae	Aotus cordifolia	P3	P	Aug-Dec
Myrtaceae	Verticordia plumosa var. pleiobotrya	DRF	P	Nov
	Baeckea sp. Perth Region	P3	P	Jan-Mar
	Verticordia lindleyi subsp. lindleyi	P4	P	Nov-Jan
Goodeniaceae	Anthotium junciforme	P4	P	Nov-Mar
Asteraceae	Millotia tenuifolia var. laevis	P2	A	Sep-Oct
	Pithocarpa corymbulosa	P2	P	Jan-Apr
	Trichocline sp. Treeton	P2	P	Dec

The species listed in Table 4 are species that have been recorded or are known to occur within the area, it does not mean these species will be present onsite, or alternatively, it does not mean that additional conservation coded species will not be present onsite. DRF species listed within the table are also listed as "Threatened" at a Federal level and fall under the EPBC Act.

2.7 Local and Regional Significance

Apart from being listed as either DRF or priority flora, plant taxa may be significant for a number of other reasons. The EPA in Guidance Statement No. 51 – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia (2004) stated that significant flora may include taxa that have:

- ≠ “a keystone role in a particular habitat for threatened species, or supporting large populations representing a significant proportion of the local regional population of a species;
- ≠ relic status;
- ≠ anomalous features that indicate a potential new discovery;
- ≠ being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- ≠ the presence of restricted subspecies, varieties or naturally occurring hybrids;
- ≠ local endemism/a restricted distribution; or
- ≠ being poorly reserved. ”

Similarly, plant communities or vegetation may be significant for reasons other than a listing as a TEC. The EPA (2004) stated that these reasons include:

- ≠ “scarcity;
- ≠ unusual species;
- ≠ novel combinations of species;
- ≠ a role as a refuge;
- ≠ a role as a key habitat for threatened species or large populations representing a significant proportion of the local to regional total population of a species;
- ≠ being representative of the range of a unit (particularly, a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range); or
- ≠ a restricted distribution. ”

As limited remnant vegetation occurs within the Cardup area due to historical land clearing, any remnant vegetation remaining onsite could represent species or communities of local endemism or of a restricted distribution, or being poorly reserved.

2.8 Bush Forever

The Government of Western Australia's Bush Forever (BF) Policy represents the states intention to develop a strategic plan for conserving regionally significant bushland and associated wetland areas on the Perth metropolitan coastal plain. The BF policy aims to protect 10% of each vegetation complex as defined by Heddlé et al. (1980).

The study area contains BF site 361 (Norman Road Bushland Cardup), which occurs within the south western corner. Similar vegetation occurs across Norman road in Whitby and is protected within BF site 354. BF site 350 (Byford to Serpentine Rail/Road Reserve) occurs adjacent to the study area on the opposite side of Robertson Road and extends along the railway reserve from Byford to Serpentine. A number of other BF sites occur in close proximity to the study area, these include BF site 352 (Cardup Nature Reserve and Adjacent Bushland), BF site 271 (Cardup Brook Bushland, Cardup/Peel Estate), BF site 321 (Brickwood Reserve and Adjacent Bushland) and BF site 351 (Cardup Brook Bushland, Cardup/Peel Estate). (Figure 3)

BF sites 361 and 354 contain three FCTs as described by Gibson et al. 1994. These are FCT 1a – *Eucalyptus haemotoxylon* – *Eucalyptus marginata* woodlands on Whicher foothills (most northern occurrence, disjunct), FCT 3b – *Corymbia calophylla* – *Eucalyptus marginata* woodlands on sandy clay soils and FCT 20b – Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands. FCT 3b is classified as a TEC and occurs within the BF Site 361 that occurs within the study area.

From the information obtained regarding vegetation complexes and TECs it is apparent that the BF site within the study area was considered to be regionally significant due to it containing the restricted Guilford complex and a TEC.

2.9 Biodiversity Linkages

Biodiversity linkages can be described as any area of remaining native vegetation that provides a corridor or linkage between larger patches of vegetation so as to allow movement of flora and fauna and their genetic material through the landscape, helping to maintain meta-populations. Linkages can prevent isolation of flora and fauna and ultimately extinctions. Biodiversity linkages can either be continuous or near continuous, the more fractured the linkage is, the less efficient the flora and fauna move along that corridor. Within built up areas, these linkages are more fractured.

The Shire of Serpentine-Jarrahdale has produced a biodiversity strategy discussion paper, which includes a biodiversity linkage strategy. This strategy aims to retain all verified Natural areas and other native vegetation within ecological linkage areas shown in Figure 3.

Biodiversity linkages have been proposed within the shire to encompass natural linkage features, including a number of major waterways. These ecological linkages are based on the regional linkages, which have been previously designed by the State Government in Bush Forever, Perth's Greenways and the System 6 study and supported by the WA Local Government (PBP and WALGA 2004).

A proposed biodiversity linkage runs along the southern, western and northern edges of the study area. The biodiversity linkage incorporates the surrounding BF Sites and links eastward to the Darling Range Regional Park. These regional linkages are designed to guide land use planning and encourage biodiversity protection.

2.10 Wetlands

Much of the Swan Coastal Plain is categorised by wetland environments. The conservation and management of these wetland areas has required classification systems to be developed in order to group and describe the variations in wetland types. One recognised system is that of Semeniuk (1987), which is based on the geomorphic setting and hydrological processes associated with the wetland. The resultant classification allocates individual wetlands with shared characteristics to wetland suites.

The DEC maintains a Geomorphic Wetland Dataset, which classifies individual wetlands into specific management categories as described in Table 5. It is important to understand that the significance of each wetland is based on hydrological, biological and human use features, which are the key components for the classification of management categories. This dynamic dataset is continually updated with site-specific wetland surveys providing new and relevant information. The guidelines for proposing changes to wetland boundaries or management categories state that relevant information should be obtained in the optimal season for vegetation condition and water levels, which is usually spring (DEC 2007).

Table 5: Wetland Management Categories and Management Objectives (Western Australian Planning Commission 2005)

Management Category	Description of Wetland	Management Objectives
Conservation (CCW)	Wetlands which support high levels of attributes and functions.	To preserve wetland attributes and functions through reservation in national parks, crown reserves, state owned land and protection under environmental protection policies
Resource Enhancement (REW)	Wetlands which have been partly modified but still support substantial functions and attributes.	To restore wetlands through maintenance and enhancement of wetland functions and attributes by protection in crown reserves, state or local government owned land and by environmental protection policies, or in private property by sustainable management
Multiple Use (MUW)	Wetlands with few attributes, which still provide important wetland functions.	Use, development and management should be considered in the context of water, town and environmental planning through landcare.

Each classified wetland listed in the Geomorphic Wetland Dataset is given a Unique Feature Identifier (UFI). However in the case of large wetlands that have undergone a degree of disturbance, a separate management category may be assigned to parts of the wetland in order to reflect the current values. In such cases, different UFIs will be also be assigned to each part.

In terms of wetland protection, the wetlands dataset and associated management categories are used as a tool by regulatory bodies (EPA, DEC and Department of Planning and Infrastructure) to guide planning and decision making. No statutory protection is afforded these management categories; however, there is a presumption against approving activities that are likely to impact on priority management wetlands such as conservation category wetlands.

