Environmental

Services

Flora and Fauna Assessment

Proposed Subdivision
Lot 172 DP 755923 & Lot 823 DP
247285 Berringer Road and
Cunjurong Point Road,
Manyana
City of Shoalhaven

September 2006

Our Reference: 04383

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City of Shoalhaven

Prepared September 2006

for

Malbec Properties Pty Ltd

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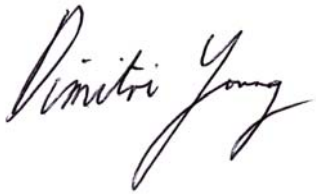
Approved by	 Dimitri Young **Manager** **Environmental Services Division**
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EXECUTIVE SUMMARY

This report has identified and described the biological environment of Lot 172 DP 755923 and Lot 823 DP 247285 Berringer Road and Cunjurong Point Road Manyana. The report has assessed the potential impacts on flora and fauna, including threatened and migratory species, endangered populations and threatened communities, or their habitats, of the proposal to undertake a residential subdivision on the property.

The development application will be assessed pursuant to Part 3A of the *NSW Environmental Planning and Assessment Act 1979* (*EP&A Act*) and will be determined by the Minister for Planning, so the Director General's Environmental Assessment Requirements were considered in preparing this report. Formal consultation was undertaken with the NSW Department of Environment and Conservation and the Commonwealth Department of Environment and Heritage.

The existing environment was described in detail from a literature review and from data gathered during fieldwork between December 2004 and August 2006. Flora and fauna surveys resulted in the detection of 184 flora species and 69 fauna species. Three vegetation communities, Northern Coastal Sands Shrub/Fern Forest, Bangalay Moist Woodland/Open Forest, and Bangalay Paperbark Woodland were identified.

Surveys targeting threatened species resulted in the detection of four threatened species, the Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite, listed on the schedules of the *NSW Threatened Species Conservation Act 1995,* and two migratory species, the Black-faced Monarch and Rufous Fantail, listed on the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999,* within the study area. In addition, the Bangalay Paperbark Woodland within the study area was determined to comprise the endangered ecological community *Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* as listed on the *NSW Threatened Species Conservation Act 1995.* No other threatened species, endangered populations or threatened ecological communities listed on the *NSW Threatened Species Conservation Act 1995*, the *NSW Fisheries Management Act 1994*, or the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* were recorded within the study area during the survey period.

The full development of the proposal will eventually involve the clearing or disturbance of approximately 18.22 ha of relatively undisturbed native vegetation and includes an extensive range of measures to mitigate impacts on flora and fauna.

An assessment pursuant to *NSW State Environmental Planning Policy No 44 – Koala Habitat Protection* was carried out, which concluded that the study area did not contain core Koala habitat and that a Plan of Management for Koala habitat was not required.

The impacts of the proposal on threatened species, endangered populations, threatened ecological communities, and migratory species listed on the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999* were assessed under the administrative guidelines produced by Environment Australia. This assessment concluded that there would not be a significant impact on matters of national environmental significance resulting from the proposal, and that a referral to the Commonwealth Environment Minister is not required

The key biodiversity conservation issue associated with the proposal was identified as the endangered ecological community *Swamp sclerophyll forest on the coastal floodplains of the North Coast, Sydney Basin and South East Corner bioregions* and appropriate impact mitigation for this community was incorporated into the proposal by the retention of all of this vegetation with an appropriate vegetated buffer.

The extent, magnitude and significance of the impacts of the proposal on threatened species, populations and ecological communities listed on the *TSC Act* and *FM Act* were assessed in accordance with the Draft Guidelines for Threatened Species Assessment (Department of Environment and Conservation, Department of Planning, 2005) and it was concluded that:

- the proposal will maintain or improve biodiversity values;
- is unlikely to reduce the long-term viability of local populations of threatened species, populations or ecological communities;
- is unlikely to accelerate the extinction of threatened species, populations or ecological communities; and
- will not affect critical habitat.

1. INTRODUCTION

1.1 Background

This report has been prepared by Bushfire and Environmental Services (BES) at the request of Allen Price and Associates, on behalf of Malbec Properties, to accompany a Major Project application (MP00_0059) to the Department of Planning for a proposed residential subdivision at Lot 172 DP 755923 & Lot 823 DP 247285 Berringer Road and Cunjurong Point Road, Manyana (hereafter referred to as Lots 172 & 823).

Lots 172 & 823 comprise approximately 20.3 ha of vacant freehold land situated to the west and north-west of Manyana village. The location of Lots 172 & 823 is shown in Figure 1 (Appendix A).

The development application will be assessed pursuant to Part 3A of the *NSW Environmental Planning and Assessment Act 1979* (*EP&A Act*) and will be determined by the Minister for Planning.

This report is the outcome of desktop studies and flora and fauna survey work undertaken by BES for this proposal between December 2004 and August 2006.

1.2 The Proposal

1.2.1 Description

The proposal involves the subdivision of Lots 172 & 823 to create 179 residential allotments and associated infrastructure including roads, drainage and Public Reserves, as shown in Figure 2 (Appendix A).

This will involve clearing native vegetation at the subdivision stage for roads and other infrastructure, with clearing of the majority of the land except for a low-lying area associated with a drainage line in the central south occurring from subsequent development applications for individual dwellings. Cleared vegetation will be mulched on-site at the subdivision stage and re-used to assist in regeneration of disturbed areas. Cleared vegetation for future dwellings may be transported to an approved waste transfer facility for disposal.

Excavation will be undertaken to construct roads and drainage structures and to install services. This may involve minor levelling and/or filling of some parts of the land.

1.2.2 Direct and Indirect Impacts

The following direct impacts on flora and fauna are anticipated from the proposal:

a) Clearing of native vegetation for the subdivision;

b) Excavation of some earth material;

c) Compaction and covering of the soil within areas to be concreted and/or bitumen sealed;

d) Death or injury to native and introduced flora and fauna inhabiting the areas to be cleared and excavated for the proposal;

e) Improved management of retained native vegetation in one Public Reserve.

The following indirect impacts on flora and fauna are anticipated from the proposal:

a) Excavation for the under-grounding of services;

b) Microclimate changes to areas of vegetation to be retained arising from clearing of adjoining areas;

c) Changes to drainage characteristics from the concentration and redirection of stormwater;

d) Weed invasion into areas of native vegetation to be retained;

e) Increased potential for discharges of sediments into receiving waters during construction of the proposal;

f) Increased predation on native fauna arising from domestic pets to be kept by residents of the subdivision;

g) Increased human activities that may incur into areas of native vegetation to be retained;

h) Alteration to the flow regimes of the ephemeral drainage lines flowing through Lots 172 & 823.

1.3 The Study Area

The study area for the purposes of this report is the whole of Lots 172 & 823 as shown in Figure 3 (Appendix A). It is bounded by residential development in the south and east, by vegetated freehold land in the north and vegetated Crown land in the west. The northern boundary is demarcated by Berringer Road and the western boundary by Cunjurong Point Road.

The locality for the purposes of this report is the land within a 10 km x 10 km grid centred on the study area.

1.4 Aim and Objectives

The aim of this investigation was to assess the ecological impact of the proposal on the flora, fauna and habitats of the study area.

The objectives of this investigation were:

a) to identify and describe the flora species and vegetation communities present in the study area and their conservation significance;

b) to identify and describe the fauna habitats present in the study area and their condition;

c) to identify the fauna species which are present or likely to occur in the study area, and their conservation significance;

d) to evaluate and assess the magnitude, extent and significance of the impacts associated with the proposal in the context of the conservation importance of the flora, fauna, habitats and other environmental features to be affected;

e) to describe and justify measures to avoid, mitigate and/or offset any adverse effects of the proposal on flora, fauna, habitats and other environmental features of conservation importance;

f) to demonstrate and justify how the proposal meets the key thresholds identified in the Draft Guidelines For Threatened Species Assessment (Department of Environment and Conservation, DOP, 2005);

g) to address the Environmental Assessment Requirements of the Director-General of the DOP regarding flora and fauna issues;

h) to determine whether the proposal involves an action that has, will have, or is likely to have, a significant impact on a matter of national environmental significance under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*; and

i) to make recommendations regarding any environmental management and impact mitigation/amelioration measures, which can be implemented to limit the effects of the proposal on vegetation, fauna, habitats, and other environmental features as necessary.

1.5 Environmental Assessment Requirements

A preliminary application has been successfully lodged with the DOP and various issues pertaining to flora and fauna have been raised in Director General's Environmental Assessment Requirements provided in correspondence from the department dated 6 March 2006 (Appendix B).

Consequently, the following flora and fauna issues raised by the DOP will be addressed by this report:

a) Impact on Threatened Species
    - Address threatened species impact having regard to the Threatened Species Assessment Guidelines and recommend offset measures to avoid or mitigate impacts of the project on threatened species and their habitat. A field survey of the site should be conducted. The assessment guidelines should specifically

report on the considerations listed in Step 3 of the draft guideline. The environmental assessment should clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guideline. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

b) Matters of National Environmental Significance

- The Environmental Assessment must consider and address the impacts of the project, if any, on matters of National Environmental Significance under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

1.6 Consultation

Consultation was undertaken with the Department of Environment and Conservation (DEC) by way of a teleconference held on 13 June 2006 and by way of written correspondence dated 22 June 2006 (Appendix C).

The biodiversity issues raised by the DEC in its response dated 27 June 2006 (Appendix C) are presented in Table 1 along with the relevant sections of this report where these issues are discussed in detail.

Table 1: Biodiversity conservation issues raised by the DEC.

DEC ISSUE	SECTION
The *Swamp sclerophyll forest* on Lot 172 should be retained and protected from development.	3.3.3 4.5 5.1.1 5.3 6.1
The western portion of the immediate catchment of the *Swamp sclerophyll forest* on Lot 172 should be retained to minimise alteration to hydrology.	
A hard-edge (such as a road) and effective runoff control measures are required on the eastern side of the *Swamp sclerophyll forest* on Lot 172.	
The western portion of Lot 172 should be retained as part of a vegetated habitat corridor linking Crown land west of Lot 172 with Conjola National Park in the north.	5.5, 6.2, Appendix D

Consultation was also undertaken with the Commonwealth Department of Environment and Heritage (DEH) and correspondence dated 1 August 2006 was received from the Department. Apart from specifying the statutory requirements of the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, the correspondence states that the Giant Burrowing Frog *Heleioporus australiacus* may be present in the Manyana area. The issues raised by the DEH are discussed in sections 3.4, 4.2, 4.3 and 5.7 of this report.

1.7 Certification

The contents of this report are certified by Dimitri Young, Manager – Environmental Services Division of BES, to comply with the *Draft Guidelines for Threatened Species Assessment* (Department of Environment and Conservation - Department of Primary Industries 2005).

2. METHODOLOGY

2.1 Review of Existing Data

A review of relevant information was undertaken prior to the commencement of field studies, which involved:

a) reviewing available literature including relevant flora and fauna studies, legislation, environmental planning instruments, topographic maps, aerial photographs and draft plans pertaining to the proposal;

b) searching the Atlas of NSW Wildlife for threatened flora and threatened fauna species recorded in the locality; and

c) searching the Commonwealth Environment Protection & Biodiversity Conservation Act Protected Matters Search Tool for matters of national environmental significance recorded in the locality.

The data gathered during the field studies and from the review of literature were analysed and interpreted in accordance with the provisions of legislation and planning controls pertaining to flora and fauna.

2.2 Flora Survey Methods

A detailed botanical survey was conducted in the study area by BES on 15, 16, 17 and 24 December 2004, 7 and 21 January 2005, and 2 August 2006 in the locations shown in Figure 3 (Appendix A).

Community Identification and Floristic Audit

The Random Meander technique documented by Cropper (1993) was used across the study area in general, to document the flora species present, including those of conservation significance, and the location and extent of vegetation communities.

A vegetation survey sheet was completed for nine 20 m x 20 m plots in locations that typified the vegetation communities present in the study area. The vegetation was surveyed at all levels present: the canopy (trees), middle canopy (trees), understorey (shrubs), and groundcover plants (plants less then one metre in height). A general description of the vegetation was then prepared. This technique was used to classify the vegetation communities. The native vegetation was assessed according to the structural classifications in Specht (1970), with characteristic and dominant plant species being identified and recorded. The boundaries of vegetation communities in the study area were marked onto a survey plan.

Targeted Searches

Specific searches for plant species of conservation significance known from the locality were conducted using the Random Meander method and by systematically walking along designated

transects, targeting areas of potential or suitable habitat. This technique was used to target the Austral Toad-flax *Thesium australe* in suitable habitats within the study area. Grid transects were used to target the Leafless Tongue Orchid *Cryptostylis hunteriana* in suitable habitats within the study area (Figure 3 Appendix A).

Limitations

The floristic audit undertaken detected as many species as possible and provides a comprehensive but not definitive species list. More species would probably be detected during a longer survey over various seasons. Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary for the assessment of the effects of the proposal on flora species.

Nomenclature

Most of the plant species names in this report are the current names published in the Flora of NSW (Harden 1990-2000). The taxonomic names have been supplemented with common names obtained from various sources. The scientific and conservation significance of individual plant species was established with reference to Briggs and Leigh (1996) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* in the national context, the *NSW Threatened Species Conservation Act 1995* in the state context, and after Mills (1993), KMA (1993, 1995 a & b), and PlantNET (accessed February 2005) in the regional context.

Flora Survey Effort

The flora survey effort employed a total of 27.5 person-hours as documented in Table 2.

Table 2: Flora survey effort employed over the study area.

DATE	METHOD	EFFORT	TARGET SPECIES
15 December 2004	Random meander	1.5 person-hours	All flora species
16 December 2004	Vegetation Plots	6 person-hours	Vegetation communities
17 December 2004	Vegetation plots	0.5 person-hour	All flora species
24 December 2004	Targeted survey	16 person-hours	*C. hunteriana* and *T. australe*
7 January 2005	Targeted survey	0.5 person-hour	*C. hunteriana* and *T. australe*
21 January 2005	Random meander	1.5 person-hours	All flora species
2 August 2006	Random meander	1.5 person-hours	All flora species
TOTAL FLORA SURVEY EFFORT		**27.5 person-hours**	

2.3 Fauna Survey Methods

Field investigations for fauna were conducted in the study area by BES on 15 December 2004 8, 9, 10, 11 and 17 February 2005, 12, 13, 14, 19, and 20 April 2005, 2 June 2005, 5 and 6 July 2005, and 2 August 2005 in the locations shown in Figure 4 (Appendix A).

Opportunistic Diurnal Surveys

Opportunistic fauna surveys involved observations of animal activity, habitat surveys and searches for indirect evidence of fauna.

Diurnal mammal searches were conducted in areas of potential habitat across the study area, with emphasis on searches for scats, tracks, burrows, diggings and scratchings. Specific bird, reptile and amphibian searches were conducted across the study area involving both visual and aural detection of species.

