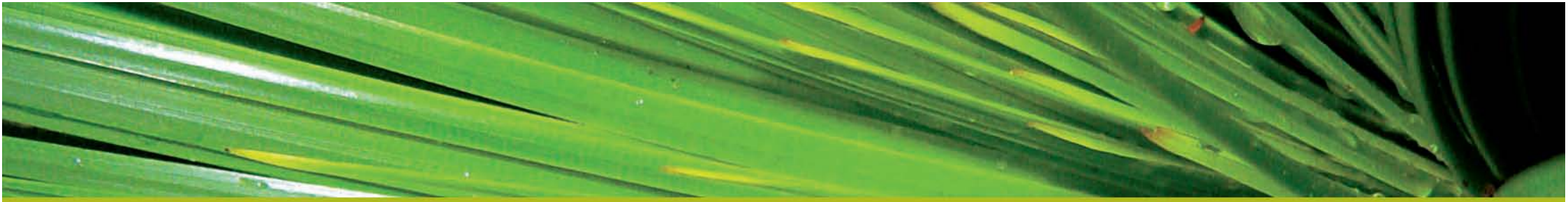

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Flora, Fauna & Threatened Species Assessment
Proposed Medical Research and Development Facility
2 Lookout Road, New Lambton Heights NSW

Flora, Fauna and Threatened Species Assessment:

Proposed Medical Research and Development Facility
2 Lookout Road, New Lambton Heights, NSW.

May 2009

Report prepared for the Hunter Medical Research Institute with instruction from ADW Johnson Pty Ltd.

This report was prepared for the sole use of the proponents, their agents and any regulatory agencies involved in the development application approval process. It should not be otherwise referenced without permission.

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Executive Summary

EcoBiological was commissioned by the Hunter Medical Research Institute to prepare an assessment of flora, fauna and threatened species for the proposed construction of a medical research and development facility within the grounds of the John Hunter Hospital, 2 Lookout Road, New Lambton Heights NSW. Field surveys were conducted during March 2009 to inform this assessment. The results of a flora and fauna survey conducted by EcoBiological in November 2007 within the study area have also been used to inform this assessment.

Data collected during the field surveys revealed that the study area supported 162 plant species within one plant community, *Coastal Plains Smooth-barked Apple Woodland*. Thirty-five trees within the study area supported 63 potential habitat hollows. An individual plant of the threatened flora species, *Tetratheca juncea* was recorded within the proposed development footprint. A total of 62 fauna species were recorded within the study area including the following threatened species listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995:* Little Bentwing-bat *Miniopterus australis*, Eastern Bentwing-bat *Miniopterus oceanensis*, Eastern Freetail-bat *Mormopterus norfolkensis*, Grey-headed Flying-fox *Pteropus poliocephalus*, Masked Owl *Tyto novaehollandiae*, Powerful Owl *Ninox strenua* and the Glossy Black-Cockatoo *Calyptorhynchus lathami*.

The Assessment of Significance revealed that for the majority of threatened species there would be minimal impact from the proposed development. However, an additional survey is required to determine the extent of impact on the threatened plant, *Tetratheca juncea*. Surveys for this species were conducted outside of the flowering season, and it is recommended that an additional survey for this species be undertaken within the study area during the known flowering period (September – December). Without information from further surveys conducted during the main flowering season, the precautionary principle must be invoked whereby it is considered likely that the proposed development will place the local population of *Tetratheca juncea* within the subject site at risk of extinction. It is recommended that the results of this targeted survey form an Addendum to this assessment. In order to ensure the safety of native flora and fauna and to preserve habitat integrity within the study area, several ameliorative measures and management actions have been recommended.

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1. Introduction

1.1. Scope

EcoBiological was commissioned by the Hunter Medical Research Institute to prepare an assessment of flora, fauna and threatened species for the proposed construction of a medical research and development facility within the grounds of the John Hunter Hospital, 2 Lookout Road, New Lambton Heights NSW (Figure 1). The following terms are used throughout this report to describe particular geographical areas:

- Study area – refers to the subject site and those additional areas which are considered likely to be affected by the proposal either directly or indirectly. The study area investigated was a 7.11 ha portion of predominantly vegetated land within the John Hunter Hospital grounds as shown in Figure 2.
- Subject site – the area directly affected by the proposal. In this case, the proposed development footprint, bushfire Asset Protection Zone (APZ) and Bushfire Fuel Management Zone outlined in Figure 3.
- Locality – land within a 5 kilometre radius of the subject site, containing flora and fauna species that would likely have a high level of interaction with the flora and fauna of the subject site.

This report is an assessment of the flora and fauna that were detected within the study area or that were considered to possibly occur in the type of habitat present, as well as threatened flora and fauna that have been recorded to occur within a five-kilometre radius of the study area.

1.2. Local Context

The study area is approximately 7.11 hectares in size and is bound by remnant bushland to the north and east and by existing development within the grounds of the John Hunter Hospital to the south and west.

Native vegetation within the John Hunter Hospital grounds forms part of a large expanse of bushland including Blackbutt Reserve to the southeast, George McGregor Park to the southwest and Jesmond Bushland Reserve to the north. The extent of vegetation and infrastructure that adjoins the study area is shown in Figure 2.

1.3. Description of the proposal

Hunter Medical Research Institute is proposing to construct two medical research and development wings (East and West wings) with an option for future expansion and associated infrastructure within the John Hunter Hospital grounds (Figure 3). A Bushfire Constraints Report prepared for the proposed development has recommended that a 40m Asset Protection Zone (APZ) be applied to the west, northwest, north and northeast of the proposed buildings, with existing landscaped areas south of the proposed West Wing to be maintained (ABPP 2009). This APZ will be maintained as an Inner Protection Area (IPA) to standards outlined in *Planning for Bushfire Protection* (NSW RFS 2006). The remaining vegetation between the recommended APZ and the powerline easement will be fuel managed in accordance with the protocols of a Fire Management Plan (ABPP 2009). No vegetation will require removal in this Bushfire Fuel Management Zone; however, maintenance of the combustible ground litter in this area to a maximum of 8 – 10 tonnes/hectare will be undertaken.

The amount of vegetation to be removed for the proposed new buildings, carparks and landscaping (batters off car park and access road) will be approximately 3.2 ha with an additional 1 ha requiring modification of the mid and ground layers to maintain the bushfire APZ as an IPA.

1.4. Geology and Soils

The study area is located on the Killingworth Erosional Soil Landscape as identified by the Soil Landscapes of the Newcastle 1: 100 000 sheet (Matthei, 1995). This landscape is characterised by undulating to rolling hills and low hills on sediments of the Newcastle Coal Measures of the Awaba Hills region. Parent rock material comprises coal, tuff, conglomerate, sandstone and shale. Elevations are between 50 – 160m, local relief is between 30-100m and slope gradients vary from 3 – 20%. Crests are generally broad and sideslopes are long, grading into narrow drainage lines. Drainage plains are long and gently inclined. Dominant soil materials include shallow to moderately deep, well to imperfectly drained Yellow Podzolic Soils, yellow Soloths and gleyed Soloths on crests and hillslopes, with shallow well-drained Structured Loams, Bleached Loams and Lithosols on some crests (Matthei 1995).

Figure 1: The location of the study area within the Newcastle region.

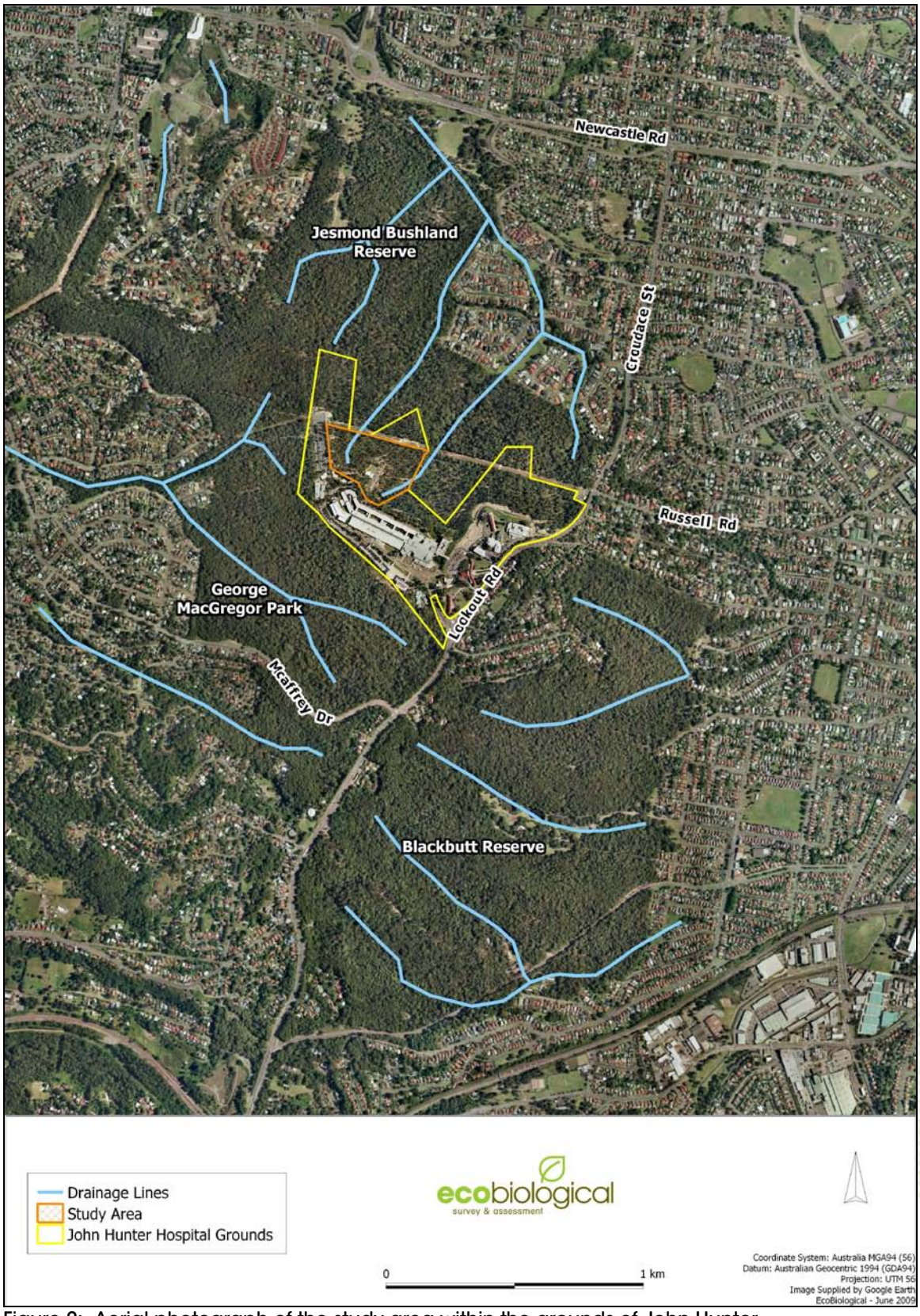

Figure 2: Aerial photograph of the study area within the grounds of John Hunter Hospital showing the extent of vegetation, waterways and infrastructure that adjoin the site.

Figure 3: Aerial photograph of the study area, proposed development footprint, bushfire APZ and fuel management zone.

1.5. Legislation

This project was undertaken in accordance with the following Acts and in consideration of the following Policies and Guidelines:

- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *NSW Threatened Species Conservation Act 1995 (TSC Act);*
- *NSW Threatened Species Conservation Amendment Act 2002;*
- *National Parks and Wildlife Act 1974 (NP&W Act);*
- *Environmental Planning and Assessment Act 1979 (EP&A Act);*
- State Environment Planning Policy 44 (SEPP44) Koala Habitat Assessment;
- Newcastle Local Environmental Plan 2003;
- Threatened Biodiversity Survey and Assessment: Guidelines for Development, Working Draft, (DEC 2004a); and,
- Lower Hunter Central Coast Regional Environmental Management Strategy (Murray *et al*. 2002a, 2002b) – 'Flora and Fauna Survey Guidelines Volumes 1 and 2'.

1.5.1. Environment Protection & Biodiversity Conservation Act 1999 (EPBC Act)

Under the EPBC Act assessment an approval is required for actions that are likely to have a significant impact on matters of national environmental significance. An action includes a project, development, undertaking, activity, or series of activities. When a person proposes to take an action they believe may need approval under the EPBC Act, they must refer the proposal to the Australian Government Minister for the Environment, Water, Heritage & the Arts. The Act identifies seven matters of national environmental significance:

1) World Heritage properties;
2) National heritage places;
3) Wetlands of international importance (Ramsar);
4) Listed threatened species and communities;
5) Migratory species listed under international agreements;
6) Commonwealth marine areas; and
7) Nuclear actions.

Points 4 and 5 are relevant to the study area and are discussed further in section 4.1.

1.5.2. NSW Threatened Species Act 1995 (TSC Act)

Schedules 1 and 2 of the TSC Act contain lists of flora and fauna species and communities, which have been determined by the NSW Scientific Committee as being under threat of serious decline that could ultimately lead to extinction. The TSC Act, pursuant to section 5A of the EP& A Act provides for a seven-part test of significance and impact to be applied to any of these listed species or communities that are found in an area subject to proposed development. Schedule 3 of the TSC Act contains a list of 'key threatening processes' deemed to be processes that have a negative impact on threatened species, populations or communities.

Seven-part tests have been prepared in section 3.5 for threatened species detected within the study area and for those that were considered to possibly occur in the type of habitat present. Relevant key threatening processes affecting individual species have also been identified.

2. Methods

A list of threatened flora and fauna reported from the local area was obtained from the NPWS database, the Atlas of NSW Wildlife. In particular, this assessment included a list of all threatened flora and fauna species recorded within a five-kilometre radius of the study area. Based on information available concerning habitat requirements of these species, an assessment was made as to the likelihood of any of the reported threatened species occurring within the study area or using the habitat of the study area as an essential part of a foraging range.

A field survey was then conducted using the list of threatened species as a guide to species potentially likely to occur within the study area. The survey was not, however, limited to the species reported on the database extract. Searches were carried out for any species listed on Schedules 1 and 2 of the TSC Act that were considered likely to occur in the type of habitat present within the study area. The likelihood of any 'key threatening processes' occurring within the study area was also assessed. The study area was visited on 14 occasions between the 17th and the 26th of March 2009. Previous surveys were also undertaken by EcoBiological within the study area in November 2007. The results of this earlier investigation have been incorporated into this report.

2.1. Flora

A floristic list was compiled from 6 quadrats and a random meander through the study area (Figure 4). Floristic identification and nomenclature was based on Harden (1992, 1993, 2000, 2002) with subsequent revisions as published on PlantNet (http://plantnet.rbgsyd.nsw.gov.au). Plants listed under the ROTAP scheme (Briggs and Leigh 1996) were also considered in this assessment along with species and vegetation deemed to be of local conservation significance.

2.2. Vegetation Community Type Determination

The identification of vegetation communities was based on dominant species present in the over-storey, shrub and ground layers. The species composition for the vegetation community was compared to the vegetation descriptions of LCCCREMS (NPWS 2000) in order to arrive at an accepted community identity.