The dataset indicates that a number of Multiple Use wetlands, UFI 12161.0 (Unknown Dampland), UFI 13011.0 (Unknown Palusplain), UFI 14014.0 (Unknown Palusplain) and UFI 13910.0 (Armadale Palusplain), cover a majority of the study area (Figure 4).

2.11 Environment ally Sensitive Areas

Environmentally Sensitive Areas (ESAs) cannot be cleared, as declared in Regulation 6 in Government Gazette No. 115 Environmental Protection (Clearing of Native Vegetation) Regulations 2004 without prior approval. These areas have been identified in order to protect the native vegetation values of areas surrounding significant, threatened or scheduled ecosystems or communities and are provided to assist landowners and managers in determining the location of ESAs under the Environmental Protection Act 1986.

As mentioned in Section 2.8, a number of BF sites surround the study area. These BF sites contain either threatened or scheduled TECs and/or DRF. An appropriate buffer has been placed around these BF sites to form the area designated as ESAs. The buffers surrounding the BF sites cover approximately half of the study area (Figure 3). The south western corner of the study area also contains BF site 361.

3. METHODS

Botanists from Cardno visited the study area on the 6th June 2008 and the 24th October 2008 and undertook a detailed field survey, conducted in accordance with EPA Guidance Statement No. 51 (2004). The subject site was traversed on foot and the vegetation assessed at 7 survey locations, selected to sample each plant community observed on the site. The position of each site was recorded with a hand-held GPS unit and all vascular plant species were recorded within a radius of at least 15 metres from that point. In addition, opportunistic plant taxa that were observed, but not located at a particular survey location, were also recorded through the course of the survey. An estimate of the Foliage Projective Cover (FPC) percentage was made for each species at each survey location.

Environmental data recorded from each site included topographic position, aspect, slope, soil colour and texture class, rock outcropping, litter cover as well as the degree of disturbance and an estimate of the time since the last fire event. The condition of the vegetation was assessed to assist in determining the conservation values of the site. The vegetation condition was rated according to Keighery (1994), the vegetation condition scale commonly used in the Perth Metropolitan Region. This scale is also appropriate for other urbanised and agricultural areas. The categories are shown in Table 6.

The second visit was specifically timed to coincide with the flowering period of the DRF species *Drakea elastica*, which is a perennial geophyte and also with the annual P2 species *Millotia tenuifolia* var. *laevis*. The additional priority species identified as occurring within the area (excluding *Centrolepis caespitosa*, see Section 3.1) are perennial species that should be flowering at the approximate time of the survey, however, can be identified outside of these times through vegetative material.

The plant communities were preliminary described and then classified using cluster analysis within the analysis package PC-ORD (McCune and Mefford 2006). Groups were defined using the Sorensen distance measure with flexible beta linkage ($\beta = -0.25$). The resulting dendrogram was scaled using Wishart's objective function and pruned with 20% of information remaining (Appendix D).

Each identified community was assigned a FCT using presence/absence species data so that a comparison could be made against the DEC's TEC database. The site data was reconciled with the SCP dataset of Gibson et al. (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded while some infraspecies that have been identified since 1994 were reduced to species level. The combined dataset was then classified into groups using a Bray-Curtis Association and a UPGMA fusion (beta level = -0.1) within the analysis package PATN (Belbin 2006).

3.1 Limitations of this Report

The survey was undertaken across two months (June and October) in 2008. These visits were timed to coincide with the optimum flowering times for a majority of the conservation-coded flora within Table 2, and most importantly the flowering period of the DRF orchid species *Drakea elastica* and the annual P2 species *Millotia tenuifolia* var. *laevis*. The other annual species listed is the P4 species *Centrolepis caespitosa*, which has an optimum flowering period of November. The survey was undertaken very close to this optimum period (24th October) and the habitat that this species is most likely to occur was in a 'Completely Degraded' condition. It is therefore considered unlikely that this species occurs within the study area.

It is generally not possible, however, to obtain a complete species list of an area from one or two visits, even at optimal times such as during spring. This is due to some species,

especially herbaceous ones, being inconspicuous for much of the year and becoming obvious only during flowering. In addition, not all species will flower in the same season and some will not flower every year. However, due to the highly degraded nature of the study area, it is unlikely that any native species, especially conservation coded species were overlooked during the two surveys.

Table 6: Vegetation Condition Scale (Keighery 1994)

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

4. RESULTS

4.1 Site Description

Observations from high resolution aerial photography indicated that the only remnant vegetation within the study area occurs within the south western portion of the site. This was confirmed by the two site visits undertaken in June and October. The study area has been largely cleared for agricultural purposes (Plate 1) and more recently, light industrial uses. Outside of the remaining patch of vegetation, a number of scattered native paddock trees remain including *Corymbia calophylla*, *Eucalyptus marginata* and *Casuarina obesa*. Planted exotic *Eucalyptus* species and other horticultural species were also present along property boundaries and around residential or industrial dwellings. Understorey species consist of exotic grass and broadleaf weeds.

Some areas within the study area had waterlogged and inundated soils during the June visit (Lot 1 and part Lot 6). Within these areas some remnant wetland species were present including *Casuarina obesa* and *Juncus pallidus*. These species were scattered and the dominant species were exotic grass and broadleaf weeds.

4.2 Flora

A total of 49 flora species were recorded across the study area from 44 genera and 19 families. Of this total, 29 species were identified as introduced (weed) species, which is 60% of the total taxa recorded within the study area. Dominant families of native species were Cyperaceae (5 taxa), Myrtaceae (4 taxa) and Proteaceae (3 taxa) and dominant families of introduced species were Poaceae (12 taxa), Papilionaceae (3 taxa) and Asteraceae (3 taxa).

Eucalyptus lane-poolei was present onsite (Plate 2). This species is not threatened, however has a disjunct distribution, occurring on the western scarp of the Darling Ranges and adjacent plains, with an isolated occurrence south-east of Busselton, and also north of Perth from south-east of Jurien Bay to north of Gingin (Brooker and Kleinig 2001).

4.3 Declared Rare and Priority Flora

No DRF or PF were recorded across the site. The DRF search undertaken in October specifically for *Drakea elastica* did not find any of the species present.

4.4 Vegetation Units

Four vegetation units were described within the study area, with only one being considered a native plant community. The remaining vegetation units retained minimum to no native vegetation and consisted of cleared paddocks with some widely scattered native trees of the species *Corymbia calophylla*, *Eucalyptus marginata* and *Casuarina obesa* and rows of planted exotic *Eucalyptus* species. Mapped MU dampland (UFI 12161) retained some remnant wetland species of *Casuarina obesa* and *Juncus pallidus* and has been defined as a separate vegetation unit. These four units are described below and illustrated on Figure 5.

