THE UNIVERSITY OF WESTERN AUSTRALIA

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT SWAN COASTAL PLAIN

VERSION 1

FEBRUARY 2007

REPORT NO: 2005/067

ATA Environmental
environmental scientists

DISCLAIMER

This document is published in accordance with and subject to an agreement between ATA Environmental **("ATA")** and the client for whom it has been prepared The University of Western Australia **("Client")** and is restricted to those issues that have been raised by the client in its engagement of ATA and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such Documents.

Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by ATA and the Client without first obtaining the prior written consent of ATA, does so entirely at their own risk and ATA denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this Document for any purpose other than that agreed with the Client.

QUALITY ASSURANCE

ATA Environmental has implemented a comprehensive range of quality control measures on all aspects of the company's operation and has Quality Assurance certification to ISO 9001.

An internal quality review process has been applied to each project task undertaken by us. Each document is carefully reviewed by core members of the consultancy team and signed off at Partner level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Document No: UWA-2003-001-FAAS_003_st_V1

Report No: 2005/067

Checked by:	Signed:		Date: 27 February 2007
	Name:	Dr Scott Thompson Senior Environmental Scientist	
Reviewed by:	Signed:		Date: 27 February 2007
	Name:	Dr Paul van der Moezel Principal	
Approved by:	Signed:		Date: 27 February 2007
	Name:	Dr Paul van der Moezel Principal	

TABLE OF CONTENTS

FIGURES

PLATES

TABLES

APPENDICES

1. INTRODUCTION

1.1 Purpose and Scope

The University of Western Australia (The University) proposes to develop the eastern portion of Lot 4 Underwood Avenue for residential purposes. The University has referred this development to the Department of Environment and Heritage (DEH) under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. The referral is an amended proposal to one that was previously referred to the DEH in 2004.

This report has been prepared in support of The University's *EPBC Act 1999* referral. It investigates the importance of Lot 4 Underwood Avenue for supporting Carnaby's Cockatoo and to determine the potential for adverse impacts on Carnaby's Cockatoo arising from the proposed development. More specifically, this report includes:

- a description of the vegetation on the Underwood Avenue site;
- a description of Carnaby's Cockatoo;
- a summary of the ecology of Carnaby's Cockatoo including its distribution, movements, breeding and foraging requirements;
- a summary of the current Western Australian (WA) government recovery plan for Carnaby's Cockatoo;
- results of an assessment of the bushland, road side verges, parkland, etc in the western suburbs of the Perth metropolitan area (Refer to Figure 1 for study area) that could be foraging and possibly future breeding sites for Carnaby's Cockatoo;
- results of a tree survey on the Underwood Avenue site that may contain hollows that may possibly be used by Carnaby's Cockatoo's as nesting sites in the future; and
- management recommendations for the conservation of Carnaby's Cockatoos to ensure that the proposed action does not have a significant impact on a threatened species listed under the *EPBC Act* 1999.

1.2 Background

1.2.1 Location

Lot 4 Underwood Avenue Shenton Park is located approximately 5km west of the Perth CBD (Figure 1). It is located at the corner of Underwood Avenue and Selby Street in Shenton Park, within the City of Nedlands.

1.2.2 Previous *EPBC Act 1999* Referral

A previous proposal for the development of Lot 4 Underwood Avenue Shenton Park was referred to the DEH (Referral 2004/1479) by The University. The DEH determined that the proposed development was a controlled action due to the area being a foraging and potential breeding site for Carnaby's Cockatoo (*Calyptorhynchus latirostris*). The reasons for the previous proposal being a controlled action (numbers 13 to 18 are the same as in the letter provided by the DEH) are outlined below. These reasons have been investigated and addressed

in detail in this report in order to demonstrate that development of Lot 4 should not be considered a controlled action.

13 Carnaby's Cockatoo has been listed as 'endangered' under the *EPBC Act 1999* due to its abundance having at least halved over the last three generations, together with a decline in both the area occupied and the quality of available habitat for breeding and feeding. The breeding population is estimated at 60,000 breeding birds, with three to five sub-populations, the largest being about 20,000 birds, and that the population is continuing to decline.

14 Carnaby's Cockatoo has been recorded in Bold Park, to the west of the site, and is known to regularly occur within the local metropolitan area. The DEH found that Carnaby's Cockatoos regularly feed in native bushland and suitable vegetation along roads and in backyards in the local area during autumn and winter, and may occasionally occur all year round.

15 The area of bushland potentially affected by the proposed action[1] is about 35ha, of which 23ha will be cleared and 12ha preserved in a proposed Conservation Area. The DEH found that the areas to be cleared included substantial stands of *Banksia prionotes*, *B. menziesii* and *B. attenuata* which are known to provide forage habitat for the Cockatoo. The DEH found that *B. prionotes*, in particular, provides high quality forage habitat. Whilst the proposed Conservation Area will include 0.1ha of *B. prionotes*, other areas of the site containing this species will be cleared.

16 The DEH found that while Carnaby's Cockatoos do not breed in the metropolitan area, recent observations indicate an increasing trend for breeding in coastal areas to the south of Perth. The DEH found, based on information provided by Birds Australia, that ongoing loss of traditional nesting sites could mean that metropolitan areas on the Perth Coastal Plain may be used for breeding in the near future. In this regard, the DEH found that potential nest sites had been identified by Birds Australia nearby in Bold Park. The DEH found that successful breeding for the Carnaby's Cockatoo requires the presence of tracts of high quality feeding habitat in proximity.

17 The DEH found that the action site contains high quality habitat likely to be regularly utilised by the listed endangered Carnaby's Cockatoo and that the loss of up to 23ha of such habitat is likely to represent a significant loss of available habitat for foraging by the Cockatoo in the Perth Metropolitan area. The DEH found that the loss of this habitat may also jeopardise successful breeding in the event of nesting occurring in the future along the coastal plain in metropolitan areas. The DEH also found that loss of habitat on the action site could adversely affect the movement of Cockatoo's between extensive areas of bushland to the west (Bold Park) and east (Kings Park).

18 The DEH in light of the comments provided in paragraphs 13-17 found that the proposed action was likely to have a significant impact on a threatened species list under the EPBC Act.

If there is a potential to significantly impact on a species of conservation significance listed under the *EPBC Act 1999*, then the proponent is obliged to refer the proposal to the DEH. The DEH *Significant Impact Guidelines* (2006) indicate a development is likely to have a significant impact on critically endangered and endangered species, if it will:

[1] Note that the proposed action referred to in this point relates to the previous development proposal and not the current proposal.

- *lead to a long-term decrease in the size of a population;*
- *reduce the area of occupancy of the species;*
- *fragment an existing population into two or more populations;*
- *adversely affect habitat critical to the survival of a species;*
- *disrupt the breeding cycle or a population;*
- *modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;*
- *result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;*
- *introduce disease that may cause the species to decline; or*
- *interfere with the recovery of the species.*

This review of the literature and habitat assessment was undertaken to test the validity of DEH reasons for determining a controlled action on clearing Lot 4, Underwood Avenue, Shenton Park, Western Australia (EPBC 2004/1479) and in the context of DEH's *Significant Impact Guidelines*. In addition, the findings from this analysis have been used to develop management strategies that could be implemented to off-set any impacts that clearing of portions of the Underwood Avenue site would have on Carnaby's Cockatoo.

2. CARNABY'S COCKATOO

2.1 Description

Carnaby's (or Short-billed) Cockatoo (*Calyptorhynchus latirostris*) is a large, pied, cockatoo. Cockatoos (family Psittacidae) are a distinctive group within the Psittaciformes. Their size (most adult Carnaby's Cockatoo have a body mass greater than 500g and length greater than 50cm), gregarious nature, distinctive calls and perky habits, makes this family a ubiquitous part of the Australian landscape. In Australia, Cockatoos are divided into four subfamilies; the predominantly black species (Calyptorhynchinae), the predominantly white species (Cacatuinae) and two monotypic species (Microglossinae and Nymphicinae; Higgins 1999). Carnaby's Cockatoo is one of five 'black' *Calyptorhynchus* species, all of which are endemic to Australia.

Three *Calyptorhynchus* cockatoos are found in southwest Australia (Higgins 1999). The Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) which is easily distinguished from Carnaby's Cockatoo by red panels on its tail, and it does not have white cheek patches. Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) is morphologically similar to Carnaby's Cockatoo. The major external difference between these two species is Carnaby's Cockatoo has a shorter upper mandible (Saunders 1979a; Plate 1). These two species are closely related and are often difficult to distinguish unless the observer is familiar with their different calls and feeding habits (Saunders 1979a; Cooper 2000; Cale 2003).

Carnaby's Cockatoos are highly gregarious, usually seen in trios, small parties or large flocks (up to 5000 birds; Perry 1948). These flocks usually contain males, females and immature birds. Male Carnaby's Cockatoos can be identified by having a black bill and red eye-ring, where as females have a light grey bill and a grey eye-ring (Higgins 1999; Cale 2003). Furthermore, the pale patch on the ear-coverts is slightly bigger and paler on females than males, and the pale fringes of leading underwing-coverts and feathers of the under body are usually broader on females (Higgins 1999). Juveniles are very similar to adult females and best distinguished by continuous harsh rasping calls begging for food (Higgins 1999). By their second year, immature males differ from juveniles and adults by having a bicoloured bill (some dark on the upper mandible, pale lower mandible; Higgins 1999). Carnaby's Cockatoos are a long-lived species, with a reproductive life estimated to be 15 years (Cale 2003).

2.2 Status

Carnaby's Cockatoo is listed under the Wildlife Conservation (Specially Protected Fauna) Notice 2005 as a Schedule 1 species – Fauna that is rare or likely to become extinct. A Recovery Plan for Carnaby's Cockatoo for 2002 to 2012 has been prepared by the former Department of Conservation and Land Management (CALM) [now Department of Environment and Conservation (DEC)] and is currently being implemented (see details below).

Carnaby's Cockatoo is listed under the *EPBC Act 1999* as Endangered.

2.3 Distribution and Population

Carnaby's Cockatoo is endemic to the forests, woodlands and wheatbelt of southwest Australia (Davies 1966; Saunders 1974a; 1979a; 1980; Saunders and Ingram 1995). They have been sighted from the lower Murchison, east to Nabawa, Wilroy, Waddi Forest, Nugadong, Manmanning, Durokoppin, Noogar, Lake Cronin, head of Oldfield River and Cape Arid (Davies, 1966; Johnstone and Storr, 1998). Most records are south of 29° S and west of 120° E (Higgins 1999), although Davies (1966) recorded them north as far as 28° S and Whitlock (1937)

recorded them at Norseman. Geographic distribution maps of breeding sites suggest that Carnaby's Cockatoo breed in areas receiving between 300 – 750 mm of annual rainfall (Saunders 1974a). On the Swan Coastal Plain, breeding has been reported at Cockleshell Gully, Cataby, Regans Ford, Gingin, Yanchep and Gnangara (Saunders 1980; Johnstone and Storr 1998).

Johnstone *et al* (2006) reported that as a result of their survey of the Perth – Bunbury Highway (Kwinana Freeway Extension and Peel Deviation) they located 23 confirmed or probable nests for Carnaby's Cockatoo. These were clustered in particular sections of the highway alignment. The highest density of foraging areas, confirmed and probable nesting trees and sightings was in the southern most section of the corridor between Doman Road and Lake Clifton in areas of intact native vegetation. All nest trees were located in the southern portion of the route. Johnstone *et al.* (2006) reported records of breeding Carnaby's Cockatoo in Tuarts in the vicinity of the Lake Clifton Road House from the Storr-Johnstone Birds Data Bank.

In some locations, breeding populations have decreased or become locally extinct (Saunders 1986; Saunders and Ingram 1987). For example, in the Coomallo Creek area north of Perth, Black Cockatoos laid 74 clutches in 1973, 75 in 1974, 82 in 1975 but only 20 in 1994 and 19 in 1996 (Saunders and Ingram 1998). Saunders (1986) reported finding 13 nests at Manmanning in 1969 but by 1977, the species had stopped breeding in the area. Saunders (1990) reported failed nestings due to predation by a cat, galahs broke Carnaby's Cockatoo eggs and took over nests, while other adult birds were killed by vehicles and Wedge-tailed Eagles (*Aquilla audax*).

We could find no recent assessment based on any actual survey data for the current number of Carnaby's Cockatoos. We note the determination for the controlled action by DEH reported that there were 60,000 breeding Carnaby's Cockatoos. This most probably came from Saunders *et al.* (1985). A review of the Saunders *et al.* (1985) article suggests that this assessment was at best an educated guess as there was no indication of how the number was determined. Because of the lack of recent published population data, Carnaby's Cockatoo's wide distribution, high level of movement between seasons and morphological and behavioural similarities with Baudin's Cockatoo, it is difficult to provide an accurate estimate of the population size of Carnaby's Black Cockatoo. It is surprising that given its status with DEC and the DEH, that attempts have not been made by government agencies to estimate the population and monitor changes in recent years.

2.4 Movements

Carnaby's Cockatoos are partly migratory and partly sedentary (Higgins 1999). In the drier regions of their geographic range where most of the native vegetation has been cleared (e.g. wheatbelt), Carnaby's Cockatoos are postnuptial migrants (Saunders 1980; Saunders and Ingram 1995). After breeding, individuals in these areas migrate to feed in higher rainfall areas including the Swan Coastal Plain, and to a lesser extent, forests dominated by Jarrah (*E. marginata*), Marri (*C. calophylla*) and Karri (*E. diversicolor*; Saunders 1980). On the Swan Coastal Plain, Carnaby's Cockatoos have been recorded foraging in most suburbs including Shenton Park bushland, Bold Park, Kings Park, road side verges, etc (Saunders 1974a; pers. observation) and in pine plantations within the greater Perth metropolitan area (Perry 1948). Vagrants have been recorded on Rottnest Island (Winnett 1989; Storr and Johnstone 1988) and Garden Island (Wykes *et al.* 1999). These later two sightings clearly indicate that Carnaby's Cockatoo will fly considerable distances over non-vegetated areas to forage.

Saunders (1980) recorded non-breeding cockatoos at Coomallo Creek foraging within a 50km radius of their breeding area, whereas cockatoos at Manmanning moved a much greater distance to the coastal plain during their non-breeding season. These data suggest that Carnaby's

Cockatoo move from areas where there is little food to southern and western coastal areas where food is presumably more plentiful during summer and autumn (Davies 1966; Saunders 1980).

2.5 Breeding Habitat

Carnaby's Cockatoo breed between July and November mostly in eucalypt woodland (Saunders 1980; 1986). Carnaby's Cockatoo nest in tree hollows that are created by fire, fungi, termites or old age, with hollows between 2.5 and 12m above the ground (Saunders 1979b; Higgins 1999). Hollows are large, ranging from 10 to over 250cm in depth (Saunders 1979b). These hollows are usually in live or dead smooth-barked Salmon Gum (*Eucalyptus salmonophloia*) or Wandoo (*Eucalyptus wandoo*). However, Carnaby's Cockatoo will also nest in Red Morrell (*E. longicornis*), York Gum (*E. loxophleba*), Tuart (*E. gomphocephala*), Flooded Gum (*E. rudis*), Gimlet (*E. salubris*), Swamp Yate (*E. occidentalis*) and Marri (*Corymbia calphylla*; Saunders 1979b; Cale 2003). When breeding, they most often forage in the surrounding shrubland and kwongan heath (Higgins 1999). On the Swan Coastal Plain, breeding could occur in Tuart, Flooded Gum, Swamp Yate and Marri. Adults return to the same breeding area each year (Saunders 1977) and some use the same tree hollow for many years in succession to raise their chicks, others shift their nests among a number of trees in the same area (Saunders and Ingram 1998).

Young remain with their parents until the parents return to the breeding area in the following year (Saunders 1980). Immature birds probably do not move into the breeding areas until they are ready to breed, although little is known of the movements of immature Carnaby's Cockatoo until they are ready to breed (Saunders 1977).

Fragmentation and degradation of native habitat through clearing for agriculture, forestry or mining have reduced potential breeding areas (Saunders and Ingram 1987: Higgins 1999). Destruction of hollow bearing trees and foraging habitat near breeding sites are believed to be the main reason for the speculated recent decline in the population of Carnaby's Cockatoo (Saunders and Ingram 1998; Higgins 1999; Cale 2003).

The social organisation of breeding Carnaby's Cockatoo is known (e.g., Saunders 1974a, 1977; 1979b, 1980, 1982, 1986; Saunders *et al.* 1985; and summarised in Higgins 1999). Carnaby's Cockatoo start reproducing at about fours years of age and continue for at least 15 years (Cale 2003). Strong pair bonds are then formed, often for life. Females lay one or two eggs asynchronously with an average of 8 days (range 1-12) between the laying of the first and second egg. Egg laying usually occurs in early July to mid-October, with inland birds laying approximately three weeks lately than those closer to the coast. Females incubate their 1-2 eggs for 28-29 days (Saunders 1982). When two eggs are laid, it is extremely rare for both nestlings to successfully fledge. The female alone broods and feeds the young birds. Initially, the female, and later the chick, rely on the male for food during the brooding and hatching of the eggs (Saunders 1977, 1982). After two to three weeks, both parents forage and return at mid-morning and dusk to feed the young (Saunders 1977; 1982). The young are dependent on parents for several months after fledgling. Fledglings are independent after about 10-11 weeks (Saunders 1977).

The breeding success of Carnaby's Cockatoo is believed to be strongly influenced by the availability of food at breeding sites (Saunders *et al.* 1995). Saunders (1977) found that birds that foraged within one or two kilometers from nesting sites had greater fledgling success than those from populations that had to travel up to four kilometres to obtain food. In a study that monitored Carnaby's Cockatoo's breeding over 25 years at Coomallo Creek, Saunders and Ingram (1998) showed that the number of breeding attempts halved by the end of the study. During this period, native vegetation cover was reduced from 90% in 1959 to 25% in 1996.

Their study revealed that although there was a surplus of trees with hollows of sufficient sizes, clearing of adjacent foraging habitat had adversely impacted on the success of breeding birds. Therefore, breeding sites typically have nearby areas of scrub and heath where birds forage on seeds and flowers of numerous trees and shrubs including *Banksia, Hakea, Dryandra, Grevillea* and *Callistemon* spp. (Robinson 1960; Saunders 1980; Higgins 1999). Unlike other cockatoo species, Carnaby's Cockatoo will not utilise cereal crops (Saunders *et al.* 1985), but will feed on *Erodium* seed (Saunders 1980). They also feed on insect larvae found under the bark and in galls of a variety of trees (Robinson 1965; Saunders 1980; Scott and Black 1981). It is not known whether Carnaby's Cockatoo would utilise the feeding resources of pine plantations if they established nesting sites in close proximity.