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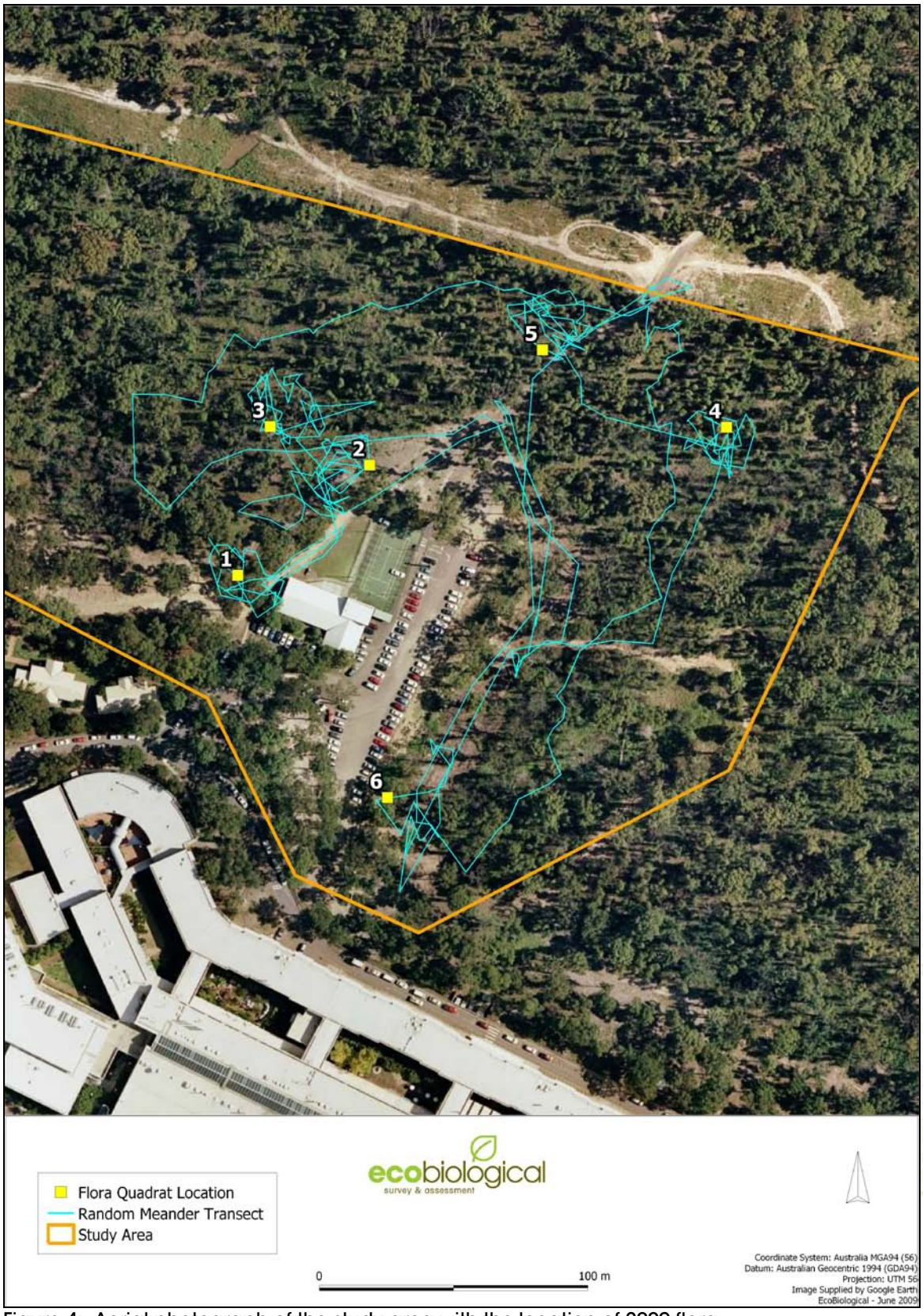

Figure 4: Aerial photograph of the study area with the location of 2009 flora surveys shown.

2.3. Habitat Hollow Survey

Hollows are an important resource utilised by a variety of forest fauna. Vertebrate and invertebrate species use hollows as diurnal or nocturnal shelter sites, for rearing young, feeding, thermoregulation and to facilitate ranging behaviour and dispersal. Approximately 400 Australian species potentially use hollows either on a permanent or opportunistic basis. Many threatened species are obligate users, requiring the presence of hollows to survive in the landscape (Gibbons & Lindemayer 2002).

A survey of the subject site was undertaken to locate trees containing potential habitat hollows. A GPS waypoint of each tree containing hollow/s was recorded as well as the size of each hollow (small <8cm; medium 8-20cm; large >20cm).

2.4. Fauna

An assessment of fauna was undertaken across the study area and the following fauna groups were surveyed in consideration of the Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004a) and the Lower Hunter Central Coast Regional Environmental Management Strategy (Murray *et al*. 2002a, 2002b) – 'Flora and Fauna Survey Guidelines Volume 1.

Three trapping transects were situated within the study area to assess the presence of arboreal and terrestrial mammals utilising those areas. Table 1 depicts the total trap night count. The location of fauna survey activities is shown in Figure 5.

Table 1: Trapping statistics for the study area

Trap type	Transect 1 (Nov 07)	Transect 2 (Mar 09)	Transect 3 (Mar 09)	Nights	Trap nights
Elliott A	20	20	20	4	240
Elliott B Tree	10	10	10	4	120
Elliott B Ground	2	5	5	4	48
Hair Tube	-	5	5	4	40
Cage	2	3	3	4	32
Harp Trap	1	1	1	4	12

2.4.1. Arboreal Mammals

Elliott B traps and hair tubes (used during the March 2009 surveys only) were placed in trees at heights of 3m or above, along three transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a honey and water mixture. These traps were set in position for four consecutive nights and checked each morning. Wafers from the hair tubes were collected after the 4-night period and checked for the presence of hair samples. Hair identification methods followed those of Brunner *et al*. (2002). If any hair sample was from a vulnerable or endangered species, the sample was sent to Barbara Triggs, an expert in the field of hair identification for a second opinion.

Spotlighting was undertaken for a total of 3.5 person hours over 3 nights for arboreal mammals. Trees were inspected during daylight hours for the presence of habitat hollows and if present these were watched at dusk to see if any nocturnal birds or mammals emerged.

2.4.2. Terrestrial Mammals

Elliott A, Elliott B and Cage traps were placed along the three transects at regular intervals. The traps were baited with a mix of rolled oats, honey, peanut butter and treacle and set in position for four consecutive nights and checked each morning.

Spotlighting was undertaken for a total of 3.5 person hours over 3 nights for terrestrial mammals. Careful daytime searches were conducted to detect the presence of fauna activity such as diggings, droppings or scratch marks.

2.4.3. Bats

Anabat II bat-call recorders (Titley Electronics, Ballina) were used to record the calls of Microchiropteran bats feeding in the area. Units were set up at dusk within the study area and recording occurred for a total of 72 hours over 4 nights. Spotlighting searches of blossoming trees were also undertaken to identify any Megachiropteran bat species.

A harp trap was placed along each transect within bat 'flyways' (in the case of the study area, this was along forest edges and in natural openings within forested areas) and left in position for 4 nights and checked for captures each morning. Any bats captured were identified in the field and placed in specially designed 'soft release' boxes erected at each transect.

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2.4.4. Birds

Birds were identified either visually, with the aid of binoculars, or by call interpretation. Surveys were conducted in the morning when bird activity is maximised (Bibby *et al*. 2000).

A bird survey transect adjacent to Trapping Transect 1 was surveyed during November 2007. All birds seen and heard within a 20-minute period were recorded.

In March 2009, two 1ha bird survey plots were surveyed on one morning using a pre-determined stopping rule. Each plot was surveyed for an initial 30-minute period, with surveying continuing in 10-minute increments until no new species was recorded during this time period.

After dark calls of threatened owl species (Powerful Owl, Masked Owl, Barking Owl and Sooty Owl) were broadcast over a megaphone in an attempt to encourage a call back response. The subject site was also searched to locate any regurgitated owl pellets. The size, shape and content of any pellets found were analysed to determine the species of owl from which the pellet originated as well as the prey species the owl had been feeding on. Analysis methods followed those of Brunner *et al.* (2002) and Triggs (1996).

2.4.5. Amphibians

Standardised survey techniques were employed throughout the survey period and included diurnal habitat searches, nocturnal spotlight surveys and dip netting for tadpoles. During diurnal surveys, dip netting and visual searches were carried out to locate any tadpoles present in any water bodies. During nocturnal surveys, spotlight searches were carried out by walking lengths of suitable habitat and using head torches to search for frogs by eye shine or by physical sightings.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were keyed out using diagnostic features including mouthparts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle height and direction, vent length and direction, and tadpole behaviour according to Anstis (2002).

2.4.6. Reptiles

During survey periods within the study area suitable reptile habitat was inspected to detect the presence of any reptile species by way of occupancy, scats or other detectable traces. Suitable habitat included roadsides, rock outcrops and crevices, any fallen hollow logs and limbs, burrows and suitable rubbish items such as sheets of tin.

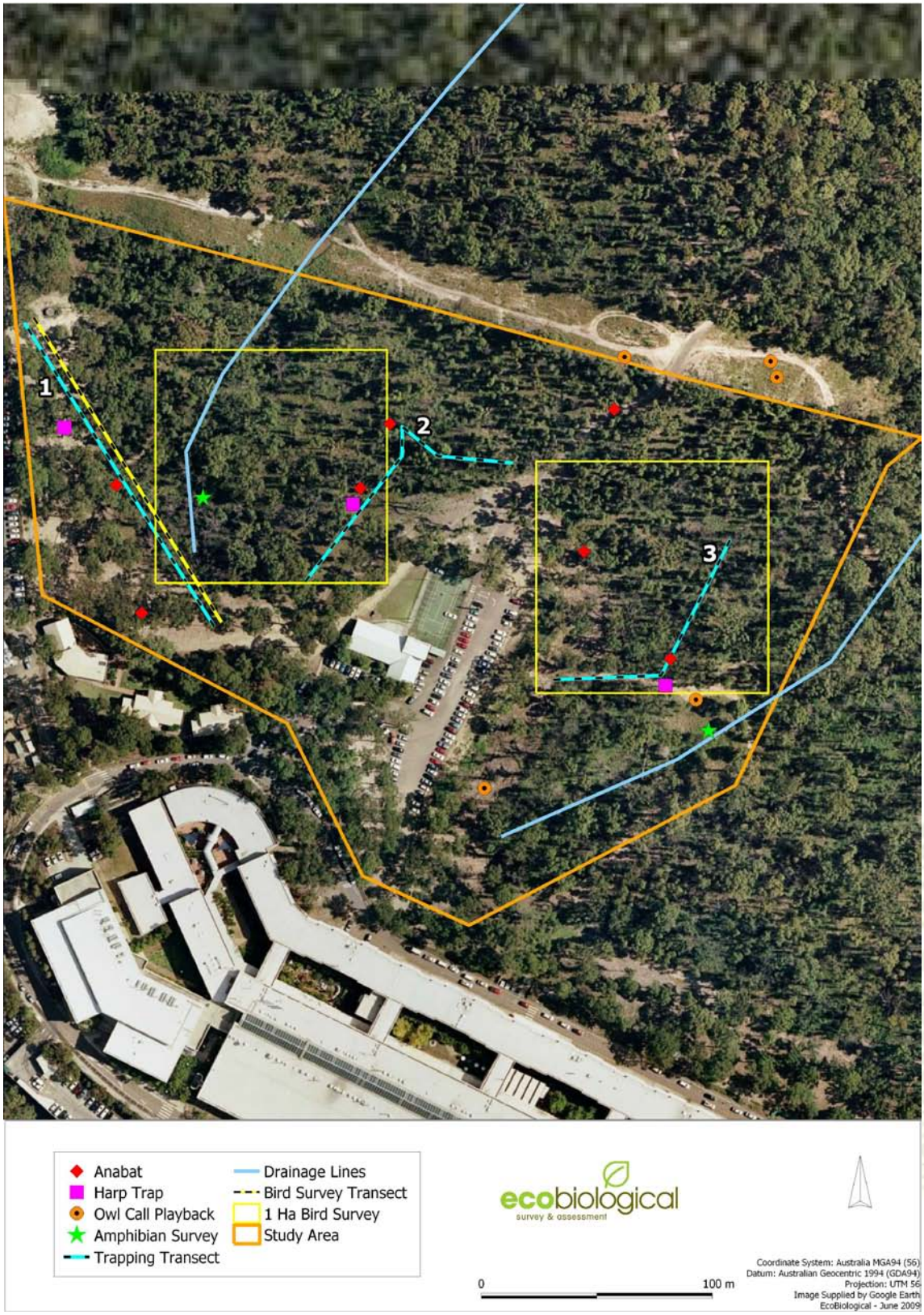

Figure 5: Aerial photograph of the study area with the location of fauna surveys shown.

3. Threatened Species Preliminary Assessment

3.1. Threatened Species Preliminary Assessment

Records of threatened species listed in the Atlas of NSW Wildlife within a five-kilometre radius of the subject site are detailed in the following sections.

3.1.1. Flora

Seven threatened flora species were previously recorded within a five-kilometre radius of the subject site (Table 2).

Table 2: Threatened flora species recorded within a five-kilometre radius of the subject site.

Scientific Name	Common Name	Status (TSC Act)	Status (EPBC Act)	Last Date Recorded
Callistemon linearifolius	Netted Bottle Brush	V	-	03/12/2004
Diuris praecox	Rough Double Tail	V	V	1/08/2008
Melaleuca biconvexa	Biconvex Paperbark	V	V	20/12/2007
Muehlenbeckia costata	Scrambling Lignum	V	-	19/11/1998
Syzygium paniculatum	Magenta Lilly Pilly	V	V	07/05/2002
Tetratheca juncea	Black-eyed Susan	V	V	29/04/2009
Zannichellia palustris		E	-	30/09/2000

E = Endangered; V = Vulnerable (NSW TSC Act 1995 & EPBC Act 1999)

3.1.2. Fauna

A total of 28 threatened fauna species, comprising 1 amphibian, 20 birds and 7 mammals were previously recorded within a five-kilometre radius of the subject site (Table 3). Four of these are shorebird or pelagic bird species (Greater Sand-plover, Lesser Sand-plover, Broad-billed Sandpiper and Providence Petrel) and would not occur within the study area due to a lack of any suitable habitat. These species were excluded from further assessment.

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Table 3: Threatened fauna species recorded within a five-kilometre radius of the subject site.

Scientific Name	Common Name	Status (TSC Act)	Status (EPBC Act)	Last Date Recorded
Amphibians				
Litoria aurea	Green and Golden Bell Frog	E	V	01/01/1990
Birds				
Anseranas semipalmata	Magpie Goose	V	-	28/10/2000
Botaurus poiciloptilus	Australasian Bittern	V	-	6/06/1996
Charadrius leschenaultii	Greater Sand-plover	V	-	16/12/1978
Charadrius mongolus	Lesser Sand-plover	V	-	6/04/1979
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	1/10/2003
Irediparra gallinacea	Comb-crested Jacana	V	-	11/06/1990
Ixobrychus flavicollis	Black Bittern	V	-	6/04/1998
Lathamus discolor	Swift Parrot	E	E	27/06/2003
Limicola falcinellus	Broad-billed Sandpiper	V	-	30/03/1979
Neophema pulchella	Turquoise Parrot	V	-	29/11/1989
Ninox connivens	Barking Owl	V	-	30/06/1985
Ninox strenua	Powerful Owl	V	-	25/06/2008
Oxyura australis	Blue-billed Duck	V	-	10/04/2003
Pterodroma solandri	Providence Petrel	V	-	24/09/1990
Ptilinopus magnificus	Wompoo Fruit-Dove	V	-	31/10/1989
Ptilinopus regina	Rose-crowned Fruit-Dove	V	-	20/01/2000
Ptilinopus superbus	Superb Fruit-Dove	V	-	24/04/1991
Stictonetta naevosa	Freckled Duck	V	-	12/11/1986
Tyto tenebricosa	Sooty Owl	V	-	25/07/2001
Xanthomyza phrygia	Regent Honeyeater	E	E	31/01/1987
Mammals				
Miniopterus australis	Little Bentwing-bat	V	-	21/10/2006
Miniopterus oceanensis	Eastern Bentwing-bat	V	-	21/10/2006
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Previously recorded by EcoBiological on 13/11/07
Petaurus norfolcensis	Squirrel Glider	V	-	1/10/2004
Phascolarctos cinereus	Koala	V	-	31/12/1986
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	21/10/2006
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	31/01/2003

E = Endangered; V = Vulnerable (NSW TSC Act 1995 & EPBC Act 1999)

3.2. Threatened Species Profiles and Determination

The following section provides summary information on the habitat requirements and distribution of threatened flora and fauna that were listed in the Atlas of NSW Wildlife preliminary assessment (with the exclusion of shorebird and pelagic species as detailed above). Profiles for two additional threatened species (Masked Owl *Tyto novaehollandiae* and Glossy Black-Cockatoo *Calytorhynchus lathami*) not previously recorded within five kilometres of the subject site have also been included due to the detection of the former on the subject site and evidence of past use of the habitat by the latter.

Callistemon linearifolius

This is a 'bottlebrush' shrub to small tree growing up to 4 metres tall and having red flowers. Preferred habitat is dry sclerophyll forest and the plant has generally been found in the Sydney and Central Coast areas although it has been recorded in the Lower Hunter area and from the Karuah Nature Reserve (S. Bell pers com). It can be readily confused with *C. rigidus* which can be found growing in the same area as *C. linearifolius* with the main, subtle distinguishing feature being the presence of glands on the lower surface of the leaves of *C. rigidus* (Spencer & Lumley 2002).