Specific searches were conducted for habitats or resources of relevance for those threatened fauna species known from the general region, or species, which might be anticipated to occur given the vegetation communities and habitats present. Opportunistic records of all fauna species observed were maintained throughout the survey period, and an inventory was compiled of all species recorded during the current investigations.

Nocturnal Spotlighting and Call Playback Surveys

Spotlighting was undertaken along a number of traverses throughout the study area. A Narva Colt 100 W hand-held spotlight with Faunatech battery pack was used in attempts to illuminate mammals, birds and amphibians.

The calls of the Sooty Owl, Powerful Owl, Masked Owl, Barking Owl, Squirrel Glider and Yellow-bellied Glider were broadcast through a Toa megaphone within areas of appropriate roosting, denning and foraging habitat in the study area. Calls were broadcast for a period of five minutes followed by a listening period of 15 minutes and spotlighting for a further twenty minutes. On 11 February 2005 the playback period commenced at 20:45h and on the 17 February 2005 playback commenced at 22:30h.

Nocturnal Stagwatching Survey

Thirty-three hollow-bearing trees located within the study area were watched at dusk for emerging nocturnal fauna species. These trees were stag-watched for up to one hour following dusk. Limited spotlighting was undertaken upon completion of stagwatching to enable positive identification of fauna within these trees.

Nocturnal ANABAT Survey

ANABAT echolocation recording was used to target microchiropteran bats in the study area. One ANABAT II bat detector linked to a Sanyo Walkman cassette recorder was used at several sites associated with potential roosting and foraging sites in the study area and along walking

transects to record microchiropteran bat echolocation calls on two nights. On 11 February 2005 the detector was employed from two hours between 20:30 and 22:30h and on 17 February 2005 the detector was employed for one hour between 22:30 and 23:30h when microchiropteran bat activity was considered to be high.

Trapping Surveys

Targeted surveys for terrestrial mammals were undertaken within all vegetation types in the study area. Thirty-five small cage traps and 50 Type A Elliott traps were set along five transects. Traps were spaced at 25 m intervals and were baited with a mixture of peanut butter, honey and rolled oats. Each trap was covered with plastic to protect captured animals from rain, and the Elliott traps were lined with cotton wool to provide insulation for trapped animals. Trapping transects were located with GPS and marked with numbered flagging tape. The traps were left in place for three consecutive nights yielding a trapping effort of 105 small cage trap-nights and 150 Elliott trap-nights and checked each morning soon after sunrise. Captured animals were identified quickly and with minimal handling, prior to release.

Habitat Analysis

A description of the fauna habitats in the study area was prepared because the type of habitat in an area influences which animals occur there, as well as diversity and abundance. This habitat assessment also has an important role in predicting threatened fauna likely to occur in an area. The information collected usually includes the type of vegetation present, the presence/absence of rock outcrops, tree hollows, dams, ponds, streams, foraging substrates and other features likely to attract threatened fauna. The study area was traversed along a number of transects to identify habitat components, which were recorded and described.

Limitations

The results of fauna surveys can be optimised by conducting investigations over a long period to compensate for the effect of unfavourable weather, seasonal changes and climatic variation. In general, the longer the survey the more species will be detected. Results can also be improved by using a wide range of techniques, since some species are more likely to be detected by a particular method. Such techniques include pitfall trapping, hair tubing and harp trapping. However, surveys are subject to constraints that determine the amount of time allocated, the methods used and the timing of the work. Thus, the results should be viewed in the light of these limitations. The fauna detected in current survey work are a guide to the native fauna present, but are by no means a definitive list of the species occurring in the study area. Nevertheless, the techniques used in this investigation are considered adequate to gather the data necessary for the assessment of the effects of the proposal on fauna species.

Nomenclature

The nomenclature in this report is based on the Mammals of Australia (Strahan 1995), Australian Bats (Churchill 1998), The Taxonomy and Species of Birds of Australia and its Territories (Christidis & Boles 1994) and Reptiles and Amphibians of Australia (Cogger 1996).

Survey Conditions

Survey conditions throughout the study period are detailed in Table 3.

Table 3: Fauna survey conditions.

DATE	TEMPERATURE	WIND	CLOUD	MOON	HUMIDITY	RAIN
15 December 2004	25 ^{0}C – 28 ^{0}C	Light	0/8	-	-	None
8 February 2005	20.2 ^{0}C – 33.2 ^{0}C	Moderate	-	-	34 %	None
9 February 2005	18.9^{0}C – 21.7 ^{0}C	Light	-	-	72 %	None
10 February 2005	16.2 ^{0}C – 21.4 ^{0}C	Light	-	-	64 %	Light
11 February 2005	18 ^{0}C – 27 ^{0}C	None	8/8	None	55 %	None
17 February 2005	10 ^{0}C – 20 ^{0}C	None	7/8	1/4	41 %	None
12 April 2005	~18 ^{0}C – 19 ^{0}C	Moderate	-	-	-	None
13 April 2005	~16 ^{0}C – 18 ^{0}C	Moderate	-	-	-	None
14 April 2005	~14 ^{0}C – 19 ^{0}C	Light	-	-	-	None
19 April 2005	~16 ^{0}C – 19 ^{0}C	Light	-	-	-	None
20 April 2005	~16 ^{0}C – 17 ^{0}C	Moderate	-	-	-	None
2 June 2005	~11 ^{0}C – 15 ^{0}C	Light	-	-	-	None
5 July 2005	~13 ^{0}C – 16 ^{0}C	None	-	-	-	None
6 July 2005	~11 ^{0}C – 15 ^{0}C	None	2/8	1/4	-	None
2 August 2005	~11 ^{0}C – 15 ^{0}C	None	1/8	N/A	-	None

Survey Effort

The fauna survey effort employed a total of 61.75 person-hours and 231 trap-nights as documented in Table 3.

Table 4: Fauna survey effort employed over the study area.

DATE	METHOD	EFFORT	TARGET SPECIES
15 December 2004	Diurnal habitat search	2 person-hours	All species
8 10 February 2005	Elliott trapping	150 trap-nights	Small terrestrial mammals
	Small cage trapping	81 trap-nights	Medium terrestrial mammals
11 February 2005	Nocturnal spotlighting	1.75 person-hours	Mammals, birds and amphibians
	Nocturnal call playback	0.5 person-hours	Mammals, birds and amphibians
	Nocturnal ANABAT	2 person-hours	Microchiropteran Bats
17 February 2005	Nocturnal spotlighting	1.5 person-hours	Mammals, birds and amphibians
	Nocturnal call playback	0.5 person-hours	Mammals, birds and amphibians
	Nocturnal ANABAT	1 person-hour	Microchiropteran Bats

DATE	METHOD	EFFORT	TARGET SPECIES
12 April 2005	Nocturnal stag-watch	10.5 person-hours	Microchiropteran Bats, Masked Owl and Glossy Black-cockatoo
13 April 2005	Nocturnal stag-watch	4 person-hours	Microchiropteran Bats, Masked Owl and Glossy Black-cockatoo
14 April 2005	Nocturnal stag-watch	4 person-hours	Microchiropteran Bats, Masked Owl and Glossy Black-cockatoo
19 April 2005	Nocturnal stag-watch	5 person-hours	Microchiropteran Bats, Masked Owl and Glossy Black-cockatoo
20 April 2005	Nocturnal stag-watch	4 person-hours	Microchiropteran Bats, Masked Owl and Glossy Black-cockatoo
2 June 2005	Nocturnal stag-watch	10 person hours	Powerful Owl, Masked Owl, and Glossy Black-cockatoo
	Nocturnal spotlighting	1 person-hour	Mammals, birds and amphibians
5 July 2005	Roost Search	2 person-hours	Powerful Owl and Masked Owl
6 July 2005	Nocturnal stag-watch	3 person-hours	Powerful Owl, Masked Owl, and Glossy Black-cockatoo
	Nocturnal spotlighting	1 person-hour	Mammals, birds and amphibians
2 August 2005	Roost Search	4 person hours	Powerful Owl and Masked Owl
	Nocturnal stag-watch	3 person hours	Powerful Owl, Masked Owl, Glossy Black-cockatoo, and Gang-gang Cockatoo
	Nocturnal spotlighting	1 person-hour	Mammals, birds and amphibians
		61.75 PERSON HOURS, 231 TRAP NIGHTS	

3. THE EXISTING ENVIRONMENT

3.1 Topography, Geology, and Soils

The study area lies at an altitude of approximately 20-30 m Australian Height Datum (AHD) and is gently-sloping land with an aspect generally to the south. Two low-lying ephemeral drainage depressions are located within the property. The most westerly drainage runs in a south-easterly direction and henceforth will be referred to as Drainage A. The second drainage runs through the centre of the property in a southerly direction and will be referred to as Drainage B. Only Drainage A supports vegetation associated with drainage lines to any substantial degree. Both drainage lines form part of the upper catchment of a small coastal lagoon that discharges onto Manyana Beach.

The study area appears to be underlain by Tertiary undifferentiated sediments comprising gravel, sand, clay, quartzite, sandstone and conglomerate (Ulladulla 1:250000 Geological Series Sheet S1 56-13). These have weathered to form red loamy and sandy soils typical of the Manyana area. Soils throughout much of the study area are covered by a thick humus layer.

3.2 Disturbances

The study area shows generally low levels of disturbance. There is a small clearing in the north where a cabin is situated and a number of walking trails leading to the south from this clearing. Access by members of the public along some of these tracks has resulted in rubbish accumulating in some locations.

Under-scrubbing is evident along the southern and eastern boundaries where a fire break with a width of about 10 m has been established and on Lot 823 where vegetation has been almost completely removed. Hazard reduction burning undertaken in the study area about 7 years ago has generally resulted in undeveloped understorey vegetation in the west and south-east of the study area. Some areas exhibit evidence of frequent fire. The study area appears to have been selectively logged in the past given the relatively low abundance of old growth elements. Weed invasion is generally minor and restricted to the margins of the study area.

3.3 Flora

The study area supports three vegetation communities and their distributions are shown in Figure 5 (Appendix A). Whilst the study area is relatively undisturbed there are few old-growth elements and the vegetation appears to have been affected by historic selective logging, wildfire and prescribed fire.

Where possible the communities have been typed with reference to the classifications of Thomas *et al.* (2000) and Kevin Mills & Associates (KMA) (1999). However, the influence of clay soils in and adjacent to the study area on the vegetation found there does not appear to have been recognised by Thomas *et al.* (2000) or KMA (1999). Consequently, the vegetation within

the study area as identified below is, in places, significantly different from that modelled and mapped by those studies. Where appropriate, the nomenclature of Thomas *et al.* (2000) and KMA (1999) has been used to suggest affinities between the vegetation within the study area and the communities described by those studies.

3.3.1 Northern Coastal Sands Shrub/Fern Forest

This community occurs across the majority of the study area on sandy clay soils. It most closely resembles the Northern Coastal Sands Shrub/Fern Forest of Thomas *et al.* (2000). The community also has affinities with the Blackbutt Forest Sub-group of KMA (1999) particularly the Blackbutt Tall Forest (PIL-SYN) and Blackbutt – Bloodwood Forest (PIL-GUM), the Peppermint – Blackbutt Forest (PIP-PIL), and the Blackbutt – Peppermint Tall Open Forest of (KMA 1995b). However it is difficult to correlate the vegetation within the study area with the communities identified by Mills (1998) given the brevity of the community descriptions.

The community comprises an open-forest dominated by Sydney Peppermint *Eucalyptus piperita,* Blackbutt *E. pilularis*, and Red Bloodwood *Corymbia gummifera* but also includes Thin-leaved Stringybark *E. eugenioides,* White Stringybark *E. globoidea*, Grey Ironbark *E. paniculata* subsp. *paniculata* and Bangalay *E. botryoides*. The canopy height is approximately 25 m with foliage projective cover of approximately 35 %.

There is a sub-canopy dominated by Turpentine *Syncarpia glomulifera* subsp. *glomulifera*, to a height of approximately 14 m with variable foliage projective cover ranging between approximately 5-25%. Within this sub-canopy, there are dense, almost closed stands of Turpentine in places. Other sub-canopy species generally occur very sporadically and include Hickory *Acacia implexa*, Saw Banksia *Banksia serrata*, Coastal Banksia *B. integrifolia* subsp. *integrifolia*, Snow in Summer *Melaleuca linariifolia,* and Black She-oak *Allocasuarina littoralis*.

Parts of the community have been affected by relatively recent prescribed burning and consequently the understorey is often dominated by Common Hop Bush *Dodonaea triquetra*. Other common understorey species include Sunshine Wattle *Acacia terminalis*, Narrow-leaf Geebung *Persoonia linearis,* the Bog-rush *Schoenus melanostachys*, Handsome Flat-pea *Platylobium formosum*, Prickly Moses *A. ulicifolia*, Hair-pin Banksia *Banksia spinulosa* var. *spinulosa,* Sydney Golden Wattle *A. longifolia,* and Black Fruited Saw-sedge *Gahnia melanocarpa.* The understorey is usually to a height of up to 4-6 m with foliage projective cover of approximately 25-40%. In the southern parts of the study area species such as Hairy Psychotria *Psychotria loniceroides,* Scentless Rosewood *Synoum glandulosum* subsp. *glandulosum,* Blueberry Ash *Elaeocarpus reticulatus,* Mock Olive *Notelaea venosa*, Coffee Bush *Breynia oblongifolia* and Mutton Wood *Rapanea variabilis* also occur patchily in the understorey.

The groundcover includes a diverse range of native grasses, shrubs, ferns, forbs and climbers such as Germander Raspwort *Gonocarpus teucrioides,* Rough Guinea-flower *Hibbertia aspera,* Bordered Panic *Entolasia marginata*, Common Bracken Fern *Pteridium esculentum*, False

Bracken *Calochlaena dubia,* Wiry Panic *Entolasia stricta,* Variable Sword-sedge *Lepidosperma laterale,* Spiny-headed Mat-rush *Lomandra longifolia,* Milkwort Boronia *Boronia polygalifolia,* Showy Guinea-flower *Hibbertia linearis,* Two Colour Panic *Panicum simile*, Dwarf Trumpet *Brunoniella pumilio,* Kidney Weed *Dichondra repens*, Whiteroot *Pratia purpurascens*, Lilac Lily *Schelhammera undulata*, Bonnet Orchid *Cryptostylis erecta,* Large Tongue Orchid *Cryptostylis subulata,* Asian Pennywort *Centella asiatica*, Basket Grass *Oplismenus imbecillis*, Thyme Spurge *Phyllanthus hirtellus*, Leafy Purple Flag *Patersonia glabrata,* Holly Lomatia *Lomatia ilicifolia*, Common Stinkweed *Opercularia aspera,* Blue Flax-lily *Dianella caerula* var. *producta*, Blady Grass *Imperata cylindrica,* Slender Tick-Trefoil *Desmodium varians*, Slender Oxalis *Oxalis exilis,* Hedgehog Grass *Echinopogon caespitosus* var. *caespitosus,* Kangaroo Grass *Themeda australis*, and Gristle Fern *Blechnum cartilagineum* to a height of approximately 1.5 m with foliage projective cover of approximately 30-40%.