Wally Kerkoff of Moora successfully developed an artificial nesting box for Carnaby's Cockatoo (Davies and Loomes 2002). Nesting logs were mounted on a six metre pole of three inch piping concreted into the ground. At the top, a plough disk supported a hollow log up to one metre high, with a cavity of least 25cm in diameter. The top was covered with a sheet of aluminium and a side entrance was provided near the top and was about 12cm square. A 12cm layer of Black and Gold potting mix was place in the bottom (Davies and Loomes, 2002). Subsequently, Davies (2005) reported that 13 of the 41 pole top nesting logs in six farms, and schools and parks in the Moora area were used by Carnaby's Cockatoo. Other pole top log hollows were used by Galahs and Australian Ringnecks. Interestingly, the five erected in the Moora township were all being occupied in October 2004 by Carnaby's Cockatoo, although it is not reported if any of these hollows were used to successfully raise chicks.

We have been given anecdotal information to indicate Carnaby's Cockatoo have bred near the Yanchep National Park and in an area south of Mandurah in recent years. It is speculated that that Carnaby's Cockatoo may have moved into these areas to breed in recent years but this conclusion is unable to be confirmed, as there are no survey data for these areas for earlier years.

Although flocks of Carnaby's Cockatoo are seen foraging in the Perth metropolitan area during summer and autumn there are no published data of any breeding taking place in the greater Perth metropolitan area. It is also interesting that Carnaby's Cockatoo will nest in the Moora townsite but have not nested in the Perth metropolitan area. It is not known if they bred in the Perth area before European settlement.

2.6 Feeding

Saunders (1980) reported Carnaby's Cockatoo at Coomallo Creek (breeding area) foraging mostly on native plants, with the only exception being *Erodium* sp.. Plant species foraged included *Banksia attenuata, B. menziesii, Dryandra fraseri, D. sessilis, D. speciosa, Hakea auriculate, H. conchifolia, H. gilbertii, H. incrassate, H. lissocarpha, H. obliqua, H. prostrata, H. scoparia, H. undulata* and *Lambertia multiflora.* At Manmanning (another breeding area), Carnaby's Cockatoo foraged on *Hakea.* spp. as well as *Grevillea apiciloba, G. armigera, G. paniculate, G. paradoxa, G. petrophiloides, Dryandra affincirciodes* and *Isopogon scarbrusculus.* A detailed summary of plants foraged by Carnaby's Cockatoo is provided in Higgins (1999; Appendix 1).

At Coomallo Creek, Carnaby's Cockatoo travelled on average 1.4km from their nests to forage, whereas at Manmanning they foraged more widely and travelled an average of 2.5km from their nest to forage (Saunders 1980). At Manmanning, road and railway reserves were extensively used for foraging, presumably as this was the closest food source to their nests. The availability of food near the nest influenced the time spent incubating eggs and fledging body mass (Saunders 1980). At Manmanning, Carnaby's Cockatoo traversed agricultural land to foraging in remnant plots of uncleared land.

During summer and autumn, large numbers of Carnaby's Cockatoo congregate and forage in pine plantations, coastal heath, woodland and southern forests along the coastal plain (Saunders 1974a; pers. obs.). Here they feed on many species including pine, marri, *Banksia* seeds, *Hakea*, *Dryandra* and *Allocasuarina*, as well as corkscrew grass, wild radish, macadamias, almonds and canola (Mawson 1995; Davies and Loomes 2002; Perry 1948; Saunders 1980; Rowley *et al.* 1989; Higgins 1999). Since the 1930s, pine plantations have become an important feeding resource during the summer months (Perry 1948; Saunders 1974a; 1980). The utilisation of pine plantations by cockatoos is likely to reflect the high energetic return of pine seeds, the concentrated food source and the loss of native habitat that has occurred on the Swan Coastal Plain since the 1930s.

2.7 Summary of Carnaby's Cockatoo Recovery Plan

Carnaby's Cockatoo is as a Schedule 1 species (Species that is rare or is likely to become extinct) under the *WA Wildlife Conservation Act* 1950 and is ranked as Endangered under the *EPBC Act* 1999. Carnaby's Cockatoos are also listed as Endangered in the Action Plan for Australian Birds (Garnett and Crowley 2000).

Cale (2003) reported that Carnaby's Cockatoo was listed as endangered because:

- much of its habitat in the wheatbelt has been cleared or fragmented. It is estimated that over 90% of this habitat has been removed;
- clearing of heathland surrounding breeding sites has reduced the availability of food (seeds and insect larvae) for breeding birds and young;
- in many woodland remnants, the lack of eucalypt regeneration and the deterioration of hollows has reduced the availability of suitable nest hollows;
- on the swan coastal plain, its original food resources have been largely replaced by introduced pine plantations which are to be reduced significantly in the future; and
- it is a highly prized cage bird and is taken illegally from the wild. Often trees are cut down or the hollows severely damaged when young and eggs are taken making them unsuitable for future breeding attempts.

The belief that Carnaby's Cockatoo numbers are in serious decline has lead to a recovery plan being released in 2003 (Cale 2003). This plan details the current status of the cockatoo and provides conservation measures to increase the population. The conservation programs that existed prior to the recovery plan consisted of:

1. **Captive Breeding.** Carnaby's Black-Cockatoos are held in captivity under two programs. These were a captive breeding program and a 'derelict program'. The captive breeding program involved the taking of eggs and chicks from the wild to increase the chances of birds reaching adults, whereas, the derelict program involved injured cockatoos that are brought to the attention of the DEC being rehabilitated before being released back into the wild. These programs aimed to increase the species in aviculture, lessen the value of birds, minimise the illegal taking of young from the wild and limit damage to nest trees and hollows.

2. **Repair of Damaged Hollows**. Over the last ten years, damaged hollows used by Carnaby's Cockatoos have been repaired by DEC staff.

3. **Public Awareness.** Perth Zoo and the Western Australian Museum discovery Centre have public awareness programs for school children. Several primary schools in the metropolitan and country areas have become involved in seed collecting and planting native vegetation to provide additional foraging areas for Carnaby's Cockatoo.

The recovery plan acknowledged that these existing measures would not adequately conserve this threatened species. Five broad strategies were outlined in the recovery plan for the period 2002-2012 (Cale 2003):

1. **Habitat management of priority areas.** This includes identifying feeding and breeding habitat in priority areas.

2. **Habitat management of non-breeding areas.** The recovery team will encourage and promote practices to retain and increase areas of native vegetation that provide food for Carnaby's Cockatoo.

3. **Monitoring of the Carnaby's Cockatoo.** Includes regularly monitoring the number of breeding pairs and use of hollows in priority areas.

4. **Community Involvement**. A coordinated public information and participation program is considered an essential strategy for this Recovery Plan.

5. **Captive-Breeding Program.** Continuation of the captive breeding program.

Achievements in the Recovery Plan

The project officer for the recovery plan has identified breeding sites for Carnaby's Cockatoo in the Shires of Coorow, Moora, Dandaragan, Victoria Plains, Katanning and Kent. Bindoon Artillery Range has also been shown to be a significant breeding site.

Damaged nest hollows have been repaired and nest box trials have commenced on a number of properties in the northern agricultural area. A protocol has been prepared for the construction of artificial nest boxes. A community information program is in place that includes public presentations, newsletter and information sheets. DEC continues with the captive breeding program from the rehabilitated and derelict birds.

Some of the Recovery Plan is being implemented by Birds Australia WA. DEC appears yet to allocate significant funds to adequately implementing its Recovery Plan.

2.8 Birds Australia WA Inc

Birds Australia WA has had a Commonwealth Government Natural Heritage Trust grant and a Lotterywest-Gordon Reid Foundation grant to implement aspects of the Carnaby's Cockatoo Recovery Plan.

2.8.1 Natural Heritage Trust – *Carnaby's Black-Cockatoo Recovery Project; Final Report to Environment Australia for the Period August 2002 to mid 2003* (McMahon, 2002).

The objectives of this project were:

- to continue to raise public interest and knowledge of the plight of Carnaby's Black-Cockatoo;

- to identify priority breeding and feeding sites for the conservation of this species; and
- to implement conservation actions within priority sites as outlined in the Recovery Plan.

Outcomes:
Staff and volunteers involved in the project attended a number of agricultural shows, talked with stakeholder groups, organised printed articles in a variety of media, distributed newsletters and information sheets, established a web-page and conducted a symposium to raise public awareness of Carnaby's Cockatoo.

Corellas and galahs were culled to reduce competition for breeding hollows, areas were fenced, land holders erected artificial nesting hollows, volunteers identified active nesting tree hollows on private land and trees were planted. Field days were organised to provide advice to landholders on the issues surrounding the decline in Carnaby's Cockatoo numbers. A program was put in place to monitor and record active nesting hollows.

2.8.2 Lotterywest – Carnaby's Black-Cockatoo Recovery Project (McMahon 2004)

The objectives of this project were:

- To provide advice and assistance for rural communities, in particular landholders, to successfully manage their breeding populations of Carnaby's Black-Cockatoo.
- To raise public awareness of the plight of the cockatoo across its range.

Outcomes:
Twenty nine chicks had their tail feathers painted with the intention of determining movement patterns of fledging. There are two possible reports that fledging flew about 160km from their nests to the Perth metropolitan area.

A DEC Community Conservation grant was used to repair 90 nest hollows. Monitoring of breeding nests was to continue in the spring of 2004.

The project officer attended a number of public events, distributed newsletters and information sheets on Carnaby's Cockatoo.

3. LOT 4 UNDERWOOD AVENUE

3.1 Vegetation

The vegetation and flora on the subject land has been surveyed by ATA Environmental. An initial interpretation of the vegetation of the study site was conducted using colour aerial photograph (1:1,000) to determine patterns in the vegetation in 1998. Preliminary field surveys were undertaken in January and July 1998 to record flora, determine the distribution of vegetation units and identify the location of any significant flora populations present at the site. Field reconnaissance and a number of 10m x 10m quadrats defined the floristic composition, vegetation condition and weed invasion of each unit. A further flora survey was undertaken in September 2000 to record ephemeral species such as orchids, annual grasses and herbs.

Floristic surveys completed on the site identified 149 species of flora in the bushland (ATA Environmental, 2000). Of these, 112 species are native to the site and 37 are introduced species (including native Australian species that are garden escapes). No Declared Rare Flora was recorded during site visits to the study area including species listed for protection under the *EPBC Act 1999*. However, four (4) populations of the Priority 3 species, *Jacksonia sericea,* were located in the western part of the site.

Priority 3 species are defined by Department of Environment and Conservation as:

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

Jacksonia sericea has been recorded in other nearby bushland areas, including Shenton Bushland (south of the study area), Kings Park (east of the study area) and at Bold Park (west of the study area). Approximately 50% of the population of the Priority 3 species will be retained in the current proposal within the western conservation area.

3.1.1 Vegetation Associations

Figure 2 illustrates the vegetation associations present on Lot 4. For the purposes of this report, the principal vegetation unit has been divided into three vegetation associations consisting of a *Banksia* Low Woodland, a *Banksia prionotes* Closed Scrub and Jarrah (*Eucalyptus marginata*) Woodland with significant variation in structure and composition.

Banksia Low Woodland

The *Banksia* Low Woodland is structurally dominated by *B. menziesii* and *B. attenuata* and, less consistently, by *Allocasuarina fraseriana.* In places, there are stunted Jarrah and emergent Tuart (*E. gomphocephala).* Species that are common in the understorey of the Woodland include *Hakea prostrata* up to 2m and low shrubs including *Mesomelaena pseudostygia, Xanthorrhoea preissii, Petrophile linearis* and *P. macrostachya. Alexgeorgea nitens, Desmocladus flexuosus, Dryandra lindleyana* and several weed species dominate the ground cover.

This vegetation association occurs over much of the western region of the study area and contains four populations of the Priority 3 species, *Jacksonia sericea.* In addition, a small population of the mallee *Eucalyptus decipiens* was found on the lower slopes of the site. *Eucalyptus decipiens* is not a Priority or DRF species but is uncommon in the Perth Metropolitan Region.

Banksia prionotes Closed Scrub

The *Banksia prionotes* Closed Scrub dominates the northern part of the central ridge at the site along Underwood Avenue. This vegetation type has been adversely affected by fire as evidenced by the extent of weed invasion, particularly Veldt Grass, and the apparent young age of the *Banksias*. Throughout the Closed Scrub are scattered young *Banksia menziesii* and *B. attenuata* and mature or dead Tuart trees. The native species diversity in the Closed Scrub is very low as the understorey layer is dominated by weeds. Other species such as *Acacia saligna* and *Pelargonium capitatum,* which are often associated with disturbed areas, are present at the periphery of the Closed Scrub.

Jarrah Low Woodland to Open Woodland

The Jarrah Woodlands at the site vary significantly in species composition and density. The eastern area comprises a Jarrah Woodland with scattered Tuarts and Marri trees over a lower tree canopy of *Banksia attenuata, B. menziesii* and *Allocasuarina fraseriana.* An isolated stand of *Banksia grandis* was found in a relatively open and degraded area of the eastern Jarrah Woodland.

Typical taller shrub species include *Jacksonia furcellata, Hakea prostrata, Xanthorrhoea preissii* and *Macrozamia fraseri.* Common smaller shrubs include *Gompholobium tomentosum, Hibbertia hypericoides, Acacia pulchella, Calytrix fraseri, Mesomelaena pseudostygia, Desmocladus flexuosus* and *Petrophile linearis.* Parrot Bush (*Dryandra sessilis*) occurs in one small stand near the eastern boundary, possibly indicating the presence of limestone at shallow depths below the sand.

3.1.2 Vegetation Condition

The condition of the vegetation was assessed using the condition rating scale of Keighery published in Bush Forever (Government of Western Australia, 2000) and is mapped in Figure 3.

Keighery's condition rating scale ranges from Pristine (where the vegetation exhibits no visible signs of disturbance) to Completely Degraded (where the vegetation structure is no longer intact and without native plant species). A description of the vegetation condition ratings applicable to the study area are outlined below:

Very Good (VG): 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 (G): Vegetation structure significantly altered by obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. 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 (D): 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.

The vegetation condition of the study area ranges from very good to degraded. All of the vegetation types recorded at the site show some signs of disturbance including the presence of non-aggressive and aggressive weeds, partial clearing, frequent fires, and informal tracks.

The vegetation towards the western and eastern boundaries of the site is in very good condition and is the least disturbed regions of the site. While the vegetation structure in these areas has been affected by clearing or selective logging in the past, the native understorey layer is intact with minimal signs of disturbance.

Areas of high disturbance are found at the higher elevations and at the ridge where informal tracks and weeds are numerous because of clearing and fires. The installation of Water Corporation infrastructure in the existing easement resulted in some clearing of vegetation in this area.

3.2 Conservation and Development Proposal

3.2.1 Proposed Development

The University proposes to develop the eastern portion of Lot 4 Underwood Avenue, Shenton Park for residential purposes and with approximately 11.9ha of bushland to be retained for conservation and passive recreation purposes (Figure 4). The retention of approximately 11.9ha for conservation and passive recreational purposes represents almost 33% of the total developable area of 36ha, which includes the area shown as future development in Figure 4.

The balance of the developable area will be for residential purposes and the remainder of Lot 4 continued to be used for University purposes.

This conservation and development proposal represents a significant improvement compared with the previous proposal referred to the DEH.

3.2.2 Conservation and Public Open Space Areas

The current conservation and development proposal for Lot 4 Underwood Avenue, Shenton Park retains two conservation areas (Conservation Areas A and B) that are connected by a vegetated Pubic Open Space (POS) corridor. This proposal (Figure 4) retains approximately 11.9ha of suitable feeding habitat for Carnaby's Cockatoo. The vegetation in the conservation and POS areas are summarised Table 1.

TABLE 1
VEGETATION TYPES PROTECTED IN CONSERVATION AND POS AREAS

Vegetation Type	Current Proposal	
	Conservation Areas (hectares)	POS Area (hectares)
Jarrah/Banksia/Sheoak low woodland	8.0	1.0
Jarrah/Tuart open woodland	0.0	0.9
Banksia attenuata/B. menziesii woodland	1.6	0.0
Banksia prionotes closed scrub	0.0	0.0
Eucalyptus decipiens low woodland	0.1	0.0

Vegetation Type	Current Proposal	
	Conservation Areas (hectares)	POS Area (hectares)
Jarrah over *Banksia menziesii* low woodland	0.3	0.0
Cleared	0.005	0.204

The current conservation and development proposal (including the POS area) protects 10.2ha of vegetation with a condition rating of Good or better. Excluding the POS area, the current proposal protects 9.7ha of vegetation classed as Good or better, which represents an improvement on the previous proposal referred to the DEH.

4. HABITAT ASSESSMENT FOR CARNABY'S COCKATOO IN THE WESTERN SUBURBS

4.1 Background

The DEH (clause 16) found that while Carnaby's Cockatoos do not breed in the metropolitan area, recent observations indicate an increasing trend for breeding in coastal areas to the south of Perth. The DEH found, based on information provided by Birds Australia, that ongoing loss of traditional nesting sites could mean that metropolitan areas on the Perth Coastal Plain may be used for breeding in the near future. In this regard, the DEH found that potential nest sites had been identified by Birds Australia nearby in Bold Park. The DEH found that successful breeding for Carnaby's Cockatoo requires the presence of tracts of high quality feeding habitat in close proximity.

The DEH (clause 17) found that Lot 4 contains high quality habitat likely to be regularly utilised by the listed endangered Carnaby's Cockatoo and that the clearing of such habitat is likely to represent a significant loss of available habitat for foraging by the Cockatoo in the Perth Metropolitan area. The DEH found that the loss of this habitat may also jeopardise successful breeding in the event of nesting occurring in the future on the coastal plain in metropolitan areas. The DEH also found that loss of habitat on Lot 4 could adversely affect the movement of Cockatoo's between extensive areas of bushland to the west (Bold Park) and east (Kings Park).

To test the validity and probity of these claims, an assessment of the suitability of bushland habitat near Lot 4 Underwood Avenue, Shenton Park in the western suburbs of the Perth metropolitan area was undertaken. This assessment included a review of the literature (see above), discussion with experts and a detailed assessment of 526 parcels of bushland, parkland and road side verge that might be utilised by Carnaby's Cockatoo for feeding and breeding.