Diuris praecox

This member of the Donkey Orchid group normally flowers in July-August with a light yellow flower having some localised brown blotches. It generally grows in open eucalypt forest on higher slopes and hilltops. Its range is from Ourimbah to Nelson Bay (Jones 1993, Bishop 2000).

Melaleuca biconvexa

A paperbark tree growing to about 20 metres tall and occurring predominantly in the Wyong and Gosford LGA. A record exists of this plant also occurring in Port Macquarie however recently this record has come into question as a possible misidentification. (S. Duncan pers. comm.) This would suggest that populations within the Lake Macquarie LGA would be at the most northerly limit of the range of this tree. *M. biconvexa* appears to have restricted habitat requirements being most commonly found in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects, along freshwater watercourses and in association with *Eucalyptus saligna* (Sydney Bluegum) or *Eucalyptus robusta* (Swamp Mahogany) (Duncan 2001). This tree has been threatened by clearing and grazing along watercourses, alterations to water flow and probably because to the untrained eye, it looks like any other paperbark, and can occur along with similar looking paperbarks such as *Melaleuca styphelioides* or *Melaleuca linariifolia*.

Muehlenbeckia costata

Muehlenbeckia costata is a scrambling climber. The low straggling stems are up to 5 m long. Large numbers of seedlings appear following bush fires, with most plants living for only 2 - 3 years. Rare individuals may live for 10 years. This species grows in coarse sandy soils and peat in heath, mallee and open eucalypt woodland on granite or acid volcanic outcrops at higher altitudes.

The species is known from a scattered distribution from Queensland to the Blue Mountains in NSW. Most records are on the New England Tablelands and North West Slopes including Bald Rock north of Tenterfield, Warra and Butterleaf National Parks near Glen Innes and Mt Kaputar.

Syzygium paniculatum

A small tree commonly known as Magenta Lilly Pilly that grows to about 15m tall and can be found in littoral rainforest growing on sand or in subtropical rainforest and growing on sandy soil derived from sandstone (Floyd 1989) from Jervis Bay to Bulahdelah.

Tetratheca juncea

Tetratheca juncea Smith (Tremandraceae) is a terrestrial herbaceous plant endemic to NSW and listed under Schedule 2 of the NSW *Threatened Species Conservation Act* 1995 as Vulnerable and having a ROTAP coding of 3VCa (Briggs and Leigh 1995). It is also listed as Vulnerable in the *Commonwealth Environment Protection and Biodiversity Conservation Act* 1999. Thompson (1976), in a revision of the *Tetratheca* genus, noted that there were records from the late 1800's of the plant occurring in suburbs of Sydney, from Port Jackson and suburbs to the south. *T. juncea* is now known to exist only from the Wyong area to Bulahdelah and inland to the edge of the main ranges with the greatest concentration of records being from the Wyong and Lake Macquarie local government areas (Payne 2000).

Tetratheca juncea propagates through both rhizomal spread and seed development and germination (Thompson 1976, Payne 2000). Propagation by seed appears to be limited by a dispersal mechanism that is most probably by ants collecting the seed for the lipid rich elaiosome (Brew *et al.* 1989, Boeswinkel 1999).

Tetratheca juncea is distinguished from other members of the *Tetratheca* genus by having generally leafless stems that have a distinctly angular, winged structure (Thompson 1976). The flowers of *T. juncea* however share the four-petalled, pink form that is characteristic of the genus. The flowering period for *T. juncea* is generally reported as being from mid to late winter through to late summer (Gardner & Murray 1992). The flowers grow from nodes on the mostly leafless stem and are commonly solitary but occasionally in pairs with each flower facing downward, suspended on a peduncle of about 10mm length. The four petals range in colour from mauve through pink to almost white (Thompson 1976, Payne 2000).

Driscoll (2003) used GIS analysis of 400 records (compiled from Payne 2000, Bartier *et al.* 2001, and S. Bell & C. Driscoll unpub) and showed that *T. juncea* has been reported from 16 separate, and often widely differing, vegetation community types as defined in NPWS (2000) and Eco Logical (2002). However over 60% of records were from within *Coastal Plains Smooth-barked Apple Woodland* (MU30) about 14% from *Coastal Plains Scribbly Gum Woodland* (MU31) and about 11% from Coastal

Foothills Spotted Gum - Ironbark Forest (MU15). These results indicate that within the range of its occurrence, T. juncea should be considered as possibly occurring in most common vegetation communities.

Zannichellia palustris

Zannichellia palustris is a small submerged aquatic plant with narrow opposite leaves less than 1mm wide and 2-7cm long (Harden 1993). This species is restricted to the lower hunter and Murray River Estuary of NSW, and is found in slow moving fresh or slightly saline environments (DECC 2008). This plant has separate male and female flowers which appear in the warmer months (Harden 1993). It is either a perennial or annual species, however it acts as an annual by dying off in summer in NSW (DEC 2005a).

This species is threatened by changes to hydrological flows, conditions and water quality (DEC 2005a). It is currently not formerly protected as none of the known populations occur in any NSW National Parks and Wildlife Service conservation reserves (DECC 2008).

Green and Golden Bell Frog (Litoria aurea)

The Green and Golden Bell Frog is a large frog with a robust body form ranging from 45-110mm in size. This species was once one of the most common frog species on the east coast of Australia. It inhabited many lentic freshwater habitats throughout its distribution which occurred predominately along the coast but also extending as far inland as Bathurst and along the highlands in the north and south of the state (White and Pyke, 1996). The Green and Golden Bell Frog has undergone a widespread and unexplained range contraction since the mid 1970's and the species is now listed as endangered under the NSW *Threatened Species Conservation Act* 1995, and as vulnerable under the federal *Environmental Protection and Biodiversity Conservation Act* 2000. Its distribution today is restricted to isolated pockets along the coast at various scattered locations throughout its former range with only one known remaining highland population at Queenbeyan.

The habitat preference and requirements of the Green and Golden Bell Frog are not well understood and difficult to define (Mahony 1999) resulting in some disagreement and confusion between biologists studying the species. Some of the differing views on Green and Golden Bell Frog ecology between biologists may be due to a failure to take into account the role of disease (a pathogenic fungus) that is probably primarily responsible for changes in its distribution and abundance in the last two decades. The species uses different habitat components throughout the various stages of its life cycle including different breeding, foraging and refuge habitats and has been known to disperse distances of up to several kilometres between these various habitats.

Generally large, permanent water bodies containing high levels of emergent vegetation such as *Typha*, *Baumea* and the introduced *Juncus acutus* are favourable for the detection of the Green and Golden Bell Frog, however it has been observed utilising a wide range of natural and man-made water bodies including coastal swamps, marshes, dune swales, lagoons, lakes, estuary wetlands, riverine floodplain wetlands, billabongs, storm water retention basins, farm dams, bounded areas, storage tanks, water troughs, drains, ditches and other excavation areas capable of capturing water such as quarries and brick pits (DEC, 2005b). Terrestrial habitat attributes that appear to favour the species include large grassy

areas associated with adjacent cover from logs, rocks or tussock forming vegetation that provide shelter. There also appears to be a preference shown to habitat containing a complexity of terrestrial and aquatic vegetation structure (Hamer *et al.*, 2002). The introduced mosquito fish, *Gambusia holbrooki*, is believed to feed on small tadpoles and habitat free of these fish is preferred (White & Pike 1996)

The Green and Golden Bell Frog is frequently active at day and night in the warmer months and can often be observed sitting in emergent vegetation well above the water level (0.5-1m). It has also been observed well away from water altogether. The breeding period generally occurs between September and March although reproductive behaviour has been noted to occur between late winter and early autumn (DEC, 2005b).

Breeding events occur most often during, and just after, heavy rain events with a peak around January/February when summer storms are common. Males call while floating in the water or from pond-side vegetation mostly at night but will occasionally call during the day. Individuals or small groups of males often respond to call play back or call imitation.

Magpie Goose (Anseranas semipalmata)

The Magpie Goose is still fairly common in the Australian northern tropics, but had disappeared from south-east Australia by 1920 due to drainage, overgrazing of reed swamps used for breeding, and hunting. Since the 1980s there have been an increasing number of records in central and northern NSW and the species has been successfully re-introduced to Victoria (Marchant & Higgins 1990).

Magpie Geese are often recorded in trios or flocks on shallow wetlands (less than 1m deep), dry ephemeral swamps, wet grasslands and floodplains and roost in tall vegetation. Their diet consists of seeds, tubers and green grass (Frith & Davies 1961; Whitehead & Tschirner 1992; Wilson 1997). During the wet season, the geese usually nest in extensive colonies and may move hundreds of kilometres to perennial swamps in the dry season (Frith & Davies 1961; Bayliss 1989; Bayliss & Yeomans 1990).

Threats to the species include inappropriate hydrological regimes of wetland habitats through drainage of swamps, ponds, dams and other wetlands for agricultural and other human purposes; degradation of habitat through water pollution; and modification of habitat and nest loss from trampling and overgrazing (DEC 2005c).

Australasian Bittern (Botaurus poiciloptilus)

The Australasian Bittern is a medium to large-sized (66-76cm) heron with mottled buff, brown and dark brown plumage (Marchant & Higgins 1990). Adults produce loud booming calls, typically four quick gasps followed immediately by loud booming usually repeated 2-3 times. The Australasian Bittern occurs in reeds and marshes in terrestrial freshwater wetlands and, occasionally estuarine habitats feeding mainly at night on small mammals, birds, amphibians, eels, crustaceans and insects. The species breeds from October through to February and nests in stands of Phragmites, Typha, and rushes (*Juncus*, *Baumea* spp.). The nest is usually comprised of a well-constructed flat platform of rushes or reeds (Marchant & Higgins 1990).

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The Australasian Bittern is distributed across south-eastern Australia, including south-eastern South Australia, Victoria, eastern Murray-Darling Basin in NSW to south-east Queensland (Marchant & Higgins 1990; Garnett & Crowley 2000; Barrett *et al.* 2003). The Australasian Bittern is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995*. The main threats to the species include the diversion of water for irrigation (Kingsford 2000); salinisation or drainage of permanent swamps; clearing of riparian vegetation; degradation of drought refuges; grazing and trampling of vegetation by livestock and; poor representation of habitat in conservation areas (NPWS 1999a).

Black-necked Stork (Ephippiorhynchus asiaticus)

The Black-necked Stork is a conspicuously large (110-137cm) long-legged stork with a glossy black head and neck, long deep pointed bill and red legs (Marchant & Higgins 1990). The species may inhabit permanent freshwater wetlands including margins of billabongs, swamps, shallow floodwaters, and adjacent grasslands and savannah woodlands. The species can also be found occasionally on inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water on a variety of prey including fish, frogs, eels, turtles, crabs and snakes (Marchant & Higgins 1990; DEC 2004b). The Black-necked Stork breeds in or near wetlands usually in the top of large (live or dead) trees and constructs a huge nest of sticks, lined with grass tufts, rushes, reeds and paperbark (Marchant & Higgins 1990).

The Black-necked Stork occurs mostly across coastal northern Australia from Pilbara, Western Australia to eastern Queensland and New South Wales (Marchant & Higgins 1990; Barrett *et al.* 2003). In NSW, the species occurs near coastal areas from the Queensland/NSW border south to the central coast. In Australia, the species has, since the 1980s, declined in the southern end of its range and is now listed as Endangered under Schedule 1 of the *NSW Threatened Species Conservation Act 1995* (Dorfman *et al.* 2001). Threats to the species include; disturbance and loss of habitat via the clearing of remnant vegetation and individuals trees, wetland modification as well as collision with powerlines (Garnett & Crowley 2000; DEC 2004).

Comb-Crested Jacana (Irediparra gallinacean)

The Comb-crested Jacana, also known as the 'Lotusbird', is an obligate freshwater species (Garnett *et al.* 2001) that occupies permanent territories all year round. The species inhabits freshwater wetlands on coastal floodplains, particularly those with abundant vegetation, such as waterlilies (*Nymphaea* spp.) and the introduced Water Hyacinth (*Eichhornia crassipes*). The species requires this floating vegetation as a means of walking over it while foraging for food and for breeding in which they construct a small floating platform supported by aquatic vegetation. The species breeds as solitary pairs, which vigorously defend their nesting territory (Smith 1991). Comb-crested Jacanas eat a wide variety of invertebrate and plant material with seeds of waterlilies and aquatic moth larvae being particularly important (Dostine & Morton 2000).

Within Australia the Comb-crested Jacana is confined to the coastal and sub-coastal fringes of the north and north-east of the continent (Blakers *et al.* 1984; Marchant & Higgins 1993). The species is most abundant and widespread in NSW in the floodplain wetlands along the Richmond and Clarence Rivers (Smith 1991). The Comb-crested Jacana is listed as vulnerable in the *NSW Threatened Species Act*

1995. Threats include the loss of wetland habitat through clearing and draining for flood mitigation and agriculture (Marchant & Higgins 1993).

Black Bittern (Ixobrychus flavicollis)

The Black Bittern is a medium-sized, dark grey-black bittern with a buff-streaked throat and foreneck and distinct yellow streaks on sides of its head and neck. The species has a characteristic booming call, not unlike, but much louder than the call of a pigeon. The species usually occurs singly or in pairs in thick vegetation in terrestrial wetlands, watercourses, swamps, billabongs, mudflats and mangroves, also streamside vegetation in shrubland or low forest (Marchant & Higgins 1990).

The Black Bittern is widely distributed in Australia, occurring from north-eastern Victoria, NSW, Queensland, to the Kimberley area in north Western Australia with a separate occurrence in the south-western corner of WA (Schodde & Tidemann 1986, Barrett *et al.* 2003). In NSW, the species occurs in the coastal regions of the north and mid-north coast, Sydney Basin Bioregion and scattered records for the south coast. The species is not well represented in reserves and is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995*. The Black Bittern is threatened by grazing and trampling of vegetation by cattle; predation by feral cats on eggs and juveniles; clearing of riparian vegetation for agriculture; drainage, salinisation, siltation and pollution of wetlands and waterbodies (NPWS 1999b).

Swift Parrot (Lathamus discolor)

The Swift Parrot is small migratory parrot (25cm) that breeds in Tasmania and migrates to south-eastern Australia for the winter months. The species is listed as endangered on the TSC Act and EPBC Act. In Tasmania, the species is dependant on Blue Gums *E. globulus* for both flower nectar and for nesting hollows, of which there has been large scale clearing of these trees in Tasmania over many years (Brereton 1997).

On the mainland, the Swift Parrot feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis* (Brown 1989). Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum (Barrett *et al.* 2003).

Turquoise Parrot (Neophema pulchella)

The Turquoise Parrot is a small (20cm) temperate woodland species that occurs from south-east Queensland through NSW to east and north-east Victoria. Generally, the distribution of the Turquoise Parrot is patchy, determined by areas of suitable habitat. Such habitat is usually steep, rocky ridges and gullies, rolling hills, valleys and river-flats comprised of eucalypt woodland and open forests with a ground cover of grasses and low understorey of shrubs. The Turquoise Parrot is an obligate granivore feeding on the seeds of grasses, herbaceous plants and shrubs and requires a reliable supply of water (Higgins 1999). Breeding occurs from August to January, usually nesting less than two metres above the ground. Nests are located in the hollows of small trees, dead eucalypts or in holes or stumps.

The Turquoise Parrot is a resident or partially nomadic species with movements usually a result of seasonal fluctuations in the distribution and availability of food. The species mostly occurs as pairs or small parties of 6-8 birds. In NSW, the species mainly occurs on or at the foothills of the Great Divide from Moree south to Dubbo, Griffith and Wagga Wagga. The species is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995* (Blakers *et al.* 1984; Barrett *et al.* 2003). Threats to the Turquoise Parrot include loss of habitat through clearing, intensive logging, burning and grazing; the destruction of nest sites; and, inappropriate fire regimes which remove nesting and feeding resources (Garnet and Crowley 2000).

Barking Owl (Ninox connivens)

The Barking Owl is a medium-sized brown hawk-like owl, spotted white on the wings, with barring in the wings and tail, and coarsely streaked brown on white underneath. It has prominent yellow eyes in a flat face and fully feathered legs with large yellow feet. It is approximately 35-45 cm in length with a wingspan of 85-100cm and weighs between 425-510g. Its voice is extremely characteristic; a loud and remarkably dog-like double bark, 'wuf wuf' or 'wuk wuk' (Hollands 1991, Higgins 1999). This bark is always preceded by a short, low groan but this is audible only at close quarters (Hollands 1991). The Barking Owl takes a wide range of prey including diurnal bird species, rabbits, gliders, small possums, bats, rodents and insects (Kavanagh *et al.* 1995).