The understorey also includes climbers such as Apple Berry *Billardiera scandens,* Love Creeper *Glycine clandestina,* Polymeria *Polymeria calycina,* Trailing Guinea-flower *Hibbertia scandens,* Old Man's Beard *Clematis aristata,* Bearded Tylophora *Tylophora barbata*, Native Sarsaparilla *Smilax glyciphylla*, Common Milk Vine *Marsdenia rostrata,* Wombat Berry *Eustrephus latifolius*, Snake Vine *Stephania japonica*, and Scrambling Lily *Geitonoplesium cymosum.*

3.3.2 Bangalay Moist Woodland/Open Forest

This community occurs in the eastern, primarily north-eastern, parts of the study area which is mapped by KMA (1999) as Blackbutt Tall Forest (PIL-SYN). However the community resembles the Bangalay Forest (BOT-BAN) and Bangalay – Rainforest (BOT-LRF) communities of Mills (1998) and has affinities with the Bangalay Open Forest / Closed Forest (Rainforest) of KMA (1995b).

The abundance of rainforest elements in the understorey appears to be the result of the relative infrequence of fires, with more frequently burnt occurrences of the community being described as Bangalay Forest (BOT-BAN) by Mills (1998). As such the vegetation within the study area is more accurately described as intermediate between the Bangalay Forest (BOT-BAN) and the Bangalay – Rainforest (BOT-LRF) of Mills (1998), with continued protection from fire driving the succession towards the Bangalay – Rainforest. The location of the Bangalay Moist Woodland / Open Forest within the study area does not occur in a part of the landscape where it would naturally have been afforded protection from fire. The protection from fire in recent times has likely been the result of anthropogenic factors such as the location of prescribed burns in adjacent areas. Similar vegetation in the locality such as that at Cunjurong Point and behind Monument Beach in Conjola National Park is mapped by KMA (1999) as Bangalay Forest (BOT-BAN), although particularly at Cunjurong Point it would appear that a similar process of largely anthropogenic fire exclusion is driving a succession towards the Bangalay – Rainforest (BOT-LRF).

The community also appears to have affinities with Coastal Sands Shrub / Fern Forest of Thomas *et al.* (2000), but it does not support the abundance of diagnostic species such as Saw Banksia, Tree Broom-heath *Monotoca elliptica*, and *Cyperus laevigatus*.

For the purposes of this report the community is described as Bangalay Moist Woodland / Open Forest.

The canopy is dominated by Bangalay but also includes Blackbutt, Thin-leaved Stringybark, Grey Ironbark and Rough-barked Apple *Angophora floribunda* to a height of approximately 20 m with foliage projective cover of approximately 20-30%. There is a moist sub-canopy to a height of approximately 10-15 m with foliage projective cover of approximately 20-40% comprising species such as Sweet Pittosporum *Pittosporum undulatum*, Scentless Rosewood, Black She-oak, Lilly Pilly *Acmena smithii,* Coastal Banksia, Hairy Clerodendrum *Clerodendrum tomentosum,* Blueberry Ash, Mock Olive *Notelaea* spp., and Parramatta Green Wattle *Acacia parramattensis.* Parramatta Green Wattle is often present to approximately 15 m with foliage projective cover of approximately 10%.

The understorey is dominated by Black Fruited Saw-sedge, Rough-fruit Pittosporum *Pittosporum revolutum*, Scentless Rosewood, Bolwarra *Eupomatia laurina*, Senna *Senna* ssp., Coffee Bush and Wallaby Weed *Olearia viscidula* to a height of approximately 2.5 m with foliage projective cover of approximately 60%.

Groundcovers include Bordered Panic, Native Violet *Viola hederacea*, Drooping Sedge *Carex longebrachiata*, Variable Sword-sedge, Basket Grass *Oplismenus imbecillis,* Spiny-headed Mat-rush, Common Bracken Fern, Common Maidenhair Fern *Adiantum aethiopicum,* Slender Tick-trefoil, and Pastel Flower *Pseuderanthemum variabile* to a height of approximately 1.5 m with foliage projective cover of approximately 40-60%. Climbers and scramblers include Jasmine Morinda *Morinda jasminoides*, which is prolific in the groundcover, Giant Water Vine *Cissus hypoglauca*, Bearded Tylophora, Snake Vine, Wonga-wonga Vine *Pandorea pandorana,* Wombat Berry, Scrambling Lily, and Common Milk Vine.

In the north-eastern extremities of the study area there is an area of approximately 0.15 ha where there is a closed sub-canopy dominated by Lilly Pilly to a height of approximately 6 m. The understorey and groundcover is very sparse and comprises just a few individuals of Scrub Beefwood *Stenocarpus salignus*, Mock Olive *Notelaea* spp., Scentless Rosewood, Spiny-headed Mat-rush, Hairy Psychotria, Drooping Sedge, and the climbers Jasmine Morinda, Giant Water Vine, and Common Silkpod *Parsonsia straminea*.

3.3.3 Bangalay Paperbark Woodland

This community occurs primarily in Drainage A which drains the western parts of the study area, flowing to the southern study area boundary (Figure 5 Appendix A). This vegetation most closely equates with the Paperbark Forest (MEL-FOR) or Swamp Mahogany – Paperbark

Forest (ROB-MEL) of KMA (1999). However the paperbarks occur as a sub-canopy beneath Bangalay and there is no Swamp Mahogany *Eucalyptus robusta*. The substrate is clayey rather than the sands usually associated with Swamp Mahogany – Paperbark Forest. Thomas *et al.* (2000) similarly describe a Northern Coastal Lowlands Swamp Forest which appears floristically and structurally similar apart from the absence of Swamp Mahogany.

The upper stratum is dominated by Bangalay which forms a canopy to a height of approximately 22 m with foliage projective cover of approximately 25%. There is a sub-canopy to a height of 12 m with foliage projective cover of between approximately 20-30% dominated by Snow in Summer, but also including Black Wattle *Callicoma serratifolia*, and Parramatta Green Wattle, with Mutton Wood *Rapanea variabilis* and Black She-oak occurring occasionally on the community margins.

The understorey is generally dense to a height of 4 m with foliage projective cover of approximately 40%. The understorey is dominated by Tall Saw-sedge *Gahnia clarkei* which is abundant in clumps to approximately 2.5 m. Other understorey species include Yellow Tea-tree *Leptospermum polygalifolium* subsp. *polygalifolium*, Swamp Paperbark *Melaleuca ericifolia*, Rough Tree Fern *Cyathea australis,* the Bog-rush *Schoenus melanostachys,* the Saw-sedge *Gahnia radula* and a few individuals of Coastal Wattle *Acacia sophorae* and Cheese Tree *Glochidion ferdinandi*.

The groundcover includes a range of predominantly forbs, ferns and climbers such as False Bracken, Native Violet, the Pennywort *Hydrocotyle peduncularis,* Basket Grass *Oplismenus imbecillis*, Asian Pennywort, the Water Fern *Blechnum camfieldii,* Fishbone Fern *Blechnum nudum,* and seedlings of Scentless Rosewood and Hairy Psychotria to a height of approximately 1 m. The density of the groundcover is influenced by the density of the understorey but is generally very sparse with foliage projective cover averaging approximately 5%. Climbers include Trailing Guinea-flower, Broad-leaved Bramble *Rubus moluccanus* var. *trilobus* and Common Silkpod. This community also includes several individuals of Christmas Orchid *Calanthe triplicata*.

3.3.4 Flora Species

A total of 184 flora species were identified during the flora surveys, and these are listed in Table 4. One hundred and sixty-four native species and 20 exotic species were identified.

Table 4: Flora species identified in the study area (* denotes exotic species).

SCIENTIFIC NAME	COMMON NAME
Acacia binervata	Two-veined Hickory
Acacia elata	Mountain Cedar Wattle
Acacia implexa	Hickory

SCIENTIFIC NAME	COMMON NAME
Acacia longifolia	Sydney Golden Wattle
Acacia mearnsii	Black Wattle
Acacia parramattensis	Parramatta Green Wattle
Acacia sophorae	Coastal Wattle
Acacia suaveolens	Sweet Wattle
Acacia terminalis	Sunshine Wattle
Acacia ulicifolia	Prickly Moses
Acmena smithii	Lilly Pilly
Adiantum aethiopicum	Common Maidenhair Fern
Allocasuarina littoralis	Black She-oak
Alphitonia excelsa	Red Ash
Amperea xiphoclada var. *xiphoclada*	Broom Spurge
Angophora floribunda	Rough-barked Apple
Arthropodium milleflorum	Vanilla Lily
*Asparagus asparagoides**	Bridal Creeper*
Austrodanthonia fulva	A wallaby grass
Austrostipa pubescens	Tall Speargrass
Banksia integrifolia subsp. *integrifolia*	Coastal Banksia
Banksia serrata	Saw Banksia
Banksia spinulosa var. *spinulosa*	Hair-pin Banksia
*Bidens pilosa**	Cobblers Pegs*
Billardiera scandens	Apple Berry
Blechnum camfieldii	A water fern
Blechnum cartilagineum	Gristle Fern
Blechnum nudum	Fishbone Fern
Boronia polygalifolia	Milkwort Boronia
Breynia oblongifolia	Coffee Bush
Brunoniella pumilio	Dwarf Trumpet
Calanthe triplicata	Christmas Orchid
Callicoma serratifolia	Black Wattle
Calochlaena dubia	False Bracken
Cassinia aculeata	Dolly Bush
Carex longebrachiata	Bergalia Tussock

SCIENTIFIC NAME	COMMON NAME
Centella asiatica	Asian Pennywort
Cissus hypoglauca	Water Vine
Clematis aristata	Old Man's Beard
Clerodendrum tomentosum	Hairy Clerodendrum
Comesperma ericinum	Matchheads
Corymbia gummifera	Red Bloodwood
*Crassula multicava**	A stonecrop*
Cryptostylis erecta	Bonnet Orchid
Cryptostylis subulata	Large Tongue Orchid
Cyathea australis	Rough Tree Fern
Cymbidium suave	Snake Flower
Desmodium rhytidophyllum	Rusty Tick-trefoil
Desmodium varians	Slender Tick-trefoil
Dianella caerula var. *caerula*	Blue Flax-lily
Dianella caerula var. *producta*	Blue Flax-lily
Dicanthium sericeum	Queensland Bluegrass
Dichondra repens	Kidney Weed
Dipodium variegatum	Blotched Hyacinth Orchid
Dodonaea triquetra	Common Hop Bush
Doodia aspera	Rasp Fern
Echinopogon caespitosus var. *caespitosus*	Hedgehog Grass
Elaeocarpus reticulatus	Blueberry Ash
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Epacris pulchella	NSW Coral Heath
Eucalyptus botryoides	Bangalay
Eucalyptus eugenioides	Thin-leaved Stringybark
Eucalyptus globoidea	White Stringybark
Eucalyptus paniculata	Grey Ironbark
Eucalyptus pilularis	Blackbutt
Eucalyptus piperita	Sydney Peppermint
Eucalyptus sclerophylla	Hard-leaved Scribbly Gum
Eustrephus latifolius	Wombat Berry

SCIENTIFIC NAME	COMMON NAME
Exocarpos cupressiformis	Cherry Ballart
Gahnia clarkei	Tall Saw-sedge
Gahnia melanocarpa	Black Fruit Saw-sedge
Gahnia radula	a saw-sedge
Gahnia sieberana	Red-fruited Saw-sedge
Geitonoplesium cymosum	Scrambling Lily
Gleichenia dicarpa	Pouched Coral-fern
Glochidion ferdinandi	Cheese Tree
Glycine clandestina	Love Creeper
Gompholobium latifolium	Broad-leaf Wedge-pea
Gonocarpus teucrioides	Germander Raspwort
Goodenia bellidifolia subsp. *bellidifolia*	Daisy-leaved Goodenia
Hakea salicifolia	Willow-leaved Hakea
Hardenbergia violacea	Twining Pea
*Hedychium gardnerianum**	Ginger Lily*
Hibbertia aspera	Rough Guinea-flower
Hibbertia linearis	Showy Guinea-flower
Hibbertia scandens	Trailing Guinea-flower
*Holcus lanatus**	Yorkshire Fog*
Hydrocotyle peduncularis	A pennywort
Hypericum gramineum	Small St John's Wort
*Hypochaeris radicata**	Flatweed*
Hypoxis hygrometrica	Golden Star
*Impatiens balsamina**	Busy Lizzie*
Imperata cylindrica	Blady Grass
Indigofera australis	Austral Indigo
Kennedia rubicunda	Dusky Coral-pea
Kunzea ambigua	White Kunzea
Lagenifera gracilis	Slender Lagenophora
Lepidosperma laterale	Variable Sword-sedge
Lepidosperma neesi	A rapier sedge
Leptocarpus tenax	A twine-rush
Leptomeria acida	Native Currant

SCIENTIFIC NAME	COMMON NAME
Leptospermum polygalifolium subsp. *polygalifolium*	Yellow Tea-tree
Leucopogon juniperinus	Juniper Beard-heath
Leucopogon lanceolatus subsp. *lanceolatus*	Lance Beard-heath
*Lilium formosanum**	Formosan Lily*
Livistona australis	Cabbage Palm
Lobelia alata	A lobelia
Lomandra longifolia	Spiny-headed Mat-rush
Lomatia ilicifolia	Holly-leaved Lomatia
*Lonicera japonica**	Japanese Honeysuckle*
Marsdenia rostrata	Common Milk Vine
Marsdenia suaveolens	Sweet-scented Doubah
Melaleuca ericifolia	Swamp Paperbark
Melaleuca linariifolia	Snow-in-Summer
Microlaena stipoides	Weeping Meadow Grass
Microtis parviflora complex	Slender Onion Orchid
Monotoca elliptica	Tree Broom-heath
Morinda jasminoides	Jasmine Morinda
*Nephrolepis cordifolia**	Fishbone Fern*
Notelaea longifolia	Mock Olive
Notelaea venosa	Mock Olive
Olearia viscidula	Wallaby Weed
Opercularia aspera	Common Stinkweed
Opercularia varia	A stinkweed
Oplismenus aemulus	Basket Grass
Oplismenus imbecillis	Basket Grass
Oxalis exilis	Slender Oxalis
Ozothamnus diosmifolium	Everlasting
Pandorea pandorana	Wonga-wonga Vine
Panicum simile	Two Colour Panic
Parsonsia straminea	Common Silkpod
Patersonia glabrata	Leafy Purple Flag
*Pennisetum clandestinum**	Kikuyu*
Persoonia linearis	Narrow-leaf Geebung

SCIENTIFIC NAME	COMMON NAME
Persoonia mollis subsp. *caleyi*	Soft Geebung
Petrophile pedunculata	Stalked Conesticks
Phyllanthus hirtellus	Thyme Spurge
Pimelea linifolia subsp. *linifolia*	Slender Rice-flower
Pittosporum revolutum	Rough-fruit Pittosporum
Pittosporum undulatum	Sweet Pittosporum
Platylobium formosum	Handsome Flat-pea
Poa labillardieri var. *labillardieri*	Tussock
Podolobium ilicifolium	Native Holly
Polymeria calycina	Polymeria
Pratia purpurascens	Whiteroot
*Protasparagus aethiopicus**	Asparagus Fern*
Pseuderanthemum variabile	Pastel Flower
Psychotria loniceroides	Hairy Psychotria
Pteridium esculentum	Common Bracken
Pultenaea daphnoides	Large-leaf Bush-pea
Pultenaea linophylla	Halo Bush-pea
Pultenaea retusa	A bush-pea
Rapanea variabilis	Mutton Wood
Rhodamnia rubescens	Scrub Turpentine
Rubus hillii	Native Raspberry
Rubus moluccanus var. *trilobus*	Broad-leaved Bramble
Rubus parvifolius	Native Raspberry
*Rubus ulmifolius**	Blackberry*
*Sambucus nigra**	Common Elder*
Santalum obtusifolium	Sandalwood
Scaevola ramosissima	Snake-flower
Schelhammera undulata	Lilac Lily
Schoenus melanostachys	A bog-rush
Senecio hispidulus var. *hispidulus*	A groundsel
*Senna floribunda**	Senna*
*Senna pendula**	Senna*
Smilax glyciphylla	Native Sarsaparilla

SCIENTIFIC NAME	COMMON NAME
*Sonchus sp**	A sowthistle*
Stenocarpus salignus	Scrub Beefwood
*Stenotaphrum secundatum**	Buffalo Grass*
Stephania japonica	Snake Vine
Syncarpia glomulifera subsp. *glomulifera*	Turpentine
Synoum glandulosum subsp. *glandulosum*	Scentless Rosewood
*Taraxacum officinale**	Dandelion*
Tetratheca thymifolia	Black-eyed Susan
Thelymitra sp.	A Sun Orchid
Themeda australis	Kangaroo Grass
Thysanotus tuberosus	Fringe Lily
Trema aspera	Native Peach
Tylophora barbata	Bearded Tylophora
Vernonia cinerea var. *cinerea*	Vernonia
Viola hederacea	Native Violet
*Watsonia meriana**	Wild Watsonia*
Xanthorrhoea sp.	A grass tree

* Denotes introduced species or planting.