The vegetation units described within the study are:

1. CcEI - *Corymbia calophylla* and *Eucalyptus lane-poolei* open woodland with scattered *Banksia attenuata* and *Banksia menzeisii* over *Kingia australis* over *Hakea spathulata*, *Banksia armata* var. *armata* and *Lepidosperma pubisquamum* on sandy soils (Plate 3);
2. C1 - Degraded dampland with scattered *Casuarina obesa* over scattered *Juncus pallidus* over **Pennisetum clandestinum* (Plate 4);
3. C2 - Cleared paddocks with scattered native species *Corymbia calophylla* and *Eucalyptus marginata* over paddock grasses and broadleaf weeds (Plate 5); and
4. C3 - Cleared paddocks with planted exotic *Eucalyptus* species along property boundaries and around residential dwellings (Plate 6).

4.5 Vegetation Condition

Most of the study area is in a "Completely Degraded" condition as the original vegetation structure has been completely altered, with no, or sparsely scattered native species remaining. A small portion of the study area (coinciding within plant community CcEI) is in a "Good" to "Degraded" condition and retains some plant structure and health. The understorey vegetation is still highly modified with the invasion of many exotic weed species.

4.6 Status of Plant Communities

Plant Community CcEI comprises BF Site 361, which has been described as FCT 3b – *Corymbia calophylla* – *Eucalyptus marginata* woodlands on sandy clay soils. FCT 3b is a well reserved community type with a "Vulnerable" status and for this reason is classified as a TEC. Observations during the survey concluded that CcEI had species composition that indicated it belonged to FCT 3b, although the vegetation condition was in a 'Degraded' to 'Good' condition.

A cluster analysis was undertaken utilising species data collected within Community CcEI (Sites 1, 2 and 3), and the analysis indicated that Site 1 closely aligned with FCT 3c – *Eucalyptus calophylla* – *Xanthorrhoea preissii* woodlands and shrublands (Appendix D) and Sites 2 and 3 with FCT 6 – Weed dominated wetlands on heavy soils.

Due to the highly degraded nature of plant community CcEI, interpretation of the cluster analysis should be mindful of altered species composition. Sites 2 and 3 retained little native vegetation, which resulted in the analysis aligning these sites with the most weed dominated FCT (FCT 6), despite this plant community obviously not being a weed dominated wetland. Site 1 retained more of its original composition and the analysis aligned it with community type 3, however aligned it with FCT 3c rather than FCT 3b. This is not an unusual result considering the similar species composition of the two FCTs and the degraded nature of CcEI. It is considered however that CcEI is FCT 3b as described by Government of WA (2000), rather than FCT 3c as indicated by the cluster analysis.

4.7 Wetlands

The majority of the study area has been mapped as unknown palusplain wetlands. Due to the extensive clearing and grazing, no wetland dependant vegetation remains and the condition of the area has been rated as "Completely Degraded".

The portion of the study area mapped as unknown dampland (UF1 12161) retains remnants of wetland dependant vegetation (*Casuarina obesa* and *Juncus pallidus*) (Plate 7). The vegetation has been highly disturbed and is in a "Completely Degraded" condition. Soils within the area were observed to be inundated during the time of the June survey and a drainage line with open water was present along the southern boundary of Lot 6. Due to the abundance of water within this area, and the wetland mapping database it can be concluded that this area would once have been a functioning wetland system, however, it has now been cleared and degraded and supports little to no wetland species or ecological function.

5. DISCUSSION

Limited flora species were recorded onsite due to its cleared and degraded nature. Highest species richness was recorded within plant community CcEI and survey work was concentrated within this area.

No DRF or PF species were recorded during the June or October visits. It is unlikely that conservation coded species were overlooked or would be likely to occur within the study area due to the degraded nature of the remaining plant community, with the understorey being dominated by weed species. This seems to be a result of historic grazing and some logging that has occurred within the area.

The plant communities described were determined through survey data collected and visual observations. A cluster analysis was also performed to confirm the visual observations. The cluster analysis grouped sites 1, 2 and 3 as one community, sites 4 and 5 as having similar composition and sites 6 and 7 with similar composition. This reinforces visual observations that Sites 1, 2 and 3 are the same community. Due to lack of structure within the remaining sites (4, 5, 6 and 7) and the species consisting mainly of weeds, they cannot be classified as separate communities and have been described as cleared paddocks with scattered trees. Site 5, which occurs within mapped MU dampland (UFI 12161) has been recognised as a separate group due to the presence of scattered *Juncus pallidus* and *Casuarina obesa*. Within the cluster analysis sites 4 and 5 were grouped together, most likely due to the dominance of the common weed species **Pennisetum clandestinum*, however have not been recognised as the same community as site 4 retains no remnant wetland species and soils were not as inundated as in site 5.

As described in Section 2.3, vegetation complex mapping indicates that the pre-1750 study area would have been covered by the Guildford vegetation complex and a small portion of the Forrestfield vegetation complex. Due to the extensive clearing of the study area the only vegetation that still remains is in the south western corner, mapped as plant community CcEI. This plant community is representative of the Guilford complex and has been determined to be FCT 3b, which is listed as a TEC. This makes this bushland pocket regionally significant and for this reason it is listed as a BF site (BF Site 361). This community therefore is should be retained with an appropriate buffer within the study area.

FCT 3b has been described by Gibson et al. (1994) as occurring on heavy soils with a distribution stretching from Waterloo to Pearce airforce base. Before European settlement (Pre-1750), FCT 3b is considered to have been the most extensive community on the eastern side of the Swan Coastal Plain (Keighery and Trudgen 1992) however, due to extensive clearing for agricultural purposes, it is know regionally rare. Species that are common within community 3b include *Corymbia calophylla*, *Eucalyptus marginata*, *Bossiaea eriocarpa*, *Hibbertia hypericoides* and *Tetraria octandra*. This community occurs within the BF site 361.

Areas mapped as ESAs within the study area comprise BF Site 361 (plus buffer area) and buffer areas associated with BF Site 350 and BF Site 271, both of which occur adjacent to the study area. The buffer areas associated with BF Site 350 and BF Site 271 consist of cleared paddocks which are void of native vegetation. Retaining these buffers in their current states would provide little to no protection for the adjacent BF Sites, one of which is a Federally listed TEC, FCT 3a. To provide protection for the adjacent BF Sites against the proposed development and other edge effects, an appropriately sized buffer or delineating boundary needs to be established. A buffer that has been revegetated with endemic species would provide some protection and also enhance the biodiversity linkage that also runs along the southern, western and northern boundaries. It should be noted that FCT 3a does not occur within the study area, however it is an offence to disturb or impact on a federally listed TEC, either directly or indirectly.

The three MU palusplain wetlands and the one MU dampland wetland mapped across the study area within the geomorphic wetlands dataset have been historically cleared and retain little to no wetland vegetation or ecological values. Soils within these areas may still become quite inundated with water during times of rain; however they no longer represent functioning wetland systems. The area mapped as MU dampland is the only mapped wetland retaining some scattered wetland vegetation, although the condition of this wetland has been rated as "Completely Degraded" and retains little to no ecological values.

6. CONCLUSIONS AND RECOMMENDATIONS

Cardno was engaged to undertake a flora and vegetation survey and wetland assessment with the aim of documenting the botanical values across the study area. Two surveys were undertaken, one in June and the other October, with the DRF species *Drakea elastica* specifically searched for during its optimal flowering period.

Investigations into the botanical values of the site concluded that the study area has a total of 49 flora species from 44 genera and 19 families. 29 of the 49 flora species recorded were introduced weed species, which is 60% of the total species recorded. No DRF or PF species were identified.