4.2 Methodology

Carnaby's Cockatoos are a well researched species and many reviews and/or published material are available describing their diet, habitat requirements, breeding and ecology in the non-metropolitan area (see summary in Higgins 1999). In addition, recent reviews and distribution data provided in a number of publications have been assessed (Cale 2003; Gole 2003; 2004; Higgins 1999; Johnstone and Johnstone nd; Olsen *et al.* 2003; Davies and Loomes 2002; Johnstone *et al.* 2006).

The following experts on Carnaby's Cockatoo have been consulted:

- Dr Peter Mawson. Principal Zoologist, Department of Environment and Conservation;
- Dr Stephen Davies, Emeritus Professor, School of Biology, Curtin University;
- Dr Harry Recher, Emeritus Professor, School of Natural Sciences and Centre for Ecosystem Management, Edith Cowan University; and
- Ron Johnstone, Department of Terrestrial Vertebrates, Western Australian Museum.

To develop a suitable research protocol to assess the potential of numerous sites in the western suburbs of the Perth metropolitan area for foraging and possibly breeding a survey of appropriate areas was undertaken. This is described below.

4.2.1 Survey Area

An arc of approximately 5km was drawn using Bold Park as the centre point. The boundary of this arc was extended to incorporate the area bounded in the north by Karrinyup Road, Mitchell Freeway to the east, and the Swan River (Figure 1). It is appreciated that this is not an ecological boundary for Carnaby's Cockatoo, however, it does encompass approximately 5km radius around Bold Park which Birds Australia and DEH identified as a potential breeding area.

Within the study area (Figure 1), all areas of bushland / parkland greater than 0.25ha that contained trees were identified from aerial photos. Between December 2004 and March 2005, these study sites were ground-truthed and the habitat assessed. We identified 526 sites. Habitat assessment rated each site on the following attributes:

1. habitat type;
2. habitat quality;
3. food resource potential;
4. traffic volumes and ethnographic interference; and
5. potential breeding sites.

The assessment criteria for each of these attributes are outlined below.

4.2.2 Habitat Type

Carnaby's Cockatoo selectively forage within specific habitats when breeding in the wheatbelt of Western Australia (Higgins 1999). It mostly breeds in Salmon Gum and Wandoo woodlands and forages in nearby kwongan heath when breeding. Carnaby's Cockatoo have been observed foraging in woodlands, parklands and heath on the Swan Coastal Plain in the Perth metropolitan area. We categorised available foraging habitat in remnant bushland and road side verges into three groups, defined below.

Native Woodlands
Native Woodlands are variable in composition and structure, but contain some or all of the following: 1) Tuart, Jarrah or Marri dominated over-storey, 2) Banksia, Sheoak dominated mid-storey, 3) sclerophyllous understorey (which can be patchy). Food resources available to Carnaby's Cockatoo in native woodlands are provided by native species.

Native Heathlands
Native Heathlands are defined as variable in composition and structure, but typically dominated by proteaceous and acacia species (1-4m in height). Within these heathlands there are very few trees, such as Tuart, Marri or Jarrah. Food resources available to Carnaby's Cockatoo in native heathlands are provided by native species.

Parklands
Parklands are extensively modified by human activity and include cemeteries, golf courses, schoolyards, ovals and streets verges. Trees are either exotic, or contain a mixture of remnant native and planted exotics, or planted native species, but the environment is generally extensively modified. Food resources available to Carnaby's Cockatoo include mostly native species (e.g. Banksia on road side verges).

4.2.3 Habitat Quality

Carnaby's Cockatoos are reported feeding in a variety of different habitats. It is presumed that the better the vegetation condition the greater the propensity for food availability. The quality of each site was categorised using the Bush Forever vegetation condition rating. The rating scales

used are based on an assessment of disturbance, and the ability of the bushland to self-maintain or regenerate. Five categories were recognised:

1. *Completely Degraded* (CD) The structure of this vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as cleared parkland with the flora comprising weed or crop species with isolated native trees or shrubs. This category included many parks, golf courses and semi-cleared areas.

2. *Degraded* (D) 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 frequent fires, the presence of some aggressive weeds in high density, partial clearing, dieback or grazing.

3. *Good* (G) Vegetation structure significantly altered with obvious signs of multiple disturbance. However, the area retains its basic vegetation structure or ability to regenerate.

4. *Very Good* (VG) Vegetation structure is altered, with signs of disturbance. Damage to the vegetation assemblage caused by fires, weeds, dieback and human activity.

5. *Excellent* (E) Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Minimal disturbance due to human activity.

4.2.4 Food Resource Potential

Saunders (1980) reported that Carnaby's Cockatoo in Coomallo Creek, an area with large tracts of uncleared land; and Manmanning, an area of extensive clearing with little native vegetation, depended mostly on native vegetation, particularly seeds of the Proteaceae for food (see above). In the non-breeding periods, Carnaby's Cockatoo from Coomallo Creek wandered locally with 50km radius of the breeding area, still feeding on native vegetation, and relying mostly on seeds of the Marri, *E. calophylla*, and Proteaceae. Carnaby's Cockatoo from the Manmanning breeding area migrated to the coastal plain where they fed on seeds of the Proteaceae, marri and *Pinus* spp. which where contained in the large plantations (Perry 1948; Saunders 1980). Other authors have reported Carnaby's Cockatoo eating a more diverse range of food sources (see above). Carnaby's Cockatoos have been seen feeding in all habitat types (e.g. parkland, woodland, heath) on the Swan Coastal Plain (pers. obs.).

The foraging potential for Carnaby's Cockatoo at each of these sites was assessed. Cooper *et al.* (2002) estimated the daily energy requirement of Carnaby's Cockatoo was 11 *Banksia attenuata* nuts per day. At sites where *B. attenuata* was not present, it was assumed that other species provided similar energy for foraging cockatoos. Five categories were used to assess the availability of potential food for three individual cockatoos (2 parents and one young) at each site. These categories are:

1. vegetation that was devoid of all available food resource potential;

2. vegetation where there were enough food resources on site to feed three Carnaby's Cockatoos for about one week;

3. vegetation where there were enough food resources on site to feed three Carnaby's Cockatoos for about one month, but the plants were degraded or fire affected;

4. vegetation where there were enough food resources to feed three Carnaby's Cockatoos for about one month and plants were in reasonable condition; and

5. vegetation where there are enough food resources to feed three Carnaby's Cockatoos for greater than one month.

4.2.5 Traffic and Ethnographic Interference

There is no record of Carnaby's Cockatoo breeding in the Perth metropolitan area, although they annually migrate to the area in summer where they remain and feed for many months. There is an obvious food source for Carnaby's Cockatoo in the Perth metropolitan area and there are potential breeding hollows for this species within the western suburbs. It is speculated that breeding does not occur in the Perth metropolitan area because of human disturbance. Therefore, sites least affected by human activity are those most likely to be selected as breeding sites if Carnaby's Cockatoo were to ever breed in the metropolitan area. We have categorised each of the 526 sites into one of the following:

1. very high interaction with humans or vehicles;
2. high levels of interaction with humans or vehicles;
3. medium interaction with humans or vehicles;
4. low levels of interaction with humans or vehicles; and
5. limited interaction with humans or vehicles.

4.2.6 Potential Nesting Sites

Carnaby's Cockatoo has specific nesting site requirements. Nests are mostly in smoothed-barked eucalypts with the nest hollows ranging from 2.5 to 12m above the ground, an entrance from 23-30cm diameter and a depth of 0.1-2.5m (Johnstone and Storr, 1998). Eggs are laid in wood dust at the bottom of the hollow after both adults have prepared the nest by stripping chips from the sides and raking the bottom. Potential nesting sites are also used by bees, Little/Western Corellas, Galahs, and to a lesser extent Australian Shelducks.

The availability of suitable nesting trees in each of the 526 sites was recorded. Although, Saunders (1979b) reported breeding was mostly confined to a couple of types of trees, a liberal view of possible suitable trees was adopted. For example, all large Tuarts with suitable hollows were assessed as a potential breeding site. Tree selection criteria are as described above.

4.2.7 Corridor Linkages

The proximity of forging areas to nests influences hatchling success. Nests within 1.4km of good feeding sites gave chicks a better chance of survival than foraging sites up to 4km away. Carnaby's Cockatoo incubating eggs and feeding chicks are likely to initially utilise vegetated areas and corridors leading away from breeding sites before they search more widely. Saunders and Ingram (1995) suggested that connectivity (corridors) between remnant vegetation fostered Carnaby's Cockatoo movement and foraging success. We assessed the connectivity among bushland sites, paying particular attention to those sites assessed as having breeding and foraging potential. This assessment was based on visually analysing figures showing the size and type of habitat (Figure 5). Connectivity is shown in Figure 6.

4.3 Assessment of Trees providing Hollows that could be used by Carnaby's Cockatoo as Nesting Sites on the Underwood Avenue Site

The entire area was searched for trees that contained hollows that may be suitable as Carnaby's Cockatoo nest sites, should the cockatoo decided to nest in the Perth metropolitan area. This survey was done by systematically inspecting every suitable tree on the site. For each tree that potentially contained a suitable hollow, its height and girth (at chest height) was estimated and recorded. The location of each hollow was recorded and the spatial location of the tree was recorded using a GPS. As most of the potential hollows were above 2m, and often much higher, it was not possible to inspect each of the hollows to determine its suitability as a nest site (e.g. diameter of opening, depth, internal composition and structure). The assessor adopted an ultra-cautious approach and included any tree that may have had a hollow even if the entrances where appreciably smaller than the 23-30 cm suggested by Johnstone Storr (1998). Therefore, many trees will be included in the results that looked like they may have contained a suitable hollow(s) from an inspection at ground level, but would be excluded if the hollow(s) were subject to closer examination.

4.4 Study Team

Assessment of sites to categorise and rate habitat type, habitat quality, food resource potential, traffic volumes and ethnographic interference was undertaken by Dr Alex Watson. Assessment of trees for suitable hollows for nesting sites on the Underwood Avenue site was undertaken by Dr Graham Thompson (Terrestrial Ecosystems) on 30 November 2006. Literature review, reporting and meetings were shared between Dr Scott Thompson (ATA Environmental) and Dr Graham Thompson (Terrestrial Ecosystems).

4.5 Limitations of the Assessment

As there is no record of Carnaby's Cockatoo breeding in the Perth metropolitan area, environmental variables that would influence their choice breeding sites are unknown. Although our study recognises that different habitats are likely to provide different foraging resources, there are no data on how Carnaby's Cockatoo utilise different resources in Perth. For example, it is not known whether Carnaby's Cockatoo would forage on exotic plants (e.g. Pine trees, almond trees) if they were to breed in the Perth metropolitan area or whether they would require native trees and shrubs. Similarly, it is not known whether Carnaby's Cockatoo would preferentially select breeding tree hollows closest to the feeding areas such as pine plantations or would utilise artificial breeding hollows erected in the vicinity of good native vegetation foraging areas. This lack of information limits our ability to predict potential impacts on Carnaby's Cockatoo of clearing native vegetation at the Underwood Avenue site.

Our assessments of habitat type and quality, the potential of various areas as a food resource for Carnaby's Cockatoo, the potential breeding sites and flight corridors among sites is subjective (i.e. it is difficult to see the world as a Carnaby's Cockatoo does). Within the study area, there are numerous old and isolated trees that have hollows that may be suitable for breeding purposes (e.g. large Tuart on Montgomery Dr, Mt Claremont). Many of these are in areas of less than 0.25ha of bush or parkland and therefore have not been included in the analysis. Many of these tree hollows are used by galahs, rainbow lorikeets or corellas as nests or are permanently occupied by bees.

In the assessment of trees potentially providing breeding hollows in the Underwood Ave site, we did not climb trees that looked as if they contained suitable hollows. Often what appears like a suitable hollow when observed from the ground is not suitable on closer inspection (e.g. there is

no hole, the entrance is too small or the hollow is not deep enough). Likewise, some hollows may have been missed, as openings are not always obvious from the ground. Therefore, it is likely that we assessed a number of trees as potentially providing a nesting site, but with closer examination, this will not be the case or vice versa. The consequence of this approach is likely to be a significant over estimation of potential nesting sites.

5. RESULTS

We examined 526 parcels of land (hence forward called sites) that could potentially be used as foraging and breeding sites by Carnaby's Cockatoo in the western suburbs of the Perth metropolitan area. Each site was categorised based on habitat type, habitat quality, size, potential as a food resource for Carnaby's Cockatoo and traffic volumes and ethnographic interferences. Each assessed site has been assigned a unique number or letter/number (Figure 5). Many of the large reserves and remnant bushland sites are made up of a composite of land forms, soils types and vegetation assemblages (e.g. Kings Park). These remnant bushland sites have been subdivided into a number of sites based on similar vegetation assemblages (e.g. Kings Parks, Cottesloe Golf Course, Karrakatta Cemetery; Figure 5). A summary of all of the data is provided in Appendix 2.

5.1 Potential Foraging Areas in the Western Suburbs

The total area of the western suburbs examined was 10,066ha of which 2,107ha is contained in these 526 sites. The majority of the sites assessed were less than 2ha (Table 2) with only 36 being greater than 10ha and most of these form part of a larger bushland reserves (e.g. Bold Park and Kings Park). The project area at Underwood Avenue is 33.65ha with site 254 being 3.85ha, site 255 being 24.22ha, site 257 being 0.55ha and site 258 being 5.03ha (Figure 7).

TABLE 2
NUMBER AND SIZE OF SITES EXAMINED

	< 0.5ha or road verge	0.5 – 2ha	2 – 5ha	5 – 10 ha	> 10 ha	Total
Number	162	205	95	28	36	526
Area (ha)	42.4	215.9	282.8	190.0	1356.2	2107.2
% to total area	2.0	10.2	13.4	9.0	64.4	

5.2 Habitat Type

Approximately 42% of the area of all sites assessed were categorised as woodland, 40% as parkland and the remainder as heath (Table 3). The project area contains 3.2% of woodland and 0.6% of the parkland in the western suburbs. Most of the sites assessed as heath are along the western coastal strip. Parkland included two large golf courses and Karrakatta Cemetery. The largest woodlands were Bold Park, Kings Park, Shenton Park bushland, part of the Wembley Golf Course and an area around Lake Gwelup (Figure 5).

TABLE 3
OVERALL AREA FOR EACH OF THE HABITAT TYPES ASSESSED

	Heath	Parkland	Woodland	Total
Number	48	417	61	526
Area (ha)	369.7	846.2	891.3	2107.2
Area %	17.54	40.16	42.30	
Underwood Avenue site		5.04	28.62	
% of area		0.6	3.2	

5.3 Habitat Quality

Thirty six percent of the area in all sites examined was categorised as completely degraded and another 7.8% degraded (Table 4). No site was categorised as excellent and 22.2% were categorised as very good. Sites 254, 255 and 257 on the Underwood Avenue project area were categorised as very good, and site 258 was categorised as degraded. Underwood Avenue site represents 4% of the area of all sites categorised as very good.

TABLE 4
QUALITY OF THE HABITATS EXAMINED

	Completely degraded	Degraded	Good	Very Good	Excellent	Total
Number	364	71	65	26	0	526
Area (ha)	760.1	163.4	468.4	715.2	0	2107.2
% Area	36.1	7.8	22.2	33.9	0	
Underwood Ave		5.0		28.6		
% Underwood Ave		3.1		4.0		

5.4 Potential of Sites Examined to be used as a Food Resource by Carnaby's Cockatoo

Less than one percent of the area of all the sites examined contained suitable feed plants in good condition (Table 5). However, 48% of the area of all the sites examined had some plants available in reasonable condition as a potential food source for Carnaby's Cockatoo. Sites 254 and 258 in the project area were assessed as having limited plants available that are a suitable food source for Carnaby's Cockatoo. Sites 255 and 257 were assessed as having plants that are suitable and in a reasonable condition as a food source for Carnaby's Cockatoo (Table 5). Sites 9 and 14 were the two that were assessed as having lots of food plants available.

TABLE 5
POTENTIAL OF THE AREAS EXAMINED AS A FOOD RESOURCE FOR CARNABY'S COCKATOO

	Number	Area (ha)	% Area	Und'd Ave (ha)	% Und'd Ave
No food available	108	117.3	5.6		
Limited plants on site suitable	280	942.3	44.7	8.9	0.94
Plants available but degraded	10	31.4	1.5		
Plants available and in reasonable condition	126	1011.5	48.0	24.8	2.45
Lots of plants available and in good condition	2	4.7	0.2		
Total	525	2107.2			

Of the 715ha assessed as having a very good habitat quality, 26.5ha had no food available, 65.4ha had limited plants suitable as a food resource (including the degraded areas), and 623.3ha was assessed as having plants available as a food resources for Carnaby's Cockatoo. Sites 255 (24.22ha) and 257 (0.54ha) in the project area, were included in the later category.

Most of the sites with the highest potential to provide a food resource are in areas categorised as woodlands; and areas categorised as heath provided the lowest potential food resource (Table 6).

TABLE 6
AREA OF EACH HABITAT TYPE CATEGORISED ACCORDING TO ITS POTENTIAL AS A FOOD RESOURCE FOR CARNABY'S COCKATOO (HA, WITH PERCENTAGES IN PARENTHESIS)

	Heath	Parkland	Woodland
No food available	41.9 (1.99)	73.1 (3.47)	2.3 (0.11)
Limited plants on site suitable	323.4 (15.35)	504.7 (23.95)	114.3 (5.42)
Limited plants but degraded	2.9 (0.14)	5.8 (0.27)	22.8 (1.08)
Plants available and in reasonable condition	0 (0.0)	262.6 (12.46)	748.9 (35.54)
Lots of plants available and in good condition	1.5 (0.07)	0 (0.0)	3.1 (0.15)

5.5 Areas Affected by Traffic and Ethnographic Interference

Forty percent of the area of all sites examined had low interaction with humans or vehicles compared with 39% having high or very high interaction with humans or vehicles (Table 7). Sites 254 and 255 in the project area were assessed as having low levels of interactions with humans or vehicles and sites 254 and 258 had higher levels of interaction with humans or vehicles.

TABLE 7
TRAFFIC AND ETHNOGRAPHIC IMPACTS ON SITES EXAMINED

	Number	Area (ha)	% Area	Under-wood Ave (ha)	% Under-wood Ave
Very high interaction with humans of vehicles	146	275.1	13.06		
High levels of interaction with humans or vehicles	222	551.6	26.18	5.0	0.24
Medium interaction with humans or vehicles	120	444.3	21.08	0.5	0.02
Low levels of interaction with humans or vehicles	38	836.2	39.68	28.07	1.33
Limited interaction with humans or vehicles	0	0	0		
Total	526	2107.2			

5.6 Potential Nesting Sites

Forty four (958ha) of the 526 sites were considered to have trees that could provide potential nesting sites for Carnaby's Cockatoo. Bold Park sites B7, B2, B3, B4 and B7 (292ha) and Kings Park sites K15 and B5 (308ha) were included in this list as was site 254 in the Underwood Avenue site (Table 8). Two of these sites were in heath, 22 in parkland and 20 in woodland. It is speculated that the 22 parkland sites might be unsuitable because of the intensity of use by humans. The 20 woodland sites are the most probable nesting sites, if Carnaby's Cockatoo were to nest in the western suburbs. These sites include Bold Park, Kings Park and site 254 on the Underwood Avenue site.