Its habitat is typically dominated by eucalypts, often red gum species and, in the tropics, paperbarks *Melaleuca* species (Higgins 1999). It usually roosts in or under dense foliage in large trees including rainforest species and typically breeds in hollows of large eucalypts or paperbarks, usually near watercourses or wetlands (Kavanagh *et al.* 1995).

This large Owl is now sparsely distributed through its historic range from Victoria through New South Wales to Cooktown in Queensland. The Barking Owl is listed as vulnerable under the *NSW Threatened Species Conservation Act 1995*. The main threats to the Barking Owl include habitat loss and degradation; loss of native hollow bearing trees and coarse woody debris; removal of dead wood, dead trees and logs; competition from feral honeybees; and possibly, predation by the fox and feral cat (Garnett & Crowley 2000).

Powerful Owl (Ninox strenua)

The Powerful Owl is a large (60cm) forest owl that inhabits forest and woodlands of the coastal, escarpment, tablelands and western slopes in NSW (Kavanagh 2002b). Habitat for the Powerful Owl comprises tall, moist productive eucalypt forests and a mosaic of wet and dry sclerophyll occurring on undulating, gentles terrain near the coast. Optimal habitat includes a tall, shrub layer and abundant hollows supporting high densities of arboreal mammals (DEC 2006). The Powerful Owl preys on arboreal mammals, particularly the Common Ringtail Possum in the lowlands and the Greater Glider in the highlands. These two species comprise more than 80% of the species' diet. Other prey species include the Sugar Glider, the Common Brushtail Possum, Grey-headed Flying Fox as well as some diurnal bird species such as the Pied Currawong (DEC 2006).

The Powerful Owl roosts in dense mid-canopy trees or tall shrubs in sheltered gullies, while nesting occurs in hollows of old eucalypts in unlogged, unburnt gullies and lower slopes within 100m of streams or minor drainage lines (DEC 2006). The species is faithful to nesting hollows (Kavanagh 1997; Higgins 1999; Kavanagh 2002b). The home range of the Powerful Owl is variable, depending on habitat productivity, however, is generally between 300 and 1500ha (Kavanagh 1997). The species systematically 'farms' this territory rather than regularly hunting across the entire home range. The breeding season of the Powerful Owl is from mid-May to mid-July (Kavanagh 1997; Kavanagh 2002a, 2000b; Kavanagh & Stanton 2002).

Blue Billed Duck (Oxyura australis)

The adult male Blue-billed Duck has a slate blue bill with a glossy black head and neck, a rich chestnut back and black-brown tail coverts. The adult female has a grey-brown bill with plumage darker than the male with each feather barred with narrow bands of light brown. Immatures are similar to the adult female but paler with a grey-green bill (Marchant & Higgins 1990). Preferred habitat is in large, deep, well-vegetated swamps where they spend almost all of their time in the water often in large flocks. Rarely they can be found using creeks, rivers and farm dams for foraging and breeding (Frith 1982a). The Blue-billed Duck feeds on the surface of the water or by diving, for aquatic insects such as chironomid larvae, caddis flies, dragonflies, damselflies, flies and water beetle larvae (Schodde and Tidemann 1986).

The Blue-billed Duck is endemic to Australia occurring mainly within temperate wetlands of the south-eastern and south-western parts of the continent (Marchant & Higgins 1990). The Blue-billed Duck has also been reported from central Australia and Tasmania with little change in reporting rate over the last 20 years (Barrett *et al.* 2003). The Blue-billed Duck is listed as vulnerable in the *NSW Threatened Species Conservation Act 1995*. Nationally the Blue-billed Duck is classed as of 'least concern' because of the very large flocks that inhabit large artificial wetlands (Garnett & Crowley 2000) although threats are noted as being the destruction or modification of habitat, particularly by drainage works, clearing, cropping or burning (Marchant & Higgins 1990).

Wompoo Fruit-dove (Ptilinopus magnificus)

This species occurs in much of the lowlands of New Guinea and adjacent islands and in Torres Strait. Within Australia, the species historically occurs from the Illawarra district of New South Wales, north to the tip of Cape York Peninsula. There are consistent although limited numbers of reports of the Wompoo Fruit-dove from the southern parts of its range (Garnett *et al.* 2000). The preferred habitat of this species is sub-tropical and tropical rainforest; however, the species has also been reported in low elevation moist eucalypt forest and brush box forests (Frith 1982b). Wompoo Fruit-doves feed on a diverse range of tree and vine fruits and are locally nomadic, following ripening fruits. Threats to this species include: Clearing, fragmentation and weed invasion of low to mid-elevation rainforest due to coastal development and grazing; Logging and roading in moist eucalypt forest with well-developed rainforest understorey, and; Burning, which reduces remnant rainforest habitat patches (NPWS 2000, 2002).

Rose-crowned Fruit-Dove (Ptilinopus regina)
Found in the islands off the north Australian coast, as well as in northern and eastern Australia. On the east coast, the species occurs in the lowlands and adjacent tablelands from Cape York to Port Stephens, although occasional vagrants have been reported further south (Frith 1982b). Frith (1982b) and Blakers *et al.* (1984) indicate that this species occurs only in rainforest vegetation, where it feeds on the fruits of rainforest trees. South of Cooktown, Frith (1982b) states that the species is rarely found away from such vegetation due to the sharp change to dryer sclerophyll vegetation types. Regionally, the Rose-crowned Fruit-dove has been recorded at Cabbage Tree Island and Seal Rocks (HBOC 1995, 1996) and from Harrington and Myall Lakes National Park (HBOC 2006).

Superb Fruit-dove (Ptilinopus superbus)
This species is mainly found in New Guinea and the associated islands in that region. Within Australia, the species is predominantly found in lowland and adjacent highland localities, from Cape York to Byfield (near Rockhampton). Occasional individuals have been reported as far south as Tasmania, illustrating the high mobility of this species (Frith 1982b). The New Atlas of Australian Birds shows a small number of records for this bird in southeast NSW during the months of March to May (Barrett *et al.* 2003).

As with the other Fruit-doves, the Superb Fruit-dove is considered to be characteristic of rainforest vegetation, although it has been recorded some distance away from this vegetation type. The species is also known from mangroves and eucalypt vegetation, but breeding only occurs in rainforest trees (Frith 1982b). The species is frugivorous, feeding only on the fruits of rainforest trees and shrubs.

Freckled Duck (Stictonetta naevosa)
The adult Freckled Duck is a dark duck with a large and pointed head. The feathers of the adult are dark brownish-black uniformly freckled with white or buff (Frith 1982a). The preferred habitat for this large bodied duck includes larger open brackish or fresh lakes, creeks, farm dams and floodwaters (Marchant & Higgins 1990). They feed on algae, seeds and plants and macro-invertebrates at wetland edges and productive shallow waters at dusk. Preferred breeding habitat is beside heavily vegetated fresh waters (Frith 1982a). The Freckled Duck is endemic to south-eastern and south-western Australia, occurring as a vagrant elsewhere e.g. coastal districts in drought years (Marchant & Higgins 1990). The Murray-Darling Basin, Lake Eyre and south-western Queensland forms the eastern breeding stronghold for the species (Pizzey 1991).

Threats to the Freckled Duck are loss of habitat and potential breeding sites, hydrological changes through altered river flow, irrigation and conservation schemes and illegal hunting. Management plans include habitat protection zones, river and wetland management and education programs for landholders and hunters (Ayres *et al.* 1996).

Sooty Owl (Tyto tenebricosa)

This is one of the Barn Owls with a mask-shaped face. It has a coastal range from southern Queensland to southern Victoria with a preferred habitat of closed and tall open forests and in particular gullies (Kavanagh 1997). It roosts by day on branches in dense trees, in hollows or in caves and at night it feeds through the tree canopy with its prey being medium sized marsupials such as the Ring-tailed Possum or the gliding possums. The Sooty Owl has a more diverse diet than the other large owls and includes both arboreal marsupials and a substantial numbers of terrestrial mammals such as bandicoots.

Regent Honeyeater (Anthochaera phrygia)

This bird was once widespread through southeast Australia. Now it is mainly found in limited areas of northeast Victoria and central-east NSW. It is has been observed breeding in several areas in north-eastern Victoria (Chiltern district, Killawarra State Forest, Benalla district), and along the western slopes of the Great Dividing Range in NSW (Bundarra-Barraba district, Capertee Valley). Regent Honeyeaters are nomadic feeders and can be found elsewhere throughout its previous range where there is suitable blossom occurring (Franklin *et al.* 1989). This species is mostly recorded in box-ironbark eucalypt associations. They prefer the wettest, most fertile sites within these associations, such as along creek flats, broad river valleys and foothills.

In NSW, riparian forests of River Oak *Casuarina cunninghamiana*, those with Needle-leaf Mistletoe *Amyema cambagei*, are also important for feeding and breeding. Mugga Ironbark *E. sideroxylon*, White Box *E. albens*, Yellow Box *E. melliodora* and Yellow Gum *E. leucoxylon* are particularly important food trees. At times of food shortage the birds also use other woodland types and wet lowland coastal forest dominated by Swamp Mahogany *Eucalyptus robusta* or Spotted Gum *E. maculata* (Franklin *et al.* 1989; Ley and Williams 1992; Webster and Menkhorst 1992; Geering and French 1998; Oliver *et al.* 1999). Nectar is the principal food, but sugary exudates from insects are also used, and insects are essential for breeding (Oliver 1998, 2000). Regent Honeyeaters build cup nests, and usually lay 2-3 eggs.

Clearance has destroyed about 75% of the Regent Honeyeater's habitat, particularly the most-favoured vegetation communities. The remainder is fragmented, and continues to be degraded by removal of the larger trees for posts, sleepers and firewood, and by ongoing declines in tree health (Robinson & Traill 1996; Oliver *et al.* 1999). Fragmentation has apparently advantaged more aggressive honeyeaters, particularly the Noisy Miner *Manorina melanocephala* which may be displacing the Regent Honeyeater (Franklin *et al.* 1989; Grey *et al.* 1998).

Masked Owl (Tyto novaehollandiae)

The Masked Owl is a medium to large sized (40-50cm) owl that inhabits eucalypt forests and woodlands from the coast, where it is most abundant, to the western plains (Kavanagh 2002b). The preferred habitat is open woodland and forest with an open understorey and sparse ground cover (Kavanagh 2002a, 2002b; Kavanagh & Stanton 2002). Potential habitat for the species is mostly in conservation areas and state forests, although the species is often found in large tracts of forest or woodland on public and private lands, including suburban bushland (DEC 2006).

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The diet of the Masked Owl consists almost entirely of small terrestrial mammals and some birds (Higgins 1999). The species roosts in hollows in live or occasionally dead eucalypts; dense foliage in gullies; and in caves or cliffs. Hollows can be located in a variety of topographic positions from gully to upper slope. The Masked Owl is a sedentary (resident) species that occupies a large home range, estimated as 400-1000ha. The estimated population size in NSW is 1,500 pairs (Debus 1994; Kavanagh 1997). Threats to the Masked Owl include habitat clearing and fragmentation, logging, fire, and predation, human hazards (e.g. road kills, fences, wires etc) (DEC 2006).

Glossy Black-Cockatoo (Calyptorhynchus lathami)

The Glossy Black-cockatoo is an obligate granivore, feeding exclusively on the seeds of *Allocasuarina* (Cleland & Sims 1968; Joseph 1982; Clout 1989; Pepper 1996, Pepper *et al.* 2000). The breeding season is through the cooler months of February to July with one egg only being laid (Garnett & Crowley 2000). Habitat includes woodlands dominated by *Allocasuarina*, open sclerophyll forests and woodlands with a midstorey of *Allocasuarina* that are dominated by Eucalyptus or Angophora species (Higgins 1999). Consequently this bird requires a forest habitat containing these trees in sufficient numbers (NPWS 1999c; Garnett & Crowley 2000) along with old-growth trees having suitable nesting hollows.

The species occurs primarily in southeastern Australia, from Shoalwater Bay in central-southern Queensland to the Victorian border region. In NSW, the distribution of the Glossy Black-cockatoo occurs near-continuously east of the Great Dividing Range from the NSW North Coast/Queensland border to the NSW South East Corner/Victorian border, extending west to the South Western Slopes (Ekert 2000).

Little Bentwing-bat (Miniopterus australis)

This species occurs along the east coast of Australia from Cape York south to coastal northern NSW. The species also occurs in New Caledonia, New Guinea, the Philippines, and the Indo-Malayan archipelago. The Little Bent-wing Bat generally occupies well-wooded habitats throughout its range, roosting during the day in caves and similar locations. As with other Bentwing-bats, this species depends on specific nursery sites in which to raise its young, and only five of these sites were known of in 1983. In central Queensland one of these nursery colonies numbers 100,000 adult bats. They forage for insects in generally well-wooded habitat of a variety of forms from swamp forest, dry forest to rain forest (Churchill 1998, Dwyer 1995a).

Eastern Bentwing-bat (Miniopterus oceanensis)

This species is widely distributed on the coast and ranges of eastern Australia, from Cape York Peninsula, south to Victoria and eastern South Australia. The species is also present in northern Western Australia and the Northern Territory. Within New South Wales, it extends from the coast to the western slopes of the Great Dividing Range.

These bats roost in caves and man-made structures such as culverts, mine shafts and farm sheds. They are territorial, moving within a 300 km radius of a maternity cave. They forage for insects in generally well-wooded habitat of a variety of forms from swamp forest, dry forest to rain forest (Churchill 1998, Dwyer 1995b).

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Squirrel Glider (Petaurus norfolcensis)

This species occurs on the coast and ranges of eastern Australia, from northern Queensland to the Victorian/ South Australian border, and also extends into the western slopes and plains. The Squirrel Glider inhabits dry sclerophyll forest and woodland, and is generally absent from the more densely vegetated coastal ranges. More recently, however, the species has been recorded in a number of coastal locations and confusion with the similar Sugar Glider is attributed as the main reason for the apparent lack of historical coastal records.

One of the reasons that the Squirrel Glider has been considered vulnerable in NSW is that its diet is specialised. It will eat insects and the occasional birds egg, however, the greater part of the diet is nectar, pollen and gum exudates particularly from wattles. The amount of habitat that supports these food resources has been significantly reduced. The Squirrel Glider requires hollows in standing trees for roosting and nesting purposes and home ranges from 2-3ha to 13ha have been reported (Quinn 1995; SWC 1996; Rowston 1998; Suckling 1995; Holland 2001; Smith 2002).

Koala (Phascolarctos cinereus)

The Koala generally occurs from the Townsville district in northern Queensland, south along the coast and ranges into Victoria and part of South Australia. Within New South Wales and Queensland, this distribution extends into the western slopes and plains. The Koala lives entirely on a diet of leaves of both eucalypt and non-eucalypt trees and it has been shown that within its range there are local and regional preferences for the tree species used for feeding. Examples of eucalypts used as feed trees are *E. camuldulensis*; *E. viminalis*; *E. ovata*; *E. teretecornis*; *E. microcorys*; *E. punctata*. Non-eucalypts recorded have been *Allocasuarina torulosa*; *Melaleuca quinquenervia*; and *Lophostemon confertus*. Throughout its range the Koala suffers from either a lack of numbers or severe over-population where problems such as eye disease and reproductive tract bacterial disease caused by *Chlamydia psittaci* become prevalent (Martin & Handasyde 1995; Moore & Foley 2000; Phillips & Callaghan 2000; Phillips *et al.* 2000).

Grey-headed Flying-fox (Pteropus poliocephalus)

This species occurs along the eastern seaboard of Australia roosting in communal colony sites, which are used permanently, annually, or occasionally depending on food availability (Tidemann 1995). Colonies can vary considerably in size from hundreds to many thousands of individuals, and fluctuate according to food resources (Parry-Jones & Augee 1991; Tidemann 1995). Fruits from numerous rainforest trees and other myrtaceous species form a large component of their diet, and consequently mass nomadic movements occur throughout their range in response to fruit availability. Large colonies are very vocal even during the day, and can significantly damage roost trees by their sheer weight of numbers.