One native plant community was described (CcEI – *Corymbia calophylla* and *Eucalyptus lane-poolei* open woodland) that occurred within the south western portion of the study area. Plant community CcEI was determined to be Floristic Community Type (FCT) 3b – *Corymbia calophylla* and *Eucalyptus marginata* mixed woodland, which is a known “Vulnerable” Threatened Ecological Community (TEC). This community comprises Bush Forever (BF) Site 316 (Norman Road Bushland) and is currently in a “Good” to “Degraded” condition.

The remaining areas within the study area are cleared agricultural land with remnant scattered trees and shrubs in places in a “Degraded” to “Completely Degraded” condition.

Environmentally Sensitive Areas (ESAs) and a biodiversity linkage extend across the southern, western and northern boundaries of the study area. The ESA along the western boundary represents a buffer associated with BF Site 350 (Byford to Serpentine Rail/Road Reserve), which comprises a federally listed TEC (FCT 3a – *Corymbia calophylla* – *Kingia australis* woodlands on heavy soils). The ESA along the southern boundary comprises BF Site 361 and its associated buffer and the ESA along the northern boundary is a buffer associated with BF Site 271 (Cardup Brook Bushland), which contains a Conservation Category Wetland (CCW).

Four Multiple Use wetlands (UFI 12161 Dampland, UFI 13011 Palusplain, UFI 14014 Palusplain and UFI 13910 Armadale Palusplain) occur within the study area. All wetlands are in a “Completely Degraded” condition, with only Dampland UFI 12161 retaining some remnant wetland vegetation (*Juncus pallidus* and *Casuarina obesa*).

From the above information, Cardno’s recommendations are that:

- ≠ native plant community CcEI, that comprises BF Site 361 and contains FCT 3b, should be retained within the study area with an appropriate buffer;
- ≠ A buffer or delineating boundary should be established along the western and northern edges of the study area for the protection of the adjacent BF Site 360 (comprising FCT 3a) and BF Site 271 (comprising CCW UFI 12158) and to enhance the regional biodiversity linkage; and
- ≠ Retain scattered native trees for heritage value where possible.

7. REFERENCES

- Atkins, K. 2008. Declared Rare and Priority Flora List for Western Australia. Perth: Department of Environment and Conservation.
- Beard J. S. 1990. Plant life of Western Australia. Perth: Kangaroo Press.
- Belbin, L. (2006) PATN v3.11, CSIRO Division of Wildlife and Ecology.
- Brooker, M.I.H and Kleinig, D.A. 2001. Field Guide to Eucalypts, Volume 2 Second Edition. Melbourne: Blooming Books.
- Bureau of Meteorology. 2008. Climate Averages. <http://www.bom.gov.au/climate/averages/tablesml> (accessed August 2008).
- Churchward, H.M. and McArthur, W.M. 1980. Landforms and soils of the Darling System, Western Australia. in: Atlas of Natural Resources, Darling System, Western Australia. Perth: Department of Conservation and Environment.
- Department of Environment and Conservation. 2007. Protocol for proposing modifications to the Geomorphic Wetlands Swan Coastal Plain dataset. Perth: Department of Environment and Conservation.
- Department of Environment and Conservation. 2008. Definitions, Categories and Criteria for Threatened Ecological Community Sites and Buffers in WA. <http://www.dec.wa.au> (accessed August 2008).
- Department of the Environment, Water, Heritage and the Arts .2008. Threatened Species and Threatened Ecological Communities. www.environment.gov.au/ (accessed August 2008).
- English, V. and Blyth, J. 1997. Identifying and Conserving Threatened Ecological Communities in the South West Botanical Province. ANCA National Reserves System and Cooperative Program, Project Number N702.
- Environmental Protection Authority. 2004. Guidance statement No. 51. Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. Perth: EPA.
- Gibson, N., Keighery, B.J., Keighery, G.J., Burbidge, A.H. and Lyons, M.N. 1994. A Floristic Survey of the Southern Swan Coastal Plain. Perth: Department of Conservation and Land Management.
- Government of Western Australia. 2000a. BushForever - Volume 1: Policies, Principles and Processes. Perth: Western Australian Planning Commission.
- Government of Western Australia. 2000b. BushForever – Volume 2: Directory of Bush Forever Sites. Perth: Western Australian Planning Commission.
- Hedde, E.M., Loneragan, O.W. and Havel, J.J. 1980. Darling Systems – Vegetation Complexes. In: Atlas of Natural Resources Darling System, Western Australia. Perth: Department of Conservation and Environment.

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- Keighery, B. and Trudgen, M. 1992. Remnant Vegetation on the Alluvial Soils of the Eastern Side of the Swan Coastal Plain. Unpublished report for Department of Conservation and Land Management, Australian Heritage Commission and Heritage Council of WA.
- Keighery, B.J. 1994. Bushland plant survey: A guide to plant community survey for the community. Nedlands: Wildflower Society of WA (Inc).
- Perth Biodiversity Project and Western Australian Local Government. 2004. Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region. Perth: WALGA
- McCune, B. and Mefford, M.J. 2006. PC-ORD. Multivariate Analysis of Ecological Data. Version 5. MjM Software, Gleneden Beach, Oregon, USA.
- Seddon, G. 2004. Sense of Place: A response to the environment. Melbourne: Blooming Books
- Semeniuk, C.A. (1987) Wetlands of the Darling System – A geomorphic approach to habitat classification. Journal of the Royal Society of Western Australia, 69: 95-112.
- Thackway, R, and Cresswell, ID, 1995 (Eds). An Interim Biogeographic Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0. Canberra: Australian Nature Conservation Agency.

PLATES



Plate 1: Degraded agricultural land with a row of planted *Eucalyptus species



Plate 2: Eucalyptus lane-poolei in association with Kingia australis



Plate 3: Plant Community CcEI – *Corymbia calophylla* and *Eucalyptus lane-poolei* over *Kingia australis* over *Hakea spathulata*, *Banksia armata* var. *armata* and *Lepidosperma pubisquamum*



Plate 4: Degraded wetland with scattered *Casuarina obesa* and *Juncus pallidus*



Plate 5: Cleared Paddocks with scattered native species *Corymbia calophylla* and *Eucalyptus marginata*



Plate 6: Cleared paddocks planted exotic *Eucalyptus* species along property boundaries and around residential dwellings



Plate 7: Remnants of original wetland vegetation within MU wetland (UFI 12161.0)

FIGURES



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHKD	APPD	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHKD	APPD