TABLE 8
ALL SITES ASSESSED AS HAVING A TREE OR TREES THAT COULD POTENTIALLY BE USED AS A NESTING SITE.

Site No	Food category	Habitat quality	Ethno. interference	Habitat type	Area (ha)	ha
K5	2	1	2	Parkland	11.1	308
K15	4	4	4	Woodland	204.2	
K15	4	4	4	Woodland	70.1	
K15	4	4	4	Woodland	22.8	
B7	4	4	4	Woodland	263.0	292
B6	4	3	3	Woodland	1.5	
B4	2	4	2	Woodland	13.0	
B3	2	4	2	Woodland	1.5	
B2	3	4	2	Woodland	13.0	
68	4	1	2	Parkland	71.8	
229	2	1	4	Parkland	63.9	
226	4	1	4	Parkland	37.1	
251	2	3	3	Woodland	33.6	
237	4	3	4	Woodland	30.3	
55	4	3	4	Woodland	13.3	
307	4	3	3	Woodland	9.8	
230	2	3	3	Woodland	8.7	
263	4	1	2	Parkland	8.3	
140	2	1	3	Parkland	7.2	
1D	2	2	1	Heath	7.2	
151	4	3	3	Parkland	6.3	
177	2	2	1	Heath	5.4	
253	2	2	2	Woodland	5.0	
220	4	1	2	Parkland	4.9	
48	4	4	4	Woodland	4.6	
261	2	1	1	Parkland	4.2	
254	2	4	4	Woodland	3.9	Underwood Ave
219	4	1	2	Parkland	3.8	
65	4	3	3	Woodland	3.8	
67	4	3	2	Woodland	3.6	
14	5	3	1	Woodland	3.1	
45	2	1	1	Parkland	2.6	
145	2	1	3	Parkland	2.5	
37	2	1	2	Parkland	2.1	
199	2	1	2	Parkland	2.0	
175	4	1	2	Parkland	1.7	
33	2	1	2	Parkland	1.4	
47	2	2	2	Parkland	1.2	
305	4	1	1	Parkland	1.0	
253	2	2	2	Woodland	0.8	
175	4	1	2	Parkland	0.8	
101	1	1	2	Parkland	0.6	
175	4	1	2	Parkland	0.4	
36	2	1	1	Parkland	0.2	

5.7 Corridors

We have judged corridors to be near continuous areas with a similar vegetation assemblage. At Coomallo Creek Carnaby's Cockatoo travelled an average 1.4km to from their nest to forage,

but at Manmanning they travelled an average of 2.5km to forage. The maximum distance travelled was about 4km. Based on foraging data while breeding, Carnaby's Cockatoo hatchlings did best at Coomallo Creek when females could forage within a shorter distance of their nest.

The most obvious corridor is the coastal stretch of heath that runs north from Mt Claremont to Trigg Beach. This heath is interrupted by the coastal development in the Scarborough foreshore area. However, much of this corridor does not contain good quality foraging areas.

Presuming Carnaby's Cockatoo will readily fly over one kilometre of residential development (author has seen this occur regularly) then the Kings Park woodland to Karrakatta Cemetery, Shenton Park bushland (perhaps including the Underwood Avenue site), bushland around Challenge Stadium, Bold Park, Wembley Golf Course and the bushland north and north west of Edith Cowan University is an obvious bushland corridor (Figure 6). The integration of parkland into this bushland corridor provides a more continuous connection. The integration of heath, bushland and parkland to form corridors provides a corridor west from Kings Park to Bold Park and then south and north along coastal heath, or north from Bold Park in woodland and parkland to an area west of Herdsman Lake.

If Carnaby's Cockatoo bred in Kings Park and required their feeding sites to be within 4km, foraging would mostly be restricted to Kings Park but could extend to the Shenton Park bushland. If Carnaby's Cockatoo bred in Bold Park and required their feeding sites to be within 4km, then birds could forage in Bold Park, the bushland around Challenge Stadium, the Underwood Avenue site, Shenton Park bushland, parkland associated with Cottesloe Golf Course, Perry Lakes and Wembley Golf Course and some coastal heath.

5.8 Observations of Carnaby's Cockatoo

During field surveys, observations were made of several flocks of Carnaby's Cockatoo. Multiple opportunistic observations were made during March and April 2005 when the site assessments were being conducted.

In addition, one author lives adjacent to the southern boundary of Bold Park and to the west of the bushland around Challenge Stadium (near Stevenson Avenue). On many occasions over the last two years Carnaby's Cockatoo have been heard or sighted in Bold Park and in the bushland to the west of Challenge Stadium between December and July. A smaller number of birds remain in the area for most of the year. The largest flock counted was 105 birds, but flocks of between 15 and 50 birds were common. Carnaby's Cockatoo in this area readily fly over residential housing to move between tracts of bushland.

5.9 Underwood Avenue Trees containing a Potential Hollow that might be used by Carnaby's Cockatoo as a Nest Site

Forty two trees were assessed as potentially containing a hollow(s) that may be suitable for a Carnaby's Cockatoo nest site (Table 9; Plate 2, Figure 8). However, very few trees fitted the nest hollow criteria described by Johnstone and Storr (1998), i.e. range from 2.5-12m above the ground, having an entrance of 23-30cm in diameter and a depth of 1.0-2.5m, although the DEC fact sheet on Carnaby's Cockatoo suggested hollows could be 2-10m above the ground and their depth varies from 0.25-6.0m. They also have a preference for smooth-barked Eucalypts especially Salmon Gums (*Eucalyptus salmonophloia*) and Wandoo (*Eucalyptus wandoo*), but nests have been recorded in York Gum (*E. loxophleba*), Flooded Gum (*E. rudis*), Tuart (*E. gomphocephala*) and rough-barked Marri (*Corymbia calophylla*). Many of the apparent hollows at the Underwood Avenue site were created by fire, and the subsequent hollow is often shallow,

black and charred making it unsuitable for a nest. Most of the large trees on the Underwood Avenue site are Jarrah with a few Tuart and Marri trees. Some of the hollows contained bee hives. Where it was obvious that the hollow contained bees then this tree was not included unless it contained a hollow not used by bees. One of the trees contained a Galah's nest, as we saw the fledging that was ready to leave the nest with its parents. Many of the other trees had smaller hollows that were being used by Rainbow Lorikeets. Some of the trees were dead stags which are seldom used by Carnaby's Cockatoo as nesting sites.

It was difficult to estimate the number of suitable tree hollows on the Underwood Avenue site that would be selected by Carnaby's Cockatoo as a nest site; however, using the nesting site criteria described by Johnstone and Storr (1998) it is likely to be very few, if any.

TABLE 9
TREES ASSESSED AS POTENTIALLY CONTAINING A HOLLOW(S) SUITABLE FOR A CARNABY'S COCKATOO NESTING SITE.

#	East	North	Tree type	Est. Height (m)	Est. Width (m)	Hollows location	Hollow orientation
1	50J 386273	6464284	Dead Eucalypt	10	1.0	Trunk	Up
2	50J 386256	6464291	Dead Eucalypt	6	1.5	Trunk x 2?	Up
3	50J 386266	6464234	Dead Eucalypt	6	0.8	Trunk x 2?	Up
4	50J 386412	6464174	Live Eucalypt	20	1.0	Trunk?	North side, 7m
5	50J 386254	6464342	Live Eucalypt	18	1.0	Trunk	East side, 4m, up
6	50J 386295	6464324	Live Eucalypt	20	0.7	Trunk x 2	East side, up, 5 and 6m
7	50J 386325	6464354	Live Eucalypt	18	1.0	Trunk	Side, 7m
8	50J 386359	6464349	Dead Eucalypt	22	0.9	Trunk	Side, 6 m
9	50J 386532	6464443	Live Eucalypt	20	1.2	Trunk x 2	Up
10	50J 386569	6464372	Live Eucalypt	20	1.2	Branch	End of dead branch, 7m
11	50J 386644	6464273	Live Eucalypt	20	2.0	Trunk	North, probably too small?
12	50J 386972	6464554	Live Eucalypt	20	1.2	Trunk	Up, 7m
13	50J 386791	6464598	Live Eucalypt	18	1.1	Branch	Up, 7m?
14	50J 386849	6464519	Live Eucalypt	22	1.3	Branch	North, 13m
15	50J 386632	6464485	Live Eucalypt	23	1.5	Trunk	East and facing up, 4m beehive
16	50J 386563	6464582	Live Eucalypt	22	1.2	Trunk x 2?	North facing and up
17	50J 386578	6464562	Live Eucalypt	25	1.1	Trunk	Galah and Rainbow Lorikeets nesting, up and west
18	50J 386590	6464577	Dead Eucalypt	25	0.8	Trunk	Up
19	50J 386525	6464608	Live Eucalypt	18	1.4	Trunk and branch x 3?	
20	50J 386510	6464580	Live Eucalypt	25	0.8	Trunk x 3?	Up, 1 south
21	50J 386530	6464545	Live Eucalypt	24	1.5	Branch	South, Rainbow Lorikeet nest?
22	50J 386509	6464521	Live Eucalypt	23	0.8	Branches	Top
23	50J 386466	6464507	Live Eucalypt	20	0.6	Trunk	Bees in hollow
24	50J 386238	6464309	Dead Eucalypt	20	0.8	Branch	Up

#	East	North	Tree type	Est. Height (m)	Est. Width (m)	Hollows location	Hollow orientation
25	50J 386238	6464309	Dead Eucalypt	22	1.2	Branch	Bees in hollow
26	50J 386238	6464309	Live Eucalypt	15	0.7	Trunk	South side
27	50J 386430	6464666	Live Eucalypt	25	0.9	Trunk x 2	South and north sides
28	50J 386422	6464671	Dead Eucalypt	16	0.8	Trunk and branches?	Top
29	50J 386525	6464650	Live Eucalypt	25	2.0	Trunk	Lots of hollows
30	50J 386473	6464628	Live Eucalypt	20	1.3	Trunk	
31	50J 386470	6464594	Dead Eucalypt	20	0.9	Branches	End of branches?
32	50J 386382	6464538	Dead Eucalypt?	18	1.4	Trunk	South side
33	50J 386339	6464486	Dead Eucalypt	22	1.4	Trunk	Bees in some hollows
34	50J 386646	6464622	Live Eucalypt	25	0.8	Trunk, branches	Lots of hollows
35	50J 386641	6464631	Dead Eucalypt	18	0.8	Trunk and branches	End of branches
36	50J 386622	6464664	Dead Eucalypt	18	1.5	Trunk and branches	Top and ends
37	50J 386636	6464674	Live Eucalypt	20	1.2	Branches	End of branches
38	50J 386636	6464674	Live Eucalypt	25	0.8	Branches	Branch
39	50J 386636	6464674	Live Eucalypt	15	1.0	Trunk?	Top
40	50J 386767	6464572	Live Eucalypt	23	0.8	Trunk	Multi hollows?
41	50J 386776	6464568	Live Eucalypt	15	0.6	Trunk and branches	Sides
42	50J 386858	6464521	Live Eucalypt	20	1.0	Trunk	South side

6. DISCUSSION

The summary of the relevant literature and the results from an assessment of 526 sites in the western suburbs of the Perth metropolitan area are discussed below in the context of the five reasons given by the Department of the Environment and Heritage for the controlled action on the Underwood Avenue site (EPBC 2004/1479).

13 *Carnaby's Cockatoo has been listed as 'endangered' under the EPBC Act due to its abundance having at least halved over the last three generations, together with a decline in both the area occupied and the quality of available habitat for breeding and feeding. The breeding population is estimated at 60 000 breeding birds, with three to five sub-populations, the largest being about 20 000 birds, and that the population is continuing to decline.*

We believe there is evidence to suggest that the population of Carnaby's Cockatoo has declined significantly in recent decades, particularly from the wheatbelt. This decline is probably due to multiple factors including a loss of breeding sites, foraging areas, being killed by feral animals (e.g. cats), motor vehicles and poachers. However, we could find no data to support the claim that it has halved over the last three generations [we note that a similar unsupported claim was made by Cale (2003)]. Similarly, we could find no data to support the estimate of 60 000 breeding Carnaby's Cockatoo as suggested by DEH. Saunders *et al.* (1985) appear to be the first to suggest the population of Carnaby's Cockatoo was 11 000 to 60 000 birds. They provide no data to support this claim, and we have concluded it is at best an educated guess. It is our view that if there are currently 60 000 breeding birds in WA as indicated by DEH, then the conservation status of Carnaby's Cockatoo should be reassessed.

14 *Carnaby's Cockatoo has been recorded in Bold Park, to the west of the site, and is known to regularly occur within the local metropolitan area. The DEH found that Carnaby's Cockatoos regularly feed in native bushland and suitable vegetation along roads and in backyards in the local area during autumn and winter, and may occasionally occur all year round.*

The research evidence and our own observations support the DEH view that Carnaby's Cockatoo regularly feed in native bushland and suitable vegetation along road side verges and backyards during summer and into autumn. They were frequently seen in Bold Park during 2004/2005/06. We were also able to demonstrate that the Underwood Avenue site represents approximately 4% of the available very good habitat in the western suburbs and appreciably less in the greater Perth metropolitan area. The Underwood Avenue site represents less than 3% of the available habitat assessed as having feed plants available and in good condition. Based on these data it is difficult to conclude that the clearing of the Underwood Avenue site would have a significant detrimental effect on Carnaby's Cockatoo in the Perth metropolitan area. However, it is appreciated that the Underwood Avenue site is in close proximity to Bold Park, and if this were to be a breeding site at some stage in the future, then feeding sites with a 4km radius would be important. Feeding sites for Carnaby's Cockatoo nesting in Bold Park could include Bold Park and Bold Park north, the Mt Claremont bushland, Wembley Golf Course, Shenton Park bushland and Karrakatta bushland, as well as sections of the Underwood Avenue site. Sites with 2km would be preferred. The Underwood Avenue site is on the periphery of the 2km preferred foraging areas.

15 The area of bushland potentially affected by the proposed action is about 35ha, of which 23ha will be cleared and 12ha preserved in a proposed Conservation Area. The DEH found that the areas to be cleared included substantial stands of Banksia prionotes, B. menziesii and B. attenuata which are known to provide forage habitat for the Cockatoo. The DEH found that B. prionotes, in particular, provides high quality forage habitat.

Whilst the proposed Conservation Area will include 0.1ha of B. prionotes, other areas of the site containing this species will be cleared.

The Appeals Committee (2004) in its report to the WA Minister for Environment noted the EPA had acknowledged that Black Cockatoos have learnt to adapt to exotic plant species as a result of clearing of native vegetation and is now utilising exotic trees in parks and gardens. It is therefore, considered that this species is not dependent for its survival on small bushland remnants as a food source (Appeals Committee, 2004).

The conclusions drawn by DEH in regard to the area to be cleared were correct, however, a revised plan has now been prepared. Data presented above indicates that Carnaby's Cockatoo feed on a diverse range of plants and *Banksia prionotes*, *B. menziesii* and *B. attenuata* are included in this list, but these species are not focal or key species. An alternative proposal for the development of the Underwood Avenue site has now been prepared that significantly enhances the habitat available as a foraging site for Carnaby's Cockatoo. The University of Western Australia has also put in place a revegetation program on the Underwood Avenue site that significantly increases the area that will remain within the conservation zone and will provide suitable foraging habitat for Carnaby's Cockatoo. The University has successfully established *Banksia prionotes* in degraded areas as a part of its revegetation program on Lot 4.

16 *The DEH found that while Carnaby's Cockatoos do not breed in the metropolitan area, recent observations indicate an increasing trend for breeding in coastal areas to the south of Perth. The DEH found, based on information provided by Birds Australia, that ongoing loss of traditional nesting sites could mean that metropolitan areas on the Perth Coastal Plain may be used for breeding in the near future. In this regard, the DEH found that potential nest sites had been identified by Birds Australia nearby in Bold Park. The DEH found that successful breeding for the Carnaby's Cockatoo requires the presence of tracts of high quality feeding habitat in proximity.*

Perry (1948) reported Carnaby's Cockatoo feeding in the Collier Pine Plantation in South Perth, Somerville Plantation in Applecross, Scaddan Plantation in Mt Lawley and the Gnangara Plantation. It is therefore evident that Carnaby's Cockatoo have been visiting and foraging in the Perth metropolitan area for in excess of 50 years. During that period there are no records that indicate the species has bred in the Perth metropolitan area. They have, however, occupied artificial nests erected in the Moora townsite, an area in which they have been known to breed in the past. Evidence is available to indicate that Carnaby's Cockatoo will shift nesting sites within established breeding areas, but there is no evidence to suggest that Carnaby's Cockatoo will shift their breeding areas. We could find no evidence to support Birds Australia's claim that there is an increasing trend for Carnaby's Cockatoo to breed in the coastal areas south of Perth (although we acknowledge there are anecdotal reports of breeding around Yanchep National Park and south of Mandurah in recent years). Recent reports of Carnaby's Cockatoo nesting around Lake Clifton and in the southern section of the Perth-to-Bunbury highway corridor do not indicate that these cockatoos have recently moved into these areas to bred, as there no comparative data on what was occurring in these areas during earlier times. Even if it was true that Carnaby's Cockatoo were shifting their breeding areas, this could not be used to infer that Carnaby's Cockatoo would breed in Bold Park or the Perth metropolitan area, given they have been visiting the area for at least 50 years and have not bred in the area to this time. Therefore, we could find no data to substantiate the suggestion by Birds Australia that Carnaby's Cockatoo might nest in Bold Park or any other remnant bushland in the Perth metropolitan area. Our data on the availability of potential nesting hollows in trees on the Underwood Avenue site would suggest that this was not a good potential breeding site, as there are few trees with suitable hollows available and there are more suitable sites elsewhere in the metropolitan area. Even if Carnaby's Cockatoo was at some stage in the future to breed in Bold Park there are numerous potential foraging sites within distances that Carnaby's Cockatoo regularly flew at Manmanning and

Coomallo Creek (Saunders 1980). The entire Underwood Avenue site only represents 1.6% of the remnant habitat and 4% of the high quality habitat in the western suburbs of the Perth Metropolitan area, and a significantly smaller proportion in the greater Perth Metropolitan area. It is on the periphery of the preferred foraging distance for nesting birds. Access to foraging sites, even excluding the Underwood Avenue site, is unlikely to be the limiting factor for Carnaby's Cockatoo breeding in Bold Park.