3.4. Fauna

3.4.1 Fauna Habitats

The fauna habitats present in the study area are those generally associated with coastal open forests and broad ephemeral drainage depressions in the coastal parts of the locality.

The study area contains foraging resources in the form of scattered Red Bloodwood sap trees and a reasonable abundance of winter-flowering trees such as Grey Ironbark. There is an abundance of fleshy fruit provided by fruit-bearing plant species such as Lilly Pilly, Water Vine, Native Peach, Sweet Pittosporum, Rough-fruit Pittosporum and Wombat Berry. There are also many flowering acacias, occasional tree or shrub banksias, and concentrations of *Melaleuca* spp. throughout the study area. These could provide foraging substrates for arboreal mammals, flying mammals and birds. Some of the Red Bloodwood trees contained incisions and chew marks consistent with those made by the Sugar Glider *Petaurus breviceps*.

There are about 40 trees containing hollows of varying sizes some of which could provide nest sites for birds such as the Gang-gang Cockatoo *Callocephalon fimbriatum* and Glossy Black-cockatoo *Calyptorhynchus lathami,* or mammals including the Common Brushtail Possum

Trichosurus vulpecula or Common Ringtail Possum *Pseudocheirus peregrinus*, which were both recorded in the study area. Several very large hollows provide potential roosting or nesting sites for forest owls such as the Powerful Owl *Ninox strenua.* The locations of trees with hollows are shown in Figure 6 (Appendix A).

There are a moderate number of fallen logs within the study area. About half of these contain hollows, limiting the amount of shelter provided for terrestrial fauna species. Shelter for such species provided by understorey and groundcover vegetation, is limited in the west probably as a result of prescribed burning. The groundcover in the east is greater because of a dense vegetative layer formed by Drooping Sedge, Variable Sword-sedge, Basket Grass, Spiny-headed Mat-rush, and Common Bracken Fern. This groundcover provides excellent shelter and foraging resources for small ground dwelling mammals and birds and a large variety of insectivorous birds. The thick understorey of Yellow Tea-tree and Snow in Summer in the Bangalay Paperbark Woodland would also provide nesting habitat for birds.

Drainage A contained water in its southern margins at times during the survey period but appears to remain mostly dry. This limits the availability of habitats for amphibians in the study area. Rock habitats were not observed within the study area.

The study area is connected to adjacent vegetated habitats along the western and northern boundaries. The roads in these locations do not appear to provide significant barriers to faunal dispersal.

3.4.2 Fauna Species

Targeted fauna surveys and opportunistic observations during the survey period resulted in the detection of 69 faunal species inhabiting the study area. All of these species are native and none are introduced. Four threatened species, the Greater Broad-nosed Bat *Scoteanax rueppellii,* Gang-gang Cockatoo *Callocephalon fimbriatum*, Powerful Owl *Ninox strenua,* and Square-tailed Kite *Lophoictinia isura* were recorded during the survey period.

Fourteen mammals, 50 birds and two reptiles and three amphibians were recorded within the study area during the survey period and these are listed in Table 5.

Table 5: Fauna species identified during this study.

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
Mammals	Agile Antechinus	*Antechinus agilis*	Direct observation
	Bush Rat	*Rattus fuscipes*	Direct observation
	Common Brushtail Possum	*Trichosurus vulpecula*	Direct observation
	Common Ringtail Possum	*Pseudocheirus peregrinus*	Direct observation
	Dusky Antechinus	*Antechinus swainsonii*	Direct observation
	Eastern Broad-nosed Bat	*Scotorepens orion*	ANABAT

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
	Greater Glider	*Petauroides volans*	Direct observation
	Gould's Wattled Bat	*Chalinolobus gouldii*	ANABAT
	Greater Broad-nosed Bat	*Scoteanax rueppellii*	ANABAT
	A Freetail Bat	*Mormopterus sp1.*	ANABAT
	Large Forest Bat	*Vespadelus darlingtoni*	ANABAT
	Little Forest Bat	*Vespadelus vultumus*	ANABAT
	Sugar Glider	*Petaurus breviceps*	Call recognition
	Swamp Wallaby	*Wallabia bicolor*	Direct observation
Birds	Australian King Parrot	*Alisterus scapularis*	Call recognition
	Australian Magpie	*Gymnorhina tibicen*	Direct observation
	Australian Raven	*Corvus coronoides*	Call recognition
	Azure Kingfisher	*Alcedo azurea*	Direct observation
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Direct observation
	Black-faced Monarch	*Monarcha melanopsis*	Direct observation
	Brown Pigeon	*Macropygia amboinensis*	Direct observation
	Brown Thornbill	*Acanthiza pusilla*	Direct observation
	Channel-billed Cuckoo	*Scythrops novaehollandiae*	Call recognition
	Common Koel	*Eudynamys scolopacea*	Direct observation
	Crimson Rosella	*Platycercus elegans*	Direct observation
	Dollarbird	*Eurystomas orientalis*	Call recognition
	Eastern Spinebill	*Acanthorhynchus tenuirostris*	Direct observation
	Eastern Whipbird	*Psophodes olivaceus*	Call recognition
	Eastern Yellow Robin	*Eopsaltria australis*	Call recognition
	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	Direct observation
	Galah	*Cacatua roseicapilla*	Direct observation
	Gang-gang Cockatoo	*Callocephalon fimbriatum*	Call recognition
	Grey Butcherbird	*Cracticus torquatus*	Direct observation
	Grey Shrike-Thrush	*Colluricincla harmonica*	Call recognition
	Grey Fantail	*Rhipidura fuliginosa*	Direct observation
	Laughing Kookaburra	*Dacelo novaeguineae*	Call recognition
	Leaden Flycatcher	*Myiagra rubecula*	Direct observation
	Lewin's Honeyeater	*Meliphaga lewinii*	Direct observation
	Magpie-lark	*Grallina cyanoleuca*	Direct observation

CATEGORY	COMMON NAME	SCIENTIFIC NAME	DETECTION METHOD
	Mistletoebird	*Dicaeum hirundinaceum*	Direct observation
	Musk Lorikeet	*Glossopsitta concinna*	Direct observation
	Noisy Friarbird	*Philemon corniculatus*	Direct observation
	Olive-backed Oriole	*Oriolus sagittatus*	Direct observation
	Pallid Cuckoo	*Cuculus pallidus*	Direct observation
	Pied Currawong	*Strepera graculina*	Direct observation
	Powerful Owl	*Ninox strenua*	Direct observation
	Rainbow Lorikeet	*Trichoglossus haematodus*	Direct observation
	Red Wattlebird	*Anthochaera lunulata*	Direct observation
	Red-browed Finch	*Neochmia temporalis*	Direct observation
	Rufous Fantail	*Rhipidura rufifrons*	Direct observation
	Rufous Whistler	*Pachycephala rufiventris*	Direct observation
	Satin Bowerbird	*Ptilonorhynchus violaceus*	Direct observation
	Silvereye	*Zosterops lateralis*	Direct observation
	Spotted Pardalote	*Pardalotus punctatus*	Direct observation
	Square-tailed Kite	*Lophoictinia isura*	Direct observation
	Striated Pardalote	*Pardalotus striatus*	Direct observation
	Sulphur-crested Cockatoo	*Cacatua galerita*	Direct observation
	Superb Fairy-wren	*Malurus cyaneus*	Direct observation
	White-browed Scrubwren	*Sericornis frontalis*	Direct observation
	White-throated Treecreeper	*Cormobates leucophaeus*	Direct observation
	Willie Wagtail	*Rhipidura leucophrys*	Direct observation
	Wonga Pigeon	*Leucosarcia melanoleuca*	Direct observation
	Yellow-faced Honeyeater	*Lichenostomus chrysops*	Direct observation
	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	Direct observation
Reptiles	Diamond Python	*Morelia spilota*	Direct observation
	Garden Sun-Skink	*Lampropholis delicata*	Direct observation
Amphibians	Bibron's Toadlet	*Pseudophryne bibronii*	Call recognition
	Common Eastern Froglet	*Crinia signifera*	Call recognition
	Peron's Tree Frog	*Litoria peronii*	Call recognition

4. CONSERVATION SIGNIFICANCE

The *NSW Threatened Species Conservation Act 1995* (*TSC Act*) and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) provide for the listing of threatened flora and fauna species. The *EPBC Act* also provides for the listing of migratory species. The *NSW Fisheries Management Act 1994* (*FM Act*) provides for the listing of threatened fish species and marine vegetation.

The *TSC Act* classifies threatened flora and fauna species as Endangered (Schedule 1, Part 1), Vulnerable (Schedule 2), or Presumed Extinct (Schedule 1, Part 4). Records of these species may be obtained by searching the Atlas of NSW Wildlife.

The *EPBC Act* classifies threatened flora and fauna species as Extinct, Critically Endangered, Endangered or Vulnerable. An indication of the threatened and migratory species likely to be encountered in a locality may be obtained by using the *EBPC Act* Protected Matters Search Tool. Both of these databases were searched on 4 February 2005 for records of threatened flora, threatened fauna and migratory species within an area of 10 km x 10 km centred on the study area. The *FM Act* classifies threatened fish and marine vegetation as Endangered, Vulnerable, or Presumed Extinct. An indication of the species likely to be encountered in a locality may be obtained by reviewing the recommendations for threatened species listed on the schedules of the *FM Act*.

4.1 Threatened Flora

The outcome of database searches for threatened flora is shown in Table 6 below with the status of each species listed as endangered (E) or Vulnerable (V). The potential for each of these species to occur in the study area and the importance of the habitats to be affected by the proposal are discussed in Table 6 and a decision made regarding the need or otherwise for further assessment in this report.

Table 6: Threatened flora species recorded or likely to occur in the locality.

THREATENED FLORA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TSC Act	EPBC Act		
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	This terrestrial orchid is known from swamp-heath and open forest on sandy soils in coastal districts. The species is known from a population approximately 1150 m to the north of the study area. Targeted surveys for the species undertaken during the flowering period failed to detect the species within the study area so it is considered unlikely that the species occurs there.	Yes

THREATENED FLORA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TSC Act	EPBC Act		
Thesium australe Austral Toad-flax	V	V	This species is associated with native grasslands and is a hemi-parasite of Kangaroo Grass which occurs in very low densities within the study area. Kangaroo Grass occurs sporadically throughout the study area and targeted surveys for the species were undertaken in conjunction with surveys for *C. hunteriana*. The species was not detected within the study area despite considerable survey effort and it is considered highly unlikely that the species would occur there.	No

Note: Habitat requirements for flora species in Table 6 have been sourced from: Bishop (2000), Clarke *et al*. (2004), and Harden (1994).

The proposal will not impact any threatened flora species but further consideration will be given to the Leafless Tongue-orchid *Cryptostylis hunteriana* in subsequent sections of this report as a population of the species occurs in similar habitat near the study area.

4.2 Threatened Fauna

The outcomes of database searches for threatened fauna and the review of recommendations for threatened species listed on the schedules of the *FM Act* are shown in Table 7 below with the status of each species listed as endangered (E) or Vulnerable (V). The potential for each of these species to occur in the study area and the importance of the habitats to be affected by the proposal are discussed in Table 7 and a decision made regarding the need or otherwise for further assessment in this report. Additional species that may inhabit the study area have also been included by correlating habitat requirements with the attributes of the study area. Marine and oceanic species have been omitted as they would not occur in the study area.

Table 7: Threatened fauna species recorded or likely to occur in the locality.