> "The Grey-headed flying fox must be acknowledged as being highly significant to the health and maintenance of many ecosystems in eastern Australia. The species performs the ecosystem services of pollination and seed dispersal for a wide range of native trees, including commercially important hardwood and rainforest species. It thus contributes directly to reproduction, regeneration and the evolutionary processes of forest ecosystems. Flying-foxes are unique in the large distances they disperse pollen and seeds. The population

of Grey-headed flying fox must be of sufficient size for this to continue. If numbers were reduced to small or localised groups, then rainforest seed dispersal and hardwood pollination processes would be severely curtailed (Eby 2000)".

Greater Broad-nosed Bat (Scoteanax rueppellii)

This species occurs along the coast and ranges of eastern Australia, from northern Queensland to the New South Wales/Victorian border. This bat appears to be most frequent in the river systems draining the Great Dividing Range. Tree-lined creeks, and the junctions of woodland and cleared paddocks, are favoured hunting areas for the Greater Broad-nosed Bat, although it may also forage in rainforest environments, flying as low as one metre above the surface of a creek. The species normally roosts in tree hollows, but roosting records in the ceilings of old buildings also exist (Churchill 1998; Hoye & Richards 1995).

Eastern Freetail-bat (Mormopterus norfolkensis)

The East-coast Freetail Bat occurs in a thin coastal band between the Sydney district and Brisbane. Little is known of the habits or the preferred habitat of this species, although it is apparent that it does inhabit dry sclerophyll forest and woodland, where it hunts for insects above the canopy or within clearings at forest edges. This species normally roosts in tree hollows or under loose bark on a variety of tree species (Churchill 1998; Allison & Hoye 1995).

3.3. Summary of Threatened Species Determination

An assessment of the likelihood of threatened species identified in the preliminary assessment occurring in the habitat types present within the study area is provided in Table 4. A seven-part test was applied to each species considered to possibly occur in the type of habitat present within the study area. Seven-part tests were also applied for two additional threatened species (Masked Owl *Tyto novaehollandiae* and Glossy Black-Cockatoo *Calytorhynchus lathami*) due to the detection of the former and evidence of past use of habitat by the latter.

A total of 12 threatened species, comprising 1 plant, 5 birds and 6 mammals were considered to possibly occur in the type of habitat present within the study area or were recorded to occur within the study area during field surveys.

Table 4: An assessment of the likelihood of selected threatened flora and fauna species occurring within the study area.

Class / Scientific Name	Common Name	Likelihood of being found within the study area	7-part test applied
Flora			
Callistemon linearifolius	Netted Bottle Brush	Unlikely – unsuitable habitat	No
Diuris praecox	Rough Double Tail	Unlikely – unsuitable habitat	No
Melaleuca biconvexa	Biconvex Paperbark	Unlikely – unsuitable habitat	No
Muehlenbeckia costata	Scrambling Lignum	Unlikely – unsuitable habitat	No
Syzygium paniculatum	Magenta Lilly Pilly	Unlikely – unsuitable habitat	No
Tetratheca juncea	Black-eyed Susan	Present within study area	Yes
Zannichellia palustris		Unlikely – unsuitable habitat	No
Amphibians			
Litoria aurea	Green and Golden Bell Frog	Unlikely – unsuitable habitat	No
Birds			
Anseranas semipalmata	Magpie Goose	Unlikely – unsuitable habitat	No
Botaurus poiciloptilus	Australasian Bittern	Unlikely – unsuitable habitat	No
Ephippiorhynchus asiaticus	Black-necked Stork	Unlikely – unsuitable habitat	No
Irediparra gallinacea	Comb-crested Jacana	Unlikely – unsuitable habitat	No
Ixobrychus flavicollis	Black Bittern	Unlikely – unsuitable habitat	No
Lathamus discolor	Swift Parrot	Possible – suitable foraging habitat	Yes

Table 4 cont: An assessment of the likelihood of selected threatened flora and fauna species occurring within the study area.

Class / Scientific Name	Common Name	Likelihood of being found on the subject site	7-part test applied
Birds cont.			
Neophema pulchella	Turquoise Parrot	Unlikely – unsuitable habitat	No
Ninox connivens	Barking Owl	Unlikely – unsuitable habitat	No
Ninox strenua	Powerful Owl	Detected during surveys	Yes
Tyto novaehollandiae	Masked Owl	Detected during surveys	Yes
Oxyura australis	Blue-billed Duck	Unlikely – unsuitable habitat	No
Ptilinopus magnificus	Wompoo Fruit-Dove	Unlikely – unsuitable habitat	No
Ptilinopus regina	Rose-crowned Fruit-Dove	Unlikely – unsuitable habitat	No
Ptilinopus superbus	Superb Fruit-Dove	Unlikely – unsuitable habitat	No
Stictonetta naevosa	Freckled Duck	Unlikely – unsuitable habitat	No
Tyto tenebricosa	Sooty Owl	Unlikely – unsuitable habitat	No
Ancthochaera phrygia	Regent Honeyeater	Possible – suitable foraging habitat	Yes
Calytorhynchus lathami	Glossy Black-Cockatoo	Foraging habitat present – evidence of past presence in the form of crushed Allocasuarina cones found within the study area	Yes
Mammals			
Miniopterus australis	Little Bentwing-bat	Detected during surveys	Yes
Miniopterus oceanensis	Eastern Bentwing-bat	Detected during surveys	Yes
Mormopterus norfolkensis	Eastern Freetail-bat	Detected during surveys	Yes
Petaurus norfolcensis	Squirrel Glider	Possible – suitable habitat	Yes
Phascolarctos cinereus	Koala	Unlikely – less than 15% koala feed trees present and last record from the locality is from 1986	No
Pteropus poliocephalus	Grey-headed Flying-fox	Detected during surveys	Yes
Scoteanax rueppellii	Greater Broad-nosed Bat	Possible – suitable foraging and roosting habitat	Yes

3.4. Field Survey Results

3.4.1. Weather Conditions and Survey Activities

The prevailing weather conditions throughout the 2007 trapping survey period (12 – 16 November 2007) were warm to hot days, mainly clear to partially cloudy skies and calm to light winds. No rain fell during the trapping survey period. The mean minimum temperature was 15 ^{o} C, and the mean maximum temperature was 26^{o} C.

Weather conditions during the March 2009 survey period (16 – 26 March 2009) were warm to hot days; mainly clear to overcast skies and calm to light winds. No rain fell during the survey period with the exception of an intermittent light shower on the evening of the 26th March. The mean minimum temperature was 16 ^{o} C, and the mean maximum temperature was 28^{o} C. A full list of survey activities and weather conditions during the survey periods are provided in Table 5.

Table 5: Schedule of activities and weather conditions during the survey period.

Activity	Date	Effort	Weather Conditions
Flora			
Flora quadrat / transect survey	15/11/07	2 person hrs	Warm, humid day, light cloud and calm conditions
Flora quadrats/ meandering transect	17/03/09	6 person hrs	Warm day, clear skies, no wind
Fauna			
Trapping	12 – 16/11/07	N/A	Warm to hot days, mainly clear to partially cloudy skies and calm to light winds.
	16 – 20/03/09	N/A	Warm to hot days, mainly clear to overcast skies and calm to light winds.
Spotlighting	13/11/07	1.5 person hrs	Warm, partially cloudy night, no rain, light winds
	17/03/09	1 person hr	Warm, clear and calm evening.
	18/03/09	1 person hr	Warm evening, with no rain, cloud or wind.
Owl call playback	13/11/07	0.5 person hr	Warm, partially cloudy, no rain, light winds.
	17/03/09	0.5 person hr	Warm evening, no rain, cloud or wind
	18/03/09	0.5 person hr	Warm evening, no rain, cloud or wind
	19/03/09	2 person hrs	Warm, calm evening, no rain, light breeze.
	23/03/09	1 person hr	Warm evening, light cloud, no rain or wind.
	24/03/09	1 person hr	Warm, clear evening, with no rain or wind.
	25/03/09	1 person hr	Warm evening, light cloud and breeze, no rain.
	26/03/09	0.5 person hr	Mild evening, overcast, no wind.
Anabat recording	13/11/07	2 recording hours	Warm, partially cloudy, no rain, light winds.
	17/03/09	24 recording hs between 2 units	Warm evening, no rain, cloud or wind.
	18/03/09	24 recording hrs between 2 units	Warm evening, no rain, cloud or wind.
	23/03/09	22 recording hrs between 2 units	Warm, humid evening, light cloud, no rain or wind.
Bird survey	14/11/07	20 min	Warm, clear sky, no rain, light wind.
	23/03/09	1.5 person hrs	Warm morning, no rain, cloud or wind.
Habitat hollow survey	17/03/09	2 person hrs	Warm, clear day, no rain, light breeze.
Diurnal herpetofauna survey	17/03/09	0.5 person hr	Warm afternoon, no rain, cloud or wind.
	18/03/09	0.5 person hr	Warm afternoon, no rain, cloud or wind.
Nocturnal amphibian survey	13/11/07	1 person hr	Warm, partially cloudy, no rain, light winds.
	17/03/09	1 person hr	Warm evening, no rain, cloud or wind.
	18/03/09	1 person hr	Warm evening, no rain, cloud or wind.

3.4.2. Flora

A total of 162 flora species were identified during vegetation surveys and subsequent identification analysis (Appendix 1). Of the species recorded, 36 are weed or exotic species, primarily found at disturbed or managed areas, roadsides and at natural forest fringes.

One threatened species was detected during field surveys, *Tetratheca juncea*. This was found in shrubby forest adjacent to the powerline easement in the northern portion of the study area (section 3.5.2 Figure 8).

3.4.3. Vegetation Community Mapping

The study area had one natural vegetation community as described below and depicted in Plates 1 and 2.

Coastal Plains Smooth-barked Apple Woodland (MU30)

Structure

Open forest to 20-25m tall, with a shrubby sub-formation.

The surveyed area has signs of recent bushfires, with a dense undergrowth stratum to 1-3m.

Floristic Description

The composition of canopy, mid-storey and shrub species at this location was indicative of Coastal Plains Smooth-barked Apple Woodland MU30 (NPWS 2000).

The forest structure had canopy dominated by *Angophora costata* and *Corymbia gummifera.* The co- dominant species was *Eucalyptus umbra,* and other common canopy species were *Eucalyptus piperita* subsp. *piperita* and *Eucalyptus resinifera* subsp. *resinifera*. Less common species included *Eucalyptus punctata, Corymbia maculata,* and *Eucalyptus siderophloia*.

The moderately open upper mid-layer had *Allocasuarina torulosa* to 12m, with a dense regrowth mid stratum to 4m likely to be as a result of recent fires. This stratum included Eucalypt saplings, *Acacia* species (*Acacia falcata, Acacia terminalis* and *Acacia elongata*), *Dodonaea triquetra* and *Leptospermum polygalifolium.* The shrub stratum was also relatively dense with common species such as *Banksia spinulosa, Acacia myrtifolia, Acacia ulicifolia* and *Pultenaea retusa.*

The ground layer varied across the subject community and the dominant herb, sedge and forb species throughout were *Pteridium esculentum, Dianella caerulea* subsp. *caerulea, Dianella longifolia, Gonocarpus tetragynus, Phyllanthus hirtellus, Pratia purpurascens*, *Lomandra longifolia, L. multiflora, L. oblique*, *Lepidosperma laterale* and *Brunoniella australis*. The indicative native grasses included *Themeda australis, Entolasia stricta, Joycea pallida* and *Aristida vagans.*

The drainage lines contained shrubs, ferns and grasses characteristic of moist substrates such as *Gahnia melanocarpa*, *Calochlaena dubia* and *Oplismenus aemulus*.

The northern portion of the study area adjacent to the powerline easement had a shrub and ground stratum dominated by heath species *Banksia spinulosa* and *Xanthorrhoea latifolia* over *Entolasia stricta* grass. The threatened plant *Tetratheca juncea* was found in this vegetation structure.

Distribution

Coastal Plains Smooth-barked Apple Woodland is distributed across a range of sedimentary geologies from the Narabeen Group, Permian Coal Measures and Medowie sediments on low to undulating topography.

This community covered the slopes to the north and east of the surveyed area.

Plate 1: Coastal Plains – Smooth-barked Apple Woodland present at the subject site.

Plate 2: Vegetation structure present at subject site (Quadrat 4).

3.4.4. Habitat Hollow Survey

A total of 35 trees bearing 63 habitat hollows were identified and mapped and the size of hollows were recorded. The majority of hollows identified (81%) were small to medium-sized with 12 large hollows also recorded, one of which was considered to be a suitable owl nesting hollow (Figures 6 and 7).

3.4.5. Fauna

A total of 62 fauna species were recorded within the study area (Appendix 2) comprising 6 reptiles, 11 mammals and 45 birds. Of these, 7 species are listed as significant (Vulnerable) under the NSW TSC Act (Table 6).

Table 6: Threatened fauna species recorded in the study area.

Scientific Name	Common Name	Survey Method
Tyto novaehollandiae	Masked Owl	Owl call playback
Ninox strenua	Powerful Owl	Owl call playback/spotlighting
Miniopterus australis	Little Bentwing-bat	Anabat recording
Miniopterus oceanensis	Eastern Bentwing-bat	Anabat recording
Mormopterus norfolkensis	Eastern Freetail-bat	Anabat recording
Calyptorhynchus lathami	Glossy Black-Cockatoo	Evidence from crushed *Allocasuarina* cones
Pteropus poliocephalus	Grey-headed Flying-fox	Spotlighting

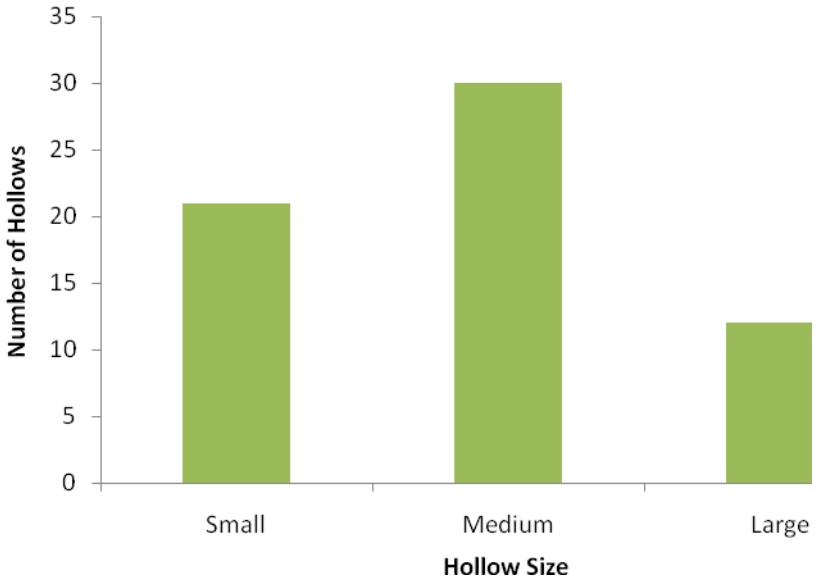

Figure 6: Hollow size frequency within the proposed development footprint. Small < 8 cm, medium = 8 – 20 cm and large < 20 cm.

Figure 7: Location of hollow-bearing trees within and adjacent to the proposed development footprint and bushfire APZ.

3.5. Threatened Species, Communities and Threatening Processes Assessment of Significance

Section 94 of the TSC Act and section 5A of the EP&A Act, as amended by the *Threatened Species Conservation Amendment Act 2002*, provides for the application of an 'assessment of significance' in the consideration of the likely impact of any development on threatened species, populations or habitats. A review of the threatened species profiles shows that there were threatened species that could be found within the study area under different conditions to those prevailing at the time of this investigation or could be found in similar habitat in the immediate region. An Assessment of Significance was applied to these species and any threatened flora and fauna species and endangered ecological communities that were recorded during the field surveys.

3.5.1. Endangered Ecological Community Assessment of Significance

No endangered ecological communities (EEC) were mapped on the study area and therefore an Assessment of Significance was not required.

3.5.2. Flora Assessment of Significance

Threatened flora species that were considered to possibly occur in the type of habitat represented both on the study area and in the locality are discussed below.

Black-eyed Susan (Tetratheca juncea)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Flora searches conducted within the study area identified a single plant of the threatened species *Tetratheca juncea* to the north of the proposed car park (Figure 8). Further surveys did not reveal additional plants; however, due to observation difficulties outside the main flowering season, the extent of a population could not be positively mapped at this time. At this stage, and without further surveys during the main flowering season, the position of the precautionary principle must be taken whereby it is considered likely that the proposed development would place a potential local population of *T. juncea* within the subject site at risk of extinction. Additional surveys should be conducted during the main flowering season (September to December), to better inform the extent of the population (total number and location of individual plants). This may result in a different outcome of the assessment of significance for this species.