17 *The DEH found that the action site contains high quality habitat likely to be regularly utilised by the listed endangered Carnaby's Cockatoo and that the loss of up to 23ha of such habitat is likely to represent a significant loss of available habitat for foraging by the Cockatoo in the Perth Metropolitan area. The DEH found that the loss of this habitat may also jeopardise successful breeding in the event of nesting occurring in the future along the coastal plain in metropolitan areas. The DEH also found that loss of habitat on the action site could adversely affect the movement of Cockatoo's between extensive areas of bushland to the west (Bold Park) and east (Kings Park).*

We concur that Carnaby's Cockatoo are likely to utilise the habitat on the Underwood Avenue site for foraging and roosting purposes when they have migrated to the Perth metropolitan area between December and July. However, there is no evidence to suggest that Carnaby's Cockatoo might breed in Bold Park, particularly as they have been coming to the area for many years and have not bred in Bold Park yet, and there are no data to suggest they will shift their breeding areas. Even if Carnaby's Cockatoo does at some stage in the future breed in Bold Park the loss of vegetation at the Underwood Avenue site under the revised plan is highly unlikely to jeopardise a successful breeding attempt given the other potential feeding resources within a 4km radius.

Given that Carnaby's Cockatoo are recorded as foraging on Rottnest Island (Winnett 1989; Storr and Johnstone 1988) and Garden Island (Wykes *et al.* 1999) we could find no evidence to support the DEH claim that Carnaby's Cockatoo movements between Bold Park and Kings Park is likely to in anyway be impeded by the loss of some vegetation at the Underwood Avenue site, as they are clearly willing and able to fly between these two sites. The annual migration of Carnaby's Cockatoo from the wheatbelt to the Swan Coastal Plain to forage at the completion of the breeding season (Saunders 1980) indicates that these birds are willing to fly substantial distances to forage.

18 The DEH in light of the comments provided in paragraphs 13-17 found that the proposed action was likely to have a significant impact on a threatened species list under the EPBC Act 1999.

6.1 Significant Impact Guidelines

To have a significant impact on an endangered species under the DEH *Significant Impact Guidelines,* the development should trigger one of the following eight guidelines. Each of these is briefly assessed below.

Lead to a long-term decrease in the size of a population
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would lead to a decrease in the size of the Carnaby's Cockatoo population.

Reduce the area of occupancy of the species
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would lead to a significant reduction in the area of occupancy by Carnaby's Cockatoo.

Fragment an existing population into two or more populations
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would lead to a fragmentation of an existing population into two or more populations.

Adversely affect habitat critical to the survival of a species
There is no evidence to suggest that the land at the Underwood Avenue site is critical to the survival of this species.

Disrupt the breeding cycle or a population
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would in anyway disrupt the breeding cycle or a population of Carnaby's Cockatoo.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would significantly modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would result in an invasive species that is harmful to Carnaby's Cockatoo becoming established in the species habitat.

Introduce disease that may cause the species to decline
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would result in the introduction of a disease that may cause Carnaby's Cockatoo to decline.

Interfere with the recovery of the species
There is no evidence to suggest that the proposed development of the land at the Underwood Avenue site would interfere with the recovery of Carnaby's Cockatoo.

6.2. Conclusion

Based on ATA Environmental assessment of the literature and available data, its study of potential breeding and foraging sites in the western suburbs, the following conclusions can be made:

a) Reported breeding Carnaby's Cockatoo population numbers by DEH are not supported by the data, and if 60,000 breeding birds currently exist then the current status of this species should be reviewed by State and Commonwealth government agencies.

b) Carnaby's Cockatoo regularly feed in Bold Park, many of the other bushland remnants, road-side plantings and in the pine plantations in the greater Perth metropolitan area. The Underwood Avenue site provides less than 3% of the high quality habitat in the western suburbs and much less in the greater Perth metropolitan area. The EPA has previously acknowledged that Black Cockatoos have learnt to adapt to exotic species as a result of clearing of native vegetation and are not dependent for its survival on small bushland remnants as a food source.

c) There are no data to support Birds Australia or DEH view that Carnaby's Cockatoo will in the future breed in Bold Park. If we adopt the precautionary principle, and Carnaby's Cockatoo were to breed in Bold Park, it is highly unlikely that the loss of the Underwood Avenue site would significantly impact on the success of these breeding attempts, given the number of other suitable foraging sites within a 4km radius. The revised development plan for the Underwood Avenue site preserves a significant proportion of the high quality habitat on the Underwood Avenue site and the proponent is currently revegetating the degraded sections of the site with a range of plant species (including *Banksia prionotes*) that will provide additional foraging species for Carnaby's Cockatoo.

d) Movement patterns and distances flown to foraging areas by Carnaby's Cockatoo do not support DEH's claim that the Underwood Avenue site forms an essential component of the Kings Park – Shenton Park bushland – Bold Park corridor.

e) There is a paucity of data on the spatial ecology and feeding biology of Carnaby's Cockatoo in the greater Perth metropolitan area and there is a lack of data on the population size and any shifts in breeding areas within WA.

f) There is no evidence to suggest that the development of the land at Underwood Avenue would trigger any one of the eight guidelines in the DEH's *Significant Impact Guidelines* for an endangered species.

The University, therefore, does not believe that the new proposal should be considered a Controlled Action for these reasons and the fact the proposal:

1. The current conservation and development proposal for Lot 4 includes:

   a. The retention of 11.9ha of high quality bushland to be managed for conservation and passive recreational purposes; and

   b. Approximately 24ha of land for residential and future development purposes.

2. The conservation and POS areas will consist of 11.9ha of high quality bushland suitable for Black Cockatoo foraging.

3. The POS area will be retained and managed for conservation and passive recreation. Passive recreational opportunities will be limited to degraded areas and undertaken in a manner not to compromise the conservation objectives.

REFERENCES

Appeals Committee (2004). *Appeals Committee Report. Superlot Subdivision Lots 4 and 105 Underwood Avenue, Shenton Park – EPA Bulletin 1099. Appeals Against EPA Bulletin 1099.* Appeals Committee, Perth, Western Australia.

ATA Environmental (2000). *Lot 4, Location 2103 Underwood Avenue, Shenton Park Environmental Assessment – Updated.* Report No. 2000-133. ATA Environmental, Perth, WA.

Cale, B. 2003. *Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan.* Department of Conservation and Land Management, Perth.

Cooper, C.E. 2000. Food manipulation by Southwest Australian Cockatoos. *Eclectus*, 8: 3-9.

Cooper, C.E., Withers, P.C., Mawson, P. R. and Bradshaw, S.D. 2002. Metabolic ecology of cockatoos in the south-west of Western Australia. *Australian Journal of Zoology,* 50: 67-76.

Davies, S. and Loomes, D. 2002. *Carnaby's Cockatoo-Coast and Catchment Final Report on the Project.* Unpublished Report for the Moore Catchment Group.

Davies, S. 2005. *Usage of Artificial Nest Boxes by Carnaby's Cockatoo. Assessment of status 2004. Report to World Wide Fund for Nature, Threatened Species Program and Men of Trees.*

Davies, S.J.J.F. 1966. Movements of the White-tailed Black Cockatoo (*Calyptorhynchus baudinii*) in southwestern Australia. *Western Australian Naturalist,* 10: 33-42.

Department of the Environment and Heritage. 2006. *EPBC Act Policy Statement 1.1, Significant Impact Guidelines.* Department of the Environment and Heritage, Canberra.

Garnett, S.T. and Crowley, G.M. 2000. *The Action Plan for Australian Birds 2000.* Environment Australia, Canberra.

Gole, C.A. 2003. *Bird surveys in selected Perth metropolitan reserves. A joint biodiversity project between Birds Australia WA and the Perth Biodiversity Project.* Unpublished Report for Birds Australia WA, Perth.

Gole, C.A. 2004. *Bird surveys in selected Perth metropolitan reserves: Rounds 1 and 2 survey reports. A joint biodiversity project between Birds Australia WA and the Perth Biodiversity Project.* Unpublished Report for Birds Australia, Perth.

Government of Western Australia (2000). *Bush Forever – Keeping the Bush in the City. Volume 1 – Policies, Principles and Processes.* Perth, Western Australia.

Higgins, P.J. (Ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.* Oxford University Press. Melbourne.

Johnstone, R.E and Storr, G. 1998. *Handbook of Western Australian Birds, Volume 1 Non-Passerines (Emu to Dollarbird),* Western Australian Museum, Perth.

Johnstone, R.E. and Johnstone, C. nd. *Review of Baudin's Cockatoo and Forest Red-tailed Black Cockatoo in south-west of Western Australia, with special reference to Collie.* Unpublished Report, Perth.

Johnstone, R.E. and Johnstone, C. nd. *Review of Carnaby's Cockatoo Calyptorhynchus latirostris within the proposed Roe Highway Stage 7 Area in Jandakot.* Unpublished Report, Perth.

Johnstone, R.E., Johnstone, C., Kirkby, T. and Humphreys, G. 2006. *Perth – Bunbury Highway (Kwinana Freeway Extension and Peel Deviation) Targeted Threatened Fauna Survey.* Unpublished Report for Main Roads Western Australia, Perth.

Mawson, P.R. 1995. Observations of nectar feeding by Carnaby's Black-Cockatoo *Calyptorhynchus latirostris. Western Australian Naturalist,* 20: 93- 96.

McMahon, L. 2002. *Carnaby's Black-Cockatoo Recovery Project; Final Report to Environment Australia for the Period August 2002 to mid 2003*, Unpublished Report for Birds Australia WA, Perth.

McMahon, L. 2004. *Lotterywest Gordon Reid Foundation Final Report October 2004 Carnaby's Black-Cockatoo Recovery Project*, Unpublished Report for Birds Australia, WA, Perth.

Olsen, P., Weston, M., Cunningham, R. and Silcocks, A. 2003. The State of Australia's Birds. Supplement to *Wingspan* 13.

Perry, D.H. 1948. Black Cockatoos and pine plantations, *Western Australian Naturalist*, 1(7): 133-135.

Robinson, A. 1960. The importance of the marri as a food source to south-west Australian birds. *Western Australian Naturalist,* 7: 109-115.

Robinson, A. 1965. Feeding notes on the white-tailed black cockatoo. *Western Australian Naturalist*, 9: 169-170.

Rowley, I, Russell, E. and Palmer, M. 1989. The food preference of cockatoos: an aviary experiment. *Australian Wildlife Research*, 16: 19-32.

Saunders, D.A. 1974a. The occurrence of the White-tailed Black Cockatoo, *Calyptorhynchus baudinii,* in *Pinus* plantations in Western Australia. *Australian Wildlife Research,* 1: 45-54.

Saunders, D.A. 1974b. Subspeciation of the White-tailed Black Cockatoo, *Calyptorhynchus baudinii,* in Western Australia. *Australian Wildlife Research,* 1: 55-69.

Saunders, D.A. 1977. The effect of agricultural clearing on the breeding success of the White-tailed Black Cockatoo. *Emu,* 77: 180-184.

Saunders, D.A. 1979a. Distribution and taxonomy of the White-tailed and Yellow-tailed Black-Cockatoos *Calyptorhynchus* spp. *Emu,* 79: 215-227.

Saunders, D.A. 1979b. The availability of tree hollows for use as nest sites by White-tailed Black-Cockatoos. *Australian Wildlife Research,* 6: 205-216.

Saunders, D.A. 1980. Food and movements of the short-billed form of the white-tailed Black Cockatoo *Australian Wildlife Research,* 7: 257-269.

Saunders, D.A. 1982. The breeding behaviour and biology of the short-billed form of the White-tailed Black-Cockatoo *Calyptorhynchus funereus. Ibis,* 124: 422-455.

Saunders, D.A. 1986. Breeding season, nestling success and nestling growth in Carnaby's Black-Cockatoo, *Calyptorhynchus funereus latirostris,* over 16 years at Coomallo Creek, and a method for assessing the viability of populations in other areas. *Australian Wildlife Research,* 13: 261-273.

Saunders, D.A. 1990. Problems of survival in extensively cultivated landscape; the case of Carnaby's Black-Cockatoo *Calyptorhynchus funereus latirostris. Biological Conservation,* 54: 277-290.

Saunders, D.A. and Ingram, J.A. 1987. Factors affecting the survival of breeding populations of Carnaby's Black-Cockatoo *Calyptorhynchus funereus latirostris* in remnants of native vegetation. In: *Nature Conservation: The Role of Remnants of Native Vegetation,* eds Keast, A., Recher, H.F., Ford, H. and Saunders, D., pp. 249-258. Surrey Beatty and Sons, Chipping Norton.

Saunders, D.A. and Ingram, J.A. 1995 *Birds of Southwestern Australia: An Atlas of Change in the Distribution and abundance of the wheatbelt avifauna.* Surrey Beatty, Sydney.

Saunders, D.A. and Ingram, J.A. 1998. Twenty-eight years of monitoring a breeding population of Carnaby's Cockatoo. *Pacific Conservation Biology,* 4: 261-270.

Saunders, D.A., Rowley, I. Smith, G.T. 1985. The Effects of clearing for agriculture on the distribution of cockatoos in the southwest of Western Australia. In: *Birds of Eucalypt Forests and Woodlands; Ecology, Conservation, Management,* eds Keast, A., Recher, H.F., Ford, H. and Saunders, D., pp. 309-321. Surrey Beatty, Sydney.

Scott, J.K. and Black, R. 1981. Selective predation by White-tailed Black-Cockatoos on fruit of *Banksia attenuata* containing the seed-eating weevil *Alphitopis nivea. Australian Wildlife Research,* 8: 421- 430.

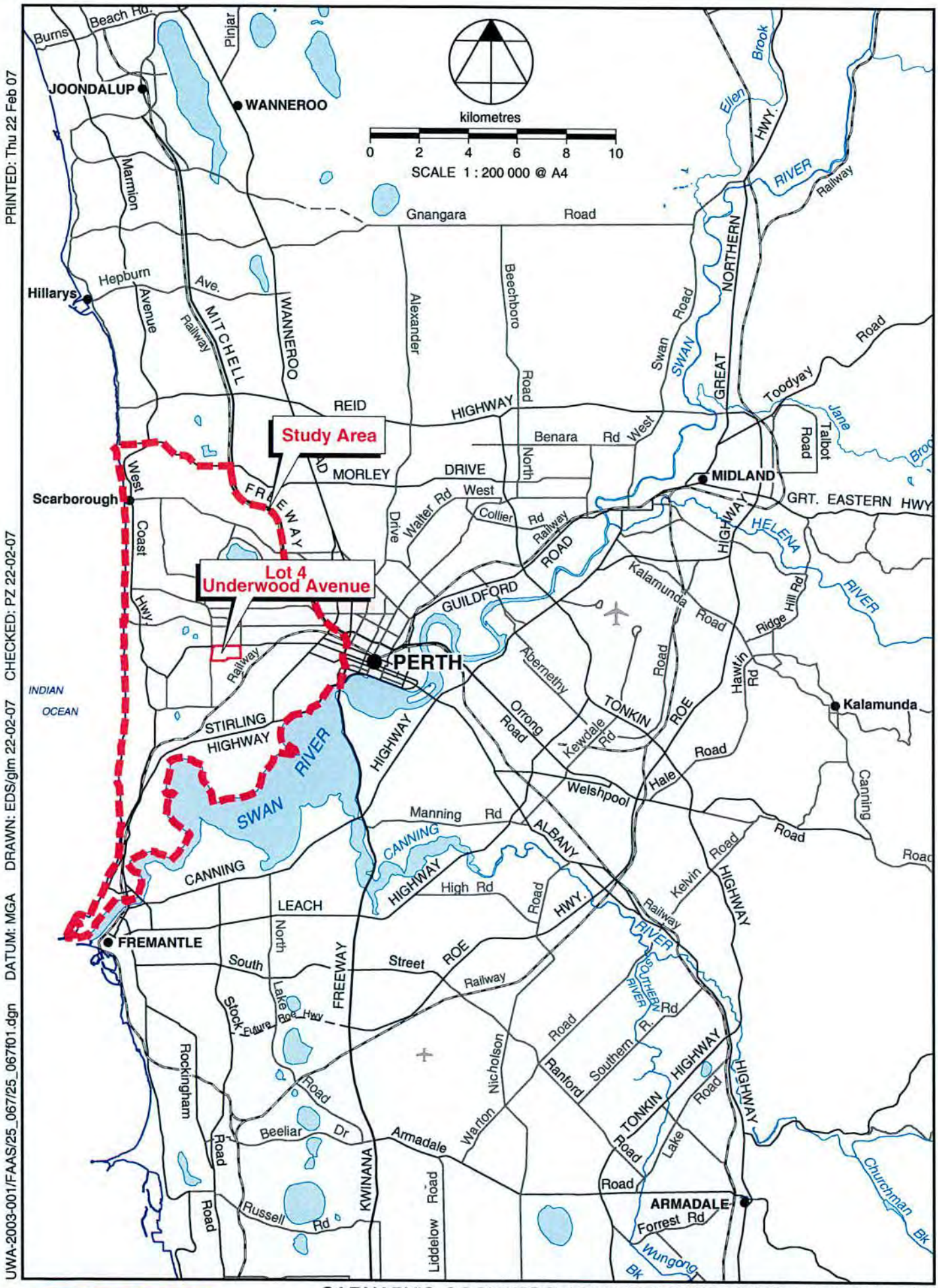
Storr, G.M. and Johnstone, R.E. 1988. Birds of the Swan Coastal Plain and adjacent seas and islands. *Records of the Western Australian Museum,* Supplement No. 28, 1-76.

Whitlock, L. 1937. Birds of the Norseman district, Western Australia. *Emu,* 37: 106-114.

Winnett, S. 1989. White-tailed Black Cockatoos on Rottnest Island. *Western Australian Naturalist,* 18: 64.

Wykes, B.J., Pearson, D. and Maher, J. (1999). *Fauna Survey of Garden Island, WA, 1996-1997,* unpublished report, HMAS Stirling, Environmental Working Paper No. 12.