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TBC Act	EPBC Act		
Mammals				
Greater Broad-nosed Bat *Scoteanax rueppellii*	V	-	This bat roosts in tree hollows and forages in forests. Suitable habitat is present in the study area for foraging and roosting. Echolocation calls attributed to this species were detected on one occasion during the survey period.	Yes
Eastern Freetail Bat *Mormopterus norfolkensis*	V	-	This bat roosts in tree hollows and forages in forests. Suitable foraging habitat and trees with hollows are present in the study area. It was not detected within the study area during the survey period.	No

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TBC Act	EPBC Act		
Koala *Phascolarctos cinereus*	V	-	No primary feed trees for this species occur in the study area. However there are individuals of supplementary feed tree species. There are no recent records of the species in the locality or evidence of the species within the study area. The species was not detected during the survey period and is unlikely to occur there.	No
Southern Brown Bandicoot *Isoodon obesulus*	E	E	This species requires thick contiguous undergrowth where the soil is light and sandy. The site contained both thick undergrowth and appropriate sandy substrate in places. Bandicoot diggings were observed in the study area but the species was not detected despite targeted cage trapping. The digging signs observed are likely to have been attributable to the Long-nosed Bandicoot *Perameles nasuta* which is common in the locality. It is considered unlikely that the species occurs within the study area.	No
Squirrel Glider *Petaurus norfolcensis*	V	-	The species dens in tree hollows and forages in open forests where it's preferred feed trees are found. There are few records of the species in the locality. The study area contains hollows that provide potential denning and breeding habitat for the species however it does not appear to provide high quality foraging habitat. The species was not detected despite numerous stagwatching and spotlighting surveys.	No
Yellow-bellied Glider *Petaurus australis*	V	-	The species dens in tree hollows and forages in open forests where preferred feed trees are found. The preferred feed tree Red Bloodwood is reasonably abundant within the study area but no evidence of sap feeding activity was observed. The species was not detected despite targeted survey techniques such as call playback, stagwatching and spotlighting within the study area.	No
Birds				
Gang-gang Cockatoo *Callocephalon fimbriatum*	V	-	Gang-gang cockatoos live as pairs inhabiting the woodlands and forests of south-eastern Australia. They feed on the seeds of eucalypts and acacias and occasionally fruits of plant species such as *Persoonia* spp. Nest sites are usually within medium sized hollows in living eucalypts and generally are located in the tall montane forests and woodlands where the species is concentrated during the summer months. Egg-laying occurs from late spring to early summer with one or two young being raised per clutch. Roosting and foraging resources are available within the study area and the species was recorded from its call immediately adjacent to the study area in December 2004.	Yes

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TBC Act	EPBC Act		
Glossy Black-cockatoo *Calyptorhynchus lathami*	V	-	This species occurs in forests and woodlands where She-oak feeding resources are prevalent and large tree hollows exist for breeding. It is known to forage in the residential parts of Manyana from time to time (Smithers pers. obs.). The study area does contain some She-oak feeding resources although no evidence of these resources being utilised by the species was observed during the survey period despite targeted searches. It is possible that the species may forage or potentially breed in the study area from time to time however no Glossy Black-cockatoos were recorded during the survey period despite targeted survey of potential breeding sites and searches for foraging evidence. Superior quality foraging and breeding habitat is available elsewhere in the large areas of bushland that occur in the locality.	No
Masked Owl *Tyto novaehollandiae*	V	-	This species breeds in hollow trees and forages predominantly on terrestrial mammals. The species may hunt for prey in the open forests in the study area from time to time but the vegetation would form a very small amount of the species' vast home range. Open forest occurs within the study area but the shrub layer is too thick over much of the study area to allow useful foraging. There were several large hollows suitable for roosting and breeding within the study area, although the species was not detected during the survey period despite targeted survey of these potential resources.	No
Powerful Owl *Ninox strenua*	V	-	Habitat for this species tends to be within eucalypt forest containing a diverse array of understorey plants. Preferred prey species include Ringtail Possums and Greater Gliders. Investigations during the survey period suggest that prey densities within the study area are moderate at best, probably as a result of the relatively low abundance of suitable hollow bearing trees. Targeted call playback surveys during the survey period failed to illicit a response from the species despite an individual being observed within the study area at dusk on two occasions. Marginal quality potential breeding habitat and associated roosting habitat occurs in the western parts of the study area, but targeted surveys failed to detect any evidence of it breeding there during the survey period.	Yes
Regent Honeyeater *Xanthomyza phrygia*	E	E	This migrant to the region forages in winter-flowering trees such as Spotted Gum, Woollybutt, and Swamp Mahogany. Winter-flowering trees such as Grey Ironbark occur within the study area but they are not abundant. The species may forage was not recorded in the study area and the foraging resources there are insignificant relative to those available elsewhere in the locality and Shoalhaven local government area.	No

THREATENED FAUNA SPECIES	STATUS		POTENTIAL TO OCCUR IN THE STUDY AREA AND IMPORTANCE OF HABITATS TO BE AFFECTED BY THE PROPOSAL	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
	TBC Act	EPBC Act		
Sooty Owl *Tyto tenebricosa*	V	-	This species is generally associated with closed forests and tall wet open forests. The study area provides marginal roosting and nesting habitat for this species, and relatively low quality foraging habitat. The species was not detected within the study area during the survey period despite the use of targeted call playback and spotlighting surveys and no roosting sites were observed. It is unlikely that the species would occur within the study area regularly nor be dependent upon the habitats there.	No
Square-tailed Kite *Lophoictinia isura*	V	-	This summer migrant to the Shoalhaven hunts for passerines in coastal open forests and breeds in mature trees near waterways. This species was observed flying over the study area and foraging in the more disturbed and open habitats to the north and northeast during the survey period. The species may hunt for prey in the study area from time to time but the vegetation would form a very small amount of the species large foraging range. There is no high quality nesting habitat for the species as there are only a few large, mature trees. None of these trees are adjacent to substantial waterways and no evidence of raptor nests was observed. The species may forage in the study area from time to time, however it is unlikely to rely on the habitats there for foraging or nesting.	Yes
Amphibians				
Green and Golden Bell Frog *Litoria aurea*	E	V	This species prefers permanent, unshaded water bodies containing emergent vegetation such as Cumbungi. Such habitats do not occur in the study area.	No

Note: Habitat requirements for fauna species in Table 7 have been sourced from Blakers *et al*. (1984), Churchill (1998), Clout (1989), Cogger (1996), Commonwealth DEH (1999), Daly and Murphy (1996), Ehmann (1997), McDowell (1996), NSW NPWS (1996), NSW NPWS (1998), NSW NPWS (2000), NSW NPWS www.npws.nsw.gov.au (accessed 2005), and Strahan (1995).

The Greater Broad-nosed Bat, Gang-gang Cockatoo, Square-tailed Kite and Powerful Owl were recorded in the study area during the survey period. The effects of the proposal on these threatened fauna species will be assessed in subsequent sections of this report.

4.3 Migratory Species

The outcome of the database search for migratory species is shown in Table 8 below. The potential for each of these species to occur in the study area is discussed in Table 8 and a decision made regarding the need or otherwise for further assessment in this report. Species encountered in marine and wetland environments have been omitted as these habitats do not occur in the study area.

Table 8: Migratory species recorded or likely to occur in the locality

SPECIES	OCCURRENCE OR POTENTIAL FOR MIGRATORY SPECIES TO OCCUR IN THE STUDY AREA	FURTHER ASSESSMENT REQUIRED IN THIS REPORT
Black-faced Monarch *Monarcha melanopsis*	This migratory species is known to breed in damp forest types and forage in rainforest and eucalypt forest. The species was detected breeding in the moist vegetation in the north-eastern parts of the study area during the survey period.	Yes
Regent Honeyeater *Xanthomyza phrygia*	This migrant to the region forages in winter-flowering trees such as Spotted Gum, Woollybutt, and Swamp Mahogany. Individuals of winter-flowering trees such as Grey Ironbark occur within the study area but they are not abundant. It is possible that the species may forage in the study area from time to time, however the foraging resources within the study area are insignificant relative to those available elsewhere in the locality and Shoalhaven local government area.	No
Rufous Fantail *Rhipidura rufifrons*	This migratory species is known to utilise dense understorey in damp forests or beside rivers. Suitable habitat occurs within the moist vegetation in the north-eastern and central parts of the study area. The species was detected in the north-east during the survey period.	Yes
Satin Flycatcher *Myiagra cyanoleuca*	This species inhabits lowland eucalypt forests. It is known to nest in dense gully vegetation. Suitable habitat is present within the study area but the species was not detected during the survey period.	No
White-bellied Sea-eagle *Haliaeetus leucogaster*	This migratory species inhabits coastal environments such as islands, reefs, headlands, beaches, bays, estuaries, mangroves, inland swamps, lagoons, rivers and floodplains. The species is known to forage and breed in the locality however the species is unlikely to forage within the study area and there is no evidence of the species nesting there.	No
White-throated Needletail *Hirundapus caudacutus*	This migratory species is associated with hillsides and is thought to spend all of its time in the air whilst in Australia. The study area is not on a prominent hillside so the species is unlikely to occur there. It was not detected during the survey period.	No

The Black-faced Monarch and Rufous Fantail were recorded in the study area during the survey period in the locations shown in Figure 6 (Appendix A). The impacts of the proposal on these species will be assessed in a subsequent section of this report.

4.4 Endangered Populations

The *TSC Act* provides for the listing of endangered populations on Schedule 1, Part 2. There are no endangered populations listed on the schedules of the *TSC Act* found in the Shoalhaven local government area.

4.5 Threatened Ecological Communities

The *TSC Act* and *EPBC Act* provide for the listing of threatened ecological communities. None of the threatened ecological communities listed by the EPBC Act occur in the study area. Two communities in the study area, Bangalay Paperbark Woodland and Bangalay Moist Woodland/Open-forest appear to have affinities with endangered ecological communities listed by the *TSC Act*. The characteristics of these communities are discussed below in the context of the Final Determinations of the NSW Scientific Committee for endangered ecological communities.

The Bangalay Paperbark Woodland identified in this report shows floristic and structural affinities with the endangered ecological community *Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (NSW Scientific Committee 2005), hereafter referred to as *Swamp sclerophyll forest*.

Fieldwork in this community recorded 25 of the 59 (approximately 42%) characteristic species identified in the final determination for the community (NSW Scientific Committee 2004b) in the study area. The Bangalay Paperbark Woodland resembles the structural and floristic description of the *Swamp sclerophyll forest* (NSW Scientific Committee 2004b) as;

- it has a canopy dominated by Bangalay;
- it has a sub-canopy of small trees including Snow in Summer a bipinnate Acacia, Parramatta Green Wattle, and rainforest elements such as Black Wattle and Mutton Wood;
- it includes shrubs such as Yellow Tea-tree and Swamp Paperbark;
- it includes the vines Common Silkpod and Jasmine Morinda; and
- it as a groundcover and understorey dominated by sedges, ferns, forbs and grasses such as Tall Saw-sedge, Common Bracken, False Bracken, Spiny-headed Mat-rush, Blue Flax Lily, Native Violet, Bordered Panic and Blady Grass.

The Bangalay Paperbark Woodland within the study area occurs along a drainage line that is associated with the floodplain of a small coastal lagoon and occurs primarily below 20 m elevation. Given the characteristics of the Bangalay Paperbark Woodland within the study area it is considered to be representative of the *Swamp sclerophyll forest* and its location is shown in Figure 6 (Appendix A).

The study area also supports a small area within the Bangalay Moist Woodland/Open-forest where there is a low closed sub-canopy (to 6 m high) of Lilly Pilly over an area of approximately 0.15 ha. This small area of closed sub-canopy is unique within the study area in that whilst elsewhere within this community there is often a patchy sub-canopy including the hardier

species associated with littoral rainforest such as Lilly Pilly, Mock Olive and Scrub Turpentine *Rhodamnia rubescens*, this is the sole location where there is a closed sub-canopy.

Whilst this community is a small occurrence of a depauperate sub-canopy rainforest or closed forest it is not considered to comprise the endangered ecological community *Littoral rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions* as:

- the closed forest is a sub-canopy below a woodland / open forest of eucalypts. It does not comprise a closed forest canopy with scattered emergent individuals of eucalypt species;
- the structure of the closed forest sub-canopy is not strongly influenced by proximity to the ocean and there is no wind pruning on the windward side of the stand.
- the occurrence is not on a headland or hind dunes;
- the community is a small isolated closed sub-canopy of Lilly Pilly within a much more extensive community characterised by a more open sub-canopy dominated by Lilly Pilly. The work of KMA (1999), KMA (1995a) and Mills (1993) identify that forests dominated by Bangalay with sub-canopies dominated by hardier rainforest species are reasonably widespread in the Shoalhaven, whilst littoral rainforests are very restricted in distribution south of Jervis Bay and occur primarily on headlands and sands;
- the community does not occur in a part of the landscape where it would naturally have been afforded protection from fire. The protection from fire in recent times has likely been the result of anthropogenic factors such as the location of prescribed burns in adjacent areas.
- the community is not particularly species diverse, containing only 19 of the 78 species listed in the final determination for Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions (NSW Scientific Community 2004a);
- The community does not include Cheese Tree *Glochidion ferdinandi* or Guioa *Guioa semiglauca* of the Simple Littoral Rainforest of Mills (1998);
- The community would represent a depauperate example of the Coastal Lowland Sub Tropical / Littoral Rainforest of Thomas *et al.* (2000), as it contains only nine of the 28 positive diagnostic species and does not include the co-dominant canopy species Brittlewood *Claoxylon australe*, Giant Stinging Tree *Dendrocnide excelsa*, or Sandpaper Fig *Ficus coronata*; and
- The community does not contain the Figs *Ficus* spp. or Kurrajong *Brachychiton populneus* characteristic of the Bunga Head Rainforest of Keith and Bedward (1999).

4.6 Flora Species of Regional Conservation Significance

The study area includes a number of plant species of local or regional conservation significance after Mills (1993), KMA (1993, 1995 a & b), and PlantNET (accessed February 2005). These species include:

Christmas Orchid *Calanthe triplicata* – The occurrence of between two and four individuals of this species within the Bangalay-Paperbark Woodland in the study area is an extension of the southern limit of the species known range (P. Hind, pers. comm., 2005) which is currently described as the Illawarra (PlantNET accessed February 2005). However anecdotal evidence suggests the species occurs as far south as Lemon Tree Creek south of Lake Tabourie (A. Findlay pers. comm., 2004).

Willow-leaved Hakea *Hakea salicifolia* – This species is near the southern limit of its known range within the study area. The southern limit is thought to be at Narrawallee (KMA 1995a).

Hard-leaved Scribbly Gum *Eucalyptus sclerophylla* - The species is near its southern known limit within the study area which is listed as Jervis Bay (Mills 1993, PlantNET accessed February 2005). However the species has also been recorded in the Mollymook – Ulladulla area (KMA 1995a) and occurs at least as far south as Burrill Lake (D. Young pers. comm., 2005).

5. EVALUATION OF IMPACTS

5.1 Impacts on Flora

5.1.1 Vegetation Community Impacts

The full development of the proposal will eventually involve the removal or modification of up to approximately 18.22 ha of relatively undisturbed vegetation comprising approximately 12.90 ha of Northern Coastal Sands Shrub/Fern Forest and 5.32 ha of Bangalay Moist Woodland/Open-forest.

Vegetation communities in the Shoalhaven LGA have been mapped and their extent calculated (KMA 1999). KMA (1999) indicates that Blackbutt Tall Forest and Blackbutt – Bloodwood Forest, which most closely resemble the Northern Coastal Sands Shrub/Fern Forest are well-represented in lands managed for conservation purposes with approximately 63% and 50% of the estimated 15220 ha and 5845 ha of the communities respectively within the Shoalhaven occurring in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes. Thomas *et al*. (2000) estimate that 13245 ha or approximately 78% of the original extent of the Northern Coastal Sands Shrub/Fern Forest community within the southern tablelands and south coast region is still extant and that 2920 ha or approximately 22% of the extant community is in conservation reserves. The impacts of the proposal on this community are acceptable in this context.

The Bangalay Moist Woodland/Open Forest within the study area appears to be intermediate between the Bangalay Forest and the Bangalay – Rainforest of Mills (1998) with continued protection from fire driving the succession towards the Bangalay – Rainforest. Communities dominated by Bangalay with an understorey dominated by rainforest species Bangalay – Rainforest whilst relatively limited in extent [a total area mapped in the Shoalhaven of approximately 106 ha (KMA 1999)], appear well conserved with an estimated 97% of the community within the Shoalhaven occurring in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes. Bangalay Forest where the understorey is not dominated by rainforest elements as a result of more frequent fires is more common in the Shoalhaven and well conserved with an estimated 85% of the 1968 ha of the community occurring in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes.