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Scale: **1:12,000**

0 100 200 400 600 800 1,000 1,200 Metres

PROJECT **Flora & Vegetation Assessment**

DRAWING TITLE **FIGURE 2 : Extent of Study Area & Cadastral Boundary**

PRINCIPAL **KOLTASZ SMITH**

Project Number
V8002 006

Drawing Number
SK02

Designed GT

Drawn MGW

Local Authority Shire of Serpentine - Jarrahdale

Sheet 1 of 1

Original
A4

Revision

Checked

Approved



Date 25/08/08

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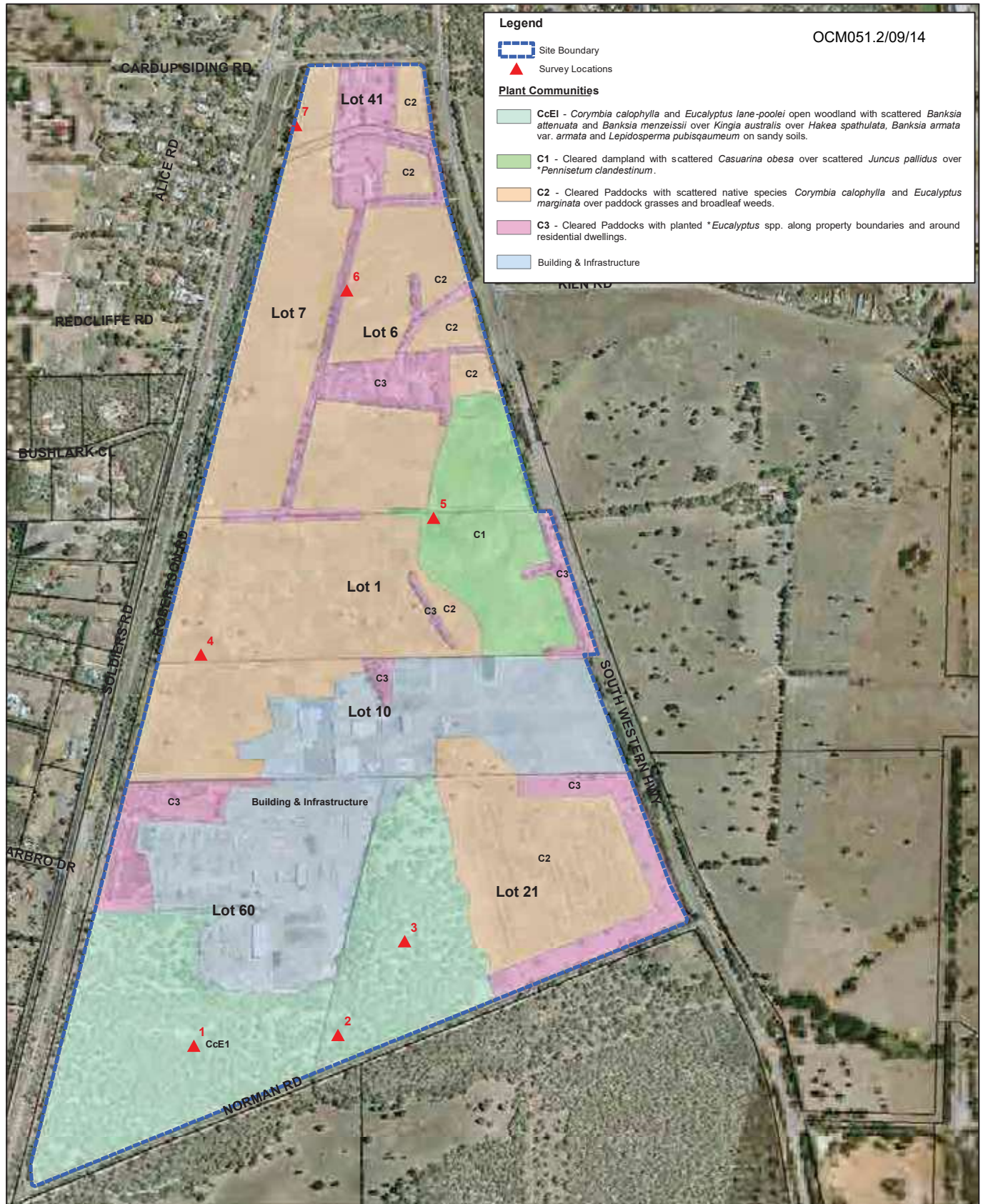
Legend

OCM051.2/09/14

-  Site Boundary
-  Survey Locations

Plant Communities

-  CcE1 - *Corymbia calophylla* and *Eucalyptus lane-poolei* open woodland with scattered *Banksia attenuata* and *Banksia menzeissii* over *Kingia australis* over *Hakea spathulata*, *Banksia armata* var. *armata* and *Lepidosperma pubisquamum* on sandy soils.
-  C1 - Cleared dampland with scattered *Casuarina obesa* over scattered *Juncus pallidus* over *Pennisetum clandestinum*.
-  C2 - Cleared Paddocks with scattered native species *Corymbia calophylla* and *Eucalyptus marginata* over paddock grasses and broadleaf weeds.
-  C3 - Cleared Paddocks with planted *Eucalyptus* spp. along property boundaries and around residential dwellings.
-  Building & Infrastructure



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD
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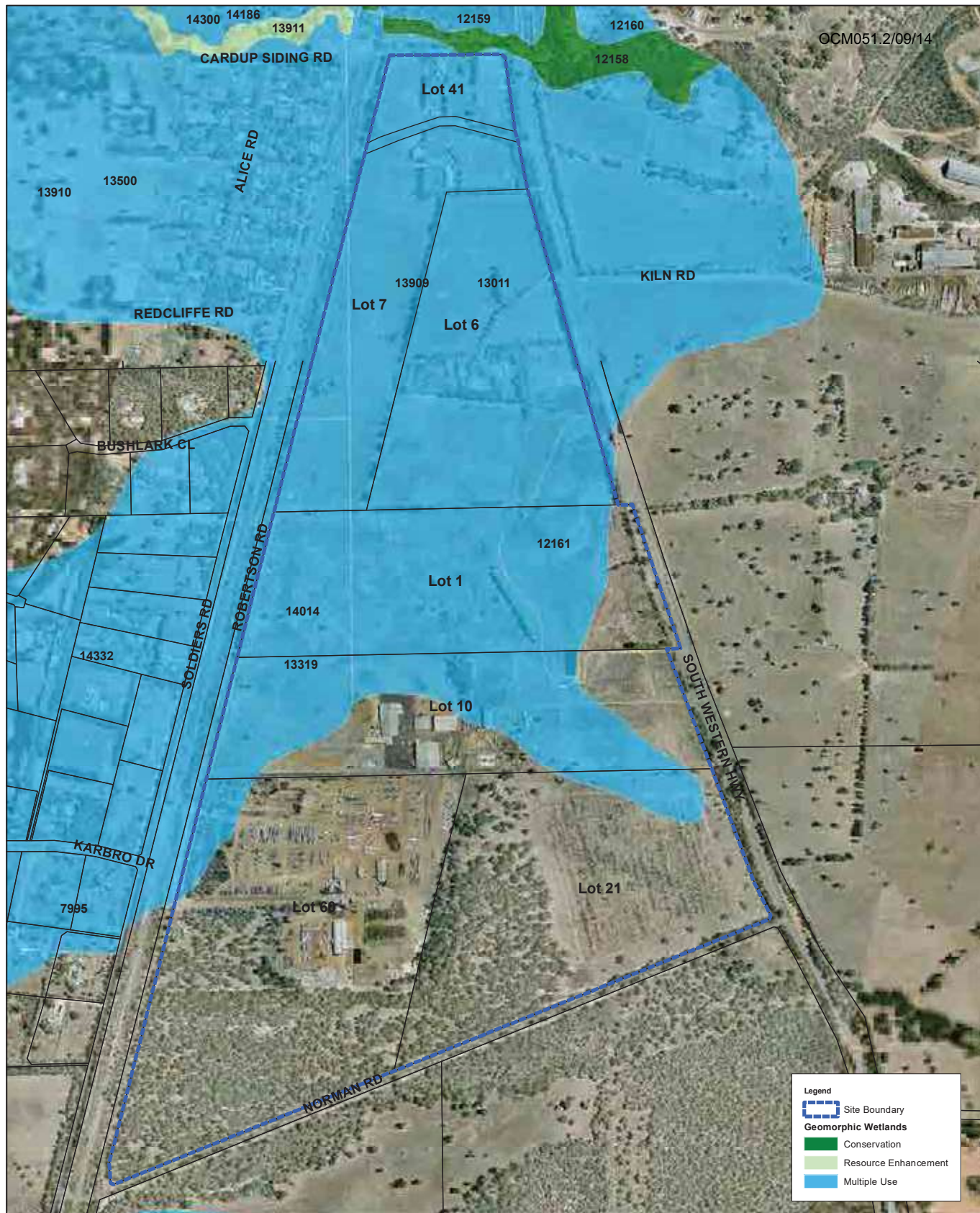