FIGURES



ATA Environmental
environmental scientists

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT, SWAN COASTAL PLAIN

REGIONAL LOCATION

FIGURE 1

BASE SOURCE: Chappell, Lambert & Everett, Photo 2002, Subdivision November 2006 (778121i)

metres

0 20 40 60 80 100

SCALE 1 : 2 500 @ A3

LEGEND

- Boundary of Subject Land
- Subdivision Detail
- Conservation and P.O.S. Area Boundaries
- Vegetation Association Boundary
- Interlocking Jarrahs
- Approximate location of *Jacksonia sericea* (Priority 3) populations

VEGETATION ASSOCIATIONS

- BmBa — Banksia Low Woodland, including *Banksia menziesii* and *B. attenuata* over *Allocasuarina fraseriana* and *Hakea prostrata*
- EmEg — Jarrah *(Eucalyptus marginata)* and Tuart *(E. gomphocephala)* Open Woodland over *Acacia saligna*, *A. rostellifera* and *Hakea prostrata*
- EmBm — Jarrah Open Woodland over *Banksia menzesii* Low Woodland
- EmBaBm — Jarrah Low Woodland over *Banksia attenuata, B. menziesii* and *Allocasuarina fraseriana* Low Woodland
- EmAf — Jarrah Woodland over *Allocasuarina fraseriana*
- Bp — *Banksia prionotes* Thicket with *B. menziesii* and *B. attenuata*
- Ed — *Eucalyptus decipiens* Very Open Tree Mallee
- Cleared — Cleared

ATA Environmental
environmental scientists

CARNABY'S COCKATOO
(*CALYPTORHYNCHUS LATIROSTRIS*)
ASSESSMENT, SWAN COASTAL PLAIN

VEGETATION ASSOCIATIONS

FIGURE 2

PRINTED: Thu 22 Feb 07

CHECKED: PZ 15-02-07

DRAWN: TE/GLM/EDS 15-02-07

DATUM: MGA

UWA-2003-001/FAAS/25_067/25_067f02.dgn

PRINTED: Thu 22 Feb 07
CHECKED: PZ 15-02-07
DRAWN: TE/GLM/EDS 15-02-07
DATUM: MGA
UWA-2003-001/FAAS/25_067/25_067f03.dgn

UNDERWOOD AVENUE

STREET

SELBY

Good to Degraded

Cleared

Good to Very Good

Good

Cleared

LAND TO BE CLEARED FOR FUTURE DEVELOPMENT (4.5282ha)

Good

Good to Very Good

Good

Conservation Area B

Public Open Space

Good

Good to Degraded

Good to Degraded

Good to Degraded

Very Good

Very Good to Good

Conservation Area A

Good

LAND TO BE CLEARED FOR FUTURE DEVELOPMENT 3.9152ha

Degraded to Good

Good

BALANCE LOT 30.4203ha

Degraded

CANCER FOUNDATION

PARAQUAD ASSOCIATION

BASE SOURCE: Chappell & Lambert, Photo 2002, Subdivision November 2006

metres

0 20 40 60 80 100

SCALE 1 : 2 500 @ A3

LEGEND

- Subject Land Boundary
- Subdivision Detail
- Conservation and POS Area Boundaries
- Vegetation Condition Boundary

VEGETATION CONDITION
(Legend Source: BUSH FOREVER Govt. of W.A.)

Pristine Pristine or nearly so, no obvious signs of disturbance (Not Applicable)

Excellent Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species (NA)

Very Good 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 Vegetation structure significantly altered by very obvious signs of multiple disturbance. 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 Degraded. 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

CD Completely Degraded. The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs (NA)

ATA Environmental
environmental scientists

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT, SWAN COASTAL PLAIN

VEGETATION CONDITION

FIGURE 3

UWA-2003-001/FAAS/25_067/25_067f04.dgn DATUM: MGA DRAWN: EDS 12-02-07 CHECKED: PZ 15-02-07 PRINTED: Thu 22 Feb 07

ATA Environmental
environmental scientists

PROPOSED RESIDENTIAL SUBDIVISION
LOT 4 UNDERWOOD AVENUE, SHENTON PARK
CITY OF NEDLANDS

CHAPPELL LAMBERT EVERETT
TOWN PLANNING + URBAN DESIGN

DATE:	13.06.06
REVISED:	05.12.06
COMPILED:	CLE, MAPS
SCALE:	1:2000 (A1)
PLAN No.	778-12L

CONSERVATION AND DEVELOPMENT PROPOSAL

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*)
ASSESSMENT, SWAN COASTAL PLAIN

FIGURE 4

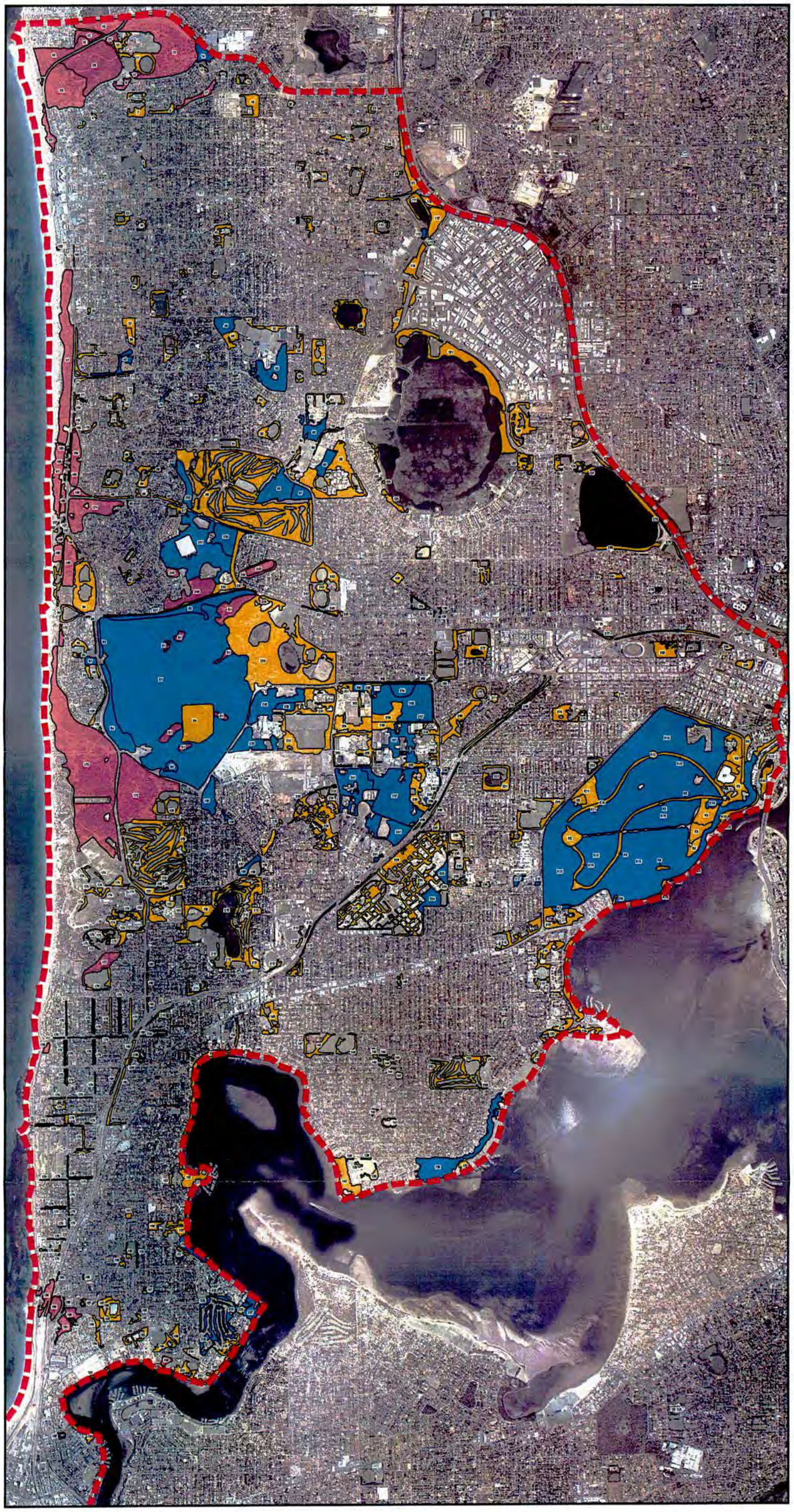
metres

0 500 1000 1500 2000

SCALE 1 : 50 000 @ A3

LEGEND

- Study Area Boundary
- 302 Site Number
- Heath
- Parkland
- Woodland



AERIAL SOURCE: DLI, April 2005.

ATA Environmental
environmental scientists

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT, SWAN COASTAL PLAIN

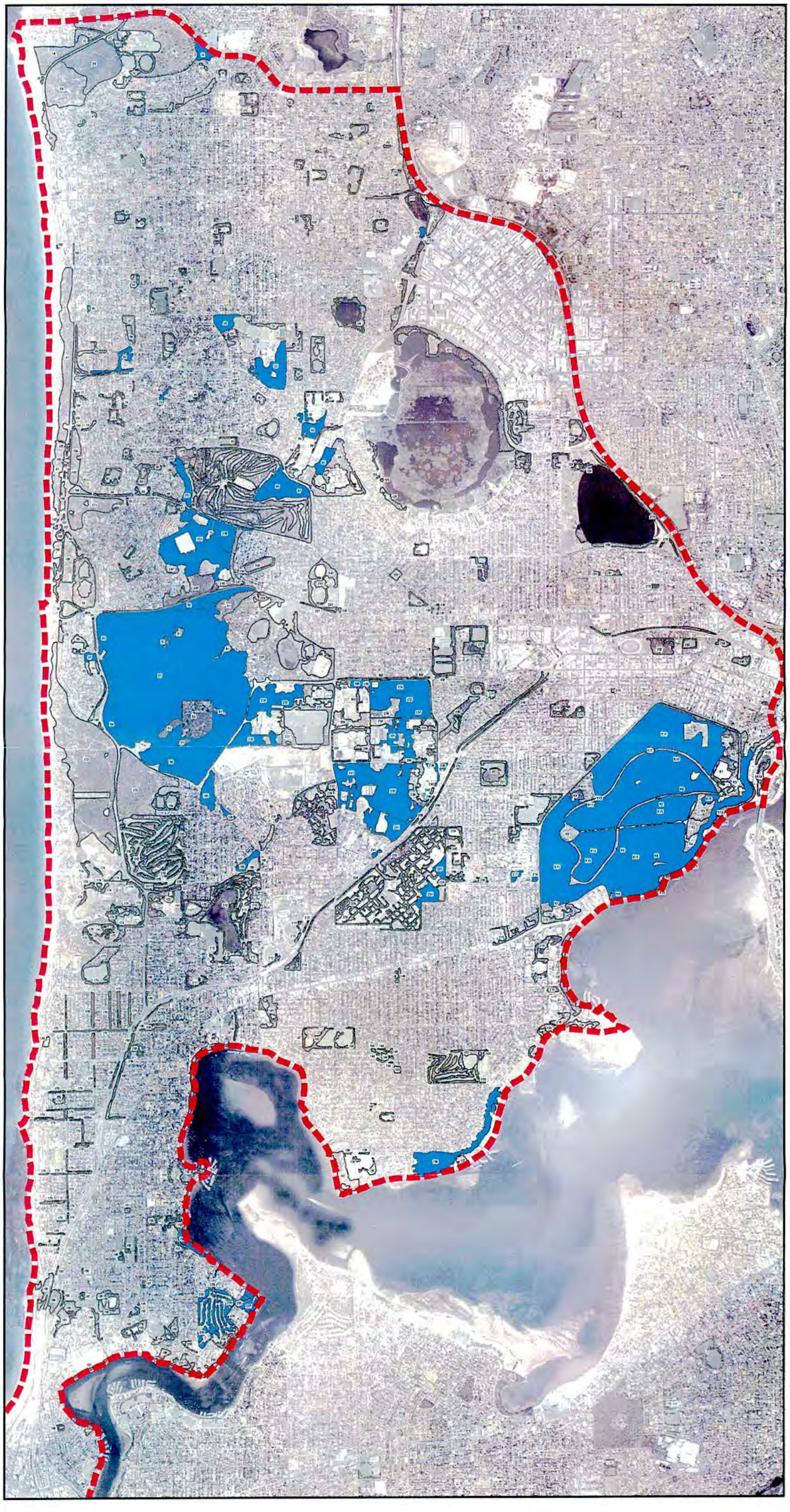
HABITAT TYPES

FIGURE 5

metres

0 500 1000 1500 2000

SCALE 1 : 50 000 @ A3



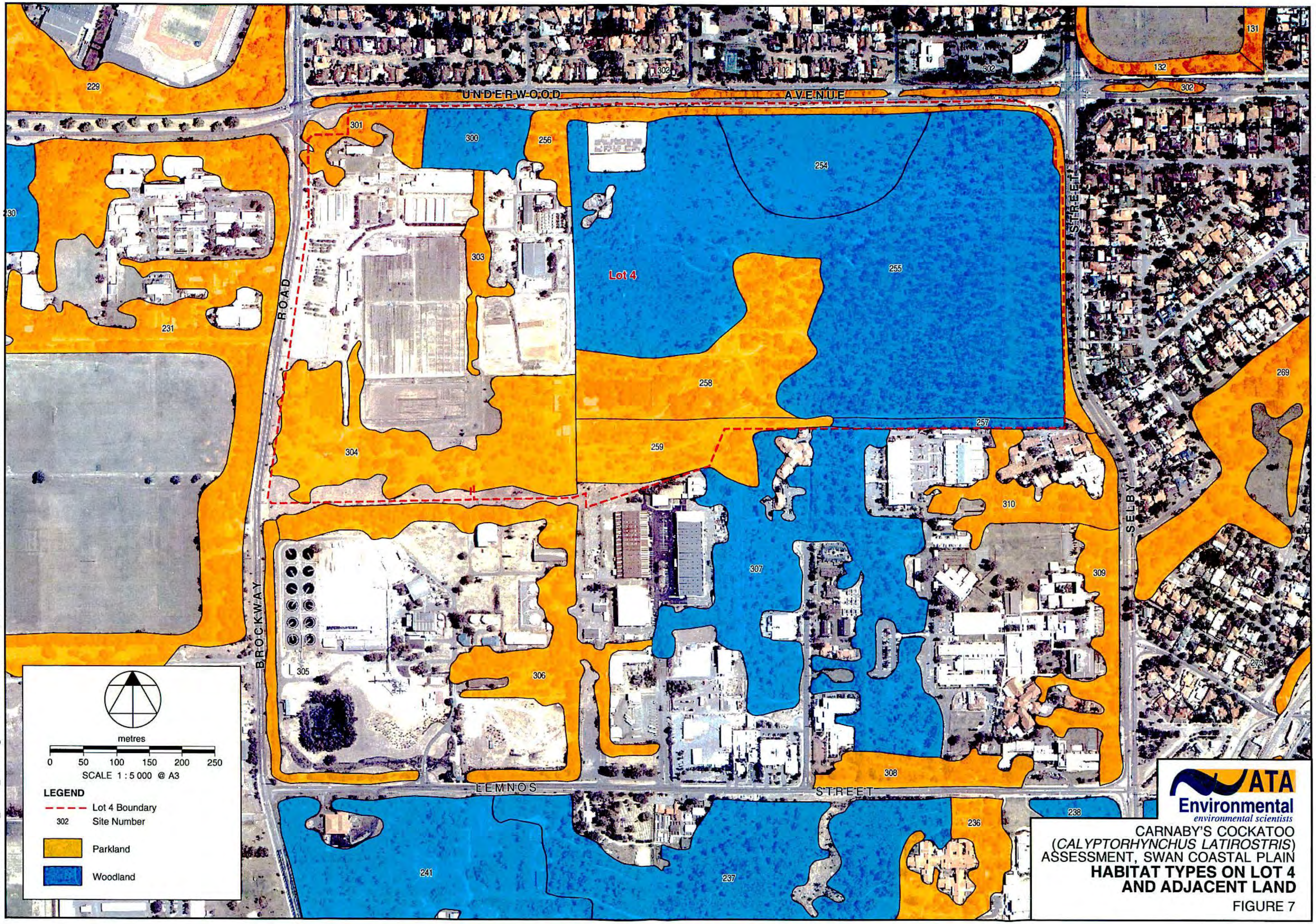
AERIAL SOURCE: DLI, April 2005.