The 5.32 ha of Bangalay Moist Woodland/Open Forest within the study area equates to approximately 5 % of the estimated 106 ha of Bangalay – Rainforest and 0.28 % of the estimated 1968 ha of Bangalay Forest within the Shoalhaven according to the mapping of KMA (1999). However the Bangalay Moist Woodland/Open Forest within the study area was not mapped as a Bangalay dominated community by KMA (1999) and similar vegetation in the locality is mapped by KMA (1999) as Bangalay Forest, which would suggest that the extent of

these communities within the Shoalhaven LGA is greater than that mapped and that the impact of the proposal on these vegetation communities may be over-estimated.

In the context of the extent of Bangalay dominated communities within the Shoalhaven, the high proportion of these communities conserved in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes, and the likely underestimation of the extent of the Bangalay – Rainforest of Mills (1998) within the locality and potentially within the Shoalhaven as a whole, the impacts of the proposal on the Bangalay Moist Woodland/Open Forest within the study area are considered acceptable.

Communities dominated by Bangalay with a sub-canopy of *Melaleuca* spp., and species associated with poorly drained areas do not appear to be common or well reserved within the Shoalhaven. Neither KMA (1999) nor Thomas *et al.* (2000) describe such a vegetation community. However forests or woodlands with emergent eucalypts [*i.e*. Swamp Mahogany or Woollybutt *E. longifolia*] and a paperbark sub-canopy, occupy approximately 1565 ha in the Shoalhaven with 58% of such communities occurring in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes (KMA 1999). The Northern Coastal Lowlands Swamp Forest of Thomas *et al.* (2000) is estimated to currently occupy 459 ha or approximately 98.7% of the original extent of the community within the southern tablelands and south coast region with approximately 14 % of the extant community in conservation reserves.

It is likely that communities where a paperbark sub-canopy is present below a canopy of emergent eucalypts are more widespread and well reserved within the Shoalhaven than suggested by KMA (1999). Many occurrences are likely to be restricted to narrow bands along drainage lines or around the fringes of water bodies and to have gone unmapped. As such, communities dominated by Bangalay with a sub-canopy of paperbarks are also likely to be more widespread than suggested by KMA (1999), and this is supported by anecdotal evidence (author's personal observation).

However, in the context of the limited known extent of communities where a paperbark sub-canopy exists below an emergent eucalypt dominated canopy within the Shoalhaven, the estimated large reduction in extent of these communities since European settlement, and their subsequent classification as an endangered ecological community, the removal or modification of 0.92 ha of Bangalay Paperbark Woodland within the study area is considered unacceptable. As such the proposal includes the retention of the Bangalay Paperbark Woodland within the study area with a 10 m vegetated buffer to the community.

In summary, the proposal will not impose significant impacts on vegetation of high conservation value in the study area. The vegetation of conservation significance, Bangalay Paperbark Woodland, will be retained, provided with a vegetated buffer and dedicated to Shoalhaven City

Council. Strategies to mitigate the impacts on vegetation in the study area are discussed in a subsequent section of this report.

5.1.2 Threatened Flora Species Impacts

The proposal will not impact on threatened flora species. No threatened flora species were recorded in the study area during the survey period despite intensive survey coverage and they are not expected to occur there. However, the study area lies near a population of the Leafless Tongue-orchid *Cryptostylis hunteriana.*

Leafless Tongue-orchid *Cryptostylis hunteriana*

With respect to the Leafless Tongue-orchid *Cryptostylis hunteriana*, the species is known from a small population approximately 1150 m to the north of the study area. The population to the north of the study area occurs in dry sclerophyll woodland / open-forest on clay with a heathy understorey.

Approximately 16.5 hours of targeted survey for the species was conducted within the study area during the survey period. Targeted surveys were timed to coincide with confirmation of flowering in the known population to the north of the study area. In addition to targeted surveys approximately 9.5 hours of random meander and quadrat flora surveys were also undertake throughout the study area during the species flowering period. Despite these surveys the species was not detected within the study area.

Targeted surveys for the species focused on those parts of the study area that provided potentially better quality habitat for the species such as those areas where the understorey includes a greater abundance of heathy species. However, targeted surveys were also undertaken in other parts of the study area that appeared less suitable as the species habitat requirements are not known precisely. Large numbers of other orchids in the genus (*C. subulata* and *C. erecta*) were detected within the study area. Where flowering stems were detected that were without leaves, and flowers were still in bud, these stems were marked and subsequently checked when the flowers had opened.

Given the survey effort for the species in the study area, it is considered reasonable to expect that the species would have been detected if it occurred there, even though the number of flowering stems at the nearby known population of the species appeared to be in lower abundance during the 2004/5 flowering season than in 2003/4.

It is considered very unlikely that the species occurs within the study area hence the proposal will not have any impacts on *Cryptostylis hunteriana*.

5.1.3 Regionally Significant Flora Species Impacts

The impact of the proposal on regionally significant flora will generally be relatively minor. Neither Hard-leaved Scribbly Gum nor Willow-leaved Hakea are abundant within the study area.

Hard-leaved Scribbly Gum is reasonably abundant elsewhere locally within Conjola National Park (KMA 1995b). Willow-leaved Hakea occurs on private property immediately to the north of the study area, in Conjola National Park (KMA 1995b), and at Narrawallee (KMA 1995a), and is likely to occur elsewhere in the locality.

The impact of the proposal on the Christmas Orchid will generally be relatively minor as the individuals of the species within the study area and their habitat within the remnant vegetation along Drainage A will be retained in a drainage reserve. Notwithstanding the potential to protect the species within the proposal, the impacts of the proposal are unlikely to be substantial given the likelihood that the species occurs elsewhere in the locality, or further south, in similar habitats.

In summary, the proposal will not impose significant impacts on any flora species of high conservation value in the study area. Flora species of regional conservation significance will be retained, provided with a vegetated buffer and dedicated to Shoalhaven City Council. Strategies to mitigate the impacts on vegetation in the study area are discussed in a subsequent section of this report.

5.2 Impacts on Fauna

5.2.1 Fauna Habitat Impacts

The fauna habitats to be removed or modified for the proposal consist of a variety of foraging resources and potential roosting, denning, breeding or sheltering sites throughout the study area. These include approximately 36 hollow bearing trees that provide potential roosting and denning habitat for a range of common fauna species. Tree hollow roost or nest sites suitable for threatened owls, cockatoos, gliders and microchiropteran bats are very limited in the study area and represent relatively low quality resources for these species. Targeted surveys during the known breeding seasons of the Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite did not record breeding by any of these species in the study area. None of the hollow-bearing trees were inhabited by threatened hollow-dependent fauna during the survey period. Other shelter includes limited and relatively low quality diurnal roosting resources for the Powerful Owl, and patchy groundcover containing a reasonable abundance of fallen logs, some of which contain hollows.

The foraging habitat to be removed includes approximately 18.22 ha of open forests and woodlands containing a reasonable abundance of blossom, sap and nectar resources, Black She-oak cones and fleshy fruits. The habitats within the study area also support a moderate abundance of fauna that provide potential prey for threatened species such as the Powerful Owl and Square-tailed Kite. The vegetation within the study area, and in particular flowering eucalypts, are also likely to attract an abundance of insect prey for microchiropteran bats and may also attract foraging Grey-headed Flying–foxes from time to time.

Notwithstanding the presence of a reasonably diverse array and abundance of fauna habitats within the study area, the fauna habitats to be removed or modified by the proposal are not important in the context of the extent of similar habitats available elsewhere, both adjacent to the study area and in the locality. Lands nearby to the west of the study area appear to be less disturbed and support a greater abundance of old-growth elements consequently providing superior and more abundant fauna habitats than those observed within the study area.

BES inspected Crown land adjacent to the western boundary of the study area and confirmed that the Crown land has significant scenic and habitat values (Appendix D). The Crown land contains tall, old growth trees with a range of hollows and these trees could provide breeding resources for hollow-dependent fauna species. There is dry forest with a relatively open understorey on the mid-slopes and crests and damp forest with a dense understorey at lower elevations. The southern part of the Crown land exhibits high integrity and structural complexity and contains some very tall, old Blackbutt trees. Habitat complexity is high with micro-habitats such as rock outcrops, gullies, ephemeral drainage lines, trees with hollows, dry forests, moist forests and extensive leaf litter evident in places.

In summary, the proposal will not impose significant impacts on fauna habitats, given the context of the study area, the conservation value of the habitats found there and the presence of similar habitats of superior quality on adjacent and nearby lands with high conservation value. Strategies to mitigate the impacts on fauna habitats in the study area are discussed in a subsequent section of this report.

5.5 Threatened Fauna Species Impacts

The Greater Broad-nosed Bat, Gang-gang Cockatoo, Square-tailed Kite and Powerful Owl were recorded in the study area during the survey period.

Greater Broad-nosed Bat *Scoteanax rueppellii*

The study area provides foraging resources for the Greater Broad-nosed Bat and there are at least 40 trees with hollows within the study area that could provide roosting habitat for this species. ANABAT surveys during the survey period resulted in the detection of the Greater Broad-nosed Bat foraging in the study area. Approximately 13 person-hours of stag watching surveys coupled with ANABAT recording failed to detect the species utilising any of the potential maternity roosting habitat within the study area.

The proposal involves the modification of up to 18.22 ha of potential foraging habitat which is a small proportion of the expected home range of this species and the extensive area of similar habitats available to this species elsewhere in the Manyana area.

There was no evidence of utilisation of the potential maternity roosting habitat within the study area during the survey period despite 13 person-hours of stag watching surveys over three

separate nights. The loss of this resource within the study area will not constitute a significant impact in the context of the abundance of similar potential habitat available to these species elsewhere in the locality. At least four trees with hollows will be retained within the Bangalay-Paperbark Woodland in the study area.

The proposal will not disrupt habitat connectivity for this species as the proposed vegetation modification will be located predominantly at the interface with existing residential development and the species is a highly mobile species capable of flying.

Gang-gang Cockatoo *Callocephalon fimbriatum*

The study area provides foraging resources and potential nesting resources for the species. The species was recorded from its characteristic calls adjacent to the study area on one occasion.

Targeted surveying throughout the nesting period of this species did not detect the presence of nests in the study area or the immediate surrounds, hence the study area does not appear to be utilised by the species for breeding.

The proposal will remove a very small area of foraging habitat for the species relative to its home range but this will not sever habitat connections for the species as it is capable of flying. About 36 trees with hollows will be removed, but the species was not recorded breeding in any of these hollows despite targeted nesting assessment during the breeding season. Four trees with hollows will be retained within the Bangalay Paperbark Woodland.

The proposal is unlikely to disrupt the life cycle of the Gang-gang Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

Powerful Owl *Ninox strenua*

A single Powerful Owl was detected just after dusk on two occasions flying from the central to the outer margins of the study area. The study area includes an approximately 5 ha sized area in the western parts that is interspersed with moderate quality roosting habitat and associated with one stag that provides relatively low quality potential breeding habitat for the species. However, no evidence of the species breeding within the study area was observed despite targeted surveys during the survey period. No calls were heard from the species, nor did it respond to call playback surveys, which suggests that the individual observed within the study area may not be a territory-holding bird.

The proposal involves the modification of a relatively small amount of lower quality foraging habitat for the species relative to its large home range and the extent of better quality habitat available elsewhere in the locality. The study area appears to support a relatively low abundance of prey species for the Powerful Owl which is probably the result of the relatively low abundance of tree hollows. Prey species such as the Greater Glider are relatively abundant in suitable habitats elsewhere in the locality.

Targeted surveys during the survey period suggest that the potential roosting and breeding habitat within the study area is not particularly important for this species. Whilst a Powerful Owl was observed in the study area just after dusk on two occasions, the species was not heard calling and did not respond to call playback suggesting that the individual was not a territory holding bird. Neither the roosting nor potential breeding habitat for the Powerful Owl within the study area appeared to be of particularly good quality relative to that available elsewhere in the locality.

The removal of vegetation from the study area will not sever habitat connections for this species as it is a highly mobile species capable of flying and the study area is located at the interface of bushland and residential areas.

Square-tailed Kite *Lophoictinia isura*

The Square-tailed Kite is a summer breeding migrant to the Shoalhaven where it prefers coastal and sub-coastal forests, especially on fertile soils with an abundance of small birds, reptiles and foliage insects. The species was observed flying over the study area and foraging in the more disturbed and open habitats to the north and northeast of the study area during the survey period. No nests were observed during the survey period.

The small area of foraging habitat to be modified by the proposal is insignificant in terms of the size of the foraging range of the species.

There is no high quality nesting habitat for the species within the study area as there are only a few large, mature trees. None of these trees are adjacent to substantial waterways and no evidence of raptor nests was observed during the survey period.

The removal of vegetation from the study area will not sever habitat connections for the species as it is highly mobile and capable of flying, and the study area is located at the interface of bushland and residential areas.

Summary

The impacts of the proposal on threatened fauna species are highly unlikely to be significant. The proposal will impact only a small area of foraging resources. No known breeding habitat will be impacted. The impacts will not affect areas of high conservation value and will be highly unlikely to disrupt the long-term viability of any local population of the Greater Broad-nosed Bat, Gang-gang Cockatoo, Square-tailed Kite and Powerful Owl. The proposal will remove trees with hollows that provide potential breeding habitat for these species, but these habitats were not utilised by these species during the survey period, are not restricted to the study area and occur abundantly on nearby lands of higher conservation value.

5.3 Impacts on Endangered Ecological Communities

The study area supports approximately 0.92 ha of partly disturbed Bangalay Paperbark Woodland, a form of the endangered ecological community *Swamp sclerophyll forest* listed on

the *TSC Act*. The community occurs within the broad drainage line that drains the central and western parts of the study area flowing to the central parts of the southern study area boundary. This drainage line is referred to within this report as Drainage A.

The remnant is in reasonably good condition with little evidence of invasion by weed species or other evidence of anthropogenic disturbance, except along its southern edge. It is reasonably diverse with at least 25 of the 59 (approximately 42%) characteristic species identified in the final determination for the community (NSW Scientific Committee 2004b) recorded there.

The Bangalay Paperbark Woodland within the study area occurs along a drainage line that is associated with the floodplain of a small coastal lagoon and occurs primarily below 20 m elevation. This remnant is not contiguous with other areas of *Swamp sclerophyll forest* or other endangered ecological communities. Beyond the southern property boundary the community abuts cleared land associated with the existing Manyana residential area which includes a road, tennis court, community hall and playing field. Other endangered ecological communities listed on the *TSC Act*, such as the *Swamp oak floodplain forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (hereafter referred to as *Swamp oak floodplain forest*), are likely to occur in the lower catchment of the coastal lagoon behind Manyana Beach. However these areas are separated from the *Swamp sclerophyll forest* in the study area by over 400 m of clearing and urban development.