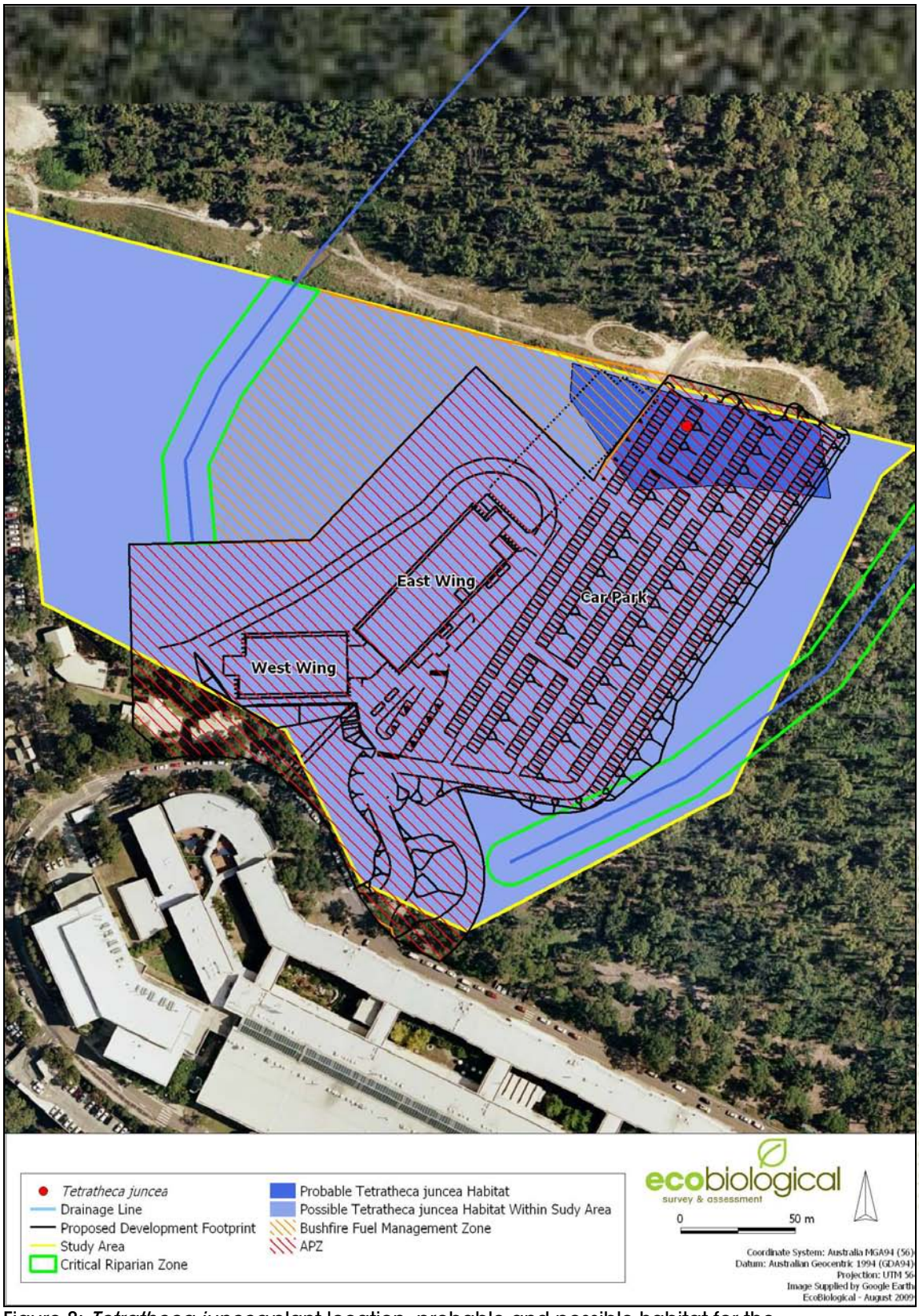

Figure 8: *Tetratheca juncea* plant location, probable and possible habitat for the species within the study area and proposed development layout.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable

ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable

(d) in relation to the habitat of a threatened species, population or ecological community:

i. the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Tetratheca juncea populations are known to occur in Coastal Smooth-barked Apple Woodland vegetation in the region. The nearest known population exists on the slopes south of the John Hunter Hospital facility and to the southeast within Blackbutt Reserve.

Coastal Smooth-barked Apple Woodland vegetation is a known habitat association for *T. juncea* and has been mapped as possible habitat within the proposed development area. A detailed habitat analysis was conducted for this species within this possible habitat, identifying known associated species and suitable habitat parameters. The northern portion of the study area adjacent to the powerline easement had a shrub and ground stratum dominated by heath species *Banksia spinulosa* and *Xanthorrhoea latifolia* which are known to be associated with *T. juncea* presence. This area was also generally more heathy in composition. The individual *T. juncea* plant was found in this vegetation structure and as such, this area has been mapped as probable *T. juncea* habitat.

Figure 8 shows areas mapped as possible and probable habitat. The proposed development would involve clearing a majority of both possible and probable habitat within the study area.

ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The proposed development site would involve clearing possible and probable *T. juncea* habitat and increasing the distance to other areas of habitat. As a result, the development is likely to isolate areas of habitat running east to west.

iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

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The habitat to be removed supports a known individual *Tetratheca juncea* plant and possibly a population. It is considered that the areas of potential habitat that are proposed to be removed as a part of the development could potentially have adverse affects on the long term survival of *T. juncea* within the study area, however, this is considered unlikely to impact significantly on the long-term survival of the species in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plan has been prepared for this species. No threat abatement plan is relevant to this species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

'Clearing of native vegetation' will occur as part of the proposed development. This will result in the loss of known and potential habitat for *Tetratheca juncea*. 'Ecological consequences of high frequency fires' is another KTP known to impact on *T. juncea*. The study area has been affected by a bushfire burning through the area approximately 4 years ago (Dan Pedersen pers. comm.). The proposed bushfire APZ and Bushfire Fuel Management Zone should assist in reducing the frequency of fires occurring in the study area.

3.5.3. Fauna Assessment of Significance

Threatened fauna species that were recorded during field surveys or considered to possibly occur in the type of habitat represented within the study area are discussed below.

Swift Parrot (Lathamus discolor)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

No Swift Parrots were recorded at the time of the surveys, which is consistent with the species migratory pattern. Suitable feed trees were present across the study area and could be used by the Swift Parrot as an opportunistic foraging source. However, no local population would be placed at the risk of extinction as a result of the proposed development.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of foraging habitat for the Swift Parrot would be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zone and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development is not considered important for the long-term survival of the Swift Parrot within its non-breeding foraging range.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

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In respect of the objectives of the recovery plan for the Swift Parrot (Swift Parrot Recovery Team 2001); the proposed development would further contribute to the loss of foraging habitat for the Swift Parrot.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with the proposed development would trigger one Key Threatening Process relevant to this species; Clearing of Native Vegetation. This would remove trees potentially used by the Swift Parrot as an opportunistic food source.

Powerful Owl (Ninox strenua)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Habitat for the Powerful Owl comprises tall, moist productive eucalypt forests and a mosaic of wet and dry sclerophyll occurring on undulating, gentle terrain near the coast. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal mammals (DEC 2006). The Powerful Owl preys on arboreal mammals, particularly the Common Ringtail Possum in the lowlands and the Greater Glider in the highlands. These two species comprise more than 80% of the species' diet.

The NPWS Wildlife Atlas contains numerous records of the Powerful Owl occurring within close proximity of the subject site in Blackbutt Nature Reserve and the suburb of Rankin Park to the southwest. Vegetation within the study area provides suitable foraging habitat and prey species for the Powerful Owl and it is likely that this area forms part of the existing local population's home range. A pair of Powerful Owls has been known to breed and roost within Blackbutt Nature Reserve to the southeast of the study area (Adam Blundell pers. comm.). Bushland within the proposed development footprint and bushfire APZ is considered to have limited potential to provide breeding resources for the Powerful Owl, with only one hollow deemed large enough to be used by the species. Preferred roosting habitat was not observed within the proposed development footprint. The gully line to the west of the proposed development footprint may have historically provided suitable roosting habitat, however, the vegetation in this area has been modified by bushfire and has a relatively sparse midstorey.

An individual male Powerful Owl responded to call playback on 4 of 7 survey occasions. The initial responding call came from approximately 500m to the east of the study area with the owl then moving towards the survey location and on several occasions flying into the study area.

The home range of the Powerful Owl is variable and dependent on habitat productivity. Kavanagh (1997) recorded home ranges of between 300 and 1500ha. The proposed disturbance area is approximately 4.2ha which represents only a very small proportion of a Powerful Owl's home range. Therefore, it is unlikely that the clearing required for the proposed development would place a local population of the species at risk of extinction.

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Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of habitat for the Powerful Owl will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development is not considered important for the long-term survival of the Powerful Owl in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

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No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

In respect of the objectives of the recovery plan for the Powerful Owl (DEC 2006), the proposed development would further contribute to the loss of foraging habitat for the Powerful Owl. No threat abatement plans are relevant for this species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with the proposed development would trigger two Key Threatening Processes relevant to this species; Clearing of Native Vegetation and Loss of Hollow-bearing Trees. This would result in the clearing of foraging habitat likely to be used by the Powerful Owl and the removal of hollow-bearing trees which may in future develop cavities large enough to support nesting habitat for this species.

Tyto novaehollandiae (Masked Owl)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Masked Owl occupies a large home range (between 400 - 1000 ha) and the species roost and nests in mid to late successional, mixed-aged forests greater than 60 years old (Davey 1993). Preferred foraging habitat for this species comprises open woodland and forest with an open understorey and sparse ground cover (Kavanagh 2002a; 2002b, Kavanagh & Stanton 2002). Other studies (e.g. Debus and Rose 1994; Kavanagh and Murray 1996) have revealed that the Masked Owl has a preference for foraging within ecotones of forests and forest edges.

The NPWS Wildlife Atlas does not contain any records of the Masked Owl occurring within a 5-kilometre radius of the subject site, however, a pair of Masked Owls is known to nest within the Jesmond Bushland Reserve to the north of the subject site (Adam Blundell pers. comm.). Vegetation within the study area provides suitable foraging habitat and prey species for the Masked Owl and it is likely that this area forms part of the home range of an existing local population.

The proposed development footprint is considered to have limited potential to provide breeding resources for the Masked Owl, with only one hollow deemed large enough to be used by the species. Preferred roosting habitat was not observed within the proposed development footprint. The gully line to the west of the proposed development footprint may have historically provided suitable roosting habitat, however, the vegetation in this area has been modified by bushfire and has a relatively sparse midstorey.

An individual Masked Owl responded to call playback on one of these occasions. The direction of the responding call came from the north of the study area. The individual was not sighted within the study area.

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The proposed disturbance area is approximately 4.2ha which represents only a very small proportion of a Masked Owl home range. Therefore, it is unlikely that clearing required for the proposed development would place a local population of the species at risk of extinction.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of habitat for the Masked Owl would be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

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The clearing of habitat for the proposed development is not considered important for the long-term survival of the Masked Owl in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

In respect of the objectives of the recovery plan for the Masked Owl (DEC 2006), the proposed development will further contribute to the loss of habitat for this species. No threat abatement plans are relevant for this species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with any future proposed development would trigger two Key Threatening Processes; Clearing of Native Vegetation and Loss of Hollow-bearing Trees relevant to this species. This would result in clearance of foraging habitat likely to be used by the Masked Owl and the removal of hollow-bearing trees which may in future develop cavities large enough to support nesting habitat for this species.

Regent Honeyeater (Anthochaera phrygia)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Regent Honeyeater is an itinerant feeder on the blossom of eucalypts and it is unlikely that a local population would inhabit the study area permanently. Typical habitat for this species is in open box-ironbark eucalypt woodlands, with nectar most often sourced from Red Ironbark, White Box and Yellow Box (Garnett & Crowley 2000) and in wet lowland coastal forests dominated by Swamp Mahogany, Spotted Gum and Riverine Casuarina woodlands (NPWS 1997).

The tree species within the study area, while not an optimal foraging source for the Regent Honeyeater, may be visited opportunistically at certain times of the year. However, the itinerant nature of this species means that no local population would likely be present or likely be placed at risk of extinction from the proposed development.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

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Not applicable.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of marginal foraging habitat for the Regent Honeyeater will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development is not considered important for the long-term survival of the Regent Honeyeater in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

In respect of the objectives of the recovery plan for the Regent Honeyeater (Menkhorst *et al.* 1998), the proposed development will further contribute to the

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loss of foraging habitat for the Regent Honeyeater. None of the threat abatement plans are relevant for this species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with any future proposed development would trigger one Key Threatening Process relevant to this species; Clearing of Native Vegetation. This would remove trees potentially used by the Regent Honeyeater as an opportunistic food source.

Glossy Black-Cockatoo (Calytorhynchus lathami)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Glossy Black-cockatoo is an obligate granivore, feeding exclusively on the seeds of *Allocasuarina* (Cleland & Sims 1968; Joseph 1982; Clout 1989; Pepper 1996, Pepper *et al.* 2000). Habitat includes woodlands dominated by *Allocasuarina*, open sclerophyll forests and woodlands with a midstorey of *Allocasuarina* that are dominated by Eucalyptus or Angophora species (Higgins 1999). Consequently this bird requires a forest habitat containing these trees in sufficient numbers (NPWS 1999c; Garnett & Crowley 2000) along with old-growth trees having suitable nesting hollows.

The study area had a moderately open upper mid-layer containing *Allocasuarina torulosa* to 12m, with a dense regrowth mid stratum to 4m likely to be as a result of recent fires. There are limited nesting opportunities for this species within the subject site with very few large hollows recorded.

A small amount of crushed cones beneath a mature *A. torulosa* tree were found within the proposed bushfire APZ north of the proposed West Wing indicating that the species has visited the site previously. There are no previous records of the species occurring within a 5 kilometre radius of the study area.

It is considered that the Glossy Black-Cockatoo would rarely occur within the study area and that the removal of a small amount of foraging habitat for the proposed development would not place a local population at risk of extinction.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

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(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of habitat for the Glossy Black-Cockatoo will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development is not considered important for the long-term survival of the Glossy Black-Cockatoo in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no recovery plan in place for this species and no threat abatement plans are relevant.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

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The clearing associated with the proposed development would trigger three Key Threatening Processes relevant to this species; Clearing of Native Vegetation, Loss of Hollow-bearing Trees and the Ecological Consequences of High Frequency Fires. This will result in the removal of an area of habitat containing suitable feed trees which may be used opportunistically (i.e. when mature Allocasuarina cones are present) by the Glossy Black-Cockatoo and will remove hollow-bearing trees which may in future develop cavities large enough to support nesting habitat for this species. The study area has been affected by a bushfire burning through the area approximately 4 years ago (Dan Pedersen pers. comm.). The proposed bushfire APZ and Bushfire Fuel Management Zone should assist in reducing the frequency of fires occurring in the study area.

Squirrel Glider (Petaurus norfolcensis)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Squirrel Glider inhabits dry sclerophyll forest and woodland, and is generally absent from the dense coastal ranges. The Squirrel Glider has a specialised diet comprised of nectar, pollen and gum exudates particularly from wattles. The Squirrel Glider requires hollows in standing trees for roosting and nesting purposes and has a home range of between 2-3ha up to 13ha (Quinn 1995; SWC 1996; Rowston 1998; Suckling 2000; Holland 2001; Smith 2002).

The Squirrel Glider was not recorded during field surveys of the study area despite a targeted trapping and spotlighting regime. However, other patches of habitat to the southwest (fragments within the suburbs of Glendale and Cardiff) and southeast (Blackbutt Nature Reserve) where Squirrel Gliders have previously been recorded are linked to the subject site by narrow, fragmented vegetation corridors (Winning & King 2004; Newcastle City Council 2001). Surveys conducted by Forest Fauna Surveys (1997) for Newcastle City Council also recorded the species within Jesmond Bushland Reserve to the north which is separated from the study area by a 30m wide powerline easement.