PROJECT **Flora & Vegetation Assessment**
DRAWING TITLE **FIGURE 5 : Plant Communities & Survey Locations**
PRINCIPAL **KOLTASZ SMITH**



Project Number **V8002** Original **A3**
Drawing Number **SK05** Revision
Designed GT Checked
Drawn MGW Approved
Local Authority Shire of Serpentine - Jarrahdale
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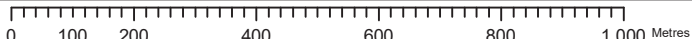
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PROJECT **Cardup Business Park - Flora & Vegetation Assessment**

DRAWING TITLE **FIGURE 4 : Geomorphic Wetlands**

PRINCIPAL **KOLTASZ SMITH**



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DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
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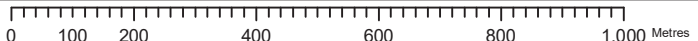
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PROJECT **Flora & Vegetation Assessment**

DRAWING TITLE **FIGURE 3 : Bush Forever Sites & Biodiversity Linkages**

PRINCIPAL **KOLTASZ SMITH**



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Project Number
V8002

Drawing Number
SK03

Designed GT

Drawn MGW

Local Authority Shire of Serpentine - Jarrahdale

Sheet 1 of 1

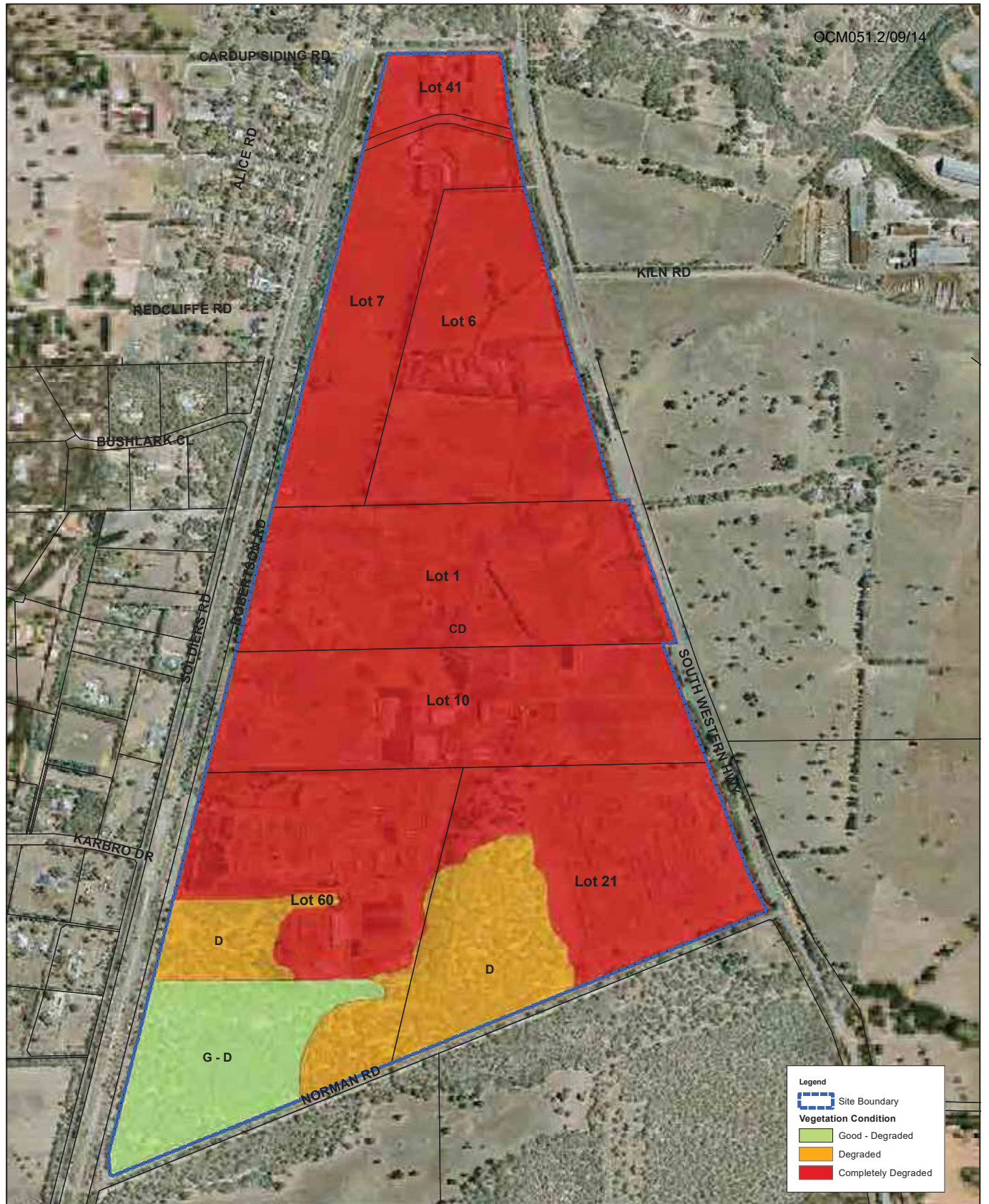
Original
A4
Revision

Checked

Approved

Date 15/08/08

OCM051.2/09/14



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
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Scale: 1:8,000



PROJECT **Flora & Vegetation Assessment**

DRAWING TITLE **FIGURE 6 : Vegetation Condition**

PRINCIPAL **KOLTASZ SMITH**



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Project Number **V8002** Original **A3**
Drawing Number **SK06** Revision
Designed GT Checked
Drawn MGW Approved
Local Authority Shire of Serpentine - Jarrahdale
Sheet 1 of 1 Date 25/08/08

APPENDIX A

Vascular Plant Species Recorded at Cardup Business Park, 2008

Appendix A: Vascular Plant Taxa Recorded within Cardup Business Park, Cardup, 2008.
 Note: * denotes an introduced (weed) species