ATA Environmental
environmental scientists

CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT, SWAN COASTAL PLAIN

WOODLAND CORRIDORS

FIGURE 6



CARNABY'S COCKATOO (*CALYPTORHYNCHUS LATIROSTRIS*) ASSESSMENT, SWAN COASTAL PLAIN

HABITAT TYPES ON LOT 4 AND ADJACENT LAND

FIGURE 7

PRINTED: Tue 27 Feb 07 CHECKED: PZ 22-02-07 DRAWN: EDS/GLM 22-02-07 DATUM: MGA UWA-2003-001/FAAS/25_067/25_067107.dgn

UNDERWOOD AVENUE

SELBY STREET

Conservation Area B

Public Open Space

Conservation Area A

metres

0 20 40 60 80 100

SCALE 1 : 2 500 @ A3

LEGEND

- Boundary of Subject Land
- Subdivision Detail
- Conservation and P.O.S. Area Boundaries
- Tree Hollow Location

BASE SOURCE: Chappell, Lambert & Everett, Photo 2002, Subdivision November 2006 (778121i)

ATA Environmental
environmental scientists

CARNABY'S COCKATOO
(*CALYPTORHYNCHUS LATIROSTRIS*)
ASSESSMENT, SWAN COASTAL PLAIN

TREE HOLLOWS POTENTIALLY SUITABLE FOR BLACK COCKATOO BREEDING

FIGURE 8

PRINTED: Thu 22 Feb 07

CHECKED: PZ 15-02-07

DRAWN: TE/GLM/EDS 15-02-07

DATUM: MGA

UWA-2003-001/FAAS/25_067/25_067f08.dgn

PLATES

A B

Plate 1. The Bill Structure of Carnaby's Cockatoo and Baudin's Cockatoo

SOURCE: Museum of Western Australia

ATA Environmental
environmental scientists

Tree 1

Tree 2

Tree 3

Tree 4

Tree 5

Tree 6

Tree 7

Tree 8

Tree 9

Plate 2 Photographs of Trees Identified as Potentially Containing a Hollow that May be Suitable as a Nesting Site for Carnaby's Cockatoo on the Underwood Avenue Site

ATA Environmental
environmental scientists

Tree 10

Tree 11

Tree 12

Tree 13

Tree 14

Tree 15

Tree 16

Tree 17

Tree 18

Plate 2 (cont) Photographs of Trees Identified as Potentially Containing a Hollow that May be Suitable as a Nesting Site for Carnaby's Cockatoo on the Underwood Avenue Site

ATA Environmental
environmental scientists

Tree 19

Tree 20

Tree 21

Tree 22

Tree 23

Tree 24

Tree 25

Tree 26

Tree 27

Plate 2 (cont) Photographs of Trees Identified as Potentially Containing a Hollow that May be Suitable as a Nesting Site for Carnaby's Cockatoo on the Underwood Avenue Site

ATA Environmental
environmental scientists

Tree 28

Tree 29

Tree 30

Tree 31

Tree 32

Tree 33

Tree 34

Tree 35

Tree 36

Plate 2 (cont) Photographs of Trees Identified as Potentially Containing a Hollow that May be Suitable as a Nesting Site for Carnaby's Cockatoo on the Underwood Avenue Site

ATA Environmental
environmental scientists

Tree 37

Tree 38

Tree 39

Tree 40

Tree 41

Tree 42

Plate 2 (cont) Photographs of Trees Identified as Potentially Containing a Hollow that May be Suitable as a Nesting Site for Carnaby's Cockatoo on the Underwood Avenue Site

ATA Environmental
environmental scientists

APPENDICES

APPENDIX 1

PLANT SPECIES FORAGED BY CARNABY'S COCKATOO

APPENDIX 1
PLANT SPECIES FORAGED BY CARNABY'S COCKATOO

Family	Genus	Species	Part eaten
Proteaceae	*Banksia*	asbyi	flowers, seeds
		attenuata	flowers, seeds
		grandis	flowers, seeds
		littoralis	flowers, seeds
		menziesii	flowers, seeds
		verticillata	flowers, seeds
		tricuspis	flowers, seeds
	Dryandra	*affincircioides*	seeds
		fraseri	flowers, seeds
		nivea	flowers, seeds
		nobilis	seeds
		praemorsa	flowers, seeds
		sessilis	flowers, seeds
		speciosa	flowers, seeds
	Grevillea	*apiciloba*	flowers, seeds
		armigera	flowers, seeds
		paniculata	seeds
		petrophiloides	seeds
	Hakea	*auriculata*	seeds
		circumalata	seeds
		conchifolia	seeds
		crassifolia	seeds
		cyclocarpa	seeds
		falcata	seeds
		gilberti	seeds
		incrassata	seeds
		lissocarpha	seeds
		multilineata	seeds
		obliqua	seeds
		prostrata	seeds
		ruscifolia	seeds
		scoparia	seeds
		sulcata	seeds
		trifurcata	seeds
		undulata	seeds
		varia	seeds
	Isopogon	*scabriuscula*	seeds
	Lambertia	*multiflora*	flowers, seeds
Myrtaceae	*Eucalyptus*	*marginata*	seeds
		todtiana	seeds
		wandoo	flowers
	Corymbia	*calophylla*	flowers, seeds, nectar
	Callistomon	*viminalis*	nectar
Pinaceae	*Pinus*	*pinaster*	seeds
		pinea	seeds
		radiata	seeds
Araliaceae	*Brassia*	*actinophylla*	fruit
Casuarinaceae	*Casuarina*		seeds
Fabaceae	*Lupinus*		seeds
Geraniaceae	*Erodium*	*botrys*	seeds
Polygonaceae	*Emex*	*australis*	seeds
Rosaceae	*Prunus*	*dulices*	seeds

List of plant species taken from http://www.birdswa.iinet.net.au/ on 7 July 2005

APPENDIX 2

SUMMARY OF THE 526 SITES SURVEYED IN THE WESTERN SUBURBS OF PERTH AS POTENTIALLY SUITABLE FOR FORAGING BY CARNABY'S COCKATOO

APPENDIX 2
SUMMARY OF THE 526 SITES SURVEYED IN THE WESTERN SUBURBS OF PERTH AS POTENTIALLY SUITABLE FOR FORAGING BY CARNABY'S COCKATOO

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
3	2	1	3	Parkland	N	0.36	382605	6471572
4	2	1	2	Parkland	N	0.192	382825	6471668
5	2	1	1	Parkland	N	0.424	383431	6471157
6	2	1	2	Parkland	N	1.359	383710	6471795
7	4	2	2	Parkland	N	2.035	383463	6471788
8	2	1	2	Parkland	N	1.274	383299	6472009
9	5	3	3	Heath	N	1.542	383245	6472089
10	2	1	2	Parkland	N	2.224	383306	6472443
11	2	1	2	Parkland	N	3.068	383337	6472400
12	2	2	2	Heath	N	0.693	383215	6472213
13	2	3	3	Heath	N	38.589	383778	6472523
14	5	3	1	Woodland	Y	3.117	384149	6472475
15	1	1	2	Parkland	N	0.284	384218	6472215
16	2	1	1	Parkland	N	0.292	384479	6472097
17	2	2	2	Heath	N	2.988	384087	6471829
18	3	1	2	Parkland	N	3.915	384663	6471883
19	2	1	2	Parkland	N	1.251	384605	6472090
20	1	3	3	Heath	N	3.191	382338	6471322
21	2	1	2	Parkland	N	1.323	385942	6471346
22	2	1	2	Parkland	N	0.932	386161	6471422
23	2	1	2	Parkland	N	0.477	386191	6471768
24	2	1	2	Parkland	N	0.243	386505	6471290
25	2	1	1	Parkland	N	4.619	386602	6471125
26	2	1	1	Parkland	N	0.462	386605	6470918
27	2	1	2	Parkland	N	1.524	385976	6470651
28	2	1	2	Parkland	N	1.143	385713	6470969
29	3	1	3	Parkland	N	0.360	385506	6470896
30	2	1	2	Parkland	N	0.870	385316	6471082
31	2	1	2	Parkland	N	0.128	385583	6471188
32	2	1	2	Parkland	N	0.520	385258	6471722
33	2	1	2	Parkland	Y	1.368	383246	6470339
34	2	1	2	Parkland	N	0.583	383875	6470259
35	2	1	2	Parkland	N	0.552	383875	6469713
36	2	1	1	Parkland	Y	0.244	383885	6469462
37	2	1	2	Parkland	Y	2.134	383320	6469193
38	2	3	3	Parkland	N	1.386	383343	6469050
39	2	1	2	Parkland	N	0.212	382762	6469278
40	3	1	2	Parkland	N	1.485	382865	6468834
41	2	4	3	Heath	N	25.598	382499	6468738
41	2	4	3	Heath	N	8.508	382499	6468738
42	3	3	2	Woodland	N	3.527	383337	6468735
43	2	1	2	Parkland	N	2.625	383714	6469542
44	1	1	2	Parkland	N	0.995	383382	6469531
45	2	1	1	Parkland	Y	2.648	384523	6470271
46	1	1	1	Parkland	N	0.496	384276	6469667
47	2	2	2	Parkland	Y	1.196	384815	6469041
48	4	4	4	Woodland	Y	4.605	384447	6469076
49	2	1	1	Parkland	N	2.468	384517	6468939
50	1	1	2	Parkland	N	0.373	384195	6468620
51	2	2	2	Parkland	N	2.310	383818	6468746

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
52	4	2	1	Parkland	N	1.232	385094	6469027
54	4	2	3	Parkland	N	2.086	385371	6468723
55	4	3	4	Woodland	Y	13.335	385214	6468723
56	2	1	2	Parkland	N	0.719	385452	6468427
57	2	1	2	Parkland	N	4.703	385724	6468838
58	2	1	3	Parkland	N	5.308	386165	6469196
59	2	1	4	Parkland	N	0.787	385751	6467837
60	3	3	3	Woodland	N	4.620	385691	6467886
61	1	1	1	Parkland	N	0.962	385531	6468225
61	1	1	1	Parkland	N	0.620	385531	6468225
61	1	1	1	Parkland	N	0.157	385531	6468225
62	3	3	3	Woodland	N	0.585	385497	6467899
63	3	3	2	Woodland	N	0.540	385426	6468009
64	4	1	3	Parkland	N	1.015	385611	6467251
64	4	1	3	Parkland	N	0.838	385611	6467251
65	4	3	3	Woodland	Y	3.825	385596	6467285
66	2	1	3	Parkland	N	16.041	385496	6467235
67	4	3	2	Woodland	Y	3.628	385330	6467034
68	4	1	2	Parkland	Y	71.805	384302	6467114
69	4	3	3	Woodland	N	11.058	385069	6467073
70	4	1	3	Parkland	N	1.819	382610	6468545
71	2	2	1	Parkland	N	1.124	382850	6468480
71	2	2	1	Parkland	N	0.455	382850	6468480
72	1	1	2	Parkland	N	0.161	383357	6468358
73	2	1	2	Parkland	N	1.215	383125	6468044
73	2	1	2	Parkland	N	0.311	383125	6468044
74	4	1	2	Parkland	N	0.199	383230	6468038
75	2	1	3	Parkland	N	1.032	383183	6468184
76	2	1	4	Parkland	N	0.524	382925	6467873
77	2	1	3	Parkland	N	0.361	382629	6468244
78	2	3	4	Woodland	N	0.973	388685	6468212
79	2	1	2	Parkland	N	0.262	384270	6468310
80	2	1	3	Parkland	N	0.741	384132	6468152
81	2	1	3	Parkland	N	0.809	384602	6467594
82	2	1	3	Parkland	N	2.370	385080	6467933
83	2	1	3	Parkland	N	1.138	384807	6468207
84	2	1	2	Parkland	N	0.799	385394	6467648
84	2	1	2	Parkland	N	0.187	385394	6467648
84	2	1	2	Parkland	N	0.059	385394	6467648
85	2	1	3	Parkland	N	1.097	385300	6467265
86	2	1	2	Parkland	N	1.148	387238	6467456
87	4	1	2	Parkland	N	1.641	383006	6467122
88	2	1	2	Parkland	N	2.407	383505	6467118
88	2	1	2	Parkland	N	0.584	383505	6467118
89	2	1	1	Parkland	N	1.095	382892	6467034
89	2	1	1	Parkland	N	0.917	382892	6467034
89	2	1	1	Parkland	N	0.718	382892	6467034
90	2	1	1	Parkland	N	0.139	383246	6466917
91	2	1	2	Parkland	N	1.472	383915	6466862
92	2	1	2	Parkland	N	1.401	382227	6465959
93	1	2	2	Parkland	N	0.662	383202	6466147
94	4	1	1	Parkland	N	9.749	382428	6465679
94	4	1	1	Parkland	N	1.564	382428	6465679
94	4	1	1	Parkland	N	1.310	382428	6465679
95	1	1	2	Parkland	N	0.650	382790	6464765
96	2	2	2	parkland	N	0.699	382556	6465141

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
97	2	3	3	Woodland	N	1.320	382880	6464778
98	2	2	4	Parkland	N	1.374	382725	6465221
99	4	1	1	Parkland	N	0.526	382881	6464776
99	4	1	1	Parkland	N	0.419	382881	6464776
100	4	1	1	Parkland	N	1.250	382822	6464279
100	4	1	1	Parkland	N	0.182	382822	6464279
101	1	1	2	Parkland	Y	0.609	383928	6461982
102	1	2	3	Parkland	N	3.284	383966	6461947
103	2	2	2	Parkland	N	5.285	383694	6461816
104	2	1	3	Parkland	N	3.104	383929	6463136
105	4	3	2	Woodland	N	5.690	384187	6463176
106	4	2	3	Woodland	N	2.174	384860	6462593
107	1	1	2	Parkland	N	0.252	384821	6462561
108	2	1	1	Parkland	N	0.279	384753	6462358
108	2	1	1	Parkland	N	0.117	384753	6462358
109	4	2	3	Woodland	N	0.987	384366	6463142
110	1	1	1	Parkland	N	0.904	386516	6470620
111	1	1	2	Parkland	N	2.200	386679	6470591
112	1	1	1	Parkland	N	4.652	386778	6470586
112	1	1	1	Parkland	N	1.610	386778	6470586
113	1	2	2	Woodland	N	0.721	386843	6470203
113	1	2	2	Woodland	N	0.464	386843	6470203
114	2	2	2	Parkland	N	3.680	386716	6469656
115	2	2	1	Parkland	N	1.167	386725	6469454
116	2	2	1	Parkland	N	0.918	386662	6469268
117	2	2	1	Parkland	N	2.042	386585	6469066
118	2	1	3	Parkland	N	1.073	386291	6470198
119	4	1	2	Parkland	N	0.177	385346	6470314
120	2	1	2	Parkland	N	1.353	385387	6470424
121	2	1	2	Parkland	N	21.985	388157	6467368
122	4	1	2	Parkland	N	7.775	388031	6467771
122	4	1	2	Parkland	N	2.943	388031	6467771
123	2	1	2	Parkland	N	2.643	388593	6467323
123	2	1	2	Parkland	N	1.486	388593	6467323
124	2	2	2	Parkland	N	0.846	388921	6467408
124	2	2	2	Parkland	N	0.731	388921	6467408
125	2	2	4	Parkland	N	1.921	387515	6466851
125	2	2	4	Parkland	N	0.977	387515	6466851
125	2	2	4	Parkland	N	0.096	387515	6466851
125	2	2	4	Parkland	N	0.081	387515	6466851
126	2	1	2	Parkland	N	2.171	387645	6466049
127	2	1	2	Parkland	N	0.816	386865	6466398
128	2	1	2	Parkland	N	1.218	386608	6466033
129	2	1	2	Parkland	N	0.778	386643	6465800
130	2	1	1	Parkland	N	0.129	386931	6465648
130	2	1	1	Parkland	N	0.084	386931	6465648
130	2	1	1	Parkland	N	0.037	386931	6465648
131	2	1	3	Parkland	N	2.966	387240	6464983
132	2	1	1	Parkland	N	1.522	387031	6464973
133	2	1	3	Parkland	N	1.864	388367	6460452
134	4	2	3	Parkland	N	2.073	388792	6460584
135	2	1	2	Parkland	N	5.517	388792	6460958
136	4	1	2	Parkland	N	0.493	388224	6460118
137	2	1	2	Parkland	N	1.301	387256	6458802
138	4	2	2	Woodland	N	19.352	387650	6459138
139	2	1	3	Parkland	N	1.188	386273	6458758

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
139	2	1	3	Parkland	N	0.280	386273	6458758
139	2	1	3	Parkland	N	0.214	386273	6458758
139	2	1	3	Parkland	N	0.146	386273	6458758
140	2	1	3	Parkland	Y	7.243	385941	6458628
141	2	1	2	Parkland	N	0.659	386462	6459423
142	2	1	2	Parkland	N	0.296	386278	6459543
143	4	3	3	Parkland	N	0.626	386538	6459986
144	2	1	2	Parkland	N	0.931	386309	6460165
144	2	1	2	Parkland	N	0.293	386309	6460165
144	2	1	2	Parkland	N	0.186	386309	6460165
144	2	1	2	Parkland	N	0.133	386309	6460165
144	2	1	2	Parkland	N	0.104	386309	6460165
144	2	1	2	Parkland	N	0.073	386309	6460165
145	2	1	3	Parkland	Y	2.522	385563	6460211
146	4	1	2	Parkland	N	1.801	385840	6460215
147	2	1	2	Parkland	N	0.860	385425	6460343
148	2	1	1	Parkland	N	0.623	386550	6461093
149	2	1	1	Parkland	N	4.248	384849	6460738
150	1	1	1	Parkland	N	0.761	384617	6460452
151	4	3	3	Parkland	Y	6.282	384024	6460045
152	2	1	3	Parkland	N	4.625	384039	6458733
153	2	1	4	Parkland	N	0.585	384025	6458625
154	1	1	2	Parkland	N	0.492	383969	6458135
155	4	1	2	Parkland	N	3.371	383877	6458007
156	2	3	3	Woodland	N	2.914	383886	6457901
157	2	1	3	Parkland	N	0.398	383490	6458036
158	2	1	3	Parkland	N	1.288	383490	6458036
159	1	1	2	Parkland	N	0.397	383360	6457823
160	4	1	2	Parkland	N	0.493	383234	6457691
160	4	1	2	Parkland	N	0.441	383234	6457691
161	1	1	2	Parkland	N	0.377	383324	6458219
162	4	1	2	Parkland	N	0.085	382466	6470018
163	4	1	1	Parkland	N	0.198	382599	6469877
164	2	3	2	Heath	N	6.805	382641	6467118
164	2	3	2	Heath	N	1.713	382641	6467118
164	2	3	2	Heath	N	0.418	382641	6467118
164	2	3	2	Heath	N	0.355	382641	6467118
164	2	3	2	Heath	N	0.114	382641	6467118
165	2	1	1	Parkland	N	0.312	382503	6467490
165	2	1	1	Parkland	N	0.158	382503	6467490
165	2	1	1	Parkland	N	0.145	382503	6467490
165	2	1	1	Parkland	N	0.132	382503	6467490
165	2	1	1	Parkland	N	0.064	382503	6467490
165	2	1	1	Parkland	N	0.048	382503	6467490
165	2	1	1	Parkland	N	0.042	382503	6467490
166	2	2	1	Heath	N	1.814	382437	6466982
167	4	1	1	Parkland	N	0.186	382425	6466526
167	4	1	1	Parkland	N	0.151	382425	6466526
167	4	1	1	Parkland	N	0.147	382425	6466526
167	4	1	1	Parkland	N	0.047	382425	6466526
168	2	3	2	Heath	N	0.684	382429	6466404
169	2	3	2	Heath	N	7.399	382425	6466188
169	2	3	2	Heath	N	2.159	382425	6466188
170	4	1	1	Parkland	N	2.024	382437	6466165
171	2	3	2	Heath	N	13.647	382841	6466810
172	2	3	2	Heath	N	0.978	382425	6465132