Suitable habitat exists within the study area and it is possible that this habitat forms part of a home range for this species. However, it is also possible that the existing powerline easement, amount of ambient light and noise from the Hospital and other edge effects may have reduced the suitability of this habitat for the Squirrel Glider. Removal of habitat on the subject site would reduce the amount of potential nesting and foraging habitat in the locality but is unlikely to have an adverse effect on the life cycle of the species such that a viable local population is likely to be placed at risk of extinction.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of potential habitat for the Squirrel Glider will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The remaining linkages and habitat will continue to provide a movement corridor for juvenile dispersal and genetic exchange and enable use of the vegetation surrounding the subject site for opportunistic foraging on seasonal nectar and pollen sources. Therefore, the habitat proposed to be removed is not considered to be of high importance to the long-term survival of the Squirrel Glider in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

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(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no draft or final recovery plan in place for the Squirrel Glider.

Predation by the Red Fox – Threat Abatement Plan is relevant to the Squirrel Glider. One of the current threats to the Squirrel Glider is predation by introduced predators such as the Red Fox (Suckling 1995). None of the objectives of the Predation by the Red Fox – Threat Abatement Plan will be met at this site. However, the extent of clearing and the location of the subject site within a residential context would not allow for an effective implementation of a fox control program (due to the possibility of baits poisoning domestic animals) and the proposed development will not promote or support habitat suitable to the fox.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with the proposed development would trigger three Key Threatening Processes relevant to this species; Clearing of Native Vegetation, Removal of Dead Wood and Trees and Loss of Hollow-bearing Trees. This will result in clearance of foraging habitat potentially used by the Squirrel Glider and the removal of hollow-bearing trees which may support nesting habitat for this species.

Cave-dwelling Microchiropteran Bats

- *Miniopterus australis* (Little Bentwing-bat)
- *Miniopterus oceanensis* (Eastern Bentwing-bat)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Both species use caves for roosting, but *Miniopterus australis* will occasionally also use tree hollows for roosting (pers. comm. G. Hoye). Both species use the canopy for foraging (Dwyer 1995a, 1995b). Research on the home ranges of these species is limited but suggests *Miniopterus* spp. exhibit a high fidelity to a particular foraging area that may change seasonally (pers. comm. G. Hoye). The proposed development will remove foraging habitat from the home ranges of both species and potential current and future roosting habitat for *M. australis*. However, the relatively small area of clearing involved in the proposed development is considered unlikely to have an adverse effect on the life cycle of these species such that a viable local population would be placed at risk of extinction.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of habitat for these Microchiropteran bats will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for these species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development was not considered important for the long-term survival of these Microchiropteran bat species in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no Recovery Plan for these Microchiropteran bats and no Threat Abatement Plan is pertinent to these species.

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(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Three key threatening processes, Clearing of Native Vegetation, Removal of Dead Wood and Trees and Loss of Hollow-bearing Trees known to affect these Microchiropteran bats will be triggered by the proposed activity. This will result in the loss of a small amount of foraging habitat for both species and potential roosting habitat for *M. australis*.

Tree-roosting Microchiropteran Bats

- *Scoteanax rueppellii* (Greater Broad-nosed Bat)
- *Mormopterus norfolkensis* (Eastern Freetail-bat)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Both species occur in forested habitats and roost primarily in tree hollows and under loose bark on trees (Churchill 1998). Hence their forest habitats provide for their daily and seasonal foraging, roosting and breeding requirements. Consequently both of these threatened species is reliant on a sufficient area of their preferred forest habitats to persist in the landscape.

The Eastern Freetail-bat was recorded within the study area and is likely to forage in bushland across and surrounding the John Hunter Hospital grounds. The Greater Broad-nosed Bat was not detected during field surveys, however, the study area and surrounding vegetation is likely to provide foraging and roosting habitat suitable for this species. While it is acknowledged that habitat loss has contributed to the decline of these species from parts of their distributions, removal or modification of a small amount of habitat for the proposed development is unlikely to have an adverse effect such that a viable local population of these species would be placed at risk of extinction.

Indirect impacts such as loss of breeding opportunities, deleterious hydrological changes, sediment and nutrient runoff, weed invasion and increased human activity within sensitive habitat areas have the potential to occur due the proposed development. These impacts have been considered and recommendations to mitigate these impacts are provided in section 6.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

Approximately 4.2ha of habitat for these Microchiropteran bats will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for these species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development was not considered important for the long-term survival of these Microchiropteran bat species in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no Recovery Plan for these Microchiropteran bats and no Threat Abatement Plan is pertinent to these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Three key threatening processes, Clearing of Native Vegetation, Removal of Dead Wood and Trees and Loss of Hollow-bearing Trees known to affect these Microchiropteran bats will be triggered by the proposed activity. This would result in the loss of a small amount of foraging and potential roosting habitat for these species.

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Grey-headed Flying-fox (Pteropus poliocephalus)

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Grey-headed Flying Fox was recorded within the study area during field surveys and is likely to use the site for foraging at certain times of the year when desired tree species are in flower. A known roosting camp occurs to the southeast of the study area within Blackbutt Reserve (Adam Blundell pers. comm.). No roosting camp was observed within the study area.

The small amount of vegetation to be cleared for the proposed development is unlikely to affect the life cycle of the Grey-headed Flying Fox such that a local viable population will be placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

Approximately 4.2ha of habitat or the Grey-headed Flying-fox will be removed or modified for the construction of the proposed medical research facility, bushfire Asset Protection Zones and associated roads and carparking.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The location of the proposed medical research facility adjoins existing development within the grounds of John Hunter Hospital. The proposed development would increase the existing cleared area within the hospital grounds which is surrounded in all directions by a large expanse of native bushland. Removal of this portion of vegetation will not cause fragmentation or isolation of habitat on the subject site for this species.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The clearing of habitat for the proposed development is not considered important for the long-term survival of the Grey-headed Flying-fox in the local area.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat will be affected by the proposal.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

There is no draft or final recovery plan for the Grey-headed Flying Fox. No threat abatement plans are relevant to this species.

(g) whether the action proposed constitutes or is part of a Key Threatening Process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The clearing associated with the proposed development would trigger one Key Threatening Process relevant to this species; Clearing of Native Vegetation. This will remove habitat potentially used by the Grey-headed Flying-fox for opportunistic foraging.

4. Federal, State and Local Plans and Policies

4.1. Environment Protection & Biodiversity Conservation Act 1999

Seven bird species listed as marine species under the EPBC Act (Black-faced Cuckoo-shrike, Silvereye, Sacred Kingfisher, Southern Boobook, Magpie-lark, Eastern Koel and Dollarbird - denoted with a ^ in Appendix 1) were recorded within the study area during field surveys. However, all of these listed marine species are relatively common sedentary or seasonal migrants to the Hunter Region and the proposed development is considered unlikely to have any significant effect on locally occurring populations.

Four flora species (*Melaleuca biconvexa*, *Tetratheca juncea, Diuris praecox* and *Syzygium paniculatum)* and four fauna species (Grey-headed Flying-fox, Swift Parrot, Regent Honeyeater and the Green and Golden Bell Frog) which have previously been recorded within a 5 kilometre radius of the subject site are listed as threatened under the EPBC Act. *Melaleuca biconvexa, Diuris praecox, Syzygium paniculatum* and the Green and Golden Bell Frog were assessed as unlikely to occur in the type of habitat on the subject site. Some potential foraging habitat was identified for the Swift Parrot and the Regent Honeyeater, however, it was considered unlikely that the proposal would have any significant effect on the lifecycle of these species.

The Grey-headed Flying-fox was recorded flying over the study area, most likely from a known colony at Blackbutt Reserve to the southeast. This species would likely use the subject site as an opportunistic foraging source when desired tree species are in flower. It is unlikely that the removal of this relatively small area of bushland would adversely affect the lifecycle of this species in the locality.

Tetratheca juncea has been recorded on the subject site and at numerous locations in remnant bushland to the south of the subject site. The targeted searches were conducted outside the known flowering period of this species and as such, the confidence level of detectability of all individuals or of a population is low.

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It was considered likely that the proposal would have a significant effect on the lifecycle on this species within the subject site, however, it was also considered unlikely that the species would be compromised in the locality. A future targeted survey within the species known flowering period will better determine the extent of impact on a local population.

Provided mitigation measures provided in section 6 are implemented, it is considered that a referral to the Minister for the Environment in relation to any of these species will not be required.

4.2. SEPP 44 Koala Habitat Protection

SEPP 44 requires that any development proposals affecting one hectare or more of a property must be evaluated for potential and core Koala habitat. Potential Koala habitat is defined as 'areas of native vegetation where the trees listed in Schedule 2 of SEPP 44 (Table 7) constitute at least 15% of the total number of trees in the upper and lower strata of the tree component'.

Should potential Koala habitat be found, further investigation for the existence of core Koala habitat should be undertaken. Core Koala habitat is defined as 'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'. If such habitat is found to be present, then a detailed Plan of Management should be prepared for the Koala colony in the area.

Table 7: List of SEPP 44 – Schedule 2 preferred Koala Feed Trees

Preferred Koala Feed Trees	
Scientific Name	Common Name
Eucalyptus tereticornis	Forest Red Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus punctata	Grey Gum
Eucalyptus viminalis	Ribbon or Manna Gum
Eucalyptus camaldulensis	River Red Gum
Eucalyptus haemastoma	Broad-leaved Scribbly Gum
Eucalyptus signata	Scribbly Gum
Eucalyptus albens	White Box
Eucalyptus populnea	Bimble Box or Poplar Box
Eucalyptus robusta	Swamp Mahogany

One species (*Eucalyptus punctata*) listed on Schedule 2 of SEPP 44 was recorded on the proposed disturbance areas at the subject site during field surveys. However, as the individual trees recorded constituted less than 15% of the total number of trees in the upper and lower strata of the tree component, further investigation was not required.

5. Conclusion

Field surveys conducted from 12 – 16 November 2007 and 16 – 26 March 2009 within the study area revealed that:

- 162 plant species were recorded within one vegetation community (Coastal Plains – Smooth-barked Apple Woodland);
- One threatened flora species, *Tetratheca juncea* was recorded as an individual plant within the northern portion of the study area;
- 35 trees within the proposed disturbance areas supported 63 potential habitat hollows;
- One Koala feed tree species (*Eucalyptus punctata*) was present within the proposed disturbance areas. However, the individual trees recorded constituted less than 15% of the total number of trees in the upper and lower strata of the tree component, and therefore further investigation under SEPP 44 was not required; and,
- 62 species of fauna were recorded during field surveys, including seven threatened species (Masked Owl, Powerful Owl, Eastern Freetail-bat, Eastern Bentwing-bat, Little Bentwing-bat, Glossy Black-Cockatoo and the Grey-headed Flying-fox).

The Assessment of Significance revealed that for the majority of threatened species there would be minimal impact from the proposed development. However, an additional survey is required to determine the extent of impact on the threatened plant, *Tetratheca juncea*. Surveys for this species were conducted out of flowering season, and it is therefore recommended that an additional survey for this species be undertaken within the study area during the known flowering period (September – December). Without information from further surveys conducted during the main flowering season, the precautionary principle must be invoked whereby it is considered likely that the proposed development will place the local population of *Tetratheca juncea* within the subject site at risk of extinction. It is recommended that the results of this targeted survey form an Addendum to this assessment.

In order to ensure the safety of native flora and fauna and to preserve habitat integrity within the study area several ameliorative measures and management actions have been recommended in section 6.

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6. Recommendations

The following recommendations are considered necessary to protect the integrity of the remaining vegetation and resident threatened species:

- A survey for *Tetratheca juncea* should be undertaken in September – December during its known flowering period within the area identified in Figure 8 to determine the extent of the population and the number and location of individual plants. The results of this survey should form an Addendum to this assessment. Should a local population of the species be confirmed within the proposed development footprint, mitigation measures such as translocation to another area within the Hospital grounds or offsetting may be required to address impacts on this species. Should a local population be found within the proposed bushfire APZ and fuel managed areas, these plants should be protected. Fuel reduction techniques such as manual slashing have the potential to impact on any plants found. Protection for identified plants should be afforded through the proposed Fire Management Plan (ABPP 2009);

- Clearing of hollow-bearing trees should be minimised where possible and those occurring within the bushfire APZ be retained if deemed appropriate under *Planning for Bushfire Protection* (NSW RFS 2006);

- The hollow-bearing tree identified in Figure 7 as containing a potential owl nesting hollow should be felled outside of the breeding season which is generally from late autumn to mid-winter. Prior to felling the tree should be inspected by an Ecologist using a cherrypicker to ensure there will be no destruction of eggs or injury caused to chicks or roosting owls that might be present;

- All other hollow bearing trees proposed for clearing should be inspected for wildlife habitation by an appropriately qualified and licensed ecologist within one week before clearing commences. An ecologist should also supervise the clearing operations where necessary to avoid injury or death of native animals. Any hollow-bearing trees should be soft-felled. The soft-felling process should include several gentle nudges followed by several minutes of monitoring the hollows. This process alerts any occupying fauna and allows them to self-relocate. Upon felling of trees with hollows, each hollow section would be inspected for wildlife. Any wildlife found should be captured, housed and relocated at a suitable time and location;

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- Best practice erosion and sedimentation control methods should be adopted, enforced and maintained during construction. The construction site should be managed to allow no accidental incursions into areas that are not part of the proposed development footprint such as nearby drainage lines and adjoining remnant vegetation;

- Potential fauna habitat trees should be retained where possible (i.e. *Eucalyptus punctata*, *Corymbia maculata*, *Allocasuarina torulosa* and *Acacia* species); and,

- The use of insecticides and herbicides within the study area should be avoided where possible to retain the integrity of the surrounding habitat for insectivorous Microchiropteran bats, Large Forest Owls and amphibian species.

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Appendix 1: Flora species recorded within the study area

KEY TO SYMBOLS

* denotes an introduced species
+ denotes presence of the species from transect surveys
Q = flora survey quadrat

1 = <5% cover, few individuals or sparse occurrence
2 = <5% cover, many individuals
3 = 5 - <25% cover
4 = 25 - <50% cover
5 = 50 - <75% cover
6 = 75 - 100% cover

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Transects
Acanthaceae	*Brunoniella australis*		2	2	2	2	2		+
Adiantaceae	*Adiantum aethiopicum*	Common maidenhair							+
Agavaceae	*Doryanthes excelsa*	Gymea Lily							+
Apiaceae	*Daucus glochidiatus*	Native Carrot							+
Apiaceae	*Hydrocotyle peduncularis*		2						+
Apiaceae	*Platysace lanceolata*								+
Apocynaceae	* *Gomphocarpus physocarpus*	Balloon Cotton Bush							+
Apocynaceae	* *Gomphocarpus physocarpus*	Balloon Cotton Bush						2	+
Araceae	*Gymnostachys anceps*	Settlers Flax							+
Araliaceae	*Polyscias sambucifolia subsp A*	Elderberry Ash			2	1			+
Asteraceae	* *Ageratina adenophora*	Crofton Weed		1				2	+
Asteraceae	* *Bidens pilosa*	Cobblers peg							+
Asteraceae	* *Cirsium vulgare*	Black thistle						2	+
Asteraceae	* *Conyza bonariensis*	Flaxleaf Fleabane					1		+
Asteraceae	* *Euchiton collinus*	Cudweed		2					+
Asteraceae	* *Facelis retusa*								+
Asteraceae	* *Heterotheca grandiflora*								+
Asteraceae	* *Hypochaeris radicata*	Catsear	1	2					+
Asteraceae	* *Senecio madagascariensis*	Fireweed							+
Asteraceae	* *Taraxacum officinale*	Dandelion							+
Asteraceae	*Lagenifera stipitata*	Blue Bottle Daisy							+
Asteraceae	*Senecio linearifolius*	Fireweed groundsel							+
Asteraceae	*Vernonia cinerea*			2	2				+
Bignoniaceae	*Pandorea pandorana subsp pandorana*	Wonga Wonga Vine		2	2	2	1		+
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern							+
Blechnaceae	*Blechnum cartilagineum*	Gristle Fern							+
Caryophyllaceae	* *Stellaria media*	Chickweed							+
Casuarinaceae	*Allocasuarina torulosa*	Forest Oak	1		3	1	1	1	+
Celastraceae	*Maytenus silvestris*	Orange bark			1				+