Family Name	Plant Taxa
Typhaceae	* Typha orientalis
Poaceae	* Aira caryophyllea Austrostipa sp. * Avena barbata * Briza maxima * Briza minor * Bromus diandrus * Cynodon dactylon * Ehrharta longiflora * Eragrostis curvula * Hordeum sp. * Lolium rigidum * Pennisetum clandestinum * Vulpia sp.
Cyperaceae	Cyathochaeta avenacea Lepidosperma leptostachyum Lepidosperma pubisquameum Mesomelaena tetragona Tetraria octandra
Juncaceae	Juncus pallidus
Dasypogonaceae	Kingia australis Lomandra caespitosa
Iridaceae	* Iridaceae sp. * Moraea flaccida * Romulea rosea
Orchidaceae	* Disa bracteata
Casuarinaceae	Casuarina obesa
Proteaceae	Banksia armata var. armata Banksia dallanneyi Hakea spathulata
Loranthaceae	Nuytsia floribunda
Mimosaceae	Acacia saligna
Papilionaceae	* Lotus subbiflorus * Trifolium campestre * Trifolium repens
Geraniaceae	* Erodium cicutarium
Dilleniaceae	Hibbertia hypericoides

Appendix A: Vascular Plant Taxa Recorded within Cardup Business Park, Cardup, 2008.
 Note: * denotes an introduced (weed) species

Family Name	Plant Taxa
Myrtaceae	Baeckea camphorosmae Corymbia calophylla Eucalyptus lane-poolei Eucalyptus marginata * Eucalyptus sp.
Asclepiadaceae	* Gomphocarpus fruticosus
Solanaceae	* Solanum linnaeanum
Orobanchaceae	* Orobanche minor
Campanulaceae	* Wahlenbergia capensis
Asteraceae	* Arctotheca calendula * Hypochaeris glabra * Ursinia anthemoides

APPENDIX B

Composition of Vascular Plant Species within Plant Communities

Appendix B: Plant Taxa Composition within each Plant Community

Plant Taxa	Community			
	C1	C2	C3	CcE1
<i>Acacia saligna</i>			X	
<i>Aira caryophyllea</i>				X
<i>Arctotheca calendula</i>				X
<i>Austrostipa</i> sp.				X
<i>Avena barbata</i>				X
<i>Baeckea camphorosmae</i>				X
<i>Banksia armata</i> var. <i>armata</i>				X
<i>Banksia dallanneyi</i>				X
<i>Briza maxima</i>				X
<i>Briza minor</i>				X
<i>Bromus diandrus</i>				X
<i>Casuarina obesa</i>	X			
<i>Corymbia calophylla</i>			X	X
<i>Cyathochaeta avenacea</i>				X
<i>Cynodon dactylon</i>		X		
<i>Ehrharta longiflora</i>				X
<i>Eragrostis curvula</i>		X		
<i>Erodium cicutarium</i>		X		X
<i>Eucalyptus lane-poolei</i>				X
<i>Eucalyptus marginata</i>			X	
<i>Eucalyptus</i> sp.		X	X	
<i>Gomphocarpus fruticosus</i>		X		
<i>Hakea spathulata</i>				X
<i>Hibbertia hypericoides</i>				X
<i>Hordeum</i> sp.				X
<i>Hypochaeris glabra</i>	X	X		X
<i>Juncus pallidus</i>	X			X
<i>Kingia australis</i>				X
<i>Lepidosperma leptostachyum</i>				X
<i>Lepidosperma pubisquameum</i>				X
<i>Lolium rigidum</i>				X
<i>Lomandra caespitosa</i>				X
<i>Lotus subbiflorus</i>				X
<i>Mesomelaena tetragona</i>				X
<i>Monadenia bracteata</i>				X
<i>Moraea flaccida</i>				X
<i>Nuytsia floribunda</i>				X
<i>Orobanche minor</i>				X
<i>Pennisetum clandestinum</i>	X			
<i>Romulea rosea</i>				X
<i>Solanum linnaeanum</i>				X
<i>Tetraria octandra</i>				X
<i>Tridaceae</i> sp.				X
<i>Trifolium campestre</i>				X
<i>Trifolium repens</i>				X
<i>Typha orientalis</i>	X			
<i>Ursinia anthemoides</i>				X
<i>Vulpia</i> sp.				X
<i>Wahlenbergia capensis</i>				X

APPENDIX C

Individual Sample Unit Data

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	1	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	405767	6430137

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments
	SL	Grey/Brown		5cm humus

Geomorphology:	Topography	Aspect	Slope (°)
	F		<5%

Litter:	Logs	Twigs	Leaves	Bare Ground (%)
	4	4	10	8

Disturbance:	Time Since Fire	Level of Human Impact	Condition
	>5	Med-high	G-D

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)	12	5	0.5
	% Cover	30	10	70

Observations	Heavily grazed understory - historic - loss of ground layer. Few dee marrie -
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Field description of vegetation	Woodland of <i>Corymbia calophylla</i> over <i>Kingia australis</i> over pasture weeds and sedges.
---------------------------------	--

Species	Foliage Projective Cover
<i>Corymbia calophylla</i>	30
<i>Kingia australis</i>	3
<i>Eucalyptus lane-poolei</i>	1
<i>Hakea spathulata</i>	0.3
<i>Lepidosperma pubisquameum</i>	5
<i>Tetraria octandra</i>	1
<i>Hibbertia hypericoides</i>	0.1
<i>Cyathochaeta avenacea</i>	0.1
<i>Ursinia anthemoides</i>	1
<i>Arctotheca calendula</i>	6
<i>Lotus subbiflorus</i>	2
<i>Romulea rosea</i>	40
<i>Ehrharta longiflora</i>	0.5
<i>Austrostipa</i> sp.	0.1
<i>Moraea flaccida</i>	0.04
<i>Solanum linnaeanum</i>	0.1
<i>Banksia dallanneyi</i>	1
<i>Briza maxima</i>	4
<i>Baeckea camphorosmae</i>	0.1
<i>Banksia armata</i> var. <i>armata</i>	0.2
<i>Lepidosperma pubisquameum</i>	1
<i>Tridaceae</i> sp.	0.2
<i>Erodium cicutarium</i>	0.4
<i>Juncus pallidus</i>	0.1
<i>Mesomelaena tetragona</i>	0.1
<i>Lotus subbiflorus</i>	0.3

<i>Bromus diandrus</i>	0.01
<i>Avena barbata</i>	3
<i>Hordeum sp.</i>	1
<i>Trifolium campestre</i>	1
<i>Monadenia bracteata</i>	0.1
<i>Aira caryophylla</i>	
<i>Wahlenbergia capensis</i>	0.05
<i>Briza minor</i>	
<i>Lepidosperma leptostachyum</i>	4

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	2	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	406097	6430161

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments
	SL	Brown/grey		Humus layer

Geomorphology:	Topography	Aspect	Slope (°)
	F		<5

Litter:	Logs	Twigs	Leaves	Bare Ground (%)
	1	2	15	5

Disturbance:	Time Since Fire	Level of Human Impact	Condition
		High	0.5

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)	14	5	0.5
	% Cover	20	5	85

Observations	Pasture understory
---------------------	--------------------

Field description of vegetation	Woodland <i>Corymbia calophylla</i> over <i>Kingia australis</i> over weeds.
--	--