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
172	2	3	2	Heath	N	0.179	382425	6465132
173	2	3	1	Heath	N	91.902	382755	6464244
173	2	3	1	Heath	N	37.187	382755	6464244
174	2	2	3	Parkland	N	1.783	383249	6462258
174	2	2	3	Parkland	N	1.696	383249	6462258
174	2	2	3	Parkland	N	1.397	383249	6462258
174	2	2	3	Parkland	N	0.989	383249	6462258
174	2	2	3	Parkland	N	0.711	383249	6462258
174	2	2	3	Parkland	N	0.639	383249	6462258
174	2	2	3	Parkland	N	0.592	383249	6462258
174	2	2	3	Parkland	N	0.560	383249	6462258
174	2	2	3	Parkland	N	0.495	383249	6462258
174	2	2	3	Parkland	N	0.451	383249	6462258
174	2	2	3	Parkland	N	0.417	383249	6462258
174	2	2	3	Parkland	N	0.265	383249	6462258
175	4	1	2	Parkland	N	0.178	382913	6461483
175	4	1	2	Parkland	N	0.173	382913	6461483
175	4	1	2	Parkland	N	0.148	382913	6461483
175	4	1	2	Parkland	N	0.055	382913	6461483
175	4	1	2	Parkland	Y	1.673	382913	6461483
175	4	1	2	Parkland	Y	0.801	382913	6461483
175	4	1	2	Parkland	Y	0.432	382913	6461483
176	4	1	2	Parkland	N	1.487	382892	6461020
177	2	2	1	Heath	Y	5.379	382916	6461283
178	2	3	3	Heath	N	0.681	382242	6459725
179	1	1	1	Parkland	N	1.482	382493	6459419
179	1	1	1	Parkland	N	1.073	382493	6459419
179	1	1	1	Parkland	N	1.037	382493	6459419
179	1	1	1	Parkland	N	0.987	382493	6459419
179	1	1	1	Parkland	N	0.932	382493	6459419
179	1	1	1	Parkland	N	0.762	382493	6459419
179	1	1	1	Parkland	N	0.754	382493	6459419
179	1	1	1	Parkland	N	0.603	382493	6459419
179	1	1	1	Parkland	N	0.580	382493	6459419
179	1	1	1	Parkland	N	0.531	382493	6459419
179	1	1	1	Parkland	N	0.525	382493	6459419
179	1	1	1	Parkland	N	0.490	382493	6459419
179	1	1	1	Parkland	N	0.482	382493	6459419
179	1	1	1	Parkland	N	0.443	382493	6459419
179	1	1	1	Parkland	N	0.440	382493	6459419
179	1	1	1	Parkland	N	0.414	382493	6459419
179	1	1	1	Parkland	N	0.382	382493	6459419
179	1	1	1	Parkland	N	0.380	382493	6459419
179	1	1	1	Parkland	N	0.377	382493	6459419
179	1	1	1	Parkland	N	0.346	382493	6459419
179	1	1	1	Parkland	N	0.342	382493	6459419
179	1	1	1	Parkland	N	0.331	382493	6459419
179	1	1	1	Parkland	N	0.327	382493	6459419
179	1	1	1	Parkland	N	0.323	382493	6459419
179	1	1	1	Parkland	N	0.303	382493	6459419
179	1	1	1	Parkland	N	0.303	382493	6459419
179	1	1	1	Parkland	N	0.294	382493	6459419
179	1	1	1	Parkland	N	0.266	382493	6459419
179	1	1	1	Parkland	N	0.257	382493	6459419
179	1	1	1	Parkland	N	0.229	382493	6459419
179	1	1	1	Parkland	N	0.191	382493	6459419

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
179	1	1	1	Parkland	N	0.153	382493	6459419
179	1	1	1	Parkland	N	0.150	382493	6459419
179	1	1	1	Parkland	N	0.135	382493	6459419
179	1	1	1	Parkland	N	0.127	382493	6459419
179	1	1	1	Parkland	N	0.106	382493	6459419
179	1	1	1	Parkland	N	0.101	382493	6459419
179	1	1	1	Parkland	N	0.081	382493	6459419
180	1	1	1	Parkland	N	2.297	383320	6460297
180	1	1	1	Parkland	N	0.873	383320	6460297
180	1	1	1	Parkland	N	0.604	383320	6460297
180	1	1	1	Parkland	N	0.408	383320	6460297
180	1	1	1	Parkland	N	0.284	383320	6460297
180	1	1	1	Parkland	N	0.265	383320	6460297
180	1	1	1	Parkland	N	0.210	383320	6460297
181	1	2	1	Heath	N	2.811	382353	6456605
182	1	3	2	Heath	N	0.512	382165	6457620
183	4	1	1	Parkland	N	0.127	382371	6457587
184	1	3	2	Heath	N	3.864	382353	6456605
184	1	3	2	Heath	N	2.890	382353	6456605
185	2	3	2	Heath	N	2.472	382598	6457099
186	4	1	1	Parkland	N	0.289	382470	6457147
187	2	1	2	Parkland	N	0.336	382722	6457053
188	2	1	2	Parkland	N	0.087	382712	6457450
189	4	1	2	Parkland	N	2.093	383037	6457103
190	1	1	1	Parkland	N	1.877	382914	6456947
190	1	1	1	Parkland	N	1.027	382914	6456947
191	2	2	2	Parkland	N	1.081	382981	6456394
192	1	1	2	Parkland	N	0.345	382455	6456010
193	2	2	3	Parkland	N	1.851	382763	6455490
194	2	1	2	Parkland	N	0.845	382990	6456631
194	2	1	2	Parkland	N	0.628	382990	6456631
195	2	1	2	Parkland	N	1.442	383294	6456697
195	2	1	2	Parkland	N	0.874	383294	6456697
196	2	1	2	Parkland	N	0.606	383296	6456925
196	2	1	2	Parkland	N	0.047	383296	6456925
197	2	1	2	Parkland	N	0.255	383433	6457253
198	2	3	3	Heath	N	1.059	383700	6456488
199	2	1	2	Parkland	N	1.515	383677	6456562
199	2	1	2	Parkland	Y	2.000	383677	6456562
200	2	1	2	Parkland	N	0.463	384132	6456589
201	2	1	2	Parkland	N	2.475	383938	6456400
201	2	1	2	Parkland	N	0.189	383938	6456400
202	1	2	1	Parkland	N	2.157	383874	6456258
203	2	2	2	Parkland	N	2.545	384491	6456490
204	4	1	2	Parkland	N	2.256	384557	6456771
205	4	3	2	Woodland	N	5.545	384592	6457060
205	4	3	2	Woodland	N	2.557	384592	6457060
205	4	3	2	Woodland	N	2.323	384592	6457060
205	4	3	2	Woodland	N	0.768	384592	6457060
205	4	3	2	Woodland	N	0.631	384592	6457060
205	4	3	2	Woodland	N	0.207	384592	6457060
205	4	3	2	Woodland	N	0.105	384592	6457060
206	2	1	2	Parkland	N	0.742	384618	6457039
207	2	2	3	Woodland	N	4.363	384814	6457114
208	2	1	2	Parkland	N	0.901	383351	6460246
208	2	1	2	Parkland	N	0.093	383351	6460246

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
209	1	1	2	Parkland	N	0.785	383595	6460408
210	2	1	3	Parkland	N	0.652	383474	6460552
211	2	1	2	Parkland	N	1.166	384110	6460859
212	2	1	3	Parkland	N	11.137	384502	6461248
212	2	1	3	Parkland	N	10.056	384502	6461248
212	2	1	3	Parkland	N	1.904	384502	6461248
212	2	1	3	Parkland	N	1.064	384502	6461248
212	2	1	3	Parkland	N	0.531	384502	6461248
212	2	1	3	Parkland	N	0.459	384502	6461248
212	2	1	3	Parkland	N	0.447	384502	6461248
212	2	1	3	Parkland	N	0.404	384502	6461248
212	2	1	3	Parkland	N	0.175	384502	6461248
212	2	1	3	Parkland	N	0.120	384502	6461248
213	2	1	2	Parkland	N	1.150	385078	6461142
213	2	1	2	Parkland	N	0.361	385078	6461142
213	2	1	2	Parkland	N	0.242	385078	6461142
213	2	1	2	Parkland	N	0.224	385078	6461142
214	2	1	2	Parkland	N	1.822	385230	6461111
215	2	1	3	Parkland	N	5.328	387883	6461646
215	2	1	3	Parkland	N	4.620	387883	6461646
216	4	2	2	Woodland	N	0.303	388241	6462235
217	4	3	3	Woodland	N	1.107	387992	6462290
218	4	1	2	Parkland	N	1.912	388601	6460075
219	4	1	2	Parkland	N	0.682	388555	6460804
219	4	1	2	Parkland	N	0.682	388555	6460804
219	4	1	2	Parkland	Y	3.831	388555	6460804
220	4	1	2	Parkland	N	1.430	388087	6463152
220	4	1	2	Parkland	Y	4.921	388087	6463152
221	4	1	2	Parkland	N	4.510	388014	6463555
221	4	1	2	Parkland	N	0.180	388014	6463555
222	2	1	3	Parkland	N	0.396	387330	6463656
223	2	1	2	Parkland	N	1.094	388935	6463769
224	4	3	4	Woodland	N	4.898	386984	6462220
225	4	3	4	Woodland	N	2.442	387044	6462355
226	4	1	4	Parkland	N	2.719	386623	6462366
226	4	1	4	Parkland	N	0.940	386623	6462366
226	4	1	4	Parkland	N	0.753	386623	6462366
226	4	1	4	Parkland	N	0.091	386623	6462366
226	4	1	4	Parkland	N	0.071	386623	6462366
226	4	1	4	Parkland	Y	37.057	386623	6462366
227	4	1	1	Parkland	N	1.770	384043	6465703
227	4	1	1	Parkland	N	0.722	384043	6465703
228	4	1	2	Parkland	N	0.711	384884	6465746
229	2	1	4	Parkland	Y	63.949	385377	6464953
230	2	3	3	Woodland	N	13.818	384557	6463667
230	2	3	3	Woodland	Y	8.693	384557	6463667
231	2	1	3	Parkland	N	16.710	385341	6464487
232	4	4	4	Woodland	N	2.020	385113	6464443
233	4	1	2	Parkland	N	2.569	385445	6463388
233	4	1	2	Parkland	N	0.305	385445	6463388
234	2	1	3	Parkland	N	11.803	385338	6463018
234	2	1	3	Parkland	N	0.266	385338	6463018
235	2	1	3	Parkland	N	1.719	384971	6462688
235	2	1	3	Parkland	N	0.273	384971	6462688
236	2	1	4	Parkland	N	5.273	386787	6463466
237	4	3	4	Woodland	Y	30.297	386758	6463098

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
238	4	3	2	Woodland	N	1.010	387027	6463683
239	3	3	2	Woodland	N	0.531	387104	6463629
240	4	1	2	Parkland	N	0.207	386991	6463323
240	4	1	2	Parkland	N	0.085	386991	6463323
241	2	3	4	Woodland	N	14.411	386525	6462881
241	2	3	4	Woodland	N	9.645	386525	6462881
241	2	3	4	Woodland	N	0.460	386525	6462881
242	4	1	1	Parkland	N	0.170	385858	6465565
243	2	1	3	Parkland	N	3.997	385506	6466069
243	2	1	3	Parkland	N	1.661	385506	6466069
243	2	1	3	Parkland	N	1.146	385506	6466069
243	2	1	3	Parkland	N	0.523	385506	6466069
244	2	2	4	Heath	N	2.407	385013	6466215
245	2	2	4	Heath	N	3.173	385013	6466215
246	2	1	1	Parkland	N	2.231	384391	6465884
247	2	1	2	Parkland	N	3.903	384693	6466533
248	1	4	2	Heath	N	10.532	383703	6465670
249	1	4	4	Heath	N	1.413	383781	6466056
250	4	4	2	Woodland	N	7.940	384627	6466585
251	2	3	3	Woodland	Y	33.580	384586	6466282
252	4	3	2	Woodland	N	0.609	384209	6466865
253	2	2	2	Woodland	Y	4.986	383992	6467104
253	2	2	2	Woodland	Y	0.810	383992	6467104
254	2	4	4	Woodland	Y	3.850	386583	6464607
255	4	4	4	Woodland	N	24.220	386652	6464472
256	2	2	2	Parkland	N	2.202	386165	6464638
257	4	4	3	Woodland	N	0.546	386882	6464225
258	2	2	2	Parkland	N	5.035	386362	6464244
259	2	2	2	Parkland	N	2.671	386369	6464196
260	2	2	2	Parkland	N	1.652	383680	6462179
261	2	1	1	Parkland	Y	4.177	383506	6462162
262	2	1	3	Parkland	N	22.765	383556	6462712
262	2	1	3	Parkland	N	0.736	383556	6462712
262	2	1	3	Parkland	N	0.619	383556	6462712
262	2	1	3	Parkland	N	0.502	383556	6462712
262	2	1	3	Parkland	N	0.374	383556	6462712
263	4	1	2	Parkland	N	1.878	386970	6460031
263	4	1	2	Parkland	N	0.648	386970	6460031
263	4	1	2	Parkland	N	0.498	386970	6460031
263	4	1	2	Parkland	Y	8.292	386970	6460031
264	2	1	1	Parkland	N	1.670	387413	6462709
265	2	1	1	Parkland	N	1.030	387354	6462709
265	2	1	1	Parkland	N	0.241	387354	6462709
266	1	1	1	Parkland	N	1.222	387677	6462188
266	1	1	1	Parkland	N	0.621	387677	6462188
267	2	1	2	Parkland	N	0.765	387039	6462994
268	2	1	1	Parkland	N	2.029	386805	6463139
268	2	1	1	Parkland	N	1.408	386805	6463139
268	2	1	1	Parkland	N	0.220	386805	6463139
268	2	1	1	Parkland	N	0.208	386805	6463139
269	2	1	3	Parkland	N	6.144	387378	6464156
270	2	1	2	Parkland	N	1.275	387496	6464640
271	2	1	2	Parkland	N	0.738	387695	6464513
272	2	1	3	Parkland	N	5.217	387041	6464513
273	2	1	3	Parkland	N	3.102	388245	6464538
274	2	1	3	Parkland	N	3.448	388424	6464361

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
275	2	1	2	Parkland	N	1.264	388868	6464558
276	2	1	3	Parkland	N	0.197	389253	6464558
277	2	1	1	Parkland	N	2.168	389395	6465301
277	2	1	1	Parkland	N	0.451	389395	6465301
278	2	1	3	Parkland	N	0.470	389841	6465844
279	4	1	1	Parkland	N	3.333	389700	6466709
279	4	1	1	Parkland	N	0.869	389700	6466709
279	4	1	1	Parkland	N	0.868	389700	6466709
280	2	1	2	Parkland	N	3.010	389617	6466378
281	2	1	3	Parkland	N	1.018	389217	6466004
281	2	1	3	Parkland	N	0.391	389217	6466004
282	2	1	2	Parkland	N	4.675	389972	6465103
283	1	1	3	Parkland	N	0.642	390210	6465240
284	2	1	2	Parkland	N	0.898	390532	6465147
285	2	1	2	Parkland	N	1.804	390807	6464927
300	4	2	2	Woodland	N	1.457	386050	6464647
301	2	1	1	Parkland	N	1.122	385871	6464664
302	4	2	1	Parkland	N	1.018	386418	6464728
302	4	2	1	Parkland	N	0.276	386418	6464728
302	4	2	1	Parkland	N	0.184	386418	6464728
303	2	2	3	Parkland	N	0.733	386077	6464475
304	2	1	2	Parkland	N	5.982	385887	6464173
305	4	1	1	Parkland	Y	0.954	385767	6463850
306	2	2	3	Parkland	N	4.846	386154	6463843
307	4	3	3	Woodland	Y	9.769	386491	6464007
308	4	2	2	Parkland	N	1.467	386713	6463691
309	4	1	1	Parkland	N	1.937	387029	6463817
310	4	1	2	Parkland	N	1.995	386960	6464097
1A	2	3	2	Heath	N	10.88	382106	6472398
1B	1	2	1	Heath	N	0.217	382140	6472019
1C	3	3	3	Heath	N	2.883	382584	6472625
1D	2	2	1	Heath	Y	7.185	382952	6472689
1E	1	3	1	Heath	N	0.440	382926	6472627
2A	2	2	2	Heath	N	22.286	382387	6471818
2B	2	3	3	Heath	N	26.113	383005	6472187
2C	1	3	2	Heath	N	1.428	383035	6472567
B1	1	4	3	Heath	N	7.059	384432	6465541
B1	1	4	3	Heath	N	2.860	384432	6465541
B1	1	4	3	Heath	N	1.182	384432	6465541
B1	1	4	3	Heath	N	1.077	384432	6465541
B1	1	4	3	Heath	N	1.024	384432	6465541
B1	1	4	3	Heath	N	0.865	384432	6465541
B1	1	4	3	Heath	N	0.514	384432	6465541
B2	3	4	2	Woodland	Y	12.962	384016	6465631
B3	2	4	2	Woodland	Y	1.508	382921	6465136
B4	2	4	2	Woodland	Y	12.950	383211	6463924
B5	4	1	4	Parkland	N	16.863	383887	6463980
B6	4	3	3	Woodland	Y	1.461	383721	6463767
B7	4	4	4	Woodland	Y	262.973	383654	6464766
K1	4	1	2	Parkland	N	2.736	390701	6463733
K10	2	1	2	Parkland	N	4.311	389264	6463440
K10	2	1	2	Parkland	N	3.679	389264	6463440
K10	2	1	2	Parkland	N	1.749	389264	6463440
K11	4	1	2	Parkland	N	6.225	388912	6463308
K11	4	1	2	Parkland	N	0.450	388912	6463308
K12	1	1	2	Parkland	N	0.687	389694	6463798

Site No	Food Potential	Habitat Quality	Ethno Influence	Habitat Type	Nesting Opport'y	Area (ha)	Easting	Northing
K13	1	1	1	Parkland	N	2.762	390667	6463038
K13	1	1	1	Parkland	N	1.596	390667	6463038
K13	1	1	1	Parkland	N	1.415	390667	6463038
K13	1	1	1	Parkland	N	0.365	390667	6463038
K13	1	1	1	Parkland	N	0.286	390667	6463038
K13	1	1	1	Parkland	N	0.241	390667	6463038
K13	1	1	1	Parkland	N	0.164	390667	6463038
K13	1	1	1	Parkland	N	0.159	390667	6463038
K14	2	1	1	Parkland	N	2.917	390491	6463370
K15	4	4	4	Woodland	N	22.102	389475	6463224
K15	4	4	4	Woodland	N	1.783	389475	6463224
K15	4	4	4	Woodland	Y	204.194	389475	6463224
K15	4	4	4	Woodland	Y	70.148	389475	6463224
K15	4	4	4	Woodland	Y	22.813	389475	6463224
K2	4	1	2	Parkland	N	0.153	389728	6463229
K3	4	2	2	Parkland	N	3.739	390164	6463040
K4	2	1	2	Parkland	N	2.161	390169	6462678
K5	2	1	2	Parkland	N	5.761	390702	6463499
K5	2	1	2	Parkland	N	1.625	390702	6463499
K5	2	1	2	Parkland	Y	11.078	390702	6463499
K6	1	1	2	Parkland	N	4.938	389510	6463134
K6	1	1	2	Parkland	N	4.185	389510	6463134
K6	1	1	2	Parkland	N	3.885	389510	6463134
K6	1	1	2	Parkland	N	0.552	389510	6463134
K6	1	1	2	Parkland	N	0.316	389510	6463134
K7	1	2	3	Woodland	N	1.119	388377	6461930
K8	4	1	3	Parkland	N	3.733	388590	6462736
K9	4	1	3	Parkland	N	1.462	388590	6462736