According to the NSW Scientific Committee Final Determination (NSW Scientific Committee 2004a) there was considered to be less than 1000 ha of remnant *Swamp sclerophyll forest* in the Sydney/South Coast region in the 1990s. The final determination suggests that the *Swamp sclerophyll forest* includes the Northern Coastal Lowlands Swamp Forest of Thomas *et al.* (2000), which is estimated to currently occupy 459 ha or approximately 98.7% of the original extent of the community within the southern tablelands and south coast region, with approximately 14 % of the extant community in conservation reserves. The Northern Coastal Lowlands Swamp Forest is described as being characterised by a canopy of Swamp Mahogany and does not mention Bangalay specifically as a canopy species. Mills (1998) also does not describe a community dominated by Bangalay with a sub-canopy of *Melaleuca* spp. within the Shoalhaven. However, Mills (1998) describes forests dominated by Paperbarks, or woodlands or forests with emergent eucalypts [*i.e*. Swamp Mahogany or Woollybutt *E. longifolia*] and a paperbark sub-canopy, and estimates that they occupy approximately 1716 ha in the Shoalhaven with 41% and 58% respectively occurring in National Parks estate, protective zonings, or lands managed by the Commonwealth for conservation purposes (KMA 1999).

As discussed above, the mapping of KMA (1999) does not include communities dominated by Bangalay with a sub-canopy of *Melaleuca* spp. Evidence suggests that such communities do occur elsewhere in the locality (Appendix D, Young 2003, Young 2006) and are also likely to comprise *Swamp sclerophyll forest*. This would suggest that the distribution of the extant area of *Swamp sclerophyll forest* in the region as stated by the NSW Scientific Committee (2004a) may

have been substantially underestimated. Much larger occurrences of *Swamp sclerophyll forest* occur elsewhere in the Shoalhaven particularly in the Jervis Bay area in association with Currambene Creek, Black Swamp, Moona Moona Creek, Carama Creek and Coonemia Creek which is the largest tributary of Lake Wollumboola. Some of these occurrences include contiguous areas of more than 250 ha (KMA 1999).

In this context, the 0.92 ha of *Swamp sclerophyll forest* within the study area is a small occurrence of the community with limited importance at a regional level.

The mapping of KMA (1999) suggests that *Swamp sclerophyll forest* within the locality is limited to occurrences associated with Pattimores Lagoon and Narrawallee Inlet, although anecdotal evidence suggests that the community is also likely to occur in association with the small coastal lagoons behind Washerwomans Beach, Monument Beach, Inyadda Beach and in association with Berringer Lake and Lake Conjola. KMA (1999) maps approximately 20 ha of Swamp Mahogany Paperbark Forest (ROB-MEL) in association with Narrawallee Inlet and approximately 13 ha in association with Pattimores Lagoon. BES recorded additional areas of *Swamp sclerophyll forest* on the shores of Berringer Lake and Lake Conjola to the west and south-west of the study area (Appendix C), and on sites west of Narrawallee Inlet (Smithers 2006), but the sizes of these occurrences have not been calculated.

In this context the 0.92 ha of *Swamp sclerophyll forest* within the study area is a small but important occurrence of the community at a local level.

The *Swamp sclerophyll forest* within the study area does not retain connectivity with other endangered ecological communities. Beyond the southern property boundary the community abuts cleared land associated with the existing Manyana residential area which includes a road, tennis court, community hall and playing field.

Connectivity with other vegetation in general will be affected in as much as the proposal will result in disturbance to or removal of the majority of the Northern Coastal Sands Shrub/Fern Forest within the study area, which abuts the *Swamp sclerophyll forest* in all directions except to the south. The impacts of this disruption to connectivity will be mitigated by the retention of a 10 m vegetated buffer around the remnant *Swamp sclerophyll forest*, and are considered to be acceptable in the context of the existing lack of connectivity to other remnant native vegetation lower in the catchment of the small coastal lagoon behind Manyana Beach, which has lead to a subsequent reduction in the ecological integrity and conservation value of *Swamp sclerophyll forest* within the study area.

The *Swamp sclerophyll forest* within the study area provides foraging resources for a range of non-threatened fauna in the canopy, mid-canopy and shrub strata, and nesting, breeding or roosting habitat in the four hollow-bearing trees that occur there. These resources will be retained within the proposal, although connectivity to these resources will be disrupted,

particularly for less mobile fauna that are not capable of flying. This impact is considered acceptable in the context of the extensive areas of similar resources available elsewhere, both adjacent to the study area and in the locality.

The proposal will not modify or remove any of *Swamp sclerophyll forest*. The community will be retained within the proposal along with a vegetated buffer that will appropriately minimise the potential for any adverse indirect impacts. The proposal may have indirect impacts on the community, mainly arising from edge effects, and changes in hydrology, however appropriate management practices, including the provision of a vegetated buffer and water sensitive urban design principles, have been incorporated into the proposal to control such effects. Other management practices to be implemented include appropriate fencing, sympathetic landscaping, and weed control as well as the preparation of a vegetation management plan for the long-term management of the community by Shoalhaven City Council.

In summary the impacts of the proposal on *Swamp sclerophyll forest* associated with the proposal are considered to be negligible at the regional/landscape and local levels.

5.4 Impacts on Endangered Populations

The proposal will not impact any endangered populations as none are listed in the Shoalhaven local government area.

5.5 Impacts on Threatened Fish

The proposal will not impact any threatened fish or marine vegetation listed by the *NSW Fisheries Management Act 1994*, as none are expected to occur there.

5.5 Impacts on Habitat Connectivity

The study area provides known habitat for the Powerful Owl, Greater Broad-nosed Bat, Gang-gang Cockatoo and Square-tailed Kite. The proposal will not isolate currently interconnecting or proximate areas of habitat for these species or any other threatened species as all disturbances associated with the proposal will occur at the interface with residential areas. An exception is the vegetation that will be retained to minimise the impacts of the proposal on *Swamp sclerophyll forest*. The *Swamp sclerophyll forest* provides a small amount of potential foraging, nesting, breeding, hibernating or roosting habitat for these species. The investigations undertaken during the survey period suggest that these resources are not important resources for these species in the context of the extensive areas of similar resources available elsewhere, both adjacent to the study area and in the locality. However these potential resources will not be isolated by the proposal as all of these species are highly mobile as they are capable of flight.

The proposal will not isolate *Swamp sclerophyll forest* within the study area from interconnecting or proximate areas of this vegetation community, as it is currently isolated from other areas of the community as a result of the impacts of the existing residential development in the locality.

BES has recorded areas of *Swamp sclerophyll forest* on the shores of Berringer Lake and Lake Conjola a few hundred metres to the west and south-west of the study area. The nearest other occurrences of the community are more than 3.3 km away at Pattimores Lagoon although anecdotal evidence suggests that some *Swamp sclerophyll forest* occurs approximately 1 km to the north-east in association with the coastal lagoon behind Inyadda Beach and a few hundred metres to the south-east behind Manyana Beach. This suggests that existing disturbances have already restricted genetic exchange and access to this community on Lot 172 for species residing within *Swamp sclerophyll forest*. Even though, the proposal will isolate *Swamp sclerophyll forest* within the study area from other areas of native vegetation, this is not considered critical to the continued survival of the community given the current isolation regime. Some genetic exchange is likely to continue to be facilitated by highly mobile fauna species that will continue to inhabit the community from time to time after the proposal has been constructed.

With respect to the habitat corridor issues raised by the DEC, the proposal will not disrupt habitat connectivity between the Crown land in the west and Conjola National Park in the north. Habitat connectivity is currently sustained by a corridor with a minimum width of approximately 400 m (Figure 7 Appendix A). The minimum width of this habitat corridor will be reduced to approximately 250 m as a result of the proposal, which retains 62% of the existing corridor width. This extent of the habitat corridor will be adequate for the provision of habitat connectivity for the Powerful Owl, Greater Broad-nosed Bat, Gang-gang Cockatoo and Square-tailed Kite and other threatened species that may inhabit the Crown land. Kelly and Barry (1986) have shown that along watercourses, a habitat corridor with a width of 80-100 m is the minimum requirement for the long-term retention of higher order consumers such as birds and mammals, which can reside in corridors with such widths. This suggests that the 250 m wide habitat corridor remaining post-development of Lot 172, will be more than adequate to connect and sustain key threatened species and flora and fauna in general.

Observations of the Crown land west of Lot 172 undertaken by BES (Appendix D) indicated that only low level disturbances arising from adjacent urban development in Manyana are present and that these were limited to the periphery of the Crown land and to the small number of existing vehicle tracks through it. The Crown land is not currently subject to conservation management plans and its conservation value has not been significantly diminished by adjacent urban uses. This suggests that urban uses arising from the proposal are also unlikely to significantly diminish the conservation value of the Crown land and hence its integrity as a habitat corridor.

The DEC indicates that the initial analysis for the development of the Regional Conservation Guidelines to precede the Regional Conservation Plan has identified the retention and enhancement of the vegetated corridor that connects Crown lands in the Manyana area to nearby Conjola National Park as a regionally important conservation outcome.

The reduction of the current corridor width from 400 m to 250 m as a result of the proposal is unlikely to significantly diminish the habitat corridor values of the remaining vegetation in the corridor and would not jeopardise the conservation outcome identified by the DEC. Despite the proposal, the remaining vegetation could still function adequately as a habitat corridor and the enhancement of the corridor would still be able to occur via active management of the Crown land to sustain its corridor and habitat values.

5.6 Impacts on Koala Habitat (SEPP No. 44)

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP No. 44) was gazetted by the NSW Government in 1995. The aims of SEPP No. 44 are:

> *"to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline."*

It requires a judgement to be made about whether the land in a study area is potential and/or core koala habitat based on the proportion of trees present that are listed as Koala Feed Tree Species in Schedule 2 of the policy and/or the presence of koalas. These listed feed trees must constitute at least 15 % of the total number of trees in the upper or lower strata of the tree component for the vegetation to be classified as *potential koala habitat*. *Core koala habitat* is land where there is a resident population of koalas including breeding females.

The policy requires the preparation of plans of management before development consent can be granted in relation to areas of *core koala habitat*, encourages the identification of areas of *core koala habitat*, and encourages the inclusion of areas of *core koala habitat* in environment protection zones.

The policy applies to this proposal because:

- the land is within the Shoalhaven Local Government Area;
- the land has an area of more than 1 ha; and
- a development application has been made for the proposal.

The study area does not contain tree species that are listed as koala feed trees on Schedule 2 of *SEPP No. 44* and thus, the study area does not contain *potential koala habitat*. There is no evidence of koalas occurring within the study area and they were not detected during surveying either through direct observation, call recognition or through characteristic scratchings or scats.

The proposal will not impact on Koala habitat and a Plan of Management for Koala habitat is not required.

5.7 Impacts on Matters of NES (Commonwealth EPBC Act 1999)

The *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) contains provisions to protect Commonwealth Land and matters of national environmental significance (NES) listed by the Act, including World Heritage properties, Ramsar wetlands, threatened species, migratory species, nuclear actions and the Commonwealth marine environment.

Under this Act a person may require assessment and/or approval from the Commonwealth Environment Minister if they are undertaking an action that has, will have, or is likely to have, a significant impact on a matter of national environmental significance.

Administrative guidelines have been produced to assist proponents in determining whether an action should be referred to the Commonwealth Environment Minister for a decision on whether approval is required.

The proposal involves the clearing and/or modification of indigenous vegetation, and construction works, which may constitute an action defined by the *EPBC Act*.

The study area provides suitable habitat for the following matters of National Environmental Significance listed on the schedules of the *EPBC Act*:

- the Vulnerable Species *Cryptostylis hunteriana*; and
- the Migratory Species Black-faced Monarch, Rufous Fantail and Satin Flycatcher.

There are no Commonwealth Endangered Species, World Heritage Properties, Wetlands of National Importance, Commonwealth Marine Areas, or Commonwealth Land to be affected by the proposal.

The Department of Environment and Heritage raised the Giant Burrowing Frog *Heleioporus australiacus* as a potential issue for the study area, but the fieldwork undertaken for this report demonstrated that the study area does not provide suitable habitat for this species and it was not recorded there during the survey period.

Commonwealth Vulnerable Species

The study area is unlikely to contain any important populations of *Cryptostylis hunteriana*; necessary for the species' long-term survival and recovery. No individuals of this species were detected there despite approximately 16.5 person-hours of targeted surveys focusing on suitable habitat when the species was known to be flowering approximately 1 km to the north.

The 18.22 ha of native vegetation to be affected by the proposal is unlikely to contain a key source population of this species. Nor would it be likely to contain any potential populations likely to be necessary for maintaining genetic diversity, or near the limit of the species' range.

Thus, with respect to Commonwealth Vulnerable Species, the proposal is unlikely to:

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

The proposal is unlikely to have a significant impact on Commonwealth Vulnerable Species listed by the *EPBC Act* that may occur in the study area.

Commonwealth Migratory Species

The Black-faced Monarch, Rufous Fantail and Satin Flycatcher are likely to utilise the mesic understorey and sub-canopy in the north-eastern parts of the study area from time to time for foraging and potentially breeding. The Black-faced Monarch and Rufous Fantail were detected within this part of the study area during the survey period and one pair of Black-faced Monarchs appeared to be breeding there. In the context of the extent of similar habitats available to these species elsewhere in the locality and region, the proposal is too small to adversely impact these species. The proposal will not substantially modify, destroy or isolate an area of important habitat, result in invasive species becoming established in such habitat, or seriously disrupt the life cycle of an ecologically significant proportion of these species' populations.

The proposal is unlikely to have a significant impact on Commonwealth Migratory Species listed by the *EPBC Act* that occur in the study area. The retention of vegetation along Drainage A will provide some potential breeding and foraging habitat for these species within the study area, albeit of lower quality than that in the north-east. As an ameliorative measure it is recommended that any clearing in the north-eastern parts of the study area be undertaken outside of the summer breeding season for these species to minimise potential impacts.

EPBC Act Conclusion

Following consideration of the administrative guidelines for determining significance for matters of national environmental significance that may occur in the study area, it is concluded that the proposal is unlikely to have a significant impact on any matter of national environmental significance, and that a referral to the Commonwealth Environment Minister is not required.

6. IMPACT MITIGATION

6.1 Threatened Species, Populations and Ecological Communities

The extent, magnitude and significance of the impacts of the proposal on threatened species, populations and ecological communities listed on the *TSC Act* and *FM Act* have been assessed in sections 4 and 5 of this report in relation to the conservation importance of the habitat, populations and individuals likely to be affected by the proposal.

The affected threatened species, populations and ecological communities were identified as the Leafless Tongue-orchid, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl, Square-tailed Kite and *Swamp sclerophyll forest*.

The Leafless Tongue-orchid was not recorded in the study area despite intensive targeted surveys during the known flowering season. The Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite were not recorded breeding in the study area despite targeted surveys during their known breeding seasons. The study area provides a very small area of foraging habitat for all of these highly mobile species.