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Transects
Clusiaceae	*Hypericum gramineum*	St Johns Wort	2						+
Convolvulaceae	*Dichondra repens*	Kidney weed						2	+
Crassulaceae	*Crassula sieberiana*	Australian Stonecrop							+
Cyperaceae	* *Cyperus difformis*			2				2	+
Cyperaceae	*Cyperus polystachyos*								+
Cyperaceae	*Gahnia melanocarpa*	Red-fruited Saw Sedge	1	1	2			2	+
Cyperaceae	*Lepidosperma laterale*	Variable Sword-sedge	1	1		2	2		+
Cyperaceae	*Ptilothrix deusta*	Ptilothrix							+
Dennstaedtiaceae	*Pteridium esculentum*	Bracken Fern		2	2	2	2	2	+
Dicksoniaceae	*Calochlaena dubia*	Soft Bracken							+
Dilleniaceae	*Hibbertia aspera*						3		+
Dilleniaceae	*Hibbertia dentata*								+
Dilleniaceae	*Hibbertia scandens*	Twinning Guinea Flower			1				+
Ericaceae	*Epacris pulchella*				2	2	2		+
Ericaceae - Styphelioideae	*Leucopogon lanceolatus var. gracilis*				2		1		+
Ericaceae - Styphelioideae	*Trochocarpa laurina*	Tree Heath							+
Euphorbiaceae	* *Ricinus communis*	Castor Oil Plant							+
Euphorbiaceae	*Phyllanthus hirtellus*	Thyme spurge				1	2		+
Fabaceae (Faboideae)	*Daviesia ulicifolia subsp ulicifolia*	Gorse Bitter Pea		1			2		+
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*	Rusty Tick-trefoil							+
Fabaceae (Faboideae)	*Desmodium varians*		1	1	2				+
Fabaceae (Faboideae)	*Glycine clandestina*	Twinning Glycine	1	2	2	2	2		+
Fabaceae (Faboideae)	*Glycine microphylla*				2				+
Fabaceae (Faboideae)	*Hardenbergia violacea*	Purple Twining Pea	2		2	2	2		+
Fabaceae (Faboideae)	*Kennedia rubicunda*	Red Kennedy Pea	1	1		1	2		+
Fabaceae (Faboideae)	*Mirbelia rubiifolia*	Heathy Mirbelia							+
Fabaceae (Faboideae)	*Podolobium ilicifolium*	Prickly Shaggy Pea					1		+
Fabaceae (Faboideae)	*Pultenaea daphnoides*				2				+
Fabaceae (Faboideae)	*Pultenaea paleacea*					3	2		+
Fabaceae (Faboideae)	*Pultenaea retusa*		1	2	2	2	2		+
Fabaceae (Faboideae)	*Pultenaea villosa*	Egg & Bacon	2						+
Fabaceae (Mimosoideae)	*Acacia elongata*				3		4		+
Fabaceae (Mimosoideae)	*Acacia falcata*	Sickle Wattle	1	2	2				+
Fabaceae (Mimosoideae)	*Acacia filicifolia*	Fern Leaf wattle							+
Fabaceae (Mimosoideae)	*Acacia floribunda*	White Sally Wattle							+
Fabaceae (Mimosoideae)	*Acacia longifolia subsp. longifolia*	Sydney Golden Wattle			2		1		+
Fabaceae (Mimosoideae)	*Acacia myrtifolia*			1	2	3	2		+

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Transects
Fabaceae (Mimosoideae)	*Acacia terminalis subsp.longiaxialis*	Sunshine Wattle			3				+
Fabaceae (Mimosoideae)	*Acacia ulicifolia*	Prickly Moses		1			2		+
Geraniaceae	*Geranium solanderi var solanderi*	Native geranium							+
Goodeniaceae	*Goodenia heterophylla subsp. heterophylla*	Forest Goodenia		2	1				+
Halgoraceae	*Gonocarpus tetragynus*	Raspwort	2	2	2	2	2		+
Juncaceae	*Juncus continuus*								+
Lauraceae	* *Cinnamomum camphora*	Camphor Laurel				1			+
Lauraceae	*Cassytha glabella forma glabella*	Devils twine							+
Lindsaeaceae	*Lindsaea linearis*	Screw Fern						2	+
Lindsaeaceae	*Lindsaea microphylla*	Lacy Wedge Fern				2			+
Lobeliaceae	*Pratia purpurascens*	White root		2	2	2			+
Lomandraceae	*Lomandra confertifolia subsp. rubiginosa*								+
Lomandraceae	*Lomandra filiformis subsp. coriacea*	Wattle Mat Rush			2				+
Lomandraceae	*Lomandra filiformis subsp. filiformis*	Mat Rush		1	2	2	2		+
Lomandraceae	*Lomandra glauca*		2	2					+
Lomandraceae	*Lomandra longifolia*			2	2	2			+
Lomandraceae	*Lomandra multiflora*	Iron Grass	1	2	2	2	2		+
Lomandraceae	*Lomandra obliqua*	Fishbone		1		2	2		+
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry			2		2		+
Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling Lily			2				+
Malvaceae	* *Sida rhombifolia*	Paddy's Lucerne	2	1					+
Myrtaceae	*Angophora costata*	Smooth-barked apple		1	3	4	3		+
Myrtaceae	*Angophora floribunda*	Rough-barked Apple							+
Myrtaceae	*Corymbia gummifera*	Red Bloodwood	3	3	2	3	3		+
Myrtaceae	*Corymbia maculata*	Spotted Gum			1				+
Myrtaceae	*Eucalyptus acmenoides*	White mahogany							+
Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark							+
Myrtaceae	*Eucalyptus piperita subsp piperita*	Sydney Peppermint				2	2		+
Myrtaceae	*Eucalyptus punctata*	Grey Gum	3					2	+
Myrtaceae	*Eucalyptus resinifera subsp resinifera*	Red Mahogany Red Messmate	2	3	3				+
Myrtaceae	*Eucalyptus siderophloia*	Grey Ironbark	3						+
Myrtaceae	*Eucalyptus umbra*	Bastard Mahogany	2		2		1	1	+
Myrtaceae	*Leptospermum polygalifolium subsp. cistmontanum*	Tea-Tree				3	2		+
Myrtaceae	*Syncarpia glomulifera*	Turpentine						3	+
Oleaceae	*Notelaea longifolia*	Mock olive							+
Oleaceae	*Notelaea ovata*	Mock olive					2		+

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Transects
Oxalidaceae	*Oxalis exilis*		1						+
Phormiaceae	*Dianella caerulea var caerulea*	Paroo Lily	1	1	2				+
Phormiaceae	*Dianella longifolia*	Flax Lily		1	1	2	2		+
Phyllanthaceae	*Breynia oblongifolia*	Coffee Bush							+
Phyllanthaceae	*Glochidion ferdinandi*	Cheese Tree		1	2				+
Phyllanthaceae	*Phyllanthus hirtellus*			2					+
Phytolaccaceae	* *Phytolacca octandra*	Inkweed						2	+
Pittosporaceae	*Billardiera scandens*	Apple-berry Dumpling							+
Pittosporaceae	*Bursaria spinosa*	Box Thorn							+
Pittosporaceae	*Pittosporum revolutum*	Hairy Pittosporum							+
Plantaginaceae	* *Plantago lanceolata*	Lambs Tongue	1						+
Poaceae	* *Andropogon virginicus*	Whiskey Grass							+
Poaceae	* *Axonopus affinis*	Carpet Grass		1					+
Poaceae	* *Briza maxima*	Quaking Grass							+
Poaceae	* *Briza minor*								+
Poaceae	* *Bromus cathaticus*	Praire Grass	2					2	+
Poaceae	* *Chloris gayana*	Rhodes Grass	3						+
Poaceae	* *Hyparrhenia hirta*	Coolatai Grass		1					+
Poaceae	* *Lolium perenne*	Perennial Ryegrass							+
Poaceae	* *Paspalum dilatatum*	Paspalum							+
Poaceae	* *Paspalum urvellei*		2	2				2	+
Poaceae	* *Pennisetum clandestinum*	Kikuyu							+
Poaceae	* *Setaria gracilis*	Slender Pigeon Grass	1						+
Poaceae	* *Sporobolus africanus*	Parramatta Grass							+
Poaceae	*Aristida vagans*	Three-awned Spear Grass		2	2				+
Poaceae	*Austrodanthonia fulva*	Wallaby Grass		2	2				+
Poaceae	*Cymbopogon refractus*	Barbed Wire Grass	1						+
Poaceae	*Cynodon dactylon*	Couch	2						+
Poaceae	*Digitaria parviflora*	Smallflower Fingerplant		1					+
Poaceae	*Echinopogon caespitosus*	Tufted Hedgehog Grass		2					+
Poaceae	*Entolasia marginata*	Bordered Panic			2				+
Poaceae	*Entolasia stricta*	Wiry Panic	2	3	4	3	3		+
Poaceae	*Eragrostis brownii*	Browns Lovegrass		1			2		+
Poaceae	*Imperata cylindrica var. major*	Bladey grass	3	3	3	2	3	2	+
Poaceae	*Joycea pallida*	Silvertop Wallaby Grass			2	2	2		+
Poaceae	*Oplismenus imbecillis*	Basket Grass						1	+
Poaceae	*Ottochloa gracillima*								+
Poaceae	*Panicum simile*	Two Colour Panic		2	2				+
Poaceae	*Poa affinis*	Tussock Grass			2				+
Poaceae	*Themeda australis*	Kangaroo grass	4	5	3	3	3	2	+
Proteaceae	*Banksia spinulosa var. spinulosa*	Hairpin Banksia				2	3		+

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q6	Transects
Proteaceae	*Lomatia silaifolia*	Crinkle Bush							+
Proteaceae	*Persoonia levis*					1			+
Proteaceae	*Persoonia linearis*	Narrow-leaved Geebung							+
Rosaceae	*Rubus hillii*	Molucca Bramble							+
Rubiaceae	* *Richardia humistrata*		1	2					+
Rubiaceae	*Opercularia diphylla*		1		1		1		+
Santalaceae	*Exocarpos cupressiformis*	Native Cherry							+
Sapindaceae	*Dodonaea triquetra*	Hop bush		1	2	2	2	2	+
Scrophulariaceae	*Veronica calycina*	Speedwell						2	+
Smilacaceae	*Smilax australis*	Thorny vine							+
Solanaceae	* *Solanum mauritianum*	Wild Tobacco						2	+
Thymelaeaceae	*Pimelea linifolia subsp. linifolia*	Slender Rice Flower			2	2			+
Tremandraceae	# *Tetratheca juncea*	Black-eyed Susan							+
Verbenaceae	* *Lantana camara*							3	+
Verbenaceae	* *Verbena bonariensis*	Purple Top	2	2				2	+
Violaceae	*Viola hederacea*	Native Violet	2	2					+
Xanthorrhoeaceae	*Xanthorrhoea latifolia subsp latifolia*						1		+
Xanthorrhoeaceae	*Xanthorrhoea macronema*								+
Zamiaceae	*Macrozamia reducta*			1			1		+

* in column 2 (scientific name) denotes an introduced species
# denotes a threatened species under the NSW TSC Act 1995

Appendix 2: Fauna species recorded within the study area

Scientific Name	Common Name	Method	2007	2009
Reptiles				
Tiliqua scincoides	Eastern Blue-tongued Lizard	Trapping	+	
Physignathus lesueurii lesueurii	Eastern Water Dragon	Reptile survey	+	+
Amphibolurus muricatus	Jacky Lizard	Reptile survey	+	+
Varanus varius	Lace Monitor	Reptile survey		+
Lampropholis delicata	Garden Skink	Reptile survey		+
Lampropholis guichenoti	Grass Skink	Reptile survey		+
Birds				
Alisterus scapularis	Australian King-Parrot	Bird survey	+	+
Cracticus tibicen	Australian Magpie	Bird survey	+	+
Corvus coronoides	Australian Raven	Bird survey	+	+
Manorina melanophrys	Bell Miner	Bird survey	+	+
Coracina novaehollandiae	^Black-faced Cuckoo-shrike	Bird survey	+	+
Acanthiza pusilla	Brown Thornbill	Bird survey	+	+
Acridotheres tristis	* Common Myna	Bird survey	+	
Platycercus elegans	Crimson Rosella	Bird survey		+
Eurystomus orientalis	^Dollarbird	Bird survey	+	
Eudynamys orientalis	^Eastern Koel	Bird survey	+	
Platycercus eximius	Eastern Rosella	Bird survey	+	+
Psophodes olivaceous	Eastern Whipbird	Bird survey		+
Eopsaltria australis	Eastern Yellow Robin	Bird survey		+
Eulophus roseicapillus	Galah	Bird survey	+	+
Calyptorhynchus lathami	# Glossy Black-Cockatoo	Evidence from crushed Allocasuarina cones		+
Pachycephala pectoralis	Golden Whistler	Bird survey		+
Cracticus torquatus	Grey Butcherbird	Bird survey	+	+
Rhipidura albiscapa	Grey Fantail	Bird survey		+
Colluricincla harmonica	Grey Shrike-thrush	Bird survey		+
Dacelo novaeguineae	Laughing Kookaburra	Bird survey	+	+
Meliphaga lewinii	Lewin's Honeyeater	Bird survey		+
Cacatua sanguinea	Little Corella	Bird survey		+
Grallina cyanoleuca	^Magpie-lark	Bird survey	+	
Tyto novaehollandiae	# Masked Owl	Owl call playback		+
Manorina melanocephala	Noisy Miner	Bird survey	+	+
Aviceda subcristata	Pacific Baza	Bird survey	+	
Cracticus nigrogularis	Pied Butcherbird	Bird survey	+	
Strepera graculina	Pied Currawong	Bird survey	+	+
Ninox strenua	# Powerful Owl	Owl call playback/spotlighting		+
Trichoglossus haematodus	Rainbow Lorikeet	Bird survey	+	+
Anthochaera carunculata	Red Wattlebird	Bird survey	+	+

Scientific Name	Common Name	Method	2007	2009
Birds cont.				
Neochmia temporalis	Red-browed Finch	Bird survey		+
Todiramphus sanctus	^Sacred Kingfisher	Bird survey	+	
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	Bird survey		+
Zosterops lateralis	^Silvereye	Bird survey		+
Ninox novaeseelandiae	^Southern Boobook	Spotlighting		+
Pardalotus punctatus	Spotted Pardalote	Bird survey	+	+
Acanthiza lineata	Striated Thornbill	Bird survey		+
Cacatua galerita	Sulphur-crested Cockatoo	Bird survey	+	+
Malurus cyaneus	Superb Fairy-wren	Bird survey		+
Podargus strigoides	Tawny Frogmouth	Spotlighting		+
Malurus lamberti	Variegated Fairy-wren	Bird survey		+
Sericornis frontalis	White-browed Scrubwren	Bird survey		+
Cormobates leucophaea	White-throated Treecreeper	Bird survey		+
Lichenostomus chrysops	Yellow-faced Honeyeater	Bird survey		+
Mammals				
Austronomus australis	White-striped Mastiff Bat	Anabat analysis		+
Chalinolobus gouldii	Gould's Wattled Bat	Anabat analysis	+	+
Miniopterus australis	# Little Bentwing-bat	Anabat analysis		+
Miniopterus oceanensis	# Eastern Bentwing-bat	Anabat analysis		+
Mormopterus norfolkensis	# Eastern Freetail-bat	Anabat analysis	+	+
Pteropus poliocephalus	# Grey-headed Flying-fox	Spotlighting	+	+
Oryctolagus cuniculus	*European Rabbit	Opportunistic sighting	+	+
Rattus rattus	*Black Rat	Trapping	+	
Lepus capensis	*Brown Hare	Spotlighting		+
Pseudocheirus peregrinus	Common Ringtail Possum	Spotlighting		+
Trichosurus vulpecula	Common Brushtail Possum	Spotlighting		+

* denotes an introduced species
# denotes a threatened species under the NSW TSC Act 1995
^ denotes a listed marine species under the EPBC Act 1999
+ indicates detection of the species within the study area

Appendix 3: Contributions and qualifications of EcoBiological staff

Name	Qualification	Title	Contribution
Kristy Peters	B. Park Mgt.	Ecologist (Ornithologist)	Bird survey, Owl call playback, Anabat analysis, report writing
Dan Pedersen	B. Sc.	Ecologist (Botanist)	Floristic survey and vegetation mapping, report writing
Adam Blundell	B. Env Sc.	Senior Environmental Scientist	Trapping design and checks, spotlighting, Anabat recording, Owl call playback, habitat hollow survey
Simon Clulow	B. Sc./B. Teach	Ecologist (Herpetologist)	Amphibian and reptile survey, spotlighting, Owl call playback, report review
Dianna Brettschneider	B. App Sc.	GIS Manager	Preparation of map layouts for report