Species	Foliage Projective Cover
<i>Corymbia calophylla</i>	15
<i>Nuytsia floribunda</i>	2
<i>Kingia australis</i>	3
<i>Romulea rosea</i>	40
<i>Briza maxima</i>	10
<i>Lotus subbiflorus</i>	5
<i>Erodium cicutarium</i>	5
<i>Ehrharta longiflora</i>	30
<i>Hakea spathulata</i>	0.2
<i>Banksia armata</i> var. <i>armata</i>	0.2
<i>Orobancha minor</i>	0.01
<i>Arctotheca calendula</i>	
<i>Lolium rigidum</i>	0.25
<i>Lomandra caespitosa</i>	0.2
<i>Trifolium campestre</i>	0.8
<i>Bromus diandrus</i>	1

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	3	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	406249	6430376

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments	
	SLG	reddish brown		quartz stone	

Geomorphology:	Topography	Aspect	Slope (°)
	F		

Litter:	Logs	Twigs	Leaves	Bare Ground (%)
	3	2	7	5

Disturbance:	Time Since Fire	Level of Human Impact	Condition
	10+	High	D

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)	15	5	0.5
	% Cover	10	2	80

Observations	
---------------------	--

Field description of vegetation	<i>Corymbia calophylla</i> and <i>Eucalyptus lane-poolei</i> over <i>Kingia australis</i> over weeds.
--	---

Species	Foliage Projective Cover
<i>Corymbia calophylla</i>	8
<i>Eucalyptus lane-poolei</i>	5
<i>Banksia armata</i> var. <i>armata</i>	0.1
<i>Kingia australis</i>	1
<i>Romulea rosea</i>	30
<i>Briza maxima</i>	10
<i>Ehrharta longiflora</i>	5
<i>Arctotheca calendula</i>	5
<i>Lotus subbiflorus</i>	5
<i>Moraea flaccida</i>	1
<i>Lotus subbiflorus</i>	1
<i>Hypochaeris glabra</i>	0.5
<i>Avena barbata</i>	1
<i>Vulpia</i> sp.	15
<i>Trifolium repens</i>	0.1
<i>Orobancha minor</i>	0.05
<i>Cyathochaeta avenacea</i>	0.3
<i>Lolium rigidum</i>	0.2

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	4	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	405783	6431032

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments

Geomorphology:	Topography	Aspect	Slope (°)

Litter:	Logs	Twigs	Leaves	Bare Ground (%)

Disturbance:	Time Since Fire	Level of Human Impact	Condition

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)			
	% Cover			

Observations	Adjacent to Rail Reserve in West - FCT 3a
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Field description of vegetation	Degraded pasture with exotic species <i>Eragrostis curvula</i> , <i>Erodium</i> , <i>Hypochaeris glabra/radicata</i> complex, <i>Gomphocarpus fruticosus</i> and <i>Cynodon dactylon</i> .
--	--

Species

Eragrostis curvula
Erodium cicutarium
Hypochaeris glabra
Gomphocarpus fruticosus
Cynodon dactylon

Foliage Projective Cover

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	5	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	406316	6431345

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments

Geomorphology:	Topography	Aspect	Slope (°)

Litter:	Logs	Twigs	Leaves	Bare Ground (%)

Disturbance:	Time Since Fire	Level of Human Impact	Condition

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)			
	% Cover			

Observations	Small Dam
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Field description of vegetation	Degraded pasture land of <i>Typha orientalis</i> , <i>Juncus pallidus</i> , Kikuyu, <i>Casuarina obesa</i> and <i>Hypochaeris glabra/radicata</i> complex.
--	--

Species*Typha orientalis**Juncus pallidus**Pennisetum clandestinum**Casuarina obesa**Hypochaeris glabra***Foliage Projective Cover**

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	6	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	406117	6431865

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments

Geomorphology:	Topography	Aspect	Slope (°)

Litter:	Logs	Twigs	Leaves	Bare Ground (%)

Disturbance:	Time Since Fire	Level of Human Impact	Condition

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)			
	% Cover			

Observations	
---------------------	--

Field description of vegetation	Cleared and degraded paddock with exotic Eucalyptus sp., Corymbia calophylla, Eucalyptus marginata and Acacia sp.
--	---

Species

Corymbia calophylla
Eucalyptus marginata
Eucalyptus sp.
Acacia saligna

Foliage Projective Cover

APPENDIX C: Individual sampling unit data

Date:	6/06/2008	Site:	7	Sampling Unit Type	relevé
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Location:	Datum	Zone	Easting	Northing
	GDA	50	406000	6432243

Soils:	Soil texture	Soil Colour	Outcrop	Soil Comments

Geomorphology:	Topography	Aspect	Slope (°)

Litter:	Logs	Twigs	Leaves	Bare Ground (%)

Disturbance:	Time Since Fire	Level of Human Impact	Condition

Vegetation Structure:	Strata	Upper	Mid	Lower
	Height (m)			
	% Cover			

Observations	Rail reserve to West - FCT 3a/3b
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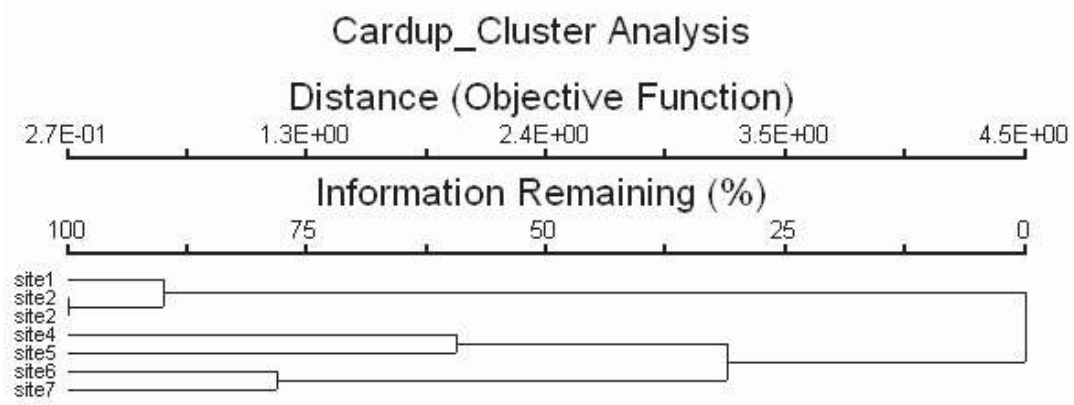
Field description of vegetation	Degraded <i>Corymbia calophylla</i> over <i>Xanthorrhoea preissii</i> with planted exotic <i>Eucalyptus</i> sp.
--	---

Species
Eucalyptus sp.

Foliage Projective Cover

APPENDIX D

Cluster Analysis and Dendrogram



PC-ORD, 5.0

Cardup_Cluster Analysis

Linkage method: FLEXIBLE BETA
 Distance measure: Sorensen (Bray-Curtis)
 Flexible beta value selected is -0.250

Percent chaining = 0.00

Column Fusion Dendrogram