In this context, the impacts of the proposal on the Leafless Tongue-orchid, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite were not considered significant. About 1.5 ha of habitat for these species will be retained on Lot 172 by the proposal. This area comprises some foraging resources and potential breeding resources and will be managed in accordance with a vegetation management plan.

The assessment identified that the key biodiversity conservation issue for the proposal in the study area is *Swamp sclerophyll forest* and the proposal has been designed to avoid direct impacts on this endangered ecological community and mitigate indirect effects via appropriate hydrological and vegetation management. The following impact mitigation measures will be implemented for *Swamp sclerophyll forest*:

a) Retention of all *Swamp sclerophyll forest* on the site as Public Reserve.

b) Provision of a vegetated buffer generally with a minimum width of 10 m around the community;

c) Provision of roads adjoining the vegetated buffer to the community;

d) Provision of an appropriate perimeter fence for the vegetated buffer and/or the Public Reserve in which it is located;

e) Preparation of a vegetation management plan for the community and the Public Reserve in which it is located to address issues such as protection and maintenance of the vegetation and constructed wetlands, weed control, vegetation enhancement, control of access, monitoring and fire management;

f) Dedication of the community, the buffer and the Public Reserve in which it is located to Shoalhaven City Council;

g) Design of water cycle management and water quality treatment systems for the proposal that maintain the existing hydrologic regime in the area of the *Swamp sclerophyll forest* and protect the community from adverse water quality impacts (Storm Consulting 2006).

The requirement of the DEC to retain all vegetation west of the *Swamp sclerophyll forest* for the purposes of buffering the community from disturbances is not necessary to achieve protection of the community. Appropriate hydrologic and vegetation management is a viable alternative to the retention of the vegetation proposed by the DEC. The 10 m wide vegetated buffer in concert with the perimeter roads and appropriate fencing is considered adequate for the mitigation of edge effects on the community. Observations of edge effects arising from urban development on Lot 172 and in other areas of *Swamp sclerophyll forest* in Mollymook (Young 2006) indicate that edge effects extend for only a few metres into this community.

The provision of roads along the buffer perimeter accords with the requirements of the DEC. This will provide a clear line of demarcation between the urban area and the conservation area.

The vegetation management plan (VMP) will be prepared by a suitably qualified person and funded by the applicant. The VMP will be approved by the consent authority prior to its implementation. Responsibility for implementation of the VMP will rest with Shoalhaven City Council as the land containing the community is required to be dedicated to Council.

The water cycle management and water quality treatment systems are described in detail by Storm Consulting (2006), and its report concludes that:

> *The proposed stormwater management systems mitigate the increases in runoff due to the increase in impervious area and maintain similar flow patterns into the EEC area. The average annual flow is maintained at similar level to existing and the cumulative frequency distribution of flows greater than 10L/s (frequent storm flows) is similar. Peak flows for the 1 year ARI event into the EEC area are reduced from 0.942 m3/s in the pre-development case, to 0.7 m3/s in the post-development case.*
>
> *The MUSIC modelling shows that the proposed stormwater treatment systems collect a large amount of pollutants contained in runoff from the site. Annual pollutant loads for suspended solids and phosphorous are reduced to below pre-development levels. Nitrogen loads are increased by a small amount (6.7%). Average concentrations for TSS, TP and TN are all less than pre-development levels.*

The 7% increase in Nitrogen load is unlikely to significantly alter the composition of *Swamp sclerophyll forest* on Lot 172. Increased Nitrogen has been implicated with the invasion of exotic grasses into native vegetation (Badgery et. al. 2005), but this appears to be limited to areas of disturbance. Maintaining native vegetation biomass via appropriate vegetation management should ensure that the potential invasion of such grasses stimulated by slightly higher Nitrogen levels will be effectively mitigated.

The measures identified by Storm Consulting (2006) will be implemented by the applicant during the construction phase of the proposal and they have been devised by Storm Consulting in consultation with BES to achieve the desired outcome of minimising hydrological changes in order to sustain the integrity of the retained *Swamp sclerophyll forest* on Lot 172 in the long-term.

6.2 Other Components of Biodiversity

The extent, magnitude and significance of the impacts of the proposal on other components of biodiversity have been assessed in sections 4 and 5 of this report as related to the conservation value of the habitat, populations and individuals likely to be affected by the proposal.

In this context, the impacts on vegetation communities, regionally significant flora species, fauna habitats, habitat connectivity, and matters of national environmental significance arising from the proposal are not considered significant.

The vegetation communities to be affected by the proposal are not restricted to the study area and are widespread and well–reserved in the Shoalhaven local government area and the region. No impact mitigation is required for the affected vegetation.

The regionally significant Christmas Orchid will be retained within the *Swamp sclerophyll forest* community and managed for conservation via an approved vegetation management plan. Drainage for the proposal will be designed to mimic as closely as possible the existing drainage regime for this vegetation in terms of water quality and quantity.

The fauna habitats to be affected by the proposal are not restricted to the study area. There are limited foraging substrates for fauna species and trees with hollows were inhabited by common and widespread fauna species. Superior habitats occur on adjacent and nearby lands. Some foraging resources and breeding habitats will be retained within the *Swamp sclerophyll forest* community and managed for conservation via an approved vegetation management plan.

The proposal will not impede or disrupt habitat connectivity in the Manyana area. Habitat connectivity to the north with a minimum width of 250 m will remain through adjacent lands to the west. The proposal includes the prohibition of cats from the new allotments in recognition of the habitat corridor values of the adjacent Crown land. No further impact mitigation is required for habitat connectivity.

The matters of national environmental significance to be affected by the proposal are the Black-faced Monarch and Rufous Fantail. These species were recorded in the north-east of the study area and could also utilise the *Swamp sclerophyll forest*. Although, the Black-faced Monarch was recorded breeding in the study area, the proposal is too small to seriously disrupt the life cycle of an ecologically significant proportion of this species population. Some foraging resources and breeding habitats will be retained within the *Swamp sclerophyll forest* community

and managed for conservation via an approved vegetation management plan. In addition, any clearing in the north-eastern parts of the study area will be undertaken outside of the summer breeding season for these species to minimise potential direct impacts.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This report has identified and described the biological environment of Lot 172 DP 755923 and Lot 823 DP 247285 Berringer Road and Cunjurong Point Road Manyana. The report has assessed the potential impacts on flora and fauna, including threatened and migratory species, endangered populations and threatened communities, or their habitats, of the proposal to undertake a residential subdivision on the property.

The affected threatened species, populations and ecological communities were identified as the Leafless Tongue-orchid, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl, Square-tailed Kite and *Swamp sclerophyll forest*.

The key biodiversity conservation issue associated with the proposal was identified as the endangered ecological community *Swamp sclerophyll forest on the coastal floodplains of the North Coast, Sydney Basin and South East Corner bioregions*.

It is concluded that:

a) The proposal includes actions to avoid and mitigate impacts on *Swamp sclerophyll forest* that will maintain or improve the biodiversity values of this endangered ecological community. Some of these actions also provide impact mitigation for threatened fauna species, migratory species and flora species of regional conservation significance.

b) The proposal is unlikely to reduce the long-term viability of a local population of the Leafless Tongue-orchid, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl, Square-tailed Kite or *Swamp sclerophyll forest*. The hydrologic and vegetation management practices to be implemented for the proposal along with the design of roads will provide appropriate long-term protection for the *Swamp sclerophyll forest.*

c) The proposal is unlikely to accelerate the extinction of the Leafless Tongue-orchid, Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl, Square-tailed Kite or *Swamp sclerophyll forest*. No populations of the Leafless Tongue-orchid were recorded in the study area. No evidence of breeding by the Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite was recorded in the study area. The extent of foraging resources for the Greater Broad-nosed Bat, Gang-gang Cockatoo, Powerful Owl and Square-tailed Kite to be affected by the proposal is very small relative to the home ranges of these highly mobile fauna species.

d) The proposal will not affect critical habitat as none is listed in the Shoalhaven local government area.

e) The study area does not contain any potential Koala habitat pursuant to *NSW State Environmental Planning Policy No 44 – Koala Habitat Protection*.

f) Following consideration of the administrative guidelines for determining significance under the *Commonwealth Environment Protection & Biodiversity Conservation Act 1999*, the proposal is unlikely to have a significant impact on matters of National Environmental Significance, and a referral to the Commonwealth Environment Minister is not necessary.

7.2 Recommendations to Mitigate Impacts on Biodiversity Values

The proposal will incorporate the following measures to mitigate the impacts on threatened species, populations, ecological communities, migratory species or their habitats, and minimise the impacts of the proposal on the flora and fauna values of the study area in general.

Vegetation and Habitat Management

1. *Swamp sclerophyll forest* within the study area will be retained within the proposal.

2. Generally, a buffer of undisturbed vegetation with a minimum width of 10 m will be provided to the *Swamp sclerophyll forest*.

3. The extent of *Swamp sclerophyll forest* will be marked in the field by an appropriately qualified person and the community and the buffer surveyed by a registered surveyor.

4. Trees will be retained within the proposal wherever possible.

5. Trees with hollows will be retained within the *Swamp sclerophyll forest* and its buffer and within the Public Reserve wherever possible.

6. All trees and vegetation to be retained will be appropriately protected from compaction of root systems, damage to trunks, and the build-up of soil around tree bases, by appropriate work practices during the construction phase of the proposal.

7. All vegetation to be retained will be protected from unauthorised access during the construction phase of the proposal. An induction program for workers will be developed and implemented to inform them of the limitations of the construction site. Temporary fencing will be installed along the edges of vegetation to be retained and workers will be instructed to avoid encroaching into such vegetation.

8. Trees with hollows to be felled during the construction phase, will be felled in accordance with the following procedures:

   a) Felling will be supervised by a fauna specialist appropriately licensed under the *NSW National Parks and Wildlife Act 1974*, for the purpose of rescuing displaced fauna.

   b) The fauna specialist will be suitably attired with protective clothing and have suitable equipment to undertake the work. A “green card” from an Occupational Health and

Safety Induction Training Course for Construction Work will also be held by the fauna specialist, who may also need to be suitably vaccinated (especially if there is potential for handling bats).

c) An appropriately skilled local wildlife carer must be notified at least 24 hours prior to the tree felling, that animals may be captured and that these animals may need care.

d) Any non-hollow-bearing trees around those with tree hollows to be felled will be removed first. At least one day will be left between clearing of the non-hollow-bearing trees and the hollow-bearing trees to allow fauna time to vacate the trees.

e) Prior to felling of the identified and marked hollow-bearing trees, the trees will be shaken or nudged by tree-felling equipment to encourage any fauna to vacate the trees.

f) If no animals emerge from the hollows after shaking or nudging, then the tree will be felled and lowered to the ground if possible.

g) If an animal emerges from a hollow following shaking or nudging of the tree, then at least 30 minutes will be allowed for the animal to leave the tree. If the animal comes to the ground, or when it is on the lower trunk, attempts will be made to capture the animal using a net. Captured animals will be immediately transferred to a suitably sized cotton bag and checked for obvious injury during the transfer process.

h) Captured animals will be placed in individual bags unless they are a family group to which separation would risk the survival of the young (i.e. a lactating female with young).

i) Once the tree has been felled, a search will be made of the branches around the tree for any fleeing fauna and hollows should be inspected with a torch for the presence of any animals. Attempts will be made to capture any fleeing fauna with a net, and animals inside hollows should be extracted by hand. Captured animals will be immediately transferred to a suitably sized cotton bag and checked for obvious injury during the transfer process.

j) Injured, shocked or immature captured animals will be placed in a cotton bag secured at the top. Bags will be wrapped in appropriate insulating material such as blankets and placed in a quiet, warm and preferably dark place until the wildlife carer can collect them. Details on the location of the capture and proposed release areas will be provided to the wildlife carer.

k) Uninjured animals will be released in appropriate habitat as soon as practicable (at night for nocturnal species).

9. Individuals of the Christmas Orchid *Calanthe triplicata* within the study area will be retained and protected within a vegetated corridor along Drainage A.

10. A Vegetation Management Plan (VMP) will be prepared by a suitably qualified person for the Public Reserve containing the *Swamp sclerophyll forest* and its vegetated buffer to be retained within the proposal. The VMP will address a number of matters including, but not limited to, protection and maintenance of the *Swamp sclerophyll forest*, Christmas Orchid *Calanthe triplicata* individuals, weed control, vegetation enhancement, control of access, monitoring and fire management.

11. Any clearing in the Bangalay Moist Woodland/Open Forest in the north-eastern parts of the study area will not be undertaken between the beginning of October and the end of February in any year to minimise potential impacts on breeding by the migratory species Black-faced Monarch and Rufous Fantail. If any clearing is to be undertaken during the breeding season then it will be preceded by targeted surveys for these species to assess potential impacts on breeding habitat.

12. Approximately 2.87 ha of land will be dedicated to Shoalhaven City Council as Public Reserve, in accordance with Council's contributions plan pursuant to Section 94 of the *EP&A Act*, including the 2.5 ha of Public Reserve containing the *Swamp sclerophyll forest* and its vegetated buffer.

Drainage Management

13. Drainage management within the proposal will be designed to minimise alterations to the hydrological regime of the catchment of the small coastal lagoon downstream of the study area.

14. Four constructed wetlands will be established by the proposal. Each of these will provide a high level of treatment to runoff from the proposed developed urban environment and will contain the following key features:

    a) Open water inlet area to collect sediment;

    b) Maintenance access to allow for collection of accumulated sediment;

    c) Shallow water, reed bed area to provide surface area for pollutant filtration; and

    d) Water level control at the outlet.

15. The principles of Water Sensitive Urban Design have been incorporated into the proposal and include the use of reclaimed water from the northern wastewater treatment plant of the Conjola Regional Sewerage Scheme for outdoor uses and toilet flushing, the provision of rainwater tanks for each household, the provision of infiltration devices on each lot to collect surface runoff, the construction of roadside swales to convey flows to the closest constructed wetland whilst removing pollutants, the construction of bio-retention trenches

running adjacent to the *Swamp sclerophyll forest* buffer to promote infiltration and interflow into the soil profile and maintain moisture for the vegetation, and the provision of a gross pollutant trap above the constructed wetland on the southern boundary to reduce suspended solids entering the wetland.

Sediment Controls

16. Appropriate sediment control measures will be established before the commencement of work on the proposal and retained in place until all bare areas have been revegetated.

17. An Erosion and Sediment Control Plan will be prepared in accordance with the Blue Book.

Landscaping

18. Exotic perennial grasses will not be sown in any areas that abut vegetation to be retained within the proposal. If grasses are to be used in these areas, for landscaping or soil stabilisation purposes, then indigenous native species or non-invasive exotic species will be used.

19. Native plants from the species list in Table 4 of this report will be included in any landscaping for the proposal.

20. No known environmental weeds or known invasive plant species will be planted within the study area in association with the proposal.

Domestic Pet Management

21. Any domestic pets to be kept within the sub-division will be restrained wholly within the dwelling curtilage at all times, or secured on a leash.

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